

WILLAMETTE RIVER BASIN

Challenge of Change



- COAST RANGE
 - Volcanics
 - Willapa Hills
 - Mid-Coastal Sedimentary
- WILLAMETTE VALLEY
 - Portland/Vancouver Basin
 - Willamette River & Tributaries Gallery Forest
 - Prairie Terraces
 - Valley Foothills
- CASCADES
 - Western Cascades Lowlands and Valleys
 - Western Cascades Montane Highlands
 - Cascade Crest Montane Forest
 - Cascade Subalpine/Alpine
- Major rivers (Fifth order and larger)
- Fourth field HUC boundaries

By **MARCIA SINCLAIR**

Based on *The Willamette River Basin Planning Atlas, Trajectories of Environmental and Ecological Change*



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There is absolutely no inevitability as long as there is a willingness to contemplate what is happening.

— Marshall McLuhan

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The Challenge

The people of the Willamette Basin have reached a pivotal point in our history. The rich soils, snow capped peaks, abundant rain, teeming rivers and picturesque views that nurtured the native Kalapuya people and dazzled Oregon Trail immigrants arriving in the Willamette Basin in the 1800s, continue to entice newcomers. By 2050 an additional 1.7 million people are expected to live here, bringing the total basin population to around 4 million. That's equivalent to adding 3 more cities the size of Portland or 13 the size of Eugene.

Our challenge is to accommodate that many more people without losing the qualities of the basin that drew us here. People know what they cherish. When asked to define quality of life, residents of the basin say the most important things are:

1. clean air and water,
2. enough water to support communities, industry, fish, and wildlife,
3. the unique character and livability of communities, and
4. significant amount of open space, natural areas, fish and wildlife habitat, and public parklands.

Yet even now, at least 1,400 miles of streams in the basin do not meet water quality standards, largely as a result of human activities. There are water right claims to nearly every drop of surface water in the basin. Even in a normal water year some 60 miles of streams go dry in the Willamette Basin due to water withdrawals. Seventeen plant and animal species are listed under the federal Endangered Species Act, including the northern spotted owl, spring Chinook salmon, and upper Willamette River steelhead.

Oregon citizens have demonstrated a willingness to act to protect the environment and the region's quality of life. They pride themselves on their innovative land use laws, established in 1973, that have reduced sprawl and enabled farms, nurseries, and timber operations to coexist next to population centers.

Citizens of the basin have also taken up several community-based planning efforts to improve livability, promote sustainability, and conserve natural resources. One of



these efforts, the Willamette Restoration Initiative, was established in 1998 to develop the Willamette chapter of the Oregon Plan for Salmon and Watersheds. Willamette Restoration Initiative developed a basin-wide strategy to protect and restore fish and wildlife habitat; increase populations of declining species; improve water quality and floodplain management – all while the basin population grows.

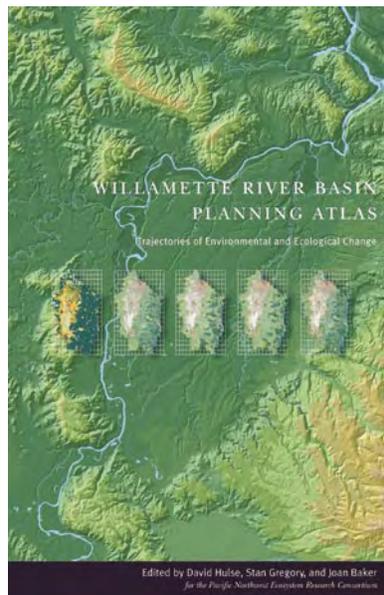
To provide scientific support for community-based environmental planning efforts, the U. S. Environmental Protection Agency initiated a five-year research effort in 1996. Thirty-four scientists at ten different institutions formed the Pacific Northwest Ecosystem Research Consortium to answer four basic questions:

1. How have people altered the land, water, and living organisms of the Willamette River Basin over the last 150 years since Euro-American settlement?
2. How might human activities change the Willamette Basin landscape over the next 50 years?
3. What are the environmental consequences of these long term landscape changes?
4. What types of management actions, in what geographic areas or ecosystems, are likely to have the greatest effects?

Consortium researchers first compiled information on historical landscape conditions, prior to large scale European American settlement and expressed this information in map form. They summarized information on population density and distribution, agricultural practices and crops, and native vegeta-

tion. This information was synthesized into a map of land use (neighborhoods, roads, orchards, nurseries, etc.) and land cover (forests, wetlands, snow, etc.). Then working with a group of knowledgeable basin citizens representing a wide range of interests, they developed three alternative versions or scenarios of the basin’s future. Using maps, charts and text, these scenarios show the combined effects of how we decide to use or manage urban, rural residential, agricultural, forest, and natural lands and water across the entire basin through the year 2050. Then the citizen stakeholders carefully reviewed the scenarios to make sure they were plausible and that the assumptions about future growth and where it would likely occur met a “common sense” test.

- **Plan/Trend 2050** vision represents the expected future landscape if current policies are implemented as written and recent trends continue.



- **Development 2050** reflects a loosening of current restrictions across all aspects of the landscape, placing greater emphasis on achieving short term economic gains.
- **Conservation 2050** places greater emphasis on ecosystem protection and restoration, although still reflecting a plausible balance between ecological, social, and economic considerations as defined by the stakeholders.

Consortium scientists then translated these assumptions into very detailed maps of land use and land cover in the basin through the year 2050. These landscape scenarios are not predictions of future change, but rather illustrate the likely outcomes of the stakeholder assumptions.

Finally, researchers evaluated the likely effects of these alternative futures, and the long-term landscape changes from the first Euro-American settlement through 2050.

The results of their research were documented in the *Willamette Basin Planning Atlas, Trajectories of Environmental and Ecological Change* published by Oregon State University Press in 2002. This full color volume, packed with maps, photos and graphs, is an outstanding tool for planners, researchers, natural resource professionals, and citizens interested in the past, present and future of the Willamette Basin.

This booklet is a summary of their findings prepared in hopes that this information will lend valuable guidance to the people of the basin as they influence the path to our future.

A Sense Of Place

The Willamette River Basin is a verdant landscape in northwestern Oregon that lies between the Coast Range on the west and the Cascade Range on the east. The basin is 180 miles long and 80 miles wide, stretching roughly from Cottage Grove to Portland and encompassing 11,478 square miles, or 12% of the state.

Capturing abundant rainfall from Pacific weather systems, this landscape is defined by its waters. The Willamette River Basin is the area in which all surface water, nearly 11,000 miles of wetlands, creeks, streams and rivers, feed the Willamette River whose main stem flows from its headwaters in the Cascades and Coast Range, north to its confluence with the Columbia River. As a consequence of its rainy position in the world, the Willamette River has the 13th largest stream flow and produces the most runoff for its land area of any river in the continental United States.



Brend Mohnwill



Marcia Sinclair

Cascade streams are colder, clearer and faster.

In the Cascades, stream flows are high during spring snow melt. Stream flows at lower elevations drop during the dry summers, but flood during winter storms, particularly when warmer rain melts layers of snow. Waldo Lake, formed by glaciers high in the Cascades, is so pure its chemistry has been compared to distilled water.

Nestled between two mountain ranges, the basin is sheltered from the full brunt of both Pacific storms and inland chill. Centered on the 45th parallel, half way between the Equator and the North Pole, it enjoys a moderate climate of cool, wet winters and warm, dry summers. In July, August, and

September, when frequent fogs cloak the Oregon coast, the basin remains relatively warm and sunny.

Elevations within the basin range from approximately ten feet above sea level at the Willamette's confluence with the Columbia River, to 4,097 feet at Marys Peak, the highest point in the Coast Range, and 10,495 feet at Mt. Jefferson in the Cascades.

THE BIRTH OF THE WILLAMETTE BASIN

Oregon lies in a geologically active zone of the Pacific Coast, where the sea floor and continent collide. Here, the ocean floor grudgingly slips under the continent. This process forms two kinds of mountains, one where rocks at the edge are forced upward, the other where rocks are heated underground to a liquid form, then vented to the surface as volcanoes. Roughly 35 million years ago, the direction of this moving, grinding seam in the earth's crust shifted direction, leaving a slab of what had been sea floor attached to the edge of

the continent. Part of this orphaned slab, still covered by shallow seas, ultimately became the floor of the basin.

As the denser, oceanic plate slides under the lighter continental coast plate, it has pushed the slab higher and piled up sedimentary rocks on the edge of the continent,



Sandie Abogast

Marys Peak is the highest point in the Coast Range



Marcia Sinclair

Mt. Jefferson towers over Olallie Lake



USDA Forest Service

Waldo Lake water is incredibly pure.

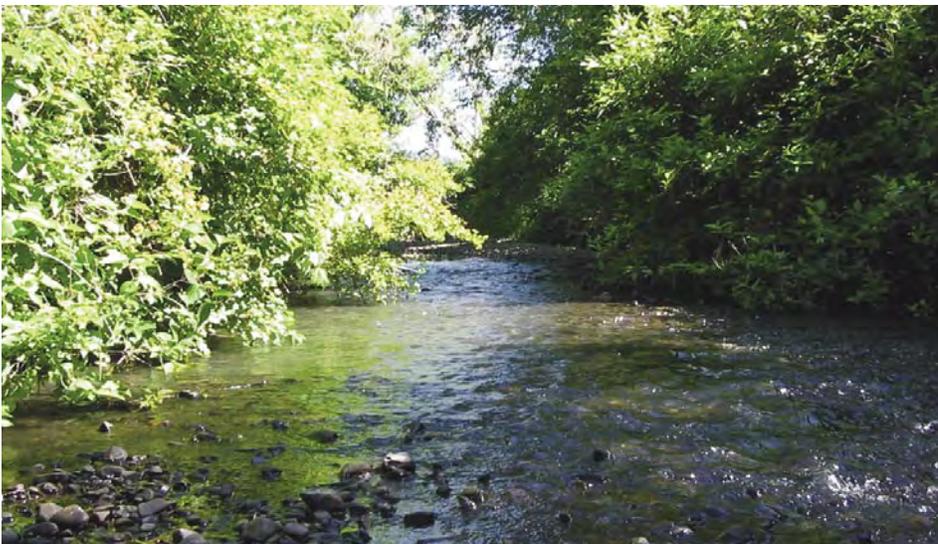
forming the Coast Range Mountains. Partial melting of the sinking plate at the high temperatures that occur deep in the earth's crust feeds a system of volcanoes that rise inland from the edge of the plate, breaking through the slab and creating the Cascades Mountain Range.

Thus, the two sides of the basin feature very different landforms, each creating different soils and stream flows. The Coast Range is largely sandstone and siltstone, mixed with older volcanic rocks. Sandstones and siltstones erode easily into fine, mobile stream sediments. Weathered volcanic

rocks are mechanically weak and prone to landslides. They produce very fine, clay-rich soils, susceptible to slow-moving earth flows. Streams in the Coast Range tend to be slower and warmer.

By contrast, the volcanic rocks of the high Cascades are newer and more resistant to erosion, so they rise to higher elevations than mountains in the Coast Range and are marked by deep valleys with steep slopes. High mountain streams that originate from snow melt are colder, clearer and move faster.

