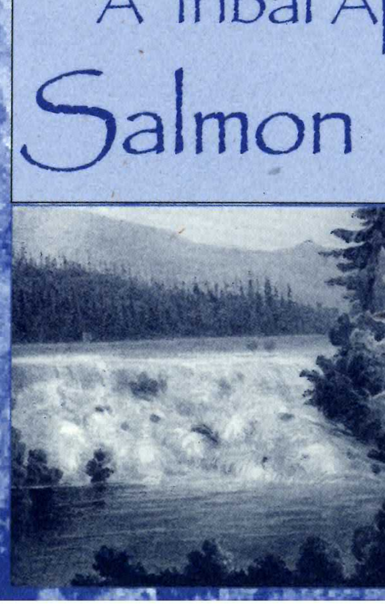
Protecting & Restoring Watersheds

A Tribal Approach to Salmon Recovery



PROTECTING & RESTORING WATERSHEDS

A Tribal Approach to Salmon Recovery

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Preface

By Wendell Hannigan

Yakama Indian Nation

Chairman Columbia River Inter-Tribal Fish Commission

Science now shows what we have known in our hearts from observation; salmon need natural rivers, flowing cold, swift, and pure, to reproduce and grow.

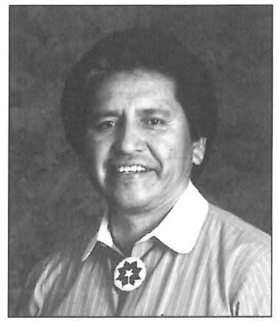
The health of both the rivers and the salmon depend on what we do on the land. We believe that by using good science, good sense, and good will in working together on common problems, we can create the conditions needed for salmon recovery.

This handbook is written for everyone whose life is touched by the Columbia River and its many landscapes: the Indians who have lived on this land for thousands of years; the natural resource managers who are working to restore watersheds in this basin; the families who have made their living working on this land for the last 150 years; and anyone else concerned with restoring and protecting watersheds.

Here you will find broad guidelines for designing restoration projects, based on *Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon,* the tribal salmon recovery plan. Other sources of detailed information and technical assistance are listed at the end.

We hope to see abundant wild salmon in the rivers again, in our lifetime and for generations to come. May this handbook contribute to making that vision a reality.

Wendell Hannigan



By Ted Strong

Executive Director

Columbia River Inter-Tribal Fish Commission

Dear Friends:

The way we live has changed our landscape. Now we must change the way we live. That doesn't mean that we can go back to the way things were. Our traditional leaders, our elders, were wise enough to know that we would have to adapt to new conditions if we were to persevere. But we are also responsible for helping to shape the path to the future.

The way things are isn't the way things have to be. Our tribes are taking an active role in leading the way to co-existence with the other creatures that help define this land as a place apart from all other places.

Our salmon restoration projects are demonstrations of that philosophy. We have found ways to keep water in streams, not by demanding an end to irrigation, but with creative uses of existing technology. The Warm Springs tribe, for instance, is using solar-powered pumps to deliver water to ponds that keep cattle away from streams. And perhaps most important, we have found ways to collaborate with our neighbors, as well as local, state, and federal agencies.

To share our approach and some of our successes, we have created a handbook which explains watershed assessment, protection, passive and active restoration, as well as our partnerships.

This handbook is one piece, but an important piece, of an overall strategy for dealing with a critically important component of salmon restoration. Our experience has shown us that when we properly restore habitat for salmon, we are really restoring habitat for many other species as well. Our handbook, and our restoration strategy then, is not an attempt to take us where we cannot go, but an attempt to keep us from losing what we can never get back.

Sincerely,

Ted Strong

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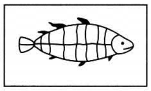

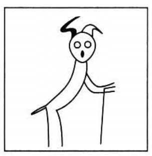

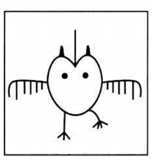

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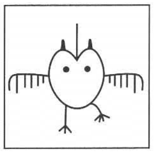

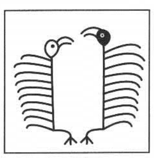

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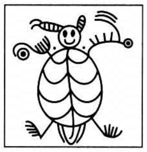
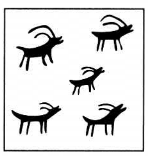
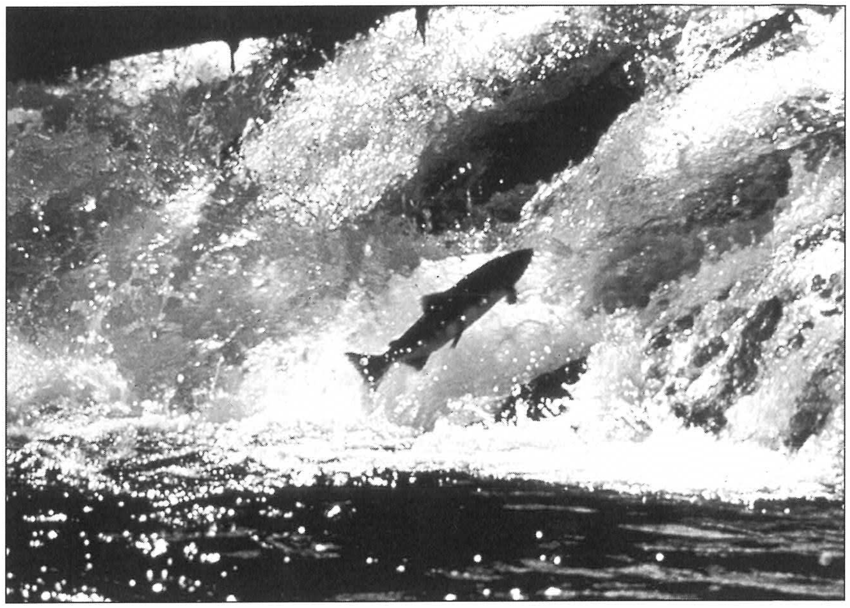




Introduction

> **"The tribes always treated water as a medicine because it nourished the life of the earth, flushing poisons out of humans, other creatures and the land. We knew that to be productive, water must be kept pure. When water is kept cold and clean, it takes care of the salmon."**
>
> ✦
>
> **Levi Holt—Nez Perce**
> **Former CRITFC Commissioner**



This handbook describes a holistic approach to watershed restoration in the Columbia Basin. It is based on *Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon*, the Columbia Basin treaty tribes' plan for salmon recovery. The fish and wildlife scientific staff of the Nez Perce, Umatilla, Warm Springs, and Yakama tribal organizations and the Columbia River Inter-Tribal Fish Commission (CRITFC) wrote *Wy-Kan-Ush-Mi Wa-Kish-Wit*, blending up-to-date science with the wisdom and history of the tribes.

> **"Rivers cannot be separated in theory or practice from the lands they drain."**
>
> ✦
>
> **Consensus of biologists and river specialists[1]**

The approach is holistic in several ways: First, by emphasizing the importance of the entire watershed to well-functioning rivers and streams. Second, by combining the science of ecology and traditional Native American understanding and respect for the natural world. And third, by including healthy human communities as part of healthy landscapes.

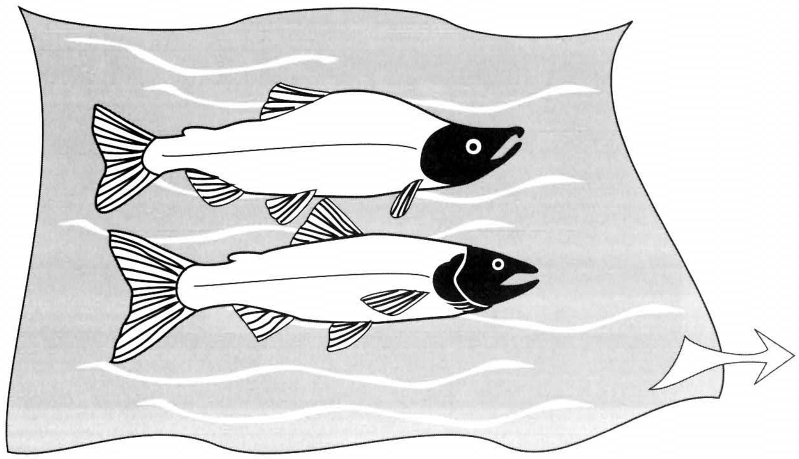
"The land is part of us." "There is a deep connection between where we live and who we are." These are themes heard frequently when tribal elders speak about watershed restoration and bringing the salmon back to the rivers of the Columbia Basin. To them, salmon restoration is not just a matter of deciding the economic, political, and scientific issues and getting to work—it's also about cultural values, spiritual practices, and ultimately about what it means to be human.

PEOPLE CREATE THEIR LANDSCAPES

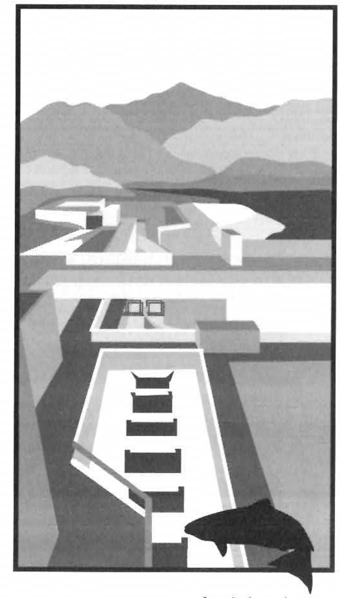
Landscapes are not just places we see, the tribal elders tell us. They contain stories, memories, gifts from the creator. Landscapes also show, without words, how humans relate to the natural world. Almost everything we do affects our landscapes.

The Columbia Basin landscapes Lewis and Clark saw were richly peopled. They were also managed by indigenous people, who took action to maintain the natural resources they relied on. Some of these actions were symbolic—returning the first salmon caught in the spring to the river so that more would follow—and some were pragmatic—setting fires to create clearings for huckleberries and other important food plants.

Wild Salmon Life Cycle

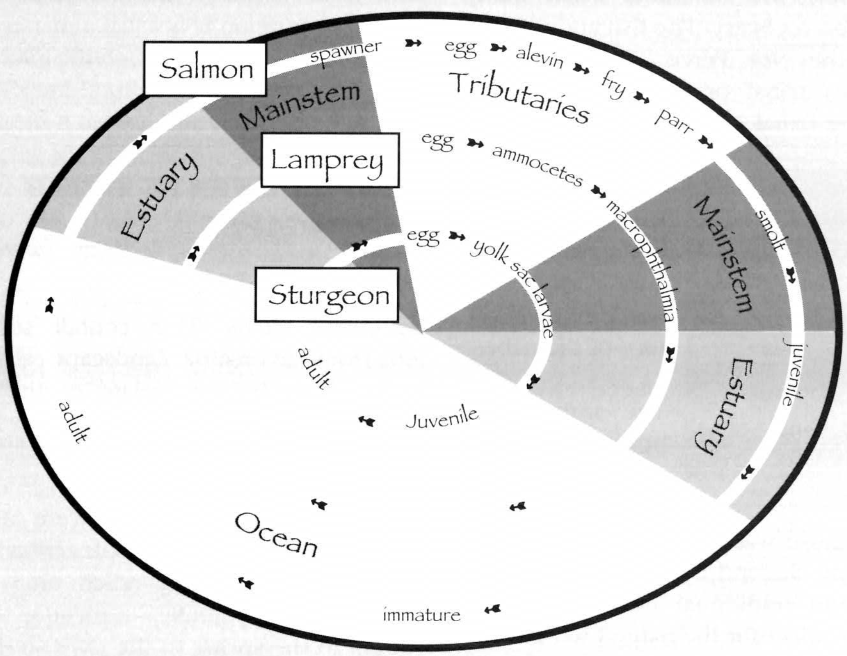


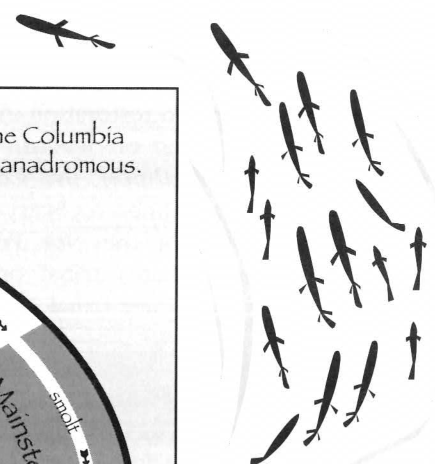
After 1 to 7 years in the ocean, the adult salmon that have survived countless hazards from predators, ocean conditions, and commercial harvest return to the Columbia River and head for their home streams.



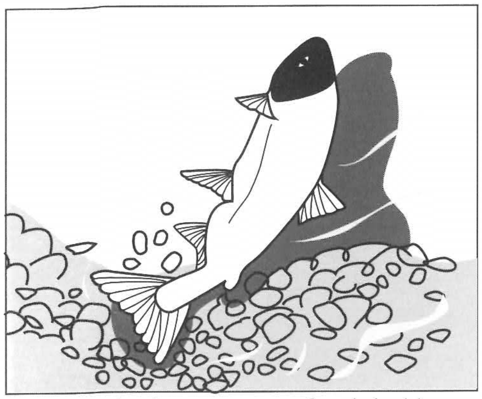
Five to 10 percent of adults die at each of the 8 or 9 dams they must pass to reach their destinations.

Life cycles of salmonids, Pacific lamprey, and white sturgeon in the Columbia River Basin. White sturgeon above Bonneville Dam are no longer anadromous.

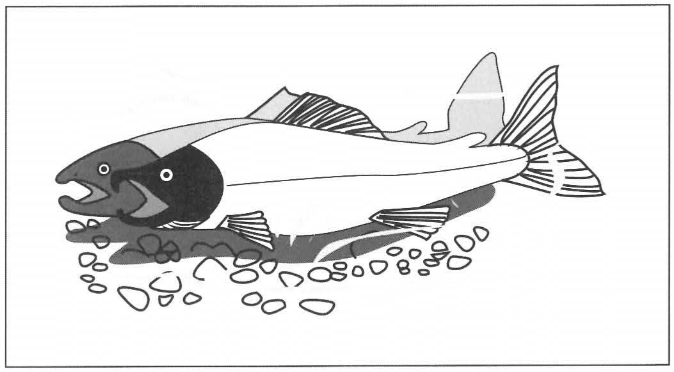




By the time they reach the estuary, the fry have become smolts, and are adapting physiologically to saltwater. Here they linger to feed and grow before entering the ocean. Predators, unfavorable conditions, and failure to adapt will deplete their numbers further.

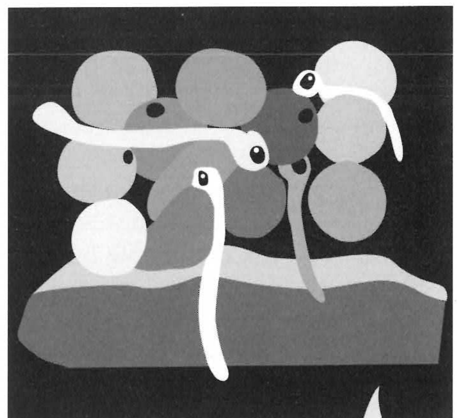


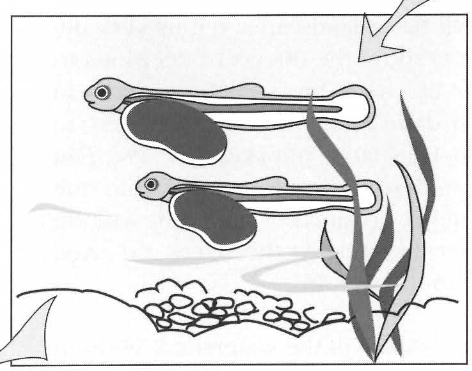
Arriving at her home stream, a female builds a nest, or redd, in fine, clean gravel.



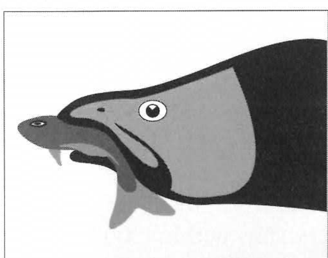
As a female deposits her thousands of eggs, a male releases milt, fertilizing them. Both male and female salmon die soon after spawning, except steelhead and cutthroat, which may survive another year or more to spawn again.

Tiny yolk-sac fry, or alevins, hatch after 2 to 8 months. They stay in the gravel for another 1 to 3 months until the nourishment from the yolk sac is used up. They need cold, pure water to aerate the gravel and wash away their wastes.

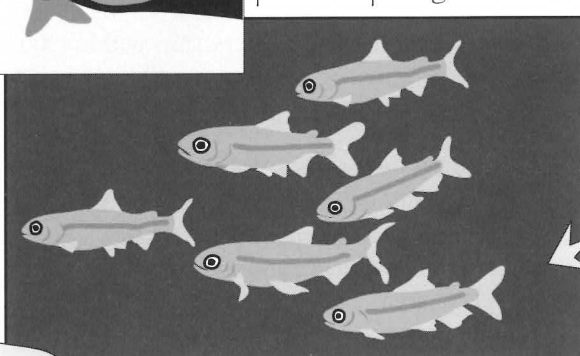




The fry emerge from the gravel and begin to feed on their own. Many are lost to predation, competition, or failure to adapt to stream conditions. Some types of salmon begin their migration downstream soon after emergence, while others stay in freshwater for a year or more.



During migration the fry are vulnerable to predators, such as birds or northern pikeminnow, walleye, and bass, which thrive in the reservoirs. Seven to 15 percent die passing each dam.



Woman picking huckleberries.

> **"Salmon was presented to me and my family through our religion as our brother. The same with the deer. And our sisters are the roots and berries. And you would treat them as such. Their life to you is just as valuable as another person would be."**
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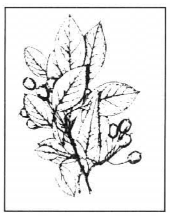
> ✦
>
> **Margaret Saluskin**
> **Yakama**



Huckleberries, cedar, willow, aspen, salmon and other fish, bear, deer, lamprey, eagle, lomatium, balsamroot—all these supported native populations in the tens of thousands in the Columbia Basin. In return, the people believed they must treat their fellow creatures and the gifts of the earth with respect. First harvest always included prayers of thanks, and parents taught their children not to waste what they hunted or gathered.

Now the Columbia Basin landscapes tell us very different stories. They show the effects of decisions to harness water for electricity; to straighten rivers to make farmland; to drain marshes and build cities; to grow livestock to feed large populations. The rain falls on human settlements and runs off into the streams in ways never dreamed of when the salmon were so numerous they turned the rivers red. And the fish must live in the runoff.

The rivers are the distillate of the watershed. Without well-functioning uplands to catch the rain, absorb it, and pass it slowly along, there cannot be healthy rivers, and, ultimately, there cannot be flourishing salmon.

SALMON—BOTH STRONG AND VULNERABLE

Pacific salmon are a genus—*Oncorhyncus*—that includes several species—chinook, sockeye, coho, chum, pink salmon, steelhead, and cutthroat trout. These species are anadromous (they spend part of their lives in freshwater and part in saltwater). Salmon life histories vary enormously, and that is part of their strength in adapting to varied conditions within a large region.

Some Northwest salmon begin their migration downstream soon after emerging from the gravel, while others stay near their natal streams up to two years. Some travel as far north as the Bering Sea, or as far south as northern Mexico. Others stay within 200 miles or so of the coast. At some point all head back toward their natal streams to spawn.

Although their ability to find their natal streams is impressive, a certain number of salmon will "stray" to spawn in nearby locations that have the right conditions. This flexibility allows salmon to recolonize previously blocked areas and contributes to their survival over millennia and changing environmental conditions.

Within the last century, however, Pacific salmon have faced challenges from human activities that exceed their strength and ability to adapt. A survey in 1991

> **"I was interested in watershed restoration because I wanted to be more efficient in managing the land and I wanted to improve my bottom line. The other part was that I love the land. And to see the progress you make out of the land, you'd have to be hard core not to get a thrill out of it."**
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> ✦
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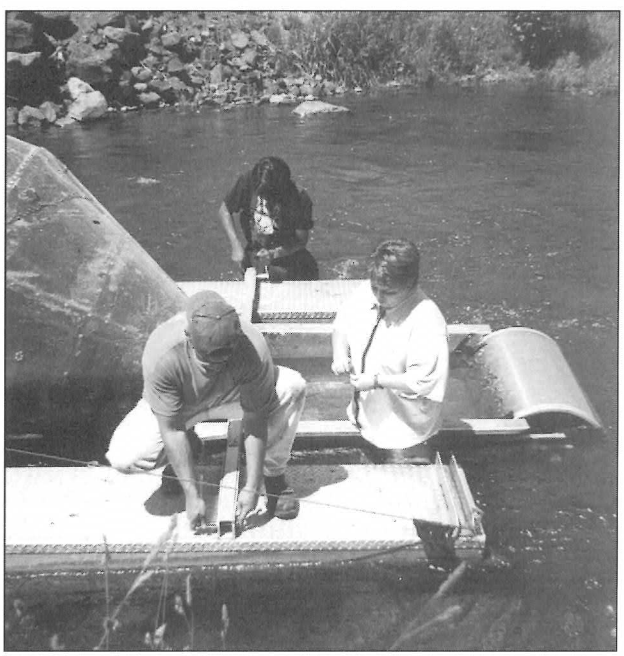
> **Dan Carver**
> **Rancher, Shaniko, Oregon.**

found that 106 stocks of Pacific coast salmon were already extinct, and 214 stocks were at risk of extinction.[2] In the Columbia Basin, many wild Snake River salmon stocks are listed under the Endangered Species Act as threatened or endangered. Upper Columbia River steelhead are listed as endangered, lower Columbia steelhead as threatened, and most other Columbia River stocks are candidates for listing.

The strength and flexibility of the salmon that return is prodigious, but dams, predators, pollutants, degraded habitat, and commercial, sport, and tribal fishers take their toll. If we don't reduce the human causes of salmon mortality, we may see the end of these species in our lifetime. Restoring freshwater habitat is a major part of the task.



Salmon Corps crew helping Warm Springs Fish and Wildlife Department set up monitoring station for juvenile salmonids.

CAN WE CREATE LANDSCAPES HEALTHY FOR ALL?

Healthy watersheds in the Columbia Basin will benefit everyone—not just salmon, but other fish and wildlife and human populations, too. On the principle of planning for the seventh generation, tribal land managers hope to create sustainable economic returns within healthy watersheds, instead of maximizing profits and leaving behind scorched earth. This goal is shared by many other landowners within the "ceded lands"—the 40 million acres ceded by the Columbia Basin treaty tribes to the United States in the Treaties of 1855.

While the Nez Perce and Confederated Umatilla, Warm Springs, and Yakama nations or tribes gave up ownership of the ceded lands, they retained permanent rights to hunting, fishing, and gathering in all the "usual and accustomed places" outside the reservations but within their traditional territories. It is strongly in their interest to help other landowners—whether they are private individuals or federal or state agencies—to maintain the health and productivity of the ceded lands. The tribes contribute technical staff time and other resources to watershed restoration within the Columbia Basin.

"Good sense, good science, good partnerships, good results"—that is the prescription for successful watershed restoration coined by Donald Sampson, a Umatilla tribal member with an education in fisheries science and manager of the watershed department of the Columbia River Inter-Tribal Fish Commission. This handbook follows that prescription, describing each component in some detail. We believe that by working together the people of the Columbia Basin can create a new landscape based on a shared vision of bounty for all—fish, wildlife, rivers, and people.

The following sections contain the basic information needed to start work in our watersheds to improve the waters and restore a bountiful and beautiful landscape.

Good Sense: Priorities For A Healthy Watershed

How do you decide where to do watershed restoration? Suppose there's a creek in your backyard; or you own 3,000 acres; or you live on a reservation; or you own a business that requires a clean water supply; or you are a manager responsible for many large watersheds. It makes good sense to start with an overview of the situation.

Start by finding out the boundaries of the watershed and its general condition. Use maps, existing information available from resource offices, or your own knowledge from living or working in the watershed. Form a preliminary idea of what you can hope to accomplish. (The next section, Good Science, provides more information about assessing the watershed and finding options for action.)

Is this a healthy watershed? A healthy stream? What fish and wildlife use it? Do salmon spawn in it? Who owns the land? Who cares about it? Who else is working on it or has studied it? How has it been used in the past? How is it being used now? What do you want for it? What is most important to accomplish first? What is possible? (The Good Science, Good Partnerships, and Resources sections will help you answer these questions.)

This section provides some basic information about watersheds and streams to help set priorities for restoration projects.[1]

WHAT IS A WATERSHED?

A watershed is an area of land that drains to a common point—a river, stream, or lake. It is defined by the ridgeline that separates it from other drainages. A watershed of any size is composed of subwatersheds, and each subwatershed, similarly, may have its own subwatersheds.

The term "watershed" is used somewhat interchangeably with "basin," and may be used loosely to refer to any scale of drainage basin. Among specialists, the terms basin, subbasin, watershed, and subwatershed can refer specifically to the nested hierarchy of land forms created by a large river (e.g., Columbia River basin), major tributary (Yakima River subbasin), minor tributary (Naches River watershed), and small creek (Rattlesnake Creek subwatershed). These relationships are illustrated on the facing page.

WHAT IS A HEALTHY WATERSHED?

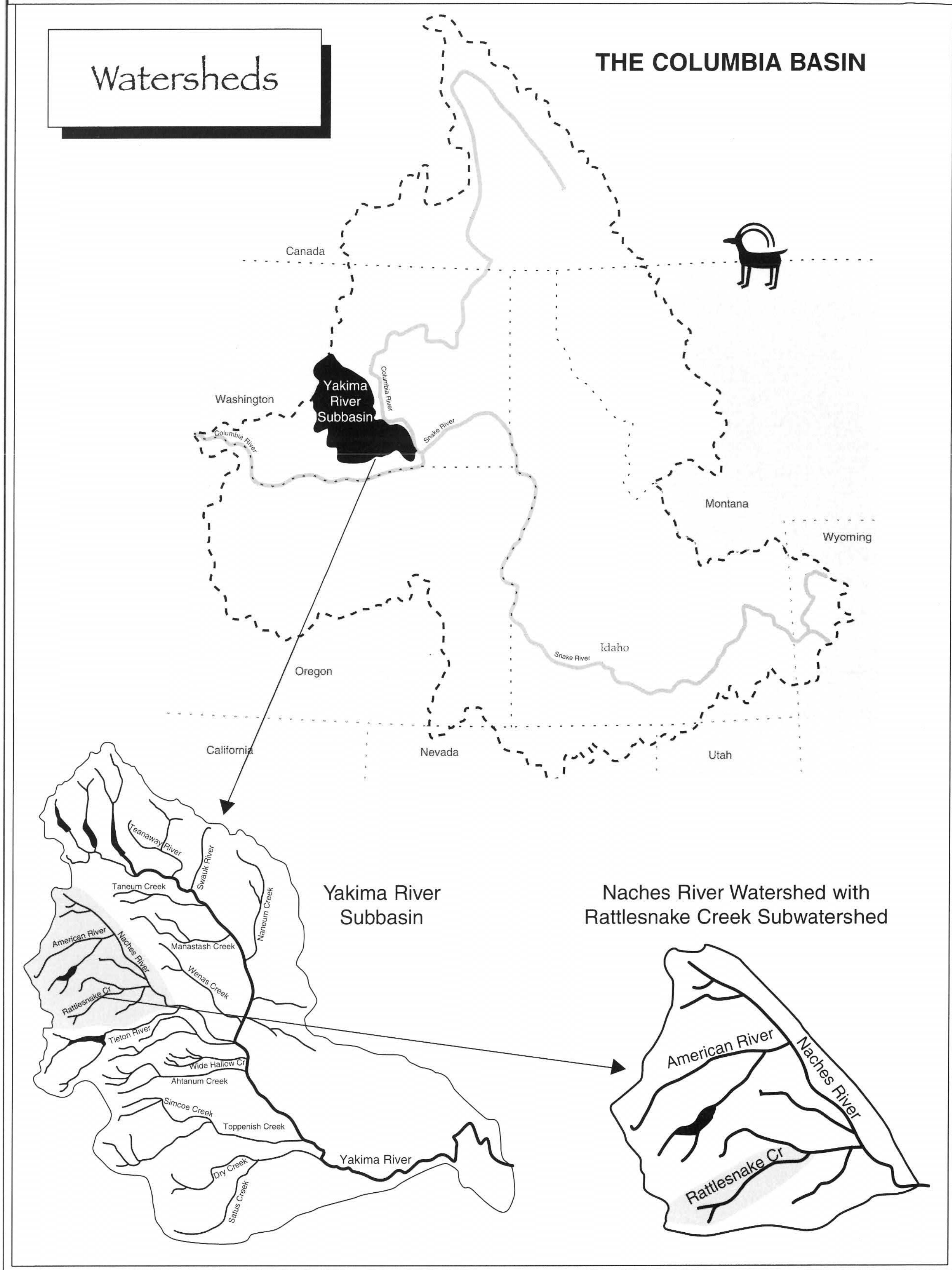
The character of a watershed depends on how it handles water and sediment. We call the watershed healthy or well-functioning when . . . .

- Rainfall sinks into the soil in the uplands and is released slowly through subsurface flow into springs, seeps, streams, or groundwater.
- Native plants take up the water and use it for growth and reproduction. Their roots help to hold the soil in place.
- The streams run clear and cool.
- The floodplains slow the velocity of the occasional floods.
- Riparian vegetation is thick and luxuriant.
- Fish and wildlife are healthy, productive, and diverse.
- The stream channel is stable, in a dynamic equilibrium with its surroundings.

Riparian vegetation performs the following functions:

- Stabilizes banks.
- Provides cover and food (both plant material and insects) for fish.
- Provides cover and food for wildlife.
- Provides migration corridors for wildlife.
- Provides breeding, resting, nesting, and foraging areas.
- Provides a source of large or coarse woody debris.
- Provides shade and cover to moderate both water and air temperature (cooler in summer, warmer in winter).

