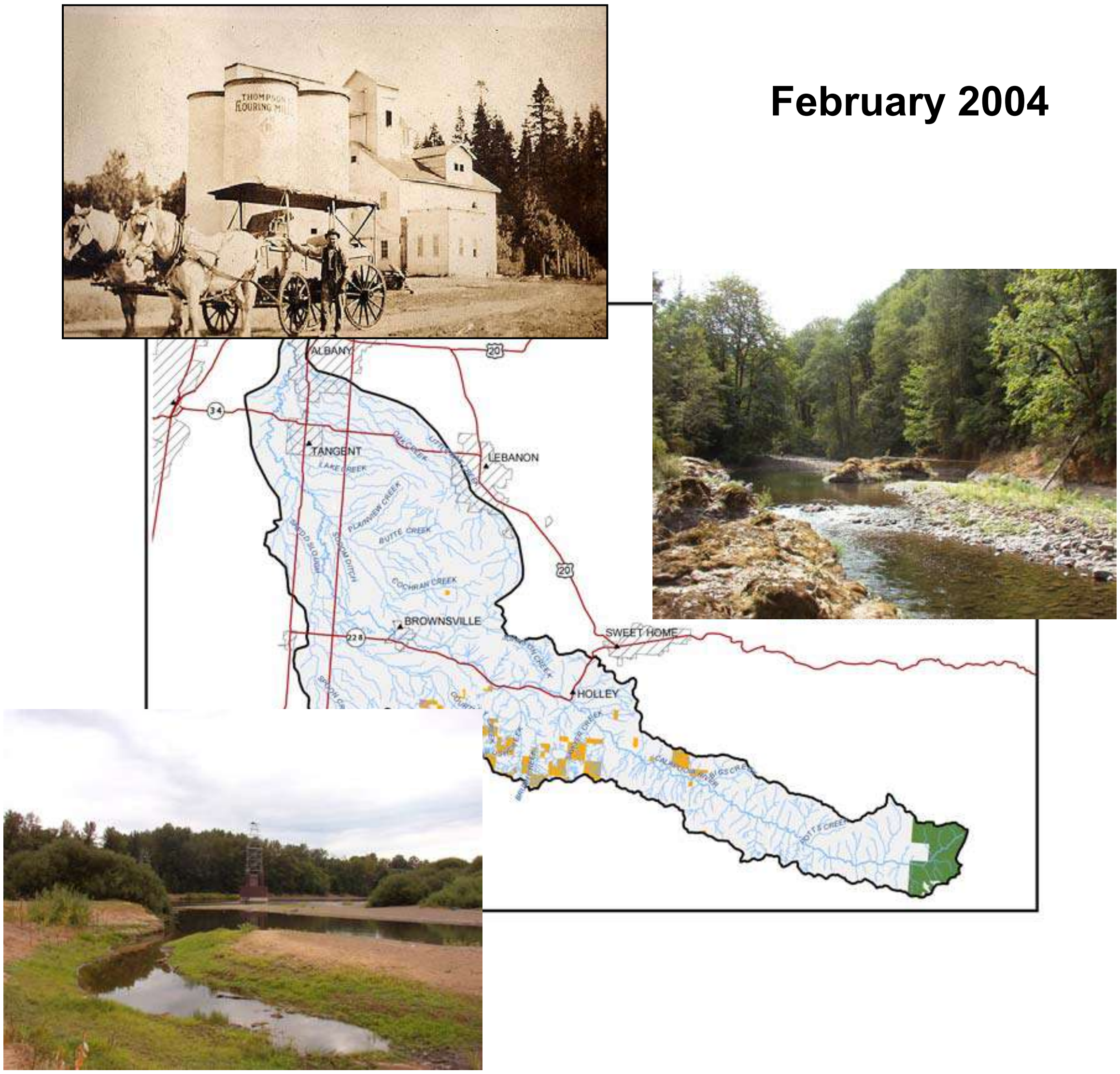
Calapooia River Watershed Assessment

February 2004



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For

The Calapooia Watershed Council

Brownsville, Oregon

Calapooia River Watershed Assessment

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This report was prepared for

The Calapooia Watershed Council

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Chapter 1. Introduction and Watershed Overview

Introduction

The Calapooia River flows out of the western Cascade Mountains to join the Willamette River at the City of Albany in western Oregon. The watershed encompasses about 234,000 acres of land and supports a variety of land uses and fish and wildlife habitats.

The Calapooia River Watershed Assessment characterizes past and current watershed conditions and evaluates opportunities for improvements in the watershed, particularly for fish habitat and water quality. The assessment will aid the Calapooia Watershed Council (Council) in identifying opportunities and priorities across all land uses for voluntary watershed restoration projects and education.

Purpose and approach

The purpose of this assessment is to better understand the natural process, management practices, and land use issues that influence fish habitat and water quality throughout the watershed. The assessment's approach follows the general framework described in the Oregon Watershed Enhancement Board's *Watershed Assessment Manual* (Watershed Professionals Network 1999). In addition to the emphasis on aquatic and riparian issues, the assessment summarizes information on wildlife populations and habitat and outlines social, economic and land use conditions.

The assessment is primarily based on existing information from watershed residents, other completed assessments, field inventories, government reports, aerial photography, and other data sources. In addition, limited fieldwork was conducted to: 1) gain an overview of the watershed and 2) field- check aerial photographic interpretations of riparian and river channel habitat, and other classifications.

In addition to existing information sources, several Council-sponsored projects collected new information for the assessment. These projects include:

- Interviews with watershed residents for historical information.
- Water temperature monitoring in the summers of 2002 and 2003.

- Water bacteria monitoring in the winter and spring of 2002-2003 (in coordination with the Oregon Department of Environmental Quality).
- A prioritized inventory of road crossings to assess fish passage barriers completed during the spring and summer of 2003.

The assessment's supporting data, summaries of resident interviews, and map source data layers, are available from the Calapooia Watershed Council.

Two watershed assessments have been completed for portions of the upper and middle watershed, primarily focused on forest lands. The Weyerhaeuser watershed analysis (Weyerhaeuser 1998) evaluated fish / riparian habitat and water quality on 54,481 acres (~23% of the watershed) of forest land in the upper watershed (including 5,900 acres within the Willamette National Forest). The Bureau of Land Management (Western Watershed Analysts 1999) completed an analysis on 33,790 acres, primarily on forest lands located in the middle portions of the watershed (~14% of the watershed). Information from these assessments was summarized for the Council's watershed assessment.

This assessment identifies key constraints on fish habitat and water quality conditions, summarizes data gaps, and outlines opportunities to address critical factors limiting fish populations. The Calapooia Watershed Council was actively involved in the assessment process and products. Draft assessment chapters were presented at Council meetings (Table 1-1) and a steering committee guided the assessment process and provided comments on the chapter drafts. The Council will use the assessment findings and recommendations to develop a detailed action plan that will describe project priorities, locations, funding sources, landowner and agency coordination, and implementation schedules.

The assessment is not intended to catalog *all* past and current information on natural resources and land use issues within the Calapooia River Watershed. The assessment focuses on issues that are critical to the Calapooia Watershed Council's mission of voluntary watershed restoration: fish populations, stream and river habitat, wildlife, and water quality. The Calapooia River has populations of spring chinook salmon and winter steelhead, both listed as threatened under the Federal Endangered Species Act. The Oregon Department of Water Quality has listed the Calapooia River and some tributary streams as water quality limited for both temperature and bacterial contamination. Significantly, the Calapooia River marks the highest upstream distribution for winter steelhead in the Willamette Basin. Identified watershed issues affecting these and other aquatic species include fish migration barriers, water diversions and withdrawals, changes in the quality of aquatic habitat, limited high-quality juvenile fish rearing habitat, increased water temperatures, and nutrient loads.

Table 1-1. The time line for Calapooia Watershed Assessment draft review chapters and Council presentations.

Chapter Topic	Council Presentation of Draft Chapter (2003)
Historical Conditions	February
Purpose of the Assessment	March
Riparian / Wetlands	May
Water Diversions / Rights	June
Fish Passage / Fish Habitat & Field Tour	July
Water Quality / Sediment	October
Wildlife / Socioeconomic	October
Condition Evaluation and Review Draft of Assessment	November

Overview of the watershed assessment area

The Calapooia River flows into the Willamette River at Albany (Map 1a, *Project Location*). The assessment covers the entire 234,071-acre Calapooia River Watershed. Elevations within the watershed range from 5,185 feet at the summit of Tidbits Mountain to less than 200 feet where the Calapooia River joins the Willamette River. Cool rainy winters, and hot, dry summers characterize the climate of the watershed. Only 5% of the annual precipitation falls from July through September (Pacific Northwest Ecosystem Research Consortium 2002). Winter precipitation usually falls as rain in the lower elevations of the watershed and snow in the mountainous areas above 3,500 feet.

Map 1b, *Watershed Overview*, shows the Calapooia River Watershed boundary and the private and public land ownership patterns. For the purposes of the assessment, the watershed was divided into three watershed areas: lower, middle, and upper (Map 2, *Shaded Relief*). Each of these watershed areas has a different mix of ownership and land use patterns. Table 1-2 outlines the ownership patterns for the three watershed areas.

Almost 94% of the watershed is privately owned. Forest lands dominate the upper portions of the watershed; a mix of agricultural land uses and several incorporated communities are located in the middle and lower watershed areas. (For more information on land uses see Chapter 3, *Social, Economic, and Land Use Conditions*.) There is a small percentage of the watershed (2%) within the urban growth boundaries of Albany, Lebanon, and Brownsville (Map 1, *Calapooia River Watershed)*. These urban areas, however, contain a significant proportion of the watershed's population and they have a disproportionate impact on the watershed. The Federal

Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) are the primary government agencies managing portions of the watershed. The BLM manages 8,723 acres of forest lands located primarily in the lower and middle portions of the watershed. The USFS manages 5,909 acres of forest land in the headwaters of the Calapooia River.

Table 1-2. Land ownership patterns (acres and percent) for the lower, middle, and upper Calapooia River Watershed (for watershed area locations, see Map 2, Shaded Relief*).*

Ownership	Watershed area location (acreage)				Percent of watershed
	Lower	Middle	Upper	Total	
Private	129,015	45,669	44,698	219,382	93.72%
State	57			57	0.002%
BLM	3,373	4,308	1,042	8,723	3.73%
USFS			5,909	5,909	2.52%
Total	132,445	49,977	51,649	234,071	100%
Percent of watershed	**56.58%**	**21.35%**	**22.07%**	**100%**	

The character of the Calapooia River and its tributaries changes as it flows out of the Cascade Mountains into the flat expanse of the Willamette Valley. For the purpose of this assessment, the Calapooia River was divided into a series of reaches based upon where they are located in the system (Map 2, *Shaded Relief*). Ten reaches are used in the assessment as a framework for characterizing riparian areas and aquatic habitat. These assessment reaches characterize the Calapooia River and riparian areas from the beginning of forest land above Holley to the river's confluence with the Willamette. River reaches were not delineated for the upper Calapooia River Watershed where most of the area is forested. The Weyerhaeuser watershed analysis (1998) and Oregon Department of Fish and Wildlife stream habitat inventories (1991) reported on conditions in this area and these reports were used to summarize riparian and stream habitats.

The following is a description of the watershed assessment reaches and the three watershed areas:

Lower watershed: This portion of the watershed includes the Calapooia River from its confluence with the Willamette River in Albany to the upper end of Sodom Ditch diversion (at the point of the split between the Ditch and the river), approximately 3 miles below the city of Brownsville (RM 1 to RM 28.5)*. This length of the river encompasses watershed assessment reaches 1 through 5. Major tributary streams joining the Calapooia River along this section

* River Miles (RM) note the miles along the Calapooia River from the river's confluence with the Willamette River (RM 0) to the headwaters (above RM 75). Brownsville is at RM 32.

include Oak, Lake, Butte, and Courtney Creeks. The valley in this portion of the watershed is broad and relatively flat. The highest proportion of low gradient stream and river channels in the Calapooia River Watershed are within this area. The Calapooia River through this section has less than 0.1% gradient, and most of the tributary streams are very flat, with the few steep streams confined to the upper portions of Butte, Cochran, and Courtney Creeks. The lower watershed is characterized by wide flood plain forests with numerous side channels and ponds along the river.

Middle watershed: This portion of the watershed includes the Calapooia River from the upper end of Sodom Ditch diversion, through Brownsville, and continuing to the beginning of forest land, approximately 4 miles above Holley (RM 28.5 to RM 48). This length of the river encompasses watershed assessment reaches 6 through 10. Major tributary streams joining the Calapooia River along this section include Warren, Brush, Johnson, and Pugh Creeks. Within this portion of the watershed, the Calapooia River transitions from a broad valley floor into a narrower valley surrounded by forested hillsides. The Calapooia River through this section ranges from 0.15 % to 0.44 % gradient. The tributary streams begin as steep headwater channels that transition into lower gradients as they flow out of the forested hills. In this middle portion of the Calapooia River Watershed, the river meanders across the flood plain cutting new channels depositing gravels and wood in the channel.

Upper watershed: This portion of the watershed includes the Calapooia River from the beginning of forest land above Holley to the mountainous upper watershed on Forest Service land (RM 48 to RM 75). Stream reaches were not characterized for the upper watershed. Major tributary streams joining the Calapooia River along this section include Biggs, McKinley, and Potts Creeks, and the North Fork of the Calapooia River. The Calapooia River flows through a narrow valley surrounded by the steep slopes of the western Cascade Mountains. The gradient of the Calapooia River through this section increases from 0.44% at the beginning of forest land to 1.94% where the North Fork Calapooia joins the river. This portion of the watershed has the highest proportion of steep headwater tributary streams. Many of these high gradient stream channels transport debris torrents during flood events, depositing logs and gravels in the river (Weyerhaeuser 1998).

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Chapter 2. Historical Conditions

Introduction

This chapter provides an overview of the watershed's historical conditions and changes over time. This historical summary provides insights into watershed conditions at the time of Euro-American exploration and settlement and into how human activities have modified fish and wildlife habitat and the landscape through time.

Methods

For this assessment, the history of the Calapooia River Watershed is divided into three time periods: Kalapuyan landscape (Pre-Columbian to 1845), American pioneers (1846 to 1879), and the transition to modern times (1880 to 1949) (Table 2-1). The historical periods end in the late-1940s. Descriptions of watershed conditions during each of these historical periods are based on evidence from written and verbal first-hand accounts and summaries of explorers and watershed residents, resource inventories, maps, drawings, and photographs. Most of the land use activities and other trends (such as a growing population) that currently shape the watershed and affect fish and wildlife populations were established by the end of World War II. Other chapters of this assessment will cover current issues and trends that affect the watershed.

Table 2-1. Calapooia River Watershed assessment historical time periods.

Dates	Period
Pre-Columbian to 1845	Kalapuyan landscape
1846 to 1879	American pioneers
1880 to 1949	Transition to modern times

The Kalapuyan landscape: Pre-Columbian to 1845

The early settlers referred to the indigenous people in the Calapooia River Watershed and surrounding areas as the "Kalapuyans" (Figure 2-1). Ethnologists have divided Willamette Valley Native American populations into smaller bands that occupied separate tributary valleys to the Willamette River, such as the Santiam, Luckiamute, Long Tom, and Marys River. Each of these bands spoke a slightly different dialect of the Kalapuya language. Along the banks of the Calapooia River lived the people the linguists called Tsankupi (Boag 1992). Trails connected the local band and neighboring bands. The Molla trail winds through the upper portion of the watershed and was a major huckleberry resource area where the groups met for trading and ceremonies (Tony Farque, USFS, Archaeologist, personal communication, as reported in Weyerhaeuser 1998).

It is not known how long Kalapuyan bands lived in the Willamette Valley prior to Euro-American contact. Technologies of roasting filberts and camas were used by these peoples for at least 9,000 years. At the time of the 1805-1806 Lewis and Clark expedition, at least six Kalapuyan bands, estimated at a total of 10,000 to 13,500 individuals, lived in the Willamette Valley (Boag 1992). By 1841, Charles Wilkes noted that only 400 or so Kalapuyans survived in the valley (Wilkes 1845). Much of the population before this period was decimated by disease introduced by Europeans (Boag 1992). There is evidence of extensive use of the watershed by Kalapuyans, including a winter village site near Holley and a campsite at the confluence of the Willamette and Calapooia rivers, the current location of Bryant Park (Mullen 1971, Weyerhaeuser 1998). The Kalapuyans referred to the deep pool at the junction of the two rivers as Takenah. In 1853 individuals in Albany were successful at persuading the legislature to change the name of the town to Takenah, which it remained for two years before reverting back to the original name (Mullen 1971). The Albany park across the Willamette River still retains the name, Takena Landing.

Figure 2-1. Sketch of Kalapuyan man near a Marys River tributary, 1841 (Wilkes 1845).

The early European explorers found vegetation patterns in the Calapooia River Watershed that were modified by the Kalapuyan people through active burning of vegetation. In 1834, Hudson Bay Company chief trader John Work, following the route of the McLeod expedition, noted extensive burning of vegetation in the Willamette Valley by the Kalapuyans (Boag 1992). David Douglas, a Scottish botanist who arrived in the Willamette Valley in the autumn of 1826, noted the aftermath of the Kalapuyan burning: "Most parts of the country burned; only in little patches and on the flats near the low hills that verdure is to be seen." A few days later he commented, "As I walked nearly the whole of the last three days, my feet are very sore from the burned stumps of low brush-wood and strong grasses" (Boag 1992, p.13).

In the late summer, when most of the Pacific Northwest tribes congregated at fishing sites to harvest salmon, the Kalapuyans set fire to Willamette Valley grasses in order to encourage the growth of camas (*Camassia quamash*), the staple of their diet (Boag 1992). One of the earliest records of encounters with Kalapuyans was on October 4, 1826, in the approximate area of Berry Creek, in southern Polk County. The McLeod expedition noted a group of Kalapuyans "gleaning a miserable existence digging roots" (Boag 1992). Camas, a member of the lily family, requires open prairie habitat. Lightning strikes are rare in the Willamette Valley, which limits the generation of natural fires. Without fires the valley would naturally have become overgrown with forest, and camas would have become rare. The burning at the end of each summer eliminates camas' competition: shrubs and seedlings of species such as Douglas-fir. Because the bulb of the camas lies hidden underground and dormant at the end of summer, fire cannot directly affect this portion of the plant (Boag 1992).

The natives' use of fire in the valley encouraged the vigorous growth of tall grassess such as tufted hairgrass (*Deschampsia caespitosa*), sloughgrass (*Beckmannia syzigachne*), meadow barley (*Hordeum brachyantheum*), and bluegrass (*Poa pretensis*), some of which reached several feet in height (Boag 1992). The native peoples called these long grasses “Kalapuya”. When Europeans came to the valley of the long grasses, they used this Native American word to refer to the Willamette's people, thus dubbing them the Kalapuya (Boag 1992). According to one early settler, "In the early days the tall, rank grass covered all this valley. We would turn our cattle on the valley and they would immediately be lost in the tall grass which reached higher than their backs" (Boag 1992, p. 3).

Although the Kalapuyans occupied a near-coastal environment teeming with runs of salmon, they depended on plants rather than fish, game, and other seafood as staples (Mackey 1974). This limited food supply constrained the population numbers. In contrast, the coastal Native American groups, such as the Chinook of the Columbia River, relied principally on relatively abundant and nutritionally rich salmon and other sea life, which could support larger and more densely concentrated human populations (Boag 1992).

The waterfalls near present-day Oregon City limited salmon runs to the upper Willamette River. These falls (until the construction of modern fish ladders) blocked most runs of salmon from the upper river. Only the strongest swimming salmon could negotiate the falls, which blocked the weaker swimming coho salmon. Spring chinook salmon and winter steelhead could negotiate the falls during the spring high flows. The much larger runs of fall chinook salmon could not pass over the Willamette falls during the low water flows in the autumn.

The powerful Chinook tribe limited the use of the fish resources by other tribes at the falls. The Chinooks controlled access to the falls, preventing the Kalapuyans from harvesting any of the returning spring salmon (Boag 1992). The Chinooks did, however, allow the Kalapuyans to gather eels that clung to the basalt cliffs behind curtains of cascading water. The Kalapuyans also collected lamprey and fished for salmon at smaller waterfalls and rapids on the Willamette River's tributary streams, such as the falls on the Calapooia River (Boag 1992). Fishing often took place at night by the light of pitchwood torches, with bone-tipped spears, woven basketwork traps, weirs, and fishing poles with hair for string and grasshoppers for bait (Boag 1992). The catch was preserved for winter storage through drying and smoking (Boag 1992).

Early vegetation and wildlife

The first Euro-American settlers found extensive gallery forests along the Willamette River and its tributaries. These extensive gallery forests, often up to two miles wide, were composed of: Oregon ash, cottonwood, willows, red alder, big leaf maple, Douglas-fir, western red-cedar, and scattered stands of ponderosa pine (Boag 1992). Between the foothills and the gallery forests of the Willamette Valley grew extensive meadows composed mostly of grasses, flowers, and scattered oak trees, or oak savanna.

The following accounts from early explorers and settlers provide a picture of the southern Willamette Valley landscape comprised of open oak savannas, rich grassland prairies, wetlands, and trees along the rivers and streams:

> *1841* (Late Summer): *The country in the southern part of the Willamette Valley stretches out into wild prairie-ground, gradually rising in the distance into low undulating hills, which are destitute of trees, except scattered oaks; these look more like orchards of fruit trees, planted by the hand of man, than groves of natural growth, and serve to relieve the eye from the yellow and scorched hue of the plains. The meandering of the streams may be readily followed by the growth of trees on their banks as far as the eye can see* (Wilkes 1845).

> *Thrifty groves of fir and oak are to be seen in every direction; the earth is carpeted with a covering of luxuriant grass and fertilized by streams of clear running rivulets, some of which sink down and others pursue their course above ground to the river…. The mountainsides are covered heavily with timber. Thus these beautiful valleys offer great inducements to those who wish to have claims of good land, with fine grounds for pasturage and timber close at hand* (Palmer 1845 as quoted in Palmer 1983).

Early explores noted grizzly bears, white-tailed deer, wolverines, wolves, lynx, California condors and other species now extinct in the Willamette Valley. Beaver were abundant and the target of extensive trapping operations by the Hudson Bay Company and others. The beaver were trapped nearly to extinction, but returned in sizable numbers by the 1900s. Charles Wilkes noted in 1841: "bands of wolves were met with and heard throughout the night in various parts of the valley" (Boag 1992, p. 63). In 1843, the Territorial Government established bounties for predators that were seen as threatening the valley's growing livestock and sheep populations -- $3 for large wolves; $0.50 for small wolves; $5 for panthers (mountain lions); $2 for bears; and $1.50 for lynx (Boag 1992).

American pioneers: 1846 to 1879

Beginning in the 1840s, the southern Willamette Valley became an attractive location for settlers from the eastern United States. During this period, American immigrant promoter and settler Joel Palmer noted the attractive environment and the "small mountain streams" that crossed the southern portion of the valley and had "valuable water privileges for such machinery as may be erected, when Yankee enterprise shall have settled and improved this desirable portion of our great republic" (Boag 1992, p. 42). In 1846 the first Euro-American settlers permanently located in the Calapooia Valley (Boag 1992). The 1850 census reported that 219 people had settled in the Calapooia River Watershed; the watershed's population grew to over 2,000 by 1880 (Table 2-2).

Table 2-2. Calapooia River Watershed population estimates, 1850 to 1890 (Boag 1992, p. 138).

Date	Population of Settlers
1850	219
1860	914
1870	1,104
1880	2,338
1890	3,000

Vegetation patterns

Accounts from the mid-1800s describe the Calapooia River Valley landscape as grass prairies, oak woodlands, wetlands, and riparian forests. In 1848 settler and immigrant promoter George Atkinson expounded on the Calapooia Valley's pastoral image: "broad prairies, forests, bands of woodland surrounding beautiful meadows...a vast region of prairies surrounded by hills" (Boag 1992, p. 25). The first systematic record of vegetation patterns in the valley were the result of work done by federally hired surveyors who came to the locale to fix township, range and section lines. Beginning during the winter of 1852-53, the surveyors' detailed notebooks make it possible to reconstruct the early geographic and vegetative landscape of the Calapooia River Valley.

The following excerpt from Boag (1992, p. 45) provides an overview of the landscape noted in the early federal land surveys:

> *The prairies of the Calapooia Valley were noted as "level...with a rich soil of clay loam which produces an abundance of superior quality grass. The prairie being nearly level is very wet during the rainy season." The surveyors described lower Brush Creek as either marshy or simply swamp. Courtney Creek, a slightly smaller brook in the western portion of the Calapooia, typified the valley's "several small streams that head in the mountains but sink on reaching the prairie." Along the Calapooia River, bottomland ranged from one-fourth to one-half mile in width and was "subject to inundation to the depth of 5 or 6 feet & is well timbered with fir maple ash & balm [cottonwood] [undergrowth] hazel vinemaple & briars." The river's characteristics varied from one end of the valley to the other. In the eastern portion it reached only fifty-five links (about thirty-six feet) in width and in the west one hundred links (sixty-six feet). Its current was described as rapid throughout its length in the Calapooia Valley proper.*

Because the federal land survey collected detailed information on vegetation features along township and range line grids, the detailed notes provide an accurate record of the vegetation types and species along the section lines. This record was used to reconstruct the vegetation patterns for the Calapooia River Watershed (Oregon Natural Heritage Program 2002). Map 3, *Historical Vegetation and 1850 Settlement*, illustrates the major vegetation types found during the 1850s surveys: large areas of the lower valley were covered in grasslands, and scattered stands of oaks and ash swales; the lower hillsides had large areas of oak savanna and stands of mixed oaks and Douglas-fir; along the Calapooia River, there was a wide corridor—ranging from ½ mile to 1 mile—of mixed hardwood trees (alder, cottonwood, ash, and willow, and other species) with some scattered conifers (ponderosa pine, Douglas-fir, and other species); Douglas-fir forests dominated the forests of the upper watershed.

Settlement patterns

The first settlers built homes at the base of hills and mountains in the Calapooia River Valley (Boag 1992). According to public land records, by 1851 settlers claimed the vast majority of the periphery of the Calapooia River Valley where the wooded foothills met open prairie: "The township contains about 20 settlers principally along the hills on the Eastern side and on the Calapooia on the Northern side...The prairie part of the of the township is principally vacant owing to the scarcity of timber and the wet state of the land in the winter" (Public land survey notes 1852-53, as quoted in Boag 1992, p. 46). Early Calapooia River Valley resident Archie Fisher recalled, "All of the first settlers to this valley chose their homes on the foothills of the Cascades or the various buttes. The reason was that good springs and plentiful wood was found there and they could live conveniently and still pasture their stock all over the open valley" (Boag 1992, p. 48). Settlement in the valley floor was also hampered by large winter wetlands. One settler observed that "before drainage ditches were opened, the whole valley was like a swamp. The streams, many of them, had no definite channels but spread out over the floor of the valley, wandering here and there all over the land" (Boag 1992, p. 47).