The valley floor, about one third of the basin, is filled with more recent sediment left by major floods. At the end of the last ice age between 17,000 and 12,000 years ago, ice dams on a lake in the present-day Missoula Valley of Montana periodically broke releasing a quantity of water equal to half the present volume of Lake Michigan. These floods poured down the Columbia channel and up the Willamette, forcing rivers to run backward and carrying icebergs that left "erratic" Montana boulders in the Willamette



Jeanine Ishii, Yamhill Basin Watershed Council

Coast Range streams like Upper Deer Creek tend to be slower and warmer.

ERRATIC ROCK STATE NATURAL SITE

This 40-ton boulder located east of Sheridan in Yamhill County is the largest erratic found in the Willamette Valley and serves as a graphic reminder of the power of ice and water.



Sandie Arbogast

Composed of argillite from British Columbia, it must have been moved by glacier to Montana, then floated here by iceberg in one of the many Missoula floods. When examined in 1950 it was estimated to weigh 160 tons but has been chipped away to its present size by tourists.¹



Tom Iraci

Trillium lights the old-growth forest floor.

Valley. The sediments left by these floods form much of the present valley floor. Nearer the river, more recent localized floods have deposited coarser sediments, creating better-draining soils that offer some of Oregon's most productive farm land and richest fish and wildlife habitat.

ECOSYSTEMS OF THE WILLAMETTE RIVER BASIN

These varied landscape conditions within the basin create a mosaic of diverse ecosystems, or areas where distinct climate and geology determine the area's collection of native species.

1. The **Willamette River and Tributaries Gallery Forest** occupies the Willamette River floodplain. This system contains deep, fertile, silty clay soils and supports riparian forests of cottonwoods, alder, Oregon ash, bigleaf maple, and Douglas-fir. A gallery forest is a narrow band of forest along a river in an area of otherwise open country.
2. The Gallery Forest is surrounded by the **Prairie Terrace** ecosystem that covers the remainder of the wide valley floor and lies



Bruce Taylor

Native prairie in bloom

3. The **Valley Foothills** formed on top of basalt and marine sandstone, along the edges of the valley floor and support

Oregon white oak and madrone on the drier sites, with Douglas-fir and some western red cedar in moister areas.

4. The **Western Cascades Lowlands and Valleys** system, volcanic in origin, supports conifer forests of Douglas-fir, western hemlock, and western redcedar, interspersed with alder and vine maples.



Defenders of Wildlife

*While Lewis and Clark reported seeing red foxes in woodlands near the Oregon Coast in 1806, those in the Willamette Valley today are considered non-native. Likely the native red fox (*Vulpes vulpes*) interbred with European red foxes released by hunting enthusiasts.*

5. The **Western Cascades Montane Highlands** occur at higher elevations where snowpack influences the potential vegetation of true firs and mountain hemlock. Montane refers to moist cool upland slopes below timberline and dominated by large coniferous trees.

6. The **Cascade Crest Montane Highlands and the Cascade Subalpine and Alpine** ecosystems lie at higher elevations and are important regional water sources.

Biologists estimate that there are 18 species of native amphibians, 15 reptiles, 154 birds, 69 mammals, and 31 fish currently breeding in the basin. Thirty-six of these species have been identified by state or federal officials as threatened, endangered, or species of conservation concern. In addition, six species that lived in the basin before Euro-American settlers arrived are now extirpated (locally extinct) or are no longer breeding in the basin. They are the California condor, the yellow-billed cuckoo, Lewis' woodpecker, the black-crowned night-heron, the grizzly bear, and the gray wolf. Their loss is most likely due to a combination of human induced conditions including unregulated hunting; predator control; loss of habitat from farming, urban development and timber harvest; and introduction of non-native species. Forty-six non-native species have taken up residence in the basin.

AQUATIC LIFE

Of the 60 species of fish that currently live in the Willamette River Basin, 31 are native and 29 are introduced. Seven of the native



California condor (*Gymnogyps californianus*)

Lewis and Clark spotted them in the Columbia Gorge in 1805 and commented on their nine-foot wingspans. The largest native birds in North America, California condors have been absent from Oregon since 1904. Biologists believe their populations dropped because they were easy prey for humans, not because they lost habitat. By 1987, when only 27 condors were left in the wild in California, a captive breeding program was launched to save the species from extinction.

The Oregon Zoo became the fourth breeding facility in the California Condor Recovery Program in November 2003. A 520 acre site along Clear Creek in Clackamas County, purchased through Metro's open space acquisition program, will house a new facility to provide the space necessary for flight cages for 16 pairs. The recovery program team will determine whether they will be released to the wild. Like their smaller cousins the turkey vulture, California condors eat carrion not fresh meat. For this reason, their reintroduction has been less controversial than that of the wolf or the grizzly bear. Source: Oregon Zoo

USGS, D. Clendenen

species are listed by either the federal or state government as threatened, endangered, or sensitive. These include upper Willamette River Chinook salmon, Lower Columbia River Chinook, Columbia River chum salmon, upper Willamette River steelhead trout, Lower Columbia River steelhead trout, the Lower Columbia River/Southwest Washington Coho

salmon, and upper Willamette cutthroat trout. Fewer species live in upland streams than in the lowlands. Headwater streams typically contain less than 10 fish species, and rivers that are major tributaries to the main stem Willamette generally support 15-25 species. The main stem Willamette supports more than 35 fish species in some reaches.



Upper Willamette and Lower Columbia Chinook are among seven basin fish species considered threatened or endangered.

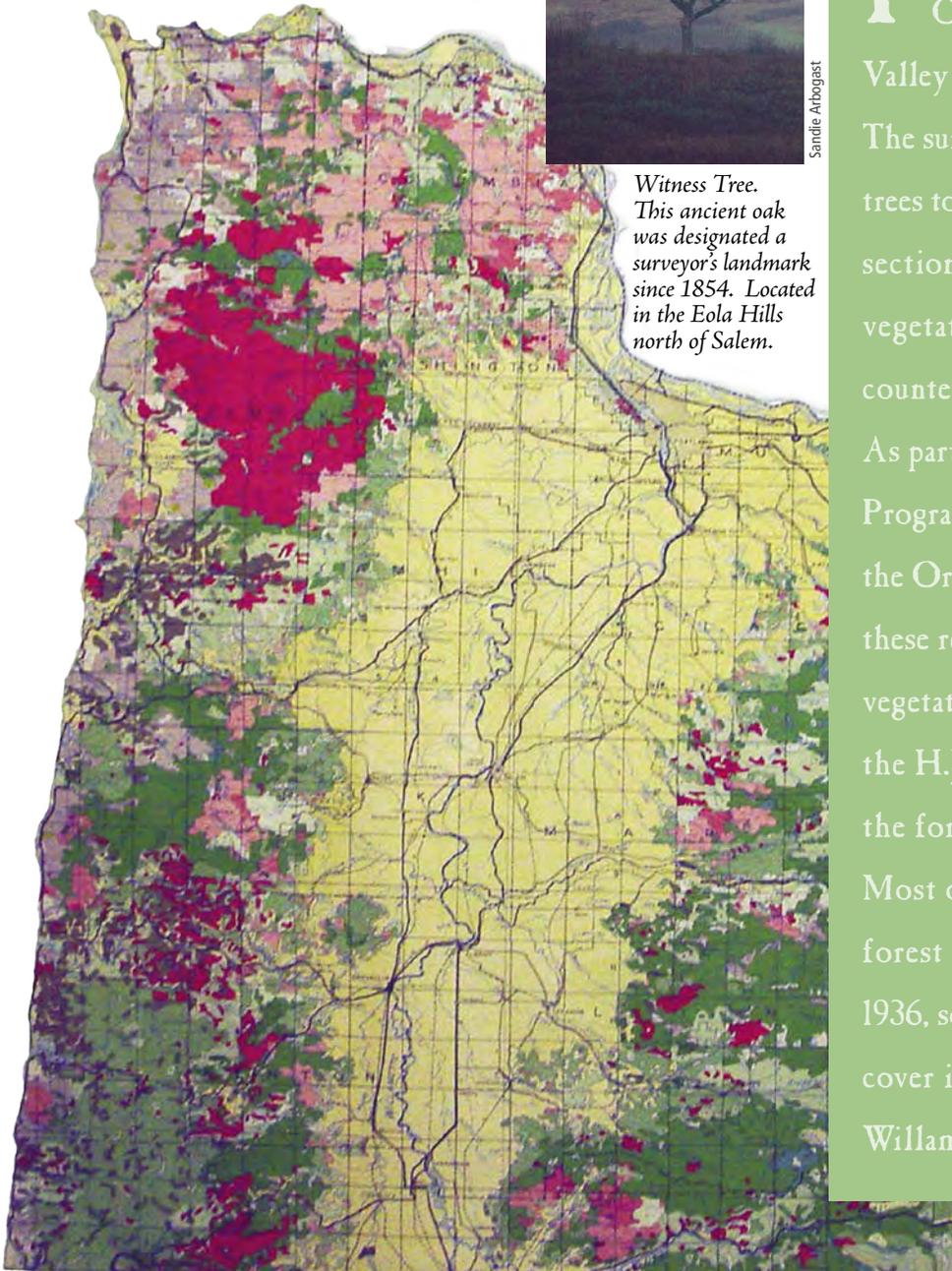
Geoffrey McMichael

How Has The Landscape Changed?



Sandile Arbogast

Witness Tree. This ancient oak was designated a surveyor's landmark since 1854. Located in the Eola Hills north of Salem.



From 1851 to 1865, the Federal Land Office, mapped the Willamette Valley in preparation for settlement. The surveyors used “witness” or “bearing” trees to locate the corners of square mile sections, and their notes detailed the vegetation, soils, and topography encountered as they crossed the landscape. As part of the Oregon Natural Heritage Program, The Nature Conservancy with the Oregon Division of State Lands used these records to reconstruct the historic vegetation of the valley. Additionally, the H.J. Andrews 1936 survey mapped the forests of the Willamette Basin. Most of the higher elevation public forest lands had not been harvested by 1936, so this map approximates the land cover in the higher elevations of the Willamette Basin prior to settlement.



Bottomland prairie grasslands are among the rarest of native communities, with over 97% of its estimated 768,000 acres in 1851 now converted to agricultural and urban use.

PRAIRIES, SAVANNAS AND FORESTS

When the first Euro-American settlers arrived in the Willamette Valley, they found it covered in tall grasses, so tall that cattle were hidden from view. It looked like a park with wide swaths of grass punctuated by groves of spreading Oregon white oaks, and in some areas California black oaks. The Willamette Valley in 1850 was dominated by prairies and oak savannas, with patches of forest scattered across the valley floor.

The native people of the region, called ‘Kalapuya’ by the settlers after the native term for “long grass,” had for hundreds of years periodically burned the valley to encourage growth of plants they used for food and fiber. Tree-ring studies reveal that frequent fires occurred in the valley from at least 1647 to 1848. Open grasslands enticed deer and elk and opened broad vistas for easier tracking and hunting. Carefully timed fires prepared the soil for cultivation of tobacco, berries, tarweed and roots. The late summer burning of the dry prairie grasses cleared shrub and tree seedlings without harming grass buds or the dormant camas bulbs that were a staple of the Kalapuya diet. The valley floor was thus kept in a food-producing early ecological stage.