Watersheds


THE COLUMBIA BASIN
Canada
Washington
Yakima River Subbasin
Columbia River
Snake River
Montana
Wyoming
Idaho
Snake River
Oregon
California
Nevada
Utah
Teanaway River
Swauk River
Taneum Creek
Naneum Creek
Manastash Creek
American River
Naches River
Wenas Creek
Rattlesnake Cr
Tieton River
Wide Hallow Cr
Ahtanum Creek
Simcoe Creek
Toppenish Creek
Yakima River
Dry Creek
Satus Creek
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Naches River Watershed with Rattlesnake Creek Subwatershed
American River
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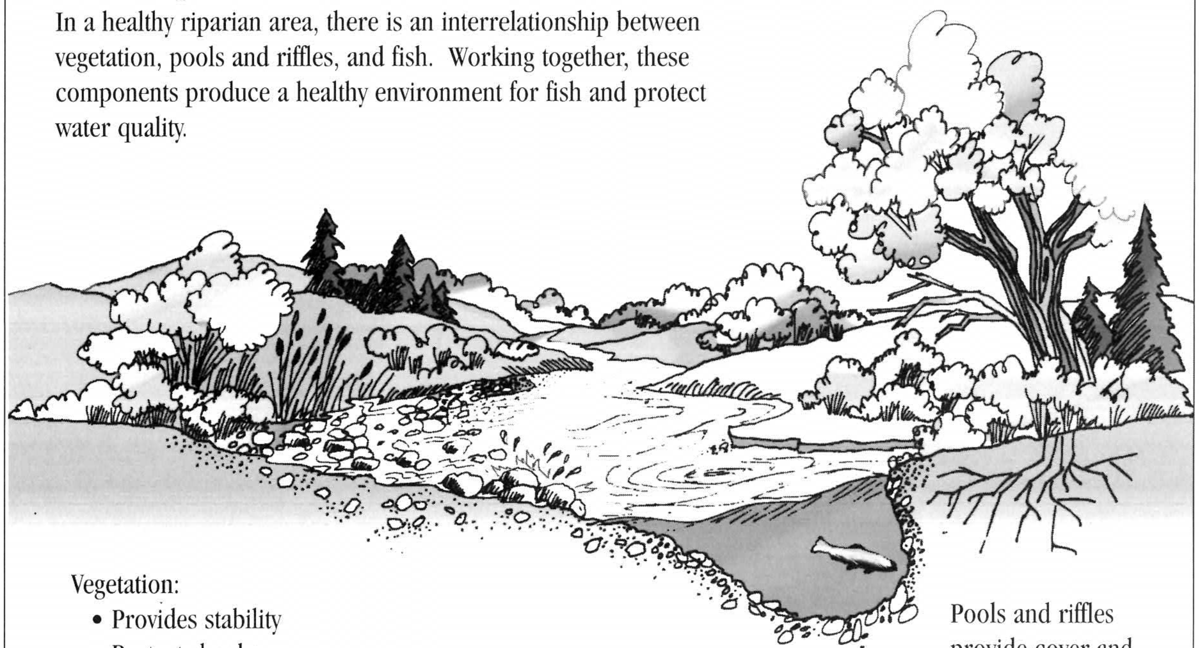
Healthy riparian areas—healthy fish populations

In a healthy riparian area, there is an interrelationship between vegetation, pools and riffles, and fish. Working together, these components produce a healthy environment for fish and protect water quality.



Vegetation:
- Provides stability
- Protects banks
- Provides cover and food for fish

Pools and riffles provide cover and food for fish.

In contrast, in an unhealthy or poorly functioning watershed:

- Upland soils are compacted and stripped of vegetation.
- Water runs off quickly, instead of being absorbed and released slowly.
- Rainfall washes sediments down into the stream.
- During storms, the stream can gain velocity and force, blowing out obstacles, carving deep banks, and scouring down to bedrock.
- Streamside vegetation suffers from lack of water between rains.

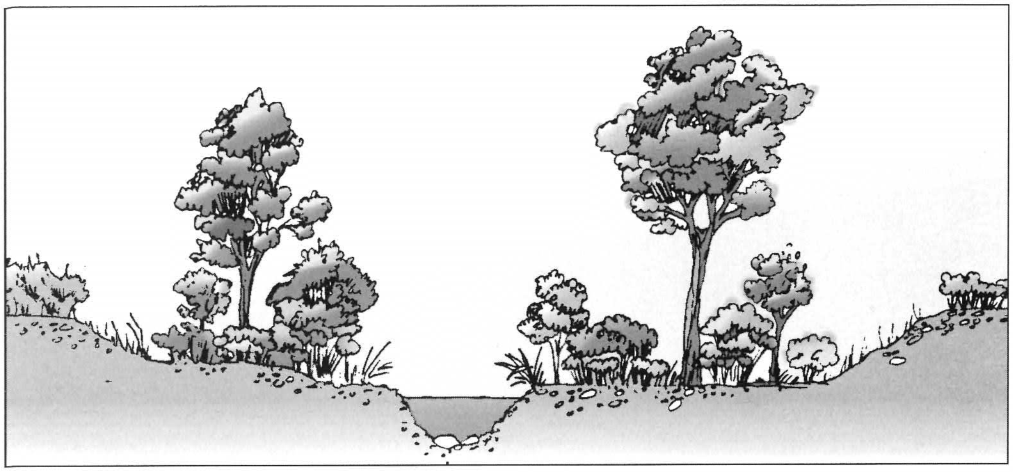
WHAT IS A HEALTHY STREAM?

It's impossible to understand a stream without knowing where it comes from. Every stream carries the story of the entire drainage basin. Because conditions throughout a basin change with seasonal cycles, climatic cycles, and human activities, the streams, too, change. Flowing water is a dynamic system.

The daily and seasonal variations in flow and the ability of the watershed to support year-round flow are of great importance to fish and wildlife. In a deteriorated watershed, rapid runoff may make the peak flows higher and the low flows lower than in a healthy watershed. For salmon, this could mean the difference between survival and death from desiccation of the eggs, high water temperatures, lack of food for juveniles, or lack of water for adult passage.

These are the components of a healthy stream system:

- Well-vegetated uplands, dominated by diverse native plants showing vigorous growth.
- Active floodplain connected to stream. (The floodplain is the land alongside the stream where high water overflows.)
- A channel with natural stability. The channel has developed a stable pattern or profile so that channel features such as pools, riffles, and undercut banks are maintained. Fish use each of these features in different ways—pools for refuge, especially from warm water temperatures; riffles for feed-



Left: wide floodplain.

Below; narrow floodplain.

ing and spawning; undercut banks for refuge from predators and high velocity water.

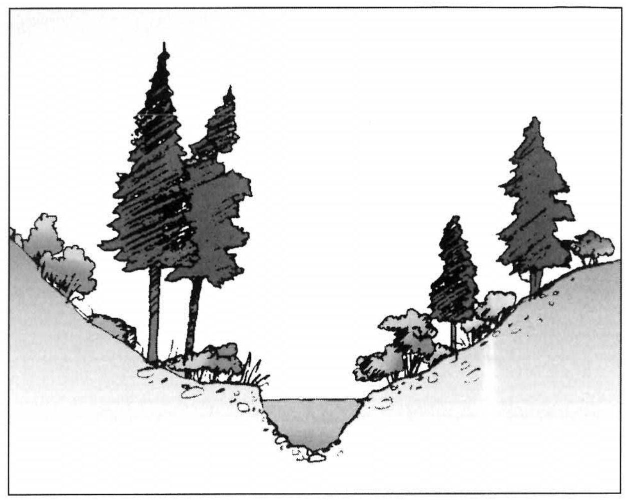
- A groundwater supply available to recharge the river during low flows.
- Healthy native riparian vegetation that has evolved into mature communities, with abundant and diverse plant life which, in turn, supports abundant and diverse wildlife.
- High quality water, which supports desirable macroinvertebrates, fish, and birds.

The floodplain performs the following functions:

- Spreads out and slows flood waters, reducing their erosive force.
- Slows water enough so that it can seep into the soil, recharge the groundwater, and slowly return to the stream.
- Filters sediment out of the water, building deep, fertile soils.

HOW DO YOU SET PRIORITIES FOR RESTORATION?

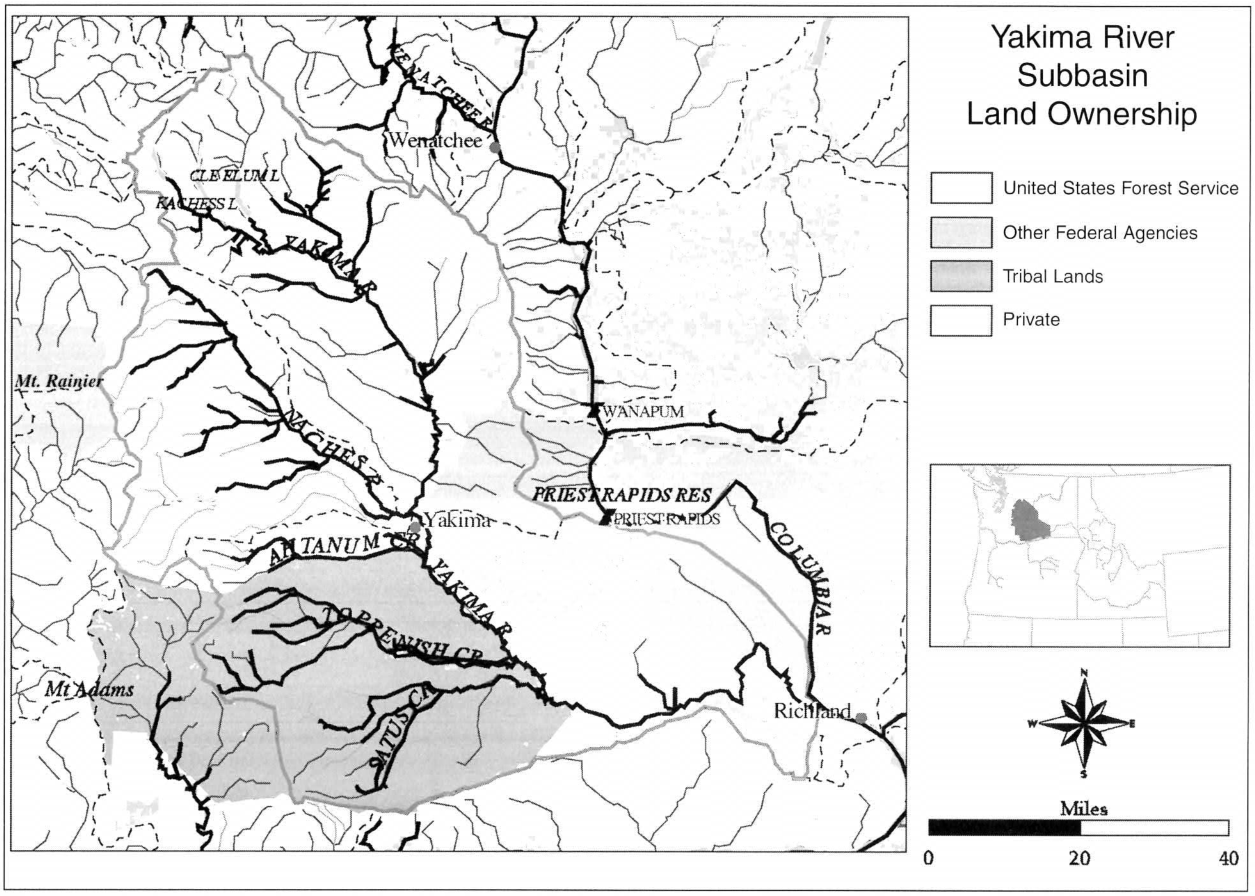
Restoring watershed function involves changing land use—and that often means changing people. To set realistic priorities you generally need to consider social, economic, and political circumstances as well as biological resources and needs. While change can initially seem threatening, working together to improve the land and water can also build community.



Know the Major Players

Most watersheds encompass multiple land holdings. To change land use practices, it's necessary to work with the owners, whether they are public agencies, tribes, or private individuals. You need to consider who owns land in the watershed, your relationship to them, and the potential benefits and costs involved in making changes.

In many parts of the Columbia Basin, citizen groups called watershed councils have been formed to address these questions. They usually include a wide range of local interests. In Oregon, the Governor's Watershed Enhancement Board (GWEB) provides some funds for watershed councils. Other state and federal agencies, such as fish and wildlife departments and the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), provide technical assistance.



Most watersheds are a checkerboard of multiple ownerships and jurisdictions.

If there is no watershed council or similar organization in your area, you can still draw on local natural resource agencies to help set priorities and plan management for restoration on your own land (see Resources section).

Know What You Want— and What's Possible

What do you want for this stream or watershed—and what's possible? Presumably, you want it all—a healthy stream and watershed that supports abundant salmon and other fish and wildlife while providing human benefits such as timber, forage, fisheries, beauty, and recreation. Is that within the potential of this watershed? Is it socially, economically, and politically feasible? (See Watershed Assessment in Good Science section.)

Find a Place to Start

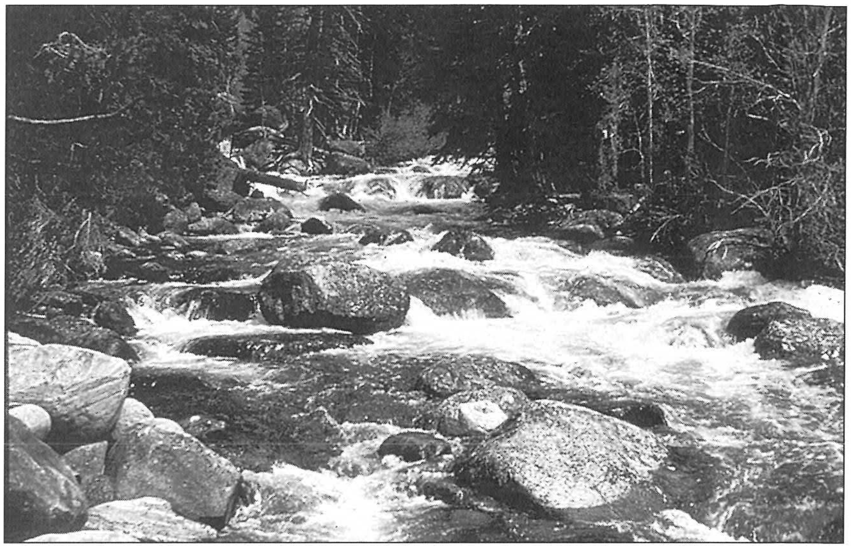
In general, the best first step is to protect the areas that are still undeveloped and biologically intact. Next, improve management practices throughout the watershed. Last and most complex, actively restore the streams. These three major options are discussed in more detail in the Good Science section.

Good Science: Steps for Watershed Restoration

"After ten years of mismanagement, there were no fish. That made me sit up and take notice. I realized I couldn't use the land at the level it had been used or it was going to get worse."

✦

Phil St. Clair
Rancher, Eastern Oregon



It's important to use good science to choose a restoration project. Ecology—the study of the relationships of living things and their environment—and hydrology—the study of the relationships of water and its environment—are key sciences for watershed restoration. An understanding of some of the relationships among water, land, plants, and animals in the watershed will help you figure out how to use your limited resources wisely. A watershed assessment is a systematic way to collect this information.

This section offers guidelines based on physical and biological science for watershed assessment, protection, and restoration.

WATERSHED ASSESSMENT

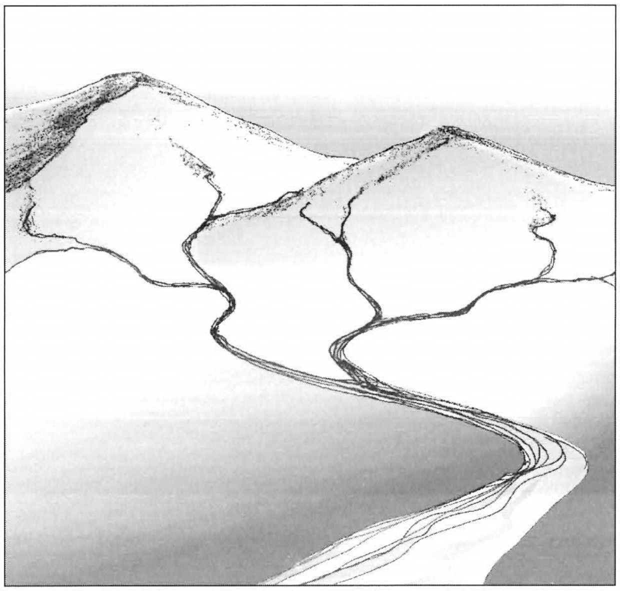
Starting in the year 2000, restoration projects proposed for funding by the Bonneville Power Administration (BPA) through the Columbia Basin Fish and Wildlife Authority (CBFWA) are required to have a watershed assessment. BPA guidelines state that the assessment should include evidence of an understanding of ecological relationships among watershed processes, functions, and biota. It should describe the status of key elements of the watershed, such as target species, habitat refuges, key habitats, key restoration opportunities, and risks to ecological function and connectivity.

It is important to synthesize information on upland land use, stream channel physical habitat, water quality and quantity, aquatic species, riparian vegetation, and erosion. The cumulative effects of land use may be caused by interrelationships that are not immediately apparent from studying one or more of these elements in isolation.

Appropriate Scale

How big is the watershed? The first question is where to draw the line for a watershed assessment. If the study area is too big, the data can only broadly describe it. If the study area is too small, the data do not represent the larger-scale ecosystem processes at work.

For an overview that will help focus priorities for restoration projects, choose watershed boundaries that represent a meaningful, functional unit for your purposes. At the least, your watershed includes all the land drained by tributaries upstream of your project. You may need to define a larger area, depending on what questions you hope to answer.



A watershed.

Finding and Sharing Data

A great deal of watershed information has been collected by various organizations, public agencies, or landowners for various purposes. Such data take a long time to collect and are often available to the public—so it makes sense to find out what is available before collecting your own. Check with StreamNet to get started (see Resources section for contact names and telephone numbers). StreamNet, a cooperative venture of the Columbia Basin's fish and wildlife agencies and tribes, is a storehouse of data related to fish and wildlife protection and restoration in the Columbia Basin. StreamNet may have the data you are looking for, or be able to direct you to other resources.

Methods

Many organizations interested in watersheds have developed assessment methods. These vary in purpose, applicability, and limitations. For example, the Federal Guide to Watershed Analysis is easy to use but is geared toward steep, forested terrain. The Governor's Watershed Enhancement Board Watershed Assessment Manual for Oregon makes good use of existing data sources but is specific to the State of Oregon. The Washington Forest Practices Board Manual focuses on forested land and does not provide a means for identifying restoration targets.[1]

PROTECTION

The numbers of native species in the Columbia Basin that are in decline, have disappeared from a certain range, or are extinct testify that something is wrong. A scientific survey of interior Columbia Basin ecosystems found, for example, that steelhead "are extinct in approximately 54 percent of their historical range," and have healthy populations in only 1.3 percent of their current range.[2] Chinook salmon have healthy populations in less than 1 percent of their current range. Twenty-four resident fish species are also threatened with extinction; they do not have to bypass dams and yet they are still in trouble.

Habitat for many native species is found in scattered pockets of land that for one reason or another have not been developed. Because these places are few and valuable, the goal is to protect them permanently by land purchase or conservation easement. Water can be protected by securing legal water rights for instream flow.

Land Purchase

One way to protect land is to buy it and set it aside for fish and wildlife habitat. There are various ways to hold land in trust, ranging from government programs to private organizations. Two private land trusts that operate on a national level are the Trust for Public Land and The Nature Conservancy. These organizations often serve as intermediaries, buying a piece of land when it comes on the market and eventually transferring it to a public agency. The Nature Conservancy may manage the land as range or farm, while working to enhance its biodiversity.

The Bonneville Power Administration has set aside funds to "mitigate" fish and wildlife habitat lost as a result of building the Columbia River dams. With BPA mitigation funds, the Columbia River treaty tribes have purchased several parcels within the lands ceded in the Treaties of 1855 to manage exclusively as fish and wildlife habitat.

Land purchase is an important part of the tribes' long-term plan for salmon recovery. Recently, for example, the Confederated Tribes of the Umatilla Indian Reservation completed negotiations for the Rainwater Ranch, which contains 8,441 acres in the headwaters

Rainwater Ranch, recently purchased by the Umatilla Tribes, will be managed for fish and wildlife habitat.

of the South Fork of the Touchet River, a tributary to the Walla Walla River. The headwaters are prime spawning and nursery habitat for young salmonids. Spring chinook were extirpated from the Walla Walla Basin at the turn of the century, but the South Fork still supports bull trout and a threatened run of summer steelhead.

The Umatilla Tribes will manage this parcel for the benefit of anadromous fish and for riparian-dependent and upland terrestrial species of wildlife. In cooperation with local citizens and public agencies, the tribes are developing a management plan incorporating appropriate measures for watershed restoration.

The US Bureau of Reclamation may also purchase land with attached water rights for watershed restoration. In eastern Washington, for example, in partnership with The Nature Conservancy, the Bureau is negotiating with two landowners near the confluence of the Teanaway and Yakima rivers to acquire fee title to one parcel containing a wetland, and to acquire a permanent conservation easement for another parcel containing riparian and floodplain habitat.

Conservation Easements

A legal restriction on future development is called a "conservation easement." A conservation easement is not an outright purchase.[3] The landowner sells or donates certain rights attached to the property but keeps others. For example, the owner may give up the right to subdivide or clearcut the property, but retain the rights to farm it, reside on it, exclude the public from it, and sell it. A conservation easement may be held by a federal, tribal, or state government entity, or by a private organization such as a land trust.

To determine the payment for a conservation easement, the land is appraised. The value of the easement is the value of the foregone development. If the easement is donated, the owner is entitled to a tax deduction equal to the value of the easement. Alternatively, the owner is paid outright for the value of the easement or some proportion of it, depending on the terms of the agreement. While some conservation easements are required to be in perpetuity, others are negotiated for 15- or 30-year terms.

Private land trusts include The Nature Conservancy, Trust for Public Lands, National Trust for Historic Preservation, and American Farmland Trust. In Oregon, the Governor's Watershed Enhancement Board has funds for conservation easements. For more information about conservation easements, contact a local office of one of the national land trusts (see Resources section).

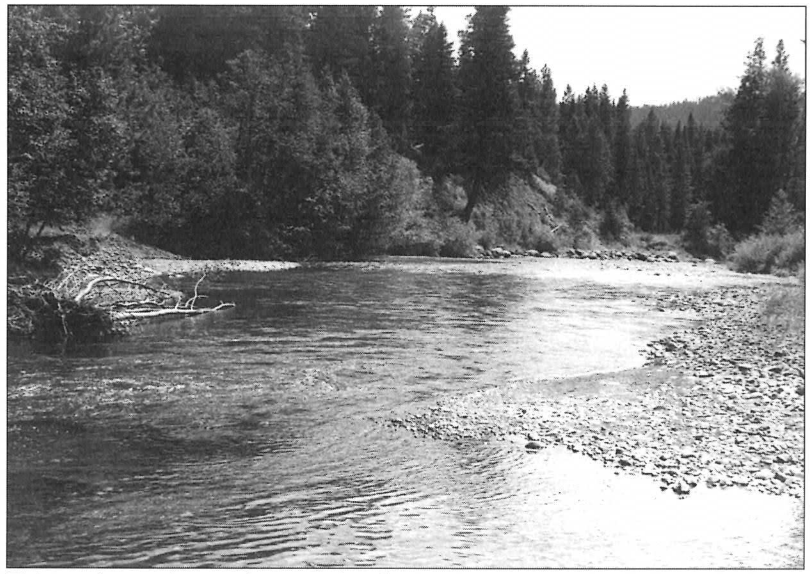
Two voluntary federal programs offer landowners financial incentives for conservation easements: the Wetlands Reserve Program of the NRCS, and the Conservation Reserve Enhancement Program administered by the Farm Service Agency.

Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary program to restore and protect wetlands on private property. It offers landowners financial incentives to enhance wetlands and retire marginal agricultural land. Congress authorized the program under the Food Security Act of 1985, as amended by the 1990 and 1996 Farm Bills.

To be eligible for this program, the land must be restorable and suitable for wildlife benefits. These are some of the eligible types of lands (for a complete description, contact NRCS, a state cooperative extension office, or the local soil and water conservation district):

- Riparian areas that link protected wetlands
- Farmed wetland pasture
- Rangeland, pasture, or production forestland where the hydrology has been significantly degraded and can be restored



Fish need enough water for spawning, feeding, and migration.

Conservation Reserve Enhancement Program

The Conservation Reserve Enhancement Program (CREP) is a federal-state partnership that provides cost-sharing and technical assistance to protect riparian zones and plant trees along salmon and trout-bearing streams in Oregon and Washington. Administered through the Farm Service Agency, NRCS, and local soil and water conservation districts, CREP is a 1998 offshoot of the ongoing federal Conservation Reserve Program. Agricultural landowners and producers will receive incentive payments on 10- to 15-year contracts for establishing and maintaining filter strips and riparian buffers, and for wetland restoration. Both cropland and pastureland are eligible. The purpose of the program, which currently obligates $250 million for each state, is to improve water quality and habitat on streams supporting fish listed as threatened or endangered under the Endangered Species Act.

Restoring Instream Flow

Many fish-bearing rivers and streams in the Columbia Basin simply don't have any water along certain reaches in late summer. That's why putting water back into the stream—or increasing "instream flow"—can be an essential step in restoring fish habitat. There are several ways to do this. First, if tribal water rights were honored (see discussion on page 16), there would be enough water for the fish. And watershed restoration will, over time, result in better retention of water in the uplands and slower release into the stream, increasing flow during the dry season. In addition, Western states are modifying their traditional water laws to recognize the importance of water in the stream.[4]

The Value of Instream Flow

Many people feel that water flowing by without being put to use is wasted. Western water law, which got its start in the gold rush days in California, is based on that philosophy. Human uses of water, such as irrigation, mining, drinking water, or manufacturing, are called "beneficial uses," and legal rights to use water are based on beneficial use. Until recently, leaving water in the stream for fish, wildlife, or recreation was not considered beneficial use.

The Native American tribes traditionally thought differently about water—and still do. Water is considered sacred, healing, life-giving—and water in a river or stream is considered valuable in itself. Tribal governments include instream uses as beneficial uses in defining their own responsibilities. For example, the water program of the Confederated Tribes of the Umatilla Indian Reservation specifies water for fish and wildlife habitat and for ceremonial and subsistence activities as beneficial use.

From a biological and hydrological perspective, water left in the stream does important work.[5]

- It recharges and maintains the volume of groundwater in storage.
- It protects water quality. Sufficient water in the stream helps to control water temperature, prevent excessive growth of algae or bacteria, dilute toxic chemicals, and provide nutrients.
- It maintains the channel and floodplain.
- It provides fish habitat.
- It provides habitat for aquatic insects and other organisms that are, in turn, food for fish, birds, and other wildlife.
- It supports streamside vegetation.

In addition to these biological benefits, of course, water in the stream has direct human uses, such as hydropower, navigation, and recreation.

Western Water Law

Throughout the West, the waters of a state are publicly owned. A state grants permission to use the water—a water right, but the holder of the right does not own the water. The water right stays with the property when the land is sold. A water right specifies a point of diversion, a place of use, a rate of withdrawal, a total volume of water to be used, and a season for the use.[6]

The original purpose of Western water law was to resolve conflicts among users, not to protect the water in the stream. According to the doctrine of "prior appropriation," the bedrock of Western water law, the first person to take water from a stream for beneficial use has priority over all subsequent users. The priority date determines who gets water when there's not enough to go around. Early rights, called "senior" rights, take precedence over later, "junior" rights. In drier years, many of those with junior rights may get no water at all.

"The water that runs through Mother Earth's veins is the blood of life to all beings."

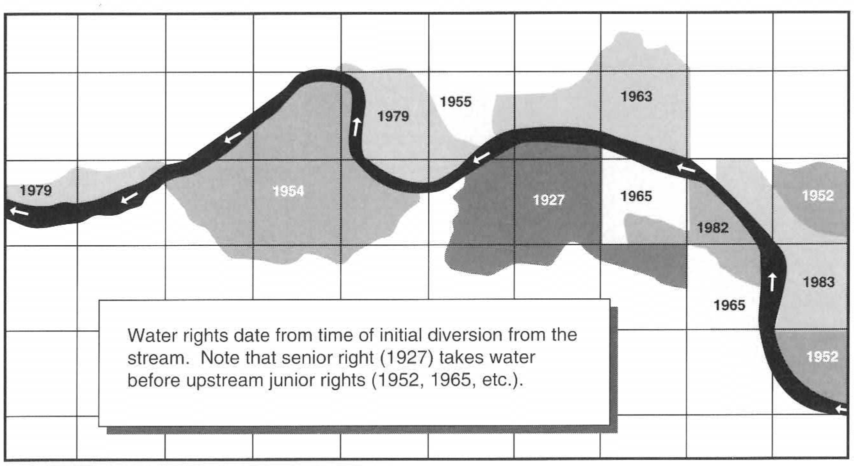
✦

Allen Slickpoo, Sr
Nez Perce tribal elder

Once the states' water agencies were set up to grant water rights, the water rights date from the time of the application. But rights claimed by earlier settlers (in Oregon, for example, all rights before 1909) date from the moment of first use and have to be "adjudicated"—established in court by a complex legal proof.

Water rights are "appurtenant" (attached) to the place of use; therefore, they transfer to the new owner when the land is sold. The rights can also be "transferred" without selling the land. If the point of diversion, type of use, or timing of use is changed, that change is also called a transfer.

Water rights are granted in perpetuity; the only way to lose a water right is to quit using the water for a certain number of years, voluntarily give it up, or break the conditions of the permit. In Oregon, for example, the Water Resources Department can place a temporary moratorium on water use if it determines there is a critical shortage in a certain area, but it cannot take back the water right.



Water rights along a creek.

Today, Western water is overappropriated. States routinely grant water rights for more water than is actually in the stream. The water is diverted for irrigation or municipal use, run through turbines, or stored in reservoirs. Some of the water is lost through evaporation, leaky pipes or canals, or the draining or filling of natural water storage areas. About 80 percent of the water that is withdrawn from streams or groundwater in the West is used for irrigation. Residential, municipal, and industrial users are beginning to compete for a larger share.

Tribal Water Rights

In their treaties with the Government of the United States, the Columbia River tribes did not give up their rights to water. They explicitly reserved the rights to continue fishing, hunting, and gathering "in all the usual and accustomed places." These reserved fishing and hunting rights have been construed, in several court cases, to include an implied reservation of the water necessary to fulfill them.[7] Moreover, because these reserved rights had been exercised since "time immemorial," the priority date of the implicitly reserved water right would also be time immemorial.