The threat of high water during floods forced the settlers to find home sites out of reach of the high water. Americus Savage, who claimed land along the Calapooia and the floor of the valley, built his home on the top of a low butte whose summit stood almost forty feet above his prairie claim (Boag 1992). During the great flood of 1861 he "resolved that it was time to see just where in the neighborhood it was safe to build...[and] he therefore took a boat and rowed across the [flooding] river inspecting the country" (Boag 1992, p. 47). The 1850 survey of residents in the valley, illustrated in Map 3, *Historical Vegetation and 1850 Settlement*, documents the location of houses at the base of the hills or above the river's floodplain.

Alternative Spellings for the Calapooia River

Historical documents reveal a number of alternative spellings for the Calapooia River. Most of the spelling variations were from the early records before the 1900s, although there were some creative forms well into this century. Numerous records, including early City of Albany street maps, referred to the Calapooia River as a "Creek".

Calapooiah

(1849 land claim notes as cited in Boag 1992, p.55)

Calapoiah

(1850 land claim notes as cited in Boag 1992, p.56)

Calamooga

(Asher and Adams Map of Oregon 1872)

Calapooya

(Willamette Valley Project 1936, p. 12, and old covered bridge in Crawfordsville)

Calapooigah

(1846 land claim notes for John R. Courtney as cited in Boag 1992, p. 99)

Wildlife

There are numerous historical records of wildlife observations, with most reports noting abundant numbers. White-tailed deer, which are attracted to grasslands rather than forests, abounded year-round in the southern Willamette Valley. One settler observed that deer ran "freely over all of these hills, especially in winter. There were some black-tailed deer but perhaps more white-tails. The black-tails would come down from the mountains in the winter. The white-tails were permanent residents here" (Boag 1992, p. 61). Another early resident stated, "The hills were full of deer...and it was never any trouble to get plenty of meat" (Boag 1992, p. 61).

With a growing sheep and livestock industry in the valley, there was constant concern about livestock losses to predators. Grizzly bears, though not as numerous as cougars, proved troublesome with a number of livestock losses noted (Boag 1992). There are few accounts of wolves in the Calapooia Valley. In 1846 one valley resident reported, "Wolves are numerous, and prey upon other animals, so that the plains are entirely in their possession" (Boag 1992, p. 62). In addition, observations were made of beaver activity and beaver ponds, but beaver were less abundant due to trapping.

The ponds and marshes of the area provided good habitat for wintering and migrating geese, ducks, cranes and other fowl. The annual number of geese flocking through the valley was so great that a Linn County newspaper jokingly reported in 1876, "The number of wild geese that have passed...going northward, during the past two weeks, is placed at 3,713,811" (Boag 1992, p. 61).

Early industry and transportation

The Calapooia River and tributary streams were essential for fueling industry in the Willamette Valley. Water powered the saw and flour mills and the river was a highway for the transport of logs from the forests to the sawmills. The industrial center of Brownsville was powered by water diverted from the Calapooia River into a 3-mile long millrace (still present today). In 1859 the partnership of Brown, Blakely, McHargue, and Johns established Brownsville's first flourmill, powered by the millrace. The mill partners requested special permission from the territorial government to purchase a right-of-way for the millrace, stating that "the erection of extensive flouring mills and other machinery in the vicinity...[is] needed to promote the public convenience, and develop the resources of an extensive agricultural region" (Boag 1992, p. 129).

A number of flour and saw mills were built in the Calapooia River Watershed between 1847 and the early 1900s (Table 2-3). Photos 2-1 through 2-5 show some of the early mills. Map 3, *Historical Vegetation and 1850 Settlement,* shows the locations of some of the early dams on the Calapooia River. All of these dams provided water power for the mills. These mills impacted the river through extensive water withdrawals and the building of dams for waterpower diversion channels, many of which were fish migration barriers.

Gold mining began in the headwaters (known as Gold Hill) of the Calapooia River Watershed in the 1870s. Mineral claims included hard rock mining and placer mining within the streams of the upper watershed. Early transportation routes into the mines came from the south through the Blue River Mining District; by 1891 a trail from Crawfordsville to the mines had been established along the mainstem of the Calapooia River (Weyerhaeuser 1998).

Flooding and poor drainage influenced the location of roads. The earliest route to the Calapooia River Valley followed along the base of the eastern Willamette Valley foothills (Boag 1992). Alexander Kirk built a winter ferry across the Calapooia in 1846-47. The ferry was located at the strategic location where the river flows out of the foothills and onto the open valley floor (Boag 1992). Because the floor of the Willamette Valley was water-soaked through much of the year, early travelers stayed along the base of the well-drained foothills bordering the valley. Kirk captured the profitable traffic by locating in a strategic location, where the road descends from the foothills to ford the river (Boag 1992). In 1871 the Oregon and California Railroad was routed through the lower watershed, creating Shedd's Station (now Shedd and near the location of Thompson's Mills). A warehouse was built in Shedd in 1872 to store the wheat to be shipped by railroad (Mullen 1971).

Log drives down the Calapooia River

The Calapooia River provided a "highway" for moving logs from the timbered hillsides to sawmills in the valley. Logs were collected next to the stream and sent downstream during the winter and spring high flows (Photo 2-6). One account, for example, noted that "Mr. 'Ted' Curran has 4,000,000 feet of saw logs in the Calapooia near J.N. Rice's (Brush Creek) waiting [*]for high waters in the creek." (Farnell 1980, p.10). Splash dams were also used to collect logs and store water for floating the logs downstream. Splash dams were usually log structures that would dam the river. When enough logs were collected for a drive, boards were placed across the dam spillway and water was stored and then released. The release from the dam would send a flood of water and logs down the valley. While there are few historical records detailing the location (or duration) of splash dams along the Calapooia River, there were a number constructed on the upper river above Holley. Some sources noted that the splash dams were at River Miles 50 and 51 (Farnell 1980). Logs were moved from the upper watershed to as far downstream as the Albany sawmills (Farnell 1980). Map 3, *Historical Vegetation and 1850 Settlement,* shows the locations of some of the splash dams and the extent of the log drives.

Table 2-3. Some of the of early grist, flour, and saw mills operated in the Calapooia River Watershed (Boag 1992, Mullen 1971).

First year of operation	Location	Description
1847-48	Calapooia River Crawfordsville	Flour mill Built by Richard Finley, washed out by flood of 1861-62. Rebuilt 1862, destroyed 1948.
1846	Courtney Creek	Saw mill built by John Courtney.
1850	Calapooia River Crawfordsville	Saw mill built by William T. Templeton.
1852	Calapooia River Crawfordsville	Saw mill built by Richard Finley.
1852	Calapooia River Albany	Magnolia Flouring Mill, located on "Calapooia Creek" at west end of First Street. Owned by Driffs, Hill, Althouse, and the Montieth brothers.
1854	Calapooia River (location unknown)	Philemon Vawter Crawford built saw mill on the Calapooia.
1858	Calapooia River Near Shedd	Flour mill east of Shedd on the Calapooia River; built by Richard Finley. Destroyed by fire in 1862 and rebuilt. Presently known as Thompson's Mills.
1859	Calapooia River Brownsville	Flour mill built by Brown, Blakely, and McHargue.
1900	Calapooia River Holley	Grist and sawmill owned by Matlock and Splawn.

Photo 2-1. Thompson's Mill (originally Boston Mill) around 1905. (http://www.rootsweb.com/~orlinngs/LinnHistory/MillFolder/BostonMills.html)

Photo 2-2. Thompson's Mill as it is today.
(http://www.rootsweb.com/~orlinngs/LinnHistory/MillFolder/BostonMills.html)

Figure 2-1. Early Thompson's Mill flour sack designs.
(http://linnhistory.peak.org/land/bostonmill.html)

Photo 2-3. McKercher Mill below Crawfordsville, circa 1897. The mill had a dam that diverted the river for waterpower (Farnell 1980). Photo: Gifford and Terrill 2001.)

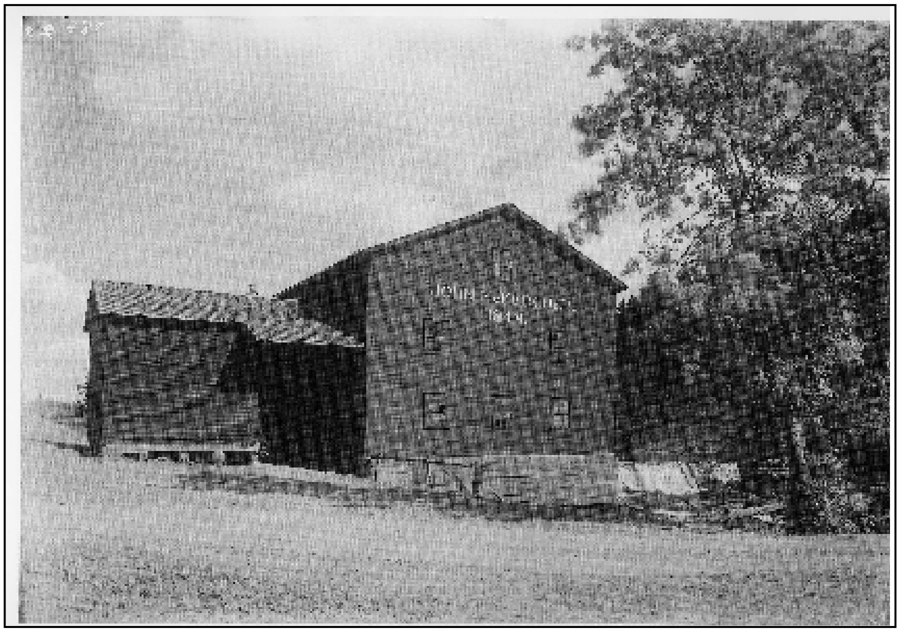
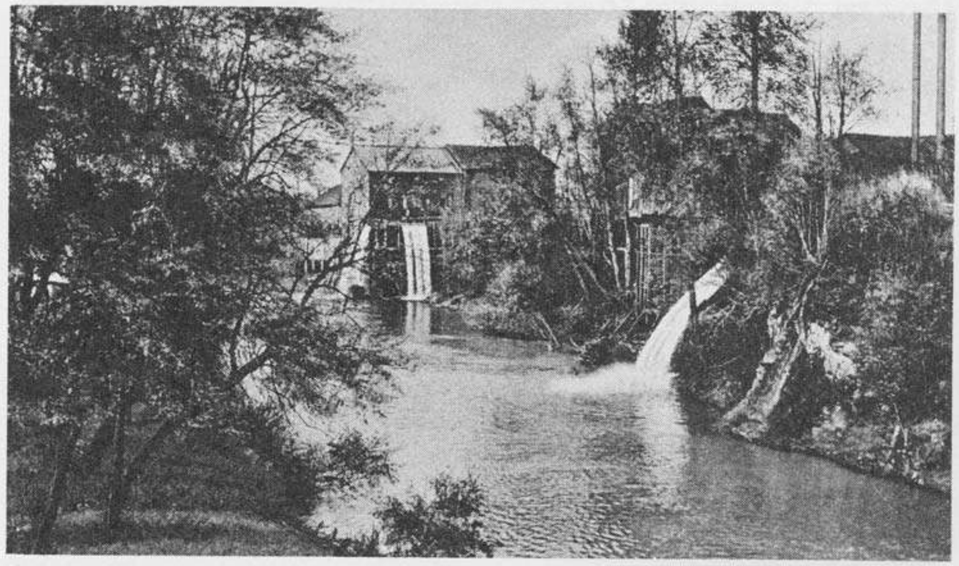


Photo 2-4. The same McKercher Mill site, circa 2001. (Photo: Gifford and Terrill 2001.)

Photo 2-5. Mills (names not cited) along the Calapooia River in Albany, circa 1878 (Mullen 1971).



(Courtesy, Tripp Family)
Water powered manufacturing plants lined the Calapooia River in Albany about 1878.

Log drives down the Calapooia River were extensive in terms of the number of logs and the long duration of the activity. It is difficult to establish the first dates for the log drives. Beginning at least in 1878, loggers were floating logs from Crawfordsville to Albany: "Loggers felled timber into the Calapooia and Brush Creek above Crawfordsville for several months of the year, and then waited for the winter rains to float the logs the forty-plus miles to the mills in Albany." (Boag 1992, p. 132). The log drives continued through at least 1911 (Farnell 1980).

The first information about log drives on the Calapooia River is found in relation to the Calapooia Boom Company, which was incorporated by A.H. Allen with others in September 1876 and run by Allen and Robinson after 1877. The Boom Company received a franchise from the Oregon State Legislature in 1876 to:

> *Construct, maintain and keep a boom or booms upon the Calapooia Creek [sic], running through the county of Linn...between the mouth of said creek, where the same flows into the Willamette River, and the east line of section 1 in township 14, south range 2 west, Willamette meridian (RM 40.6) for a period of ten years...in which boom or booms all logs or timber coming, running or being driven down said Calapooia Creek...shall be held secure, sorted, and be delivered by said company to the owners.*

> *The object of the Act to secure, through the said company and their assigns, the restoration, or opening, of the channel of said creek, and the maintenance of the same hereafter, free from obstruction, so that timber, logs, lumber and other floatables can be run from the mountains to the valley below* (Farnell 1980, p. 7).

Photo 2-6. Upper Photo: A logging crew floating logs on the South Santiam River. Lower Photo: Logs cut by the Scroggins Logging Company above Holley for floating down the Calapooia River (Steinbacher 2002, p. 32).

A logging crew drives logs down the Santiam River on their way to Scoggins Lumber Mill in Lebanon. Logs were dumped in the Middle Fork, South Santiam, and their tributaries during high water in the spring and floated down river. The bark on these trees, sometimes a foot thick, was removed before transporting them to the mills.

Logs cut by a Scroggins Logging Company crew up the Calapooia River above Holley could be floated down river by the use of splash dams during periods of high water. Later a railroad was built to Dollar Camp on the Calapooia and logs could be hauled out throughout the year.

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Allen, Robinson and Company "improved" the river for log drives. This practice "eliminated sloughs and minor courses, removed trees and debris, tore out drifts...." (Boag 1992, p. 133). The manipulation of the river forced the river into a narrower channel, separating it from the floodplain, which had a dramatic impact on fish and riparian habitat. The log drives eliminated important side channel areas, removed habitat-creating logs from the channel, and reduced riparian trees and other vegetation. The floating logs also shed bark, which sank to the bottom of the river and disrupted fish spawning areas. In addition, the decomposing bark removed needed oxygen from the water which affected fish and other aquatic life (Boag 1992).

Large volumes of logs were moved down the Calapooia River. In many cases, one large drive of logs would supply the Allen, Robinson and Company Mill for as much as a year. An Albany newspaper provided accounts of the log drives:

> **December 6, 1878:** *Allen, Robinson & Co. are now ready to celebrate Thanksgiving--that is they will be if the rain continues. They have 5,000,000 feet of logs in the Calapooia above Brownsville and it takes water to bring it to Albany* (Farnell 1980, p. 8).
>
> **[No date] 1878:** *In consequence of so much rain, the roaring Calapooia is up again and we may look for a plentiful supply of logs from above, making the faces of the hardy logger beam with joy* (Farnell 1980, p. 8).
>
> **March 7, 1879:** *LOGS ARRIVED. The big drive of saw-logs belonging to Allen, Robinson & Co. commenced arriving last Saturday and the tail end of it got in on Monday. Lumbermen give it as their opinion that there is a little over 3,000,000 feet in the drive, enough to keep the sawmill running about one year. The sawmill will start up as soon as the river falls sufficient to allow it, and in a very short time will run night and day* (Farnell, J.E. 1980, p. 8).
>
> **April 11, 1879:** *THE SAW MILL RUNNING. The first drive of logs from the mountains arrived in this city a month or so ago, and contained about 3,000,000 feet and the second drive, containing about 1,500,000 got in last Saturday. It will be impossible for this mill to work up so many logs in the space of one year, and the proprietors will probably have to sell some to the mills down the river* (Farnell 1980, p. 8).
>
> **December 12, 1879:** *A MAMMOTH DRIVE OF LOGS. During the past year a large force of men have been at work in the mountains above Brownsville on the head waters of the Calapooia, getting out saw logs for Allen, Robison & Co. of this city, and have put into the creek about seven million feet. The last rain raised the Calapooia so that the entire drive was started, and the men were so fortunate as to get it all out of the mountains before water fell. On Thursday of last week they were running so fast and thick at Crawfordsville that men could cross the river on them, and we are informed that on last Monday the entire drive had passed there. The next rise in the river will probably bring the drive to Albany. About 2,000,000 feet of logs have already been sold to the Buena Vista and Independence mills* (Farnell 1980, p. 9).

> **January 1907:** The *raging Calapooia flooded its banks...the late freshets in the Calapooia River have assisted them very materially in driving the logs. At present time they have over 4,000,000 feet in the river, most of which is at the mill* (Farnell 1980, p. 17).

One newspaper account describes the dangers of working on the log drive crew:

> *Ralph Newton drowned in the Calapooia about a mile above Crawfordsville Tuesday afternoon. He was engaged with a number of other men employed by the Calapooia Lumber Company in breaking a log jam in the prevailing high water so that logs could be floated to the company's pond below Crawfordsville. He was working with a peavy when he was thrown in above the jam then reappeared below it, and was then lost to sight* (Farnell 1980, p. 20).

Agriculture

With rich alluvial soils, the Calapooia River Valley soon became a productive agricultural area. In the late 1850s wheat production increased and provided for the expansion of gristmills on the Calapooia River and elsewhere in the southern Willamette Valley (Boag 1992). The wet prairies of the Willamette Valley floor were the focus of agricultural crops and grazing. With an improved road and water transportation system, farmers increased agricultural production, especially wheat (Table 2-4). From 1845 to 1885 wheat was the principle crop in Linn County (www.cityofalbany.org).

Table 2-4. Wheat production in the Calapooia River Valley, Linn County, and the Willamette Basin, 1850 - 1890 (quantities listed in bushels; ND = no data; Boag 1992.)

Year	Calapooia Valley	Linn County	Willamette Basin
1850	2,265	21,893	199,558
1860	ND	145,273	660,081
1870	23,881	479,294	660,081
1880	103,301	911,411	2,086,826
1890	ND	1,116,074	5,779,509

The extensive prairie grasses provided great opportunities for cattle grazing. In 1852 one Calapooia River Valley settler observed that the "nutritive qualities" of the prairie grass was "unsurpassed by any species of grass throughout the world" (Boag 1992, p. 109). Another early Linn County resident noted: "the grazing of our country are one of the chief sources of wealth and prosperity, and that if proper care were observed the great natural meadows...would continue to be a source of incalculable advantage to her citizens" (Boag 1992, p. 110). Table 2-5 illustrates the increases in the cattle numbers in the Calapooia Valley, Linn County, and the Willamette Basin.

Large numbers of hogs ran at large in the watershed, contributing to the decline of the native vegetation. The hogs plundered the valley camas bulbs. One early settler wrote, "Swine...were the chief destroyers of the roots which were the chief foods of the natives" (Boag 1992, p. 110). So destructive were hogs that in 1857 Linn County residents petitioned the territorial government "to enact some law to prevent swine from running at large and that all persons keeping swine be compelled to keep the same upon their own land" (Boag 1992, p. 110).

Table 2-5. Number of cattle in the Calapooia River Valley, Linn County, and the Willamette Basin, 1850 - 1890). (ND = no data.) (Source: Boag 1992.)

Year	Calapooia Valley	Linn County	Willamette Basin
1850	522	4,619	32,794
1852	972	5,784	ND
1860	ND	20,121	93,094
1870	1,069	8,810	45,692
1880	2,055	12,754	73,970

To settle and farm the wet valley bottomlands, the settlers had to drain them. One settler remembered: "This valley was too wet for much farming just at first. Later, when drains had been opened up and the sloughs drained, wheat farming became all important" (Boag 1992, p. 122). In 1877 a correspondent for the *Willamette Farmer* wrote:

> *The country is flat, but the farmers have an easy-going way of ditching...They plow a few furrows in the center of sloughs, and by just waiting the winter rains do the balance. I saw a few drains made in this way that were seven or eight feet wide and three feet deep, which were used as main drains into which were run one or two furrows at right angles, and this slow draining has enhanced the value of the land very much* (Boag 1992, p. 123).

The land draining reduced the sloughs, ponds, and other standing water which were habitat for ducks, herons, geese, and other aquatic animals. One farmer observed that "the running water cut deeper until the sloughs and lakes became a connected stream" and drained away (Boag 1992, p. 123). Other Calapooia residents noted (Boag 1992, p. 123):

> *The geese and ducks are almost gone from the valley....It has not all been from shooting, however. The draining of the lakes and swamps have had much to do with their disappearance.* [The Calapooia Valley] *has largely ceased to be the home of the crane, curlew, gray plover, and even the snipe, as well as the beaver, muskrat and wild duck. These damp-land and water fowls and animals, which once found here their breeding places, have gone forever, unless farmers in the near future construct artificial fish ponds, and reservoirs for irrigation where needed.*

With the absence of fire, trees replaced the prairie grasses: "Since the advent of the whites the Indians have ceased to burn over the country every fall....The fires burnt, and kept down, all young growth of every kind of timber in the Willamette" (Boag 1992, p. 124).

Floods

Periodic flooding in the Calapooia Watershed impacted the early settlers (see text box on the next page, *Willamette Valley Floods*). During the winter of 1852-53 Wilson Blain remarked, "Heavy rains, deep snows, high waters--perfect floods, great destruction of property along streams, a considerable amount of livestock perished, poor homeless emigrants badly discouraged...." (Boag 1992, p. 66). The flood of 1861 was the largest in post Euro-American settlement history (Taylor and Hattan 1999). Settler Michael Plaster noted "December the 1 the big freshet on Calapooya [sic]; all the bridges & Rigg's mill went off." The flood also destroyed Richard Finley's gristmill on the Calapooia River (Thompson's Mills), and settlers soon ran out of flour and were forced to use cornmeal (Boag 1992, p. 66).

Willamette Valley Floods

Most major floods in the Willamette Valley are the result of rain-on-snow events where heavy rains, accompanied by very warm temperatures, fall on the mountain snow pack. The following is a list of some of the most notable Willamette Valley floods (Taylor and Hatton 1999).

1813 (Type of flood unknown):

There is almost no historical record on this flood, but it was probably as great as the 1861 flood. This may have been the flood described by Indians to survivors of the 1861 flood.

1861 (Type of flood: Rain-on-snow):

Known as the “great flood” it is the largest magnitude flood in the historical record. Every town on the Willamette was flooded or washed away. The river at Albany was 19 feet over its banks.

Dec. 3, 1862 (Type of flood: Rain-on-snow):

Champoeg (town at the present site of the state park) was demolished and West Linn had only two houses remaining.

February 5, 1890 (Type of flood: Rain on snow):

This was the second largest flood of known magnitude on the Willamette River. Almost every bridge in the valley was destroyed. Millions of feet of saw logs resting in the river near mills were washed away.

January 1-8, 1923 (Type of flood: Rain on snow):

The most serious flood in the Willamette Valley since the 1890 flood. The flood damaged roads, bridges, and killed livestock.

December 26-29, 1945 (Type of flood: Rain on snow):

Damage in the Willamette Valley totaled in the millions of dollars.

December 22, 1964 (Type of flood: Rain on snow):

This flood impacted the entire state and it was the largest flood in the valley since the building of reservoirs. Dams on the tributary rivers were calculated to have reduced flood levels in Salem by 7.5 feet. Even with the dams there was extensive damage and thousands of people were evacuated from their homes.

February 5-9, 1996 (Type of flood: Rain on snow):

This flood was comparable in magnitude flood of December 1964 for many tributaries in the Willamette Valley.

Transition to modern times: 1880 to 1949

Linn County's population grew rapidly during the first half of the 20th century. The County's 18,603 residents in 1900 increased to over 50,000 by the 1950s, and more than doubled again by 2000 (Table 2-6). By the end of the 19th century Albany, Brownsville, and Crawfordsville were busy community centers (Photo 2-7). In 1906, the largest sawmill and planing mill in Linn County, owned by Calapooia Lumber Company, was located at Crawfordsville (Mullen 1971). In 1934 Linn County had 33 active lumber mills (Willamette Valley Project 1936). Agricultural production in the Calapooia River Watershed continued to expand into the 1930s. Extensive irrigation of crops began in the 1930s (Mullen 1971). The text box on page 28 provides historical observations noted by Calapooia River Watershed Residents at a Council open house in 2002.

Table 2-6. Linn County population estimates, 1900 to 2000 (U.S. Census Bureau 2003).

Date	Population
1900	18,603
1910	22,662
1920	24,550
1930	24,700
1940	30,485
1950	54,317
1960	58,867
1970	71,914
1980	89,495
1990	91,227
2000	103,974

Logging continued to be an important part of the local economy. According to the Weyerhaeuser Watershed Analysis (1998, p. 11):

> *In 1906, the Thurston Brothers Lumber Company had a camp twelve miles up the Calapooia River from Crawfordsville (placing it just downstream of Big Creek). The camp was headquarters for the drive crew that drove their logs down the Calapooia to their mill at Crawfordsville. Steam donkeys were used to bring the logs to the river and a large boom held the logs at the Thurston sawmill. Dynamite was used to blast boulders, hung up logs and dams built with dirt and logs. In the early 1900s there were several logging operations along the Calapooia River.*
>
> *The Dollar Steamship Lines moved from Mabel (Mohawk Valley) to the Calapooia River around the 1930s. In 1929-30, a railroad line was built from* [Sweet Home] *to what is known as Dollar Camp located downstream of Big Creek. Gilbert and Eaton logging built a camp on King Creek sometime during the mid-1940s on the Calapooia River. By that time log trucks were being used to transport the logs out the watershed. Weyerhaeuser bought the Dollar holdings in 1939.*

Photo 2-7. Crawfordsville in 1912 (Steinbacher 2002, p. 32).

In 1912 Crawfordsville was a busy village larger than Sweet Home. Philemon Crawford purchased 10 acres from Timothy Riggs and Robert Glass to build the town. The deed was written such that if any intoxicating liquor was sold on those 10 acres, the property immediately reverted back to Riggs and Glass. By 1870 a flourmill, sawmill, shoe factory, and steel knife factory were in operation.

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Historical Observations by Calapooia River Watershed Residents

From the Calapooia Watershed Council Open House, Brownsville, December 5th, 2002

One property lost 200 feet of fields in the 1958 floods and another 100 feet in the 1962 floods. After the 1962 floods they rip-rapped the banks and did not notice any bank loss in the 1964 flood. McKercher Mill was taken out in the early 1950s.

There were numerous lumber mills in the watershed during the 1950s. There was a lumber mill at Mitchell [RM 53]*, and a sawmill east of Holley. Water was pumped to the mill ponds 100 feet from the river. The mill on Brush Creek was on the west fork.*

In the 1940s there were major floods every year. The Willamette River would back up into the lower Calapooia River. The flooding stopped when they built the dams on the rivers.

