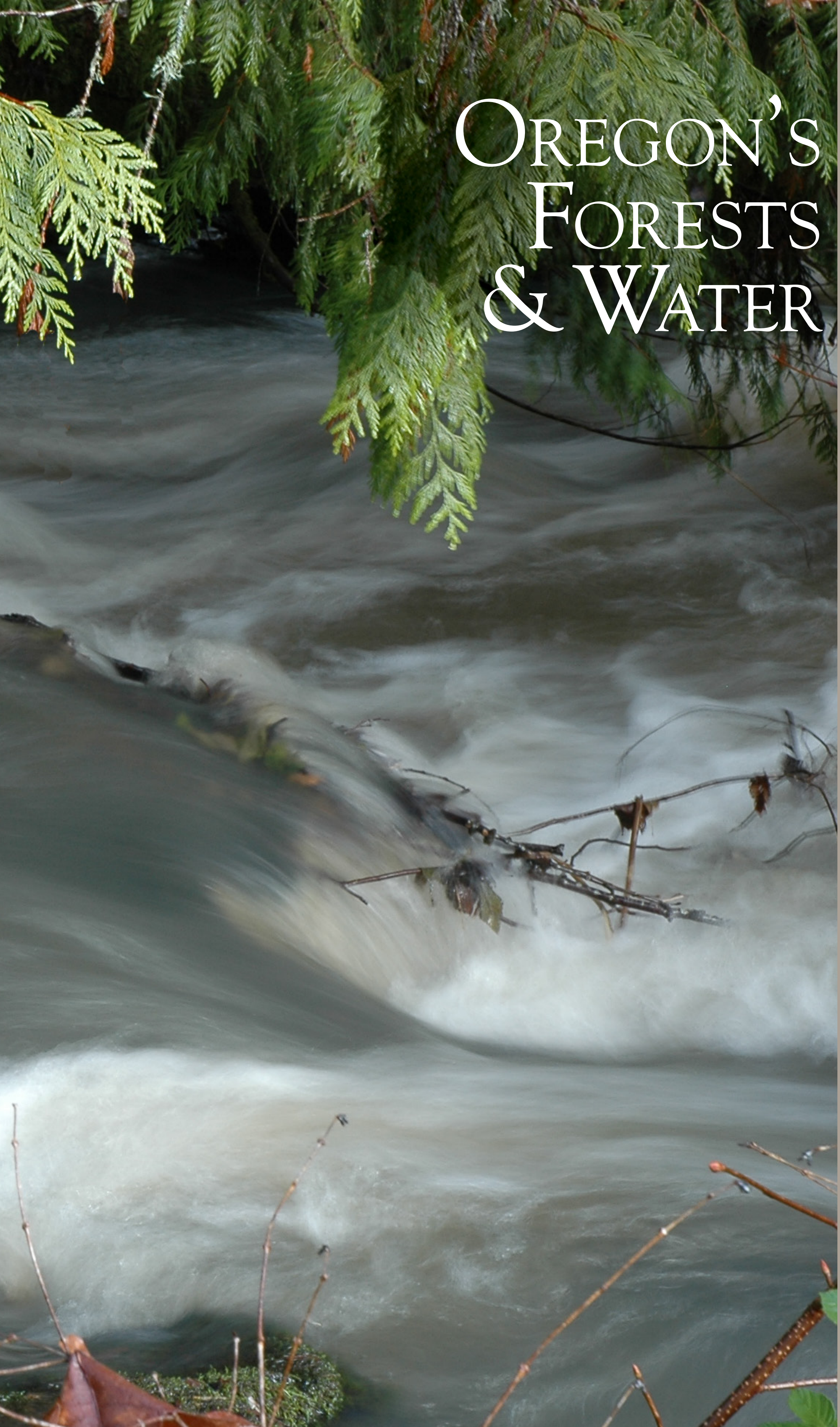
Oregon's Forests & Water



How Forest Management Works to Protect Water Quality

A Special Report of the Oregon Forest Resources Institute

When poorly designed or jammed with debris, culverts can prevent fish passage and cause fill failure and flooding. There have been advances in culvert design (see caption on page 20) in recent years. This new culvert on Oak Creek in Oregon State University's McDonald-Dunn Forest upgraded what was once a fish barrier, opening new stretches of habitat upstream. As part of the state's Oregon Plan for Salmon and Watersheds, private forest land-owners in recent years have improved more than 1,600 stream crossings on forest roads.

Private Forests, Public Interest & Water Quality

Ask Oregonians what they care about most when they think of Oregon forests, and invariably it's the water. Recent public opinion polls by the Oregon Forest Resources Institute (OFRI) bear this out, reflecting citizen awareness that of all land uses, forested watersheds produce some of our highest-quality water and therefore require careful stewardship by forest landowners. Professional foresters and scientists have long recognized the potential of forest management activities to affect water quality. Their work provides valuable background for the Legislature and state agencies as they adopt laws, rules and best management practices to minimize or mitigate impacts. For private forest landowners, good water quality is a priority. "It just makes sense," says John Blackwell, chairman of the state's Board of Forestry. "Forest landowners have a huge capital investment, so they have a strong interest in protecting the resource. Beyond that, many either live on or close to the land and take a natural pride in forest ownership and protection."

People expect water to be available, clean and safe. Besides providing water for native fish and wildlife, good water quality is a necessity for fishing, boating, swimming, irrigation, power, municipal water systems and other downstream uses. Because it is a vital part of our lives, water quality is a social as well as economic and environmental concern. We must ultimately consider the many demands we put on water, and assign values on its use.

Inevitably, multiple uses and values come into conflict. A prime example is the hydroelectric dam system on the Columbia River that provides a low-carbon source of electricity, a navigable waterway and flood control, but inhibits fish passage and harnesses the river's inherent wildness and natural beauty.

For private forest landowners, good water quality is a high priority.

The Willamette Valley is another example of such trade-offs. Over time, the Willamette River was straightened for navigational purposes, and the Willamette Valley was deforested to make fields for farmland. Dams and levees were installed to protect homes and industries. For years, the river operated as the valley's sewer system, a repository for raw sewage and untreated waste. These human activities dramatically altered the landscape as well as the quality of the water. Gene Foster, manager of the watershed management section of Oregon's Department of Environmental Quality (DEQ), says that the Willamette's overall water quality has improved compared to the 1930s, when a fish placed in its most polluted reaches might die within five to 10 minutes.

Water quality today remains a high-priority issue for the general public, landowners and foresters. This report examines the natural cycles of water in Oregon's forests, forest management activities focused on protecting water quality, current regulatory and voluntary protection measures, and scientific research that will guide landowner and policymaker actions in the future. ■

Forest Ecosystems Benefit People & Water

Water is an integral part of the forest landscape. Water flows link the soils, plants and animals of forest ecosystems with ponds, lakes, streams, rivers, the ocean and, ultimately, the atmosphere. Once water reaches an Oregon stream, it begins a journey through managed and unmanaged forests and rangelands, and then passes by lowland farms and urban centers on its way to the Pacific Ocean. Along the way, some of it is diverted to reservoirs or other storage systems to provide drinking water, crop irrigation and a host of other uses for a growing population.

The source of water for most municipalities is groundwater or surface water from Oregon's rivers and streams, most of whose headwaters are found in forested watersheds. Broadly, the quality of water in the forested environment is judged by its physical, biological and chemical characteristics, including such features as clarity, sediment content, temperature, dissolved oxygen content, bacteria, insects, algae and a variety of nutrients. Pesticides and toxics such as mercury and other heavy metals are typically not included in base measures of water quality due to the high cost of laboratory analysis.