The name “Willamette” is a product of both French and English interpretations of the indigenous people’s unwritten language and is thought to mean “green river.” The river and its tributaries provided native people with a rich supply of salmon and other fish. Willamette Falls, between today’s north basin communities of Oregon City and West Linn, attracted native fishermen from several tribes for over 10,000 years. Names of Indian bands—Calapooia, Luckiamute, Yamhill, and Clackamas—are now names of major tributaries to the Willamette River. Sadly, a series of disease outbreaks thought to be malaria began in 1831, devastating the native population. By 1841, the centuries-old practice of annual Willamette Valley burning had ended.



Oregon State University

Fire is a tool used by present day land managers to restore native prairies. Burning stimulates growth of some native grasses and forbs while discouraging weeds and tree seedlings.

By 1850, Euro-American settlement had already produced fundamental change in landscape processes and patterns that were several thousand years old. Settlers were drawn to the grassland-forest edges where dwellings were safe from the flooding and high water of the low-lying fertile prairies and they had access to fuel and building materials from the upland conifer forests. These edges had been maintained through burning. As the Kalapuya were displaced by Euro-American settlers, burning decreased and as early as 1852, young firs and “oakgrubs” were reported growing up on the prairies.

Regular burning also had maintained the hilltop tree communities as grassy savannas or woodlands with open canopies and brushy undergrowth. Once burning stopped, tree seedlings popped up in the openings. In addition, settlers introduced non-native plants. Native perennial plants died out when grazed by settler’s cattle, sheep, and horses. In the absence of fire, the unique communities that evolved under the fire regime of presettlement times were lost. The area covered by lower elevation woodland and savanna in 1851 has now been reduced by 88%.

THE RIVER

On its 186-mile journey north, the Willamette River flows through three distinct landscapes which define its shape and character. In 1850, the southern, upper third of the river from Eugene to Albany flowed through a broad unconstrained floodplain, snaking through a braided complex of side channels and islands.

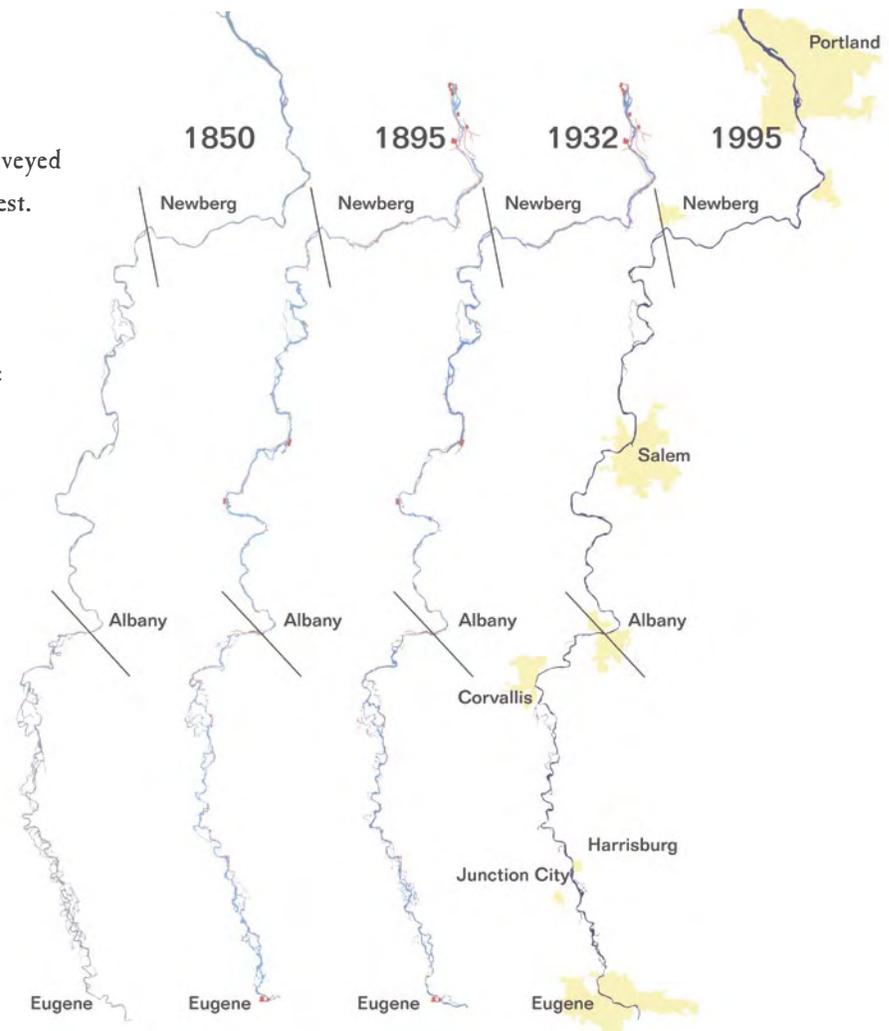
The middle reach, from today's Albany to Newberg, flowed through a series of basalt outcrops and hills within the floodplain that forced the river to bounce back and forth between these resistant formations. Several big tributaries including the Middle Fork Willamette, Coast Fork Willamette, McKenzie, Long Tom, Marys, Calapooia, Santiam, and Luckiamute rivers, delivered large amounts

of sediment into a basin created by the blockage of the Salem Hills. Past floods carved channels through these sediment deposits.

In its final reach, from Newberg to its confluence with the Columbia, the Willamette was confined to a basalt trench that limited its channel complexity and meanderings over time. The position of the river channel in this reach is today essentially identical to the river in 1850. The 45-mile stretch downstream of Willamette Falls is nearly flat and controlled by the backwatering effect of the Columbia River. Given these differences in basin geomorphology (changes to land surface through time), it is not surprising that the channels of the upper Willamette River have changed more dramatically than the simpler channel of the lower river.

A River Through Time

In 1850, the U.S. General Land Office surveyed the land base and rivers of much of the West. The Willamette River network and its riparian vegetation, stream channels, and wetlands were mapped according to monumented section lines. After the large floods of the 1800s the U.S. Army Corps of Engineers sent letters to communities along the river asking them to identify the high water mark. In 1895 and 1932, the Corps surveyed the entire length of the river for navigation. Collectively, these maps provide an excellent record of the historical locations and configuration of the Willamette River and its numerous side channels, tributaries, and islands.



Beavers, Nature's Hydrologic Engineers

The American Beaver, *Castor canadensis*, has played a pivotal role in Oregon's natural and cultural history. The Willamette Basin landscape was partially shaped by this industrious creature, known both for its engineering prowess and its luxuriant fur.

Beavers are slow, waddling vulnerable creatures on land but nimble swimmers. To escape predators each beaver family creates a barrier of water at the door of their riverbank den by constructing a dam that impounds water and raises its level. By damming rivers, they modify river systems. Biologists call the beaver a "keystone species," for as it shapes its own habitat it creates habitat for other creatures.

Beavers turn forests into meadows, creating openings and edges—fruitful areas where habitats come together. Behind their dams, water spreads across the landscape in shallow wetlands and collects in deep pools. Pools shelter otters, turtles, and salmon. Wetlands provide habitat for frogs, snakes, dragonflies, and birds while moderating floods, filtering surface water and raising ground water tables. A landscape full of beavers is a landscape rich in clean water and abundant wildlife.

Wealth of a different kind drew trappers to the Willamette Valley in the 1700s. Beaver hats were the rage in Europe and beaver pelts were in great demand. From 1811 to about 1840 beavers were trapped in massive numbers, nearly to extinction. Fortunately, beaver hats dropped out of fashion by the 1850s.

There is limited data on historic numbers of beavers in the Willamette Valley and their specific influence on its ecosystems. However, there is evidence that generally beaver activities significantly affect both surface water and ground water abundance and that their absence from the landscape may have contributed to degradation of wetlands throughout the West.

Note: While beavers have long been considered nocturnal, trapper's journals indicate they were active by day (diurnal). There is some evidence that where hunting and trapping pressure has eased, beavers are returning to their day jobs.²



"When kept indoors they will cut down the legs of tables and chairs and build little dams between pieces of furniture. Left on their own, they will rearrange waterways".

—Alice Outwater,
Water, A Natural History



Rivers are dynamic and complex living systems. When waters rise or flood, they move gravel around, carve new banks, topple trees, and push sediment downstream. These processes form and reform habitat for aquatic creatures by carving new side channels, building sheltering alcoves, damming pools with large logs, and forming new gravel bars. They build the structures that protect fish, cool water and cleanse spawning sites. Floods enrich the river's aquatic life as well as its floodplain soils, riparian plant communities and riverside wildlife habitat.

It is not surprising that floodplains are desirable places for people, too. The first significant changes to the river's floodplain brought on by Euro-Americans occurred even before settlers arrived. The Hudson's Bay Company trapped so many beavers that the animals were virtually wiped out by the early 1830s. This had long-term effects on the basin's hydrology, vegetation, and wildlife.



Hardened banks and straightened channels simplified the river system.

When Oregon Trail emigrants started settling the Willamette Valley, they too were drawn to the rivers and valley floor. They chose sites primarily by environmental factors, family ties, and farming suitability. Rivers provided transportation. Hill slopes provided safety from valley floods as well as access to fuel and

building materials. Open areas provided livestock forage and made it easier to clear land. These early settlers were powerfully drawn to floodplains for fertile agricultural soils and to rivers for energy and transportation.

Prior to 1850, almost 95% of the Euro-Americans in Oregon lived in the Willamette Valley, without any significant clustering of population. Statewide by 1850, decimated native populations were removed to reservations. Many of the native people in the Willamette Basin were moved to the Grande Ronde reservation, thirty miles west of Salem. The free land provided by the Donation Land Claim Act to anyone settling and making improvements proved a powerful incentive to pioneers. The 1850s created a boom in the state's population, almost entirely within the Willamette Valley, and this trend continued into the late 1800s.

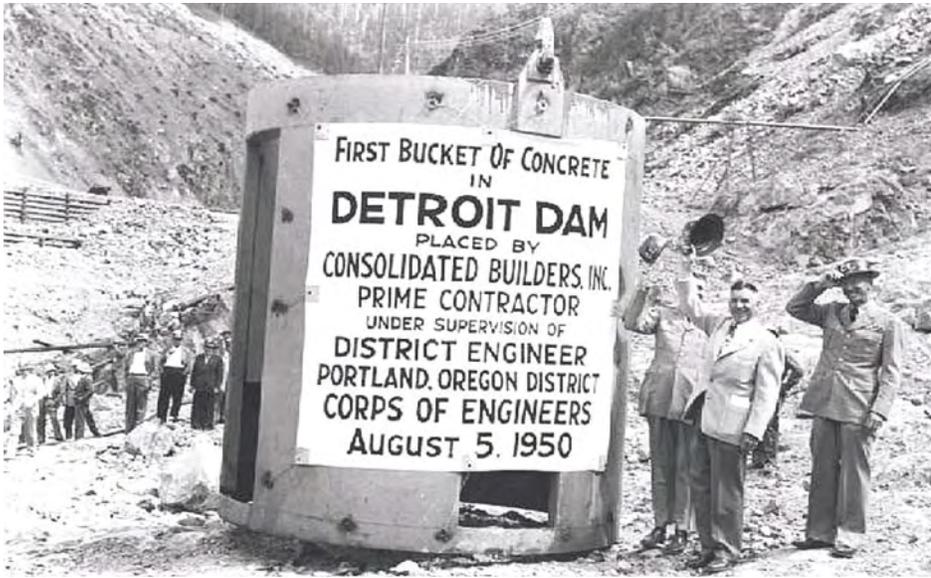
These new immigrants began changing the landscape. By 1895, human activities along the Willamette River had changed the



The Salem flood of 1890, looking across the Willamette River to the east. Some buildings collapsed under the weight of the water.