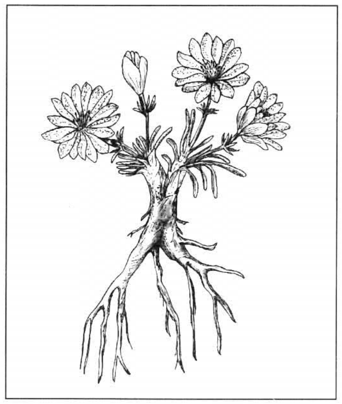
Further, the US Supreme Court has ruled that when the federal government created Indian reservations, it implicitly reserved the amount of water necessary to support present and future homelands. This is true whether the reservation was created by treaty or executive order. The priority date of these implied water rights is the date of the reservation.[8]

Native fish species that should be protected under the tribes' reserved fishing rights include both anadromous fish such as salmon and sturgeon, and resident fish such as trout, whitefish, and sucker. Because these species have different life cycles, their needs vary, too. The natural river system provided a wide range of habitats that supported the native fish. It is difficult, however, to meet the same range of needs in the highly manipulated and dammed river system of today.

Many native plant species that are culturally important to the tribes, for food, medicine, or other purposes, also have water needs, especially if they are adapted to riparian areas or marshes.

How Much Water Do Salmon Need?

The amount of water in the stream needed by fish, particularly salmon, is not a constant; it varies depending on season and stage of life cycle. Adult salmon need enough water to get past rocks, riffles, and other obstacles. They need enough water for spawning. The eggs and tiny fry will not survive without adequate stream flow to wash through the gravel and aerate them. The developing juveniles need enough water for feeding and refuge until they are ready to head downstream. During migration, they need higher flows to hurry them along the hundreds of miles to the sea.[9]



Nutritious bitterroot (*Lewisia rediviva*) grows in rocky places, from river bars to high ridges, and flowers in the spring.

Salmon respond best to the natural "flow regime," which has peaks from fall rains or spring snowmelt and valleys from summer drought. They take many cues for feeding, migration, and spawning from the timing and quantity of fresh water flows.

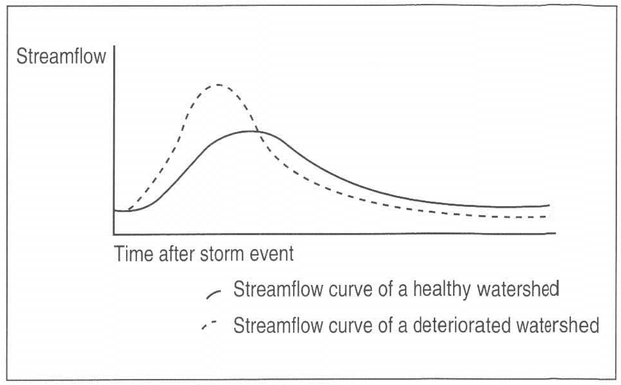
Water temperature is another important variable for fish. Temperature generally varies inversely with flow; higher flow means colder water, especially for a stream that is also used for irrigation. Salmon need cold water; they need temperatures between 39° and 49° F for spawning, and between 45° and 58° F for rearing. Water temperatures between 60° and 73° F may not kill the fish directly, but do make them more vulnerable to stress and disease. Sustained temperatures above 73° F can cause death. Both juvenile and adult salmon take refuge in pools and areas of colder groundwater infiltration to survive summer water temperatures.

Calculating exactly how much water fish need is not easy, but it is safe to say that the more closely a river or stream approaches its historical natural flow, and particularly its natural flow regime or cycle, the better it is for the fish. Most Western rivers today have been greatly altered by human activities such as dams, irrigation diversions, development in the floodplain, grazing, logging, and removal of beaver. In general, these changes result in warmer temperatures, higher highs, and lower lows, and they decrease the diversity of habitats and life histories possible for salmon.

Water Conservation

Because nearly all rivers and streams are fully appropriated or overappropriated, water conservation by itself is not an effective way to increase instream flow.[10] Without explicit planning to put the water back in the stream, the conserved water is most likely to go to additional irrigation. Although it seems paradoxical, sometimes switching to more efficient irrigation can actually reduce instream flow. In areas of heavy irrigation withdrawals, return flows from cultivated fields may be the only source of water for the stream during dry periods. If a new irrigation system uses considerably less water, the return flows may stop.

In Washington, the water conserved with state assistance goes into a trust and can, theoretically, stay in the stream. In Oregon, under the 1987 Conserved Water program, a minimum of 25 percent of the water conserved with state assistance goes back to the state to hold for instream flow. The state's percentage can vary up to 75 percent, depending on the amount of public funding. The irrigator may retain between 25 and 75 percent for use on the land. In Idaho, conserved water goes back to the state for reallocation, but not for instream use.



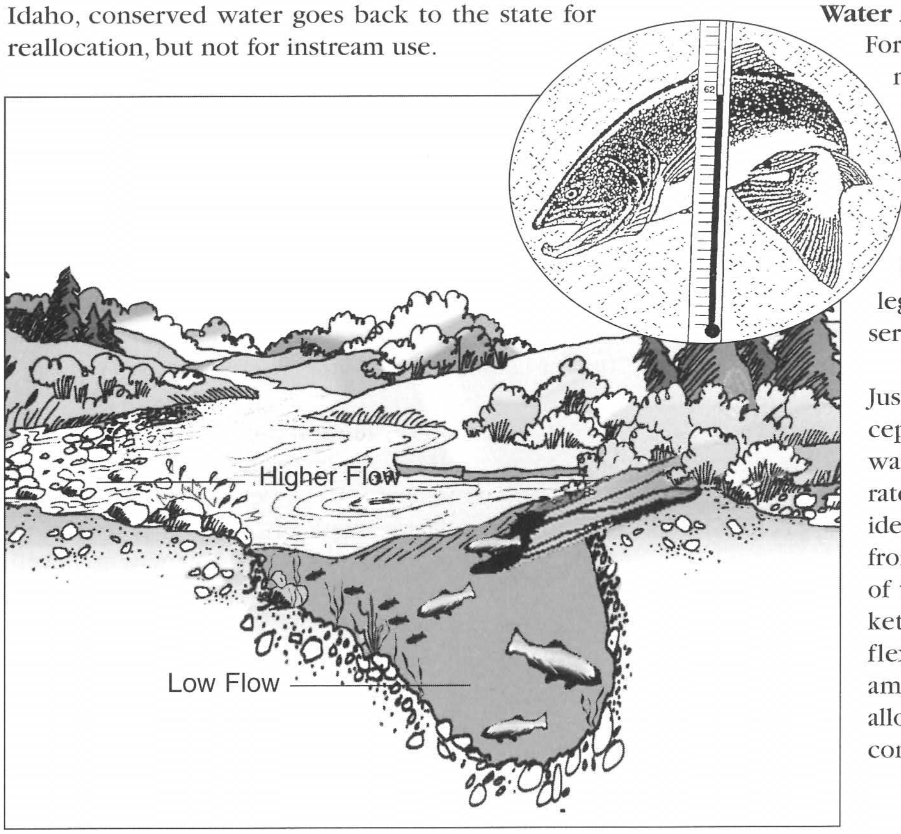
A healthy watershed releases water slowly.

The expense of changing systems is often a barrier to water conservation. Many existing small-scale irrigation systems were built by hand two or three generations ago. To replace them now with state-of-the-art, water-saving equipment can be quite expensive. Washington and Oregon have programs, often funded in partnership with one or more tribes, state agencies, or federal hydropower mitigation programs, to help with the costs.

Water Acquisition

For the reasons detailed above, the most effective way to ensure more water in the stream is to lease or purchase existing, senior water rights and transfer them, by the means available in the particular state, to instream use—or to create legal instream rights from conserved water.

Just as instream use is a new concept in Western water law, putting water rights on the market, separate from the land, is also a new idea, one that has met resistance from agricultural interests in most of the Western states. Water marketing, however, creates more flexibility for allocating water among potential uses; it also allows voluntary and financially compensated change.



Salmon are adapted to cold water and a natural flow cycle.

In most states, water legally acquired for instream flow still cannot belong to private individuals or groups; rather, it must be transferred to the state. Arizona and Alaska have passed laws allowing private holding of instream rights, but the Columbia Basin states have not. In Oregon, Washington, and Idaho, private organizations can hold leases for instream rights and can broker donations and purchases from willing sellers. Once the water right is converted to instream use, it is held by the state in public trust.

Organizations actively working on acquiring water rights for instream flows include the Oregon Water Trust, the Washington Water Trust, The Nature Conservancy, Trout Unlimited, and the Environmental Defense Fund, among others. In this decade, these groups have received donations of more than 213,000 acre-feet of water, and have purchased about 31,000 acre-feet.[11]

Such relatively small water transfers wouldn't have much effect on major rivers, but they can make a big difference in the smaller tributaries where salmonids spawn. For example, the Oregon Water Trust recently purchased senior water rights totalling 1.61 cubic feet per second from four landowners on Squaw Creek, a tributary of the Deschutes River in Central Oregon. Irrigation withdrawals dried up the creek in late summer. Because these are senior rights, permanently converting this water to instream flow will keep several miles of the creek running again.

The water will benefit resident bull trout, redband trout, and other aquatic life. It could also reconnect the creek to the Deschutes River and make it once again prime habitat for steelhead salmon. Steelhead were abundant on Squaw Creek until the late 1950s, when two dams without fish passage were constructed on the Deschutes River. The Warm Springs Tribes have proposed taking ownership of the dams, which are on the Warm Springs Reservation, and restoring fish passage.

Since 1992, the Bureau of Reclamation has become a major player in water marketing for instream flows. Federal legislation allows this agency to both lease and permanently acquire water to increase flows for salmon. The National Marine Fisheries Service 1995 Biological Opinion on the survival of Snake River salmon requires Reclamation to provide 427,000 acre-feet of additional water from Idaho reservoirs. It leases the water yearly from the Idaho Power Company and the state water bank.

Reclamation also works with landowners to increase instream flows in other parts of the Columbia Basin where federal dams provide water for agriculture. For example, Reclamation has leased water rights to put water back into the Teanaway River in late summer, when irrigation withdrawals previously dried it up and prevented fish access (see details below).

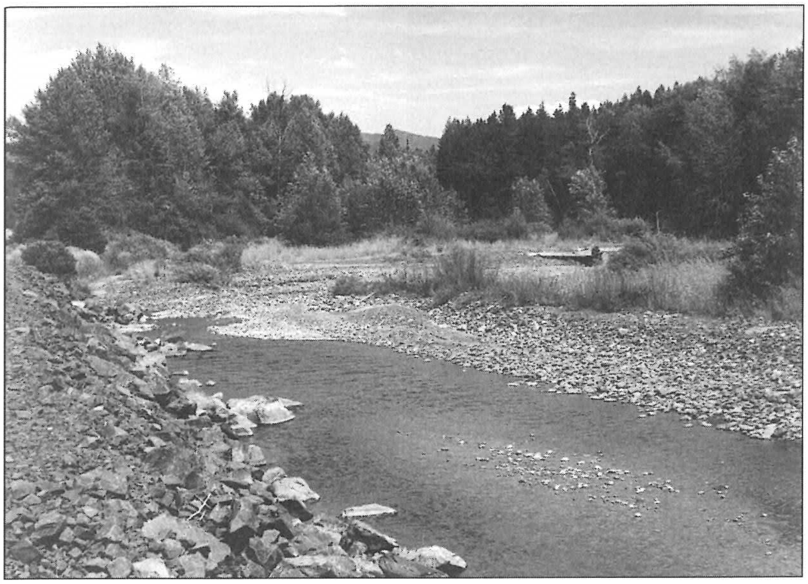
Benefits to the Landowner

There are many benefits to the landowner from improving instream flows, starting with the satisfaction of seeing the fish come back. More efficient water delivery systems can increase agricultural productivity without new water rights. Pipe-and-pump systems, once installed, are less work than gravel berms or pushup dams and ditches, which have to be reconstructed or cleaned out annually. Selling or leasing water rights for instream flows can have financial benefits. Conservation easements usually carry tax incentives, and the owner still has the use of the land.

Case Study: Returning Water to the Teanaway River

The Teanaway River, a tributary of the Yakima River in eastern Washington, was settled by European-Americans over 120 years ago. Irrigation began in this basin in the early 1880s with a series of diversions and associated open earthen ditches and laterals that are still being used. Extensive logging in the headwaters, road building, overgrazing, and development on the floodplain have contributed to degradation of habitat in the watershed.[12]

As natural runoff declines in the Teanaway River during summer and fall, the instream flows drop dramatically. This, coupled with the peak demand for irrigation in mid- to late summer, often dewaters the lower river and prevents fish access or spawning. Even when the lower river does not dry up completely, instream flows in mid- to late summer are often well below the minimum for salmon passage to upstream spawning areas. The US Environmental Protection Agency (USEPA) and the Washington State Department of Ecology have listed the Teanaway River as violating Section 303(d) of the federal Clean Water Act because of lack of instream flows.



Teanaway River, eastern Washington.

Depending on the type of water conservation system they choose, the landowners can get up to 100 percent funding. The funding comes through the Yakama Indian Nation from the Bonneville Power Administration and the Northwest Power Planning Council as off-site mitigation for the dams on the mainstem Columbia River.

As a temporary measure to increase flows while the conservation projects are being completed, the Bureau of Reclamation is leasing irrigation water rights from farmers in the Teanaway River Basin and transferring them to instream flows. Since the water-leasing program began, the Teanaway no longer dries up. When the projects are done, the farmers will resume irrigating and the water leases will no longer be needed.

Historically, the Teanaway River was a substantial producer of spring chinook, steelhead, and coho. Even now a few spring chinook spawn in the lower river and the North Fork. An occasional steelhead still spawns in the Teanaway as well. Resident bull trout are listed as threatened under the Endangered Species Act. Spring chinook and steelhead are proposed for listing. Coho salmon were extirpated from the Yakima River and its tributaries.

The farmers build pushup dams to raise the water level high enough to divert water out of the Teanaway River into their irrigation ditches. These gravel berms can be three to five feet high and sometimes span the width of the river, entirely blocking fish passage. It is estimated that approximately 30 to 50 percent of the diverted water is lost to evaporation and leakage.

The Bureau of Reclamation is working with the Yakama Indian Nation, Bonneville Power Administration, Washington Department of Ecology, local landowners, and others to replace the ditches and berms with piped and pressurized water systems in the Teanaway River. These water conservation systems will allow farmers to irrigate the same acreage, but with approximately half as much water. The water freed as a result of conservation will be left to increase instream flows.

The benefits to the landowners, in addition to the funding, are substantial; they will no longer need to clean out the ditches or rebuild the pushup dams. The new system is a more reliable source of water that adds value to the property. And the new system meets Endangered Species Act requirements for avoiding harm to listed species.

The Teanaway River project involves a combination of protection (leasing instream rights) and passive restoration (removing pushup dams). The next section deals with passive restoration in greater detail.

PASSIVE RESTORATION

Modern land use tends to simplify natural systems because of our focus on the individual species (e.g., wheat), process (e.g., hydropower), or type of place (e.g., flat valleys) that has economic value to us. Restoration efforts often use the same strategy, focusing on one variable such as water quality or number of pools, when a larger view of the processes in the watershed would give better long-term results.

> **"A common thread in the decline of native fishes . . . . is the degradation and simplification of habitat . . . ."[13]**
>
> ✦
>
> **Dan Bottom**
> **Fisheries biologist**

In past decades, efforts to improve salmon habitat consisted largely of instream construction, such as riprap, log weirs, gabions, and other artificial structures. Several long-term studies of the effects of these instream structures have found that they often fail, and can even cause greater damage downstream.[14] Tribal staff are moving toward stream restoration methods that more closely mimic nature or simply allow natural processes to do their work. The latter methods are called "passive" restoration.

Passive restoration means allowing natural processes to return to a stream by stopping activities that cause degradation or prevent recovery.[15] "Active" restoration refers to manipulating the ecosystem to re-establish the desired function.

Improving land management and letting nature do the repair is often more effective than trying to compensate for the damage. Passive restoration includes changing land use in the watershed to prevent soil erosion and increase water infiltration; managing cattle to protect riparian vegetation and streambanks; keeping toxic chemicals out of the water; managing construction, timber harvest, and roadbuilding to prevent sedimentation; and choosing not to build, harvest, or graze in sensitive areas.[16]

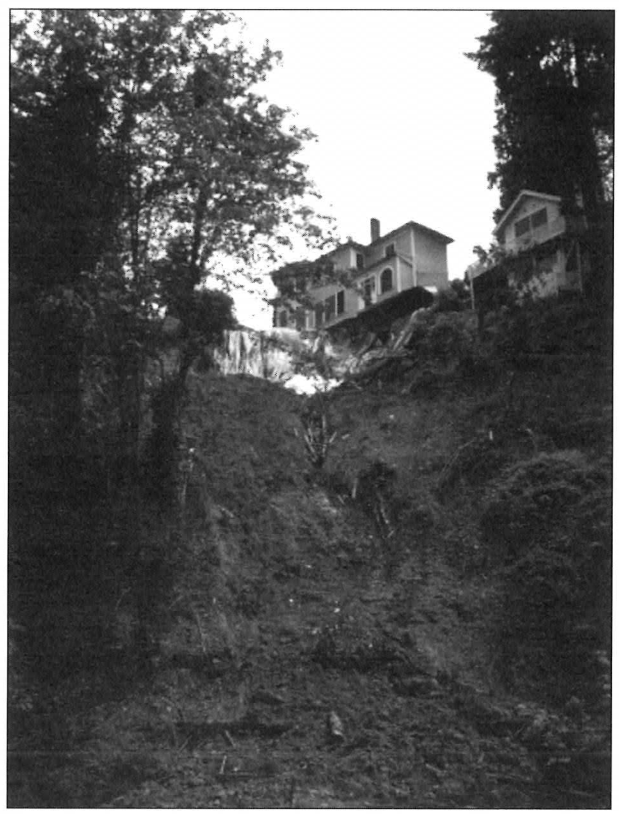
Most human activities have some effect on watersheds. In the following pages we examine urbanization, dams, agriculture, livestock grazing, timber harvest, and roads, in terms of how they affect watersheds and fish habitat, and what we can do to limit harmful effects and improve watershed health.

How Does Urbanization Affect the Watershed?

The 1998 listing of Lower Columbia steelhead salmon as threatened and Upper Columbia steelhead as endangered brought watershed problems home to the cities in the Columbia Basin. Steelhead, like other anadromous species, need cold, clean water, and sufficient water for migration, spawning, and rearing. They spend one to three years in freshwater before heading to the ocean; they are, therefore, especially vulnerable to the dangers of dewatered, polluted streams.

Effects of Urbanization

Concentrations of housing, business, industry, and roads—in short, towns and cities, and even rural residential areas—radically alter the capture, storage, and release of water. Local streams are usually confined by channels, pipes, or culverts, or even filled in. Extensive paved surfaces prevent rain from filtering



Paved surfaces above, cleared slopes below, and heavy rain created a landslide.

into the soil and send it off into drains and ditches carrying sediments and chemicals from countless human activities. Forested or brushy slopes are cleared for housing, and muddy runoff gets even worse.

Chemical waste products and sewage find their way into the rivers, streams, and groundwater by several routes. Some industrial wastes are legally discharged into the waterways under regulations and permits. Some are illegally or accidentally discharged. Sewage may seep from septic systems or overflow in storms. Runoff carries substances that spill or accumulate on the ground, such as oil and gasoline, into the storm drains and from there into the rivers and streams.

Some of the chemicals carried in runoff as "nonpoint source pollution" are highly toxic and persistent. Many organochlorine-based chemicals, such as dioxins, furans, PCBs, chlorinated pesticides, and DDT, tend to drop out of the water column and bind to sediments and other organic matter, where they can easily be taken up by aquatic species, including fish. Heavy metals, especially mercury, and radionuclides can also be taken up by the aquatic environment.

Consumption of chemically contaminated fish can cause human health risks. In fact, the USEPA has identified fish consumption as the main route of human exposure to toxic substances. Subsistence fishers and others who frequently eat fish are at greater risk of exposure to aquatic contamination. Human health effects documented for these toxic substances include cancer and reproductive, developmental, and neurological disorders. These substances can also be harmful to fish-eating wildlife and birds.

Most fish consumption advisories in the US concern mercury, PCBs, dioxins, chlordane, and DDT levels in fish. Approximately 30 fish advisories were issued in the states of Washington, Oregon, and Idaho in 1996.[17]

Preventing/Reducing/Restoring

It is often less expensive to prevent further damage than to repair what has been done. Therefore, the first priority for city planners, developers, and residents is to gain an understanding of local watersheds and shape new land uses appropriately. The following recommendations or measures are being taken in the Portland metropolitan area. They have applicability to towns and cities everywhere.[18]

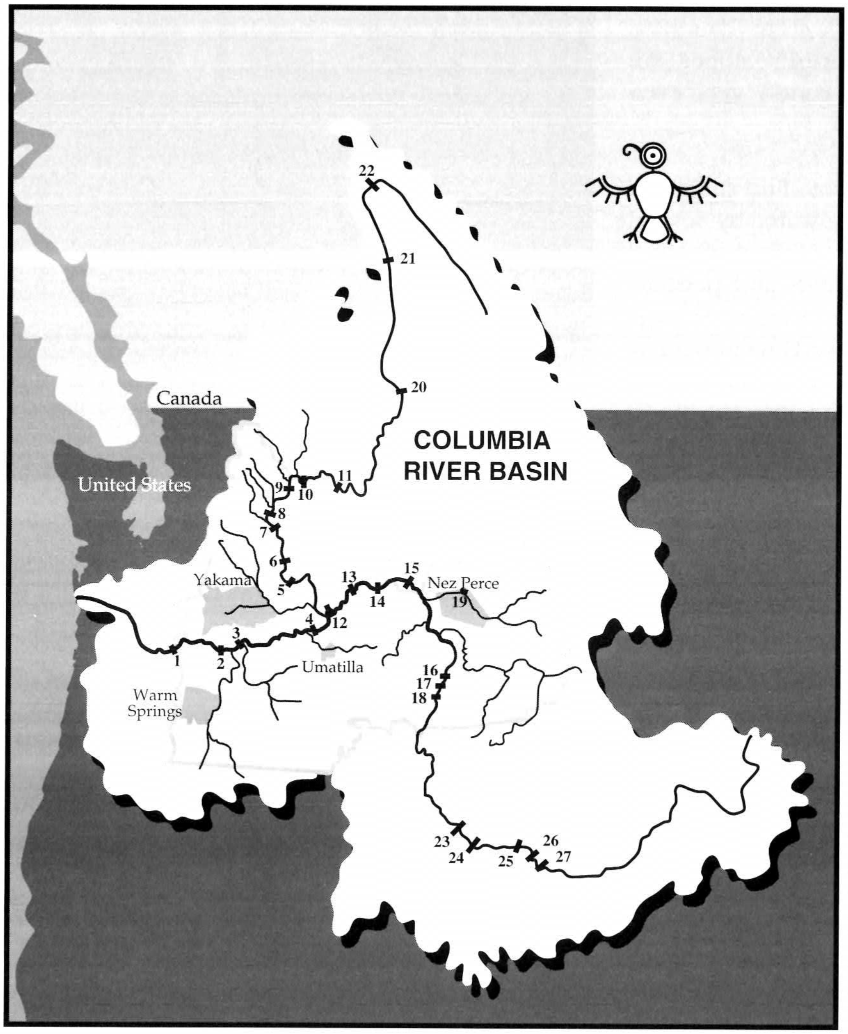
An urban riparian buffer.

- Establish riparian reserves along rivers and streams.
- Avoid new development in floodplains and wetlands. Avoid filling in floodplains.
- Manage construction properly to prevent sedimentation during construction.
- Require catch basins, natural filtration systems, grassy buffer strips, and other methods to manage runoff from paved areas. Protect as many natural detention ponds as possible to protect the natural runoff regime.
- Conserve water.
- Educate the public to keep motor oil and other toxics out of storm drains.
- Promote alternatives to pesticides and chemical fertilizers.
- Reduce or eliminate industrial discharges into waterways.

Monitoring is an important part of reducing and preventing chemical contamination from urban and industrial processes. (See the Good Results section.)

How Do Dams Affect the Watershed?

Dam construction and operation alter not only the physical and chemical functions of rivers, but also the communities of aquatic organisms and many aspects of the entire watershed. Dams, from simple earth berms on tributaries to the enormous dams of the mainstem Columbia, have many negative effects on salmon, perhaps more than any other human action.



Mainstem Dams on the Columbia, Snake and Clearwater Rivers

	DAMS	Date of Operation
1	Bonneville	1938
2	The Dalles	1957
3	John Day	1968
4	McNary	1953
5	Priest Rapids	1959
6	Wanapum	1963
7	Rock Island	1933
8	Rocky Reach	1961
9	Wells	1967
10	Chief Joseph	1955
11	Grand Coulee	1941
12	Ice Harbor	1961
13	Lower Monumental	1969
14	Little Goose	1970
15	Lower Granite	1975
16	Hells Canyon	1967
17	Oxbow	1961
18	Brownlee	1958
19	Dworshak*	1971
20	Arrow Lake	1968
21	Revelstoke Canyon	1983
22	Mica	1973
23	Swan Falls	1901
24	C.J. Strike	1952
25	Bliss	1948
26	Lower Salmon Falls	1907
27	Upper Salmon Falls	1932

*Dworshak is on the Clearwater River

Tribal Ceded Area

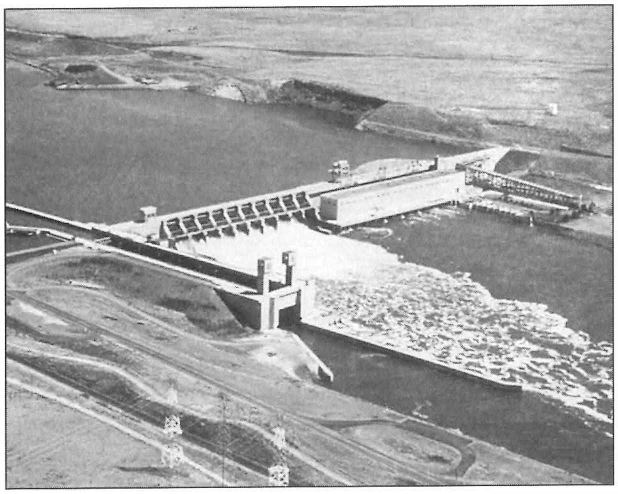
Several of the major Columbia River and Snake River dams were constructed without provision for fish passage. Dams in the Columbia Basin have blocked off more than half of the original salmon habitat. Many tributaries also have dams without fish ladders. Small irrigation dams rebuilt or modified yearly, such as "pushup dams," often block fish passage, too.

Dams capture and hold sediment and organic material, blocking the flow of nutrients downstream and causing higher levels of erosion and other changes to the river channel for miles below the dam. Dams alter the temperature regimes of naturally flowing rivers; stream temperatures are higher for a longer period in the summer and lower in the winter. Shifts in temperature regime can change the timing of salmon incubation and spawning, reducing life history diversity. Loss of diversity makes a population more vulnerable to environmental change.[19]

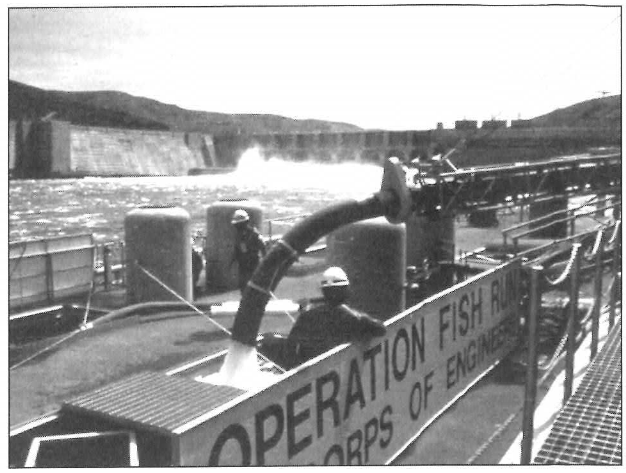
Large Dams

The still water of reservoirs behind large dams slows the downstream migration of juvenile salmon and makes them more vulnerable to predators. Lack of current is disorienting to both juvenile and adult anadromous fish.

Dams used for flood control, irrigation, hydropower, and recreation also alter the natural patterns of high and low water (the hydrograph). Salmon migrations, both upstream and downstream, are closely correlated with flow. Changes in flow can put migrants in the wrong place at the wrong time. For example, juvenile salmon depend on river energy to migrate



Ice Harbor Dam on the Snake River.



U.S. Army Corps of Engineers workers pump Snake River juvenile salmon from collection facility onto a barge for transportation past eight dams.

passively downstream tail first. If they do not reach saltwater at the proper time and size, they may fail to adapt physiologically and may suffer higher mortality from disease or predators. Juvenile salmon are estimated to take more than twice as long to reach the Columbia River estuary since the mainstem dams were constructed.[20]

Fluctuations in daily river flows caused by daily changes in power demands can strand juvenile fish in pools near shore, where they die from heat stress, predation, or desiccation. In a recent study of stranding in the Hanford Reach conducted by Washington Department of Fish and Wildlife and Grant County Public Utility District, biologists counted 31,500 dead juvenile salmon in the limited areas they sampled.[21]

A percentage of juvenile fish traveling downstream are injured or killed passing through turbines. Others are injured or killed going through bypass facilities. Studies have found that each dam with fish passage on the mainstem Columbia and Snake kills between 5 and 17 percent of the migrants.[22]

Snake River salmon are removed from the river at Lower Granite Dam, put into trucks or barges, transported past the next eight dams, and released below Bonneville Dam to continue their journey to the sea.

"The dams are by far the biggest 'nets' in the river . . . . The artificial distinction between 'harvest' and those who kill salmon for other economic reasons must cease."

✦

Salmon policy statement of the Confederated Tribes of the Umatilla Indian Reservation

Transportation entails some mortality. It is likely that transportation also interrupts or compromises the physiological changes juvenile fish undergo as they migrate, impairing their ability to fully adapt to salt water. They are more exposed to predators upon release from the barge or truck, when they are unnaturally concentrated in one place.[23]

Downstream migrants have the best chance of survival by passing over the dams in controlled spill or surface bypass systems. Mortality estimates for passing through spill, turbines, or a screen system were 4 percent, 18 percent, and 20 percent, respectively, in the only comparative study done so far.[24] A potential hazard of spill is the tendency of falling water to capture air, supersaturating the river with dissolved gas. This can cause air bubbles in the fish bloodstream, similar to "the bends" of divers who ascend too quickly. Recent engineering changes to the mainstem dams, including spill deflectors or "flip lips," and others under development, such as raised stilling basins downstream, have reduced this problem.

It is widespread scientific consensus that salmon need natural river conditions to complete their life cycle and survive for generations to come.[25] Operating dams to follow the natural river hydrograph more closely would reestablish some of the ecological functions of the river and would assist salmon migration. Minimizing daily fluctuations in flow during periods of egg incubation, emergence, and early life of salmon fry would improve survival.