Paul Adams, professor and forest watershed extension specialist at the Oregon State University (OSU) College of Forestry, says that overall water quality from Oregon's forestland is quite high. He also states that there is no general conclusion that can be drawn about the effects of forest management or other human activity on water quality in forested watersheds. "Excellent water can and does come from managed forests," he says, "and conversely, even old-growth watersheds with no human disturbance sometime produce low-quality water."

A comprehensive assessment by DEQ of the biological, chemical and habitat conditions of rivers and streams in the Willamette Basin, published in December 2009, showed that urban and agricultural lands had a significantly higher proportion of their lands in impaired conditions compared to forested lands. However, the report also cautioned that because forestlands occur at higher elevations in the basin, agricultural and urban lands may be the recipients of degradation that occurred in forestland. The report is important as a benchmark for understanding future watershed restoration and protection actions on a major land-use scale.

Most of Oregon's drinking water originates in forest watersheds.

Typically in the forest landscape, water undergoes filtration as it moves slowly through the soil and into a stream. However, Oregon's active weather patterns often disrupt this scenario. Forested watersheds are dynamic and subject to small and large disturbances over time.

Because of factors that include climate, soil type, forest type, geology and topography, water movement in a forest is variable. Though rare, intense rain and rain-on-snow events can exceed the capacity of the soil to take up water. Soil erosion may result. If the runoff is rapid enough, water overflows the stream banks and flooding can occur. The area of over-bank flow is called the flood plain. All natural watersheds have flood plains.

Landslides are a function of saturated soils, along with soil type, steep slopes and, in some cases, human influences. In some areas of Oregon, landslides occur in forests with regularity even without human influence, often delivering large amounts of sediment to streams, reducing shade and sometimes changing a stream's course. While the effects can be visually dramatic, the effects on fish and water are variable. Landslides in forested sites, for example, have historically carried large wood and unsorted soil, rocks and pebbles into streams, reducing water quality in the short term, but in the long term creating backwaters, pools, gravel deposits and other characteristics of productive fish habitat.

Any disturbance – such as fire or logging – that reduces the amount of trees, vegetation and ground cover will reduce interception and transpiration. A reduction in forest canopy also can allow more sunlight to reach the stream. This can be either beneficial or detrimental depending on the aquatic species. Increased sunlight can increase plant growth, which will benefit some aquatic organisms, but if stream temperatures increase as a result, other species may be negatively affected. Another way fire affects soil quality is by scorching it so hotly that its ability to take up water is compromised.

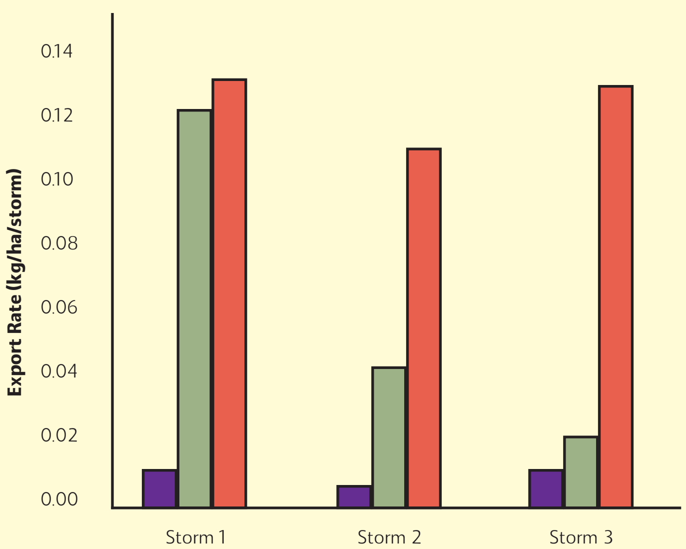
Water Quality Problems Due to Development

There are less conspicuous phenomena that can affect water quality. Air pollution from cars, industrial emissions and other sources, even from far across the globe, escapes into the atmosphere and falls with the rain on Oregon's mountains. Elements such as lead, mercury and arsenic can occur as human-created pollutants but also exist naturally in rocks and soil and can enter water. In addition, legacy pesticides and pollutants such as DDT or polychlorinated biphenyls (PCBs) can enter water with soil erosion. Soils can contain coliform bacteria and other microorganisms deposited by wildlife, domestic animals and humans. All these elements can and do become part of the water that is carried from forest to stream to municipal treatment plant to your kitchen tap.

Once streams leave the forest, they generally pass through agricultural and suburban areas and other land that, in some cases, was previously forested and then cleared for other use. Beyond the farms are cities, many of which were built on wetlands or along waterways for industry and transportation needs. There, vast areas of streets, parking lots, buildings and other often oil-based, impervious surfaces capture and carry runoff to waterways.

From these nonpoint pollution sources comes the detritus of urban life, including contaminated sediment, yard chemicals and petroleum products from vehicles. Point pollution sources such as manufacturers and sewage treatment plants can discharge treated effluent containing potentially toxic chemicals not removed by treatment processes. Occasional overflows of untreated sewage from treatment plants contribute to poor water quality. ■

Comparison of Storm Nitrate Export from Oak Creek, Oregon



Of all land uses, forested land generally excels at protecting water quality. This 2007 study of storm nitrate export from Oak Creek sub-basins compares the natural processes at work in forested watersheds with streams draining agricultural and urban watersheds. This chart is representative of how forest streams compare typically with their agricultural and suburban counterparts. Note that "natural processes" are only at work in the forestland. The high nitrate in the suburban and agricultural catchments are a result of added nitrogen by humans (fertilizer, lawn care products, etc.).

Data Source: Poor and McDonnell, 2007, *Journal of Hydrology*

Doug Decker
State Forester
Oregon Department of Forestry
Salem

"Oregon forests produce cleaner water than any other land use, supplying drinking water for more than 2.8 million Oregonians – 75 percent of our state's population. The Department of Forestry has indicators in its sustainability plans that measure the health of forest streams, and our forest practices rules reflect our commitment to protecting water quality. These rules are continually evolving as forest science learns more about the relationship between management activities and water quality. While the Oregon Forest Practices Act establishes practices to meet water quality standards, forest landowners often go beyond them, depending on their varying objectives. But it's safe to say that owners who draw all or part of their livelihood from their forestland are in it for the long haul and want the best for their land, and for them water quality is a prime concern."

Water Cycle Terminology: a Glossary

Interception
In forest environments, not all precipitation falls directly on bare soil. Rain, fog and snow first make contact with the forest canopy, understory trees or vegetation, or the layer of dead branches and leaves on the ground. This process is known as interception.

Evaporation
Of the precipitation that occurs, both the water that is intercepted by vegetation or dead matter and what falls on the soil directly, a portion of it returns to the atmosphere by evaporation.

Infiltration
The downward entry of water into the soil to the groundwater system is infiltration.

Soil Uptake
Some water in the soil is taken up by the root systems of plants and trees for nourishment. This is soil uptake.

Transpiration
Most of the water from soil uptake moves up into the leaves and from there back into the atmosphere in a process called transpiration.

Evapotranspiration
All the processes above – interception, evaporation, soil uptake and transpiration – are known collectively as evapotranspiration. This process varies with climate, soils and types and quantity of particular vegetation, but it can return a significant amount of moisture to the atmosphere.