There used to be 4 lumber mills on Courtney Creek and water was fed through a mill race.

After the 1964 floods, there were fewer salmon in the river. People used to scuba dive in the pool under Sodom Dam and poach salmon.

The river became much wider after the floods in the late 1950s. The river channel used to be 60-70 feet wide and now it is 200 feet wide. The river used to be much colder, as far down as Albany. People used to skate on the mill race during the winter months and in the 1960s and 70s the snowdrifts in the upper watershed lasted through the spring.

Agricultural land uses have changed dramatically through time. In the 1940s and 50s crops in the watershed included grass seed, green beans, strawberries, grain, potatoes, hops, row crops, and livestock. Now agriculture is almost entirely limited to grass seed.

In the 1960s, hedge rows were removed from agricultural lands in the lower watershed. There are now fewer song birds and frogs than there used to be.

1940s Fish Habitat Survey

In the 1940s the U.S. Bureau of Fisheries (now the U.S. Fish and Wildlife Service) conducted the first systematic survey of fish habitat in the Willamette Basin, including the Calapooia River in 1941 and 1945(McIntosh et al. 1990). Information from these surveys provides an excellent quantitative view of the river's fish habitat and a way to compare current conditions to those found in the 1940s (McIntosh et al. 1990). The survey recorded information on fish sightings and a variety of habitat elements, including spawning areas and fish passage barriers. Many of the fish habitat conditions noted in these historical surveys have improved since the 1940s. For example, many of the observed fish passage barriers (such as the Finley Mill dam) and logging debris in the river are no longer present. Some of the dams noted in the 1940 surveys, such as the Brownsville Dam, are still present. Log jams were noted, and these log accumulations in the river channel were thought to be fish passage barriers. Current research shows that migrating salmon and other fish can usually pass through the log jams and these collections of large wood provide quality fish habitat (see Chapter 6, *Fish Populations and Aquatic Habitat*). Unfortunately, other conditions and issues observed in the surveys—for example, fish poaching—continue to occur in the watershed.

The information below summarizes the information from the 1941 and 1945 surveys (All information cited from McIntosh et al. 1990):

1941 Calapooia River Survey, September 29 to October 2

This survey noted a number of fish passage barriers (RM = River Mile):

> *Sometimes, according to reports, the water is so low that the bypass around the Dollar log pond* [an old logging camp up the river from Holley, RM 56; this camp is no longer present] *is dry or almost dry. In such cases the entire stream above Dollar would be inaccessible* (p. 267).
>
> *Across the main channel at Dollar* [RM 56] *is a dam of earth and rubble 130' wide, 15' long and 7' high on the downstream side. Water is diverted by the dam into a log pond on the left, and returns to the river some distance below* (p. 268). [This dam is no longer present.]
>
> *10,240 yards above Dollar is a large log jam 100 yards long. The lower end of the pile rests over a narrow bedrock channel in which there are several small falls obstructed by logs. No passable channel could be found. Barrier at all times....Numerous other log jams occur in the stream, many of which appear passable only with great difficulty* (p. 268).

> *Spring chinooks and steelheads ascend the river each year being impeded by the old mill dam at Crawfordsville. It is reported by the operator of the mill that a part of the dam washed out in the spring of 1941 permitting some of the chinooks to escape to the upper river. An employee of the logging company at Dollar reported 200 chinooks during June in a big pool in the "narrows" two miles below Dollar...* (p. 269).

1945 Calapooia River Survey, September1-2

This survey noted habitat conditions within and along the Calapooia River:

> *From the confluence with the Willamette upstream to the town of Tangent, the earth banks average about 25' high with marginal vegetation of willow, alder, cottonwood, ash and scattered conifers. The water is very sluggish and yellow colored and the bottom is about 90% mud and silt....The Albany ditch, which comes from the South Santiam River just above Lebanon, joins the Calapooya River in Albany* [sic]. *Before entering the river, however, the Albany ditch goes through the mountain states power plant located at the edge* [sic] *of Albany....It was reported that some salmon had been taken in back of the power plant and that several arrests had been made* (p. 263).
>
> *....the lower 25 miles of the stream is a mud bottom slough of no value as salmon spawning area. Above this section there is 1 mile of good spawning area available up to the Finley Mill Dam* [RM 45]. *The area above the dam is available only to steelhead and part of the chinook run at high water stages. The number of chinooks able to ascend depends upon water conditions when the run arrives at the dam. A large number of chinook salmon have been observed to be blocked below the dam in the fall, and these fish are easily captured by poachers in the vicinity. A ladder at this dam is badly needed. The dam and fishway above Brownsville should also be improved and the diversion screened. The log jam above Dollar should be removed* (p.264).

Noted Diversions/Fish Passage Barriers:

Diversion 1:

> *A diversion dam located 2.5 miles above Brownsville, OR is a low water barrier. The dam is 143' wide, between 3-4' high, and is of wood construction. A fishway channel through bedrock on the left side is not passable at low water* (p. 261). [The Brownsville Dam exists today and still has fish passage problems.]

Diversion 2:

> *The Finley Mill dam is located just below Crawfordsville, OR. This is an impassible barrier, has nothing but possible historical value to owner and serves no purpose. It is of log and plank construction, 145' wide and 10' high, and has no fishway. Between 12 and 20 chinook salmon adults were held in pool below dam unable to go over the dam* (p. 261). [This dam is no longer present.]

Diversion 3:

> *Cascades probably passable at all times are located about 1-1.5 miles above Crawfordsville, OR. These consist of a number of small falls and rapids, none having over a 1' drop* (p. 263).

Diversion 4:

> *A log jam, probably passable at all times, is located about 1.5 miles below Sweet Home highway bridge. It is 25' wide and 6' high* (p. 262).

Diversion 5:

> *Another log jam, also passable, is located 1,000 yds below Mitchell, OR [RM 42.4] . It diverts part of the river around an island for about 150 yds before it again enters main stream* (p. 262).

Diversion 6:

> *This diversion occurs about 21 miles above the mouth and supplies the woolen mill at Brownsville, OR. The take-off is just above the dam, on the left bank. The diversion was 18 cfs and the river flow below it was approximately 30 cfs on September 1, 1945. There are no protective devices. The headgate is 10' wide, 2' deep and of wood construction* (p. 262). [This diversion—the Brownsville Ditch—is still in place; the diversion is now screened to prevent access by fish.]

Conclusions

By the 1950s, the landscape features of the Calapooia River Watershed had changed dramatically. Lands that were historically grass prairies, oak woodlands, wetlands, and riparian forests had been converted to farmlands, and, to a lesser extent, other land uses. The end of the Kalapuyan practice of using fire to control vegetation resulted in conversion of areas that were once grasslands and open oak woodlands to conifer forests. Human population had increased, with people concentrated in Albany, Lebanon, and Brownsville. Stream habitat, especially along the Calapooia River, had been modified through a number of practices, including log drives down the river, removal of large wood from the channels, loss of riparian habitat, and bank stabilization. A number of dams within the Calapooia River presented obstacles to fish migration.

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Chapter 3. Social, Economic, and Land Use Conditions

Introduction

This chapter examines social and economic conditions in the Calapooia River Watershed and surrounding Linn County. The chapter concentrates on how the economy and social setting influence land use patterns that in turn impact the watershed and fish and wildlife habitat. This chapter will answer questions such as: What are the economic conditions in Linn County? What are primary human uses in the watershed and where do they generally occur? Where will development and growth occur in the future?

Methods

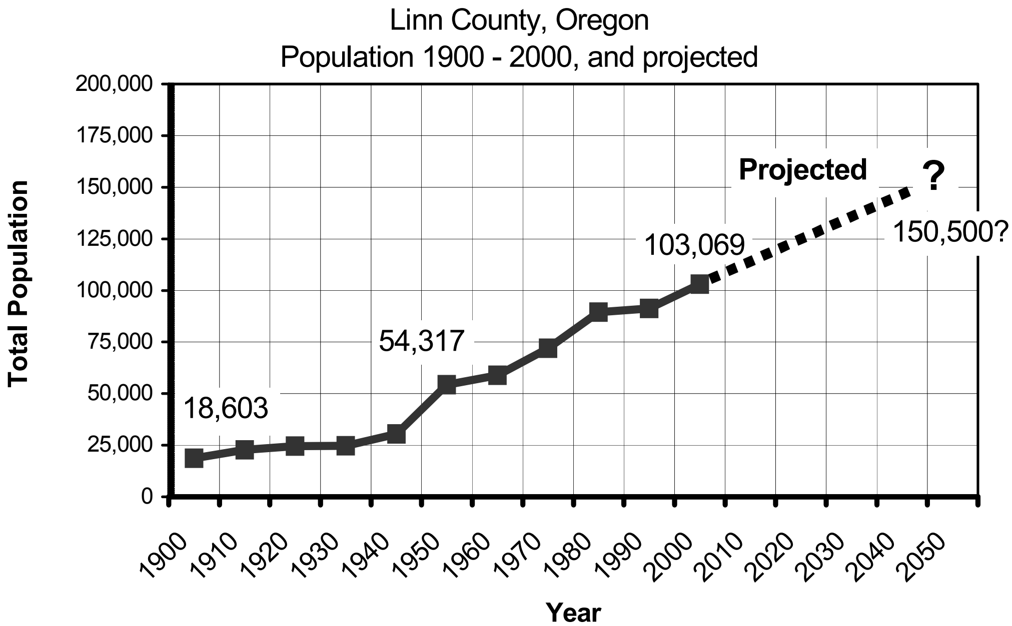
Information on population trends was obtained from the US Census Bureau. The Oregon Employment Department provided economic data and Linn County supplied land zoning designations for the watershed. Summaries of land cover and agricultural uses were obtained from Oregon State University. Population density, zoning, and land cover for the Calapooia River Watershed are displayed in a series of maps (Maps 4-6).

Population trends and patterns

While there are no precise data on the total human population residing within the Calapooia River Watershed, information on population patterns and trends within Linn County provides insights for the watershed. The Calapooia River Watershed covers approximately 16% of Linn County. Linn County's human population has increased over the last century, with periods of relatively slow growth followed by dramatic increases. At the beginning of the 1900s, Linn County's population was nearly 19,000, which gradually grew for the first 40 years of the century (Figure 3-1). Following Word War II there was a period of economic growth throughout the Willamette Valley, and Linn County's population grew rapidly. In 1940, the county's population was 30,485; by 1950 the population was 54,317. The decades of the 1950s through the 1970s were marked by steady population growth. Oregon's economic recession of the early 1980s slowed population growth in the County. This period was followed by a dramatic increase in population fueled by the booming economy of the 1990s. In 1990, there were 91,227 residents in Linn County; by 2000 the population increased to 103,069. Over the next 50 years, the number of people living within the Willamette River Basin is expected to double (Pacific Northwest Ecosystem Research Consortium 2002). While it is difficult to predict Linn County's future population, if past trends are an indication, growth will continue. Oregon's

Office of Economic Analysis has projected that Linn County's population will be 150,551 in 2040 (Oregon Office of Economic Analysis 1997).

Figure 3-1. Linn County population, 1990 to 2000 (US Census Bureau 2003). Total population counts are displayed for 1900, 1950, and 2000. The dotted line shows the projected population growth though 2040.



The 2000 US Census provides information on population density within the watershed. Most of the watershed's area has relatively low population densities, with less than 68.8 people per square mile (Map 4, *Population Density by Census Block Group*). The highest concentration of residents within the watershed is within the city of Albany, primarily along the lower Calapooia River and Oak Creek; and in Lebanon, encompassing portions of the upper Oak Creek drainage. Areas with moderate population densities (68.9 to 289 people per square mile) surround the urban growth boundaries of Albany (lower Calapooia River, Oak Creek and Lake Creek) and Lebanon (upper Oak and Butte Creeks). Moderate population densities are also found within and around the smaller communities of Tangent (lower Calapooia River and Lake Creek), Brownsville (middle Calapooia River and Courtney Creek), and Holley (middle Calapooia River). In 2000, the two major urban areas within the watershed, Albany and Brownsville, had populations totaling 40,852 and 1,149, respectively (US Census Bureau 2003). The watershed's boundary encompasses only a portion of Albany and its population. However, the portion of Albany within the watershed includes rapidly developing areas near the Calapooia River and Oak Creek.

Economic trends

In 2002, there were a total of 46,562 employed residents in Linn County. Table 3-1 provides an overview of the employment patterns for individuals employed within Linn County. This employment summary is for individuals who work in Linn County, including those who commute from other counties. A number of Linn County residents commute to work in other counties. Compared to most counties in the Willamette Valley, the share of residents who stayed in the County for work is relatively low, representing about 71.6% of the work force (Oregon Employment Department 2003).

A large percentage (28.4%) of Linn County residents commute outside the county for work. For these commuting residents, Benton County represents the most likely destination. Approximately 12.8% of Linn County's workers work in Benton County. Most of the other Linn County workers (15.6%) commute to jobs in the Salem or Eugene Area (Oregon Employment Department 2003).

This pattern of commuting holds steady for many residents within the Calapooia River Watershed. Many individuals live in Brownsville and outlying rural areas because it is a central location for commuting to Albany, Corvallis, Eugene, and Salem, where there are manufacturing, government and other jobs (Mary Wright, Oregon Employment Department, personal communication, 2003). The lower housing costs and the attraction of a rural lifestyle in Linn County provide another incentive for individuals to live in the county and drive to work. Census statistics for Brownsville support this conclusion. In 2000, there were 664 employed individuals (over age 16) who resided in Brownsville (Table 3-2). Of the employed individuals, 513 commuted to work with a mean travel time of 24.2 minutes (US Census Bureau 2003). Manufacturing represented the largest proportion of total employment (26.7%) for Brownsville residents and most manufacturing jobs are located in the larger cities.

Table 3-1. Linn County employment, 2002 (Oregon Employment Department 2003).

Category	Number
Total Linn County employment	**46,562**
Estimated farm employment	7,802
Nonfarm Payroll employment	
Private	
Natural resources and mining	570
Construction	2,090
Manufacturing	8,170
Durable goods	5,620
Wood product manufacturing	2,250
Primary metal manufacturing	1,660
Nondurable goods	2,550
Trade, transportation, and utilities	8,670
Wholesale trade	1,510
Retail trade	4,760
Transportation, warehousing, and utilities	2,400
Information	570
Financial activities	1,390
Professional and business services	3,040
Administrative and support services	1,770
Educational and health services	3,810
Health care and social assistance	3,580
Health care	3,190
Leisure and hospitality	2,450
Accommodation and food services	2,310
Other services	1,320
Total private	**32,080**
Government	
Federal government	330
State government	520
Local government (includes education)	5,820
Total government	**6,680**
Total nonfarm employment	**38,760**

Table 3-2. Employment by category for residents (16-year-old and over) of Brownsville, 2000 (US Census Bureau 2003).

Industry category	Number	Percent
Agriculture, forestry, fishing, hunting and mining	28	4.3
Construction	59	9.2
Manufacturing	172	26.7
Wholesale trade	27	4.2
Retail trade	79	12.3
Transportation, warehousing, and utilities	28	4.3
Information	6	0.9
Finance, insurance, real estate, and rental and leasing	8	1.2
Professional, scientific, management, administrative	27	4.2
Educational, health, and human services	99	15.4
Arts, entertainment, recreation, accommodation and food services	43	6.7
Other services	42	6.5
Public administration	26	4.0
Total employment	**644**	**100**

Since the 1970s, Linn County has experienced one of the highest unemployment rates in the state of Oregon. Two factors drive the high unemployment rate. The first is the high proportion of workers who are employed by the manufacturing sector. Manufacturing industries are usually the first to experience job layoffs during economic down times (Mary Wright, Oregon Employment Department, personal communication, 2003). The second issue contributing to Linn County's high unemployment rate is the large number of workers who commute outside of the County for work. Unemployment rates are based on the county of residence of employees, while employment numbers are determined by the county of location of the employer. For example, when a manufacturing employer, located in Corvallis terminates jobs affecting employees who reside in Linn County, then the County's unemployment rate increases.

Figure 3-2 shows Linn County's average annual percent employment and unemployment between 1990 and 2002. During this period, the unemployment rate was consistently above 7%, always exceeding the state average unemployment rate (Figure 3-3). The only time the rate dipped below this was in 1995 when the average annual rate was 6.1%. Over the twelve-year period, the highest unemployment rate was in 1992 at 10%. The current economic downturn has affected Linn County unemployment rates. There was 9.7% unemployment in 2002 and it is anticipated that the average annual unemployment for 2003 will exceed 10% (Mary Wright, Oregon Employment Department, personal communication, 2003).

Unemployment, and the resulting economic insecurity, can affect the health of the Calapooia River Watershed. Residents who have little income are less likely to pursue involvement in watershed restoration or other conservation practices since they perceive that there is some sort of "cost" (in time or money) for participation (Gibson 2003). Repairing leaking septic tanks, for example, requires financial resources that may be beyond the means of residents who are unemployed.

Figure 3-2. Linn County average annual employment and unemployment, 1990 to 2002 (Oregon Employment Department 2003).

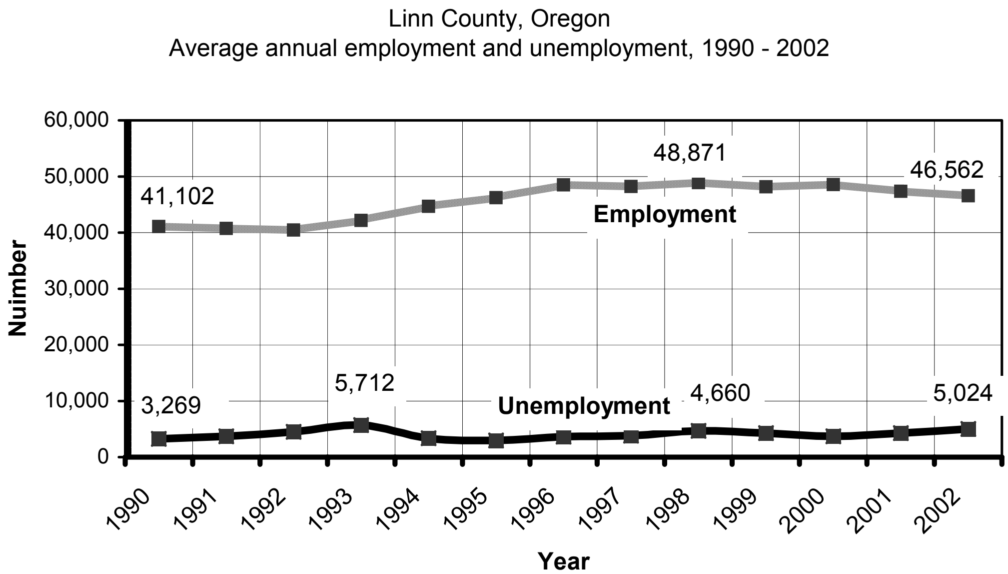
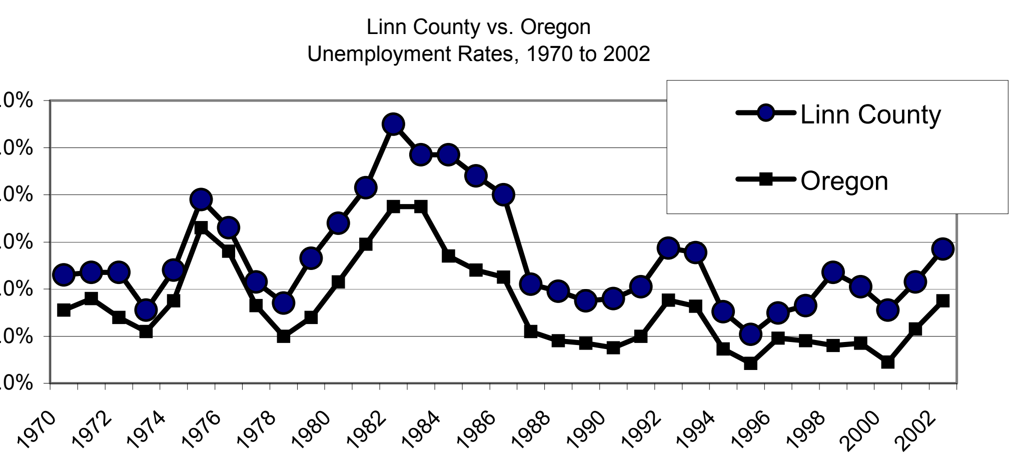


Figure 3-3. Linn County average annual percent unemployment compared to Oregon's average annual percent unemployment, 1970 to 2002 (Oregon Employment Department 2003).



Land use and land cover

Permitted land uses within the Calapooia River Watershed are enacted through city or county zoning ordinances. These land use regulations create areas where the type, location, density and lot coverage are restricted. Land use zoning (potential land use) helps determine where future growth and development will occur and which rural areas are protected for farming and forestry. Within the watershed there are three primary land zoning categories: 1) Farm and Forest; 2) Industrial; 3) Rural and Urban Development. Map 5, *Linn County Zoning*, displays the primary land use designations for the watershed.

The majority of the watershed is designated for farm or forest uses. Exclusive Farm Use (EFU) zoning protects agricultural lands from future development and specifies procedures for land divisions. Exclusive Farm Use covers over 47% of the watershed, located primarily in the lower and middle portions of the watershed. Farm / Forest designation (almost 10% of the watershed's area) provides for mixed farming and forest uses. Forest Conservation and Management (FCM) lands are private, state or federal lands that are suitable for commercial forest uses or conservation. The Forest Conservation and Management zoning, primarily located in the middle and upper portions of the watershed, occupies almost 37% of the watershed's area.

Rural Residential (RR) zoning allows for limited residential development outside of urban areas. Rural Residential zoning permits residential lots of 1, 2.5 or 5 acres. Rural Residential zoning covers about 2% of the watershed's area. Rural Commercial (RCM) and Rural Center (RCT) designations, located in Crawfordsville and Holley, occupy less than 1% of the watershed's area. These designations allow limited higher density residential and commercial development in unincorporated communities.

The highest density development (residential and commercial) occurs within cities. There are four incorporated cities within the watershed – Albany, Tangent, Lebanon, and Brownsville – all of which have designated urban growth boundaries (UGBs). All current and anticipated future development for these areas will take place within the urban growth boundaries. City and Urban Growth Management (UGM) zoning designations occupy about 2.5% of the watershed.

Land cover information was obtained from Oregon State University's Pacific Northwest Ecosystem Research Consortium. This information, derived from satellite imagery, provides a general snapshot of land uses, vegetation, and agricultural crop types for 1990 (See Map 6, *Land Use Land Cover ca 1990*). Table 3-3 shows the land cover types, acreages, and percent coverage of the watershed. Agriculture and Forestry are the dominant land uses within the Calapooia River Watershed. Forests and other natural vegetation (wetlands, riparian, and other areas) cover the largest proportion of the watershed (53%). Agricultural crops cover about 45% of the watershed's area. Grass seed crops dominate agricultural production, occupying more than 23% (including burned grass) of the watershed's area, primarily located in the lower watershed below Brownsville. Built areas (residential and commercial development) occupy the smallest proportion of the watershed (less than 2%).

Table 3-3. Calapooia River Watershed land use and land cover types, 1990. (Pacific Northwest Ecosystem Research Consortium 2002).

Category	**Acres**	**Percent**
Agricultural		
Bare/fallow	2,719.2	1.2%
Berries & vineyards	132.1	0.1%
Burned grass	2,540.2	1.1%
Christmas trees	1,220.6	0.5%
Double crops	184.9	0.1%
Field crop	21,872.7	9.4%
Grass	51,126.1	21.9%
Hayfield	9,245.1	4.0%
Hops	0.9	0.0%
Irrigated field crop	988.1	0.4%
Late field crop	345.8	0.1%
Mint	10.4	0.0%
Orchard	2,168.0	0.9%
Park	529.6	0.2%
Pasture	11,493.3	4.9%
Row crop	1,145.5	0.5%
Sugar beet seed	11.6	0.00%
Total agricultural	**105,734.1**	**45.3%**
Built		
Built high density	558.8	0.2%
Built low density	2,099.2	0.9%
Built medium density	1,520.9	0.6%
Total built	**4,178.9**	**1.7%**
Natural		
Flooded/marsh	532.4	0.2%
Forest	107,883.3	46.1%
Natural grassland	2,425.3	1.0%
Natural shrub	12,948.6	5.5%
Total natural	**123,789.6**	**52.80%**
Remote sensing artifacts (shadow and other)	**194.7**	**0.2%**
Total area	**233,897.3**	**100.0%**

Forest products have long been an important component of Linn County's economy. Lands devoted to forestry and other conservation practices account for approximately 46% of the Calapooia River Watershed's area. The smallest proportion of the forest land base is managed by the federal government. The Forest Service manages 5,909 acres (2% of the watershed) in the upper portions of the watershed. The Bureau of Land Management manages approximately 8,723 acres (3% of the watershed) located in the middle portions of the watershed. The remaining 41% of the watershed in forest land uses is in private ownership. Approximately half of the private forest lands are owned by private timber companies, with a large proportion under Weyerhaeuser management primarily in the upper watershed (approximately 22% of the watershed). Landowners with smaller acreages comprise the remaining private forest land base. Linn County forest harvest has declined dramatically since 1986, with most of the reduction due to declining harvests off of Forest Service and BLM lands (Figure 3-4). Beginning in the 1990s, new management policies on public lands have emphasized maintaining older forests, which has resulted in reduced harvest rates. Most of the public lands in the watershed are now managed to meet conservation goals (for example protecting older forests for spotted owls and other animals). Most of the current harvest in the watershed occurs on private forest lands. These forest lands are managed to comply with the Oregon's Forest Practices Act, which specifies practices for protecting watershed health, including minimizing sediment inputs to streams, providing vegetation along streams, and maintaining fish passage at road crossings.

Information on agricultural production for Linn County from 1990 to 2002 was obtained from Oregon State University. These data provide a method for updating the 1990 land cover information with information on current agricultural crop coverage (Table 3-4). Grass seed production dominates agricultural production in Linn County and the Calapooia River Watershed. Grass seed production throughout the County, and proportionately in the watershed, has increased from 1990 (184,450 acres) to 2002 (over 200,000 acres). The next largest agricultural crops are hay and forage (36,500 acres) and grain crops (9,600 acres). Figure 3-5 shows the trends in grass seed, grain and hay / forage production from 1990 through 2002.

Figure 3-4. Linn County forest harvest from public and private lands, 1986 through 2002. USFS = U.S. Forest Service; BLM = Bureau of Land Management (Oregon Department of Forestry 2003).