Drawing down impoundments would increase the water velocity and improve aspects of water quality such as temperature, turbidity, and organic nutrients. Removing or breaching dams that have filled with sediment or have otherwise outlived their usefulness would restore lost salmon habitat.

Adult passage over dams can be improved by engineering changes based on bioenergetic studies of salmon. Some studies indicate that adult salmon lose less energy from leaping over vertical barriers than from swimming through submerged weirs and baffles.[26] This suggests that if fishways are correctly designed, adult salmon could negotiate high dams such as Grand Coulee and Brownlee, which do not now have fish passage, and reclaim hundreds of miles of former habitat.

Small Dams

Traditional methods of irrigation in which water is allowed to flow freely across a field ("flood" irrigation) or to run down each row from a system of ditches ("furrow" irrigation) are still common in parts of the Columbia Basin. The water is diverted from the stream in a ditch or canal, or by a pipe-and-pump system. In summer, as the water levels in rivers and streams drop, many irrigators find they need a small dam to get the water up to the level of the intake. So every year they use a tractor to push gravel in the stream bed into an earthen berm to hold the water. In the fall, they breach the dam.

These "pushup" dams often block fish passage entirely. When they are breached, the resultant rush of sediment and gravel downstream can destroy spawning beds. Yearly disturbance of the stream channel can create many unintended consequences for banks and substrate.[27]

Replacing small dams with permanent and more efficient irrigation delivery systems restores fish passage and natural stream functions. It also saves labor and provides the irrigator a more reliable water source. (See Teanaway River example, page 18.)

Pushup dams that are constructed yearly for irrigation disturb the stream channel and often block fish passage.

How Does Agriculture Affect the Watershed?

Agriculture is an important land and water use in the Columbia Basin, and good agricultural management is one of the keys to healthy streams. Cultivation exposes soil to erosion by wind and water, then surface water runoff can carry sediment and agricultural chemicals into the streams. Canals, ditches, and pipes that divert water for irrigation can also divert juvenile fish into the fields. Thus, the environmental challenge for farmers is to find ways to raise crops while slowing or preventing erosion, and to irrigate without harming fish.

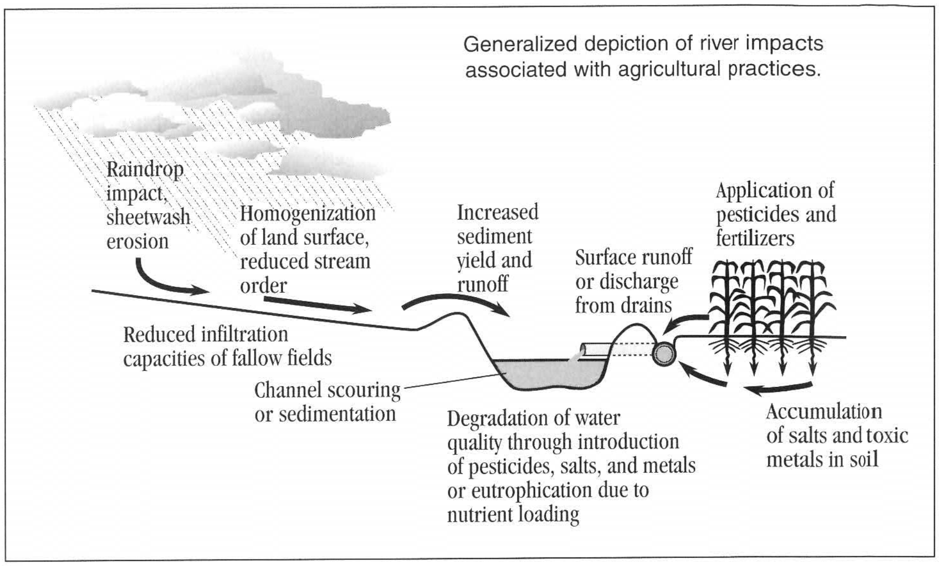
Effects of Agriculture

When the soil is exposed and compacted or heavily eroding, water runs off more rapidly and carries more sediment to the streams. The net result is an altered hydrograph, with higher peak flows and lower low flows. This means bigger floods, less riparian vegetation, and less salmon habitat. Excessive sediment clogs spawning gravels, fills in pools, and alters channel width and mean depth.[28]

Erosion represents a permanent loss of fertile topsoil and nutrients from croplands. In addition, eroding soil carries pesticides and other long-lasting organic compounds into the streams. These compounds are chemically bound to soil particles, but can be released into the food chain.

Agricultural chemicals have a substantial effect on both surface water and groundwater. Recent US

Geological Survey (USGS) studies of water quality and fish communities in the central Columbia plateau, for example, found nitrate concentrations exceeding drinking water standards in about 20 percent of the wells sampled.[29] The highest concentrations were generally in shallow wells in irrigated areas, and were attributed primarily to agricultural fertilizers.



Pesticides were detected in 60 percent of shallow wells and 46 percent of deeper public supply wells, also correlated with irrigated agricultural areas. High levels of pesticides, including DDT, also were detected in fish tissues in the Yakima River Basin, one of the most intensively irrigated areas in the United States.[30] These levels were high enough to pose a risk to human health from eating fish from the lower Yakima River. The Washington Department of Health issued an advisory warning against eating bottom fish (largescale sucker, bridgelip sucker, mountain whitefish, carp, channel catfish, and northern pikeminnow) from the lower Yakima River more than once a week because of high levels of DDT found in their tissues.[31]

Preventing/Reducing/Restoring

Any farming practice that reduces runoff and soil erosion benefits both land and water. In addition, methods that use fewer synthetic chemicals ("alternative" or sustainable agriculture) result in less damage to the watershed.

Reduce Runoff and Erosion

Water-conserving irrigation methods can make a big difference in soil erosion and the discharge of sediments into the streams. A USGS study of water quality in the central Columbia plateau[32] found less suspended sediment and lower concentrations of DDT in streambed sediment and fish tissue in areas where sprinkler or drip irrigation predominated. "For nine drainage basins sampled in 1994, average daily yields of suspended sediment . . . . ranged from 0.4 pound per acre from a basin with no furrow irrigation to about 20 pounds per acre from a basin where about 60 percent of cropland is irrigated by the furrow method," the study states.[33]

Many agricultural practices in common use can dramatically reduce erosion, including the following.[34]

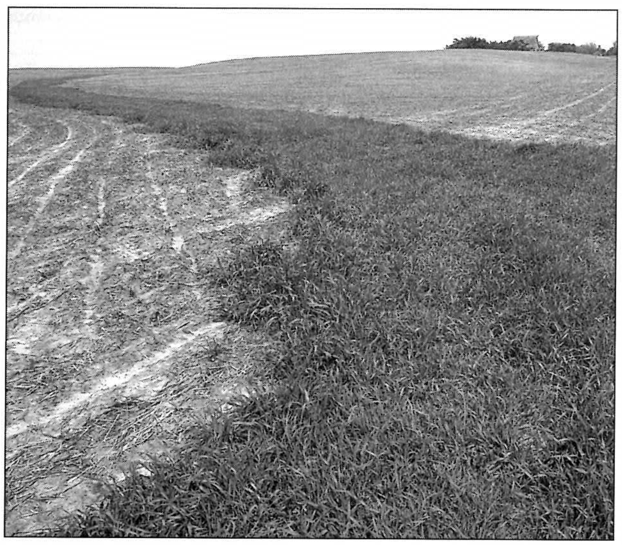
Riparian buffers (also called filter strips)—Bands of vegetation along streams or other bodies of water, usually trees and grass. If they are wide enough, filter strips can filter sediment and other pollutants from runoff and allow some sediment to settle out. Filter strips also take up and store nutrients, control wind and dust, provide wildlife habitat and scenic beauty, prevent stream freezing and ice damage to banks, and prevent channel scouring. The Conservation Reserve Enhancement Program provides incentives to establish riparian buffers.

Contour farming—The practice of preparing land, planting crops, and cultivating them on a level or nearly level contour around a slope. Each crop row serves as a small dam to hold water on the slope. Compared to up-and-downhill farming, contour farming can cut soil losses by as much as 50 percent on long, gentle slopes.

Crop rotation—Alternating a row crop with a cover crop such as hay or legumes gives the land a rest between row crops, improves the tilth of the soil, and protects it from erosion.

Contour stripcropping—Combines the soil savings of contouring and crop rotations. Planting alternat-

Contoured rows.



Contoured grassy buffer strip.

ing contoured strips of row crops, small grains, and hay on a hillside can reduce soil losses up to 75 percent from those on hillsides farmed up and down with continuous row crops. The bands of hay or small grain slow runoff and trap sediment from row crop strips above them.

Field borders—A strip of perennial grass, legumes, or a mixture of the two established at the edge of a field. They can be used as turnstrips for machinery and eliminate the up-and-down-hill end rows that could cause soil erosion.

Terraces—Raised mounds of earth with flat tops and sloping sides, constructed across the slope of a cultivated hillside. Terraces reduce soil erosion by breaking long slopes into a series of shorter slopes. On shorter slopes, water doesn't build up as much speed and has less power to tear away soil particles.

Conservation tillage—Any tillage and planting system that leaves at least 30 percent of the ground after planting covered with the previous year's crop residues (no-till, ridge-till, or mulch-till). The disadvantage of this method is that it results in the use of more herbicides for weed control.

Grass waterways—A means to carry concentrated runoff water from hillsides without causing soil erosion. If natural watercourses in a field are continually cultivated, they become areas of bare, loose soil, vulnerable to erosion, where gullies form. If the watercourses are shaped and seeded to a grass cover, water flows over the grass without disturbing the soil, and cleaner water goes into the stream, lake, or reservoir.

Contour buffer strips—Strips of grass or legumes on a contoured field break up a long slope of row crops.

Water and sediment control basins—Where contours or terraces are impractical, short earthen embankments built across a drainageway help prevent erosion. These require frequent cleaning and maintenance.

Native tree and shrub plantings—Native vegetation on erodible steep hills, wet soils, or other suitable areas covers the ground, adds variety to the landscape, and is among the best sources of food and cover available to many species of wildlife.

Conservation Reserve Program

The federal Conservation Reserve Program, started in 1986 and modified in 1990 and 1994, pays out between one and two billion dollars a year to make it financially attractive to protect wetlands, riparian areas, and highly erodible land. The farm owner, operator, or tenant agrees to retire environmentally sensitive cropland for 10 to 15 years, and in return receives annual payments plus half the cost of planting trees or other permanent vegetative cover. In 1996, the Federal Agriculture Improvement and

Reform Act made it easier to sign up. Approximately 2.3 million acres in Idaho, Oregon, and Washington are enrolled in this program. (See descriptions of related programs in the Conservation Easement section.)

Reduce Chemical Inputs

Reducing soil erosion and runoff, which carries sediment into the waterways, also helps to keep pesticides and herbicides out of surface water and groundwater. Most of these chemicals bind to soil particles; therefore, the less erosion, the less movement of the chemicals. It is also desirable to reduce synthetic chemical inputs.

A landmark study by the National Research Council reported that "alternative" agricultural methods could be as successful and profitable, for small or large farms, as "conventional" methods.[35] The difference is that alternative systems reduce synthetic chemical inputs (pesticides, fertilizers, and antibiotics), and "more deliberately integrate and take advantage of naturally occurring beneficial interactions" to raise healthy crops.

Alternative systems may require more information and more intensive management because it is necessary to balance and incorporate "natural processes such as nutrient cycles, nitrogen fixation, and pest-predator relationships into the agricultural production process. . . . The objective is to sustain and enhance rather than reduce and simplify the biological interactions on which production agriculture depends, thereby reducing the harmful off-farm effects of production practices."[36]

Pump-and-pipe irrigation withdrawal.

The study also found, however, that "Many federal policies discourage adoption of alternative practices." It recommended changes in policy as well as in research and extension programs to give farmers more incentives and more information. Recently, Congress has given more money to research in sustainable agriculture. Most extension programs now incorporate information on integrated pest management, conservation tillage, and many methods of reducing off-farm inputs.

Screen Irrigation Diversions

Irrigation diversions, including ditches, canals, or intake pipes and pumps, can inadvertently divert juvenile fish onto the fields or into ditches that will periodically run dry. While screening these intake points can be expensive, in most areas there are public funds available for all or part of the cost.

Screen designs are site-specific. The design depends on the type of diversion, the amount of water flow, and the type and amount of debris commonly encountered. For example, rotary screens are drums that turn slowly at an angle to the flow; the fish are diverted into a pipe and sent back into the stream. Rotary screens often have a self-cleaning feature—the screen rotates or jets blow across it to clear debris.

Installing an infiltration gallery in the stream channel solves the problem in another way, and has the advantage of replacing diversions such as pushup dams that block fish passage. An infiltration gallery is a perfo-

Irrigation diversion along the John Day River in central Oregon.

rated intake pipe buried in the channel; there is no exposed diversion structure and water goes directly into the irrigation system through the pipe.

State departments of fish and wildlife and the NRCS provide information on screening diversions and sources of funding or partial funding. Federal funds for the Columbia Basin are available under the Mitchell Act screening program and the BPA fish and wildlife program.

How Does Livestock Grazing Affect the Watershed?

Livestock grazing is a major land use in the Columbia Basin. It peaked in the 1880s, when there were millions of cattle and sheep in or moving through the Intermountain West.[37] Because of this early and widespread alteration of the landscape, it is hard to determine what the natural range communities would look like without the effects of livestock grazing. It is also hard to realize that streams that look "normal," in the sense that they have looked that way during several generations of human impact, may not be biologically or hydrologically healthy.

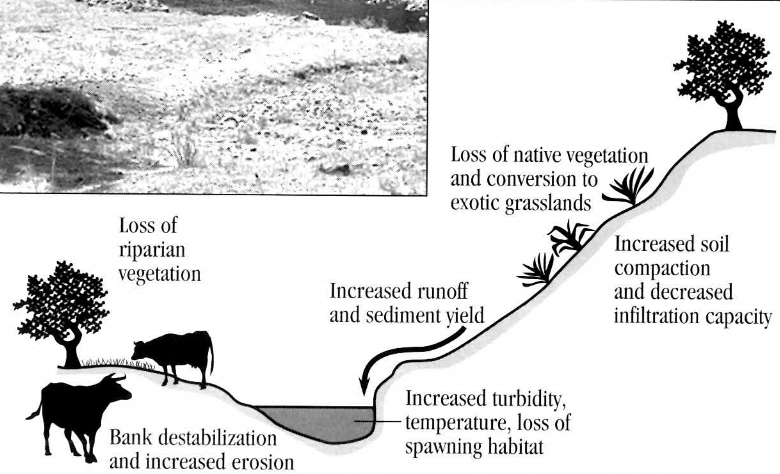
Effects of Livestock in Riparian Areas

Riparian areas are critical to the survival of native fish, wildlife, and plants in the Columbia Basin, and to the landscape as we know it. They provide habitat for some four-fifths of the total number of species in the basin. Like so many birds and mammals, cattle naturally prefer the lush, shady areas near streams to the hot, dry uplands. Unfortunately, cattle can love the stream to death. While sheep may have less effect per animal, in the aggregate they also exert a major toll. Some areas significantly damaged by sheep grazing from roughly 1890 to 1930 have not yet recovered.[38] Since that time, cattle have become the predominant livestock in the region.

Cattle are water-lovers. An adult cow drinks 15 gallons of water a day in the summer.[39] When cattle hang out along the stream, they create major changes in riparian plants, topsoil, and stream channel. Trampling breaks down the banks and compacts the soil. Young shoots of willow, alder, aspen, or cottonwood are cropped down and do not survive. With the removal of plant cover, widespread surface soil erosion increases, gullies and rills develop, and topsoil goes into the stream.[40]

These effects are synergistic; with the loss of topsoil, it is harder to reestablish vegetation. With little or no vegetation, the trampled streambanks are much more likely to erode, weaken, and slump into the stream.

Uncompacted soil absorbs precipitation and lets it slowly recharge the groundwater, while trampled, compacted soil lets water run off quickly, contributing to erosion and flooding. As the surface soil loses its ability to hold moisture, native plants fail to survive the summer and are replaced by less desirable, drought-resistant species, or introduced, weedy species that do well in disturbed soil.



Generalized depiction of impacts of grazing on rivers.

Livestock are a major dispersal agent for exotic species and other weeds. They create disturbed soil conditions more favorable to weeds and exotics and distribute the seeds in their manure. They reduce the competition from native species, both by browsing selectively on them and by causing the generalized effects of more erosion and drier summer soil.

Effects on the stream channel vary with the nature of the soil and rock substrate, vegetation, gradient, sinuosity, and other site characteristics. In some areas the combined effects of grazing on soils, vegetation, erosion, and hydrology cause downcutting and headward channel erosion, while in other areas (often a different part of the same stream) the channel widens.

The wide, shallow stream is more susceptible to summer heating and winter icing. The downcut, deeper channel lowers the water table. Vegetation dies away to be replaced by sagebrush and drought-tolerant weeds on the banks high above the water. The result is less forage for both livestock and wildlife.

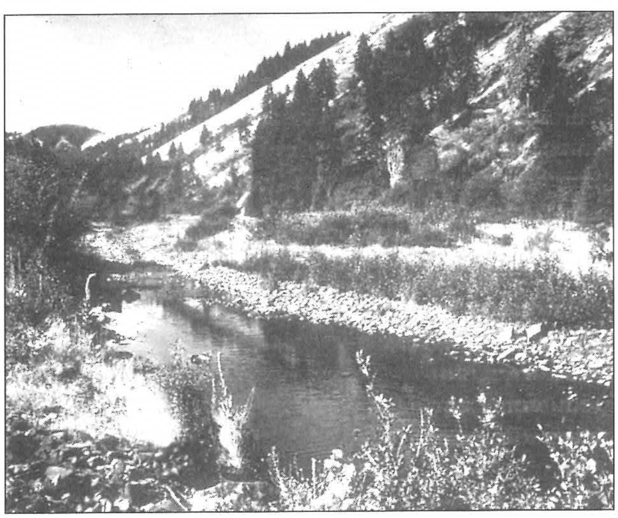
These changes add up to loss of fish habitat. Stable, well-vegetated, overhanging banks provide areas of refuge for both juvenile and adult salmon. Riparian vegetation shades the stream, providing cooling and also moderating daily temperature changes. Vegetation also provides habitat for insects that drop into the stream and are eaten by fish.

With erosion, more sediment goes into the stream, where it clogs the gravels. If salmon spawn in those gravels, the young may not emerge. Fine sediment hinders the flow of water and oxygen to the embryos and, ultimately, suffocates them.[41] Summer water temperature rises because of the lack of shade and lack of groundwater infiltration. Some streams that have lost significant amounts of riparian vegetation can reach summer temperatures as high as 90° F, causing direct mortality to salmon. Lack of deep pools, combined with overall excessive temperatures, deprives fish of summer rearing habitat and areas of thermal refuge.

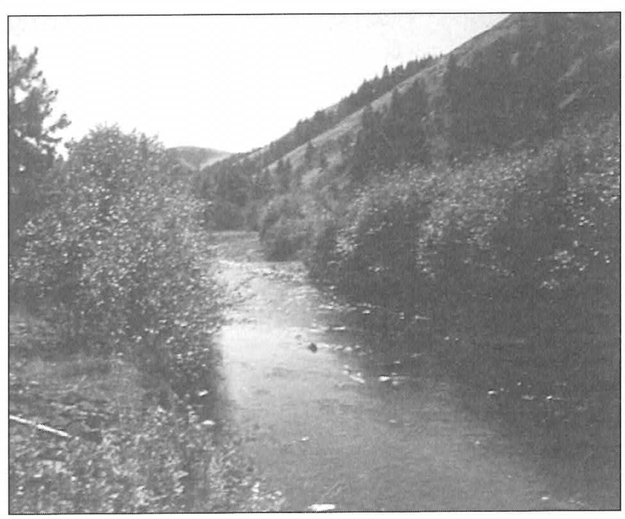
Preventing/Reducing/Restoring

Many ranchers are finding that managing grazing for watershed health is actually more profitable than pushing the land to its limits.[42] When riparian areas are in better condition, they produce more forage.[43] When the adjacent uplands are in better condition, they produce more forage, too. When streams are unhealthy, fish and wildlife suffer, property values are lower, and the landowner may have to deal with violations of water quality standards and Endangered Species Act provisions against "take" of listed species. Good management prevents damage downstream and improves relations between neighbors.[44]

Depending on the current condition of the watershed, improved management may involve excluding cattle from the riparian area or changing grazing



Meacham Creek (a small tributary of the Umatilla River) in 1988 before livestock exclusion.



Meacham Creek in 1992, three and a half years after livestock exclusion. Vegetation rebounded from 20 percent cover to 80 percent cover in some reaches.

regimes, providing off-stream water sources, and changing uplands management to improve soil and water retention.

Excluding Cattle from Riparian Areas

Keeping the cattle out of the stream and away from the riparian area is one of the most beneficial actions that can be taken to restore fish habitat. Research shows that removing cattle from riparian areas results in rapid improvement in riparian vegetation, as well as gradual improvement in stream channel morphology.[45] Channel morphology improvements include natural rebuilding of streambanks,[46] decreased bank angles, more undercut banks that provide cover for fish, and narrower and deeper channels.[47] Because channels are narrower and deeper, water velocity increases.

Another benefit of establishing riparian reserves is that shade to the stream from vegetation increases markedly. One study demonstrated 75 percent more alder and willow shade 10 years after grazing was redirected out of riparian areas.[48] More overhanging brush, more vegetative biomass, and taller vegetation have been attributed to removal of cattle from streamside areas.

Some studies show, further, that artificial structures placed in streams to improve fish habitat are much more likely to stay in place in areas that are not grazed than in areas that are grazed.[49]

The speed and quality of recovery after exclosure vary with the characteristics of soil, vegetation, and stream channel. Native vegetation will not come back quickly if it has been entirely eliminated from an area overgrazed for decades. A combination of fencing, replanting of native vegetation, and some form of active restoration may be necessary to bring a heavily damaged reach back to healthy function within the owner's lifetime.

The tribal salmon recovery plan recommends setting aside riparian corridors and suspending grazing until standards for recovery of soil, stream channel, vegetation, and fish habitat are met.[50, 51] The plan recommends protecting the entire floodplain and, ideally, extending the buffer zone 300 feet from the outer edge of the floodplain or to the ridgetop, whichever is less. Monitoring is an important part of the strategy. When riparian vegetation, stream channel, bank stability, and fish habitat have been restored to acceptable standards,[52] limited grazing, with continued monitoring, can be resumed. (See Monitoring and Evaluation section for further discussion.)

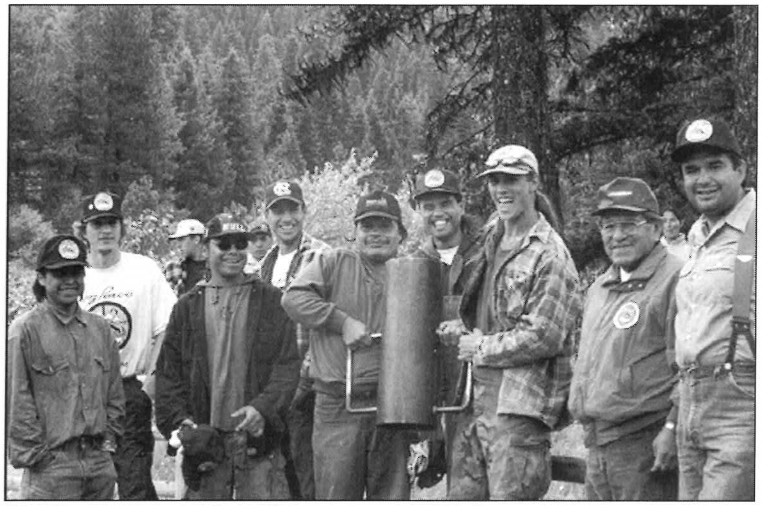
Case Study: McComas Meadows Restoration

McComas Meadows, a 400-acre meadow in the Nez Perce National Forest of Idaho, adjacent to sacred lands of the Nez Perce Tribe, is a passive restoration project that is showing good results after six years of cattle exclosure. Part of the Nez Perce ceded lands, McComas Meadows was homesteaded in around 1860. The land was drained to raise hay. In more recent decades it was leased for season-long grazing.

McComas Meadows, 1998.

The meadow's recovery is of major cultural significance to the Nez Perce Tribe. "People would come there to rest on their way to the holy mountain or to other places," explains Felix McGowan, a Nez Perce fisheries biologist. "It has a lot of special significance to my family and many others. My father and grandfather told me the family went up there every year to go hunting and fishing. It wasn't very far to go from there over into the Salmon River or the Bitteroots, then come back and rest and return to the lowlands before the snow."

"The whole area was medicine," Silas Whitman, Nez Perce fisheries manager, says. "It was a place of a lot of happiness. My elders would tell about the wild-



Nez Perce crew who fenced the perimeter of McComas Meadows, holding fence post pounder affectionately dubbed "Brutus."

flowers that used to grow in the meadow, how good it would smell, how quiet it was. The water was cold and clear, and there was always game. It was said that all the animals were represented there. In late summer the meadow would be full of camps, with racks to cure hides."

When the Nez Perce National Forest acquired it in 1991, the meadow was in "terrible condition," according to Wayne Paradis, USDA Forest Service fisheries biologist. Streambanks were unstable and completely devegetated, and the deep-cut channel was mostly sandy. In 1986, BPA had funded the modification of a natural migration barrier at the mouth of Meadow Creek. Chinook salmon had been planted in the area in 1988, but virtually no returning fish had been observed.

The Forest Service excluded cattle from the meadow in 1992. The Nez Perce tribal fisheries department obtained BPA "early action watershed" funds in 1996 to remove the former fence and expand the enclosed area to the surrounding ridgetops. Salmon Corps crews removed the old fence, which crisscrossed the meadow and surrounded the old homestead, and Nez Perce Fisheries and McFarland Enterprises of Lapwai installed five miles of new fencing.

The Forest Service established monitoring systems and collected baseline data; the monitoring is now being continued cooperatively by the tribe and Forest Service staff. The tribe plans to plant willow and alder along 2.5 miles of Meadow Creek in the summer of 1999.

After six years of exclosure, the meadow has now "recovered tremendously," Paradis says. Bank stability has increased by 40 to 50 percent; the sandy bottom is now predominantly cobble; and a storm in 1995 deposited enough sediment to help reduce the width/depth ratio. The storm also caused some channel migration, which restored some of the natural meanders. The meadow is now well covered with grasses, forbs, and some shrubs. The grasses are a mix of the species introduced by previous owners and a few hardy native species.

The tribe hopes to reintroduce important food species such as camas and couse-couse, which were formerly gathered there in summer, as well as naturally spawning fall chinook. "We are trying to revitalize it with a mixture of cultural knowledge and science," Whitman says.

Changing Grazing Regimes

Some grazing regimes, particularly short rotations in winter and/or early spring, have been shown to allow significant improvements in riparian vegetation and channel under some conditions of soil and topography.[53]

A joint publication of the US Bureau of Land Management (BLM) and USEPA, "Managing Change: Livestock Grazing on Western Riparian Areas,"[54] describes the pros and cons of several alternative grazing regimes for improving watershed and riparian health. The publication emphasizes that spring-to-fall, unrestricted grazing throughout an area will definitely damage both stream and watershed—even with a relatively small herd. "Indeed, this is the kind of grazing that severely damaged rangeland watersheds throughout the West," the authors say.

All streams do not respond the same way to the same grazing regime. To plan a grazing regime, you need to know your stream's characteristics. The Rosgen system is widely used to classify streams. The Coarse Screening Process provides specific standards for assessing fish habitat.[55] The highest priority should be placed on streams that are the most sensitive to grazing disturbances and have the highest potential for recovery.

There are limitations, however, to what the best-planned and shortest grazing rotation can do in a damaged riparian area; it is difficult to re-establish woody vegetation without a period of complete rest from grazing. If livestock are present when the soil is moist, trampling will still cause soil compaction and damage to the streambank. For areas that have been heavily grazed, an initial period of rest is probably necessary for recovery.

To protect fish habitat, at the least, livestock should be kept out of the stream along any spawning reaches, before and during spawning and during the incubation period (two to eight months).

Managing Uplands for Watershed Health

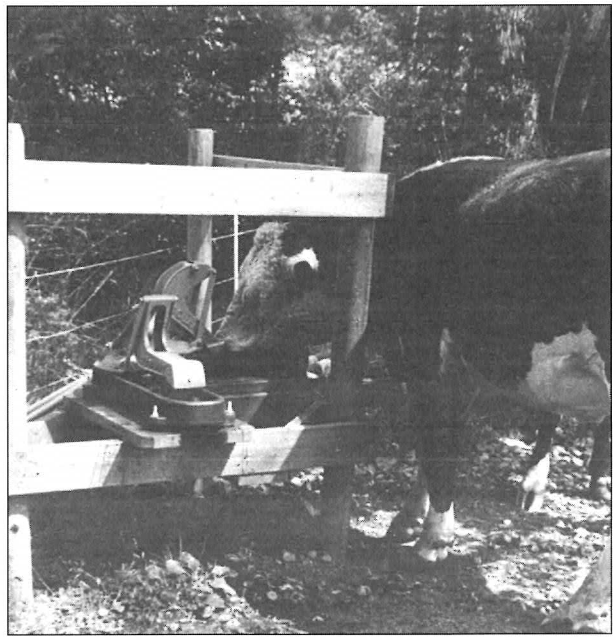
It's essential to include the uplands in any plan to restore riparian areas or streams. Partnerships with public agencies and tribes can help defray the initial costs of change.

For example, Dan Carver, a central Oregon rancher, found technical assistance and funding sources so that he could significantly increase water infiltration in the uplands and provide offstream water sources for his cattle.

Carver, a third-generation logger on the Oregon coast, moved inland to central Oregon in 1988 to raise cattle. He went to the Soil Conservation Service (now the Natural Resources Conservation Service) for technical advice on improving his land. A steelhead-bearing stream, Buck Hollow Creek, a tributary of the Deschutes River, runs through his property.

"They assigned a guy to take an inventory, find out what my goals were, and help design a plan," Carver says. A cornerstone of the plan they jointly developed was to disperse the cattle over more of the land. He set his priorities to do two things: get more forage in the uplands, and develop more offstream water sources. The two are related, and both help to disperse the cattle.