Subsurface Flow
Water that reaches the ground seeps into the soil and into myriad channels in the upper soil layers, and from there moves toward streams through subsurface flow.

Groundwater Flow
Water that seeps deep through the soil into underground aquifers instead of traveling via subsurface flow to a stream is groundwater flow.

Overland Flow
Much less common in Oregon except during high-rain events, overland flow occurs when water moves on top of the soil surface toward a stream.

Forestry's Impact on Water Quality

Natural disturbances in the forest environment such as flooding, landslides and fire affect water quality. The same is true for human activities, including forest management. Timber harvest, thinning, reforestation, vegetation management, forest road construction and maintenance, and treatments to reduce fire risk all have the potential to affect water quality. Before turning to a discussion of measures – both regulatory and voluntary – to minimize the risk of these activities, it is helpful to understand the risks themselves. Understanding risks and their effects is the first step in developing incentives and a regulatory framework that encourage responsible water protection.

Timber harvest includes either the selective removal of some trees from an area, all the trees from a particular stand or area, or periodic thinning of trees for forest health or commercial purposes. Tree harvest can have a range of effects on water yield. With less vegetation to intercept rainfall and transpire soil water, water flow may increase. An increase in flow may cause stream temperatures to decrease during the summer, especially in conjunction with retained vegetative buffers required by the Oregon Forest Practices Act (OFPA).

After timber harvest, small watersheds may have somewhat higher peak flows, which with the resultant in-stream water power can increase sediment yield from stream beds in small basins. Such increases are minor compared to the range of natural sediment yield during flood flows, which have not been shown to be impacted by tree harvesting. Depending on timing, harvest-caused changes in sediment movement can be problematic for some aquatic ecosystems.

Ground-based logging systems may compact some areas of soil, locally reducing infiltration rates and increase the risk of overland flow. Poorly located skid roads – the paths on which felled trees are dragged to the landing – too many skid roads, or skid roads located too near water all may increase sediment yield as well.

The first step is understanding the dynamics of forest management.

Reforestation of harvested areas on private and state lands is required by the OFPA and desired by forest managers who want to take advantage of the growing capacity of the land. Commercial timber harvest intervals, known as rotations, in Oregon forests occur generally every 40 to 80 years. During that period, landowners may also thin a timber stand one or more times to capture economic value and enable the remaining trees to grow larger. Shortly after a final harvest, new young trees are planted in the harvest site – some 30 million to 40 million of them in Oregon every year.

The OFPA requires planting after clearcut harvests, but the Act goes one step further to ensure these new forests reach maturity. Landowners are required to achieve "free-to-grow" status for these young trees, which means the planted trees must beat out competing vegetation in order to return the land to a forested landscape. Landowners use a variety of methods to accomplish this task, including manual, mechanical and chemical tools when needed to hold back competing vegetation until the new trees are established. All methods are regulated by state and federal agencies, and strict rules require forest operations to take precautions to minimize the possibility of chemicals entering streams or waterways.

Poorly constructed forest roads and improper maintenance have the potential to increase sediment delivery to streams. Historically, roads were a major contributor of sediment to streams, but modern road siting, engineering, construction methods and drainage control have greatly reduced the problems from new roads (see next section). The greatest risks roads now create are due to failure of a stream-crossing structure (e.g., a culvert) that then causes the road fill material at the crossing to wash into the stream. Design standards now require larger structures and limit the size of fills. In addition, many forest landowners have voluntarily upgraded stream crossings (see pages 16-17).

Wildfire & Other Natural Disturbances

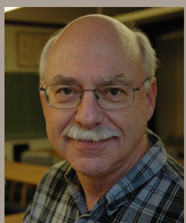
Wildfire, whether naturally ignited or human-caused, can have immense impacts on water quality – modifying flow, increasing sediment yield and changing water temperature and water chemistry (e.g., ash delivered to streams). The effects are often confounding because there are a number of "winners and losers." For example, it is not uncommon for fish size and numbers to increase after a canopy opening resulting from disturbances such as wildfire and logging. Wildfire often "resets" downstream aquatic habitat with delivery of sediment and woody material that may make conditions more productive for some fish. Severe fire can scorch the soil, altering its ability to absorb water. Suppressing fire impacts water quality through the introduction of people, machines and fire-retarding chemicals.

Forests have been subject to small- and large-scale natural disturbances, including glacial and interglacial periods during the past three million years. Within the past 10,000 years, Oregon's forests have been impacted by volcanoes, wildfire, storms and floods, as well as by the hand of Native Americans, who often used fire to improve game habitat and increase berry yields. Thus, forest conditions are highly variable over time and across the landscape.

Commercial forestry in Oregon is little more than a century old, but without question it has brought changes to forest ecosystems. Over the past 20 years, advancement in forestry practices – as well as upgrades to Oregon's forest protection laws – have reduced forestry's impacts on water quality significantly. To the casual observer, local forest impacts may appear dramatic in the short term. However, contemporary practices disperse relatively small impacts over time and across the landscape, keeping the range of variability acceptable.

Hydrologist George Ice of the National Council for Air and Stream Improvement (NCASI) states, "If we look at data from the U.S. Geological Survey National Water Assessment program, it becomes clear that water quality from Oregon's forested watersheds is among the best in the nation." ■

In recent years, improvements in forest harvesting equipment have minimized the impact of older, heavy equipment at harvest sites. The ability of forest soils to absorb, filter and transport rain water can be highly affected and compromised by compaction due to heavy equipment. Machines such as this mechanical feller are much lighter and more nimble than their predecessors, resulting in less disturbance to a logging site.



Marvin Pyles
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"Landslides are a natural part of mountainous terrain ecosystems in Oregon and elsewhere. Most occur in direct response to large regional storms, but the stage for a landslide is set naturally by geologic processes of weathering and accumulation of geologic debris. Forest management activities such as road building and timber harvesting are capable of adding to the landslide susceptibility of hill slopes. As we have learned more about identifying high-risk sites over the past several decades, forest managers have responded by developing practices aimed at reducing hill slope impacts. Harvesting by cable yarding, for example – the aerial removal of logs by cable to a nearby ridge top – involves much less impact on soils than occurs with numerous mid-slope roads. There also have been many improvements in forest roads related to location, design, construction, drainage and maintenance."

Wildfire has the potential to have a major effect on water quality. It can destroy the trees and vegetation along streams in riparian management areas, resulting in increased water temperature. The reduced forest canopy can result in more rainfall reaching streams, often causing increased erosion and sedimentation. Fires in overstocked drier forests can be much hotter and larger than historic averages, with the potential of permanently altering the character of soils and their absorption and drainage potential.

Regulation & Protection of Aquatic Resources

Commercial forestry in Oregon grew slowly during the first half of the 20th century, but the post-World War II housing boom and economic growth produced record harvests. With advances in our scientific understanding of forests and water processes, professional foresters and researchers began to see the need for changes in timber management practices to protect aquatic and other forest resources. As a new environmental consciousness swept the country in the 1970s, Congress created the Environmental Protection Agency (EPA) in 1970 and passed legislation such as the Clean Air Act (1970) and Clean Water Act (1972).