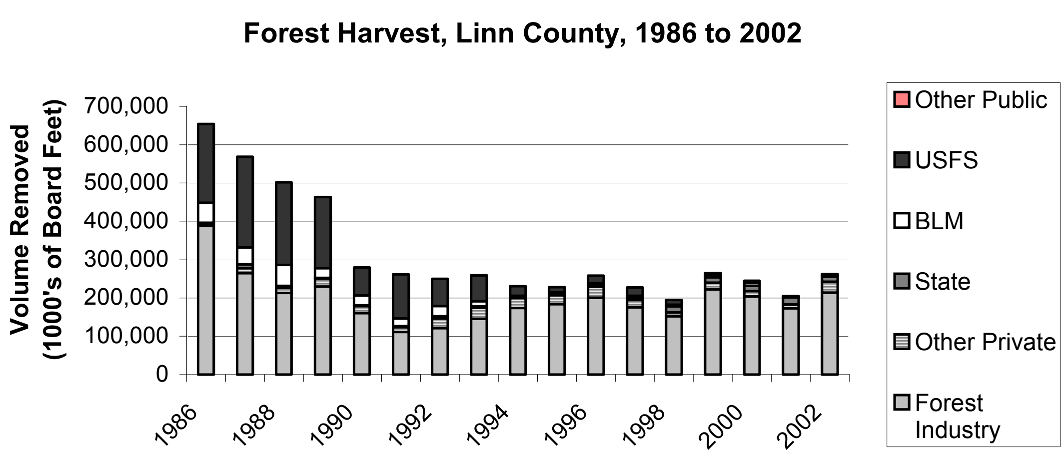
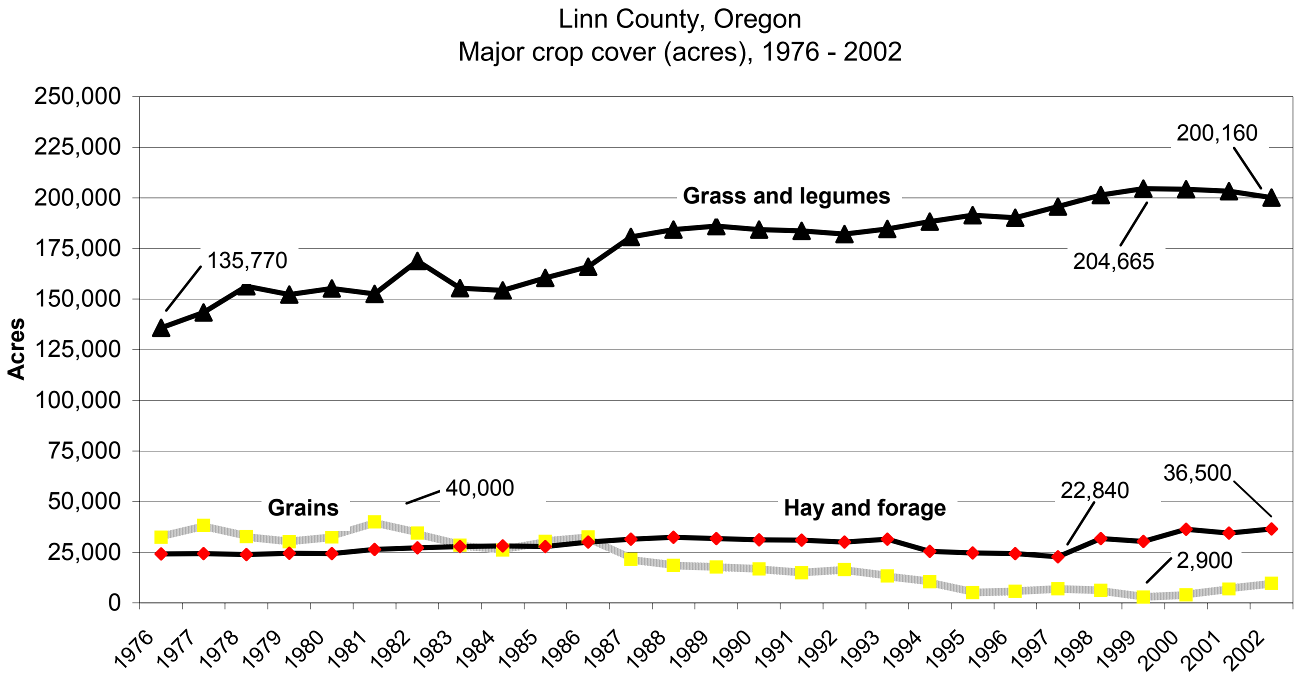


Table 3-4. Agricultural production (acres) in Linn County, 1990 – 2002 (Oregon State University 2003).

Crop Type	Year												
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Grains	16,700	148,00	16,500	13,300	10,500	5,100	5,700	6,900	6,200	2,900	4,000	7,000	9,600
Hay and forage	31,200	31,000	30,100	31,400	25,400	24,670	24,390	22,840	31,840	30,400	36,400	34,400	36,500
Grass and legume seed	184,450	183,750	182,150	184,700	188,300	191,450	190,280	195,700	201,500	204,665	204,330	203,430	200,160
Field crop	7,600	7,796	8,546	8,230	8,540	9,760	9,685	13,215	10,915	9,540	8,475	7,171	6,840
Tree fruit and nut	1,710	1,669	1,670	1,635	1,665	1,672	1,773	1,786	1,723	1,665	1,620	1,610	1,635
Small fruit and berry	735	735	680	670	695	710	675	708	685	740	730	705	685
Vegetable and truck crop	1,425	1,965	1,840	1,960	2,975	3,200	3,055	3,518	3,323	3,532	8,515	4,713	4,695
Specialty product	0	0	0	0	0	0	120	130	135	154	150	170	250
Not disclosed	6,470	5,925	6,000	6,630	5,845	6,360	6,030	6,700	4,729	4,693	593	3,586	4,231
All Crops	**250,290**	**247,640**	**247,486**	**248,525**	**243,920**	**242,922**	**241,708**	**251,497**	**261,050**	**258,289**	**264,813**	**262,785**	**264,596**

Figure 3-5. Trends in Linn County grass seed, grain and hay / forage production, 1976 through 2002.



Agricultural land use and conservation programs

Since agriculture is the dominant land use in the lower Calapooia River Watershed, conservation practices on these lands can have a significant impact on the watershed's habitats, and on water quality. Conservation programs such as the Conservation Reserve Enhancement Program (CREP) provide incentives for agricultural landowners to protect and restore key habitats such as riparian areas. Oregon State University student Jennifer Gibson (1993) recently studied Willamette Valley landowners' perceptions of conservation programs. This study provides insights into the influences on landowners' decisions about whether or not to participate in such conservation programs. Over half of the landowners in the study sample represented grass seed growers, another quarter represented other farmers and ranchers and the last quarter represent non-farming rural residential. Grass seed farmers were of particular interest because they manage the majority of the acres in production in the southern Willamette Valley (including the Calapooia River Watershed) and thus have significant impact on watershed health.

The study found that landowners consider themselves stewards of the land, but most grass seed farmers do not participate in formal conservation programs. For the most part, landowners did not feel like conservation programs were relevant to them. Key perceptions that influenced landowners' reluctance to participate included:

- There is a large amount of paper work (often confusing) that is required before, during and after the project.
- Dealing with the paperwork and government agency bureaucracy is draining.
- Ongoing and long-term maintenance of the project is required, and this is usually not funded.
- Inflexible bureaucracies that do not adapt to the individual needs of landowners.

The study concluded that there is a need for:

- Increased landowner knowledge and understanding of conservation programs, particularly how the programs could apply to their personal land stewardship goals.
- Improvements in landowner relationships with administrating government agencies.
- Utilization of new avenues for education on conservation programs and relationship building.

According to Gibson (1993): "If agencies want to target agriculture in the southern Willamette Valley, they need to address conservation program compatibility with commercial production of grass seed on flat wet land and a recent history of little government interaction other than the still tender topic of field burning" (p. 58). "A number of grass seed farmers told me they simply did not know or see any conservation programs going on in the area" (p. 63). One farmer suggested that it would be a good idea to pursue demonstration projects where people could see how different management practices could be implemented.

George Pugh, a Calapooia River Watershed grass seed farmer and member of the State Board of Agriculture, agreed that government agencies should learn to work with the landowners' conservation objectives (George Pugh, personal communication, 2003). There are large areas of marginal ground where there is little economic benefit and perhaps the best use would be in conservation programs. He cited opportunities to engage grass seed farms in conservation programs:

> *There is a new openness to conservation programs, but until farmers see their neighbor doing it, they will not jump on the bandwagon. With a market incentive to reduce the acres in grass seed, farmers are looking for options to reduce production. Thus there is a need for conservation programs that offer economic incentives, reduce hassles and paperwork, and meet the farmers' land use objectives.*

Social and economic trends and watershed health

Over the next 50 years, the number of people living with the Willamette River Basin is expected to double, reaching 4 million by 2050 (Pacific Northwest Ecosystem Research Consortium 2002). This projected population growth will affect the Calapooia River Watershed. Attracted by the convenient commuting to nearby cities and the beauty of the area, families will continue to locate in the watershed. Development pressure will primarily focus on areas within and surrounding the urban areas of Albany, Tangent, Lebanon, and Brownsville. There will also be increased development pressure in the outlying rural areas surrounding these communities and the rural centers around Crawfordsville and Holley.

The growth of the urban and rural population will offer challenges and opportunities for maintaining and restoring water quality and fish and wildlife habitat within the Calapooia River Watershed. Continued urban and rural development, if poorly planned, can affect flood plains, riparian areas and water quality. The Council may wish to work with Linn County and the cities to assure that future development is done in a way that minimizes impacts on the watershed. It will be important for the Council to engage residents living in these areas, while continuing to work with the agricultural and forest industries that dominate the watershed's land uses.

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Chapter 4. Vegetation, Wetlands, and Other River Features

Introduction

This chapter includes an evaluation of vegetation and other natural and human features along the Calapooia River and three primary tributaries. In addition, this chapter includes a summary of wetlands and hydric soils throughout the watershed. A hydric soil is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic (without air) conditions in the upper soil layers. The purpose of this evaluation is to characterize natural and human features along the Calapooia River and tributaries in order to understand their influence on fish and wildlife habitat and water quality, both today and historically. Another purpose of this evaluation is to highlight opportunities to improve conditions near the river and tributaries that would benefit fish and wildlife habitat and water quality.

The three selected tributaries are Oak Creek near Albany; Courtney Creek, a tributary that parallels the Calapooia River near Brownsville; and Brush Creek, a tributary upstream of Brownsville that enters from the south. These three tributaries were selected by the Calapooia Watershed Council for evaluation because of their larger size and because of the Council's interest in the development along these streams. Lower Oak Creek is increasingly influenced by urban development as Albany's growth expands towards the stream. Courtney Creek is bordered by grass seed fields and is subject to a number of water diversions. A high density of rural development influences Brush Creek.

Methods

Aerial photographs were used to characterize current conditions within the study area. Black and white aerial ortho-photographs (digital), flown in April 2000, provided a base map for the analysis. The photos were of exceptional quality, and because the photos were taken before hardwood vegetation had developed leaves, water features were easy to distinguish. The flow of rivers and streams appeared normal for this time of year. Grass seed fields could be easily distinguished from other areas growing grass at this time of year because fertilizer applications had recently occurred on the grass seed fields and the machines left patterns within the fields. The black and white photographs were supplemented with color aerial photographs (hard copy) flown in June, 2000. The color photographs provided detail that allowed enhanced resolution of features on the ground.

Vegetation types and other features were delineated for each side of the main channel of the Calapooia River, Sodom Ditch, and the three tributaries using a Geographic Information System (GIS). The Sodom Ditch near Thompson's Mill was considered to be the main channel of the river since the former main channel is now mostly dewatered during the summer. Calapooia River features were mapped from the Willamette River upstream 52.7 river miles to a point where commercial forest land dominates the streamside area. This mapping resulted in 10 river reaches that characterized riparian habitat. The river reaches are described in Chapter 1 and Map 2, *Shaded Relief*. Weyerhaeuser Company has already conducted a watershed analysis upstream of reach 10 on the Calapooia River (Weyerhaeuser 1998). The width of mapping was at least 500 feet from the edge of the Calapooia River main channel but was expanded where the historic extent of trees mapped in the 1850s was more than 500 feet. The historic extent of trees was determined using General Land Office survey notes and maps from the 1850s compiled by the Natural Heritage Program (http://www.fsl.orst.edu/pnwerc/wrb/metadata/verg1851_v4.html). Coverage for the historic extent of vegetation was available only for the portion of river downstream of McKercher Park.

Features along Sodom Ditch were mapped to a lateral distance of 500 feet from the edge of the ditch. Features along Oak Creek were also mapped to a lateral distance of 500 feet from the stream edge from its confluence with the Calapooia River to Interstate Highway 5. Upstream of the highway, mapping extended 100 feet from the stream edge. Features along Brush Creek and Courtney Creek were also mapped 100 feet each side of the streams.

Vegetation types and other features mapped in this analysis included water features, vegetation, crops, and human infrastructure (Table 4-1). Areas with trees were characterized according to hardwood/conifer dominance, age class, and canopy closure. If more than 50% of the crown canopy of a stand was conifer it was considered a conifer stand. Otherwise, it was a hardwood stand. Trees that appeared to be less than 25 years old were considered "younger" and trees 25 years or older were considered "older". Stands of trees were segregated into three canopy closure classes; 0-33%, 34-66%, and 67-100%.

Geometric characteristics of river and stream channels in the study area were measured from the ortho-photo base map and United States Geological Survey (USGS) contour maps. Characteristics included channel gradient and channel sinuosity. Lengths and areas of channel and vegetation features were calculated using the GIS.

Wetlands throughout most of the basin were evaluated through the use of the National Wetland Inventory maps. No information was available for the upper basin that is mostly forest land. Relatively few wetlands would be expected in this steeper terrain. Hydric soils were mapped using the Linn County soil surveys.

Table 4-1. Mapped features along the Calapooia River and selected tributaries.

Water features	
CM	Calapooia main channel
ST	Tributary stream of the Calapooia River
PN	Pond, natural
PA	Pond, artificial
SC	Side channel
AL	Alcove
PC	Mill race for Thompson's Mill
DIV	Brownsville canal
GB	Gravel bar
Vegetation	
YH3	Younger hardwoods (< 25 years), 67-100% crown closure
YH2	Younger hardwoods (< 25 years), 34-66% crown closure
YH1	Younger hardwoods (< 25 years), 0-33% crown closure
OH3	Older hardwoods (> 25 years), 67-100% crown closure
OH2	Older hardwoods (> 25 years), 34-66% crown closure
OH1	Older hardwoods (> 25 years), 0-33% crown closure
YC3	Younger conifers (< 25 years), 67-100% crown closure
YC2	Younger conifers (< 25 years), 34-66% crown closure
YC1	Younger conifers (< 25 years), 0-33% crown closure
OC3	Older conifers (> 25 years), 67-100% crown closure
OC2	Older conifers (> 25 years), 34-66% crown closure
OC1	Older conifers (> 25 years), 0-33% crown closure
CC	Recent clearcut (< 10 years)
BR	Brush
GR	Grass (not grass seed field)
Crops	
GRS	Grass seed field
CF	Other cultivated field (e.g. corn, wheat)
NU	Nursery operation
OR	Orchard (e.g. filbert)
CT	Christmas trees
Infrastructure	
CD	City, developed (commercial and residential)
RD	Rural, developed (mostly homes and stores)
FC	Farm complexes (house, barns, outbuildings, stored machinery and vehicles)
RO	Major road
B	Bridge
RR	Railroad tracks
GO	Gravel operation
OT	Other (cemetery, settling ponds, etc.)

Results

Channel characteristics

The Calapooia River downstream of where forest land begins (RM 52.7) has a low channel gradient compared to other medium-sized rivers in the Pacific Northwest (Figure 4-1). Channel gradient is the slope (elevation change divided by horizontal distance) of the river surface, usually expressed as a percent. The channel gradient of the Calapooia River downstream of Thompson's Mill is only 0.06%. For comparison, the gradient of the lower McKenzie River is 0.20%. As is true for most rivers, the gradient of the Calapooia River generally increases in an upstream direction, but is still only 0.44% at the beginning of the forest land. Within the forest land segment of the Calapooia River, channel gradient increases steadily and is 1.94% between the North Fork Calapooia River confluence and the Forest Service boundary.

Figure 4-1. Elevation profile of the Calapooia River main channel from the Willamette River to the Forest Service Boundary. Channel gradient in percent is shown for each river segment.

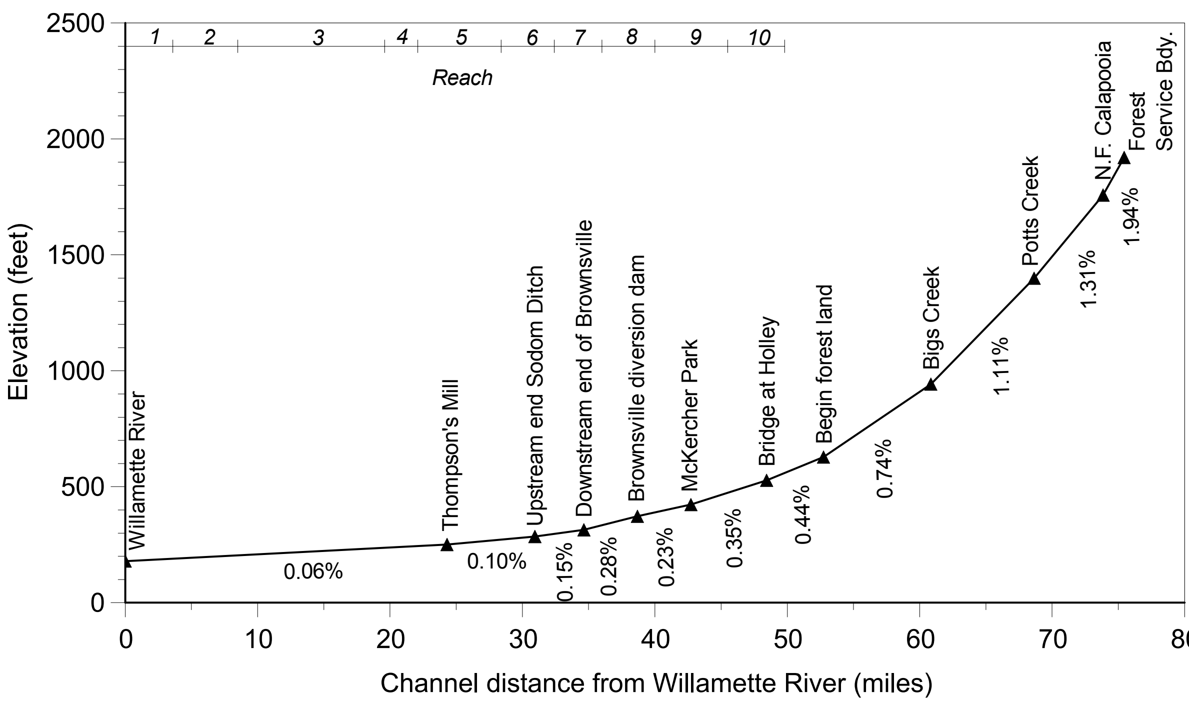
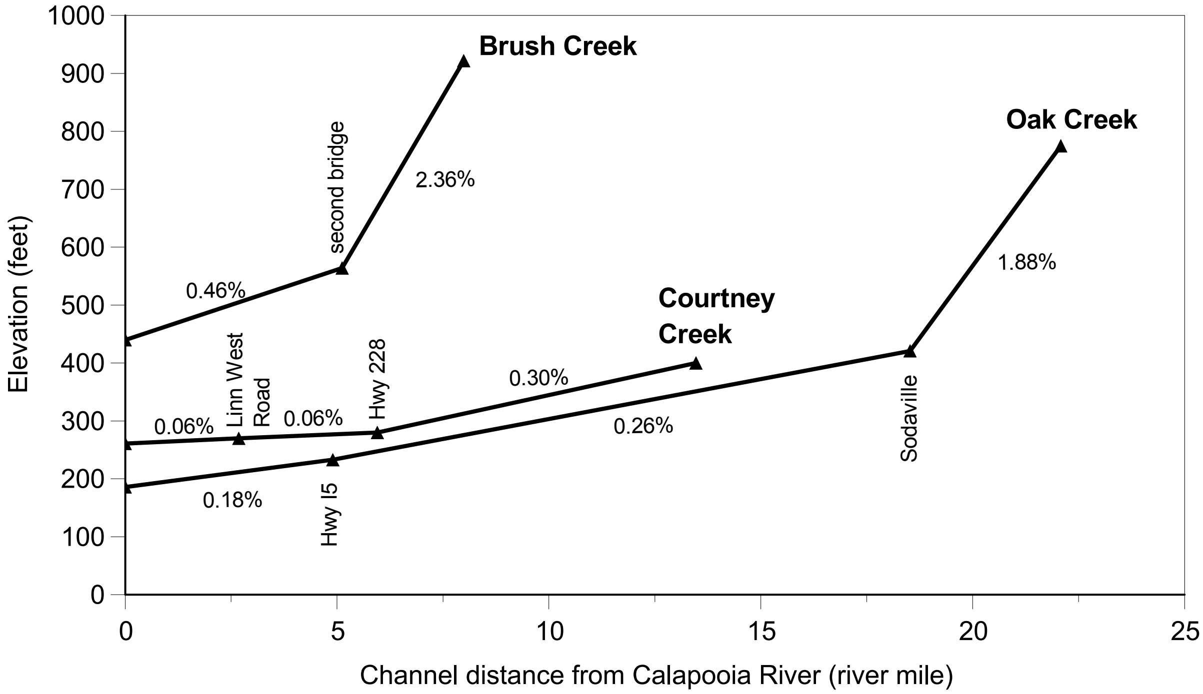


Figure 4-2. Elevation profile of Brush Creek, Courtney Creek, and Oak Creek from the Willamette River to the end of mapping. Channel gradient in percent is shown for each stream segment.



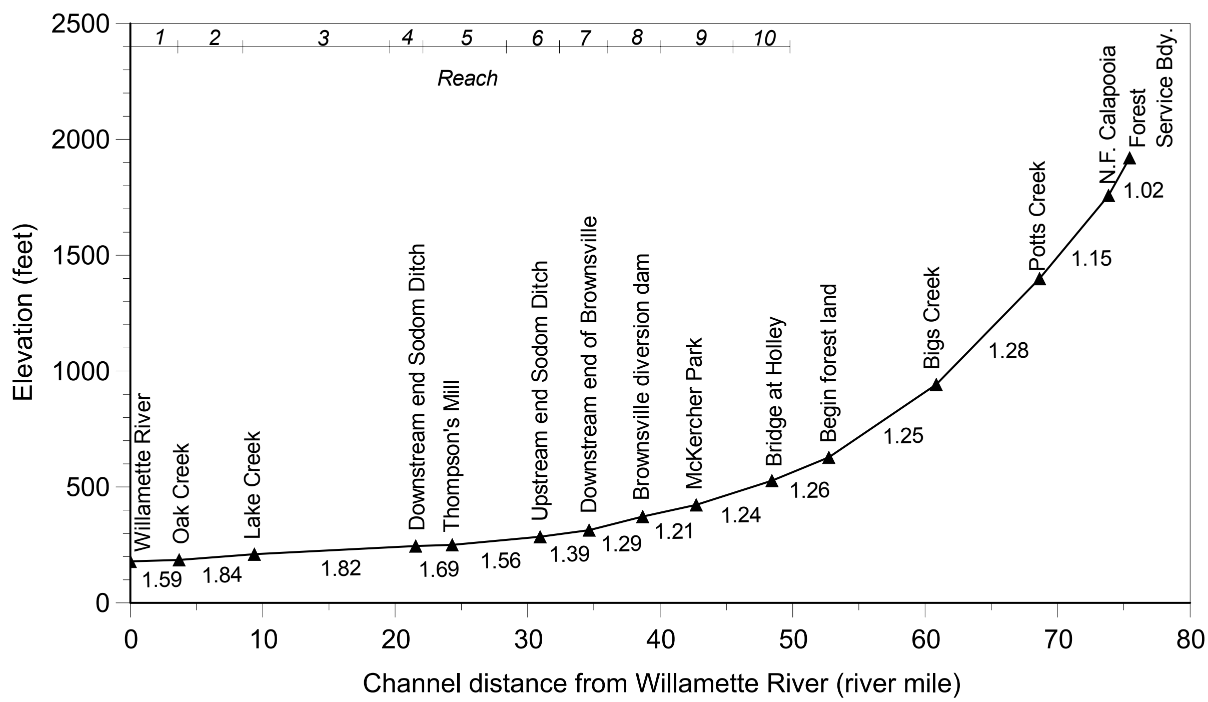
Both Courtney Creek and Oak Creek are low gradient (0.06 to 0.30 %) throughout most of their length, except for Oak Creek upstream of Sodaville where it steepens to 1.9% in its uppermost reach (Figure 4-2). Brush Creek begins at a moderately low gradient in its lower reach and steepens to 2.4% in its upper reach, where foothill slopes bound it.

Channel sinuosity in the Calapooia River, as with most rivers, decreases in an upstream direction as the channel gradient steepens (Figure 4-3). Channel sinuosity is the channel length of a reach divided by the straight line length of the valley and is a measure of how much a river meanders within its flood plain. Sinuosity is very high downstream of the Sodom Ditch diversion, ranging from 1.6 to 1.8. Even as far upstream as the Potts Creek confluence, the Calapooia River has a moderately high sinuosity of 1.2 to 1.4. Riprap has been placed along certain segments of the river to limit meandering of the river for the purpose of protecting fields and other infrastructure. However, riprap cannot be identified in aerial photographs and no field inventory of riprapped banks has been done. Consequently, the effects of riprapping on channel sinuosity have not been evaluated.

All three of the tributaries have very high channel sinuosity in their lowest reaches (Figure 4-4), ranging from 1.31 for Courtney Creek to 1.45 for Brush Creek. Channel sinuosity has been greatly reduced in upper reaches in Courtney Creek where the stream has been converted to a ditch as it flows through grass seed fields. The same is true for the middle reach of Oak Creek.

All other factors being equal, channels with high sinuosity often contain more features that are favorable for fish and wildlife than do channels with low sinuosity. A highly sinuous river creates a larger number of ponds, islands, alcoves, side channels, and gravel bars. These features provide special habitat niches for certain species during various life stages. For example, western pond turtles in the Willamette Valley are nearly always found in ponds and alcoves and not elsewhere along the river. Also, juvenile spring chinook salmon and winter steelhead use these type of features during non-summer months.

Figure 4-3. Elevation profile of the Calapooia River main channel from the Willamette River to the Forest Service land boundary. Channel sinuosity is shown for each river segment.