"If you have a plan, you don't always need to spend money to make changes," he says. "For example, the usual way to salt the cattle was to roll a block of salt off a cliff into the creek. Since my plan said to disperse the cattle, I don't salt in the creek any more."



Offstream water sources, such as this "nose pump," operated at will by the thirsty cow, help to disperse cattle.

"When I took over, the cattle weren't using much of the range," Carver says. "They were hanging out on the creeks. When they mess up the creek they're licking mud, getting worms, and costing me money. My goal is to get the cattle where the grass is." He developed eight springs and drilled two wells for livestock watering away from the creek.

"We want our cows to get a drink and get back to work," he says. "Cattle using offstream water sources gain more weight. In some pastures we haul water, and that's not fun, but hauling water is cheaper than hauling hay, and you're using the feed that's out there."

Another part of Carver's plan was to "catch the rain" with terraces, grassed waterways, and sediment basins. Carver obtained funding from various sources, including the NRCS Small Watershed Program, the BPA's fish and wildlife mitigation program, and the Governor's Watershed Enhancement Board, for some of these projects.

"We've built about 50 sediment basins in the high drainages. They capture water in a storm and the water trickles out over months," Carver says. "It creates lots of greenery, feeds the streams lower down, and provides watering ponds for wildlife as well as cattle. In 1990, a 50-year storm would all run off. Now we figure we stop about a third of the water."

Sediment basin in uplands of Buck Hollow Creek watershed.

After 10 years of conservation management, Carver finds that his cows are fat, his land is green, and steelhead are returning to Buck Hollow Creek in the largest numbers since the 1960s. The credit for this last success must go, not only to one person's efforts, but to the community of landowners and public agencies in the Buck Hollow Creek watershed.

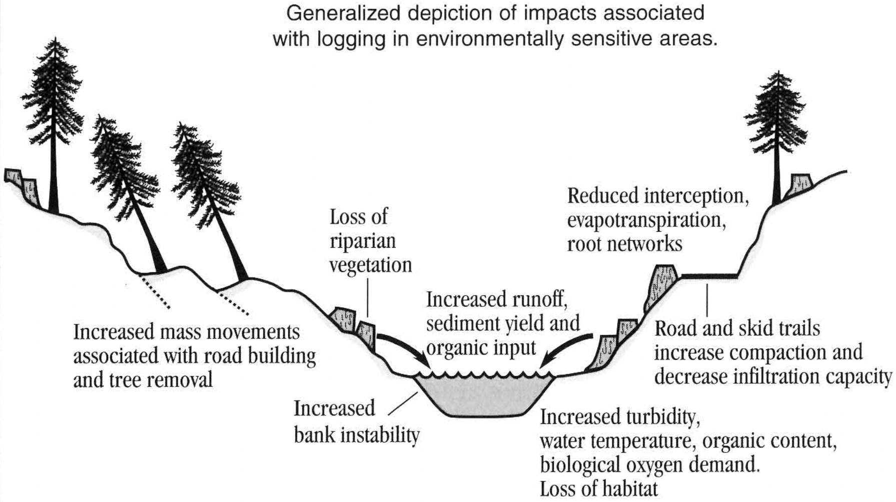
In 1990 the Sherman and Wasco County Soil and Water Conservation Districts started up a watershed restoration program for Buck Hollow Creek, with technical assistance provided by the Oregon Department of Fish and Wildlife (ODFW) and NRCS, and with additional support from the Confederated Tribes of the Warm Springs Indian Reservation, the Oregon Department of Agriculture, and the BLM. Since 1990, nearly all of Buck Hollow Creek has been fenced. While some of the riparian corridor is still grazed, the grazing is of short duration and takes place in the winter. A fish passage barrier has been removed, and Oregon Water Trust has leased one irrigation water right for instream flow. High school students received training to help with long-term monitoring.

ODFW monitors Buck Hollow Creek yearly. In 1994, fisheries technicians found only 10 or 12 redds. In 1998, they counted 180 redds, more than in any year since 1968. Assuming three adult fish per redd, there would be more than 500 spawners. Very few of these were wild steelhead; most were naturally spawning hatchery fish. ODFW personnel reported an increase in the number and quality of pools in the stream, improved channel definition, increased amounts of woody debris, abundant new alders 4 to 14 inches tall emerging from gravel bars along the stream, beaver activity, 70 to 80 ducks, and six bald eagles.[56]

How Does Timber Harvest Affect the Watershed?

Because harvesting timber typically involves road-building, road use, heavy equipment, soil compaction, and removal of trees and other vegetation, it has multiple effects on the watershed. These are not necessarily direct or intended effects; rather they are the result of long-term relationships between human actions and runoff, erosion, sedimentation, and other physical processes.

Generalized depiction of impacts associated with logging in environmentally sensitive areas.



Cumulative Effects

A survey of cumulative, long-term effects of forestry on fish habitat in the Pacific Northwest found one clear overall trend: "simplification of stream channels and loss of habitat complexity,"[57] including fewer and smaller pools, a long-term reduction in large woody debris, and the loss of "edge" habitat—the backwaters and small side channels that are important feeding and refuge areas for juvenile fish.

Loss of fish habitat is the end-product of many interrelated changes on the land. Timber harvest creates a relatively short-term soil disturbance but removes trees that may take generations to regrow. A road may create erosion and runoff that continue for as long as the road is there, whether it is used or not.

Timber Harvest

Trees hold the soil on steep slopes and stabilize streambanks. Well-vegetated hillsides catch the rain and release it slowly. Removing vegetation makes slopes unstable and causes more rapid runoff, which increases soil erosion and carries more sediment to the streams. Logging also alters the snowpack size and melting regime. Gaps in the forest are more likely to accumulate snow, releasing larger quantities of water at once when the snow melts.

When rain falls or snow melts on compacted soils and devegetated slopes, more water from a wider area runs off quickly into the stream, making storm flows higher. An increase in storm flows is likely to cause channel erosion and more sedimentation in the stream.

Removing trees from the riparian area deprives the stream of its future source of large woody debris. This has a major influence on small streams. Water flowing around logs and root wads forms pools, which are important areas of refuge for fish. Large woody debris also makes waterfalls and creates storage sites for sediment and organic material such as leaves and twigs. This organic material is an important source of nutrients at the bottom of the food chain. The net effect of large woody debris is to increase habitat diversity in the stream. Its loss accordingly diminishes survival opportunities for fish.

Roads

Logging road construction and the roads themselves may cause even more erosion and delivery of sediment to streams than the removal of vegetation.[58] Logging roads are often built along watercourses or on steep slopes subject to landslides. Stream crossings contribute large amounts of sediment to the streams. Roads can function as drainage channels, carrying heavy sediment loads. Heavy equipment used off-road compacts the soil and leaves skid tracks, which also become water channels when it rains.

This road has become a drainage channel.

A USDA Forest Service study found erosion to be two to three times the natural rate in logged areas in the Snake River Basin, declining gradually with regrowth of vegetation.[59] Sediment delivery to streams after logging has been found to increase as much as 45 times the background level in a highly erodible area[60] and seven times the background level in a less erodible area.[61] Another study found that sediment delivery, even from well-constructed roads, stays 5 to 20 percent above background for as long as the roads are in use.[62]

Sediment has many consequences downstream. Increased sediment from logged and roaded areas may be stored in tributaries and small streams until a big storm washes it out into the mainstem rivers, where it increases turbidity, clogs potential spawning gravels, and has other deleterious effects on water quality and fish habitat. Further, when the flows subside, the sediment settles out, building up the channel. The stream then uses its excess energy laterally to further erode streambanks. Erosion of streambanks can lead to landsliding, which deposits more sediment in the stream.[63]

Preventing/Reducing/Restoring

Full protection is the best alternative for the following:

- Riparian areas
- Roadless areas
- Pristine headwaters
- Old growth forests
- Areas of refuge, where habitat is intact and supports an unusual variety of fish and wildlife

Prevention is more effective than restoration. Although improved forest management can reduce some of the deleterious effects of logging on the watershed, it cannot entirely eliminate them. In some areas where salmon runs are threatened or endangered, it may be necessary to stop logging in the watershed to allow the streams to recover.

Some companies or agencies voluntarily adopt "best management practices" (BMPs) to protect soil and water; some BMPs are required in state and federal regulations. One computer simulation study of forest practices in the watershed of the South Fork of the Salmon River in Idaho found that helicopter logging and maximum erosion mitigation could theoretically have reduced sediment yields significantly from those generated by past operations. The same study concluded, however, that "some increases in sedimentation are unavoidable even using the most cautious logging and roading methods."[64]

The following are some of the options for improving forest practices. When in doubt, use this test: are the effects of this action reversible? Once too many trees are removed, it takes generations to replace them. On the other hand, it's easy to reduce a buffer zone if monitoring shows it's wider than necessary to protect a stream.

Leave Riparian Buffers

Leaving wide buffer strips along the streams can reduce logging impacts. How wide? The goal should be to protect all the riparian functions, including sediment filtration, groundwater recharge, recruitment of large woody debris, water temperature moderation, bank and channel maintenance in "dynamic equilibrium," and diversity of habitat. For this purpose, all streams, including their floodplains, should be protected, not just fish-bearing streams. The network of smaller streams has a large influence on downstream water quality. CRITFC scientists recommend riparian buffers extending 300 feet from each side of the floodplain or to the ridgetop, whichever is less.[65] The Conservation Reserve Enhancement Program provides financial incentives to private landowners to maintain wide riparian buffers.

Minimize Road Erosion

In watersheds that are already significantly degraded, BMPs are not adequate to protect streams from the continuing and cumulative impacts of roads. Consider which unused or unnecessary roads might best be obliterated and revegetated. (See further discussion on page 37.)

Reduce Soil Compaction

There are various ways to reduce soil compaction and erosion during harvest operations.[66,67] On flatter ground, existing skid trails can be used and reused. Slash laid on the skid trails lightens the impact. Using helicopters or overhead cables for transporting the logs leaves less damage on the ground.

The "harvester-forwarder" logging system uses tractor-trailers with low-pressure, big rubber tires that cause somewhat less soil compaction. The National Marine Fisheries Service has accepted the use of this method in some watersheds where there are listed salmon runs.

When a skid trail must cross a watercourse, it should cross it at right angles over a temporary culvert covered with rocks. Water bars at intervals along the tracks can be used to redirect the water into vegetation so that it does not build up erosive force.

Manage for Forest Diversity

American agriculture and forest management have favored "monocropping"—replacing the natural variety of vegetation with single, desired species. Single-species systems have biological disadvantages; they are more unstable and more vulnerable to environmental change. Worldwide, traditional agricultural systems maintain more variety within a single field or forest. Some modern managers are experimenting with more biologically diverse production systems.

Case Study: The Warm Springs Huckleberry Ecology Project

The Confederated Tribes of the Warm Springs Reservation of Oregon hope to manage their forests to enhance growth of huckleberries and other wild plant resources, as well as maintain sustainable timber harvest. In 1992, the tribes started operating on an "Integrated Ecosystem Management Plan" for the reservation.

Warm Springs Tribes Culture and Heritage Committee with Forestry Department Manager Bodie Shaw (back to camera) among the huckleberries.

Huckleberries are a culturally important food to the Columbia Basin tribes. Traditionally, they were picked in late summer at high-elevation camps and preserved for later use in the winter. They are rich in vitamin C and have medicinal properties. But huckleberries have become both less prevalent and less productive in recent decades.

Huckleberries were more abundant in the past—why? The tentative answer is that they benefited from traditional management with periodic fires. USDA Forest Service research indicates that huckleberry productivity increases slowly but dramatically after fire clears out the smaller trees. The berries also respond well in areas where trees are thinned. But they don't do well in clearcuts—and that may explain the current decline.

"With the exclusion of fire and the introduction of grazing, huckleberries were outcompeted by other vegetation," Warm Springs Forestry Department Manager Bodie Shaw says. "Huckleberries need sunlight. We don't know exactly how much. With a full canopy cover, there are few plants. In a clearcut there are lots of plants but few berries."

Shaw, with a master's degree in forestry, is also on the faculty of the Oregon State University School of Forestry. In partnership with Oregon State University and the Forest Service, the Warm Springs tribes are conducting a three-year study funded by the Ford Foundation that will integrate ecological, historical, economic, sociological, and cultural research about huckleberries and how to manage the forest for their benefit.

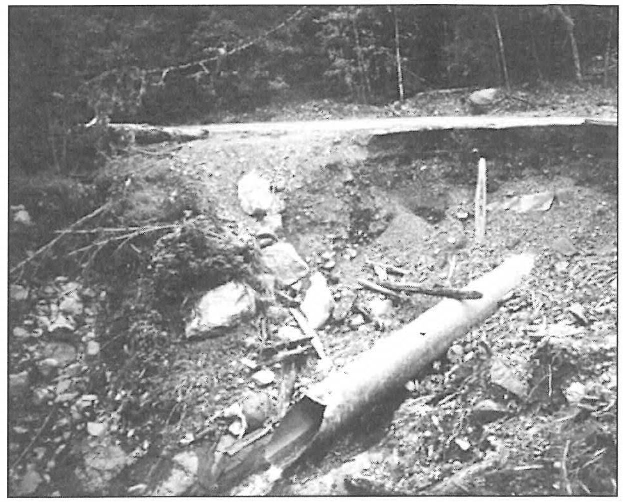
Tribal members of the Culture and Heritage Committee will conduct oral history interviews with elders. They want to document historical camps and trails and map the places huckleberries were found, including the traditional place names. The committee also wants information on traditional methods of land management.

Both the Forest Service and the tribes have built management for huckleberries into recent timber sales. The tribes have placed conditions on the harvest to protect huckleberries from excessive soil compaction. The Forest Service has required thinning of trees and protecting certain open areas. The results will be carefully monitored.

"We want to identify issues and concerns of the tribes," John Davis, a forester with the Mt Hood National Forest said, "and find opportunities to do something different."

How Do Roads Affect the Watershed?

Roads are a major source of sediment delivery to streams (see also discussion on page 34). Roads also compete with rivers and streams for use of the floodplains.



Logging road washout, Second Creek, Mt. Hood National Forest. A debris torrent plugged the culvert, overflowed the road, and continued downstream.

Effects of Roads

Once a road is built in a floodplain, people expect the river to stay in its bed. The river's normal flooding cycle creates maintenance problems. Flood waters may flow over the road or undercut it. The road usually wins this battle, and the river gains hard embankments but loses a good deal of its fish habitat. The landowners win a very costly road.

A road under water.

The many small gravel or paved roads used for logging can cause more erosion and sedimentation in streams than removing trees and other vegetation. Unused roads continue to distribute sediment into streams if they are not properly maintained, or if they are abandoned but not decommissioned.[68] Even after decommissioning, stream recovery is slow.

The point where a road crosses a stream is often a source of sedimentation. If high streamflows exceed the culvert's capacity, the stream will back up. Trees, branches, and sediment carried down in storms can also plug culverts and start this chain of events. If the culvert is not at the lowest point of the road, water can travel down the road or along the road in a drainage ditch, eroding the ditch. Or the water may cross the road, eroding it, and dumping sediment directly into the stream.

Excessive sediment in the stream is extremely harmful to salmon. It can fill in the spaces around spawning gravels, depleting the oxygen and smothering the eggs. It can impair the ability of juvenile or adult fish to navigate and feed by reducing visibility.[69]

Because roads are often cut into hillsides, they can sever subsurface flow pathways and cause flow that would normally travel underground to surface. Roads can serve as drainage networks during high flows, increasing runoff significantly. A combination of these factors alters the flow regime, making higher high flows and lower low flows.[70]

Preventing/Reducing/Restoring

Impacts on streams from erosion and sediment delivery are rapid, significant and long-lasting, while the benefits of restoration, such as road obliteration, are relatively slow. That's why it makes more sense to prevent road impacts by not building new roads and by restoring and decommissioning wherever possible. (See the Resources section for more information on preventing road erosion and sediment delivery to streams.)

This culvert was too small to carry flood waters and has been replaced. Improperly designed or sized culverts can block miles of upstream spawning and rearing habitat.

Restoration of existing roads can proceed in several ways, as follows.

Control Erosion During Construction

If a new road is to be constructed, locating it well away from the floodplain saves maintenance costs and protects the stream. During construction, there are many methods to prevent soil erosion, some required in federal contracts. One example is the use of "slash filter windrows." As a road is built, the slash is piled at the toe of the new construction so that it catches and filters sediment. Other forms of erosion control include dry seeding of cut-and-fill slopes, straw mulch on cuts and fills, filter windrows on fill slopes at drainage crossings, and using good quality gravel on the road surface.[71]

Replace Inadequate Culverts

The Forest Service is currently developing risk assessment guidelines to help determine which culverts are most in need of replacement.

Control Stream Crossing Failures

The road should slope up on either side of the culvert to prevent an overflowing culvert from sending water down the length of the road. A road that slopes down on one side of the culvert can be corrected by building a mound of earth, called a dip, downslope of the culvert. The dip will funnel the water from an overflowing culvert across the width of the road and back into its natural stream channel on the other side of the road. Dips can often be built inexpensively.[72]

Outslope the Road

Outsloping means building a convex slope on the downhill side so that the water runs off onto the adjacent hillside. In the past, roads have generally been insloped. Insloped roads have a ditch on the uphill side. The ditch can serve as a stream channel during high flows, eroding for long distances and eventually depositing the sediment into the stream.

Decommission Roads That Are No Longer Needed

Decommissioning involves removing culverts and surrounding road fill, pulling sidecast material upslope onto the stable portion of the road surface, regrading banks, and reestablishing natural drainage patterns. The former road surface and cleared area is then revegetated.[73]

ACTIVE RESTORATION

Active watershed restoration refers to "purposeful reconstruction .... chemical cleanup .... and biological manipulations"[74] of the environment to restore stream function and fish habitat. Some forms of active restoration—planting native vegetation and removing artificial structures—are beneficial in many situations and have a low risk of failure. Others—adding instream structures—are less likely to succeed, may cause negative effects downstream, and should be used with caution.

Native willow, cottonwood, and alder cuttings planted in McCoy Meadows in 1997 by Salmon Corps crew.

Doing a watershed assessment is essential before considering active restoration, since poor conditions in the uplands can quickly subvert any work done on the stream.

Restoring Native Vegetation

Streambank vegetation is crucial to a healthy stream system. Roots of riparian plants hold the streambank together and prevent erosion into the stream. Vegetation shades streams and lowers the water temperature. Overhanging branches and roots provide cover for fish. For all these reasons, replanting vegetation is an important part of stream restoration.

Replanting alone, however, will not turn around an eroding, denuded streambank. A heavily used area will need protection for a period of time—from a year to a decade—to allow new plants to take hold and grow. That's why replanting works best when it is part of an overall watershed approach that coordinates management changes in uplands and riparian corridors. Restoration starting in the headwaters is more likely to last.

Why Native Vegetation?

Native plants have adapted over thousands of years to local conditions.[75] Other species have adapted in the same environment and depend on native plants for their own needs. More important still, native plants have native enemies to keep them in check. Most "noxious weeds" are introduced species without natural enemies.

Many native plants are cultural resources for Columbia Basin tribes. They are gathered for food and ceremonial uses and are treated with respect. In the culture of the Columbia Basin peoples, the plants and animals that provide food for people are not just utilitarian things, like products bought and sold in the market; they have intrinsic identity and value.

Which Species?

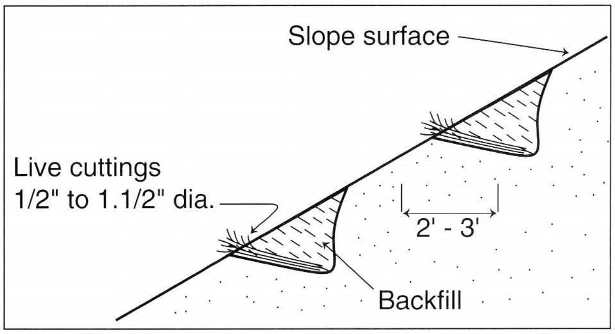
The native species that are currently growing at or near the site are probably the ones that are most appropriate for local conditions, unless certain species are absent because of selective grazing or

Idaho fescue, an abundant native bunchgrass that makes good forage.

weed competition. Native species obtained from other localities may not be equally robust in the long run because of differences in the environment from their place of origin. There may also be concerns about dilution of the gene pool of existing plant populations when nonlocal plants are introduced to a site.

Bioengineering

The use of live, native vegetation to stabilize streambanks is called "bioengineering." It is "an applied science that combines mechanical, biological, and ecological concepts to create a living structure for slope stabilization."[76] Dormant cuttings of woody species are planted using various techniques to position them against the direction of slope movement so that both the stems and roots will increasingly hold the soil and resist sliding.



One bioengineering technique: Brushlayer—placing live branch cuttings in a trench perpendicular to the slope. The trench is backfilled with soil and compacted slightly to eliminate air spaces.

The species chosen should root easily from cuttings, be adaptable to the site conditions, and be available from local sources. Willow, alder, cottonwood, salmonberry, dogwood, elderberry, and hawthorn are some of the species commonly used for bioengineering in the Northwest. It is best to use a variety of species to minimize failure caused by insects or disease. Cuttings should be harvested during the dormant season, roughly September or October to March. They should be planted immediately after harvesting.

The NRCS is a good source of information on bioengineering. To match the technique and species to site conditions, you will need to inventory the site's topography, exposure, geology, soils, and hydrology. NRCS can provide technical assistance.

Reconnecting the Floodplain to its Stream

Rivers tend to migrate laterally by erosion of one bank and deposition on the other. This process creates meanders and "point bars," and, by the extension of the point bar, a floodplain. A floodplain is the relatively flat area near the stream or river channel formed by periodic flooding. It is often an attractive place to build a house, put in a crop, or graze livestock, because of its rich soils and vegetation. When we prevent a river from changing course or overflowing its banks, however, we lose both the biological and physical benefits of the natural river.[77]

The floodplain slows flood waters and acts as a natural reservoir; its vegetation holds the soil in place; its soil holds water for later release. The ponds and marshes that form after a flood are rich in nutrients and support a variety of organisms. Flooding adds nutrients to the stream, too. It deposits sediment on the banks, encouraging the growth of riparian species. Cottonwood trees, for example, need wet, recently deposited sediment for germination of seeds. Without it, no young cottonwoods grow, and eventually the riparian forest dies off.

This railroad bed cuts the river off from its floodplain and prevents the formation of marshy areas or backwaters that would absorb some of the force of flooding.

Effects of Disconnecting the Floodplain

The European-American settlers in the Columbia Basin often straightened the stream channels, drained the adjacent marshes, cleared off the trees, and dug ditches to bring water to the new crops growing in the floodplain. Straightening the channel and disconnecting it from the floodplain actually increases the force of floods, because it increases the slope of the channel and the velocity of the water. Sediment is not dispersed on the floodplain but stays in the water, further increasing its erosive force and damaging fish habitat.

The periodic cycling of nutrients from floodplain vegetation to stream channel is lost. The productive backwaters that are refuge and nursery to young fish and other aquatic life are gone. The connections between groundwater and surface water are altered or severed locally.

Benefits of Restoring the Floodplain

Restoring the stream to its natural channel and reconnecting channel and floodplain can produce benefits on several fronts.

- Reduces flooding downstream.
- Reduces sediment load.
- Raises water table.
- Lowers water temperature.
- Enhances vegetation.
- Restores fish and wildlife habitat.
- Increases forage for livestock.

How It's Done

Floodplains can be managed in several ways. It is best to protect the whole floodplain, but if that is not possible because of existing development, there are still many choices for improvement.[78]

Reestablish Riparian Buffer

At the least, reestablishing a well-vegetated riparian buffer zone is essential—the wider and the more trees the better.

Restore Backwaters and Side Channels

It is highly desirable to keep backwaters and side channels available for high flow events. Sections of the old channel or ditch that fill up only in flood stage, then gradually subside, serve many purposes:

- Bank stabilization by reducing erosive force
- Groundwater recharge
- Refuge for fish during floods
- Habitat for other wildlife

Allow Cell Flooding

If a long reach of river is diked or leveed to protect property on the floodplain, more water goes directly downstream, putting pressure on the system to cause worse flooding somewhere else. The 1993 Mississippi River floods stimulated development of the concept of "cell" flooding—the idea that certain areas or cells, such as agricultural fields, parking lots, or other areas of lower value, can be flooded while other cells containing houses, barns, or other structures are protected with well-maintained dikes. It's a matter of setting priorities. Some dikes may be removed or breached, culverts may be installed, or streambanks lowered to relieve instream pressure and reduce erosion.

The main principle to keep in mind is to remove the section of the dike on the lower end of the field to be allowed to flood. That way the river or stream can back-flood rather than cut through from the upper end of the field, which would cause erosion. Back-flooding can create an area of refuge for fish and recharge groundwater, in addition to breaking the force of the flood.[79]

Restore Meanders

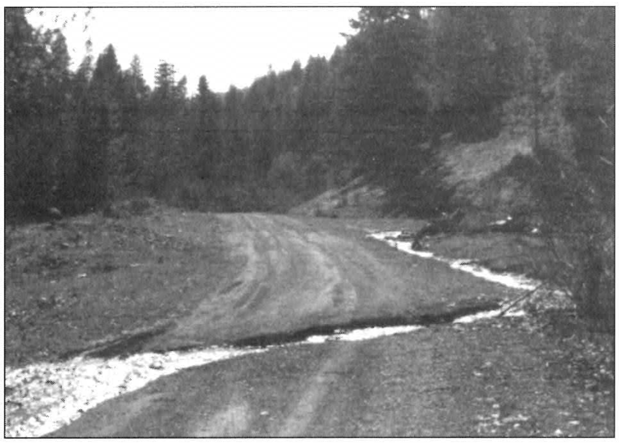
A straightened stream can be reconnected to parts of its former meandering channel by removing dikes or levees that keep it in check. The old channel can be identified from historical photos, or sometimes by the presence of a residual line of vegetation. This requires some help from a geomorphologist or hydrologist, some planning, some heavy equipment, and a lot of work.

Restored meanders on Asotin Creek, eastern Washington.

Funding for such projects is available through the Bonneville Power Administration's fish and wildlife mitigation program and other programs. As with any major restoration project, careful selection of the site is critical to success. Restoring meanders and the hydrologic function of a floodplain may have beneficial effects extending far beyond the site.

Improve or Remove Road Fills

A road fill that crosses the floodplain, with a culvert or a bridge over the stream, blocks the natural spread of floodwaters. High flow backs up around the culvert or bridge, creating road maintenance problems in addition to problems for the stream and the fish.



This road will require extensive maintenance and is dumping sediment into the stream

One possible improvement is to install culverts for the smaller channels in the floodplain that are active only during floods. These channels provide areas of refuge for fish and take pressure off the main channel. Complete road removal and restoration is often the best solution (see Roads and Restoration section). If nonessential roads are removed and the floodplain restored, the stream will benefit hydrologically, and the organization or private landowner maintaining the road will benefit financially.

Case Study: McCoy Meadows Restoration Project

The McCoy Meadows project in the Upper Grande Ronde watershed of northeastern Oregon is an example of successful reconnection of creek to floodplain and restoration of a meandering channel.

Site History

Military journals from the early 1800s indicate that McCoy Meadows, a large meadow complex on McCoy Creek, was previously a hub of tribal use in spring, summer, and fall. It was a campsite holding as many as 200 lodges, a base from which men and women would go out to hunt, gather, and fish. There are several archeological sites in the area.

The meadow has been in private ownership since white settlement in the mid-1800s. It was originally part of a large sheep ranch; subsequently, various parcels were sold off and the meadow was grazed, farmed, and irrigated.

By the mid-twentieth century McCoy Creek had been straightened and confined to a ditch running along one side of the meadow. In the summer the creek ran shallow and warm, supporting small fish tolerant of warm water, such as shiners, dace, suckers, and northern pikeminnow. No salmon had been seen here since the 1970s, although summer steelhead spawn in the subbasin.

Before the restoration project began, the creek's former meandering channel was visible as a complex of willows and other wetland vegetation. A small trickle called McIntyre Creek entered the meadow from the opposite side and ran through part of the old channel. Beaver activity on McIntyre Creek helped to maintain a narrow band of willows and other vegetation along it, but McIntyre Creek often dried up in the fall.

Funding and Planning

In 1992 the Confederated Tribes of the Umatilla Indian

McCoy Creek and meadow before 1997 restoration project.

Reservation, with the assistance of the USEPA, obtained a grant of $180,000 from the Oregon Department of Environmental Quality for a large meadow restoration project. The tribes believed that reconnecting McCoy Creek to its old channel and natural floodplain would benefit fish habitat. They expected riparian vegetation to rebound, water temperature to drop, beaver to return, and the water table to rise. The owners of McCoy Meadows were willing to fence their cattle out of the meadow and contribute in-kind assistance to the project. Negotiations and planning took several years.


McCoy Meadows August 1998, one year after McCoy Creek was reconnected to its former channel and six years after cattle exclusion. Beaver pond in foreground.

Baseline Conditions

Before starting the reconstructive work, tribal biologists surveyed stream conditions. McCoy Creek was in poor condition; it ran straight, with few or no pools, little streamside vegetation, and high water temperature. It did not provide safety or adequate food for juvenile fish, and its high temperature and lack of pools could be lethal to spawners.

Reconstruction

Project hydrologists used an elevation survey of the entire meadow and a 1937 aerial photograph to identify the former channel. Putting the creek back in its channel required the use of heavy equipment. A large meander was created by blocking off the ditch with a long gravel berm and sending the creek to the left. Parts of the ditch were left connected to the creek for use as refuge for juvenile fish during times of high water. Salmon Corps workers planted 10,000 willow, cottonwood, and other native plant shoots. When the work was done the areas that had been compacted by the bulldozers and trucks were churned, raked, and replanted.

McCoy Creek now ran in its old channel. Where the beavers had managed to survive on a trickle from McIntyre Creek, there was now ample water. New beaver dams sprang up, in some places literally overnight, creating new pools, and raising the water table to nourish riparian plants.

Quick Results

Once the creek was restored to its old channel, Oregon Department of Environmental Quality temperature gauges showed that the water leaving the meadow was 5° to 6° F colder than the water entering the meadow.[80] Upwelling groundwater made pools 10 degrees colder. In 1998, temperatures in the restored reach were 8 to 10 degrees colder and fluctuated less during the day than immediately upstream or downstream.

It was inferred that the nearly immediate temperature reduction occurred for two reasons:

Subinfiltration

The underground flow of water, or subinfiltration, popularly called "subbing," lowers water temperature quickly. Subinfiltration began immediately when the dam across the old ditch was complete. Water from the creek began to filter underground through the dam and come out a short distance downstream.