Federal agencies such as the Forest Service, the Fish and Wildlife Service and the Natural Resources Conservation Service, as well as Oregon's departments of Environmental Quality (DEQ), Forestry (ODF), Fish and Wildlife (ODFW) and Agriculture (ODA) increased their efforts to protect and restore the environment. In 1971, the Oregon Legislature enacted the Oregon Forest Practices Act (OFPA), the first comprehensive statewide act of its kind in America. Under the Act, ODF is responsible for protecting water quality on state and private forestlands. The Board of Forestry, the citizen board that governs ODF, sets Best Management Practices (BMPs) through rules promulgated under the OFPA. By law, these BMPs must ensure that forest practices meet the water quality standards adopted by the state's Environmental Quality Commission "to the maximum extent practicable." If the standards are not met, then rule changes to meet standards may be necessary. In the 1990s and early 2000s, major upgrades to the OFPA boosted water-quality protection for forest streams during harvesting and road use. In large part, says Ted Lorensen, retired assistant state forester with ODF, the "OFPA was initially – and remains today – very 'water-centric' – not only because factors such as the original Alsea watershed study and the federal Clean Water Act were important drivers, but also because foresters and scientists had come to realize the importance of water as an agent of change in the forest landscape." For instance, included in the OFPA were rules that addressed the potential impacts of forestry on aquatic resources: road construction and maintenance, harvest practices, stream crossings, reforestation and pesticide use.

The law and related rules have changed steadily over time.

Improving Forest Roads

Forest-road regulations are a case in point. Forest operators – the contractors who do road construction and maintenance for landowners – are well-versed in today's OFPA regulations and the environmental standards that minimize impact. Those regulations permeate nearly every aspect of road construction and use. The law and related rules have changed steadily over time. In the 1980s, new rules addressed roads planned for steep sites, directing, for example, "full-bench" construction on steeper slopes. When constructing a full-bench road, the entire road surface is excavated into the hill. Where previously soil was pushed to the downhill side of the road (sidecast) to become a potential source of erosion and sediment, it is now removed and hauled to a stable site (end haul). In the 1990s, rule changes required landowners to maintain fish passage (both upstream and downstream for juveniles and adults) and to design road crossings to pass 50-year storm events. More recent changes have addressed wet-weather hauling, landslides and public safety, and road maintenance.

While forest roads facilitate timber harvest and other management activities, the general public often uses them for recreational purposes. Additionally, they offer firefighters and equipment access to otherwise inaccessible forested areas when combating wildfire. Research and experience have shown that runoff from these unpaved but semi-impervious forest road surfaces can gather in roadside ditches and flow downhill toward streams. To thwart sediment from entering a stream, engineers and foresters have devised multiple methods to intercept these flows and divert them onto the forest floor, where the runoff can filter into the ground.

In general, forest engineers seek to disconnect road drainage from streams, and have devised responsive practices to avoid stream impacts and meet OFPA requirements. The first is road location. Older forest roads usually were constructed parallel and close to streams for ease of construction. By building new roads away from streams, often up to midslope or ridgetop areas, any erosion is less likely to impact water quality. Methods have been devised to divert water from drainage ditches into flat areas where it can seep harmlessly into the soil. Devices such as water bars or dips are built into today's forest roads. These devices trap overland flow from the road surface and redirect it to the side of the road. Cross-drains divert water from ditches on the uphill sides of roads under and across them into adjacent areas where the runoff can filter into the soil. Many other road-related improvements occur at stream crossings. Properly engineered bridges and culverts can minimize or mitigate the introduction of sediment to a stream. Contemporary culverts are improved and monitored, and recent innovations such as "squash" and bottomless-arch culverts are much more effective than older designs. When poorly designed or jammed with debris, culverts can prevent fish passage and cause catastrophic fill failure and flooding.

Despite improved engineering and stricter rules, today's forest managers have inherited a legacy of roads and stream crossings across the landscape built under older rules. These older roads and crossings have a significant impact on water quality. Survey and remediation work began as early as October 1995, when Gov. John Kitzhaber announced the Oregon Coastal Salmon Restoration Initiative (CSRI) and directed state natural resource agencies to develop a plan aimed at restoring the health of Oregon's native coastal salmon populations to productive and sustainable levels. Most large landowners have completed the survey work and are actively implementing voluntary remediation, but the task is a large one. As future harvests occur, landowners are legally responsible to improve roads and stream crossings within the operation area.

Protecting Riparian Zones

The areas next to streams are known as riparian management areas (RMAs). For fish-bearing streams and those used for

Regulations Protecting Forest Streams

Because of their importance to water quality and fish abundance, the Oregon Forest Practices Act contains strict regulations that protect riparian management zones during timber harvest and forest management activity. In the landscape at left, located in the xxxxxx watershed near xxxxxxx, the dotted white line encircles the riparian management zone – an area on either side of the stream left undisturbed during the course of harvest.

Peter Daugherty
Acting Private Forests Division Chief
Oregon Department of Forestry
Salem

Peter Daugherty oversees the development of water policy on Oregon's private forestlands. He works closely with the Department of Environmental Quality and others in reviewing monitoring results, deciding when and how to revise policy to better meet goals, and providing background for the Board of Forestry as it develops responsive policy. "Many people don't realize that beyond meeting the many OFPA regulations designed to protect water quality, forest landowners have developed a whole array of voluntary Best Management Practices for the Oregon Plan for Salmon and Watersheds that exceed regulations when it comes to enhancing water quality," he says. "Professional foresters understand water resource protection and can often exceed regulatory goals more efficiently and economically, and it's important to give them that freedom."

domestic water supply, OFPA rules require no tree harvest and limited or no forest management activity within 20 feet of the high-water mark. These are "no-touch zones." In addition to no-touch zones, forested buffers – areas with a specified amount of live trees – are required to be maintained from 50 feet up to 100 feet from the high-water mark, depending on stream size and type. Small, non-fish-bearing streams are not subject to this rule, though in some regions understory and non-merchantable vegetation must be left within 10 feet, and in all cases the streambed and banks must be protected from management disturbance.

RMA buffers help protect stream water and mitigate effects of nearby management activity. They also protect stream banks and help ensure that organic matter from overhanging vegetation falls into the water, contributing to stream ecology. Buffers also retain large trees to become the source of woody debris to help reset aquatic habitat when floods and landslides occur.

Since RMAs are the main method for protecting streams from harvest disturbances, there is much interest in riparian zone research, which seeks to test the effectiveness of current practices (see pages 13-14 for more information about studies currently in progress). The ODF and Board of Forestry closely monitor forest science research, as it helps inform future improvements to the OFPA – including avoiding costs to landowners for unnecessary or ineffective practices.

Reforestation after harvest is a requirement of the Oregon Forest Practices Act. Re-establishing the new forest as quickly as possible is a goal of both the state and forest landowners. Every year in Oregon, owners plant 30 million to 40 million new trees and are responsible for keeping them healthy and viable until they are higher than competing vegetation and "free-to-grow." Here region manager Jerry Anderson (right) and forest engineer Seth Sanders inspect a young Douglas-fir on Forest Capital Partners land in western Oregon.

Light Harvest Practices

Timber yarding – moving logs to roads for hauling – has changed a good deal over the past half-century. To meet landowner objectives to harvest quickly and safely while protecting the soil, logging machinery has become lighter, more nimble and technologically advanced. Forest operators now have an array of machinery they employ on specific types of forest conditions and harvests. The lighter weight and longer reach of machinery reduces soil compaction so the porosity of the soil and its ability to absorb and filter water are less likely to be compromised. Ground-based harvest is restricted to areas with more gentle slopes.