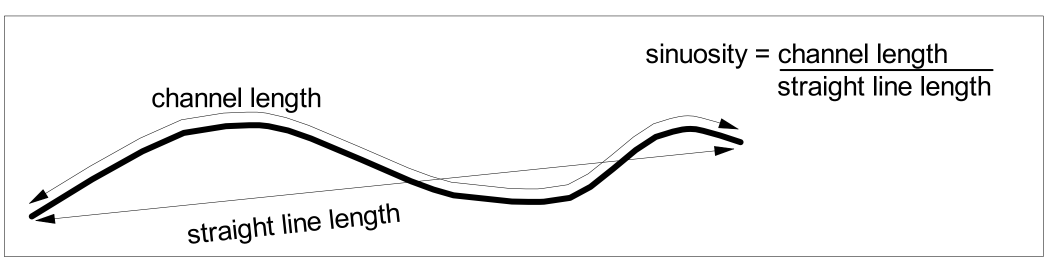
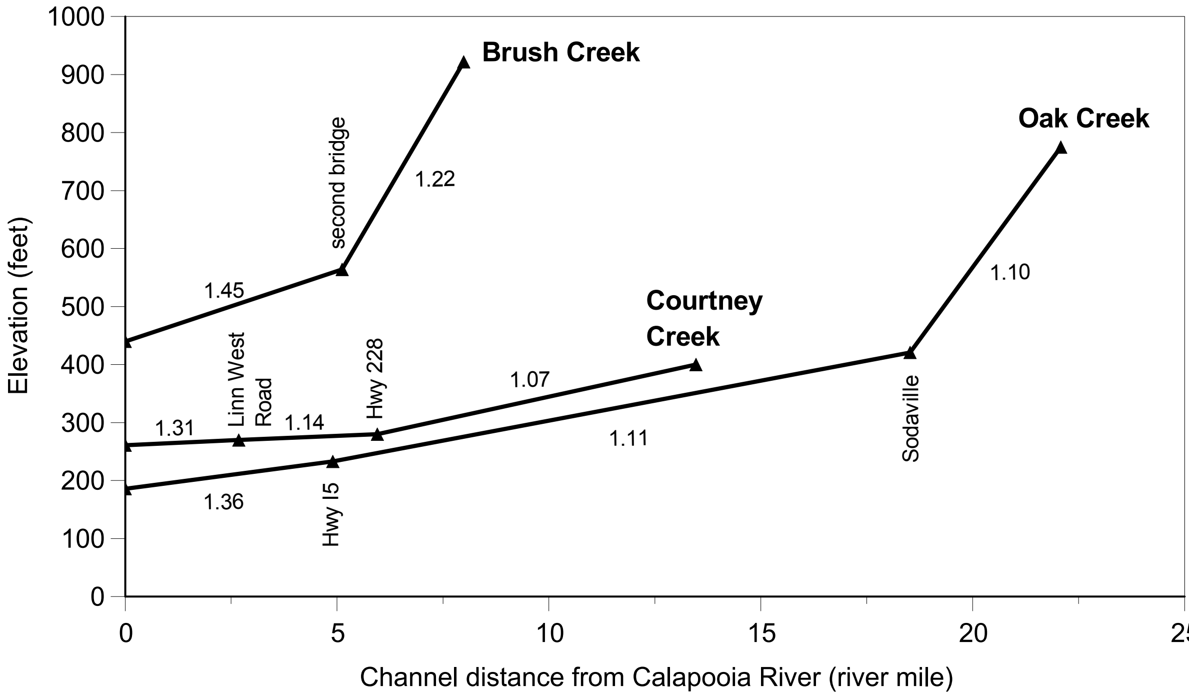


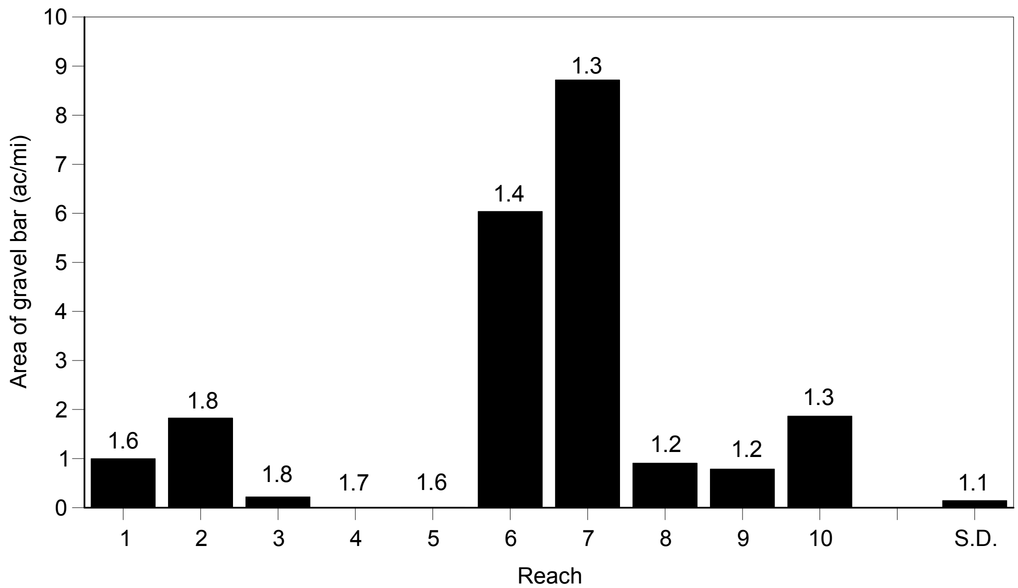
Figure 4-4. Elevation profile of Brush Creek, Courtney Creek, and Oak Creek from the Calapooia River to the end of mapping. Channel sinuosity is shown for each stream segment.



The combination of channel gradient and channel sinuosity reflects where gravel deposition occurs along the Calapooia River. The greatest amount of gravel deposition occurs in reaches 6 and 7 (Figure 4-5). These reaches extend from the Sodom Ditch diversion to the Brownsville Dam. In these reaches, channel sinuosity increases and channel gradient decreases, thereby slowing the water velocity and causing much of the gravel load to settle out rather than move further downstream. Gravel bars were not observed along the three mapped tributaries in this study using aerial photographs, although gravel bars may be present if evaluated in the field.

Areas with gravel bars benefit fish because the aggregate provides favorable habitat for aquatic insects and often creates areas of sorted gravels that are the right size for spawning. Zones of cooler water are often found immediately downstream of gravel bars. As a portion of the river flows subsurface through a gravel bar, the water loses heat to the gravel and exits at the downstream end at a cooler temperature. When the river becomes too warm, fish will often retreat to these cool zones for refuge.

Figure 4-5. Area of exposed gravel bar (acres per mile of main channel) with channel sinuosity shown above each bar for the various reaches.

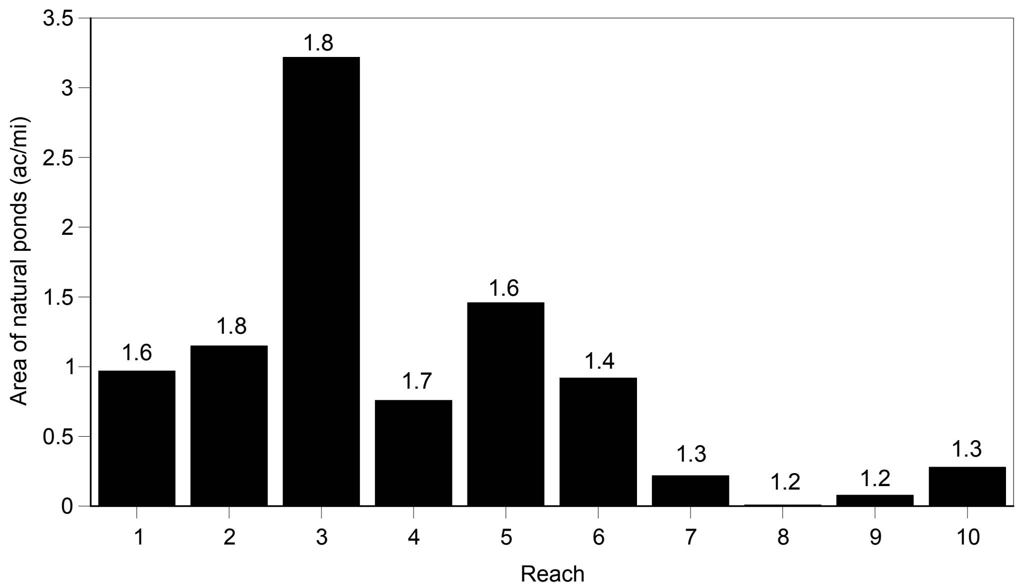


Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Numerous natural ponds border certain reaches of the Calapooia River. These are a result of previous channel meandering. The ponds are usually segments of the old main channel that were abandoned once a new channel formed and are often called oxbows. Reaches with higher numbers of these ponds coincide with high sinuosity (Figure 4-6). The density of natural ponds (pond area per mile of channel) is greatest downstream of Brownsville and is especially high within reach 3. Because the ponds occur in low-lying areas that are too wet to farm, most of these ponds are still surrounded by mature, natural vegetation.

Many of the natural ponds are connected to the main channel during high flows and then become isolated from the river during lower flows. Fish that retreat into the ponds during high water can become trapped within the ponds for the remainder of the year. The survival of native fish can be threatened if water temperatures become too warm during the summer and if largemouth bass inhabit the pond. Largemouth bass are an introduced species that thrive in warm water. This is a particular concern for the native, young spring chinook salmon, which commonly seek out slow, backwater areas during high flows.

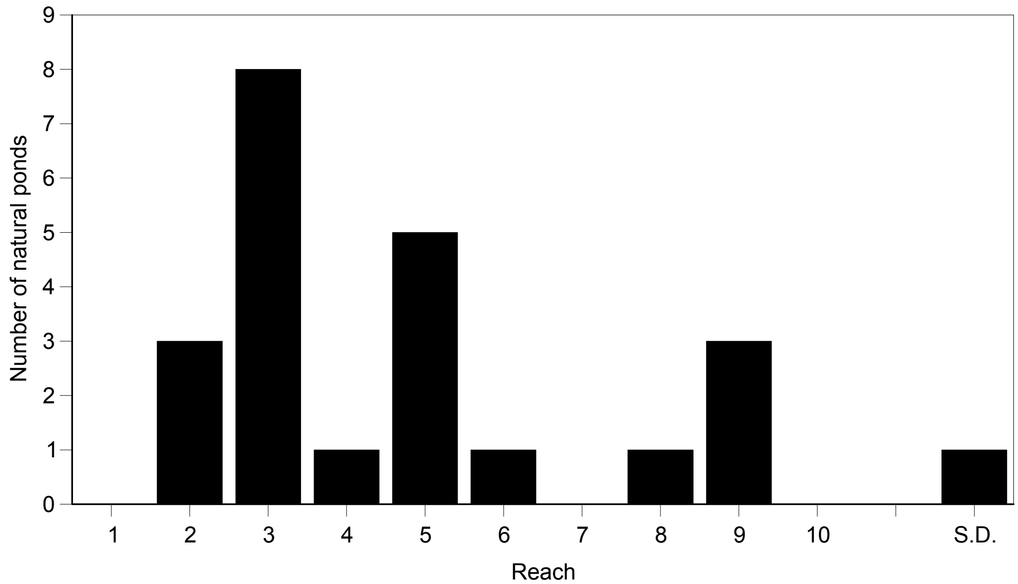
Figure 4-6. Area of natural ponds (acres per mile of channel) within the historic riparian tree boundary. Channel sinuosity is also shown for each reach.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land

A potential type of restoration project to benefit fish is to re-connect ponds to the main channel and allow fish to move out of the ponds during both high and low flows. Out of the 102 mapped natural ponds, 23 are within 100 feet of the main channel (Figure 4-7). These are the ponds where it would be most economical to re-connect a channel. The highest numbers of such ponds are in reaches 3 and 5. This type of project requires various state and federal permits.

Figure 4-7. Number of natural ponds per reach that are less than 100 feet from the main channel. These are the ponds that might be good candidates for channel re-connection projects.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

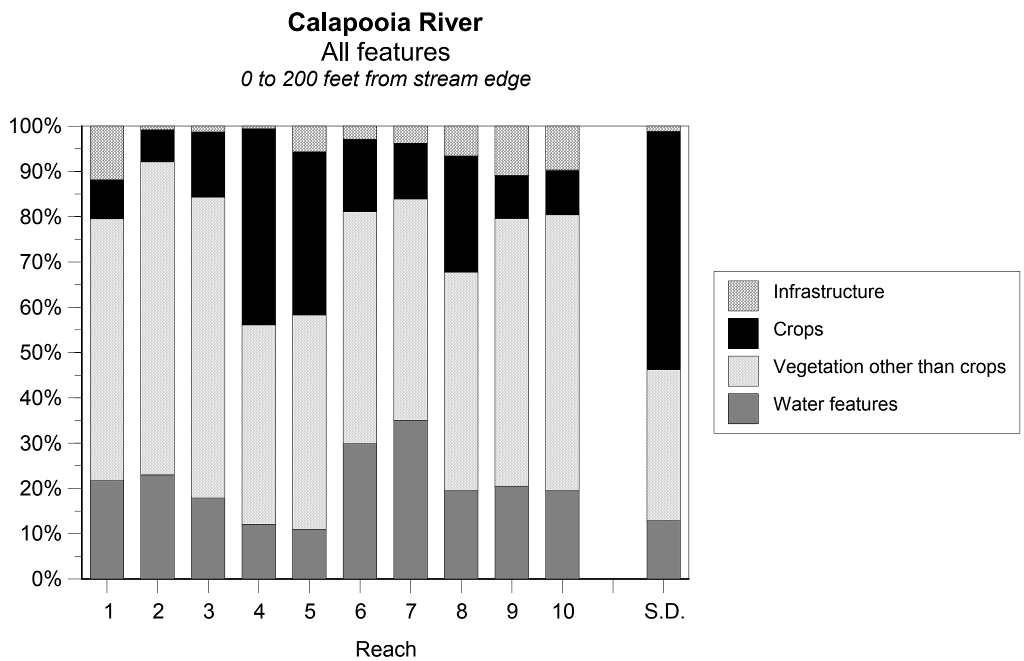
Land type and use characteristics

An analysis of the data indicates that natural vegetation is the most dominant feature within 200 feet of the main channel of the Calapooia River (Figure 4-8; Map 9, *Riparian Vegetation and Land Use along Calapooia River*). Crops (mostly grass seed fields) occupy a sizable component of the streamside area in reaches 4, 5, and 8 of the Calapooia River and along Sodom Ditch. Human infrastructure is highest in reach 1 near Albany and in reaches 9 and 10 of the upper study area.

When analyzed for all land within 500 feet of the main channel, crops make up an even higher percentage of the total (Figure 4-9). The dominance of natural vegetation decreases correspondingly since some segments of the river are bordered by only a narrow band of natural vegetation (Map 10, *Segments with Narrow Bands of Trees*).

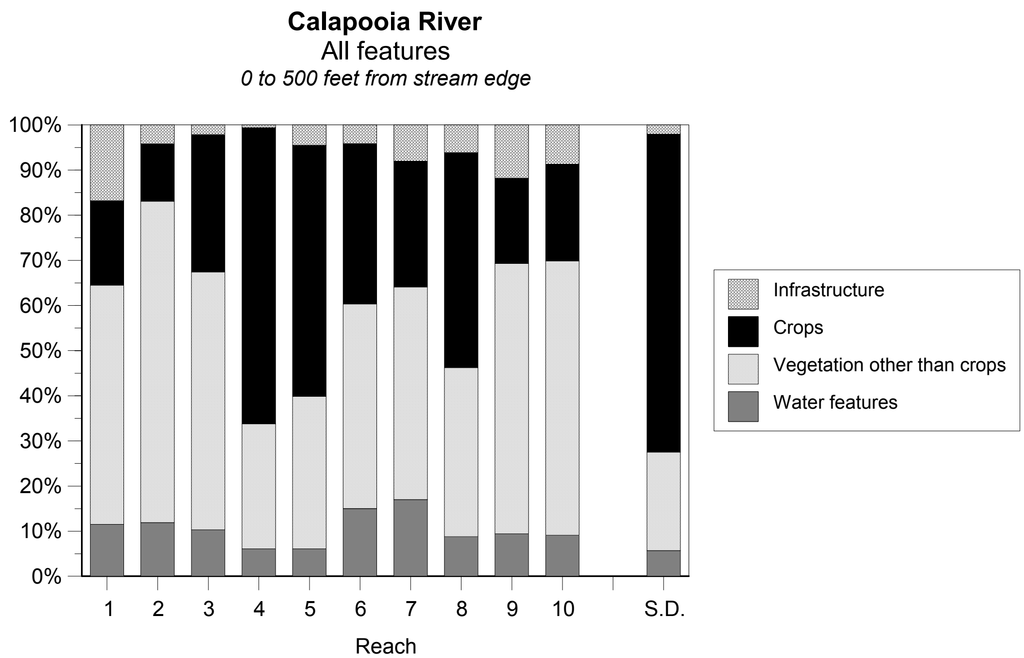
Features along the three tributaries evaluated in this study (Oak Creek, Courtney Creek, and Brush Creek) were mapped to a distance of 100 feet each side of the channel (Maps 11-13, *Riparian Vegetation and Land Use along Oak, Courtney, and Brush Creeks*). All but the upper reach of Courtney Creek (C3) is dominated by natural vegetation (Figure 4-10). The upper reach of Courtney Creek is dominated by grass seed fields. Grass seed fields also make up a sizable component of the features along lower Brush Creek, middle Oak Creek and middle Courtney Creek. Human infrastructure is only a minor component of the corridor along these streams.

Figure 4-8. Coarse-scale analysis of features within 200 feet of the Calapooia River main channel characterized as the percent of total acres.



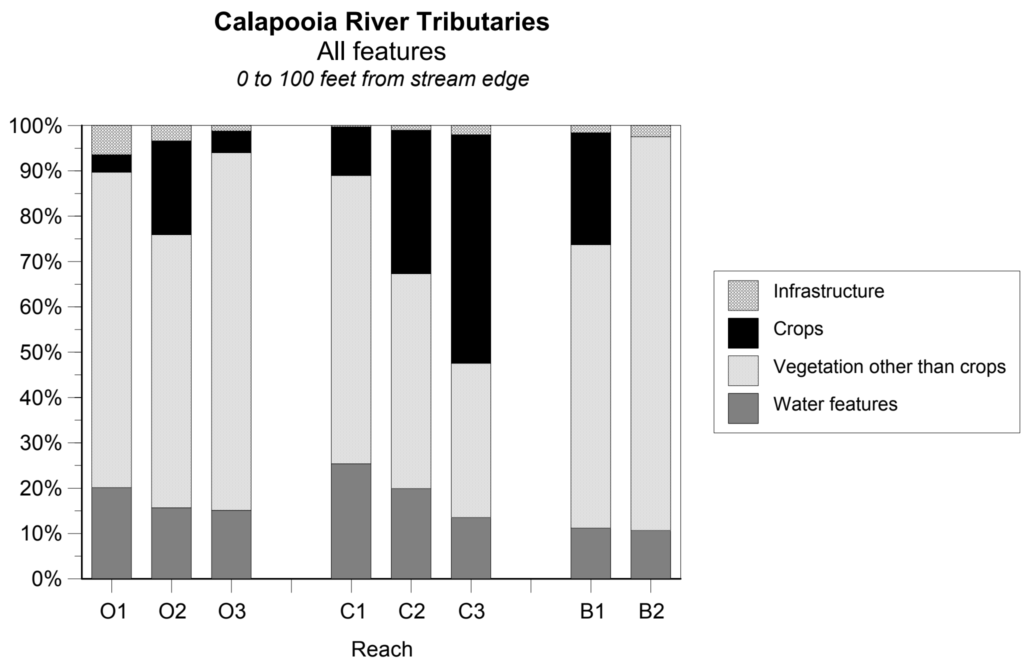
Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-9. Coarse-scale analysis of features within 500 feet of the Calapooia River main channel characterized as the percent of total acres.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-10. Coarse-scale analysis of features within 100 feet of three tributaries characterized as the percent of total acres.



Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

Water features

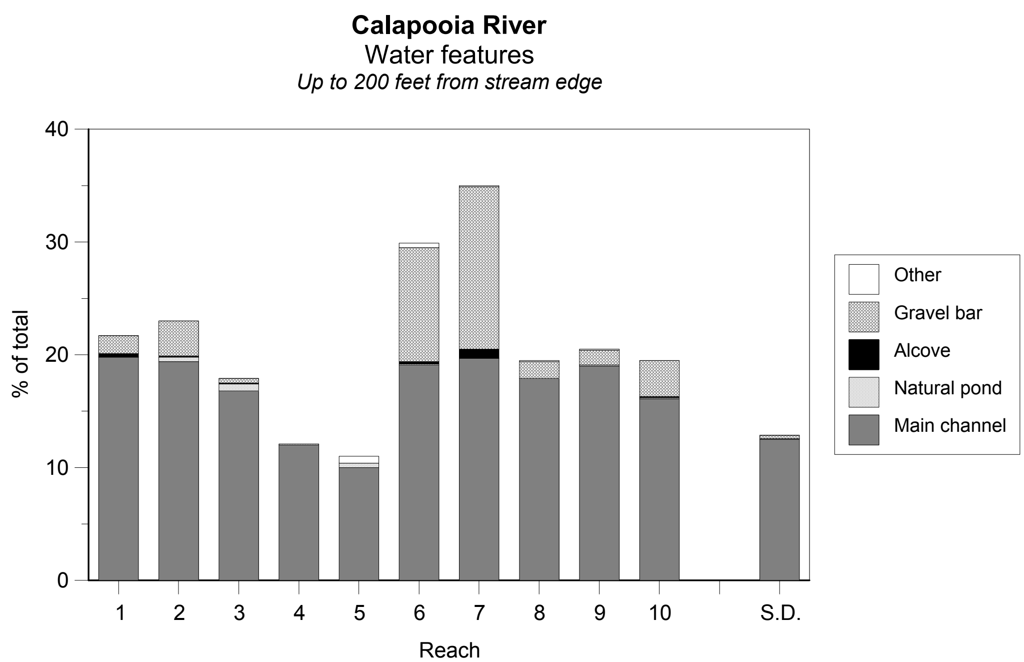
A breakdown of individual types of water features indicates that most of the area within the Calapooia River and up to 200 feet from the river edge consists of the main channel itself (Figure 4-11). The area of gravel bar adjacent to the shore (exposed during the summer) is a sizable component for reaches 6 and 7 but not elsewhere. Natural ponds, though numerous in some reaches, are usually narrow and therefore do not comprise much area. Alcoves, which are like side channels but without an upstream connection to the main channel during low flows, are only a minor component of the water feature area. Other features, such as side channels, tributary streams, and artificial ponds are a very minor component.

Results for the Calapooia River are similar when the width is increased to 500 feet of the main channel since most water features are near the main channel. The exception is the area in natural ponds, a feature that often occurs at greater distances from the main channel.

Unlike the Calapooia River main channel, the tributaries have few natural ponds. The channel encompasses nearly all of the area in regards to water features (Figure 4-12). Natural ponds may have once been more common but were obliterated when segments of these streams were channelized in order to make farming more efficient.

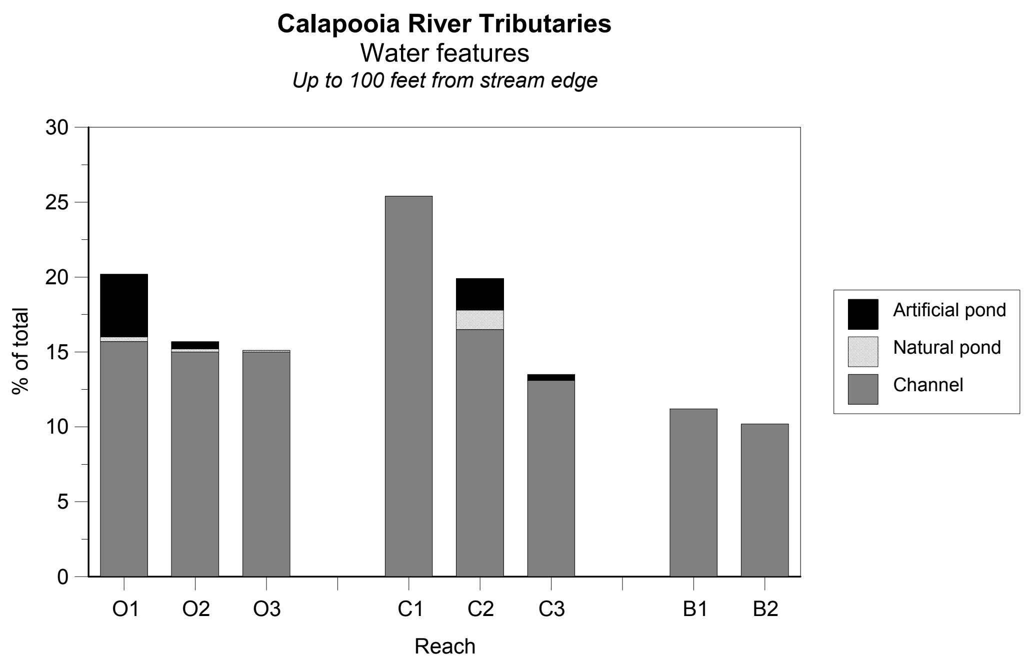
Alcoves, side channels, and natural ponds have a small overall area because they are usually narrow. Their influence on river the ecosystem is greater than what their area would suggest. Being narrow and long, these features have a sizable amount of edge habitat. The productivity of algae, aquatic plants, insects, and other animals is usually highest along the edges of a water body where the water is shallow enough for sunlight to reach the bottom surface of the water body.

Figure 4-11. Fine-scale analysis of water features within the Calapooia River and up to 200 feet from the river's edge as a percent of overall total acreage.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-12. Fine-scale analysis of water features within 100 feet of tributary streams as a percent of overall total acreage.



Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

Vegetation

Hardwoods are the primary natural vegetation growing within 200 feet of the Calapooia River main channel (Figure 4-13). An overwhelming majority of these older hardwood stands have a dense (67 to 100%) tree canopy. Typically, these hardwood stands consist of Oregon ash, black cottonwood, bigleaf maple, and red alder. These trees usually occur in combination so no attempt was made to segregate older hardwood stands by species. Younger hardwood stands are relatively scarce and occur mostly in reaches 6 and 7. These reaches also have a high percentage of area in gravel bars. Younger hardwoods, usually found sandwiched between a gravel bar and the older hardwood stands, are probably a result of tree establishment in areas cleared of vegetation during a major flood.

Older conifer-dominated stands are found mostly along reaches 9 and 10 where the valley floor is narrower. Typically, conifer stands along the Calapooia River grow on sloping ground on the outside bends of the river. Most conifers are Douglas-fir. Clearcuts of recently-harvested Douglas-fir trees (less than 10 years old) did not occur within 200 feet of the stream for the study area. There are few areas with conifers between the age of 10 and 25 years. Grass and brush make up a sizable component of the area within 200 feet of the stream for some reaches, especially reaches 9 and 10.

Grass areas are typically grazed, although some fields may also be used for hay production. Brush areas are usually occupied by a mixture of introduced Himalayan blackberry and Scotch broom, along with native species such as willow and dogwood.

When vegetation is characterized for a distance up to 500 feet from the river, grass becomes a more dominant vegetation type (Figure 4-14). Otherwise, the composition is similar to what grows for a distance up to 200 feet from the river.