Beavers

Beaver dams create deep pools, a higher water table, and more subinfiltration. Beavers make trails and channels along the streambed that link groundwater to the stream. Putting more water through the beavers' territory had an immediate as well as a long-term effect.[81]

One year later, McCoy Creek shows most of the characteristics of a stream reach in good condition. The channel has become narrower and deeper and the water colder. The riparian vegetation around the beaver dams has thickened and the marsh area has expanded outward some 50 feet. Elsewhere, willow and cottonwood starts show new growth, and other greenery pokes up in streamside silty gravel. The winter and spring floods stayed in the channel and floodplain without "blowing out" any of the reconstructive work.

And the landowners are pleased. They know that in the long run the meadow will produce four or five times the forage it produced in the past, and if they want to try short grazing rotations they may do so.

"We never would've been able to get this restoration underway without backing from the tribes, NRCS, and others," says landowner Mark Tipperman. "We're happy with the results. It seems to be working."

Reintroducing Beaver

Before the arrival of Europeans in America, beaver populations are estimated to have been in the hundreds of millions. Beavers began to be killed for fur trade in the eastern United States in the 17th century. When eastern populations declined, western populations were exploited to the point that beaver nearly went extinct in the United States. Today, with laws regulating trapping, beaver populations have rebounded, but still only to a fraction of their former abundance. Removing beavers has had dramatic effects on stream ecosystems.[82]

Beavers modify streams by building dams out of brushy debris and mud, slowing the water and creating a stair-step profile in the stream channel. The dams trap sediment, raise the streambed and the water table, and change the stream flow regime. The floodplain and associated wetlands expand. The plant community diversifies. Trapping sediments and slowing the water allows nutrients to build up. The number and diversity of aquatic insects increase. (Aquatic insects are an important part of the food chain that supports fish.)

Beavers alter the riparian area by felling deciduous trees along the stream. Clearing these trees allows conifers to dominate gaps where the deciduous trees once stood. Altering the mix of tree species improves the availability of nutrients in the soil and groundwater. These effects can last for decades or even a century, as generations of beavers remain in the same pond.[83]

A beaver dam on Meacham Creek.

Why Bring Them Back?

Why bring them back? In addition to improving fish habitat and stream function, beavers can help landowners. In arid areas, beaver dams help to maintain moisture even during the worst droughts. The meadows that form at the edges of beaver ponds produce more forage for livestock. With proper management of both beavers and livestock, ranchers can increase the feed available for cattle.

Restoration by beavers can be highly cost-effective. It's nearly free to reintroduce or encourage beavers to return to an area and build a dam, while placing artificial dams in a stream can be quite expensive. Further, there are no maintenance costs on beaver-built dams; if a dam fails after a big flood, the beavers simply repair and rebuild it themselves.[84]

Although historically many landowners have despised beavers, opinions are changing as we realize that beavers are an important part of the ecosystem. They can add value to property and return streams to healthy conditions hospitable to fish.

BENEFITS OF BEAVERS

- Raised water table
- Erosion control
- Slower stream
- Better water quality as riparian vegetation filters out contaminants
- Groundwater recharge and stabilization of stream flows through droughts
- Water available during droughts
- Protection of downstream structures and crops by decreasing floods
- Enhancement of fish habitat with more aquatic insects and deeper water
- More habitat diversity and therefore more biological diversity
- More and better cattle forage

✦

How to Do It
Sometimes all it takes to bring beavers back to a stream is to quit shooting them. Beaver families migrate and colonize new areas when they reach the limits of the food sources near home. As beavers help to return a stream to its natural functioning state, salmon habitat is improved.

Reintroducing a species, however, always requires caution. A stream must have enough riparian vegetation to keep the banks stable after beavers have felled a number of trees. Otherwise, beaver activity could cause rapid erosion. A stream with relatively low gradient is a good choice.

For successful reintroduction, landowners need to be willing to change grazing regimes, or already have cattle at a distance from the stream. Transplanting beavers into a site where grazing is not properly managed may result in failure.

While beavers may help to create the conditions for re-establishing willows and other riparian species, they also use these same species for building materials and food. If they are being reintroduced into degraded riparian areas in the shrub-steppe zone, it may be helpful to provide a pickup truckload of aspen or other trees near the site to encourage the beavers to stay and to allow cuttings time to get established.

Consider whether moving beavers to a new location will cause damage to an irrigation system or clog culverts. Avoid areas with high road densities, where the woody debris beavers add to the stream is likely to plug culverts and cause sedimentation problems.

Be sure to transplant beavers in August or September. It is believed that beavers transplanted in August or later realize that winter is approaching and that they need to build a lodge and store food for winter.[85] If beavers are reintroduced earlier in the spring or summer, they often move to a different location. Since beavers are social and recognize parents and siblings, transplanting an entire family of beavers at one time also seems to cause them to stay longer in the new location. It may be necessary to supplement their food supply for the first winter.

Placing Instream Structures

Instream structures, from engineered structures such as concrete revetments to natural structures such as root wads, are often used with the intention of stabilizing the bank, diffusing the current, encouraging sediment deposition, creating pools, or otherwise improving fish habitat. To be successful, however, instream structures should be combined with improvements in land management throughout the watershed. It is also essential to figure out beforehand how any instream addition will affect conditions both upstream and downstream.

Tribal staff prefer using natural objects such as root wads or woody debris when instream modifications are necessary. These can add habitat complexity to a stream in the short term while wider changes in the watershed get underway.

Levees or riprap are almost never recommended. Hard structures on streambanks deflect the energy rather than dissipating it; velocity and sediment load interact to create scouring or deposition. It's difficult to accurately predict the downstream consequences of adding hard structures to a stream. It may be necessary to remove artificial structures such as levees or riprap to restore a river or stream to some of its key natural functions.[86]

Much current research indicates that in many situations instream structures either have no effect, are rapidly destroyed by spring high flows, or have deleterious consequences downstream.[87] Placing structures in a severely degraded stream where watershed management practices are not likely to change is not recommended. One study shows that restoration structures in the most heavily damaged watersheds are the most likely to be ineffective.[88]

Sometimes instream structures can be successfully incorporated into a larger restoration strategy, if carefully planned by an experienced fluvial geomorphologist (a river specialist) or hydrologist. Unless you are a trained restoration scientist, however, do not attempt to place instream structures on your own. Although it may appear simple, avoiding unintended consequences downstream is quite tricky.

Woody Debris and Root Wads

In healthy streams, woody debris and root wads can create habitat diversity by forming pools, waterfalls, and places for sediment to collect, while also adding organic nutrients to the water. Often the best management for improving stream habitat is to allow trees to remain where they fall. It was previously considered proper stream management, however, to remove woody debris, in the belief that it impeded fish passage.

Large woody debris.

When research showed that logs could be beneficial, funding for salmon recovery emphasized placing logs across the stream. This was done with maximum engineering; the root wads and branches were removed, the logs were cabled into place, and a V-slot was cut to allow fish passage. Subsequent studies showed this method could actually harm stream function and habitat-forming processes.[89]

The goal of adding woody debris should be to provide similar amounts and sizes as would naturally be in the stream. It's important to leave the root wads and branches on the trees. These structures should be placed carefully so that they do not diminish channel forming processes, such as pool formation, channel migration, streambank building, or vegetation regrowth.[90]

Levees

Levees are fill material used to build up stream banks, keep water in the channel, and prevent the channel from changing course. Building levees changes the natural dynamics of the river, with reverberations upstream and downstream. Squeezing floodwaters through a narrow channel instead of spreading them across the floodplain increases downstream flooding.

The water runs more swiftly and gains more power to scour streambanks downstream or incise channels. More sediment is carried downstream. Where the channel widens, the stream loses its power to transport sediment and deposits it. In addition, as flood waters rise and the natural channel is forced through a section of levees, it may back up and flood upstream.

Levees on a heavily used stream.

What good can one dead tree do?

Quite a lot—if it falls into a stream.

The Upper Grande Ronde River once supported a large population of spring and fall chinook and coho salmon. Coho are now extinct in that area, and fall chinook may be—but small numbers of spring chinook continue to return and spawn in the upper reaches. The river has been heavily used for agriculture for several generations, runs close to a highway for many miles, and drains a watershed in the Wallowa-Whitman National Forest largely managed for timber harvest. Until about ten years ago, woody debris was systematically removed from the stream in the belief that it blocked fish passage.

It is now recognized that woody debris actually performs critical functions for water quality and fish habitat, and that it does not often block passage. But few trees have fallen into the Upper Grande Ronde River after management policy changed. Here is the story of one tree that fell.

A ponderosa pine stood on a spot between the Upper Grande Ronde River and the highway. It had seen about 100 summers and winters. Most of its companions had been removed to make way for the road, and very little other vegetation remained on this reach of stream, in an area heavily grazed by livestock. Spring floods gradually cut away the soil under its roots, and on a stormy day in 1992 the tree toppled over with a sigh and a loud, booming splash. It fell parallel to the bank on the outside of a curve, roots bare to the sky, branches flailing the water. The river flowed around it and sometimes over it, but not even the next years' floods had enough strength to wash it away.

When a fisheries biologist noticed it a year or two later, here is what the fallen tree had created:

- A deep pool on both sides downstream of its root wad
- A large gravel bank downstream of its scraggy top
- New vegetation taking root in the gravel and sediment of the bank
- No more erosion on the outer edge of the curve

"Lots of people notice that tree," a forest ranger said. "It's right by the road, and it's a perfect example of what happens naturally when a tree falls into the stream."

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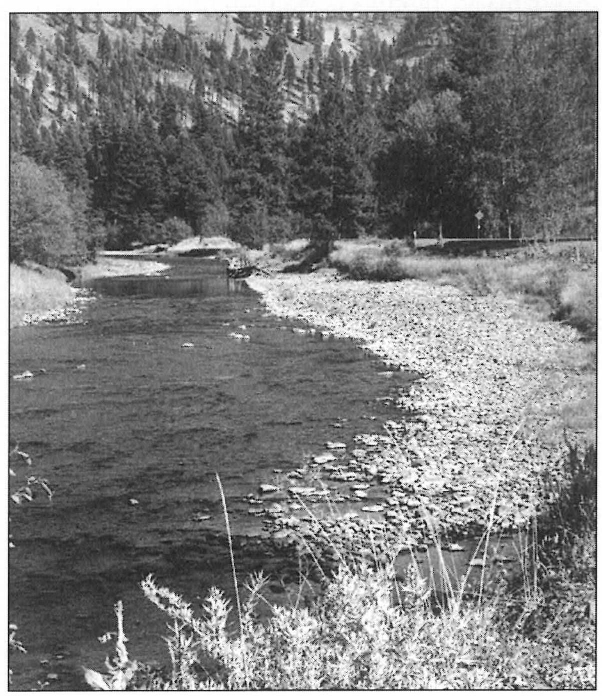

Riprap

Rocks used to armor the riverbank are called riprap. Use of riprap has downstream effects. The riprap serves to bounce water off one section of the streambank and deflect it to another. This concentrates the river energy and erodes the bank even more. The new erosion stimulates the landowners downstream to riprap their own banks and pass the problem along. Riprap prevents the development of meanders, meander-bend pools, and pools beneath undercut banks, all of which are highly beneficial, both in terms of stream dynamics and fish habitat.[91]

Riprap can be an even more difficult problem than levees, because the cumulative effect of individual uses can freeze entire sections of the river into place.

Removing Fish Passage Barriers

Barriers to fish passage created by human action range from Grand Coulee Dam to minor culverts. Many thousands of miles of habitat can be opened again to anadromous fish if we are willing to remove the barriers or provide fish passage around them. In the case of Grand Coulee, that would require a technologically challenging redesign and a lot of money. But in many other cases a relatively small expenditure can accomplish a great deal.

Large dams are discussed earlier in this section, as are small dams such as gravel berms or pushup dams. Many small, permanent irrigation dams also can or do block fish passage if they were not designed with fish in mind. It is often possible to modify these at relatively low cost to allow fish passage. Technical assistance and some funding is available from NRCS, Bonneville Power Administration, and the Bureau of Reclamation.

Removing or repairing culverts is a small-scale but extremely effective way to increase fish habitat. Culverts can block fish passage in various ways. As soil erodes away under the outfall, the pool drops farther below the culvert than a fish can jump. Or, by constricting the flow, a culvert can create water velocities too fast for a fish to enter. Plugged culverts cause water to find another path, but it is often not a path a fish can follow.

Culverts like this block fish passage into small streams that could otherwise provide spawning and rearing habitat or refuge areas.

Supplementation: Using Hatcheries to Increase Naturally Spawning Runs

While it is important to restore fish habitat, it is equally important to put the fish back into the streams. Properly managed hatcheries can be effective tools for restoring naturally spawning wild salmon populations.[92] The hatchery should be a part of "gravel-to-gravel management"—a holistic approach to restoring natural habitat on tributary, mainstem, estuary, and ocean.

Standard hatchery operation is "concrete-to-concrete" management. Fish are released from the hatchery and return to the hatchery to be artificially spawned. In this case, the purpose of hatchery production is to raise fish strictly for harvest.

In contrast, the Columbia River tribes are successfully using hatcheries to increase or restore naturally

"Standard hatchery practice has taken fish out of the wild spawning population, put them in a hatchery, and had them return to the hatchery, never again to spawn in the natural habitat. That's concrete-to-concrete management. What we're saying here is you take some of those fish from the natural spawning population into the hatchery and rear them, then release them back into the natural habitat so they will return to spawn there—it's concrete to gravel to gravel. That way the naturally spawning population will increase."

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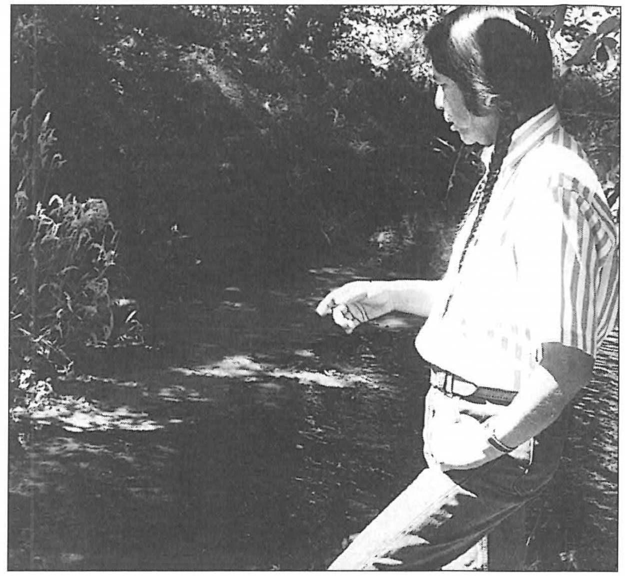
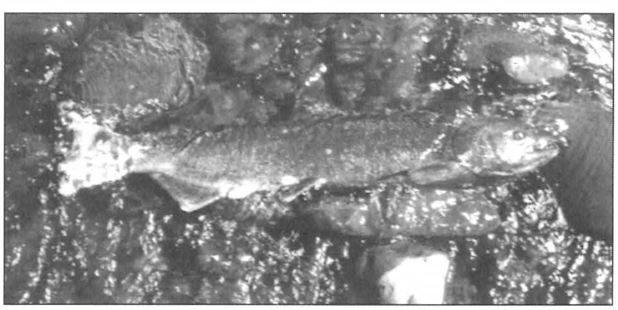
Don Sampson
CRITFC Watershed Department Manager



Armand Minthorn, member of Umatilla Tribe's Board of Trustees, at Minthorn Springs acclimation site.

occurring runs. This practice is called "supplementation." In supplementation, young fish from a hatchery are moved to an acclimation site on a healthy reach of stream, where conditions are favorable for feeding and rearing. They leave when they reach migration size, and return to spawn naturally in this natal reach. Their bodies become part of the nutrient cycle of the stream and watershed instead of ending up in a landfill.

Supplementation relies on the natural environment for most of the life cycle, and is less intrusive than expensive captive rearing programs. It works because young salmon "imprint" on the stream they are released into. It is believed that young salmon learn cues such as the smell and taste of the water in the particular tributary they rear in. When, as adults, they leave the ocean and head back into fresh water to spawn, they search for their own unique stream.



Part of the cycle of birth and death. The body of this spawned-out female spring chinook will become food for eagles, ravens, other fish, or aquatic insects.

Supplementation was used to bring salmon back to the Umatilla River basin, where the last chinook and coho spawned more than 70 years ago. (See Good Partnerships section.) Fall chinook released from acclimation ponds on the lower Yakima River near Prosser, Washington, are also returning in numbers large enough for a modest harvest season in 1998.

Good Partnerships

> **"We were walking a tightrope between water for salmon and water for agriculture. We gradually quit screaming and fighting and began to talk."**
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> **Don Sampson, former chairman Confederated Tribes of the Umatilla Indian Reservation, describing Umatilla Basin Project**

Partnerships are the key to success in watershed restoration. A single watershed may cross city, county, and state lines; it may require tribes, landowners, watershed councils, states, local governments, federal agencies, and citizen groups working together to restore watershed function and healthy fish and wildlife. In many cases, there isn't a single entity with the authority (and funding) to get the work done. All of the projects described in this handbook, whether they were initiated by an individual landowner, tribal staff, or a federal agency, are based on partnerships.

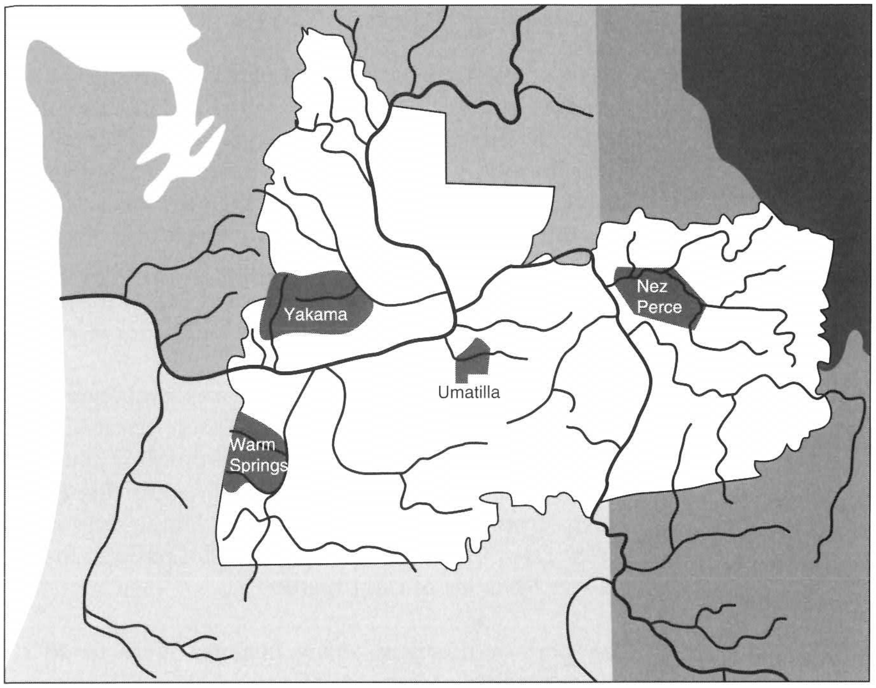
This section explains the Columbia Basin treaty tribes' interest in helping to restore and maintain healthy watersheds in areas outside the reservations; it describes how a successful partnership brought salmon back to the Umatilla River; it introduces the Salmon Corps, a powerful tool for the work of restoration; and it summarizes steps to forming partnerships for local projects.

THE CEDED LANDS

In the Columbia Basin, tribal interests and rights go beyond the borders of the reservations. In the Treaties of 1855, the Columbia Basin treaty tribes ceded a vast territory—approximately 40 million acres—to the United States, but reserved rights to fishing in the "usual and accustomed places" and the rights to hunt, gather roots and berries and pasture horses and cattle on "open and unclaimed land" within the ceded area. These rights have been confirmed repeatedly in the courts.[1]

The courts also established that the federal government and treaty tribes should cooperate in the management of the Columbia River. The 1988 Columbia River Fish Management Plan, an agreement among tribal, federal, and state parties with jurisdiction over Pacific salmon originating in the Columbia Basin, provides procedures for these parties to "co-manage" anadromous fish production, harvest, and habitat.[2] It also bound the parties to the agreement to use their best efforts and authorities, including habitat protection authorities, to rebuild salmon runs.

Most of the habitat in question, however—not just the river itself, but the vast watershed that is the Columbia Basin—is either privately owned or under the jurisdiction of federal agencies. Therefore, because there are many owners and managers of the land, it is important to work as partners to accomplish salmon restoration.



Area in white was ceded by the Columbia River Treaty Tribes in 1855 treaties.

"By building a partnership you create an understanding and build some trust," Don Sampson explains. Sampson is the manager of the Watershed Department of CRITFC and former chairman of the Confederated Tribes of the Umatilla Indian Nation (CTUIR). "In the past 100 years there's been a change in mind and heart. By working together you can make changes for the long-term that are much more sustainable than anything you can get from litigation."

THE UMATILLA BASIN PROJECT [3]

These changes are visible in the partnerships that successfully returned coho and chinook salmon runs to the Umatilla River in north-central Oregon. Because of dams, other passage obstructions, and seasonal dewatering of the river for irrigation, no salmon had spawned in the Umatilla River since 1920. Now, after 70 years of absence, coho, spring chinook, fall chinook, and steelhead are all coming back—thanks to a cooperative effort spearheaded by the CTUIR in partnership with the Oregon Department of Fish and Wildlife, the Bonneville Power Administration, the US Bureau of Reclamation, Oregon Water Resources Department, and the Hermiston, Stanfield, West Extension, and Westland irrigation districts.

Irrigation and the River

At the time of the treaties with the Columbia River tribes, tens of thousands of coho, spring and fall chinook, and steelhead reared in the Umatilla River basin and found their way back to spawn. But soon after the turn of the century the state began allocating Umatilla River water to "beneficial uses," primarily irrigation. The Bureau of Reclamation subsidized the construction and operation of dams and irrigation canals that blocked fish passage and dewatered the river from June to October.

Because of low flow and blocked passage, coho and chinook salmon stocks were extirpated from the Umatilla River by 1920. Drastically reduced numbers of steelhead continued to return and spawn.

Tribal Water Rights

In the Treaty of 1855, the tribes never gave away the water they had used since aboriginal times. Instead, the Treaty explicitly reserved several rights that require water to support—such as the continuing right to fish. These rights were for both on-reservation use ("consumptive" use) and instream flows on and off the reservation, including rivers on the ceded lands. While the federally reserved rights had not been quantified, they were unmistakably senior to all other rights, dating from 1855, and, in the case of instream flows, "from time immemorial." (See discussion in Restoring Instream Flow section on page 16.) Although the tribes' water rights are considered federally reserved, the US did not protect this water for the tribes, but instead played an active role in diverting this water to non-Indian irrigators.

In the late 1970s, tribal leaders of the Umatilla Reservation decided to try to bring salmon back to the Umatilla River. They recognized that to do that they had to bring some of the water back.

"It was long-term thinking," Don Sampson explains. "It came from a sense of belonging to the river—our ancestors are buried there, our encampments and villages have been there for thousands of years, and the salmon were there for thousands of years, too. Those things have a right to that place.

"There is a spiritual connection between where we live and what we eat. It runs through your blood. People want to go back to those places. The plants are there to be gathered, the fish are there to be caught."

Finding a Win-Win Strategy

The tribal leaders knew that if they chose to go to court to take water away from irrigation and put it back into the river, they would eventually win. But they were concerned about the impact of a successful legal decision on the local irrigation economy. Their goal was to bring the salmon back—not to harm the local community.

"We were walking a tightrope between water for salmon and water for agriculture," Sampson remembers. "If the Indians could restore salmon and if the irrigators could secure a source of water for their living, each would be more satisfied." Local water users, including the Cities of Pendleton, Hermiston, Stanfield, Umatilla, and other groups, also wanted to find a way out of the impasse without endangering the local economy.

"We gradually quit screaming and fighting and began to talk," Sampson says. "We found leaders who shared a common vision, and we began to build something sustainable."

The tribal leaders teamed up with Oregon Department of Fish and Wildlife to identify problems, propose projects, establish numerical goals for adult salmon returns, and seek funding.

They decided the following actions would be necessary:

- Put more water in the lower reach of the river, below the irrigation dams.
- Address obstacles to fish passage.
- Restore stream habitat.
- Build a hatchery to restore naturally spawning runs by releasing juveniles into the stream.

Building Partnerships

Each of these steps required partnerships in various combinations of federal, state, tribal, and private interests. A Umatilla Basin Project Steering Committee was formed. The committee asked the Bureau of Reclamation to study ways to increase streamflows on the Umatilla River without adversely affecting irrigation. Tribal representatives and local water users studied the alternatives and agreed on a two-phase plan that involved both pumping and water storage.

Water from the Columbia River was exchanged for water from the Umatilla River. Three irrigation districts now receive water pumped from the Columbia at McNary Dam. The water formerly supplying these areas from the Umatilla River and McKay Reservoir now stays in the river to benefit fish passage in the lower 50 miles of the Umatilla.

As part of the plan, many changes were made to improve fish passage up the river. New fish screens and fish ladders were installed at Three-Mile Dam and structural changes were made to help migrating fish find the entrance to the fish ladder. New fish screens and ladders were constructed at four other irrigation diversions on the lower Umatilla River.

Hatchery facilities to reintroduce salmon to the river were built at Bonifer Springs on Meacham Creek, an upstream tributary of the Umatilla River, and at Minthorn Springs, an ideal water source just off the mainstem Umatilla River, where juvenile salmon could be acclimated to the stream, released, and allowed to return to spawn naturally. Acclimation facilities also were constructed at Gibbon and Thornhollow, on the Umatilla River mainstem.

The CTUIR, ODFW, and the Forest Service are jointly implementing many instream and riparian enhancement projects throughout the Umatilla Basin. Several areas have shown remarkable habitat recovery. This is expected to directly increase natural fish production in these streams by providing better conditions for the survival of both adults and young.

The Oregon Department of Environmental Quality, the Umatilla Basin Watershed Council, and the Umatilla tribes are working on a study of water quality in the basin that will result in defining a "total maximum daily loading" (TMDL) of pollutants for water-quality-limited streams. The TMDL provides a criterion for meeting water quality standards. Approximately 30 water-quality-limited reaches have been designated under the Clean Water Act in the Umatilla Basin. The TMDL process in the Umatilla Basin is designed as another cooperative project between local parties.

The Salmon Return

The visible result of all these partnership efforts is in the river—the salmon have returned. Thanks to the restoration program that the Umatilla tribes began in the late 1970s, spring chinook started returning in small numbers in the late 1980s. In 1996, 2,300 returned. Fall chinook and coho returns also increased over the last decade. More than 6,000 salmon of all species returned in 1997 and 1998.

The Umatilla Tribes' goal is to see 47,000 natural and hatchery-produced salmon adults return each year to the Umatilla Basin. Much work remains to be done to make this goal a reality. The tribes are committed to working for restoration rather than accepting extinction. Today's success is a good start, but the future depends on continuing cooperation and understanding among all parties. The tribes hope that the successful cooperative strategy used in the Umatilla Basin can be applied to resolve other problems throughout the Columbia River system.

Visitors watch Brian Connor, Umatilla, as he measures a returning salmon at the Three-Mile Dam facility.

SALMON CORPS

The Salmon Corps, administered by the Earth Conservation Corps, began in 1994, with the goal of engaging Native American youth in the Pacific Northwest to repair the disappearing salmon habitats of the Columbia Basin. Salmon Corps comprises more than 100 young adults (18 to 25 years old) at six sites in the Columbia Basin. Eighty-five percent of Corps members are Native American. Non-native members are drawn as much as possible from the local area.

"After they've spent a few days working side by side with us they understand better who we are and why we protect the land the way we do."

Charles Sams
Salmon Corps director

"We believe the people who live in a place are the best stewards of the resources there," explains Charles Sams, director of Northwest operations for the Earth Conservation Corps and a tribal member. Salmon Corps members are trained in habitat restoration and experienced at working in partnership with local landowners and organizations.

"Conservation begins with the boots on your feet" is the Earth Conservation Corps" slogan. A nonprofit founded in 1989, Earth Conservation Corps' mission is to do environmental restoration and strengthen communities while providing training and opportunity for at-risk youth.

Salmon Corps works in partnership with AmeriCorps and many tribal, federal, state, and local organizations to define its projects and collaborate on funding. Private landowners can also initiate projects by contacting a Salmon Corps field director and negotiating a contract. (See Resources section.) Because of its nonprofit status, low overhead, regional sites, and training with natural resource professionals, Salmon Corps can successfully complete a wide variety of projects for one third to one half of market cost.

In four years, Salmon Corps has served more than 350 young adults. The program has graduated more than 70 percent of these participants. The national average for programs for at-risk youth is 49 percent. Crew members have completed more than 300 watershed and salmon habitat restoration projects. In partnership with local landowners, they have built 365 miles of riparian fence and outplanted tens of thousands of native trees and other vegetation. They have monitored water quality and have released more than six million anadromous fish into the Columbia Basin.

Salmon Corps field directors are on-site managers, responsible for day-to-day operations. Tribal liaisons, appointed by tribal government, provide guidance and in-kind support and help choose projects that meet tribal watershed restoration priorities defined in the salmon restoration plan, *Wy-Kan-Ush-Mi Wa-Kish-Wit.*

Building Community

Gina George,
Yakama Salmon Corps
field director.

Gina George is the Yakama Salmon Corps field director. Gina, a Yakama tribal member, grew up near Goldendale, Washington. "I was raised along the Columbia River," Gina says, "fishing and gathering our traditional plant foods. I was in AmeriCorps when I first heard of Salmon Corps. We were doing a lot of work for the City of Goldendale and the farmers and ranchers there, and my cousin was in the Umatilla Salmon Corps. I thought it was a great opportunity, especially the scholarship money for school. I tell people in our program how important education is—you can't go anywhere and get a job without it."

The education can work both ways. "Many of those who live closest to us know the least about us," Charles Sams comments. "On many Salmon Corps projects we find the landowners initially skeptical. After they've spent a few days working side by side with us they understand better who we are and why we protect the land the way we do."