To protect soil productivity and prevent erosion, the OFPA prohibits ground-based yarding on unstable, wet or easily compacted soils where it would damage soil productivity through disturbance, compaction or erosion. Operators are responsible to protect soil productivity.

In areas with steep slopes or streams that must be protected, forest operators use a variety of cable yarding techniques. After trees are felled, an aerial cable system lifts them high overhead, away from streams to a ridge-top landing, where they can be processed into desired log lengths and loaded onto trucks. This technique minimizes ground impacts and soil compaction, because soils disturbed by yarding are more prone to erosion and delivering sediment to streams.

The ridge-top, roadside log landing also means most machinery and soil disturbance are distant from streams, as are roads for the trucks that haul the logs to mills.

Beyond harvesting by cable yarding, there are operators who specialize in aerial removal of logs by helicopter, eliminating the need for a single wheel or track on the ground. Piloting these aircraft, some of which have lifting capacities exceeding 25,000 pounds, is a specialized skill. This method is more expensive and is reserved for commercial areas that lack road access and have unique forest values.

Planting the Next Forest

Tree planting itself has no direct effect on water quality, but landowner objectives for young trees may involve the application of herbicides to control competing vegetation and quickly reestablish the forest. Chemical use is strictly regulated by the U.S. EPA, the ODA and the ODF. No applications may take place within specified distances of water, and numerous precautions are required to prevent the possibility of chemical migration to a stream through drift or runoff.

As to frequency, there may be only one to three applications per site in a rotation cycle (which varies depending on landowner objectives), depending on forest type and competing vegetation, and sometimes none at all, especially in east-side forests. Such limited use translates into forestry use of pesticides representing well under 5 percent of the total amount of such chemicals used in Oregon annually. However, due to aerial spraying and multiple sites harvested and treated at staggered intervals in local watersheds, public concerns about pesticides reaching forest streams are taken seriously. Dr. Jeffrey Jenkins, professor of environmental and molecular toxicology at OSU, has done work in forested watersheds. He says there is no definitive research concluding that modern forest practices result in herbicides reaching streams in amounts harmful to fish or that violate water quality standards. Based on his research and experience, he says there is likely not enough herbicide use in forestry for concern, particularly when one considers the pervasive downstream use of chemicals in farmland and more populated areas. "Compared to chemical use in other areas," he says, "forestry use of herbicides is much less intensive."

Though it may look somewhat chaotic to the casual observer, fisheries biologists have learned that the presence of logs and rocks in streams creates pools and backwaters that fish use for resting, feeding and spawning. The Oregon Forest Practices Act protects these areas, known as riparian management zones, limiting harvest activities, by preserving standing trees and offering incentives that encourage landowners to speed stream enhancement through voluntary measures.

ODF and private forest landowners are not the only entities with an interest in water quality. The federal government, manager of Oregon's largest amount of forestland – 18.2 million acres – takes a strong interest. Brian Staab, regional hydrologist with the U.S. Forest Service in the Northwest, cites watershed protection and restoration as a major goal of the agency. He says they are working to achieve that goal by applying robust protection measures to all new and ongoing activities, implementing restoration projects to address the effects of past management actions, and developing the information to guide these actions through inventory, assessment, and monitoring programs. The Forest Services focuses limited resources in priority watersheds and implements a range of integrated actions at the watershed scale. These include removing and improving roads, reconstructing degraded stream channels and floodplains, removing unneeded dams and other barriers, restoring instream flows, managing invasive species, and applying a variety of silvicultural treatments. Increasingly, these actions are implemented across ownerships.■

Gene Foster
Manager, Watershed Management
Oregon Department of Environmental Quality
Portland

Gene Foster, who is responsible for DEQ's watershed management programs, says the agency adopts standards designed to protect beneficial uses such as aquatic life, recreation, and drinking water. An ambient water quality monitoring program maintains 131 monitoring stations across the state, with findings and trends reported to the Legislature each biennium. The Total Maximum Daily Load (TMDL) program uses water-quality monitoring data where standards are not met to create a plan for those water bodies to meet standards.

How OFPA Laws Address Water Quality Issues

Oregon Forest Practice Laws Protect Streams and Lakes

Following are some of the regulations that govern forest practices around water resources.

Notification and Written Plans

The ODF must be notified at least 15 days prior to forest operations such as timber harvesting, road construction, site preparation, chemical applications, slash treatment and land clearing. A detailed written plan explaining how water resources will be protected is required prior to operations within 100 feet of fish-bearing or domestic-use streams and large lakes, and within 300 feet of significant wetlands.

Timber Harvest near Streams, Lakes and Wetlands

Riparian management areas (RMAs) consisting of 20- to 70-foot-wide buffers (depending on stream size) are required on each side of forest streams used for domestic water supply. Where fish are present, RMA widths are 50 to 100 feet. Streams without fish and those that don't provide domestic water supply have RMAs of zero to 70 feet. Harvest and operating restrictions within the RMA include the following:

- retention of understory vegetation within 10 feet and all trees within 20 feet of streams
- retention of a specific number, size and type of trees between 20 feet and the outer RMA boundary (depending on stream size and geographic region)
- no skid trails within 35 feet of streams except where crossings occur
- minimizing yarding across streams and protecting the bed and banks with practices such as fully suspending the log above the stream
- protection of residual timber, the litter layer and the soil surface when using prescribed fire near streams and lakes

Landowners must protect forest lakes and wetlands according to special tree and vegetation retention buffers that are prescribed in specific widths according to landscape features. They must also retain trees along small, steeply banked non-fish streams likely to experience landslides so that if slides do occur, the trees will move with the slides into fish-bearing streams, contributing to fish habitat.

Road Construction across Streams

Because a stream winds its way through a forest, there are times when a road must cross it. Landowners must minimize the number of crossings and must design them to allow fish passage and handle a stormwater event that, on average, might occur only every 50 years. Road location, design, construction and maintenance must minimize erosion and promote filtering of sediments from runoff. Use of large road fills (more than 15 feet deep) or any machine activity in streams requires a written plan.

Road Use near Streams

When forest operations use roads, the soil disturbance associated with the machinery and trucks must be contained near the road. OFPA rules require that forest road operations must not deliver sediment-filled water to forest streams, lakes or wetlands. Road use and maintenance must minimize erosion and ensure that sediment from road runoff is filtered onto the forest floor. Hauling must cease during wet weather if the road surface breaks down or begins to deliver sediment.

Chemical Application near Streams

Strict state and federal laws govern forest chemical use near streams. Mixing and staging areas for aerial spraying are not allowed within 100 feet of streams used by fish or for domestic water supply. Aerial application is only allowed under specific weather conditions, and is not allowed within 60 to 300 feet of such streams, depending on the type of chemical. Ground application is generally allowed beyond 10 feet, but wider buffers are required for some chemicals. Near community water sources, chemical applicators must inform system managers of planned applications within 50 feet for ground-based applications or 100 feet for aerial applications.

Opportunities to Improve Riparian Habitat

Oregon forest regulations provide incentives and streamlined processes for landowners and operators who want to improve aquatic and riparian habitat where opportunities exist. Oregon's forest sector is the largest single contributor to voluntary stream and watershed enhancements since the 1998 origin of the Oregon Plan for Salmon and Watersheds. Many landowners have replaced older culverts and bridges to open streams to fish passage. Landowners and operators are encouraged to develop site-specific riparian vegetation retention prescriptions under a plan for an alternate practice (subject to ODF approval) where the goal is to improve conditions in an RMA. For example, as an incentive to improve fish habitat, landowners may harvest more standing trees from RMAs in exchange for providing immediate fish habitat improvements through placement of large wood in streams. Further, a landowner who chooses to manage RMAs in ways that exceed the required protection levels may participate in a Stewardship Agreement, which will provide assurances that the state will not later modify regulations for that property.