US Army Corps of Engineers Portland District

Salem Public Library Historic Photograph Collection



US Army Corps of Engineers Portland District

Major dams on Willamette tributaries are effective water control systems but block miles of spawning habitat and disrupt salmon's temperature-dependant life cycle.

nature of the riparian forests. More than half of the bottomland hardwood forests and woodlands had been converted to agriculture and almost all of the mainstem riparian conifer forests were gone. Agriculture and industrial development displaced up to one-third of the former floodplain forests of the Willamette. Drain tiles and ditches allowed farmers to drain their land and convert seasonally wet sites into farms. Prairies and wetlands were tilled and cultivated. Most remaining native prairie was found between Corvallis and Harrisburg.

To accommodate the growing population, cities were built. The highest population densities occur along the Willamette River and particularly at the confluences of the major rivers:

- Eugene (Coast Fork Willamette, Middle Fork Willamette, and McKenzie rivers);
- Corvallis/Albany (Marys, Calapooia, and Willamette rivers);
- Salem (Willamette River)

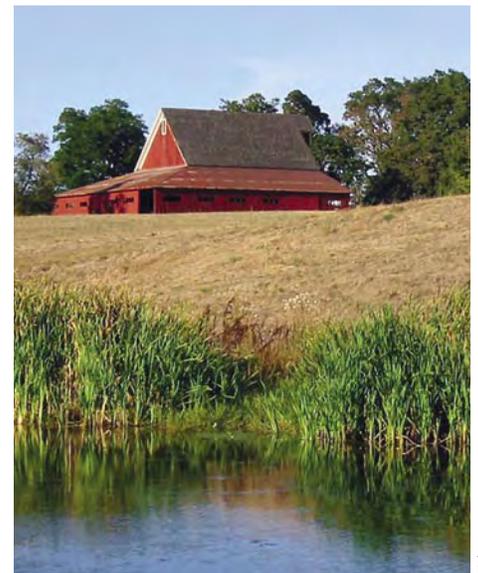
- Portland (Willamette, Clackamas, and Columbia rivers).

The junctions of rivers are particularly dynamic places. The combined energy of the flows of the tributaries and the main stem create an abrupt increase in the power of the river. The consequences can be seen in places like the mouth of the Santiam River which moved several hundred feet between 1850 and 1932. Once settlers invested labor and resources in relatively permanent structures along rivers, they didn't want the rivers moving around. The new citizens of the basin determined to protect their communities and investments from flooding and erosion by controlling the Willamette, particularly after a major flood in 1861 that covered 320,000 acres (substantially more than the 1996 flood).

The U.S. Army Corps of Engineers constructed 13 major dams on the Willamette's tributaries such as Cougar Dam on the McKenzie and Detroit Dam on

the North Santiam. The Corps reported that "snags and drift piles" were a common feature in the Willamette River, as valley cottonwoods toppled and conifers washed down from the mountains during floods. But these woody components of the river's channel were a hazard to boats. Between about 1880 and 1950, the Corps removed over 69,000 snags from the channel and overhanging trees from the river banks. The Corps also hardened 96 miles of riverbank with riprap, closed side channels, and redirected the river's water by creating "wing dams" to direct the river's flow into the middle of the channel. The channel was dredged to provide deeper water for river travel and its gravel shores were mined.

As a result, the upper Willamette was changed from that complex braided network of 1850 to a simpler straightened channel. The total area of river channels and islands in the section between Eugene and Albany



Rick Cameron

Dams and drain tiles facilitated farming to the riverbank, a practice that contributed to loss of lowland streamside forests.

decreased from about 25,000 acres to slightly more than 8,000 acres and the total length of all channels decreased from 210 miles to 115 miles. Today, the Willamette River between Harrisburg and Corvallis is largely a single channel with a few remnants of a previously braided network. Habitat for aquatic and riparian organisms no longer offers the variety of depths and velocities that previously characterized this section of the river. Overall, more than one third of the area of small tributaries and more than one half of the alcoves and sloughs were lost. Refuge for aquatic life during floods has been greatly reduced, and the mosaic of channel landforms that supported a complex patchwork of floodplain vegetation is now simplified.

The attention paid to forest management in western Oregon would lead one to assume that upland conifer forests have seen the most radical change since Euro-American settlement began. Maps developed from the H.J. Andrews 1936 surveys of the basin uplands and adjusted for known historic fires, portray the forests of the Cascade and Coast ranges as large expanses of old growth with scattered openings. Estimates range from 60-75% of the forested area. Yet, while logging and reforestation have altered the make up of these forests, creating a mosaic of younger and older stands and greater fragmentation, conifer forests remain the dominant feature of the basin's mountains.

The plant communities of the foothills and valley floor on the other hand have been significantly altered. Since 1850, oak savannas have essentially disappeared. Only 20% of the areas covered by bottomland gallery



U.S. Fish and Wildlife Service

Some of the best remaining examples of a gallery forest plant community are located at Luckiamute Landing at the confluence of the Luckiamute and Willamette rivers.

forest in 1850 are forested today. Over 90% of the wetlands and grasslands have been converted to agricultural use. Formerly, 96% of the riparian areas within the basin were along small streams. By 1990, more than half had

been converted to agriculture. In 1850, forests comprised 75% of the riparian areas of major tributaries. By 1990 they were reduced to a third of their former extent.



Much of the lowland flood plain has been converted to agricultural use.

The Future Is Now

Today the basin is home to approximately 2.5 million people, almost 70% of Oregon's population. There are about 100 cities within ten counties in the basin. The state capital, the state's three largest cities, and its three major public universities are all located here.



Jay Wilson

Seventy percent of Oregon's prime farm land is found here, too. Basin farmers reap about 50% of Oregon's \$3.7 billion total annual agriculture sales, growing the widest variety of products in the state including vegetables, berries, hazelnuts, hops, grass, Christmas trees and nursery products.

To achieve all this, we've sacrificed important major components of the natural landscape. By 1990, 42% of the Willamette Valley ecoregion had been converted from natural vegetation to agricultural use and 11% to cities, suburbs and rural home sites. We lost two thirds of the original older conifer forests, replacing most of them with younger forests. Approximately half of the conifer forests in the uplands and two thirds of the conifer forests in the lowlands were converted to a variety of other non-forest uses.

Riparian plant communities have seen tremendous change since the early 1800s. Two thirds of the conifer and hardwood riparian forests in the lowlands are gone. More than 85% of the riparian forests along the Willamette River have been converted. And natural grasslands and wetlands each have been reduced to less than 1% of their extent in 1851.

On the one hand, it is obvious that the activities of people who have settled in the Willamette Basin over the past 150 years have significantly altered the landscape. Regrettably, in many cases these activities have disrupted natural processes needed to establish and maintain high quality fish and wildlife habitat.

On the other hand, no one in 1851, or even in 1951, talked about ecosystems,

Do Oregon's Land Use Laws Protect Fish and Wildlife Habitat?

Oregon's land use law was originally written to protect open space and farm land. It does so by requiring cities and counties to develop comprehensive plans that address 19 statewide planning goals ranging from citizen participation, to air and water quality, natural hazards, transportation, and coastal resources.

Goal Five, the goal that addresses protection of natural resources, also addresses conservation of scenic and historic resources and open space. Air and water quality are addressed under Goal Six. Goal 14 created our famous urban growth boundaries, those invisible lines that constrain the spread of urban development.



While this system has been reasonably successful in managing sprawl, and has benefited fish and wildlife, it lacks explicit direction on protection of fish and wildlife habitat. Goal Five language is broad and vague, providing limited direction to the jurisdictions charged with defining local protection programs. It lacks descriptions of specific valuable natural resources or habitat types of greatest concern. And it still relies on traditional tools such as zoning and development regulation. As a result, county and city planners lack the means to link local resources to a larger integrated system and encourage conservation measures.

Thirty years ago, our focus was on preserving Oregon's working landscapes. Today, we have a greater recognition of the importance of our ecological systems. We have much greater knowledge of how these systems work and the capability to illustrate that knowledge through sophisticated mapping tools. The State of Oregon will advance its habitat protection when it incorporates this knowledge into its statewide land use policy.³

riparian areas or endangered species. As a society, we have enjoyed great economic benefit from the way we've used these lands and waters. But we have also learned a lot about how natural systems work. We recognize that natural resources can be exhausted and that we have a responsibility to be effective stewards of our natural systems because they are our life support systems.

We have the opportunity now to stop and reflect on where we've come from and where we are going with respect to protecting and conserving our natural resources and thus our quality of life.

LAND USE

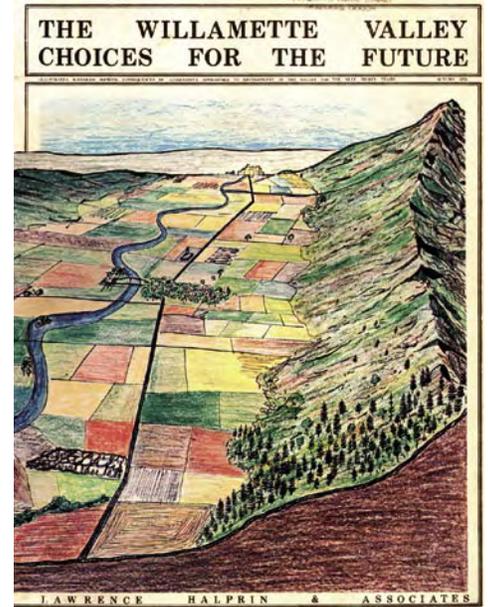
Oregon's land use laws came into being as a response to concern over changes in the Willamette Basin. In the 1960s, Oregonians began to recognize that residential development in the basin was creating sprawling suburbs and visual clutter that was consuming agricultural land and obliterating the emerald matrix of farms, forests and small towns that they loved. What's more, their population was expected to double in twenty years. In response to these concerns, then Governor Tom McCall commissioned a team of consultants headed by landscape architect Lawrence Halprin to assess conditions in the basin and make recommendations.

Halprin's famous report *The Willamette Valley, Choices for the Future*, published in 1972, identified the two most significant factors that shape land use in the valley: the single family house and the automobile. Halprin laid out two scenarios, one in which citizens of the valley

continue on the same trajectory, and the other in which they take significant steps to alter the future. In the second scenario, they develop a system of land use that: coordinates the many different levels of government; contains development within boundaries; greatly reduces reliance on, and influence of, the automobile through development of an advanced public transit system; protects open space; and reduces energy use.⁴

The Halprin report was a major impetus behind Oregon's land use laws. Under its influence, Governor McCall, along with dairy farmer and state senator Hector McPherson, wrote sweeping legislation that passed in 1973. Senate Bill 100 identified 19 land use goals intended to protect Oregon's quality of life. It stipulated that each county and city would create a comprehensive plan to determine how these goals would be achieved within their boundaries. As a result, control over land use in Oregon remains very much in local hands.