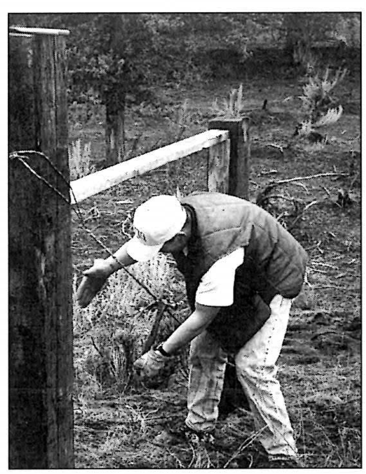
Gina's crews get varied experience in environmental and community work. In addition to replanting native vegetation, installing fencing, and other riparian or instream restoration work, they have pulled trash from high alpine lakes, helped repair elders' homes on the Yakama Reservation, and traveled to huckleberry fields near Mt. Adams to thin out the trees near the huckleberry bushes. "The elders thought it needed to be done," Gina said. "Huckleberries are important food for the Yakamas. They grow better with just the right amount of light and space and shade. I had 11 in my crew and we did 25 acres in four days."

An important benefit for the Salmon Corps members is the opportunity to get to know tribal elders better. "In western culture the youth can make radical changes," Sams explains, "But on tribal lands you have to get the elders to say what should be done. The elders and youth work together a lot, and that helps build community."

Building Fences

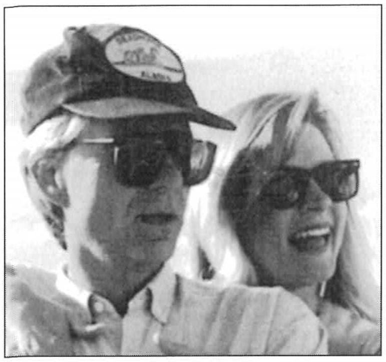
A Warm Springs Salmon Corps crew helped install high-tensile, smooth-wire fencing for a rancher on the South Fork John Day River of central Oregon. Phil St. Clair found that keeping his cattle entirely out of a riparian area was the only way to stop heavy soil erosion and allow the vegetation to recover.

"My wife's father had this place, and when he died my family bought it and it was leased for a few years," Phil St. Clair explained. "I started to realize some things were going wrong .... For one thing, there were no fish. That made me sit up and take notice. I couldn't use it at the level I was using it, or it was going to get worse.

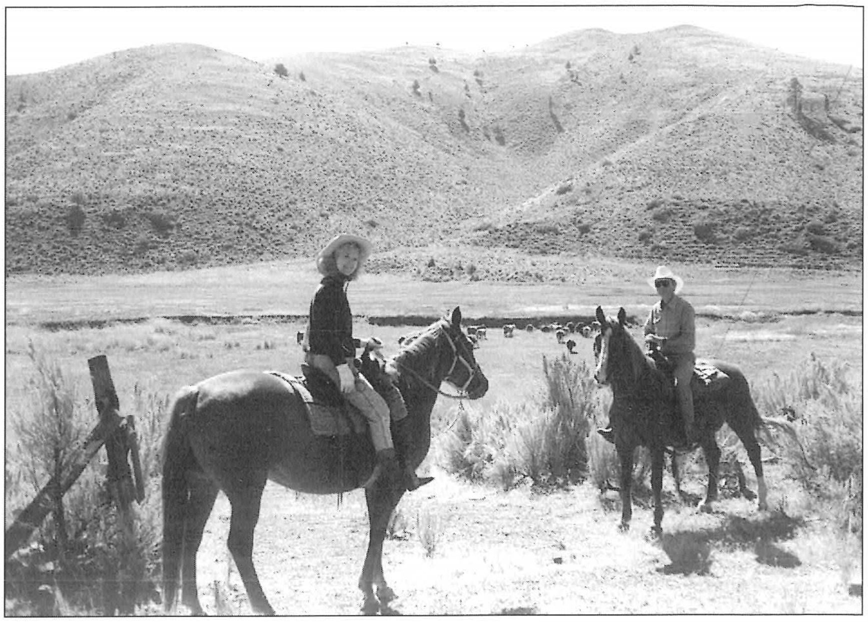


A Salmon Corps worker.

"In this juniper and sagebrush steppe country, floodplain and hillside is all there is. The deeper soil and water are in the floodplain. So I



Phil and Kristy St. Clair at their ranch in central Oregon.



raise hay on the floodplain and let the cows onto it in the fall after cutting the hay and getting a little regrowth," St. Clair explained. But he was losing more of his hay meadow each year to erosion from winter and spring floods. The worst damage was along a field he used for breeding heifers.

"The ground that was eroding is my most productive and fertile soil," St. Clair said. "I can't afford to see it go down the river. In the condition this field was in, if I wanted to see recovery in my lifetime, I had to build a fence."

St. Clair designed a fencing and bank stabilization project with help from the US Fish and Wildlife Service's Partners for Fish and Wildlife program and the Oregon Department of Fish and Wildlife. He obtained some funding from the Governor's Watershed Enhancement Board, some materials from ODFW, provided some of his own funds, and put up about two miles of fence with some help from Oregon Trout and a Salmon Corps crew from the Confederated Tribes of the Warm Springs Indian Reservation.

"I appreciated the help immensely," St. Clair said. The riparian area is showing signs of recovery, with new vegetation, a more stable stream channel, a rising water table, and more redband trout (these are resident fish; a natural barrier downstream prevents salmon from spawning here).

"We've signed an agreement with ODFW not to graze in the riparian corridor for 10 years, unless we both agree the area has recovered sufficiently," St. Clair said. The river is being monitored by Shaun Robertson, a Warm Springs Tribe fisheries biologist, who will survey fish populations, channel width, water temperature, macroinvertebrates, and other variables.

STEPS TO GOOD PARTNERSHIPS

After you have chosen a protection or restoration project, you will need to build good partnerships for finding funding and getting the work done. The following is an overview of the process. See Resources section for more sources of information and contacts.

- Find out if there is a watershed council or other organization already involved in watershed restoration in your area. If so, it may be able to help.
- Identify all the people with interests in this watershed, stream reach, and project. These are the "stakeholders." They may be:
    - private landowners
    - tribes
    - watershed council
    - state agencies
    - federal agencies
    - environmental organizations

Some of the CRITFC staff, tribal fisheries staff, interns, and commissioners at 1995 watershed workshop.

- Organize several meetings to explain the project, gather and share information, and listen to all points of view.
- Form a technical advisory team of staff from agencies and organizations that can help you gather information and find solutions to problems.
- As a means of resolving conflicts and building consensus, search for underlying common values and goals.
- Describe the shared vision of what the watershed/stream reach could be—and what everybody is willing to agree is desirable.
- Identify issues and decide on strategies.
- Make the project a feasible, do-able size.
- Decide how to monitor and evaluate the project.
- . Change your strategies depending on what the monitoring shows.

Good Results: Monitoring and Evaluation

WHY MONITOR?

- To pinpoint what to do and where it will be most effective.
- To justify continued funding of your project. You can demonstrate what you have completed, what results have occurred, and/or what further work or adjustments you propose.
- For adaptive management. To find out whether your restoration efforts had the intended effect, and, if not, what to do in the future to improve the outcome.
- For getting the story out. A successful restoration project with supporting monitoring data is a powerful public relations or educational tool.

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Monitoring is probably the most talked about and least undertaken part of restoration. Why? Because, as rancher Phil St.Clair commented, "It's work and it costs money." On the other hand, it's second only to watershed assessment in importance. There's no point in spending time and money on restoration if you don't know whether or not it did any good.

This section offers an overview and some startup advice for monitoring watershed restoration. Detailed guides to monitoring are listed in the Resources section.

This section also includes a brief discussion of the value of monitoring water quality to identify and reduce water contaminants coming from urban, industrial, and agricultural sources.

Field crew sampling Meacham Creek fish population to estimate abundance, age, and growth characteristics.

ESTABLISH A MONITORING GOAL

The key to good monitoring is establishing a clear goal and focusing your question or questions. Then set up the monitoring plan to answer those questions. Monitoring without a clear goal may get you random information that you can't use.[1]

With monitoring, as with watershed assessment, there is always a question of scale. How far do you need to go with your monitoring, in terms of time and geographic area? That depends on the scale of your question.

Wy-Kan-Ush-Mi Wa-Kish-Wit notes that there are several types of monitoring, with increasingly larger questions requiring a wider geographic range and more effort.

- Implementation: Was the project implemented and completed as planned?
- Results: Was the project effective in producing anticipated results?
- Cumulative results: Were groups of related projects effective in producing desired aggregate results?
- Management effects on salmon: Did anadromous fish populations (monitored by life stage) respond to human-caused changes in the ecosystem?

- Trends: Is there a measurable trend in environmental conditions and/or the productivity of anadromous fish populations over their entire life cycle?
- Validation: Are models and assumptions about biological and physical processes and relationships used in management accurate and reliable?

A basic question is whether or not the project was completed. If you obtained funding from an agency or foundation, you'll need to account for its use.

As a bare minimum, you can monitor photo points. Monitoring photo points (taking photographs at the same point[s] repeatedly over time) is a relatively easy, inexpensive, and effective way to document project completion. It can also establish visible baseline conditions and visible trends in vegetation and channel that may be related to restoration.

Other basic questions: Have important water quality parameters improved locally? Has salmon habitat improved locally? Have salmon come back to, or increased in, this stream? These can probably be answered with a well-designed monitoring plan carried out by trained volunteers, with some technical advice, over a period of several years. The larger questions concerning cumulative effects of projects, management, and trends over a wider area require considerable scientific and funding support.

DEVELOP A MONITORING PLAN

What parameters to measure, what methods to use, when to monitor, and how often to monitor are key questions. There's no simple answer; it depends on what type of monitoring you undertake. As you consult guides and develop a monitoring plan you will also work out a protocol.

The following questions may help to focus your monitoring goals.

- What were your issues or concerns for starting this project?
- What factors potentially limit salmon survival in this area?
- Are these limiting factors within your control, or are they influenced by upland management activities that are out of your control?
- What is currently known about stream conditions? What additional information is needed?
- Which stream health variables are expected to respond to project management?
- What are the constraints of budget, personnel, expertise, site conditions, etc.?

Assign priorities to what you need to know. Narrow it down to specific parameters, based on your goals.

Choose Parameters

While you need to select parameters that can feasibly be measured, given staff, budget, and weather constraints, it is also important that the parameters be able to indicate changes beyond natural variability. Parameters such as temperature, flows, and sediment that can be measured during the summer base flow period generally reflect a variety of conditions, such as those resulting from the annual cycle of streamflows, channel response to these flows, vegetative growth, and watershed impacts. These parameters are also the easiest to measure.

The following are some commonly measured parameters you may want to use.[2] Some of the measurement methods require sophisticated equipment and training, while others are relatively accessible and can be set up and used by any careful person following technical guidelines. For more detailed information, consult one of the publications or individuals listed in the Resources section.

Temperature
Temperature is monitored either by a thermometer, paper chart thermograph, or digitally recording thermistor. The analog or digital recorders allow for continuous monitoring. Digital recorders are most convenient in allowing transfer of data directly to a computer. Stream temperatures can vary across the stream, through time, and with water depth. Measurements should generally be taken in a turbulent stretch of the stream to obtain an average.

Suspended Sediment
Suspended sediment is an important variable to measure, because high concentrations can affect spawning success. It is measured by obtaining a water sample and then drying or filtering the contents and

weighing. Measurements can be complicated, since sediment concentrations vary greatly over time, among cross sections, among points across the stream, and with depth in the water column. A depth-integrated sampler, which measures concentrations at all depths, is preferred. Samples are best taken throughout high flow events, since this is when most sediment becomes suspended.

Changes in Flows

Peak Flows

Peak flows are an important consideration in salmon habitat maintenance and restoration, since they shape channels, determine how much sediment can be carried by the channel, and determine whether or not erosion, deposition, or scouring of sediment will occur. Changes in peak flows can be measured a number of ways. One way is to measure water surface elevation (called stage), convert this measurement to streamflow, and compare this to streamflow in a similar basin in which management or restoration activities are not taking place. To establish a valid statistical relationship, these measurements have to be taken over a number of years.

Low Flows

Changes in low flows can significantly affect fish habitat. This parameter is most accurately measured by comparing an unmanaged or pristine watershed to a restored or heavily managed watershed. It is often difficult to detect these differences among large streams, so these changes are better measured in smaller tributaries.

Channel Cross Sections

Changes in channel morphology, as measured by cross-sectional features (area, form) may be valuable to monitor for several reasons: they can be used as benchmarks for other parameters such as width-to-depth ratios or channel incision; they may provide information on channel or bank stability; and they can also provide information on the balance between sediment and flow. Measure changes in cross section by surveying a series of cross sections at each of several key stream segments in order to account for site-specific factors. Segments surveyed for cross section should represent spawning and rearing areas that might reflect channel-forming processes. While changes in cross section are easy to observe, it can be difficult to determine their cause.

Pool Characteristics

Changes in pool characteristics can indicate trends, since sedimentation is often related to management activities. Pools may change because of other factors, however, such as changes in streamflow or woody debris. Streamflow affects pool depth, area, and volume; therefore, it's important to measure streamflow each time you measure pool variables.

Channel Bed Material or Substrate Sedimentation

The size and transport of particles on a streambed is important because it affects the distribution of energy in a stream, the stability of the streambed, and the amount of aquatic habitat available. Fine particles fill up the spaces between larger particles of gravel, reduce the oxygen flow, and thereby reduce the survival of salmon eggs and newly hatched fry. This parameter can be measured either through the use of pebble counts or bulk samplers. Timing is important; sampling too soon after a high flow event may give misleading results, since high flows will mobilize smaller particles and transport them downstream.

Large Woody Debris

Large woody debris is a critical component of fish habitat in a stream. It helps with pool formation, contributes to bank stability, and generally results in higher salmonid productivity. For these reasons, it is an important parameter to monitor. The most common method is to measure the size and frequency of pieces within a defined reach.

Streambank Stability

The "dynamic equilibrium" of a stable stream involves, by definition, a range of behavior in any stream parameter and is continually adjusted by a multitude of factors. Channel stability is reflected in upper bank, lower bank, and in-channel stability factors. Due to its multiple facets and dynamic nature, measurement requires care in order to meaningfully follow trends. It is nevertheless useful to have a rough indication of a shift in the equilibrium of a stream. One of the most common measurement methods evaluates parameters at various points in the channel and bank, weights them, and tallies a result.[3]

Riparian Vegetation

Riparian vegetation is important for stream shade, recruitment of large woody debris, inputs of organic matter, and cover for fish. Qualitative and quantitative measures include assessment of vegetation type (tree, shrub, forb, grass), density, height class, percentage cover, and buffer width. A summary of some useful methods is provided in the EPA guide to monitoring. [4]

Fish Community

Fish can be monitored to detect presence or absence of a species, number or density of individuals of a species in a fixed area or stream length, productivity, and species or age class diversity. The composition of the fish community can be used as an index of the health of the stream. Fish can be counted by electroshocking, which is commonly used because of its high accuracy, or by direct observation by snorkeling.

Salmon Abundance

There are a variety of techniques to assess changes in salmon numbers. Redds can be counted to obtain an estimate of numbers of spawning salmon pairs. Emergence traps are used to estimate the numbers of fry emerging from a single redd. Counts are also made of salmon returning to a stream to spawn, of fish carcasses following spawning, or of the number of juveniles or smolts migrating out of a stream to downstream rivers and the ocean.

Macroinvertebrate Community

Macroinvertebrates are "large" organisms without backbones, such as insects, worms, and snails (compared to vertebrates, they're actually small). They are often used in monitoring programs because they are an important source of food for fish, as well as an indicator of general stream habitat and water quality conditions. Certain types of aquatic insects can survive only in streams with high water quality. Macroinvertebrates are relatively easy to sample and are abundant in streams. Sampling techniques vary depending on whether presence/absence, relative abundance, or density or biomass estimates are sought. Data are usually analyzed for species richness (the total number of different species present), abundance, or diversity (a combination of richness and abundance). Stream health can be defined in terms of the types and combinations of macroinvertebrates present.

Get Baseline Data

To measure change it is essential to have pre-project baseline data. Therefore, the monitoring plan should be completed and the baseline data gathered before the project starts.[5]

MONITOR CONTAMINANTS

Numerous permitted industrial processes, agricultural and forestry practices, and nuclear waste discharges can contribute highly toxic, persistent chemicals to the water environment. These can pose health risks to fish, wildlife, and people, especially people who eat fish.

Chemical contamination in fish cannot be detected by smell or taste. Although visible physical abnormalities in fish such as lesions or tumors may be indicative, laboratory analysis is the only way to confirm the presence of contaminants in fish tissue. Although fish tissue analyses are very expensive, the states, the USEPA, and industry itself must provide this type of monitoring to protect health and assure that water quality standards are not being violated.

Individuals or groups concerned about exposure can examine a state's human health risk assessment methodologies to determine whether water quality standards are adequately protecting human health.

Because many tribal members rely on fishing for some portion of their subsistence, the Columbia River Inter-Tribal Fish Commission conducted a study to document fish consumption rates, patterns, and habits and to assess tribal members' exposure to contaminants from fish.[6] They found that those who eat fish and who participated in the survey consumed approximately 58.7 grams of fish per day. This is approximately nine times the 6.5 grams per day estimate for the general population that the USEPA and the states use to develop water quality criteria for human health. The results of the study indicate that current water quality standards may not adequately protect those for whom fish is a staple.

Other kinds of monitoring that can be helpful in understanding and controlling toxic pollution are the following: monitoring industrial permits and researching the chemicals being discharged; obtaining local information on pesticide use and finding out whether or not these pesticides are illegally entering fish bearing waters; monitoring Forest Service herbicide spraying near fish-bearing streams; and preventing spraying during windy or other weather conditions that distribute the chemicals beyond the intended area.

EVALUATE AND INTERPRET THE RESULTS

Monitoring watershed conditions and water quality is a long-term project requiring both commitment and technical assistance. To conclude that stream conditions and habitat have changed, and that the change is due to a restoration project, requires baseline data from before the project and several years of monitoring after the project. The data need to be collected in a consistent and precise way, and a technically trained person needs to review both the data and the methods periodically to be sure they are valid.

> **". . . . Education is to the mind what dreams are to the heart. If we use both sides of our brain and the fullness of our heart, we just might see precious life restored to our great homeland."**
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> ✦
>
> **Ted Strong**
> **CRITFC executive director**

Tribal, federal, or state fish and wildlife agencies or departments of environmental quality or the equivalent can usually provide some of the technical assistance needed to collect, evaluate, and interpret the data. Such help is essential.

When monitoring results are in, and you have answers to some of the basic questions you started with (has salmon habitat improved?), it's time to celebrate. If the project succeeded, you know more about designing the next one. And if it failed, you also know more about designing the next one. Human wisdom, in both the Native American tradition and in modern science, involves observing, learning, and changing in response to the natural world. May your work go well.

footnotes

INTRODUCTION

1 Stanford et al. 1996

2 Nehlsen et al. 1991

GOOD SENSE

1 The following discussion is based substantially on Montana Department of Environmental Quality 1995

GOOD SCIENCE

1 REO 1995, GWEB 1997, and Washington Forest Practices Board 1997

2 Quigley et al. 1997

3 Information on conservation easements from Jayne Cronlund, Three Rivers Land Conservancy, Lake Oswego, Oregon (personal communication), and from Small 1992.

4 This section based on information from Gillilan and Brown 1997, Landry 1998, Sterne 1997, tribal legal staff, WaterWatch, Oregon Water Resources Department, Oregon Water Trust, Idaho Department of Water Resources, and Washington Department of Ecology.

5 See, especially, Gillilan and Brown 1997.

6 See Wilkinson 1992 for broad discussion of Western water law.

7 *United States v. Winters* (1908) and *United States v. Adair*, 723F.2d 1394, 1408-15 (9th Cir. 1983), cert. Denied, 467 US 1252 (1984)

8 Cohen 1982, pp. 575-580; see also Pisani 1996.

9 A detailed summary of Pacific Salmon habitat needs, with extensive bibliography, is in Appendix A of Amendment 14 of the Pacific Coast Salmon Plan, Pacific Fishery Management Council, 1998.

10 This discussion is based on information from Gillilan and Brown 1996; Douglas Parrow, in OSU Extension 1992; Natural Resources Law Center 1997; and personal communications from staff of Oregon Water Resources, Idaho Department of Water Resources, and Washington Department of Ecology.

11 Landry 1998

12 Teanaway case study contributed by Tracey Yerxa, US Bureau of Reclamation.

13 Bottom 1997

14 Frissell and Nawa 1992

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17 Kyle 1998 p. 6-7

18 This information obtained from Portland City Councilman Erik Sten's office.

19 This discussion based on Independent Scientific Group 1996 and information from Robert Heinith, CRITFC.

20 Columbia Basin Fish and Wildlife Authority 1991

21 Washington Department of Fish and Wildlife 1998

22 Marmorek et al. 1996

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25 Independent Scientific Group 1996; National Research Council 1996

26 Orsborn 1987

27 See, for example, discussion in The Oregon Plan News, Vol. 1:1 September/October 1998

28 See Mount 1995.

29 USGS 1998

30 USGS 1997

31 For more information contact Yakima Health District, 104 N. First St. Yakima, WA 98901 (1-800-535-5016)

32 USGS 1998

33 USGS 1998, p. 15

34 National Association of Conservation Districts. No date.

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36 National Research Council 1989, p. 3-4

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41 Bjornn and Reiser 1991

42 Holechek 1992 and 1994; Klipple and Costello, 1960; Houston and Woodward 1966; Johnson 1953; Martin 1975

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44 Chaney et al. 1993

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46 Platts et al. 1983

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48 Claire and Storch 1983, as cited in Platts 1991

49 Duff 1980

50 Columbia River Inter-Tribal Fish Commission 1995

51 Rhodes et al. 1994

52 Rhodes et al. 1994 provide clearly defined standards and a method for assessing fish habitat.

53 Sippel 1995

54 Chaney et al. 1993

55 Rosgen 1996; Rhodes et al. 1994

56 Information by personal communication from Ryan Bessette, Wasco County Soil and Water Conservation District, The Dalles, OR and James Newton, ODFW, The Dalles, OR. 1998

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58 King 1993

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68 Harr and Nichols 1993

69 Bjornn and Reiser 1991

70 Furniss et al. 1996

71 Information obtained by personal communication from USDA personnel.

72 Furniss et al. 1996

73 Harr and Nichols 1993 and Furniss et al. 1991. Both provide excellent examples of techniques for road restoration.

74 Kauffman et al. 1997

75 See Center for Environmental Education 1998

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77 This section draws substantially from Robbins 1998.

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79 Personal communication, Janine Castro, NRCS, Portland, OR

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82 Information on beavers drawn from Naiman et al. 1988; Naiman and Rogers 1997; Grant County Conservationists 1997; Stuebner 1994

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86 Robbins 1998

87 Frissell and Nawa 1992

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91 Robbins 1998

92 This section based substantially on personal communication from Douglas Dompier, CRITFC. See also Cuenco 1994 and Cuenco et al. 1993.

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1 See Cone and Ridlington 1996

2 See Cone and Ridlington 1996

3 This section draws on information provided by personal communication from Rebecca Hiers, Confederated Tribes of the Umatilla Indian Reservation staff, and Don Sampson, CRITFC; Natural Resources Law Center 1997; Cone 1996; and a summary of the Umatilla Basin Project written by the Umatilla Basin Project Steering Committee.

GOOD RESULTS

1 This discussion partly based on the following: CRITFC 1995; McCullough and Espinosa 1996; and lecture by Greg Pettit, Oregon Department of Environmental Quality, at Governor's Watershed Enhancement Board annual conference, Ontario, OR, August 1998.

2 See USEPA 1991a

3 Pfankuch 1978

4 USEPA 1991b

5 Pacific Rivers Council 1996, p. 183

6 CRITFC 1994

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US Pacific Railroad Expeditions & Surveys, 1857

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Pages 2-3 — Wild salmon life cycle
Mary Lockyear

Pages 4 — Woman picking huckleberries
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Page 7 — Watersheds: The Columbia Basin
Mary Lockyear, based on Federal Guide for Watershed Analysis

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Page 15 — Water rights
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Mary Lockyear, drawn from Range Plant Handbook. USDA Forest Service. 1988

Page 17 — Hydrograph
Mary Lockyear

Salmon and water temperature
Mal Karr, CRITFC

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Mary Lockyear, based on Montana Stream Management Guide

Page 19 — Teanaway River
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Page 20 — Urban landslide
Metro Regional Parks and Greenspaces

Page 21 — Urban riparian buffer
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Page 22 — Dams on Columbia, Snake, and Clearwater rivers
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Page 23 Ice Harbor Dam
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Fish transportation
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Page 24 Pushup dam
Oregon Department of Water Resources

Page 25 Generalized depiction of river impacts associated with agricultural practices
Based on illustration by Janice C. Fong, from California Rivers and Streams, by Jeffrey F. Mount. University of California Press. 1995.

Page 26 Contour crop rows
Natural Resources Conservation Service, Portland Office

Contoured grassy filter strip
Natural Resources Conservation Service, Portland Office

Page 27 Pump
Oregon Department of Water Resources

Irrigation withdrawals from John Day River
Margaret Hollenbach

Page 28 Cattle in stream
Jon Rhodes, CRITFC

Generalized depiction of impacts of grazing on rivers
Based on illustration by Janice C. Fong, from California Rivers and Streams, by Jeffrey F. Mount. University of California Press. 1995.

Page 29 Meacham Creek, 1988 and 1992
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Page 30 McComas Meadows
Heidi Steubers, Nez Perce Tribe

Page 31 Nez Perce crew
Heidi Stubbers, Nez Perce Tribe

Page 32 Nose pump
Hans and Suzanne Butschun, Blue Skies West, Centralia, WA

Page 33 Sediment basin
Courtesy Ryan Bessette, Wasco County Soil and Water Conservation District

Generalized depiction of impacts associated with logging in environmentally sensitive areas
Based on illustration by Janice C. Fong, from California Rivers and Streams, by Jeffrey F. Mount. University of California Press. 1995.

Page 34 Road as drainage channel
Jon Rhodes, CRITFC

Page 35 Scenic forest
Metro Regional Parks and Greenspaces

Page 36 Warm Springs Tribes Culture and Heritage Committee
Judith Vergun, Oregon State University

Page 37 Road under water
US Forest Service

Logging road washout
Dan Shively, Gifford Pinchot National Forest

Page 38 Culvert
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Page 39 Native plants in McCoy Meadows
Confederated Tribes of the Umatilla Indian Reservation

Idaho fescue
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Page 40 One bioengineering technique
Natural Resource Conservation Service

Railroad bed on floodplain
Jon Rhodes, CRITFC

Page 41 Restored meanders on Asotin Creek
Mark Shaw, Bonneville Power Administration

Page 42 Road on floodplain
Jon Rhodes, CRITFC

McCoy Creek before restoration
Confederated Tribes of the Umatilla Indian Reservation

Page 43 McCoy Creek 1998
Confederated Tribes of the Umatilla Indian Reservation

Page 44 Beaver dam
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Page 45 Beaver building beaver dam
Mary Lockyear

Page 46 Large woody debris
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Levee
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Page 47 One tree, two photos
Margaret Hollenbach

Page 48 Culvert blocking fish passage
Metro Regional Parks and Greenspaces

Page 49 Spawned out female spring chinook
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

Armand Minthorn at Minthorn Springs
Margaret Hollenbach

Page 50 Scenic rangeland
Jon Rhodes, CRITFC

Page 51 Ceded lands
CRITFC

Page 53 Brian Connor measures returning salmon
Becky Hiers, Confederated Tribes of the Umatilla Indian Reservation

Page 54 Gina George
Gina George

Salmon Corps worker
ECC—Salmon Corps

Page 55 Phil and Kristy St. Clair
Phil and Kristy St. Clair

Page 56 CRITFC staff and interns
CRITFC

Page 57 Field crew sampling Meacham Creek fish population
Todd Shaw, Confederated Tribes of the Umatilla Indian Reservation

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Glossary

Active restoration
Reconstructing hydrologic, physical, geomorphic, or chemical processes and patterns in a stream channel or watershed.

Adaptive management
Changing management techniques in the light of knowledge gained during monitoring or assessment.

Aggradation
The raising of the elevation of the streambed through deposition of sediment eroded at another location.

Alluvium
Sediment deposited or transported by streams.

Anadromous
Species that reproduce in freshwater and spend part of adult life in the ocean.

Appurtenant
Attached. Water rights are appurtenant to a piece of land.

Aquifer
Rock formation or subsurface layer in which water collects.

Base flow
The portion of streamflow contributed by groundwater.

Benthic
Bottom-dwelling.

Bioengineering
Controlling erosion, sediment delivery, and floods through the use of living structures. Combination of biological, ecological, and structural concepts to achieve these ends.

Boulder weir
A small-scale barrier made of boulders that raises water level or diverts flow.

Channelization
Artificially straightening the meanders of a stream channel or river.

cfs
Cubic feet per second. A measure of streamflow volume.

Conservation easement
A legal restriction on future development.

Discharge
The flow of a stream, measured as a volume.

Diversion
Removal of water from its natural channel for use in a different location.

Ecosystem
A community of organisms and the environment with which they interact.

Ecosystem management
Management to maintain structure and function of an entire ecosystem.

Escapement
In a particular year, the number of anadromous fish that reach a spawning area.

Exotic species
A species introduced into an environment from elsewhere.

Extinct
Gone; no living representatives on the planet.

Extirpated
No longer present in a certain area, although populations of the species exist elsewhere.

Fallow
Fields left bare and unplanted during certain seasons.

Floodplain
The land adjacent to a stream that is periodically flooded by high water.

Flow regime
The pattern of stream discharge over time.

Fluvial
Pertaining to rivers or streams.

Gabion
Wire structure filled with rocks and placed in a stream to stabilize stream banks, control erosion, and divert stream flow.

Geomorphology
The study of landscapes and the processes that change them.

Gradient (of stream)
Slope of stream, or change in elevation of stream over a distance.

Gravel berm
A temporary structure built to divert water.

Hydrograph
A graph that depicts streamflows over time.

Hydrology
The study of the circulation of water on earth surface, subsurface, and atmosphere.

Infiltration
The process of water moving into the soil.

Infiltration capacity
Maximum rate at which a given soil can absorb water.

Instream flow
Water flowing through a natural stream channel.

Intermittent stream
A stream with water part of the year.

Macroinvertebrates
Aquatic insects that are large enough to see without the aid of magnification.

Native
A species that evolved in the particular environment or area that it currently resides in.

Nonpoint-source pollution
Pollution that comes from diffuse sources rather than a distinct point. Examples may be pesticides from fields, sediment from roads, or nutrients from animal excrement, carried into streams in runoff.

Passive restoration
Stopping human activities that are causing degradation to a watershed or preventing recovery.

Peak flow
The highest streamflow during a period of time, typically a year.

Photopoint
A location at which photographs are taken to document change over time.