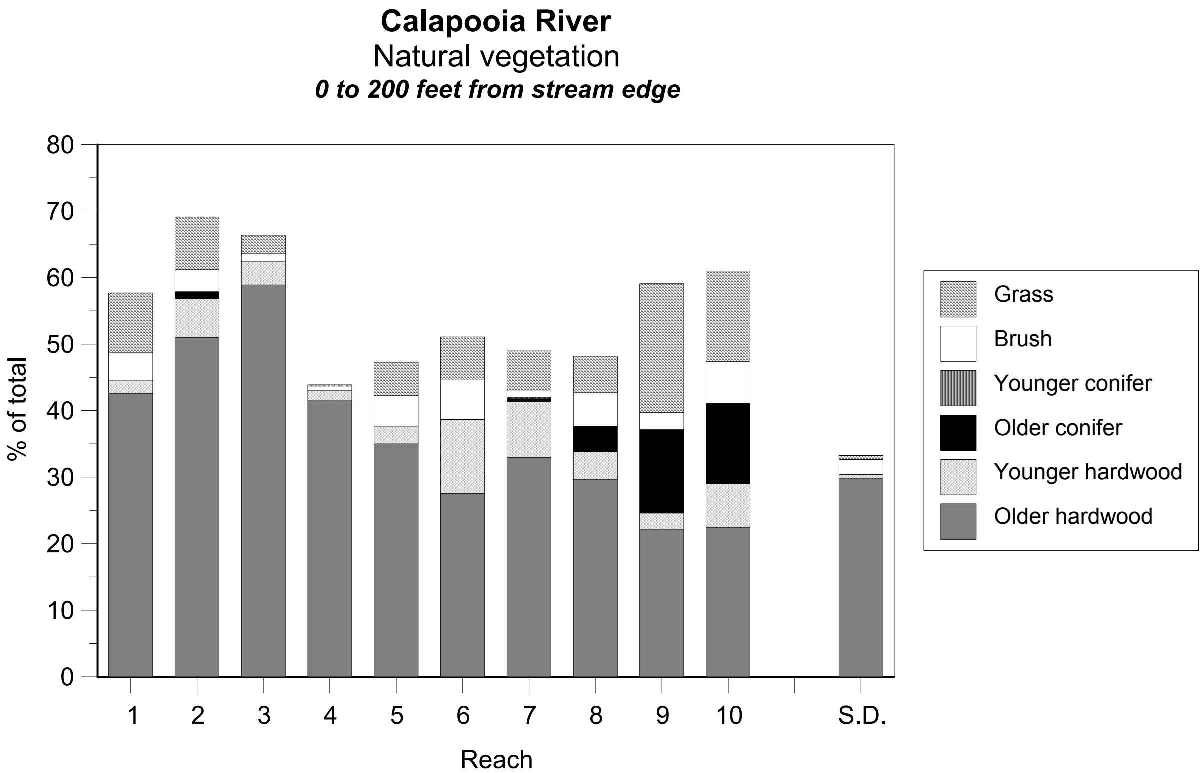
Tributary reaches that flow through areas with intensive grass seed cultivation have few older trees (Figure 4-15). Instead, younger hardwoods, brush, and grass dominate streamside areas. Older hardwoods are extensive along the lower reaches of Oak Creek and Courtney Creek and usually continue well beyond the 100-foot-wide swath that was mapped for each stream.

Because the main channel of the Calapooia River is so wide (75 to 100 feet in most reaches) even the tallest trees along the river provide little shade during the summer. The June 2000, aerial photographs indicate that only in reaches 4 and 5 do streamside trees provide much shade to the river. In these two reaches, the flow is split between Sodom Ditch and the river, and so, the river channel narrows to about 25 feet. Upstream of the study area on forest land, low amounts of shading (less than 40%) on the main channel persist up to the North Fork Calapooia River confluence (Weyerhaeuser 1998). Upstream of this confluence the river is narrow, and shading levels alternate between moderate (40-70%) and high (>70%).

The large width of the Calapooia River, compared to the small size of trees now growing along the river, limits the amount of wood that accumulates in the channel. Few log jams could be seen in the aerial photographs. Most logs that were observed had been rafted to the outer boundaries of the flood plain and now have minimal interaction with the river during normal flows. Elsewhere in the Willamette Valley, logs (other than cottonwood) along rivers, are commonly cut up for firewood. This practice of removing logs for firewood, probably also occurs along the Calapooia River. The removal of large wood from the river also occurs because of the fear that it will lodge against bridge piers. Large wood is important for fish in streams and rivers because it creates pools, hiding areas, bars of gravel that are sorted by size, and is a substrate for aquatic insects.

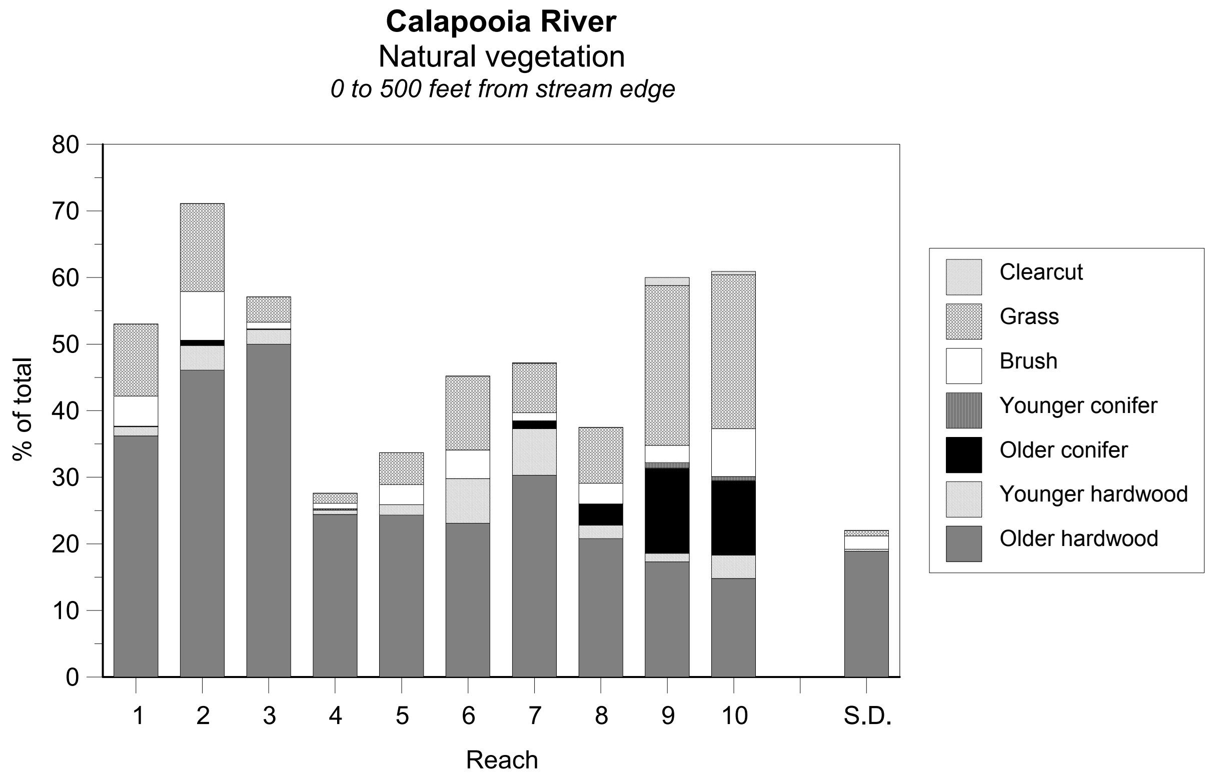
An evaluation of riparian conditions along the main channel and other fish-bearing tributaries upstream of the study area (55 miles total) by Weyerhaeuser Company (Weyerhaeuser 1998), indicates that a majority of riparian zones (64%) are bordered by vegetation that has low near-term potential for providing large wood to the channel (Table 4-2). Only 14% of channels were bordered by stands that had a high potential for providing large wood in the near-term.

Figure 4-13. Fine-scale analysis of vegetation types (excluding crops) within 200 feet of the Calapooia River main channel as a percent of overall total acreage.



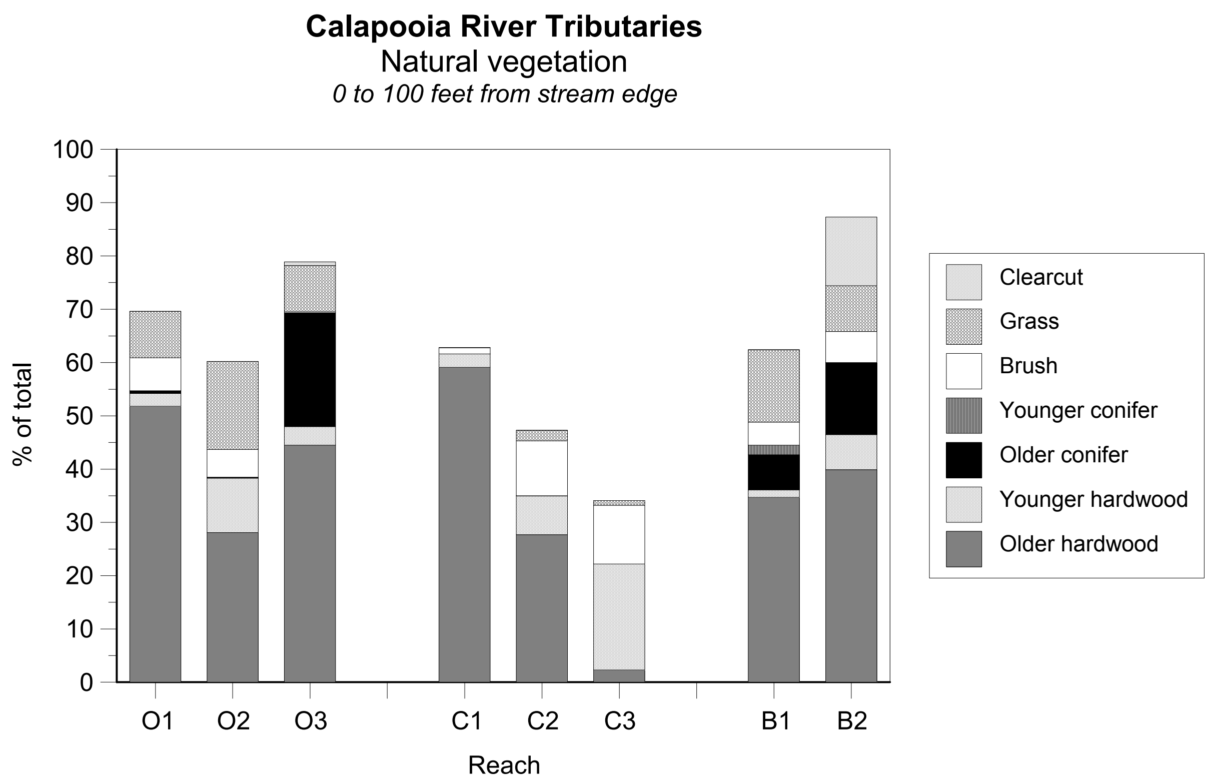
Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-14. Fine-scale analysis of vegetation types (excluding crops) within 500 feet of the Calapooia River main channel as a percent of overall total acreage.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-15. Fine-scale analysis of vegetation types (excluding crops) within 100 feet of three tributaries as a percent of overall total acreage.



Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

Table 4-2. Summary of riparian conditions on forest land upstream of the study area (Weyerhaeuser 1998). Small trees are less than 12" DBH and medium-size trees are 12 to 20" DBH. Dense stands have more than 66% crown cover and sparse stands have less than 66% crown cover. DBH means diameter at breast height.

Near-term large wood recruitment potential	Riparian stand condition	Miles of riparian condition	Percent of total
Low	Small hardwood, sparse	7.4	6.7
	Small hardwood, dense	7.9	7.2
	Small hardwood/conifer, sparse	0.7	0.6
	Small hardwood/conifer, dense	23.6	21.4
	Small conifer, sparse	2.8	2.5
	Small conifer, dense	25.5	23.2
	Medium hardwood, sparse	3.1	2.8
	Subtotal	*71.0*	*64.4*
Moderate	Medium hardwood, dense	0.9	0.8
	Medium hardwood/conifer, sparse	3.5	3.2
	Medium conifer, sparse	19.9	18.1
	Subtotal	*24.3*	*22.1*
High	Medium conifer, dense	5.9	5.3
	Medium hardwood/conifer, dense	9.3	8.4
	Subtotal	*15.2*	*13.7*
Total (both sides of stream)		110.3	100.0

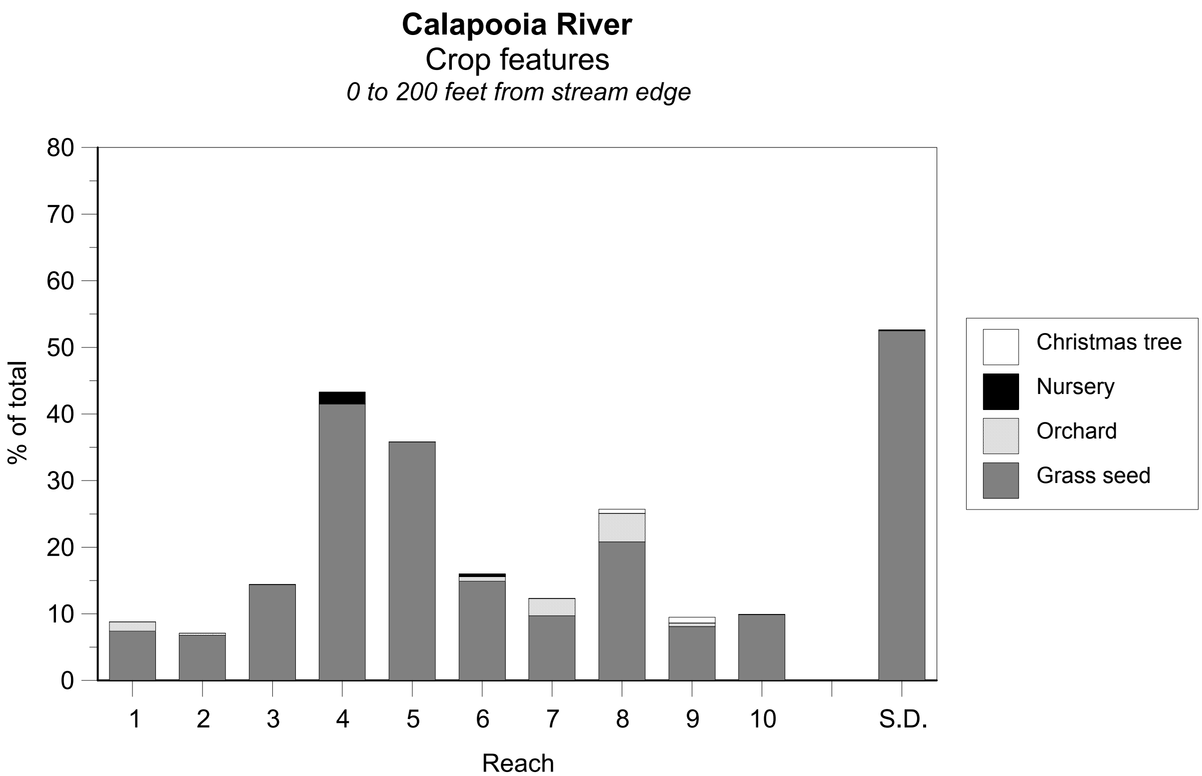
Crops

Crops that grow within 200 feet of the main channel of the Calapooia River are mainly grass seed (Figure 4-16). Grass seed fields are most dominant along reaches 4 and 5 of the Calapooia River and along Sodom Ditch. Some orchards (usually filberts) occur, mainly along reaches 7 and 8. Only small areas with Christmas trees and plant nurseries occur this close to the main channel.

Within 500 feet of the main channel, minor crops such as orchards, nurseries, and Christmas tree farms, make up a slightly greater percentage of the total area (Figure 4-17). Nevertheless, grass seed fields are still the overwhelming crop next to the river.

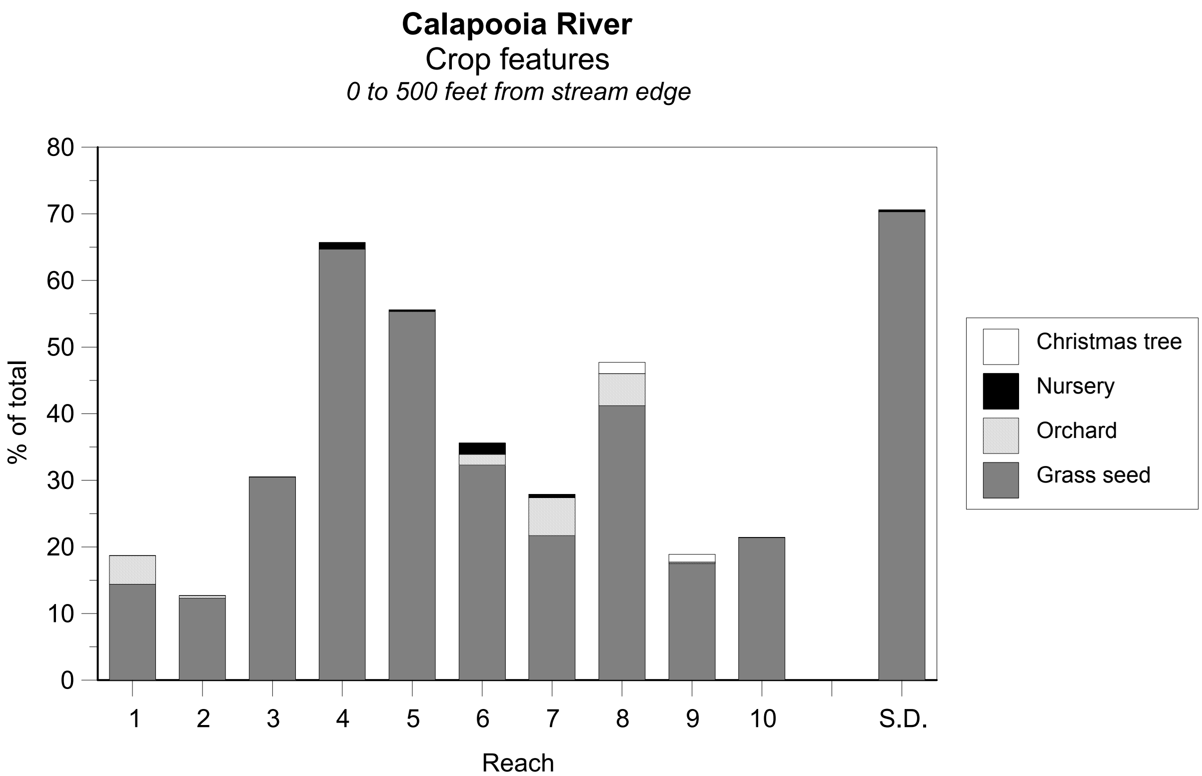
All crops within 100 feet of the three tributaries are grass seed field, except for a segment of orchards along the lower reach of Courtney Creek (Figure 4-18).

Figure 4-16. Fine-scale analysis of crop types within 200 feet of the Calapooia River main channel as a percent of overall total acreage.



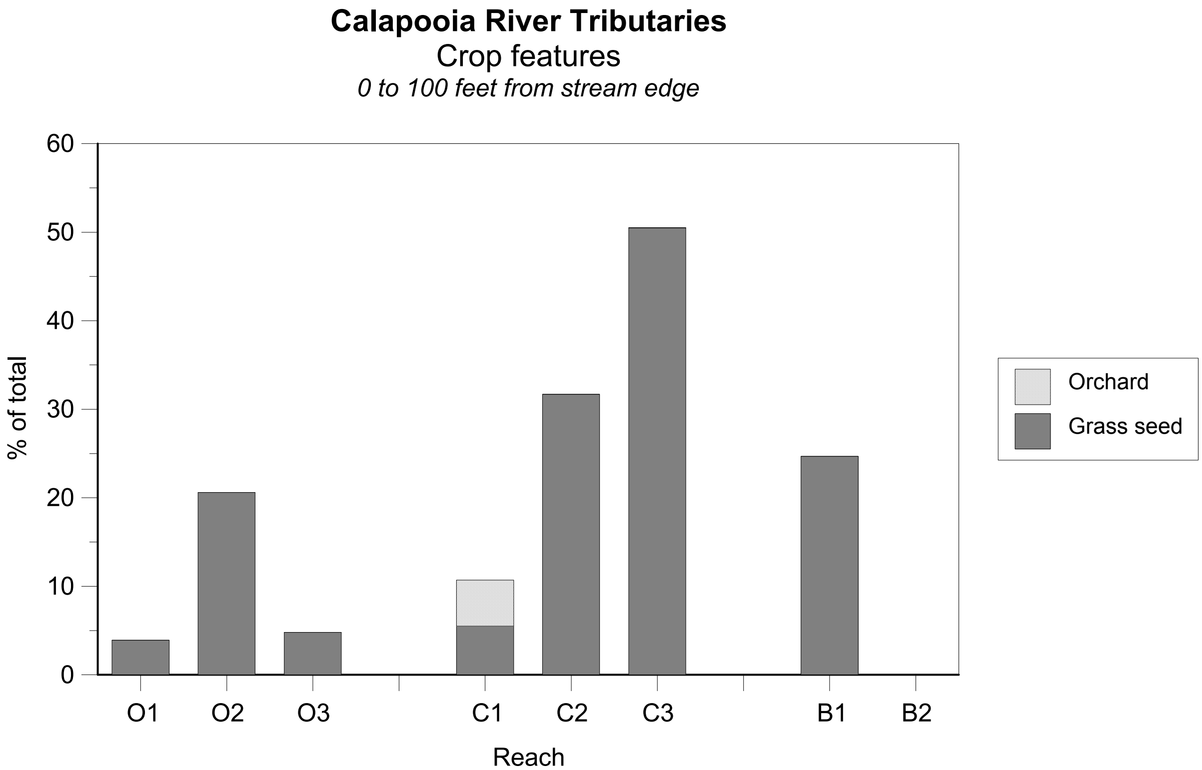
Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-17. Fine-scale analysis of crop types within 500 feet of the Calapooia River main channel as a percent of overall total acreage.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-18. Fine-scale analysis of crop types within 100 feet of three tributaries as a percent of overall total acreage.

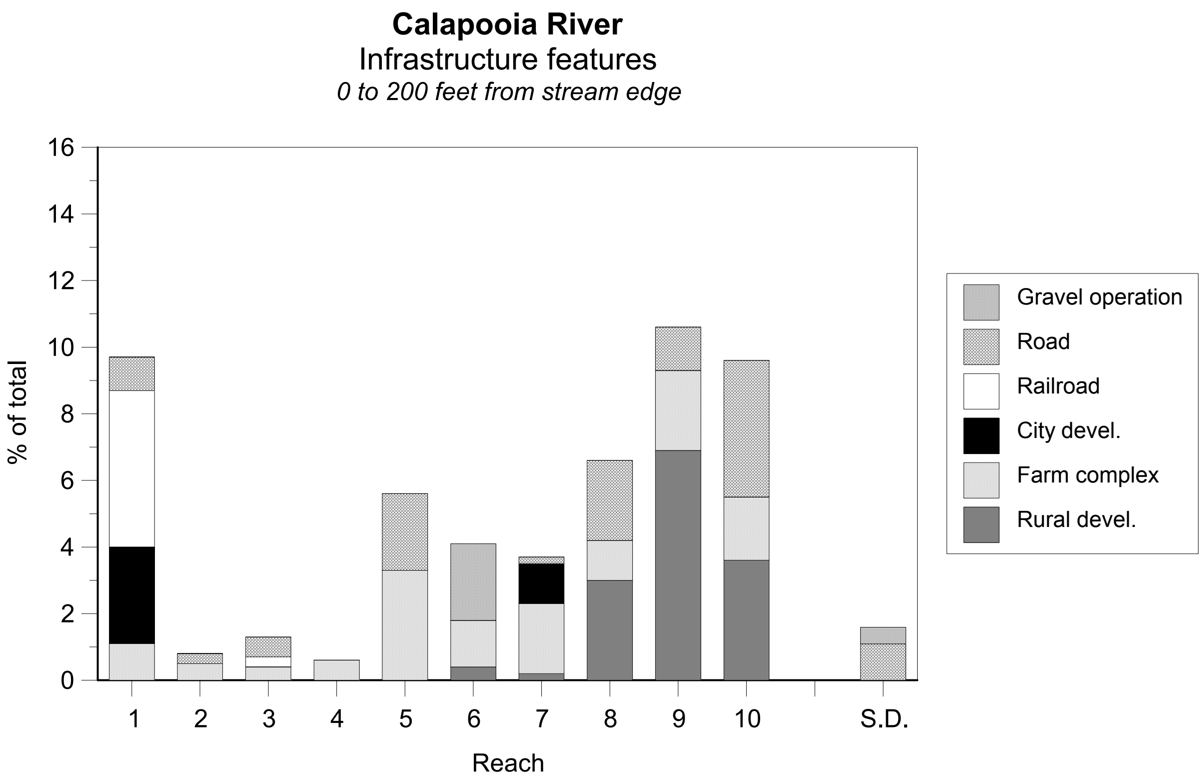


Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

Human infrastructure

The type of human infrastructure within 200 feet of the Calapooia River main channel varies widely among reaches (Figure 4-19). A railroad grade along with urban buildings and homes are dominant in reach 1, located next to Albany. Farm complexes, usually consisting of a house, barns, out buildings, machinery, and vehicles, are most common in reaches 5, 9, and 10. Rural development (usually homes) within 200 feet of the main channel occurs mainly along reaches 8, 9, and 10. Gravel removal within the Calapooia River occurs where reach 6 and Sodom Ditch connect. The removal is done to keep the Calapooia River channel from being plugged by gravel and causing all the flow to go down Sodom Ditch. Other gravel mining within or along the river has occurred in the past or is still occurring; some of the artificial ponds appear to be old gravel pit ponds. Major roads are a sizable component of the areas in human infrastructure for only reach 10. Other roads (usually farm roads with a dirt surface) occur within 200 feet of the river but were not evaluated in this study.