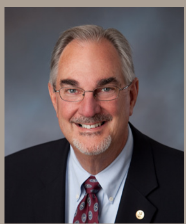
Scientific Research on Water Quality

Scientific research into issues related to water quality and forestry is ongoing, and Oregon is particularly fortunate to have resources such as those in Corvallis, which is a nexus for forest-related science. Many productive research collaborations involve experts from the OSU College of Forestry and schools and departments related to fisheries, biology, toxicology and others. The U.S. Forest Service Forest Sciences Laboratory (FSL), the U.S. Geological Survey Forest and Rangeland Ecosystem Science Center (FRESC) and the U.S. EPA's Western Ecology Division (WED) are also located there. Ongoing scientific investigation is a key factor for ODF and the Board of Forestry as they continue to refine and improve responsive forest practices. Below are just a few of many examples.

Paired Watershed Studies. Some of the more ambitious current projects related to water quality consists of three paired watershed studies in different western Oregon locations: Hinkle Creek near Roseburg in the Cascade Range, and the Trask and Alsea watersheds in the Coast Range. These studies involve a cooperative research effort lasting a decade or more to quantify the impacts of contemporary forest management practices on forested watersheds. In addition to the above organizations, NCASI, ODF and ODFW are participating, as well as forest landowners who are making their forestland available to the researchers and adjusting the timing and design of management activities to fit investigators' needs. The methodology involves massive data-collection efforts on two similar stream systems in the same watershed, one left untouched and the other managed under current forest practice rules – the goal being to distinguish the effects on aquatic ecosystems of naturally occurring disturbances versus those caused by forest management. Arne Skaugset, associate professor at the OSU College of Forestry and head of the Watersheds Research Cooperative (WRC) that serves as the umbrella organization for the studies, says it is too early in the studies to draw conclusions, but early data suggest that impacts from forest management activities are falling well within the range of natural variability.

Ongoing research is a key factor in protection of water quality.

Landslide Research. Marvin Pyles, professor at the OSU College of Forestry, has done major research on landslides. He says it is difficult to generalize about causes because natural factors, such as faults that cause slides, are often hidden. Advances in harvest techniques, he says, have done a good job of minimizing risk. Yarding from the tops of hills, for example, means more roads can be situated on ridge tops, which is preferable to mid-slope or lower. Slides are natural occurrences in our relatively young geologic region that we'll never eliminate, but they can be beneficial in the long run if the slide includes trees to supply large woody debris to streams. They can, as OSU College of Forestry Dean Hal Salwasser puts it, "mess things up for a year or so, but they then provide 10 or 20 years of benefit to the stream through gravel deposition and the introduction of large wood that revitalizes pools, backwaters



Hal Salwasser
Dean
College of Forestry
Oregon State University
Corvallis

"In terms of forestry education, water has been the central issue foresters have been trained to deal with since the beginning. Maintaining clean water is a key part of the social license for forestry today, and forestry education is designed to reflect those values. Every forest everywhere, no matter the use, is a watershed and a wildlife habitat, and every forester is trained to care for both. For example, we teach hydrologic processes and the role of forest watersheds in recharging groundwater, and our forest engineering students learn ways of removing trees without impacting streams."

and spawning beds."

Riparian Zone Studies. There are major climatological differences between the eastern and western sides of the Cascade Range. As a result, the pine and mixed-conifer forests of the drier east side differ significantly from the Douglas-fir forests of the wetter west side, or the fir, alder and hemlock forests of the Oregon coast. OFPA rules acknowledge these variations, and research continues to shed light on these geographical differences. John Bailey of OSU's College of Forestry is an expert on fire and forest ecosystems, and has been focusing recently on riparian zones in east-side forests. His concern is that, unlike in west-side forests, eastern Oregon riparian zones are more fire-prone. Without active management, they can act like "wicks" during wildfires. Bailey is exploring whether strategic thinning and other methods can reduce that risk.

RipStream. Stream temperature is important for salmon and trout rearing, yet temperatures can differ at the same location between years and at different locations within a year. Determining whether timber harvesting or natural variability increases stream temperatures is difficult. To that end, the ODF developed its Coast Range study – the Riparian Function and Stream Temperature (RipStream) project – to test the ability of current forest practices rules to meet water quality standards for temperature and to see how riparian areas function and change after harvest. ODF collected data from 2002-10. The project entered a data-analysis phase in 2011.

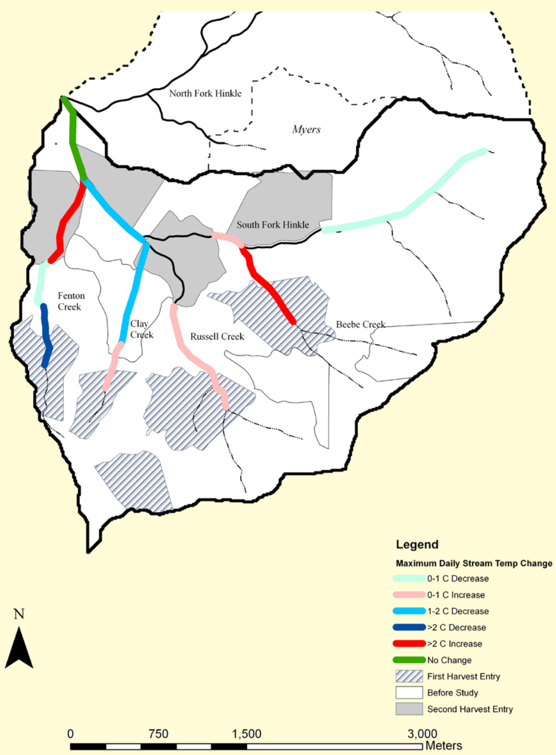
The RipStream study accounted for natural variability in stream temperature by including many sites (33), maintaining an uncut upstream control reach for each site for the duration of the study, and recording data from two years pre-harvest to five years post-harvest. Sites' riparian areas were cut to minimum OFPA regulations and minimum State Forest guidelines, depending on ownership. Jeremy Groom of OSU's College of Forestry has collected and analyzed this data for the past four years.

Groom first examined the data to see if current harvesting practices met two of the DEQ's temperature criteria, an anti-degradation criterion and a temperature threshold. The anti-degradation criterion, also referred to as the Protecting Cold Water (PCW) criterion, prohibits harvesting from increasing stream temperatures by more than 0.3° C. The threshold criterion prohibits increasing stream temperatures above either 16° C or 18° C, depending on the stream. Groom found that harvesting did not result in an increase of stream temperatures above threshold levels. However, he also found that streams on private lands typically increased by more than 0.3° C, exceeding the PCW criterion.