The law has been tested and modified over the past 30 years, and while it has gone a long way to keep urban development compact, preserve open space and farm land, and keep air and water clean, its language provides vague protection for natural resources and little or no explicit protection to wildlife and fish habitat.



Halprin's report recommended establishment of urban growth boundaries to conserve farm land and open space.

Jim Omernik

Measure 37

A ballot measure passed in November 2004 may significantly alter Oregon's land use planning system. Ballot Measure 37, approved by 61% of voters, states that property owners should be compensated when land use regulations restrict use of their property or lower its fair market value. To receive compensation, a property owner must file a claim with the government agency that enforces the disputed land use restriction. The measure further requires that if the city, county, regional government or state where the claim is filed lacks funding to provide compensation, the land owner may use his or her property as permitted at the time he or she acquired it. Because most jurisdictions have limited funds, claimants will likely receive a waiver, not compensation.

In many places, city and county zoning went into effect in the 1960s. Oregon's land use laws went into effect in the 1970s. These laws were established because of public outcry against sprawling development spreading across the Willamette Valley. Up to that time, virtually any forest or farm owner could subdivide his or her land so long as he or she could provide water and septic services. While it is unlikely that every eligible landowner will file a claim, it is conceivable that this measure will encourage increased development on agricultural and forest lands outside urban growth boundaries. Measure 37 will be the subject of much public debate and litigation for some time to come.⁵

FOREST MANAGEMENT

Much of the forested land in the Willamette Basin is publicly owned and managed by the USDA Forest Service and USDI Bureau of Land Management. These agencies have jurisdiction over very different lands. National forests are primarily contiguous tracts located in the higher elevations in the Cascades and Coast Range, while BLM lands comprise a checkerboard pattern in the foothills and lowlands. Federal forests in the basin are managed under the Northwest Forest Plan, adopted in 1994 in response to listing of the northern spotted owl as a threatened species. The plan aims to protect old-growth dependant species while providing a sustainable and predictable level of harvestable timber. It has received mixed reviews. One of its key features is the designation of Late-Successional Reserves, large tracts managed for old growth forest structure.

The Oregon Department of Forestry manages a small area of state owned forest land in the basin under the Northwest Oregon State Forests Management Plan, adopted in 2000. The rest of the basin's forested landscape is in private ownership. Some is managed for industrial timber production while nearly half of the total lowland conifer forest is in non-industrial private ownership. Private timber harvest activities are regulated by the Oregon Department of Forestry under the Oregon Forest Practices Act. This set of statutes restricts logging adjacent to fish bearing streams.

Thus, the forested landscapes of the basin are managed under differing strategies and standards for protection of habitat. To a



Marcia Sinclair



David Zahler

Mature west side Cascade forest.

large extent, emphasis on private industrial forest lands is on maximizing wood yield by cutting timber more frequently at younger ages. By contrast, on publicly owned lands, priorities have shifted from sustainable harvest levels of wood products to the sustainability of whole ecosystems. National forest timber outputs have been reduced considerably from the record levels of the 1970s and 80s due to greater protection for riparian areas and wildlife habitat.

CONTROLLING THE RIVER

The Willamette River and its major tributaries have reached flood stage many times over the last 150 years. While floods in recent memory—particularly 1964 and 1996—each were proclaimed the “flood of the century,” historical floods were much larger, inundating vast areas of the Willamette Valley. The floods of 1861 and 1890 covered more than 320,000 acres, providing us our best scientific delineation of the functional floodplain of the Willamette River. Floods of 1964 and 1996 filled most of the historic floodplain of the lower narrower river, but substantially

less than the extent of the historical floodplain in the upper southern section.

Moreover, it hasn’t rained as much over the past 20 to 30 years. Communities along the river may think current conditions are normal, but it has been abnormally dry. It’s likely we’ll see future floods similar in magnitude to historical floods if we return to historic climate patterns. Even with flood control, it is likely there will be significant loss of buildings and roads within the floodplain.



US Army Corps of Engineers

Cougar Dam blocked 25 miles of the best McKenzie watershed spring Chinook spawning habitat. Its fish passage facility didn’t function and isn’t used.⁶

Between 1941 and 1969, the U.S. Army Corps of Engineers built 11 major water storage reservoirs on tributaries to the Willamette River to provide irrigation water, inexpensive power and, most importantly, minimize the Willamette’s damaging floods. Operation of the dams has lowered peak flows in the river during winter, and increased summer low flows, significantly



US Army Corps of Engineers

Downtown Portland during the 1894 flood.

altering the natural hydrological dynamics of the river. In addition, there are over 100 small private dams constructed primarily for purposes of irrigation.

As a result of the attempts by agencies and communities to control the river, more than 96 miles or 25% of the river's banks have been hardened with riprap, dikes and levees. While only a quarter of the river's length, 65% of these are at river bends. Most of the highly dynamic sections of the river have been armored to keep their form and position permanent.

While these measures have provided benefits to humans, they have reduced the quality of aquatic habitat. The river wants to move. Hardening it eliminates complex habitat structures and prevents it from transporting sediments. Dams alter seasonal water flow patterns and act as barriers to fish migration and sediment movement. These structural changes to the river system have contributed to the decline of native fish populations, particu-

larly salmon. For example, 71% of historic spring Chinook production in the Santiam River system occurred above Detroit Dam. Today, Chinook no longer breed above the dam.⁷

THE UNDERGROUND RIVER

Hyporheic is a Greek word meaning "under river." Hyporheic flow occurs when river water moves into the spaces between rocks and gravel particles below and on the sides of the river. An amazing amount of water flows in this underground river. Think about the amount of water that flows from the McKenzie River to Corvallis in a day. That's about how much water enters the Willamette's hyporheic zone during dry summer conditions.

As hyporheic flow brings surface water into contact with river gravels, changes take place in the chemical nature of the water. The river conditions its water through these processes, changing the balance of nutrients, dissolved gases and minerals. When we



Fresh gravel bars cool and purify water. Alcoves and side channels shelter young fish.

reduce and simplify the way the river interacts with its riverbed, including the way it moves and moves through sediments, we limit the river's connection with its hyporheic zone and its ability to improve its own water quality.

It is likely that the river used to be in contact with five times as much gravel bed as it is today, given that it lost about 80% of its island area since 1850. Newly formed gravel bars are particularly effective at reducing water temperatures as water flows through them into alcoves and side channels. During the hottest time of day, the uppermost portion of some alcoves is 3.6-9 degrees Fahrenheit cooler than the main channel. So, when we reduce the river's freedom to move and to create new gravel bars, we reduce the river's capacity to cool itself.

This is important because native salmon and other aquatic organisms are sensitive to changes in water quality including temperature. Salmon require cool temperatures, high dissolved oxygen, natural nutrient concentra-



Willamette Falls during 1996 flood.

Bruce Johnson

tions, and low levels of pollutants. Individual species have specific preference ranges that vary by life stage. Changes in temperature prompt spawning activity and support growth. Most embryo and fry prefer temperatures below 14°C (57.2° F) and bull trout like a chilly 6°C (42.8° F). Higher temperatures lead to disease and temperatures above 25°C (77°F) are lethal to most salmon species.⁸

WATER QUANTITY

The stereotype of western Oregon is that it's rainy and wet, and water is plentiful. But 70 to 80% of the annual precipitation in the Willamette Basin falls between October and March; less than 5% in July and August. Stream levels drop during these summer drought periods, limiting supply at the time of the year when demands are greatest. So, even in a region of the state known for its abundant rainfall, water is scarce at certain times of year in certain locations.

GROUND WATER

Oregonians depend on water pumped from the ground to provide much of their water supply. These below-ground aquifers are out of sight and may seem limitless, but in a number of areas within the Willamette Basin, aquifers are declining or becoming

contaminated from salts, septic systems, and industrial pollution. Some may recover quickly, while others may not, depending on the source of the water and the time it takes to percolate down to the aquifer. The state has designated 13 ground water management areas where the water table is falling and water use is restricted. The

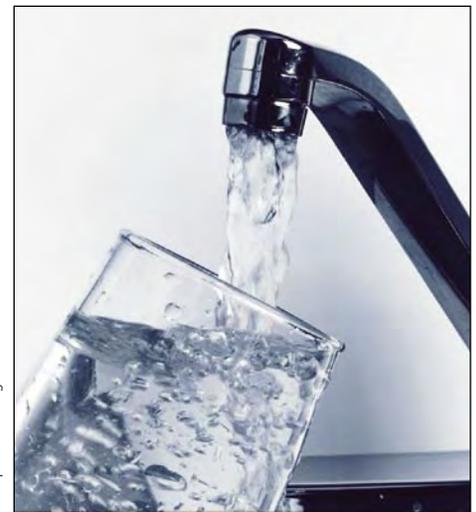


Oregon Water Resources Department

Groundwater is finite, even in the rainy Willamette Basin.



Irrigation accounts for 49% of surface and ground water withdrawals.



Oregon Department of Agriculture

Domestic use accounts for 15%, mostly from city systems that draw surface water.



City of Wilsonville

Wilsonville kept growing but their ground water supply didn't. Today, residents drink Willamette River water purified in a new state-of-the-art treatment plant.

Oregon Department of Environmental Quality is monitoring nitrate contamination of groundwater as well.

The Cascades are volcanic and highly variable in their ability to hold water. Some parts are very porous and permeable. For example, some wells in the basalt flow below part of the Clackamas watershed yield more than 1,000 gallons per minute. By contrast, much of the sandstone and siltstone Coast Range has low well yields of 5-20 gallons per minute. The valley's more recently deposited sand and gravel fall in between, with well yields of 50 to 300 gallons per minute.

Groundwater plays an important role in sustaining summer stream flows. Larger groundwater discharge, as well as the gradual melting of deep snow packs at high elevations, helps moderate seasonal flow variations in streams draining Cascade watersheds, compared to those draining the Coast Range or lower elevations.

WATER RIGHTS

Oregon's water laws are based on the principle of prior appropriation. The first person to obtain the right to draw water from a stream or groundwater aquifer has priority over rights issued at a later date. It is essentially first come, first served. When water is in short supply, the water right holder with the oldest permit date will be the last to be shut off. This means those who hold more recent water rights take the full brunt of a water shortage, rather than the shortfall being shared among all users.

Water rights are issued for both out-of-stream and in-stream uses. Out-of-stream means the water is physically removed from the stream



Salem Visitor and Convention Bureau

Water quantity helps define quality of life in the basin.

for city, industry, irrigation, or livestock use. In-stream use means the water stays in the stream for fish and recreation. Seventy-five percent of in-stream rights are dated 1960 or later. So, fish habitat is often lowest priority and even in a normal water year some 60 miles of streams go dry in the Willamette Basin due to water withdrawals.

In most areas of the Willamette Basin, no water is available for new surface water rights and in dry years more recent water rights are not satisfied. Almost half of all water withdrawn is used for irrigation. Commercial use represents 19.5%, domestic use 15%; and industrial use 13%. Forty-two percent of the domestic, industrial and commercial withdrawals are provided through public water supplies, of which 88% are from surface water.