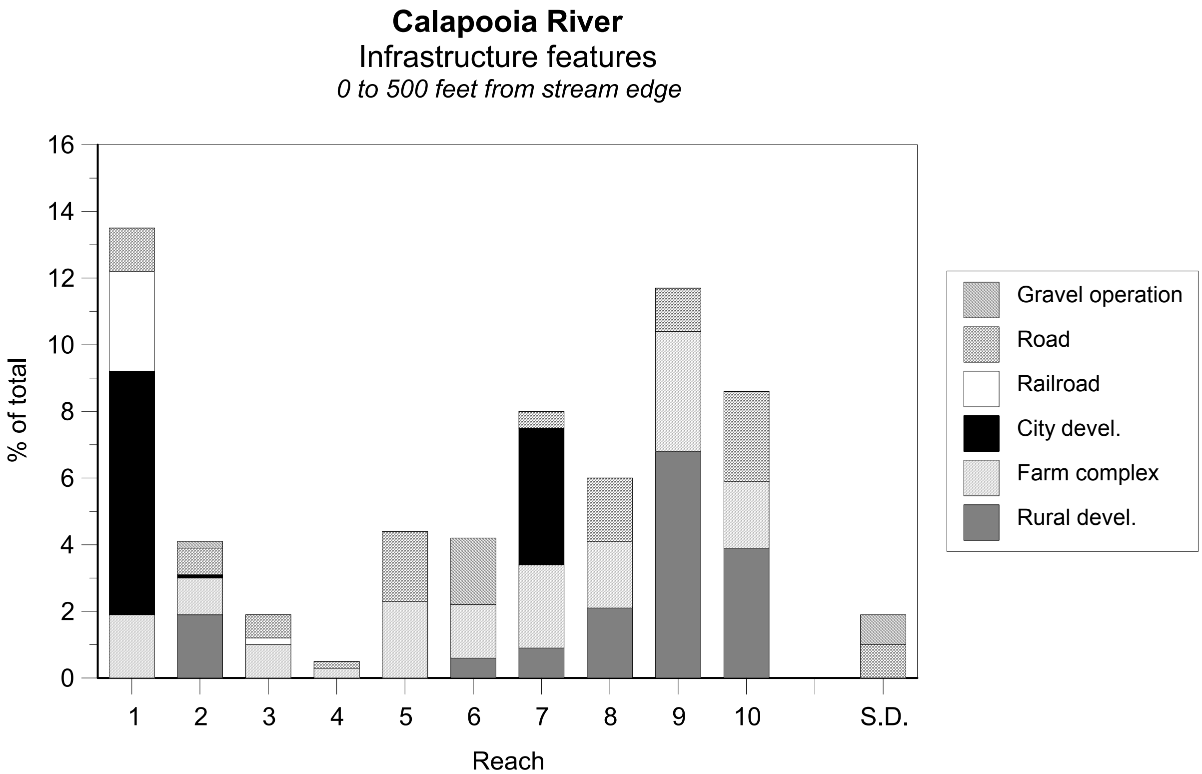
Figure 4-19. Fine-scale analysis of infrastructure within 200 feet of the Calapooia River main channel as a percent of overall total acreage.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

The summary for land within 500 feet of the main channel is similar to the one for land within 200 feet of the main channel (Figure 4-20).

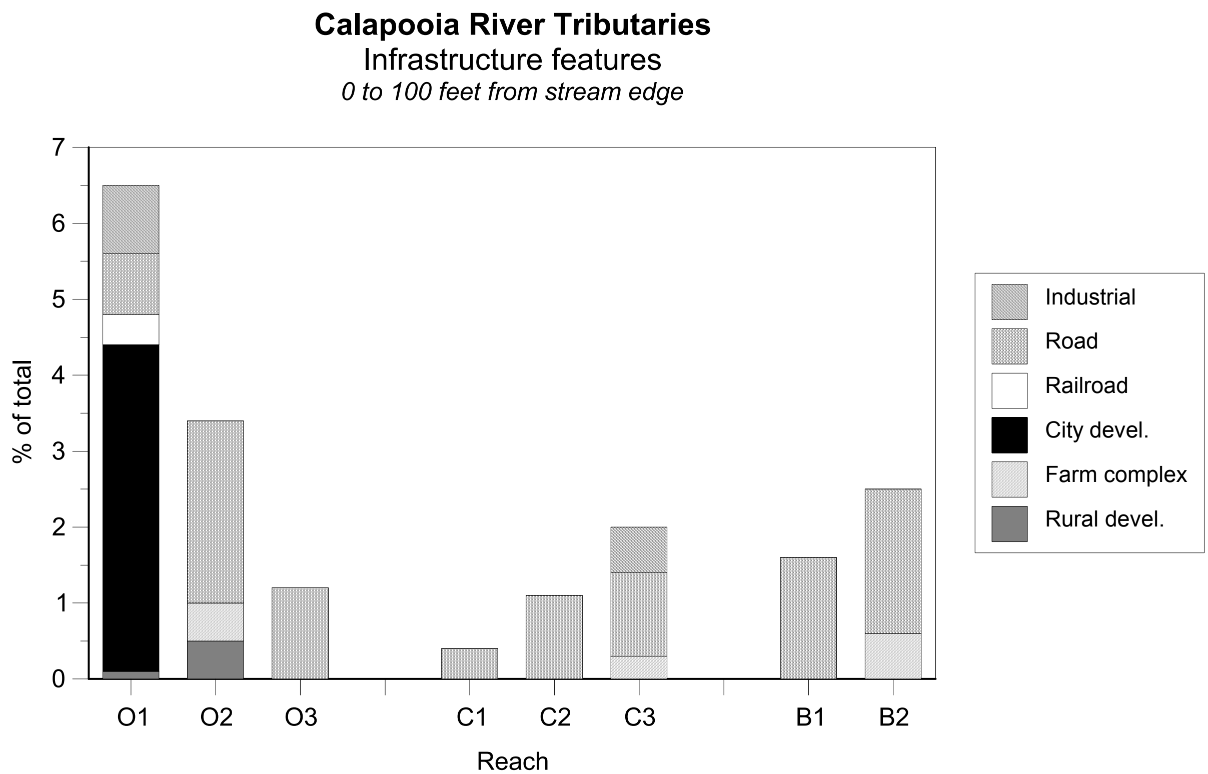
Figure 4-20. Fine-scale analysis of infrastructure within 500 feet of the Calapooia River main channel as a percent of overall total acreage.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Compared to some reaches of the main channel, streamside areas for the tributaries usually have little human infrastructure. One exception is the lower reach of Oak Creek, where city development is rapidly expanding towards the stream. All of the lower reach of Oak Creek along the north bank is within the urban growth boundary of the city of Albany. Among other reaches, roads are the most common human infrastructure within 100 feet of the stream (Figure 4-21).

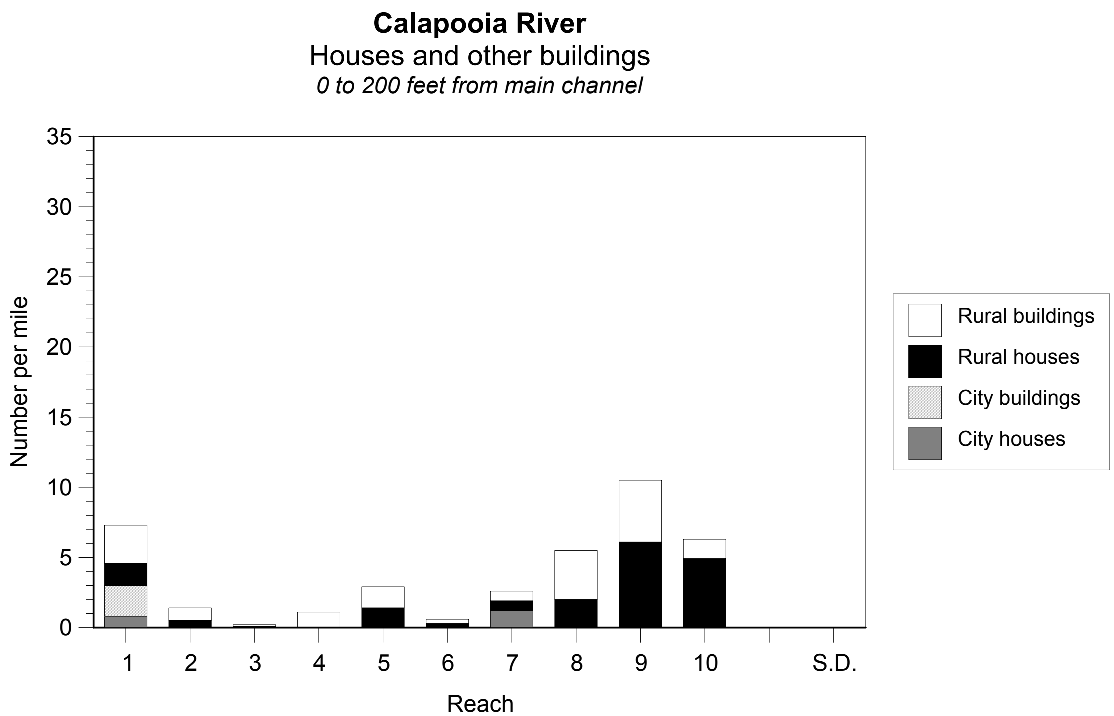
Figure 4-21. Fine-scale analysis of infrastructure within 100 feet of the three tributaries as a percent of overall total acreage.



Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

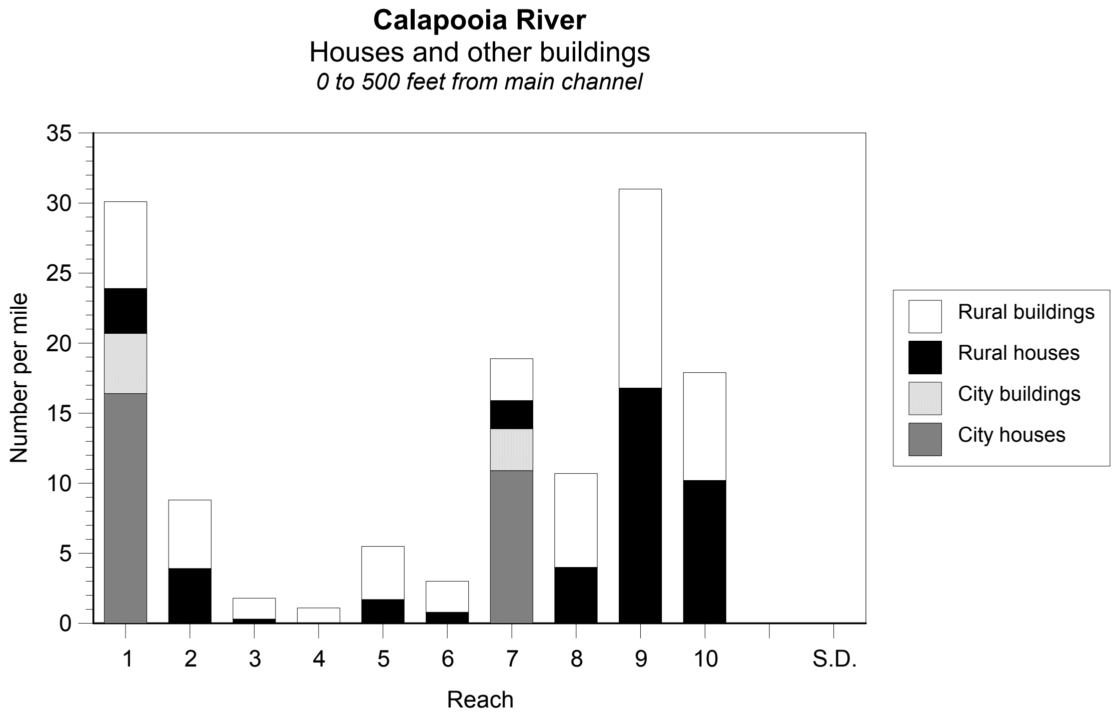
Individual houses and buildings are relatively scarce within 200 feet of the Calapooia River main channel, except in reach 1 near Albany and reaches 8, 9, and 10 (Figure 4-22). The number per mile of channel is about evenly split between houses and other buildings. House and building density increases substantially for distances up to 500 feet from the main channel (Figure 4-23). Densities of combined houses and buildings exceed 30 per river mile in reaches 1 (Albany) and 9, with a majority of structures consisting of houses. Houses are also relatively abundant in reach 7 (Brownsville) and in reach 10 (upstream of Holley). Only a few houses and buildings are found within 100 feet of the three tributaries evaluated in this study (Figure 4-24).

Figure 4-22. Number of houses and buildings (number per mile) within 200 feet of the Calapooia River main channel.



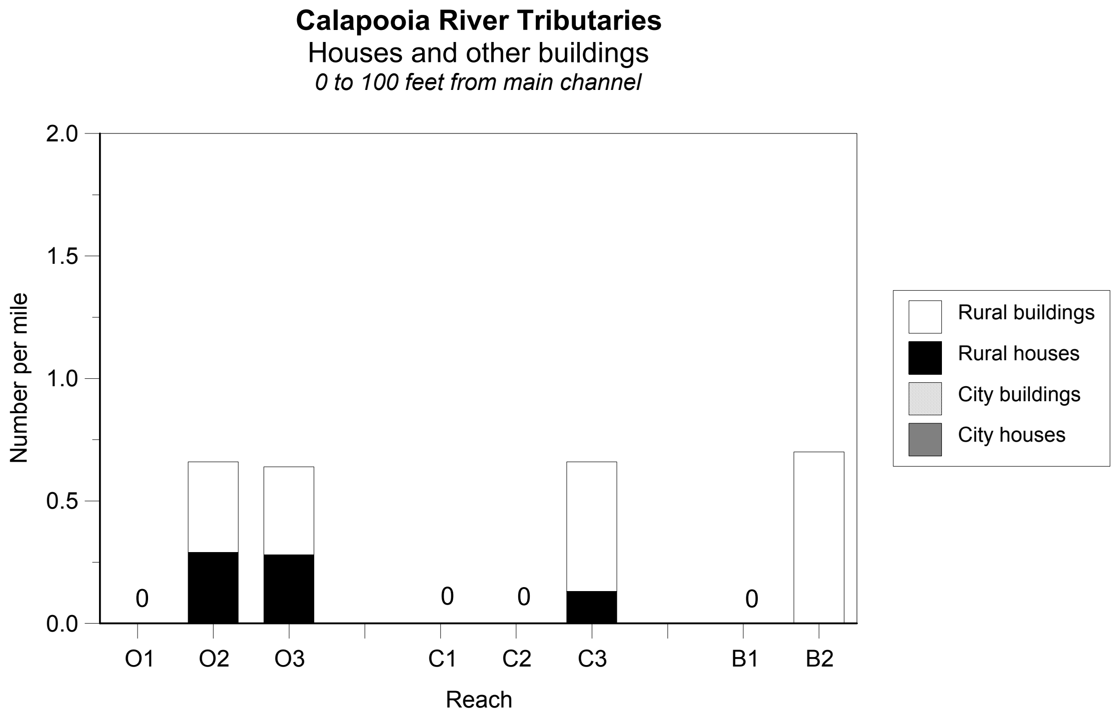
Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holly to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-23. Number of houses and buildings (number per mile) within 500 feet of the Calapooia River main channel.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-24. Number of houses and buildings (number per mile) within 100 feet of the three tributaries.



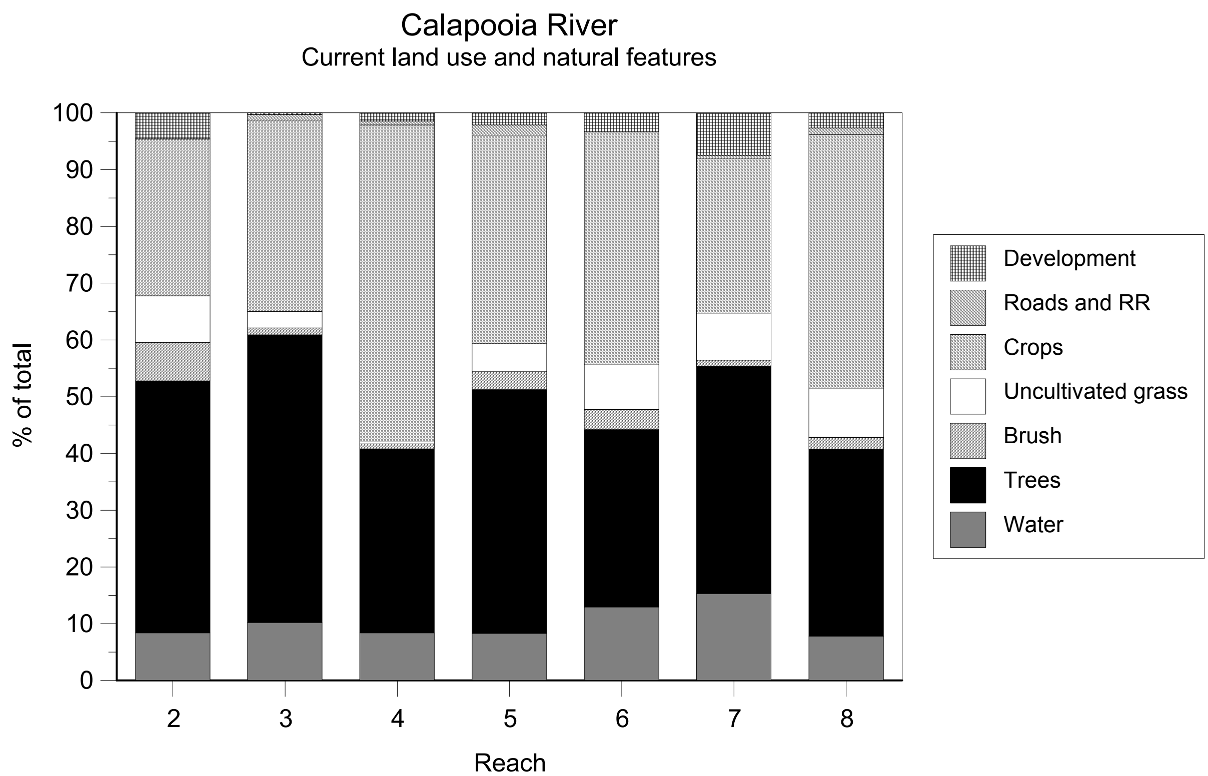
Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

Comparison with historic conditions

Notes and maps from the original land surveys conducted in the 1850s indicate that the Calapooia River (data available for reaches 2 through 8 only) was bordered by a continuous corridor of trees. Because of repeated burning of the valley floor by Native Americans during the previous centuries, vegetation beyond this corridor of trees was mostly native prairie or oak savanna. An examination of natural and human features that currently occupy land within this historic corridor of trees indicates that the combined percentage of trees and water features is only about 50% of what it was in the 1850s (Figure 4-25). The greatest percent of the 1850s corridor still occupied by trees and water features (61%), occurs in reach 3.

Most of the original 1850s corridor that is now not trees or water features, has been converted to grass seed fields, with minor components of brush, grass, roads, and development. An examination of aerial photographs indicates that most of the higher ground next to the river has been converted to other uses and that trees are now confined to mostly flood-prone areas.

Figure 4-25. Current features and land use within the area along the Calapooia River delineated as having trees and water during the 1850s land surveys. Surveys were available for only reaches 2-8.



Reach	Miles	Description
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park

Segments with narrow bands of trees

River banks that currently support a narrow band of trees (less than 40 feet wide and could support trees at a greater distance from the bank) or no trees at all occur along each reach of the Calapooia River (Map 10, *Segments with Narrow Bands of Trees*, Table 4-3, Figure 4-26). Overall, 22% of the river bank has a narrow band of trees or no trees; the remaining river banks have stands of trees that extend beyond 40 feet from the bank. Narrow bands of trees were most common within reach 5 (42%) and the Sodom Ditch reach (34%). Areas beyond the narrow bands of trees are commonly grass seed fields or grass, and would require only a minimum of site preparation to establish trees, if the goal of a restoration project was to increase the width of the streamside forest. Narrow bands of trees are found most often on the outside of river bends. In many cases, the band of trees was probably once wider but channel migration to the outside of bends has undercut existing trees.

Along the tributaries, the percent bank length with a narrow band of trees is less than 20%, except for the middle reach of Oak Creek and the two upstream reaches of Courtney Creek (Table 4-4, Figure 4-27). These three reaches flow through areas of intensive grass seed cultivation and over 50% of their bank length has only a narrow band of trees.

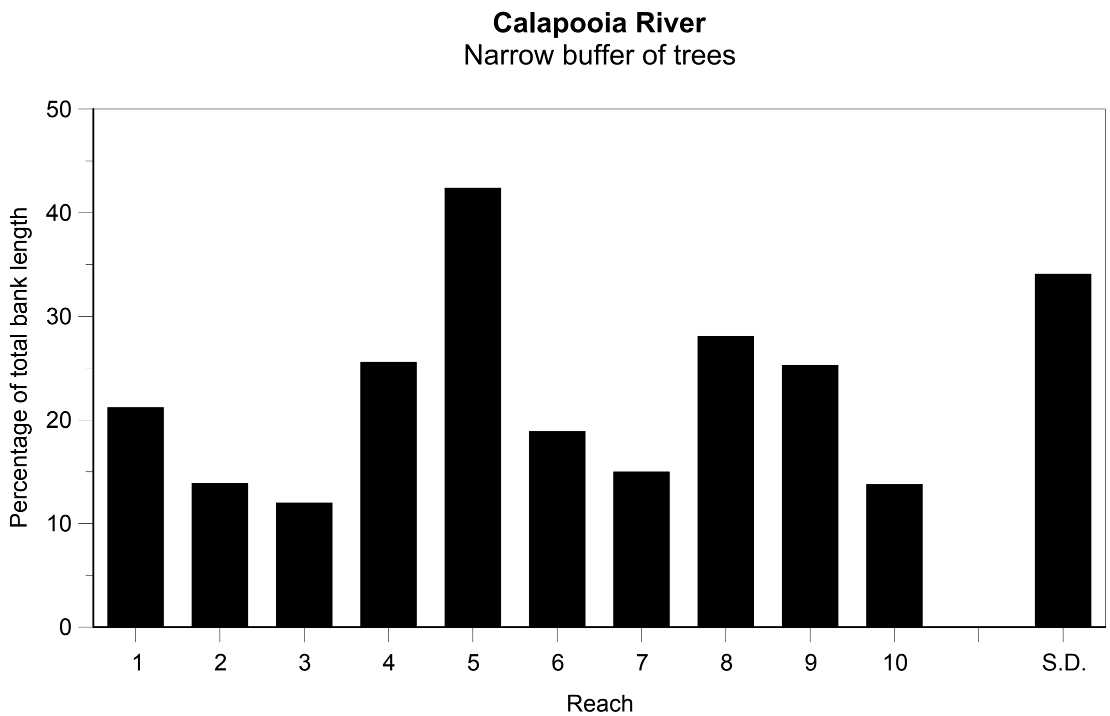
Table 4-3. Calapooia River banks with narrow buffer of trees (less than 40 feet wide) or no trees with areas that could be planted with trees up to and beyond 40 feet.

Reach	Bank length with narrow tree buffer (mi)	Total bank length (mi)	% Bank length with nonexistent or narrow tree buffer
1	1.57	7.42	21
2	1.58	11.34	14
3	2.92	24.36	12
4	1.41	5.52	26
5	5.62	13.26	42
6	1.40	7.40	19
7	1.21	8.10	15
8	2.27	8.06	28
9	2.89	11.44	25
10	1.18	8.60	14
Sodom Ditch	4.47	13.12	34
Total	*26.52*	*118.62*	*22*

Table 4-4. Tributary banks with narrow buffer of trees (less than 40 feet wide) or no trees with areas that could be planted with trees up to and beyond 40 feet.

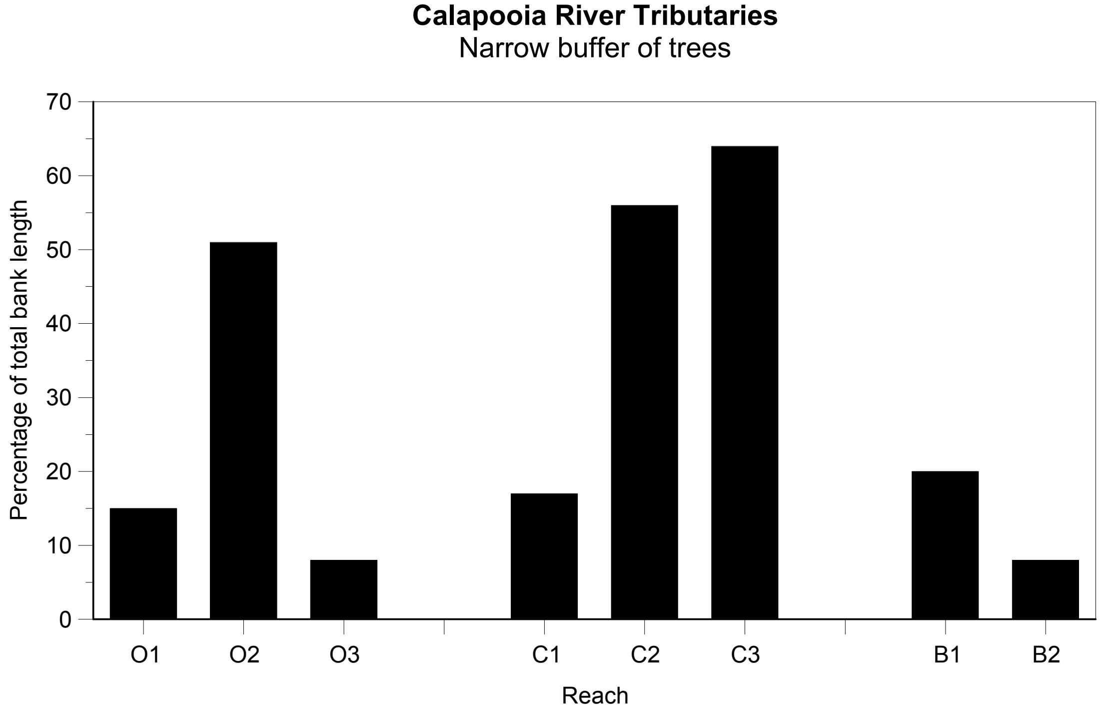
Reach	Bank length with narrow tree buffer (mi)	Total bank length (mi)	% Bank length with nonexistent or narrow tree band
Oak 1	1.51	9.80	15
Oak 2	13.90	27.24	51
Oak 3	0.60	7.12	8
Courtney 1	0.93	5.36	17
Courtney 2	3.63	6.54	56
Courtney 3	9.62	15.04	64
Brush 1	2.05	10.24	20
Brush 2	0.47	5.74	8
Total	*32.71*	*87.08*	*38*

Figure 4-26. Percentage of Calapooia River bank length with a narrow buffer of trees (less than 40 feet wide) or no trees; these areas could be planted with trees up to and beyond 40 feet.



Reach	Miles	Description
1	3.7	Willamette R to Oak Cr
2	5.7	Oak Cr to Lake Cr
3	12.2	Lake Cr to Butte Cr
4	2.8	Butte Cr to Thompson's Mill
5	6.6	Thompson's Mill to Sodom Ditch diversion
6	3.7	Sodom Ditch diversion to Brownsville
7	4.1	Brownsville to Brownsville Ditch diversion
8	4.0	Brownsville Ditch diversion to McKercher Park
9	5.7	McKercher Park to bridge at Holley
10	4.3	Bridge at Holley to beginning of forest land
S.D.	6.6	Sodom Ditch (including lower Butte Cr)

Figure 4-27. Percentage of tributary bank length with a narrow buffer of trees (less than 40 feet wide) or no trees; these areas could be planted with trees up to and beyond 40 feet.