Groom, with help from ODF riparian specialist Liz Dent and statistician Lisa Madsen from OSU, is now broadening the scientific investigation to determine exactly how much stream temperatures increased and what features of the stream, such as shading and channel width, for example, were associated with those changes. ■

Stream Temperature Changes, Hinkle Creek

The data shown here come from sophisticated monitoring equipment set up as part of the Hinkle Creek Paired Watershed Study, located in Douglas County. The figure clearly shows that at Hinkle Creek the full spectrum of responses of stream temperature to timber harvest was observed; maximum daily stream temperatures increased, decreased and remained about the same. Analysis of these data continues to investigate the processes that caused the changes and their downstream impacts. Water quality criteria such as temperature, sediment, turbidity and so on are monitored and quantified over a decade or so, with timber harvests taking place at planned intervals. Similar data are being monitored simultaneously for comparative purposes on a similar stream in the same watershed where no forest management is taking place – hence the term, "paired watershed study." Researchers hope to be able to assess the effects of forest management activities on water quality.



Researchers here in the Hinkle Creek watershed inventory stream segments, using electroshock technology (which temporarily brings fish to the surface to be identified and counted) to monitor fish abundance as part of the paired watershed studies currently in progress in Oregon. Such research tracks the movement and quantity of fish in the watershed to measure possible effects of forest management.

Voluntary Efforts Protect Water and Fish Habitat

Across the state, citizens have joined with private forest managers to tackle watershed issues on a voluntary basis. Some of the most significant activity began in 1997 when the Oregon Legislature and Gov. John Kitzhaber joined with landowners statewide to create the Oregon Plan for Salmon and Watersheds (OPSW), a unique grass-roots conservation plan to address water quality and fish habitat issues. ODF and other agencies realized that tackling these issues would require citizens working collaboratively and voluntarily across land-use types and property boundaries. Regulation alone could never fully address the challenge. Since its inception, the OPSW has spawned scores of private local and regional watershed councils that organize volunteer efforts and provide organizational and technical support for landowners and others seeking to enhance water quality and fish habitat in Oregon waters.

Today some 100 local and regional watershed councils across the state continue the voluntary restoration work. Watershed improvements on private lands fall into four general categories: aquatic habitat (in-stream); riparian habitat (near-stream); upland habitat (higher in the watershed); and roads and stream crossings.

Between 1997 and 2009, private forest landowners contributed more than $89 million in private funds toward watershed enhancement. Early efforts focused on forest roads, thousands of miles of which were surveyed, improved, vacated, closed or relocated. Hundreds of stream crossings were improved by replacing or repairing culverts where fish passage was blocked or threatened. Forest landowners worked with fish biologists to place boulders and large wood in streams to speed habitat improvement. Many landowners went well beyond OFPA regulations with voluntary road construction and maintenance improvements. Greg Sieglitz, the monitoring and reporting manager for the Oregon Watershed

Voluntary Improvements by Private Forest Landowners

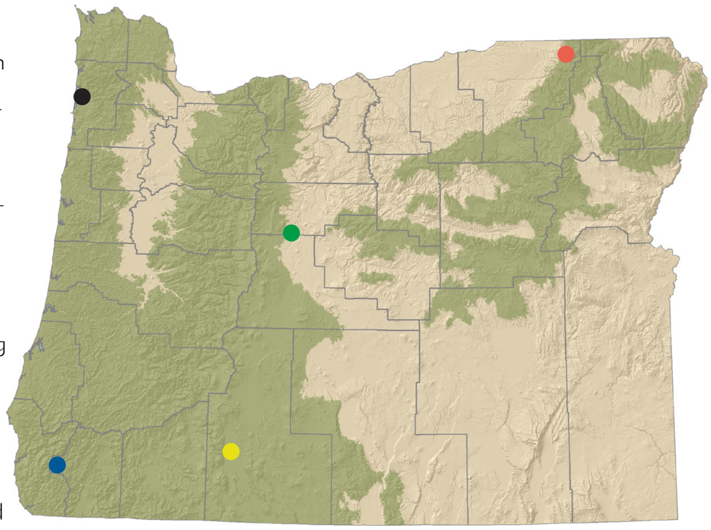
The following are Oregon Plan actions reported by private forest landowners between 1997 and 2009. Private landowners have contributed more than $89 million cumulatively toward such restoration activities.

Road miles surveyed	16,457
Road miles improved	3,238
Road miles vacated, closed or relocated	546
Number of peak flow improvements (increase culvert or bridge size to pass high flows)	7,901
Number of surface drainage improvements	18,299
Number of stream crossings improved for fish passage	1,643
Number of large wood placement projects	514
Number of other in-stream projects (boulder placement, side channels and alcoves)	156
Number of conifer restoration projects	64
Number of riparian management projects (voluntary tree retention)	2,466

Data Source: OWEB, based on projects completed and reported to the Oregon Watershed Restoration Inventory.

Voluntary Efforts at Work in Oregon

Following are a few of the many projects funded solely or in part by OWEB that show the reach and positive impact of volunteer efforts across the state.



Tillamook Bay-Wilson River: Following numerous voluntary actions aimed at improving agricultural practices, investigators found a significant and consistent decrease in E. coli bacteria concentrations in the Wilson River on Oregon's north coast. Monitoring over a six-year period indicated that concentrations have not exceeded the water quality standard since 2004.

South Coast: Monitoring and research designed to evaluate the voluntary removal of fish migration barriers in southern coastal streams found that juvenile salmonids had moved upstream and were occupying newly opened stream habitat in more than 85 percent of the areas sampled.

South Central Oregon-Williamson River Delta: Following a wetland and lake restoration project on more than 2,000 acres in the Klamath basin, researchers have documented declines in harmful phosphorous levels and increases in habitat and use by endangered species.

Northeast Oregon-Walla Walla River: Restoration projects designed to increase stream flows in the Walla Walla River watershed have resulted in maintaining year-round flow for the first time in 100 years. Although more work is needed to provide high-quality fish habitat, positive effects for fish and water quality have already been documented.

Central Oregon-Upper Deschutes: Macroinvertebrates are good indicators of stream health. Four years after completion of some voluntary projects, a 2009 research study looking at abundance of aquatic insect communities found a noticeable increase in insects representative of those found in cooler stream temperatures and higher-quality water.

Enhancement Board (OWEB), says the forest industry is still the largest single contributor. As a result, OWEB has had to fund very few forest road projects. OWEB has dedicated a large portion of its funds in recent years to riparian improvement and the removal of fish barriers.

While roadwork continues, much of the focus has shifted to aquatic habitat. Strategic placement of large logs can enhance aquatic habitat by creating pools and backwaters that fish use for shelter, feeding and spawning. Fish also benefit from restored connections to side channels and alcoves. Other voluntary actions promote healthy riparian habitat: selective thinning of over-dense stands and, conversely, reforesting under-producing areas; managing vegetation along streams to enhance stream structure; and re-establishing conifers in riparian areas where they are scarce.

From 1997 to 2010, combined efforts statewide have restored more than 5,400 miles of stream banks and opened an additional 4,150 miles of streams by removing barriers to fish passage. Statewide funding for completed and reported restoration exceeds $660 million.

OWEB coordinates and administers a grant program to which private citizens and watershed councils can apply for funding. OWEB provides grants to help Oregonians take care of local streams, rivers, wetlands and natural areas. Community members and landowners use scientific criteria to decide jointly what needs to be done to conserve and improve rivers and natural habitat in the places where they live. Grants are funded from the Oregon Lottery, federal dollars and "salmon" license-plate revenue.

Forest landowners with small forested tracts, whether or not they practice forestry, may not be familiar with stream and riparian enhancement. In Oregon, there are a number of training and education opportunities. The Oregon State University Extension Service offers programs in all aspects of forestry and resource protection. Extension foresters across the state are available to advise landowners on individual problems. Landowners also find local advice through members of watershed councils and through participation in council-driven stream improvement efforts.