Melting snow feeds surface streams on the east side of the basin.

What Are Our Choices For The Future?



Rick Cameron



Salem Visitor and Convention Bureau

It would seem that some policies we currently rely on to protect wildlife and fish species, conserve farm land, keep forest systems intact and maintain quality of life may not result in the future we desire for the 21st century. Should we continue with our current policies? Or are our most treasured resources—the very sources of our high quality of life—in jeopardy? Oregonians have said that their most important measures of quality of life are clean air and water; reliable water supplies; livable communities; and open space and wildlife habitat.

Our Consortium researchers and collaborators assessed the condition of the basin in 2050 under three plausible future scenarios: Plan/Trend 2050, Development 2050 and Conservation 2050.

Let's find out what they learned ...

PLAN/TREND 2050

What if we continued using current plans and doing what we've been doing? Our land use laws protect farm land, open space, habitat and quality of life, don't they?

Plan/Trend 2050 envisions a future in which we will continue to plan and manage Willamette Basin lands as we do now, under current land use and environmental laws and contemporary trends. In other words, we will remain on our current trajectory. The picture this scenario paints is based on a projected population of four million residents, current city and county comprehensive plans, agency policies, existing water rights, and projected crop patterns.

Under Oregon's land use laws, cities and counties develop comprehensive plans that identify broad goals for land use. To achieve these goals, each jurisdiction identifies zones in which specified land uses are allowed. It is the job of each jurisdiction's planning department to determine if a proposed development or other land use is allowed within each zone. In the language of urban planning, housing density is expressed through zoning codes which are often abbreviated. For example:

Single Family Residential Zone	Code	Approved Use	Examples in Portland Metro Area
Residential 10,000	R10	One single family home per 10,000 square foot lot or about 4 dwellings per acre	Neighborhoods in the West Linn hills and near Lewis and Clark College
Residential 5,000	R5	One single family home per 5,000 square foot lot or 8 dwellings per acre	Irvington, Hawthorne, Westmoreland neighborhoods
Residential 2,500	R2.5	One single family home per 2,500 square foot lot or 18 dwellings per acre	Parts of Sellwood and Rose City neighborhoods
Multi-family Residential Zones	Code	Approved Use	Examples in Portland Metro Area
High density residential	RH RX	Generally 10-120 dwellings per acre	Pearl District lofts, Lloyd Center area apartments
Residential 2,000	R2	Allows 21-30 dwellings per acre	Park blocks near Portland State University



Marcia Sinclair

Plan/Trend 2050 keeps urban growth boundaries tight, conserving the most agricultural land.

Urban and Rural Housing

Based on current comprehensive plans and county population projections, Plan/Trend shows 93% of the 2050 population living inside urban growth boundaries, where residential densities have increased significantly over 1990 levels, from 4.2 houses per acre to 7.9. But to accommodate the larger number of people, 2050 urban growth boundaries have expanded by 51,000 acres. Of the 495,000 acres within urban growth boundaries, 80% are developed, and less than 20% remain undeveloped or covered by vegetation rather than structures. In Plan/Trend 2050, 6.7% of the basin is slated for urbanization, up from 6% in 1990. Nearly two thirds of this expansion occurs in the cities of Portland, Salem, Eugene/Springfield, Albany, and Corvallis.

No new rural residential zones are created. Residences built after 1990 are located within the vacant rural parcels in

existing 1990 rural residential zones. These so-called “grandfathered” parcels were platted prior to adoption of Oregon’s land use planning system in the early 1970s. As urban growth boundaries expand, some former rural residential zones are incorporated into urban areas. Under Plan/Trend 2050, this occurs in over 25,700 acres zoned rural residential in 1990, with over 14,000 of these acres being converted from rural residential to low density urban uses in Clackamas County alone. Over 13,000 acres in Clackamas County were brought into the urban growth boundary in December 2002.

Agriculture and Forestry

Approximately 40,000 acres of agricultural lands are converted to other uses by 2050 under this alternative, most to urban uses adjacent to 1990 urban growth boundaries. The total area of land in agricultural production remains at approximately 20% of the basin. While forest management policies

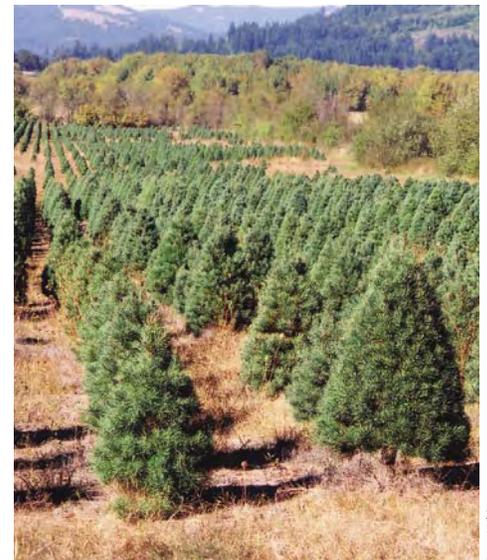
change over time, it is assumed that federal forests are managed under the Northwest Forest Plan, private and state forests under the State Forest Practices Act.

Water

Cities demand nearly twice as much water as in 1990 because of population and economic growth. Demand for irrigation water also goes up. Per capita municipal use of water is projected to decline somewhat in the Portland area but remains at 1990 levels elsewhere.

Summary:

- Urban Growth Boundaries expand by 51,000 acres
- Conserves the most agricultural land
- 20,500 acres affected by expanded rural residential development since 1990
- Has the least undeveloped land within the urban growth boundary
- Riparian vegetation on water quality limited streams increases by 10%



Gary White

DEVELOPMENT 2050

What if we let people develop their land with fewer restrictions? What if we further relaxed our current land use laws and focused our priorities on making the greatest short term economic gain?

The **Development 2050** scenario assumes greater reliance on market-oriented approaches to land and water use. Under this scenario, the population grows to four million people and we follow recent trends by further relaxing land use laws. In addition, environmental protections are relaxed in both state and federal forest management policies. As a result, there are fewer restrictions on where intensive development occurs.

Urban and Rural Housing

One of the major changes under this scenario is an expansion of residential areas both inside and outside of urban growth boundaries.

For urban areas, about the same percentage of people live inside urban growth boundaries as in 1990, but the urban growth boundaries are expanded by 129,000 acres. Of the total 573,000 urbanizing acres, 81% are covered by buildings and roads with less than 19% covered by vegetation. While 6% of the basin lies within urban growth boundaries in 1990, Development 2050 slates 7.8% of the basin for urbanization. This dramatic urban growth boundary expansion assumes new homes are built at densities somewhat higher than in 1990 by redeveloping and infilling only 5%.

Rural residential development is key to the future under this scenario. Development 2050 assumes a general relaxing of restrictions on where new rural residences may occur. This spread of rural residential housing is a notable departure from trends that began in the late 1970s when Oregon's land use laws went into effect.

Agriculture and Forestry

With the expansion of housing and businesses onto farm land, approximately 181,000 acres of 1990 agricultural lands are converted to other uses under this scenario, with most of these converting to rural residential and urban uses or fragmenting into areas considered too small to farm. The scale of this expansion gave this scenario the greatest potential to increase the conflicts between residential development and agricultural activities. Residents in rural areas may object to slow moving farm machinery, farm odors and chemical sprays. Additionally, rural residential expansion introduces human disturbance such as noise, traffic and light pollution to open space and natural areas that serve as habitat for wildlife.

Development 2050 also affects the amount of land used for forest products. When population density reaches 70 persons per square mile, industrial forests shift to nonindustrial and are used for housing. Under this scenario, there are no protections for riparian areas on private and state lands and the Northwest Forest Plan relaxes its protection to allow logging closer to streams on federal lands.

Forestlands continue to occupy more than two-thirds of the basin, so natural vegetation remains extensive, but urban and rural development encroaches on native habitat, reducing its value. River straightening and channel simplification continue from 1990 to 2050 at the same rate as from 1930 to 1990.

Water

With its emphasis on economic gain over natural resource conservation, per capita municipal demand for water is 12.5% greater in Development 2050 than in the Plan/Trend 2050 scenario.

Summary

- Urban Growth Boundaries expand by 129,000 acres
- Converts the most agricultural land to urban uses
- 121,500 acres affected by expanded rural residential development since 1990
- Relaxed riparian protection and shorter harvest rotations reduce the age of standing forests
- Aquatic habitat in the Willamette River declines under this scenario, as the main channel is further straightened and simplified
- As agricultural land is converted to urban use, more native vegetation is planted resulting in modest local improvements in wildlife habitat

TWO TIERS OF CONSERVATION LAND

In thinking about future conservation, the researchers and stakeholders understood there needed to be a way to provide for lands managed only for conservation purposes, as well as lands that would continue to be part of the working landscape of farms and forests but managed to provide “ecological services.” Thus, two tiers of conservation and restoration lands are phased in under Conservation 2050.

1 Tier 1 lands are managed as a naturally functioning landscape, for example a county park managed as native woodland, savanna and grassland communities, or public open space managed as wetland. This is a different concept from the other future scenarios in that it allocates land to natural vegetation, creating groupings of land allocations you won't find in the other scenarios. These areas are called “Tier One Conservation Zones.”



Metro Regional Government

Smith and Bybee Wetlands Natural Area, located in north Portland industrial area, supports one of the last remaining large populations of painted turtles.



2 The second grouping, Tier 2 lands, are managed to produce goods and services in harmony with natural processes. Each site isn't fully “natural” but it provides much of the structure and many of the same “services” as a native system while still providing landowner income. Examples of Tier 2 lands include:

- An oak savanna site where the understory is composed of both native and non-native herbs, grasses and forbs and is maintained by grazing or mowing instead of burning.
- A poplar plantation on agricultural land within the river's floodplain.
- Flooded rice fields.



CONSERVATION 2050

What if we placed higher priority on the long term health of our ecosystems? What if we first identified priority areas for restoration and conservation, then weighed our subsequent land management decisions against how they affect these areas and systems?

Like the other scenarios, **Conservation 2050** also assumes four million residents. It places greater emphasis on conservation and restoration of native habitats and the species that depend on them. Then it projects changes in land and water use that prioritize ecological services to the year 2050. The river's floodplain complexity and function are conserved and restored as are upland habitats. To support this, we make appropriate changes in our urban, forestry and agricultural practices while striking a plausible balance between ecological, social and economic considerations.

Urban and Rural Housing

In Conservation 2050, 94% of the population of four million people resides inside urban growth boundaries, which have expanded by 54,000 acres. Urban growth boundaries occupy 6.8% of the basin. New homes are built in more compact arrangements—9.3 homes per acre compared to 4.2 homes per acre currently—and by redeveloping 12-15% of 1990 urban residential areas at higher densities. Of the 498,000 total Conservation 2050 urban growth boundary acres, 79% are covered by buildings and roads, more than 20% in vegetation.

This scenario shows urban growth boundaries expanding to include former rural residential zones. Some rural development occurs outside urban growth boundaries but here a different development pattern is used. Approximately half of new rural dwellings will be clustered into groups on parcels 20 acres or larger, in areas adjacent to 1990 Rural Residential Zones that qualify as Tier 1 native habitat. The clustered pattern allows a larger percentage of the parcel to remain native habitat. Land developers and residential owners would be encouraged to use this

pattern of development through financial, tax, and regulatory incentives.