Plunge pool
A deep pool created in a stream by vertically falling water.

Redd
A depression in streambed gravel dug by a female salmonid (or other fish) to lay her eggs in.

Refugia (Latin)
Refuges. Locations where fish and wildlife species have survived despite widespread historical disturbances.

Riparian
The area alongside a stream.

Riparian vegetation
Plants that grow alongside a stream.

Riprap
Large rocks or boulders placed on a streambank to deflect energy and stabilize the bank.

Rootwad
The roots of an uprooted or washed out large tree.

Salmonid
Fish in the Salmonidae family, which includes salmon, trout, chars, whitefish, ciscoes, and grayling.

Sinuosity (of a stream)
The degree of curvature of a stream.

Stock (of fish)
A group of fish that is isolated geographically and is genetically self-sustaining. Typically, a local population of fish that originates and returns to a specific watershed.

Stream reach
A stretch of a stream between two points. The US Environmental Protection Agency has classified streams in the US into river reaches and assigned each reach a unique number.

Subbasin
A subdivision of a large stream basin such as the Columbia. A subbasin may contain several watersheds.

Substrate
The material that composes the bed or bottom of a stream or lake.

Subsurface flow
Water that flows underground in the unsaturated layer of soil between the top of the water table and the land surface.

Succession
The process by which one plant species colonizes an area, making it hospitable to another species, which then begins to dominate, and so on until the climax species is reached.

Surface runoff
Water that exceeds the soil's infiltration capacity and, therefore, runs overland.

Sustainable agriculture or fisheries
Use of natural resources at a rate that can be continued indefinitely while maintaining the abundance of the resource.

Terrace (agricultural)
Raised mounds of earth with flat tops and sloping sides, constructed across the slope of a cultivated hillside.

Terrace (geological)
An area of deposited sediments from a previous floodplain that has been abandoned as river flow decreased, or as channel incised.

Thermal refugia
Areas that offer protection from heat.

Tributary
A stream or river that flows into a larger stream or river.

Water right
Legal right to use water at a defined point of diversion, time, and place of use.

Watershed
An area drained by a single river or river system, defined by a ridgeline.

Watershed restoration
Restoring the vegetation, soil, and stream functions that support a diversity of terrestrial and aquatic life.

Weir
A structure across a stream that raises water level or diverts flow. Can also be in the form of a notch or a depression in a dam.

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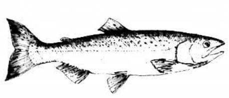
RESOURCES

Tribal Contacts

If you would like more information about how to do watershed restoration in your area, or about tribal watershed restoration programs, please contact one of the following tribal staff members.

Gary James
Fisheries Program Manager
Confederated Tribes of the
Umatilla Indian Reservation
PO Box 638
Pendleton, OR 97801
(541) 276-3165

Silas Whitman
Fisheries Program Manager
Nez Perce Tribe
PO Box 305
Lapwai, ID 83540
(208) 843-2253



Patty O'Toole
Fisheries Program Manager
Confederated Tribes of the
Warm Springs Reservation of Oregon
PO Box C
Warm Springs, OR 97761
(541) 553-3257

Lynn Hatcher
Fisheries Program Manager
Confederated Tribes and Bands
of the Yakama Indian Nation
PO Box 151
Toppenish, WA 98948
(509) 865-5121

Don Sampson
Manager
Watershed Department
Columbia River Inter-Tribal Fish Commission
729 NE Oregon, Suite 200
Portland, OR 97232
(503) 238-0677

Organizations

WATERSHED ASSESSMENT

Oregon Governor's Watershed Enhancement Board (GWEB)
255 Capitol St. NE, 3rd Floor
Salem, Oregon 97310-0203
(503) 378-3589

Contact GWEB for a copy of its watershed assessment manual, or for assistance in conducting watershed assessments.

USDA Forest Service
Regional Interagency Executive Committee
333 SW 1st, PO Box 3623
Portland, OR 97208-3623
(503) 326-6265

Washington State University
Darin Saul
PO Box 644132
Pullman, WA 99164-4132
(509) 335-3357

Washington State University is beginning an extensive program to work with tribes conducting watershed assessments.

StreamNet
Pacific States Marine Fisheries Commission
GIS Coordinator
45 S.E. 82nd Drive, Suite 100
Gladstone, OR 97027-2522
(503) 650-5400

StreamNet is a storehouse of information about stream restoration.

LAND ACQUISITION

The Nature Conservancy
Western Regional Office
2060 Broadway, Suite 230
Boulder, CO 80302
(303) 444-1060

The mission of the Nature Conservancy is to preserve plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and water they need to survive.

Trust for Public Lands
Northwest Regional Office
Smith Tower, Suite 1510, 506 Second Avenue
Seattle, WA 98104
(206) 587-2447

Over the last 25 years the Trust for Public Land has worked with hundreds of landowners. Working only with willing sellers, TPL offers advice on land value, tax planning, appraisals, title searches, property surveys, and environmental assessments. Through its relationships with governments, foundations, community groups, and local businesses, TPL also can help mobilize support and funds to protect an important conservation property.

The Rocky Mountain Elk Foundation
PO Box 8249
Missoula, Montana 59807-8249
(800) CALL ELK (225-5355)

The RMEF, based in Missoula, Montana, has generated millions of dollars to acquire and enhance elk habitat, acquire critical wildlife habitat, and fund important wildlife research and conservation education programs. Its work has been concentrated primarily in the Western elk states.

WATER ACQUISITION AND INSTREAM FLOW CONSERVATION

The Conservation Fund
1942 Broadway, Suite 201
Boulder, CO 80302
(303) 444-4369

A nonprofit dedicated to advancing land and water conservation.

Environmental Defense Fund
Pacific Northwest Office
60440 Woodside Road
Bend, OR 97702
(541) 317-8424

A national conservation organization.

Environmental Resources Trust, Inc.
2944 Macomb Street NW
Washington, DC 20008
(202) 244-4738

ERT's goal is to engage market forces by bridging the traditional gap between environmental and economic aspirations. ERT has an office in Bend, Oregon.

The Nature Conservancy
Western Regional Office
2060 Broadway, Suite 230
Boulder, CO 80302
(303) 444-1060

The mission of the Nature Conservancy is to preserve plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and water they need to survive.

Oregon Water Trust
111 SW Front Ave, Suite 404
Portland, OR 97204
(503) 226-9055

The Oregon Water Trust is a nonprofit group that uses a market-based approach to help maintain and restore surface water flows in the rivers and streams of Oregon. OWT works cooperatively with willing water users to acquire part or all of existing out-of-stream water rights. OWT works closely with community leaders, local watershed councils, government agencies, and a range of public interest groups to prioritize and implement its efforts.

Washington Water Trust
1165 Eastlake Ave E, Suite 400
Seattle, WA 98109
(206) 223-8454

Washington Water Trust is a private nonprofit organization established in 1998 to restore instream flows in Washington's rivers and streams by acquiring existing water rights and converting them to instream use. WWT's focus is on market-based approaches, involving transfers from willing sellers or donors.

Columbia Basin Flow Augmentation Program
US Bureau of Reclamation
Pacific Northwest Region
1150 North Curtis
Boise, ID 83704
(208) 378-5092

BOR provides water for flow augmentation. The flows are provided to increase water in the salmon migration corridor in the lower Snake and Columbia Rivers.

Washington Trust Water Rights Program
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504-7600
(206) 407-6637

The Trust Water Rights Program provides a mechanism for voluntary transfers of water rights to instream or off-stream uses.

Yakima River Basin Water Acquisition Program
US Bureau of Reclamation
Yakima Basin Area Office
PO Box 1749
Yakima, WA 98907-1749
(509) 575-5848

In 1994 $150 million was allocated to fund water conservation projects. About $12 million of this was appropriated for water acquisitions to meet target instream flow levels for salmon and steelhead recovery efforts.

WaterWatch of Oregon
213 SW Ash
Portland, OR 97204
(503) 295-4039

WaterWatch is a nonprofit membership organization, founded in 1985, which advocates for the protection and restoration of Oregon streamflows to benefit fish and wildlife, water quality, recreation and scenic beauty.

AGRICULTURAL MANAGEMENT

Natural Resources Conservation Service

Look in your telephone book under the federal government, Department of Agriculture section, for a local USDA NRCS office.

Agricultural extension office

Look in your telephone book for the local land grant university or county extension office.

Soil and Water Conservation Districts

Look in your telephone book for a local Soil and Water Conservation District.

RANGE MANAGEMENT

Range conservationist at local Bureau of Land Management office

Phone numbers for local BLM offices can be found by calling the state offices listed below. The Oregon State Office has information on Washington.

Bureau of Land Management, Oregon State office
PO Box 2965
Portland, OR 97208
(503) 952-6003

Bureau of Land Management, Idaho State office
1387 South Vinnell Way
Boise, Idaho 83709-1657
(208) 373-4000

Range conservationist at local Forest Service office

Look in your telephone book under the federal government, Department of Agriculture section, for a local USDA Forest Service office.

Natural Resources Conservation Service local office

Look in your telephone book under the federal government, Department of Agriculture section, for a local USDA NRCS office.

Oregon State University Extension office or Range Resources Department

A list of county offices can be found at this web site:
http://wwwagcomm.ads.orst.edu/AgComWebFile/extser/index.html

Or contact the main OSU Extension office at:
125 Ballard Extension Hall
Corvallis OR 97331-3604
(541) 737-1388

Eastern Washington University Extension office
Eastern Washington University
526 5th St.
Cheney, WA 99004-2431
(509) 359-6200

County Extension Agent

Look in the government, county pages of your telephone book for a local contact.

Columbia River Inter-Tribal Fish Commission
729 NE Oregon, Suite 200
Portland, OR 97232
(503) 238-0667

FOREST MANAGEMENT

Look in your telephone book for a local tribal office. Or look under the federal government, Department of Agriculture section, for a local USDA Forest Service office.

BIOENGINEERING

Natural Resources Conservation Service

Look in your telephone book under the federal government, Department of Agriculture section, for a local USDA NRCS office.

BEAVER REINTRODUCTION

Grant County Conservationists
Keystone Project
HCR 77, Box 2070
John Day, OR 97845
(541) 575-1167

Confederated Tribes of Warm Springs Reservation of Oregon
PO Box C
Warm Springs, Oregon
(541) 553 3233

PLACING INSTREAM STRUCTURES

Contact a local tribal, USDA Forest Service, or NRCS office.

PARTNERSHIPS

River Network
PO Box 8787
Portland, OR 97207-8787
(503) 241-3506

Local Watershed Councils

Contact CRITFC to receive a copy of *Columbia Basin Watersheds*, which lists Watershed Councils within the Columbia Basin.

Watershed Department
Columbia River Inter-Tribal Fish Commission
729 NE Oregon, Suite 200
Portland, OR 97232
(503) 238-0667

MONITORING AND EVALUATION

US Environmental Protection Agency
Contact: Dr. Barbara Karn
(202) 564-6824
USEPA has a program to encourage volunteers to monitor their own watersheds. Information can be found at the following web site:
http://es.epa.gov/ncerqa/rfa/empact.html

More information can be found by contacting the Volunteer Monitoring Coordinator at
USEPA (4503F)
401 M Street SW
Washington, DC 20460
http://www.epa.gov/OWOW/monitoring/
Or contact your local tribe, NRCS office, or CRITFC for help in starting a monitoring program.

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DIRECTORIES & WEB PAGES

Directory of Funding Sources for Grassroots River and Watershed Conservation Groups
Profiles of private, corporate, and federal funding sources for river and watershed groups. Includes name, address, phone number, contact name, deadlines, and a brief description of each source's particular interests. Contains a section on how to write grant proposals and a bibliography of state and local foundation directories. 1998. 60 pages. $35.

Compiled by Alison Cook and Pat Munoz.
River Network
PO Box 8787
Portland, OR 97207
(503) 241-3506

Fundraising Alerts
River Network's River Fundraising Alert is a quarterly publication designed to help river and watershed organizations support themselves financially.

River Network
See address above

Watershed Information Funding
An extensive list of funding programs compiled by For the Sake of the Salmon. Includes federal and state governments, private foundations, and web links to grant information for Washington, Oregon, and California.

http://www.4sos.org/homepage/watershed/funding.html

Healing the Watershed. A Citizen's Guide to Funding Watershed and Wild Salmon Recovery Programs

Compiled by the Pacific Rivers Council, 1994. $25.
PO Box 10798
Eugene, OR 97440
(541) 345-0119

Catalog of Federal Funding Sources
US EPA Office of Water, Report: EPA 841-B-97-008

To obtain a free copy, call 1 (800) 490-9198, or download from:
http://www.epa.gov/OWOW/watershed/wacademy

A Guide to Funding Resources
Rural Information Publication Series, No. 56

Rural Information Center
National Agriculture Library, Room 304
Beltsville, MD 20705-2351
1 (800) 633-7701

GRANTS

Here are some potential sources of state, federal, and private grants for watershed projects. Refer to catalogs of funding sources such as those listed above for more extensive information.

STATE: OREGON

Governor's Watershed Enhancement Board
(GWEB)
GWEB provides grants for four types of projects: 1) assessment and/or monitoring of natural resource conditions; 2) on-the-ground watershed management; 3) opportunities for learning about watershed concepts; and 4) watershed council support. Grants range from <$1,000 to $100,000 plus. In addition, it is likely that GWEB will administer the dispersal of state lottery funds for salmon restoration beginning in 1999.

The Governor's Watershed Enhancement Board
255 Capitol St. NE, 3rd Floor
Salem, Oregon 97310-0203
(503) 378-3589 ext. 831

Conservation Reserve Enhancement Program
A newly established federal program through the Department of Agriculture. Funds are administered through states to landowners on a voluntary basis to protect riparian buffer zones. This program has a $9 billion trust fund available to enroll riparian areas and wetlands.

Ken Bierly, Program Manager
Governor's Watershed Enhancement Board
255 Capitol St. NE, 3rd Floor
Salem, Oregon 97310-0203
(503) 378-3589 ext. 831.

Fred Ringer, Program Specialist
Farm Service Agency
7620 SW Mohawk
Tualatin, OR 97061-8121

Oregon Department of Environmental Quality (DEQ)
Clean Water Action Plan Funds
Beginning in 1999, the Oregon DEQ will administer Environmental Protection Agency funds from the President's Clean Water Action Plan for watershed restoration based on priorities developed in a Unified Watershed Assessment process.

Dave Powers
Oregon DEQ
811 SW 6th Avenue
Portland, OR 97204

Oregon Partners for Wildlife Program
Establishes partnerships between US Fish and Wildlife Service, state fish and wildlife agencies, and private organizations and individuals to carry out wildlife conservation to conserve fish and wildlife species.
Oregon State Office/ US Fish and Wildlife Service

Maureen Smith
2600 SE 98th Avenue, Suite 100
Portland, OR 97266
(503) 231-6179

Oregon Department of Fish & Wildlife (ODFW)
Salmon and Trout Enhancement Program (STEP)
A program to restore and rehabilitate native stocks and to ensure that harvest does not exceed capacity.

Fish Restoration and Enhancement Program
A program to restore and enhance natural fish production, restore fish hatcheries and increase hatchery production.

Watershed Management Program
Encourages public and private partnerships, particularly with local watershed councils.

For all three of these programs, contact:
Charlie Corrarino
ODFW
PO Box 59, 506 SW Mill Street
Portland, OR 97207
(503) 872-5252 ext. 5431

Riparian Tax Incentive Program
Incentive for landowners to protect and restore riparian vegetation within 100 feet of a stream. Incentives are in the form of tax exemption for riparian lands protected.

Habitat Conservation Division
ODFW
PO Box 59, 506 SW Mill Street
Portland, OR 97207
(503) 872-5255

Metro Regional Parks and Greenspaces
Environmental Education Grants
Purpose is to build a comprehensive environmental education program around urban natural areas through field and hands-on learning; to teach about ecological systems and watersheds; and to foster community involvement in the stewardship of urban natural areas in the Portland/Vancouver region.

Salmonid Education and Enhancement Grants
Develop programs and projects that will benefit salmon, steelhead, and watershed health in the Portland/Vancouver Region.

Habitat Restoration Grants
Restore and enhance fish and wildlife habitat, wetlands, streams, riparian corridors, and upland sites in the Portland/Vancouver region.

For all three of these programs, contact:
Lynn Wilson
600 NE Grand Avenue
Portland, Oregon 97232-2736
(503) 797-1781

STATE: WASHINGTON

Farm Service Agency (FSA): Conservation Reserve Enhancement Program
A newly established federal program through the Department of Agriculture. Funds are administered through states to landowners on a voluntary basis to protect riparian buffer zones. This program has a $9 billion trust fund available to enroll riparian areas and wetlands.

Local USDA Service Center; Soil and Water Conservation District Office; or:
Sandi Snell, Salmon Recovery Office
(360) 902-2229

Washington Department of Ecology

Centennial Clean Water Fund

Provides local and tribal governments with money to enhance water quality in Washington. Supports five categories: 1) marine water facilities; 2) groundwater activities and facilities; 3) freshwater lakes and rivers; 4) nonpoint activities and facilities; and 5) discretionary.

Kim McKee (360) 407-6566

Washington State Water Pollution Control Revolving Fund

Provides low-interest loans to local governments for projects that improve and protect the state's water quality.

Brian Howard (360) 407-6510

Federal Clean Water Act Section 319 Nonpoint Source Fund

Provides grant funding to local governments for projects that improve and protect the state's water quality.

Dan Filip (360) 407-6509

Watershed Management Planning Grants

A new program that provides three types of grants: 1) grants to initiating governments to begin first stage of organizing a local watershed planning effort; 2) grants for planning units to conduct watershed assessment; and 3) grants for planning units to develop a watershed management plan.

Laura Lowe
(360) 407-7255

For general questions about all four programs, contact:
Kim McKee (360) 407-6566
Department of Ecology, Water Quality Program
Financial Management Section
PO Box 47600
Olympia, WA 98504-7600
(360) 407-6400
http://www.wa.gov/ecology/wq/funding

Washington Department of Transportation Fish Passage Grants

Grants for: 1) field surveys to determine fish passage problems; and 2) fish passage barrier removal design and construction.

Fish Passage Grant Program
Washington State Department of Transportation
Environmental Affairs Office
PO Box 47331
Olympia, WA 98504-7331
(360) 705-7492

STATE: IDAHO

Partners for Wildlife Program

Establishes partnerships between US Fish and Wildlife Service, state fish and wildlife agencies, and private organizations and individuals to carry out wildlife conservation to conserve fish and wildlife species.

Peggy Guillory
Boise, ID
(208) 378-5098

Federal Clean Water Act Section 319 Nonpoint Source Fund

Provides grant funding to local governments for projects that improve and protect the state's water quality.

Charlie Vidondo
Non-Point Source Management Program
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706
(208) 373-0274

FEDERAL

For more information about the following programs administered by the USDA Natural Resources Conservation Service and the USDA Farm Services Agency, contact your local Natural Resources Conservation Service (NRCS) branch, or Farm Service Agency (FSA), listed in your telephone book under Federal Government, Department of Agriculture. Decisions about which of these programs are most appropriate for you and application materials can be obtained from these agencies.

Bonneville Power Administration Fish and Wildlife Program (Columbia Basin)
Provides funding under Bonneville Power Administration's Northwest Power Act responsibilities.

Connie Little
FY2000 Proposals
PO Box 3621
Portland, OR 97208-3621
(503) 230-4296

Farm Service Agency

Conservation Reserve Program
Offers long-term rental payments and cost-share assistance to farmers establishing permanent vegetative cover on environmentally sensitive crop land.

USDA FSA Public Affairs Staff
1400 Independence Avenue, SW
STOP 0506
Washington DC 20250-0506

Continuous Sign Up
Allows farmers who want to use practices such as filter strips, etc., to sign up a piece of land and put these techniques into practice.

Small Watersheds Projects (Public Law 566)
Grants for improving watersheds and for watershed management.

Assistant State Conservationist
Portland, OR
(503) 326-2751

National Marine Fisheries Service

Anadromous Fish Conservation
To conserve the nation's anadromous fish resources.

Office of Fishery Conservation and Management
US Department of Commerce, NOAA
National Marine Fisheries Service
1335 East-West Highway
Silver Spring, MD 20910
(301) 731-2347

Community Based Restoration
Goal is to foster ties between communities and NMFS to accomplish habitat restoration.

National Marine Fisheries Service
Office of Habitat Conservation Restoration Center
Chris Doley or Robin Bruckner
(301) 713-0174

Natural Resources Conservation Service (NRCS)

Wetlands Reserve Program
Offers financial assistance to landowners for wetlands restoration and protection projects. Contact local or state NRCS office.

Forestry Incentive Program
Supports good forest management practices on privately owned, non-industrial forest lands. Eligible practices are tree planting, timber stand improvement, and site preparation for natural regeneration. Contact local or state NRCS office.

Environmental Quality Incentive Program (EQIP)
Provides assistance to farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. Contact local or State NRCS office.

Stewardship Incentives Program
Provides private, non-industrial landowners with assistance keeping their lands productive and healthy. This includes funds for tree and shrub planting, wildlife habitat enhancement, instream fisheries habitat enhancement, riparian and wetland enhancement, and more. Contact local or state NRCS office.

Wildlife Habitat Incentives Program (WHIP)
Provides financial incentives to develop habitat for fish and wildlife on private lands.

WHIP Program Manager
USDA Forest Service
Cooperative Forestry Staff
PO Box 96090
Washington, DC 20090-6090
(202) 205-1389

US Army Corps of Engineers: Aquatic Ecosystem Restoration
Provides up to $5 million per project to restore aquatic ecosystems. The projects must be cost-shared with 35 percent non-federal funds. Restoration projects are in areas that affect water such as rivers, lakes, and wetlands. Projects are evaluated based on their benefits to the environment through restoration, improvement, or protection of aquatic habitat for plants, fish, and wildlife.

Ms. Taunja Berquam, Special Programs Manager
US Army Corps of Engineers, Portland District
ATTN: Planning
PO Box 2946
Portland, Oregon 97208-2946
(503) 808-4733

US Environmental Protection Agency

Environmental Education Grants

Provides support for environmental education projects that focus on: 1) improving teaching skills; 2) education about human health; 3) building state, local, or tribal capacity to develop environmental education programs; 4) community-based organization to educate communities; and 5) public education through print or other media.

US Environmental Protection Agency
Office of Environmental Education (1707)
Environmental Education Specialist
401 M Street, SW, Washington, DC 20460
(202) 260-8619

Nonpoint Source Implementation Grants (319 Program)

Provides grants to states to implement nonpoint source projects and programs in accordance with Section 319 of the Clean Water Act. States and tribes can apply.

US Environmental Protection Agency
Office of Wetlands, Oceans, and Watersheds
Assessment and Watershed Protection Division
Nonpoint Source Control Branch (4503F)
401 M Street, SW, Washington DC 20460
(202) 260-7100

Wetlands Protection: Development Grants

Provides grants to support wetland development or augmentation and enhance existing programs.

US Environmental Protection Agency
Office of Wetlands, Oceans, and Watersheds
Wetlands Division (4502F)
401 M Street SW
Washington DC 20460
(800) 832-7828

Environmental Justice Grants

The purpose of the Small Grants program, established in 1994, is to assist community-based grassroots organizations and tribal governments that are working on local solutions to local environmental problems. For more information call:

Office of Environmental Justice
24-hour hotline: 1-800-962-6215
http://es.epa.gov/oeca/oej/98grants.html

PRIVATE

National Fish and Wildlife Foundation

Challenge grants in five areas: 1) conservation education; 2) fisheries conservation and management; 3) neotropical migratory bird conservation; 4) wetlands and fisheries conservation and management.

Gris Batchelder
National Fish and Wildlife Foundation
1120 Connecticut Ave., NW Suite 900
Washington, DC 20036
(202)-857-0166
(202) 857-0162 (fax)

River Network Watershed Assistance Grants (1999)

Supports innovative efforts to build the capacity of community-based partnerships to restore or conserve watersheds.

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Useful Web Sites

RIPARIAN BUFFERS

Riparian Buffers: Rationale, Strategies, and Resources and Protecting Streamside Corridors
http://www.teleport.com/~rivernet/leff.htm

UNL AgNIC Water Quality Page Riparian Buffer Zone Information
A page with links to Riparian Buffer Zone information
http://www.unl.edu/agnicpls/wqrip.html

Riparian Ecosystem Creation and Restoration: A Literature Summary
An extensive web-site created by the USGS with literature review on riparian restoration.

http://www.npwrc.usgs.gov/resource/literatr/ripareco/ripareco.htm

Bibliography of riparian resources
http://glinda.cnrs.humboldt.edu/wmchome/rip_bib/rip_index.html

BASIC HYDROLOGY & WATERSHED EDUCATION

Gulf of Maine Aquarium homepage
Has easy-to-understand, nicely illustrated descriptions of basic stream concepts.
http://octopus.gma.org/streams/streams.html
Watershed basics presented in easy-to-understand manner, with informative graphics.
http://octopus.gma.org/streams/whatis.html

Green: Global Rivers Environmental Education Network
GREEN is working with EcoNet to compile pointers to water-related resources on the Internet. Here are some starting points for "getting your feet wet":
http://www.igc.apc.org/green/resources.html

GENERAL STREAM RESTORATION

Stream Corridor Restoration: Principles, Processes, and Practices
Download restoration manual
http://www.usda.gov/stream_restoration/

Stream Care Guide
Information for residents and businesses on how to care for your stream.
http://www.rivernetwork.org/strcare.htm

The Center for Watershed Protection
The Center for Watershed Protection works with local, state, and federal governmental agencies, environmental consulting firms, watershed organizations, and the general public to provide objective and scientifically sound information on effective techniques to protect and restore urban watersheds. The Center also acts as a technical resource for local and state governments around the country to develop more effective urban stormwater and watershed protection programs.
http://www.pipeline.com/~mrrunoff/

USEPA: Watershed Tools
An extensive compilation of "tools," from data analysis methods to funding sources to basic information on watershed restoration.
http://www.epa.gov/docs/owowwtr1/watershed/tools/index.html

USEPA: River Corridors and Wetlands Restoration
Lists agencies involved in restoration and links to their www sites. Also lists restoration projects by state.
http://www.epa.gov/owow/wetlands/restore/

USEPA: Ecological Restoration: A Tool to Manage Stream Quality
Executive summary of this document. Has link to entire document.
http://www.epa.gov/owowwtr1/NPS/Ecology/exsum.html

Know your watershed
CTIC is a nonprofit, information/data transfer center that promotes environmentally and economically beneficial natural resource systems.
http://www.ctic.purdue.edu/cgi-bin/KYW.exe

Watershed Management Council Home Page
Great articles on watershed issues.
http://watershed.org/wmchome/

Habitat restoration information center
http://www.habitat-restoration.com/index.html
Bibliographies put out by same group
http://www.habitat-restoration.com/litbibs.htm

National Watershed Manual (NRCS)
http://www.ftw.nrcs.usda.gov/pl566/WSM.html

The Oregon Plan homepage
"The Oregon Plan represents an unprecedented undertaking on the part of the State of Oregon to restore our state's salmon and trout resources. Our goal is to restore populations and fisheries to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits."
http://www.oregon-plan.org/

Restoration and Reclamation Review, University of Minnesota
Restoration case studies
http://www.hort.agri.umn.edu/h5015/rrr.htm

The West Today Commission Reports
Reports on water issues in the West.
http://www.den.doi.gov/wwprac/reports/west.htm

PASSIVE RESTORATION: GRAZING, AGRICULTURE, FORESTRY, AND URBAN MANAGEMENT PRACTICES

USDA Forest Service/NRCS
Forest Service and NRCS page that explains why buffers are important and how they function to dampen the effects of agriculture on a stream.
http://waterhome.tamu.edu/texasyst/agroforestrynotes/afnote3.htm

National Handbook of Conservation Practices—
NHCP(NRCS)
http://www.ncg.nrcs.usda.gov/nhcp_2.html

USEPA Non-Point Source Pollution
The USEPA has a page on ways to reduce non-point source pollution. The first link is a description of how to reduce the impacts of grazing on stream water quality, and the second is managing agriculture to reduce impacts to streams.
http://www.epa.gov/OWOW/NPS/MMGI/Chapter2/ch2-2e.html

Monitoring Streambank Stability: Grazing Impacts or Stream Variability?
A graduate student paper that hypothesizes that widespread use of the same set of grazing standards over large areas and entire grazing allotments cannot be considered a reliable basis for monitoring efforts because of the natural variation occurring within and between streams in the same watershed.
http://www.montana.edu/wwwpb/ag/stream.html

Role of BMPs in Restoring the Health
Has information on best management practices for agriculture.
http://geb.isis.vt.edu/SWAMP/als5984/notes/notes4.html

What is Sustainable Agriculture?
Information and principles on sustainable agriculture.
http://octopus.gma.org/streams/whatis.html

ACTIVE RESTORATION

Upper Clark Fork River Streambank Stabilization Pilot Study
A report on a study conducted to determine what streambank stabilization methods work best.
http://www.rwrp.umt.edu/PROJECTS/STAFFPROJECTS/SP04.html

Stream Restoration: A Colossal Hoax
This page is a strongly opinionated piece criticizing instream restoration efforts.
http://webpages.marshall.edu/~ragette2/streamre.html

From the Proceedings of the Sixth Federal Interagency Sedimentation Conference
Information on topics covered in conference and how to order a publication of proceedings.
http://water.usgs.gov/public/wicp/proceedings.html

MONITORING AND WATERSHED ASSESSMENT

California Watershed Information Technical Systems: Watershed Assessment and Monitoring
Information and databases from California on monitoring. Has links to documents such as the Washington Department of Fish and Wildlife Timber/Fish/Wildlife Monitoring document.
http://ceres.ca.gov/watershed/assessment_monitoring.html

Monitoring Water Quality, USEPA
This page addresses methods and tools to monitor, assess, and report on the health of America's water resources, and software and automated information systems to manage monitoring data.
http://www.epa.gov/OWOW/monitoring/

DAMS

Dams
http://www.teleport.com/~rivernet/dams.htm

Small Dams: Restoring Free-Flowing Water through Small Dam Removal.
http://www.igc.apc.org/wisrivers/smldam.html

Remove or Decommission the Four Lower Snake River Dams
This web site includes position statements from a wide variety of interests on this issue
http://www.cyberlearn.com/remove.htm

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Our experience has shown us that when we properly restore habitat for salmon, we are really restoring habitat for many other species as well. This handbook, and the tribes' restoration is not an attempt to take us where we cannot go, but an attempt to keep us from losing what we can never get back.

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