OFRI offers a helpful and recently updated guide titled *Oregon's Forest Protection Laws: An Illustrated Manual*, with pertinent advice and easy-to-understand drawings on a variety of subjects related to protecting water resources, such as forest roads, reforestation and riparian regulations. ■

Peter Bisson
Aquatic Biologist
U.S. Forest Service,
Pacific Northwest
Research Station
Olympia, WA

"Our real consciousness of the seriousness of culvert problems dates back to the 1990s. In the Forest Service Region 6 (Oregon and Washington), an inventory identified over 10,000 inadequately designed culverts, many of which were blocking miles of stream habitat to fish. In both states, a lot of agency and volunteer work addressed many of these culvert issues, and advances in culvert design and placement have taken place, though we still have more to do. Riparian issues in general are another case where our understanding has been broadened. The Northwest Forest Plan showed policy folks that there was more to riparian protection than shade and temperature. Scientists now know that organic matter for the food web, soil stabilization for root systems, habitat for wildlife and microclimate control are all part of the streamside ecosystem function that riparian regulations must work to protect."

One method of protecting water quality is by the aerial removal of logs by cable, a technique called "yarding." Here an operator transports a log, suspended from a carriage (both visible out the machine's window), up an incline from a logging site far downhill. The yarder is sited on a ridge-top landing, where the logs are loaded onto a truck for removal. This technique keeps roads and any soil disturbance far away from streams.

Ensuring Good Water Quality

The relationship of forestry and water is not a new phenomenon, but in recent decades our knowledge has grown considerably. Knowledge from disciplines such as wildlife biology, hydrology and engineering has become part of every forester's education and daily routine. Sustainable forest management embraces not just the economics of forestry, but a full menu of environmental and social outcomes. As population increases and urban growth continues, society will be the ultimate arbiter of water use and will have to confront possible trade-offs as it wrestles with difficult decisions regarding water quality and quantity.

Climate change in the coming decades will certainly affect Oregon – not only its forests, but water as well. The Oregon Climate Change Research Institute, composed of a network of more than 100 researchers in the Oregon University System and affiliated state and federal labs, produced an Oregon Climate Assessment Report for the Legislature in 2010. Climate changes in Oregon, the report says, will affect the state substantially, and will include increased temperatures, warmer and drier summers, rising sea levels and possibly some increase in extreme precipitation. Reduced summer precipitation and winter snowpack in the mountains will create problems for summer water supply in much of the state, particularly related to irrigation for agricultural production and water temperature for fish. Warmer and drier summers will likely make wildfire more of a problem. The implications for plant and animal species are many, and forest scientists are studying potential effects on trees. "The future has new issues – fires getting worse and new invasive species appearing," says biologist Peter Bisson. "Policies need to be developed to effectively say 'some things we have to live with, other things we can do something about.'"

Looking to the future to protect forest streams in Oregon.

Monitoring could help identify trends and threats to water quality and quantity; however, it becomes more challenging in the current fiscal climate because monitoring is expensive. Marganne Allen of ODF, for example, is wrestling with how to maintain monitoring activities in light of budgetary constraints. Another problem has to do with the difficulty of detecting effects due to forest management or other human impacts, given the range of natural background processes and the effects of natural disturbance. Retired assistant state forester Ted Lorensen recalls the period of the early 1970s when the original OFPA regulations were crafted. "The problems were quite obvious back then," he says, "so people could agree quickly on how to address them. Now the problems have become so narrow that there's a lot more debate. Even the ability to measure the direct and indirect effects are difficult."

Hydrologist Arne Skaugset concurs: "Some of what we call 'pollutants' in forested watersheds are naturally occur-

Improving Fish Passage through Culvert Research

Private forest landowners have engaged in their own research in order to improve the effectiveness of culverts. This large culvert test bed is a research project sponsored by the National Council for Air and Stream Improvement, undertaken with the support of forest products companies, to measure the ability of cutthroat trout to pass upstream through culverts. Wild cutthroat trout were captured and tagged with a radio frequency device that enabled scientists to track their movements within the culvert to assess their ability to pass upstream as researchers vary water flows and pipe slopes. The results will help biologists and forest road engineers accurately determine which culverts need replacing, and how to install them.

ring, unlike, say, the presence of pharmaceuticals or other chemicals you might look for around an urban environment. So if you're looking for sediment in a forest stream, for example, you're certain to find it. The challenge is measuring how much a certain action you took changed the amount. What we're finding so far are minute differences, which for the most part are falling within the range of recent anthropogenic natural variability; that is, the past 100 to 200 years of North American settlement.

"In the Alsea watershed study of the 1950s and 1960s," he continues, "there were visible changes in the appearances of the streams, but today you need detailed analyses, such as those in our current paired watershed studies, to make distinctions. Following that early study, regulators tried to set standards, but came to the conclusion that arbitrary standards weren't going to work. Instead they developed a set of best management practices to make sure that the forest sector was doing a good job."

"Water coming out of forestland today is likely to be cleaner than anything you get out of the lowlands," says toxicologist Jeffrey Jenkins, adding that he believes the regulatory burden is currently focused on forestry.

"Forestry is a less damaging, less intensive land use, but there are still reasons for concern about pollutants such as excess sediment and legacy pesticides from forestlands," says Joshua Seeds, a nonpoint source pollution analyst for DEQ. "The agriculture and urban communities have regulatory burdens as well, and they need to meet water quality rules."

Regulatory compliance is one of the costs of commercial forestry, and over the years landowners have, for the most part, willingly shouldered that burden. Landowners have adapted best practices in response to new scientific research. They have helped craft new regulations and are following them. They are adopting sustainability standards and contributing millions of dollars to salmon restoration efforts, with the recognition that in the long term, healthy forest ecosystems are in landowners' – and the public's – best interest. Scientists, policymakers and planners do agree on one thing: of all land uses, a forested watershed does the best job of protecting water quality. They see the insidious risk of forest conversion as perhaps the greatest danger. In other words, if forestland becomes more valuable for purposes other than growing and producing forest products, common business sense will tell landowners to sell. If that happens, the state could lose a good deal of its forestland in close proximity to urban areas, with a concurrent loss of water quality. Therefore, a good way to assure high-quality water in the future is to ensure that private forestland is sustained in working forest uses.

Over the last century, the softwood lumber and plywood industry has grown in Oregon to the point that the state is the leading U.S. grower and producer of these products. The forest sector is an economic and cultural mainstay of the state – some go so far as to call it the "backbone" of Oregon's economy. The sector's success has not reduced the expanse of Oregon's forests. With the exception of some conversion for urban growth and related infrastructure, the state has as much forest cover as it did prior to our 1859 statehood, standing timber volumes are the highest in 50 years, and annual forest growth in Oregon today exceeds forest harvest by a wide margin. Forest landowners and operators, large and small, understand that their social license to operate in forest ecosystems depends on them continuing to excel at caring for water quality, watersheds and wildlife. And they are taking seriously the responsibility to do their part to protect these precious public resources. ■

Of all land uses, a forested watershed does the best job of protecting water quality. If forestland becomes more valuable for purposes other than growing and producing forest products, common business sense will tell landowners to sell. If that happens, the state could lose a good deal of its forestland in close proximity to urban areas, with a concurrent loss of water quality. A good way to assure high-quality water in the future is to ensure that private forestland is sustained in working forest uses.

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