Conserving components of our complex natural systems at times forces expansion of urban growth boundaries, for example to allow for riparian corridors in urban areas. Because of this, urban growth boundaries expand more under Conservation 2050 than Plan/Trend 2050. More agricultural land is converted to urban uses, while some agricultural lands grow natural vegetation instead of a conventional crop.



Conservation 2050 provides greater protection for flood plains, riparian areas, and wetlands in urban areas.

Sandie Athogast

Agriculture, Forestry and Natural Vegetation

The mix of crops doesn't change much but farmers convert low productivity farm land to habitat. This isn't imposed on farmers, but instead encouraged through a variety of incentives. Conservation easements, transfers of development rights, and restoration grants are a few examples of ways that farmers can be compensated for raising habitat instead of other crops. This could result in restoration of 12.5% of private agricultural land. That means that under this scenario, there's a 248,000-acre reduction in land in traditional agricultural production, but less than a fourth of that is urbanized. Most is restored as habitat. Riparian areas on farms and on public lands are replanted.

Federal forest lands limit harvesting to young stands on a 60-year rotation. Most federally managed forest lands are in reserves. National wildlife refuge lands that were leased for agriculture are converted to native habitat. Riparian zones are at least 300 feet

wide on either side of streams on federal forest lands, 200 feet wide on state forest lands, and 100 feet wide on private lands with additional riparian vegetation in Tier 1 areas.

Strategic restoration of the main stem of the upper reach of the southern Willamette River includes increasing the river's access to its historic floodplain. By recreating alcoves and side channels, the channel complexity increases. Floodplain forests are restored on flood-prone lands and near major tributary junctions.

Water

Conservation 2050 proposes that water is sometimes converted from out-of-stream use such as irrigation to in-stream use to restore fish habitat. Federal reservoirs are managed to allow natural flows through the dams in March and April every year.

In this scenario, in-stream water rights increase by 10%. In part, this is due to city water conservation and through changes in irrigation practices when agricultural lands are converted to Tier 1 natural condition.

Summary

- Urban Growth Boundaries expand by 54,000 acres
- Conserves the most prime farm land as defined by soil classification
- 4500 acres affected by expanded rural residential development since 1990
- Restores over 50,000 acres of oak savanna in large patches throughout the valley
- Increases native bottomland forest at stream junctions and flood-prone lands
- Increases amount of riparian vegetation outside public and private forest lands
- Increases protection for riparian vegetation in forest lands



Marcia Sinclair

Rural Development Effects on Soils and Riparian Areas

	Plan/Trend 2050 New Rural Structures		Development 2050 New Rural Structures		Conservation 2050	
	Number	Acres	Number	Acres	Number	Acres
Class I soils	472	675	6,120	6,075	254	189
Class II soils	3,264	5,157	46,559	49,763	1,356	1,061
Class III soils	4,422	7,376	29,234	33,755	2,051	1792
Within 300 feet of water	1,624		17,016		428	
In the 100 floodplain	762		0		8,361	

WHAT WAS LEARNED?

General Conclusions

The Consortium's research shows that most of the big landscape and environmental changes have already occurred. Stakeholders thought it implausible that we would witness in the next 50 years the scale of change that took place between 1850 and 1990, despite a doubling population and regardless of the future scenario. That said, the quality of life in the Willamette Basin in which we live in 2050 will be greatly shaped by the decisions we make now.

There are significant differences in environmental qualities among the scenarios and significant local variations within each future. For example, in **Plan/Trend 2050** and **Conservation 2050**, much of the population growth takes place within compact urban areas, minimizing the effects on farm land and natural areas. In these two futures, the number of people living inside urban growth boundaries nearly doubles but the amount of built land expands by less than 25%. By contrast, in **Development 2050** new housing is built at much lower density, requiring a 56% increase in the amount of developed land to accommodate a smaller total urban population than the other two futures. With this expansion comes an associated loss of 24% of prime farmland.

Conservation 2050 shows the most substantial improvement to natural resources, recovering 20 to 70% of the losses sustained since Euro-American settlement. There is further decline in natural resource quality in both **Plan/Trend 2050** and **Development 2050**. Wildlife abundance drops by 15% under **Plan/Trend 2050** and 50% under **Development 2050**.

Urban and rural housing

Plan/Trend 2050 shows the most efficient use of land with the lowest rate of increase in urban areas. However, under Plan/Trend 2050 the compact urban growth boundaries with current environmental protocols retain the least amount of unbuilt urban open space per resident. Under the Plan/Trend 2050 scenario, rural populations increase through 2020 and then decrease or remain constant through 2050, with the exception of the Metro counties (Clackamas, Multnomah, and Washington) where rural populations decrease from 1990 through 2050 due to urban expansion onto previously rural lands.

Development 2050 urbanizes the most land because of low density development and fewer restrictions. Development 2050 consumes land at three times the rate of other scenarios. If all vacant lands are

considered, Development 2050 provides the greatest amount of land per resident because of its much larger 20-year supply of buildable land. Under Development 2050, rural populations increase in all counties through 2050.

Conservation 2050 results in more unbuildable space within urban growth boundaries than Development 2050 because the conservation scenario protects riparian lands, floodplains, steep slopes and wetlands. Under Conservation 2050, rural populations increase each decade through 2050, again with the exception of the declining rural populations in the Metro counties.

Rural residential development rises as a significant component of every future scenario. This type of development breaks up larger farm acreage and expanses of habitat. Small parcels with scattered buildings punctuate open space and natural areas with expansion of roads and infrastructure.

Agriculture

The three future scenarios envision qualitatively different landscapes. Plan/Trend 2050 keeps most of the 1990 agricultural lands in agricultural production. Development 2050 allows more development in rural areas, leading to fragmentation and conversion of agricultural fields. Conservation 2050 encourages use of field borders, low-input crops in sensitive areas, and the conversion of cropland to native vegetation. In each future, the Willamette Valley would continue to support a variety of crops. Interestingly, developers target prime farmland, while restoration activities tend toward farmland of lower quality. Conservation 2050 protects the most Class I and II soils—those considered best for farming.

Forestry

Forest management trends are defined differently for the different forest ownerships in the basin—federal forests managed by the Forest Service and Bureau of Land Management, state, private and industrial forests. Results show that differences in management style can have consequences as significant as the differences between the futures' scenarios.

In general, under Development 2050 more older timber is cut, harvest rates go up and stream protection declines. The Conservation scenario emphasizes cutting younger timber on industrial lands and leaving more mature forest. The result is a three-fold increase in acres of old growth (200-year-old) conifer forest on industrial forest land. Most federal forests are in reserves and timber harvest is limited to young stands on a 60-year rotation. Over all, there's greater stream protection, gradually decreased harvest rates and patch sizes, and patches of legacy trees are retained.



Gary White

Water Use

Both Development 2050 and Conservation 2050 irrigate fewer acres than Plan/Trend 2050. Plan/Trend 2050 has the most agricultural diversions of surface water—for irrigation, livestock, and other uses, where in a dry year, diversions are up by 165% for August, and 220% for September relative to 1990 diversions. The other two scenarios show smaller increases, reflecting their assumptions about farm acreage and water use per acre. The Development and Conservation scenarios have offsetting trends: Development 2050 has higher water use per capita but more rural residents get their water from wells; Conservation 2050 has lower use per capita but more users tap surface water from city systems.

In anticipating future crops, researchers projected increased irrigation in parts of the northern basin that severely reduces stream flows in 2050. In two of the three scenarios for 2050, the natural supply of water is insufficient to meet out-of-stream



Oregon Department of Agriculture

demands, and even more miles of streams go dry. Preventing streams from running dry requires a combination of conservation, shifting water from out-of-stream uses to in-stream flows, and protecting in-stream flows so that water left in a stream in one place is not withdrawn for out-of-stream use further downstream.

Using water rights information to represent demands, it seems water is abundant below federal dams but often scarce in certain watersheds at certain times of year. Surface water scarcity will increase under all alternative futures, but less under Conservation 2050.

Terrestrial Ecosystems

Several factors determine the utility of habitat for wildlife species: how it is arranged across the landscape; whether it is fragmented or contiguous; and how many individual animals or birds are trying to use a single area of habitat. Because of these factors, the percentage of species that gained or lost habitat differed between the three scenarios. Conservation 2050 had almost as great a percentage gain (+31%) as Development 2050 lost (-39%). Ten percent of the species lost habitat under Plan/Trend 2050; by comparison, 44% of species gained habitat by

moving from 1990 back to pre-Euro-American conditions. The urban fringes and forested uplands had fewer numbers of species in the future landscapes than in 1990.

Riparian conditions would improve on public lands under all future alternatives. Future losses of riparian forests will not be as great as the changes observed over the last 150 years.

Plan/Trend 2050 showed little change in habitat quality, because it had the least affect on agricultural lands. Interestingly, there are some increases in species numbers in Development 2050, largely because landscaping in yards, gardens, and small farms provided better habitat than had the agricultural lands they replaced. However, this fragmented habitat in proximity to human communities may not be attractive to many native wildlife species.

Conservation practices in Conservation 2050 improved wildlife habitat without significantly changing the agricultural system. While none of the alternative scenarios removes buildings in riparian areas, under Conservation 2050 riparian areas on agricultural lands are restored to native plant communities. Older conifer forests increase under Conservation 2050 by more than 248,000 acres. More than 104,000 acres of natural grassland, 65,000 acres of bottomland floodplain forest and 26,000 acres of wetlands could be restored through plausible conservation measures.

The wildlife populations responded in remarkably similar ways to Plan/Trend 2050 and Development 2050; both resulted in declines for a majority of the study species.

By contrast, Conservation 2050 enhanced habitat for all but three of the species. For wildlife species already stressed by habitat loss and fragmentation, the choice between alternative futures may be critical to their long-term viability.

Tier 1 lands

An important assumption of Conservation 2050 was the restoration of native vegetation, much of which takes place on agricultural lands. Did these efforts result in an improvement in species habitat? Conservation 2050 increases natural grasslands and wetlands 2-5 fold. While the percentages of increases in grassland and wetlands seem small, they translate to 104,226 acres of natural grasslands and 26,056 acres of wetlands. Conservation 2050 also saw the greatest increase in the number of native species along the Willamette River riparian corridor and improvement throughout the valley, from use of field borders, riparian vegetation, and small areas of restored prairie.

Aquatic Ecosystems

Conversion of lands to agriculture and urban/residential uses has taken a heavy toll on Willamette Basin lowland streams. Native fish species have suffered loss and degradation of habitat, rising stream temperatures, pollution and competition from nonnative fish. Some species of fish and aquatic organisms are more sensitive to pollution than others. Of the 31 native fish fauna in the Willamette Basin, only 13% are considered tolerant of pollution. Introduced species have a greater advantage, as they tend to be tolerant of pollution and

habitat degradation, with 69% classified as pollution tolerant, such as carp, bullhead and bass. Changes in upland streams have been more moderate.

Plan/Trend 2050 and Development 2050 would not result in any measurable worsening of stream biota and habitat quality in the basin, overall. Converting agricultural land to urban and residential uses will not, by itself, cause significant additional stream degradation. However Development 2050 allows development into riparian areas, increasing the risk to stream habitat from degraded riparian functioning.

By contrast, the conservation measures in Conservation 2050 would partially (by 20-65%) restore lowland stream biota and habitat quality to pre-Euro-American conditions. Lowland stream and river systems support greater numbers of fish species than headwater streams and rivers, so their management is critical to maintaining and restoring the aquatic environment of the Willamette River Basin. Almost half of the loss of the ability of river habitat to support fish that occurred over the last 150 years could be recovered through plausible restoration efforts over the next 50 years while human populations are doubling.

Water withdrawals have decreased total habitat quantity in lowland streams by 7% since 1850 and are projected to further decrease habitat by 4 to 8% by 2050, depending on the future scenario. More densely developed urban areas under Plan/Trend 2050 and Conservation 2050 generate more stormwater runoff which will need to be treated before it reaches waterways.

What Can We Do?

It is the mark of a good action that it appears inevitable in retrospect.

— Robert Louis Stevenson

It is plausible to double the human population without sacrificing the integrity of our natural systems and their influence on the quality of life for future inhabitants of the basin. It will take a shift in attitude and priorities, and a fair amount of work. But it can be done. Consortium researchers tell us that by taking the right combination of actions now, we can see *increases* over the next fifty years in habitat and populations currently on the decline.

Here's how ...

Take care of both uplands and lowlands. Conservation policies and projects have primarily focused on upland forested systems. Many have been effective. Meanwhile, the fish and wildlife that live on the valley floor have lost far more habitat.

Manage urban and rural housing development. Our land use system provides us a lot of local control over stewardship of our land. That system can be used

to plan our communities in ways that protect habitat and prime farm land. Comprehensive plans and zoning ordinances provide the means to cluster rural residences in ways that conserve native habitat and high wildlife use areas on large parcels planned for development. In addition to codes and regulations, local jurisdictions can use incentives such as expedited permitting processes and reductions in system development charges to



Dennis Wolverton



James Yuskavitch

Volunteers plant a mix of native species to reestablish riparian vegetation along the Middle Fork of the Willamette River.

encourage developers and land owners to conserve habitat and ecological function.

Restore riparian areas in the valley.

Reestablish riparian vegetation along lowland streams and rivers in agricultural and urban areas. Riparian areas are more than trees along the river. They are important habitat for many species of wildlife and hugely important to stream habitat quality. Planting native vegetation along streams and rivers is a cost-effective way to improve habitat for both aquatic and terrestrial creatures, in all settings: forested, agricultural, urban, and rural residential. While any natural vegetation is good, forested riparian areas are best for shading and adding logs and nutrients to the stream. Vegetation nearest the stream has the greatest influence, so it is most important to plant the full length of the stream. One long zone is more useful than several shorter disconnected zones.

Restore river floodplains. The river's floodplain is the extent of the landscape over which the river meanders over time. It is the area that historically the river filled during major floods. Floodplains are dynamic places



Alan D. St. John

Fender's blue butterfly depends on Kincaid lupine. Both are on the Endangered Species List.

where water floods then recedes, where trees fall down, islands and channels are reshaped, and river junctions move across the landscape. Work toward freeing rivers and streams and reopening historic river channels. At a minimum, manage reservoir releases to mimic the natural seasonal high and low flows.

Let the river move gravel and silt around. Rivers are dynamic systems that function best when allowed to create and recreate habitat in the form of alcoves, gravel bars and side channels. Local restoration projects should be planned to recognize and, ideally, take advantage of the river's action. Local restoration projects should be planned with this in mind so that they are not destroyed by the river's natural actions.

Restore low cost, high return areas of the Willamette River. Some sections of the river and its floodplain have been developed, while other sections remain relatively wild. The best areas of the river and its floodplain to restore are those that have highest potential for recovery of complex, biologically diverse habitats and where people are likely to be supportive. Place priority on restoring areas where people haven't invested in buildings or major changes to the land.

Don't build in the floodplain. Minimize development in 100-year floodplains and find opportunities to remove buildings and other structures.

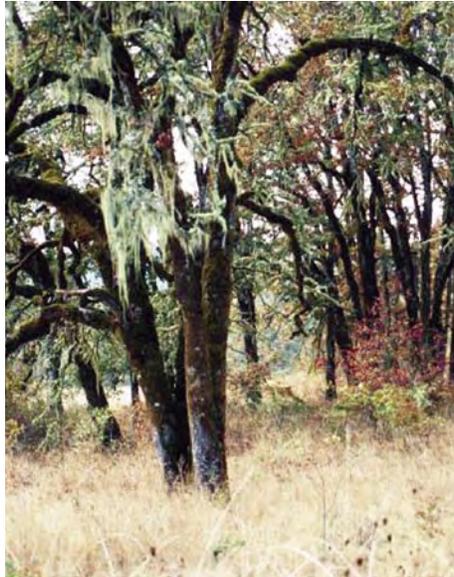
Let the river cool itself. When rivers flow through gravel, important chemical changes take place and water temperatures drop. If we encourage the river to flow more freely through islands, alcoves and gravel

bars, it will increase habitat for aquatic creatures and improve water quality.

Conserve water. We need to decrease our water consumption if we are serious about protecting and improving stream flows for fish and wildlife. The water conservation measures included in Conservation 2050 will not be adequate.

Find ways to voluntarily convert out-of-stream water rights to in-stream water rights while maintaining their original priority date. We need to get water back into our streams. Some streams are over-tapped to the point that they will likely go dry in dry years. These include small streams in the Deep Creek, Molalla, Pudding and Tualatin watersheds.

Plan for terrestrial wildlife. The more different types of habitat in the basin, the greater the variety of species the basin will support. We've lost 80% of our bottomland forest, 97% of our natural grassland, and nearly 100% of our oak-savanna. The unique species that live in these habitats struggle to survive in what's left. We should focus



Bruce McCune

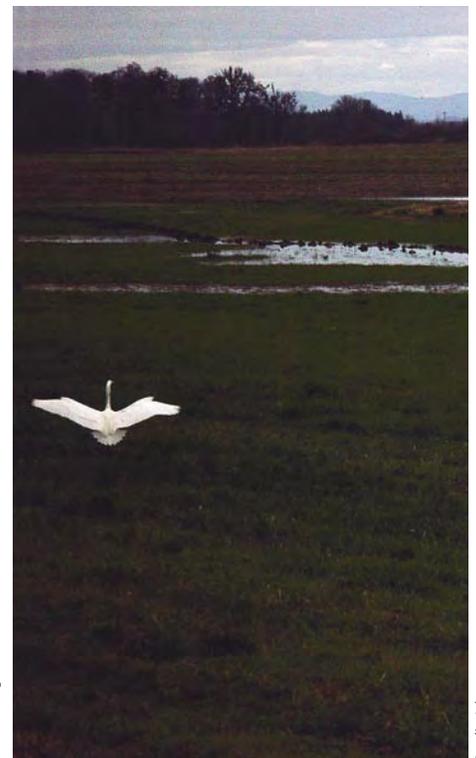
our restoration efforts on these valley and hillside habitats. Distribution of habitat is important, too:

- Conserve the high quality habitat. It is easier to hold on to what's already there than to create new habitat from scratch.
- Avoid surrounding or fragmenting high quality habitats with very poor habitats. Place high quality habitat within reach of other good sites, and cluster poor habitats.

- Expand the habitat value of refuge areas. Lands adjacent to established refuge areas should be managed with increased attention to conservation practices.
- Avoid barriers to wildlife movement. Design the habitat to encourage individuals to move from good habitat to good habitat, not from good to bad.
- Cluster human activities that alter habitat or convert land to new uses such as urban development and logging. Concentrating these activities will leave larger areas of habitat where species can increase their numbers.
- Restore natural processes and dynamics. This is more ecologically and economically effective over the long term than attempting to engineer or manipulate conditions.

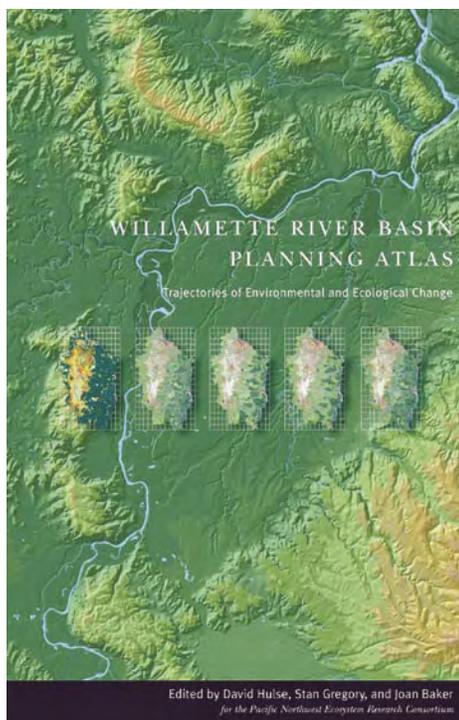


Sandie Arbogast



Sandie Arbogast

HOW CAN I LEARN MORE?



Visit www.willametteexplorer.info, the Willamette Basin Explorer website, part of a new Natural Resources Digital Library at Oregon State University. The Willamette Basin Explorer is an incredible source of information on the natural and cultural history of the basin; research and recommendations for its future; stories of its people, landscape and rivers; an interactive mapping tool; links to other resources; and information to help citizens and policy makers with important decisions.

You can view the entire *Willamette River Basin Planning Atlas, Trajectories of Environmental and Ecological Change* in PDF format, including maps, tables and complete descriptions of the data, assumptions, and processes that led to the future scenarios, conclusions and recommendations. Log onto www.willametteexplorer.info, click on **Additional Resources**, and scroll to **Pacific Northwest Ecosystem Research Consortium** where you'll find a link to the Atlas.

Copies of the *Willamette River Basin Planning Atlas, Trajectories of Environmental and Ecological Change* can be purchased from bookstores and online.

SOURCES

The *Willamette River Basin Planning Atlas, Trajectories of Environmental and Ecological Change*, edited by David Hulse, Stan Gregory, and Joan Baker and published by Oregon State University Press, served as the primary source of information for this publication. Additional information was drawn from the following:

1. Allen, John Elliot., Marjorie Burns. 1986. *Cataclysms on the Columbia*. Timber Press, Portland, Oregon. 182.
2. Outwater, Alice. 1996. *Water, A Natural History*. BasicBooks. New York. pp. 19-33.
3. Wiley, Pam. 2001. *No Place For Nature, The limits of Oregon's land use program in protecting fish and wildlife habitat in the Willamette Valley*. Defenders of Wildlife. Lake Oswego, Oregon.
4. Halprin, Lawrence and Associates. 1972. *The Willamette Valley Choices for the Future*, report prepared for Willamette Valley Environmental Protection & Development Planning Council, 2005. Salem, Oregon.
5. Land Conservation and Development Commission website. 2005. Salem, Oregon.
6. Primozych, David, Richard Bastasch. 2004. *Willamette Subbasin Plan*. Northwest Power Conservation Council. Portland, Oregon. 3-111.
7. *Ibid.*, 3-346.
8. Spence, B. C., G. A. Lomnicki, R. M. Hughes, and R. P. Novitzki. 1996. *An Ecosystem Approach To Salmonid Conservation*. ManTech Environmental Research Services Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon). 5.2.3.

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