Reach	Miles	Description
O1	4.9	Oak Cr. - Calapooia River to Hwy I5 bridge
O2	13.6	Oak Cr. - Hwy I5 bridge to Sodaville
O3	3.6	Oak Cr. - Sodaville to end of mapping
C1	2.7	Courtney Cr. - Calapooia River to Linn West Road bridge
C2	3.3	Courtney Cr. - Linn West Road bridge to Hwy 228 bridge
C3	7.5	Courtney Cr. - Hwy 228 bridge to end of mapping
B1	5.1	Brush Cr. - Calapooia River to second bridge
B2	2.9	Brush Cr. - second bridge to end of mapping

Wetlands

Wetlands are lands in-between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of classification under the National Wetland Inventory system, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly *hydrophytic plants*, (2) the substrate is predominantly undrained *hydric* soil, and (3) the area is saturated with water or covered by shallow water at some time during the growing season of each year. A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic (not oxygenated) conditions in the upper part. Hydrophytic plants grow in water or on a substrate that at least periodically is deficient in oxygen due to excessive water content. Hydrophytic plants have morphological, physiological and reproductive adaptations that allow them to thrive in inundated or saturated soils where upland plants cannot.

Wetlands mapped during the National Wetland Inventory are categorized by *system* and by *class*. Some wetland systems also have *subsystems*. The following definitions are for the wetland types found in the Calapooia basin:

The *Riverine System* (channels) includes all wetlands and deepwater habitats contained within a channel, except wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Subsystems of the Riverine System include:

> Lower Perennial - The gradient is low and water velocity is slow. Some water flows throughout the year. The substrate consists mainly of sand and mud. Oxygen deficits may sometimes occur, the fauna is composed mostly of species that reach their maximum abundance in still water, and true planktonic organisms are common. The gradient is lower than that of the Upper Perennial Subsystem and the floodplain is well developed.
>
> Upper Perennial - The gradient is high and velocity of the water is fast. Some water flows throughout the year. The substrate consists of rock, cobbles, or gravel with occasional patches of sand. The natural dissolved oxygen concentration is normally near saturation. The fauna is characteristic of running water, and there are few or no planktonic forms. The gradient is high compared with that of the Lower Perennial Subsystem, and there is very little floodplain.
>
> Intermittent – The channel contains flowing water for only part of the year. When the water is not flowing, it may remain in isolated pools or surface water may be absent.

The *Lacustrine System* (lakes) includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 20 acres. Similar wetland and deepwater habitats totaling less than 20 acres are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 6.6 feet at low water. The only subsystem of the Lacustrine System mapped within the Calapooia basin is the Limnetic, which includes all deepwater habitats greater than 6.6 feet.

The *Palustrine System* (wetlands) includes wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. It also includes wetlands lacking such vegetation, but with all of the following characteristics: (1) the area is less than 20 acres; (2) active wave-formed or bedrock shoreline features are lacking; (3) the water depth in the deepest part of the basin is less than 6.6 feet at low water. The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie. It also includes the small, shallow, permanent or intermittent water bodies often called ponds.

Wetland systems and sub-systems can be further described by adding the following *class* codes. These include:

Emergent. Wetlands with emergent and rooted herbaceous (non-woody) hydrophytes, excluding mosses and lichens representing more than 30% of the areal cover. These plants are typically perennial, can tolerate water at their base, but they cannot survive long periods in which they are completely submerged.

Scrub/shrub. Wetlands with woody vegetation less than 20 feet tall. Woody vegetation in this wetland type may contain true shrubs, young trees, or trees and shrubs that are stunted by environmental conditions.

Forested. Wetlands with woody vegetation that is 20 feet or taller covering 30% or more of the area.

Aquatic bed. Wetlands dominated by plants that grow principally on or below the surface for most of the growing season in most years (algae, duckweed, etc).

Unconsolidated bottom. Wetlands where vegetation is absent over the majority (70%) of the area. Bottom consists of mud, sand, cobble, gravel, or organic matter.

Unconsolidated shore. Wetlands with less than 75% coverage of bedrock, stone, or boulders, vegetative cover < 30%, and not permanently flooded.

Streambed. Wetlands consisting of a channel that is completely dry at low water periods and vegetative cover <30%.

Wetlands in the Calapooia basin are abundant and occur throughout the basin (Map 7, *USFWS National Wetlands Inventory*). Most wetlands occur within, along, or adjacent to stream and river channels. Linear wetland features occur along 458 miles of stream (Table 4-5). Other wetlands, mapped as polygons, occupy 3400 acres. Polygons are areas of wetlands, such as a shallow pond. Assuming that the average width of a linear wetland is 30 feet, wetlands occupy over 5000 acres (7.8 square miles), or 2.8% of the basin.

In addition to the wetlands mapped during the National Wetland Inventory, restored wetlands occur along Oak Creek near Lebanon at the Oak Creek Wetland Mitigation Bank. This is the site of a wetland bank that was established to compensate for wetlands filled or drained elsewhere. The wetland bank has a capacity of 88 acres of restored wetlands.

Table 4-5. Length and area of wetland features identified in the Calapooia basin. The forested portion of the basin upstream of Holley is not included.

Linear wetland features

System / Subsystem	Class	Miles	Percent
Palustrine (P)	Aquatic bed (AB)	2.6	0.6
	Emergent (EM)	181.7	39.7
	Forested (FO)	69.6	15.2
	Scrub/shrub (SS)	32.7	7.1
	Unconsolidated bottom (UB)	1.0	0.2
Riverine – lower perennial (R2)	Aquatic bed (AB)	0.4	0.1
	Unconsolidated bottom (UB)	61.8	13.5
	Unconsolidated shore (US)	0.7	0.2
Riverine – upper perennial (R3)	Unconsolidated bottom (UB)	23.0	5.0
Riverine – intermittent (R4)	Streambed (SB)	84.1	18.4
	Total	*457.8*	*100.0*

Wetland polygons

System / Subsystem	Class	Acres	Percent
Lacustrine – limnetic (L1)	Unconsolidated bottom (UB)	83	2.4
Palustrine (P)	Aquatic bed (AB)	40	1.2
	Emergent (EM)	1181	34.7
	Forested (FO)	1449	42.6
	Scrub/shrub (SS)	180	5.3
	Unconsolidated bottom (UB)	111	3.3
	Unconsolidated shore (US)	2	0.0
Riverine – lower perennial (R2)	Unconsolidated bottom (UB)	272	8.0
	Unconsolidated shore (US)	86	2.5
Riverine – upper perennial (R3)	Unconsolidated bottom (UB)	1	0.0
	Total	*3404*	*100.0*

Wetlands are most common downstream of Brownsville adjacent to the Calapooia River. Many are depressions resulting from the river creating a new course and abandoning its previous channel. Sizable areas of wetlands also occur in upper portions of Oak Creek, lower Oak Creek near Albany, lower Brush Creek, and lower and upper Courtney Creek.

Emergent and forested Palustrine wetlands comprise 55% of the linear wetland features and 77% of the polygon wetland features, while Lacustrine wetlands make up only a small portion of the total wetland acreage. Most Riverine wetlands are of either the lower perennial or intermittent subsystem.

The City of Albany (contact the Planning Department) recently conducted an inventory of wetlands within their urban growth boundary. Included in the wetland inventory was a determination of significance using the state method. It provides more detail than that provided by the National Wetlands Inventory.

The mapping of soils in the Calapooia Watershed by Linn County includes a determination of which soil associations are hydric. As stated before, a hydric soil is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic (without oxygen) conditions in the upper layer of soil. Hydric soils are extensive throughout the lower watershed (Map 8, *Soils*). Overall, hydric soils make up 23% of the watershed. Wetlands are often found in areas mapped as having hydric soils but not all areas mapped as having hydric soils are currently wetlands.

Discussion

About one-half of the land along the Calapooia River that supported trees in the 1850s has since been converted to grass seed fields and other development. Remaining patches of older trees are mostly in low-lying areas that are too wet for farming. Older stands of trees are most extensive downstream of Brownsville where the river meanders widely over a relatively flat floodplain. Here also, natural ponds are abundant, a result of the river abandoning its old channel and forming a new path. Most of the ponds are bordered by older hardwood stands and few have been altered by farming or development. Human infrastructure near the river is limited mostly to roads and a sparse number of houses or farm complexes. The lower reaches of Oak Creek and Courtney Creek share these characteristics, although few natural ponds occur along these tributaries.

Except for the most downstream reach near Albany, development along the Calapooia River is most concentrated within and upstream of Brownsville. Here, stands of older trees are less extensive, while crops and houses are closer to the river. A decrease in channel gradient and a widening of the valley floor results in extensive gravel deposition from the Brownsville diversion dam downstream to the Sodom Ditch diversion (reaches 6 and 7) and probably represents some of the best non-summer habitat for fish within the study area. Abundant gravel substrate is conducive to the production of aquatic insects and areas of slower water during high flows. Gravel deposits along the tributaries were not evident in the aerial photographs, although those most upstream reaches of Brush Creek and Oak Creek probably have a gravel substrate due to the higher gradient and the adjacent hill slopes.

Over 20% of Calapooia River banks (22 miles) throughout the study area are bordered by a band of trees that is less than 40 feet wide or no trees at all. Along the mapped tributaries, 38% of stream banks (33 miles) have a narrow band of trees or no trees. This varies widely among reaches with the upstream reaches of Brush Creek and Oak Creek having 8%, and the upstream reach of Courtney Creek having 64%. Most banks with a narrow band of trees are adjacent to crops, grass, or other land types that would allow relatively easy tree regeneration, if the intent is to restore a wider riparian forest along the river. Nevertheless, blackberry and Scotch broom, aggressive introduced species that are a common component of streamside areas, can complicate tree regeneration efforts.

The construction of houses along the Calapooia River may increase in the near future, although current land zoning does not allow much subdivision of existing parcels. Portions of the nearby McKenzie River already support up to 20 riverfront homes per mile (Alsea Geospatial 2001). Limited opportunities for future riverfront development next to the McKenzie River, combined with high land costs, could cause some who desire a riverfront house to consider the Calapooia River as an alternative. The highest density of houses along the Calapooia River (within 200 feet of the water) is in reach 9 near Holley and averages 6 houses per mile. New housing sub-divisions within the city limits of Albany can be seen close to the Calapooia River in the 2000 aerial photographs.

Wetlands are a common feature throughout the Calapooia Watershed. Evidence of wetland loss, since the area was settled by pioneers, can be seen in maps and aerial photographs. Channelized stream courses and ditches appear throughout the lower-gradient portions of the basin. Wetlands were not inventoried prior to the 1980s so it is not possible to quantify this loss in wetlands. A sizable portion of the remaining wetlands occur in areas that are too wet for the growing of grass seed, thereby lessening the prospect of further reductions in wetland area or loss of vegetation next to wetlands.

References

Alsea Geospatial. 2001. McKenzie River subbasin assessment. Technical Report. Prepared for the McKenzie Watershed Council. Alsea Geospatial, Corvallis, OR.

Weyerhaeuser Company. 1998. Calapooia River Watershed Analysis. Part II – Module Reports. Weyerhaeuser, Springfield, OR.

Chapter 5. Stream Flow and Water Use

Introduction

This chapter includes an evaluation of stream flow and water use in the Calapooia River Watershed, with special focus on the main channel and three selected tributaries; Oak Creek, Courtney Creek, and Brush Creek.

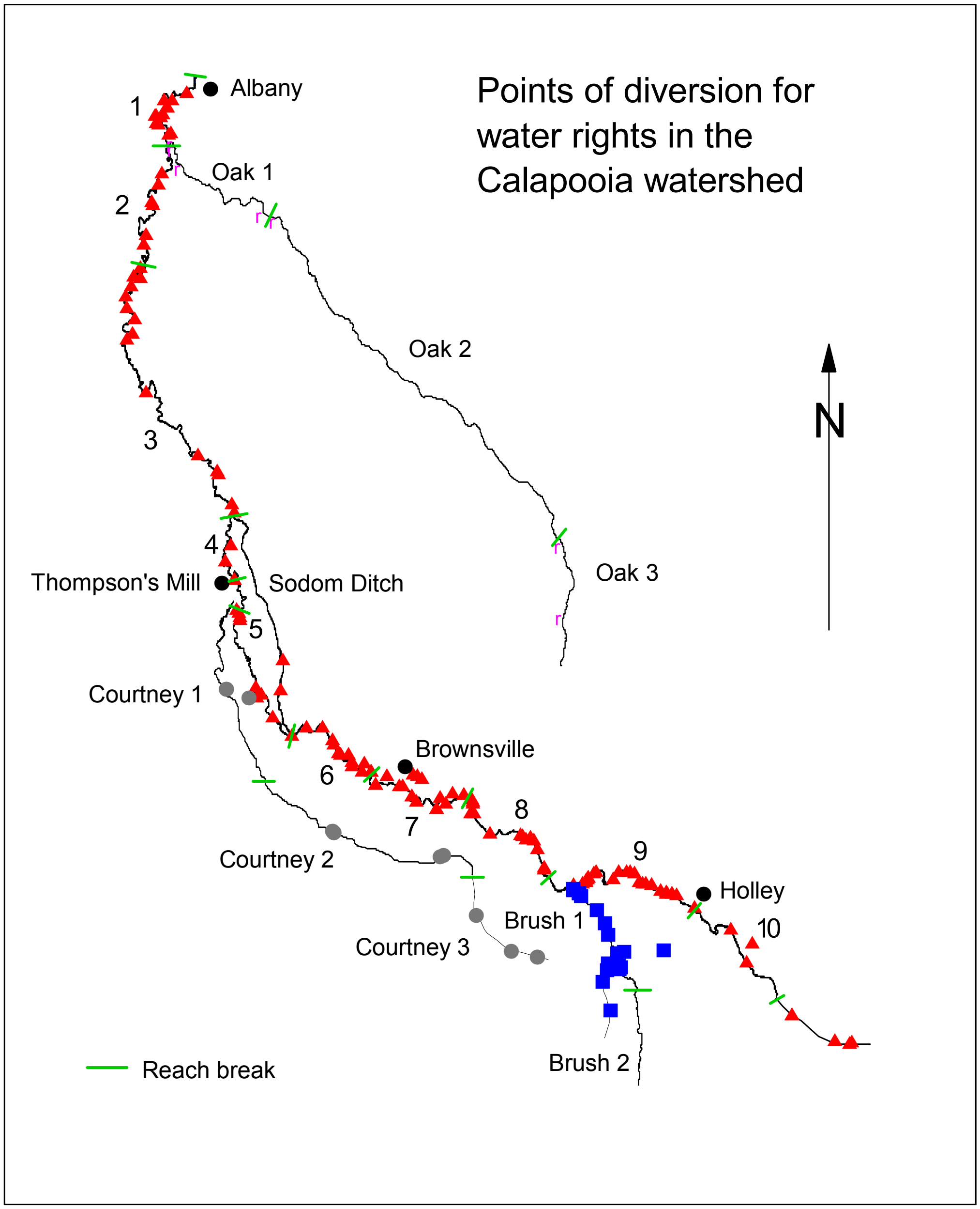
The amount and timing of water runoff influenced the pattern of early settlement in the Calapooia River Watershed. Pioneer settlement first occurred in the middle portion of the watershed near the transition between hillslopes and the broad Willamette Valley floodplain. Here, year-round water was available from tributary streams (such as Brush Creek) to irrigate crops. Higher land that did not flood during the winter was available for building houses and towns (such as Brownsville), and this part of the Calapooia River could be used to power milling equipment (such as was done at the falls near McKercher Park) or to transport logs downstream. Over time, several hundred surface water rights were granted in the basin by the State to irrigate crops, store water, power equipment, and for other uses (Figure 5-1).

Water use laws are enforced by the Oregon Water Resources Department. Some basic tenants of water use law include:

- Those who hold water rights with the oldest priority dates get first use of the water. Those who have a younger or "junior" water right get use of the water in order of the priority date of their permit, until no more water is available.
- Water rights need to be used (exercised) at least once every 5 years. In practice, this rule is rarely enforced unless a third party makes a complaint.
- A holder of a water right cannot provide water to a third party unless re-distribution of water is included in the permit (most commonly granted to irrigation districts).
- Instream water rights (water purposely left in the stream to benefit fish and other aquatic life) are subject to use by priority date, just like water rights that involve consumption of water.

The purpose of the following evaluation is to characterize natural and modified flows in the Calapooia River and tributaries in order to understand the influence of water use on fish, water quality, and landowners. Another purpose of this evaluation is to highlight opportunities to improve conditions for fish by identifying where voluntary changes in water use would be most beneficial.

Figure 5-1. Points of water diversion for the Calapooia River and tributaries.



Methods

The Calapooia River has only two sites where flow measurements have been made for extended periods. One site is near the bridge at Holley and the other is about three miles upstream of the Willamette River confluence at Albany. Neither of the gauges still operates due to lack of funding. The Holley gauging record is from 1936 to 1990 and the Albany record is from 1941 to 1980. No systematic measurements have been made of tributary flows within the basin.

Monthly flow and annual peak flow data were obtained for the two Calapooia River sites from the U.S. Geological Survey web site (http://waterdata.usgs.gov/nwis/sw). Surface water rights information for the Calapooia Watershed was obtained from the Oregon Water Resources Department in both tabular form and as a GIS layer indicating points of water diversion. Certain water rights could not be found in either data base. Missing information was provided by Michael Mattick, the local water master for the Oregon Water Resources Department.

Results

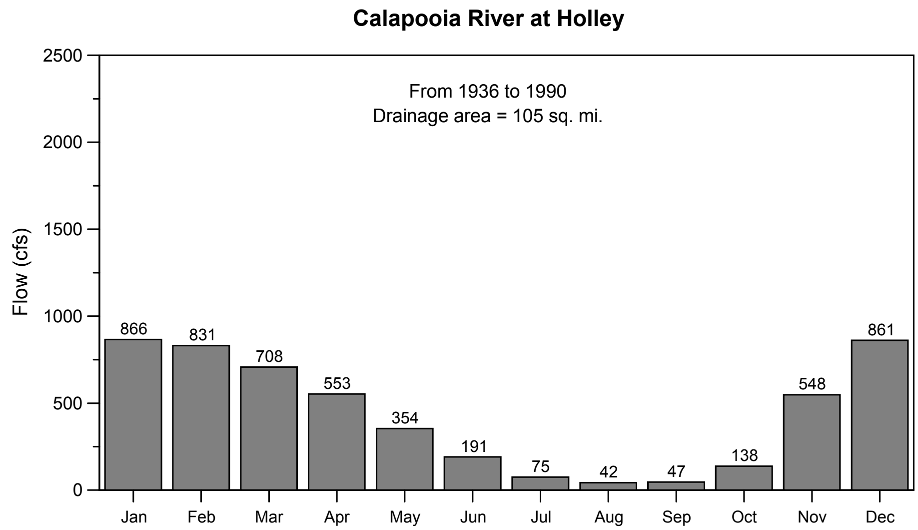
Monthly flows

Flows in the Calapooia River vary greatly throughout the year due to seasonal precipitation and summer use of water (Figure 5-2). The average monthly January flow in Albany is 55 times the average August monthly flow. Nearly 90% of the runoff occurs during the six wettest months (November through April).

Flows are nearly the same for the Albany and Holley sites from July through September, although the Albany site has a drainage area 3.5 times larger than the drainage area for the Holley site. Flows during a normal August (50% exceedence based on daily values) at Holley are 38 cubic feet per second (cfs) and 34 cfs at Albany (Figure 5-3), while flows during droughty summers (80% exceedence) are 29 cfs at Albany and 23 cfs at Holley. The 80% exceedence flow is that value which is exceeded 8 out of 10 years. The 50% exceedence flow is that value which is exceeded 5 out of 10 years, or the median flow. A measurement of the Calapooia River flow at Albany during the summer of 2002 indicated that the flow had dropped to 13 cfs, or less than one-half of the 50% exceedence flow. Rainfall during the spring and early summer of 2002 was abnormally low.

River flows are the sum of shallow groundwater and tributaries entering the river; minus deep infiltration of water lost to aquifers underneath the river bottom, evaporation from the water surface, transpiration by streamside vegetation, and water withdrawals by humans (Figure 5-4). During the summer in western Oregon, the shallow groundwater inputs drop to a relatively steady level. This level is not influenced much by the small amount of rain that falls during the summer. Since river flow records were not kept prior to irrigation, the natural summer flows of the Calapooia River are not known.

Figure 5-2. Average monthly flows for the two gauging sites on the Calapooia River.



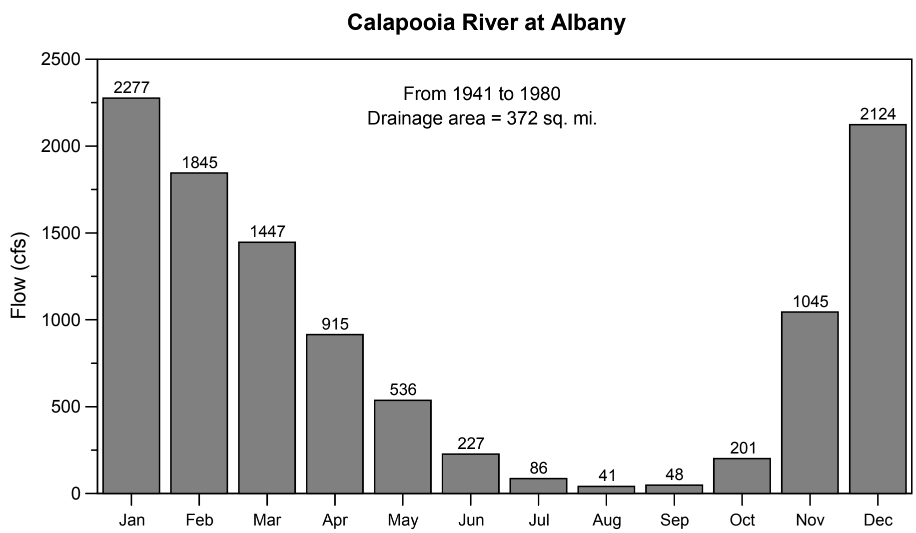
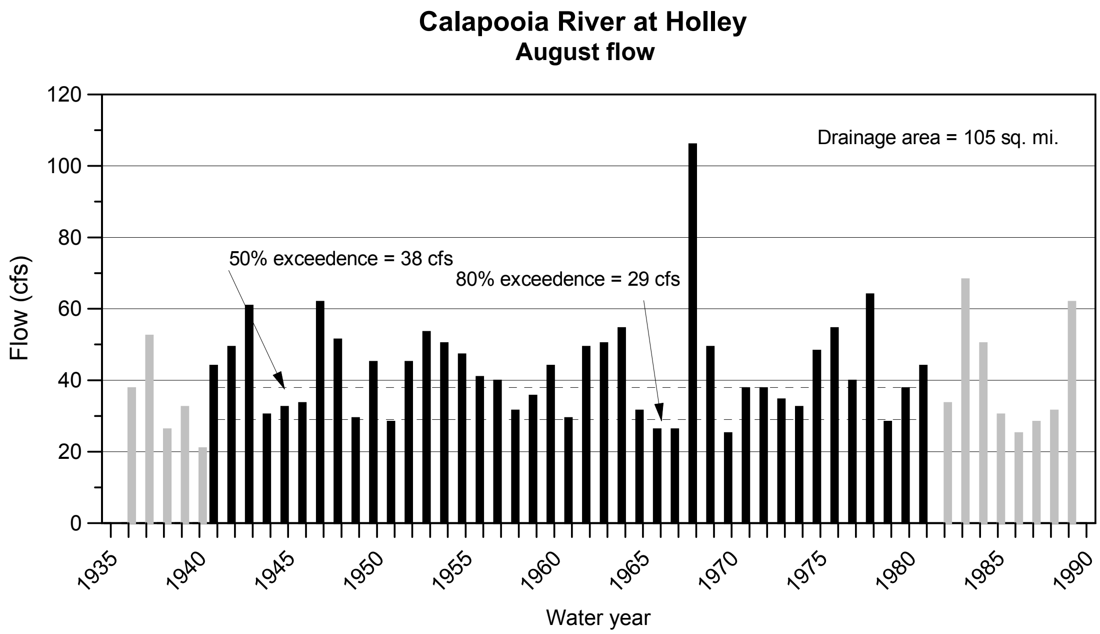


Figure 5-3. August Calapooia River flows for the upper gauging site (Holley) and the lower site (Albany). Exceedence values were calculated using daily flow values. The 80% exceedence flow is that value for which flow is exceeded 8 out of 10 years. The 50% exceedence flow is that value for which flow is exceeded 5 out of 10 years, or the median flow. The exceedence values were calculated only for those years where flow was recorded at both gauging stations.



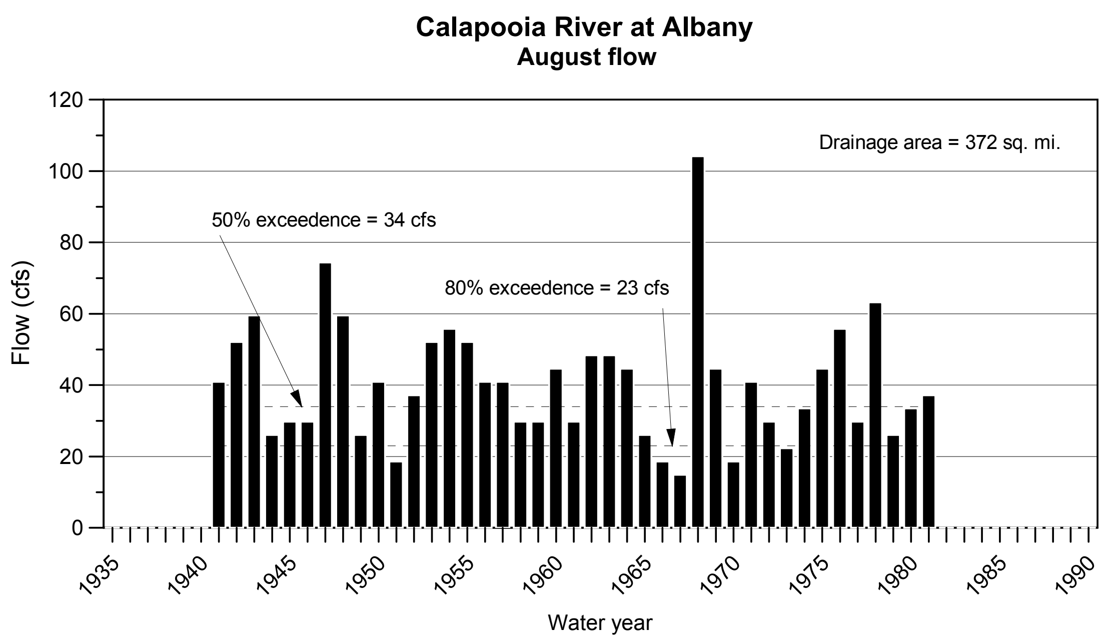
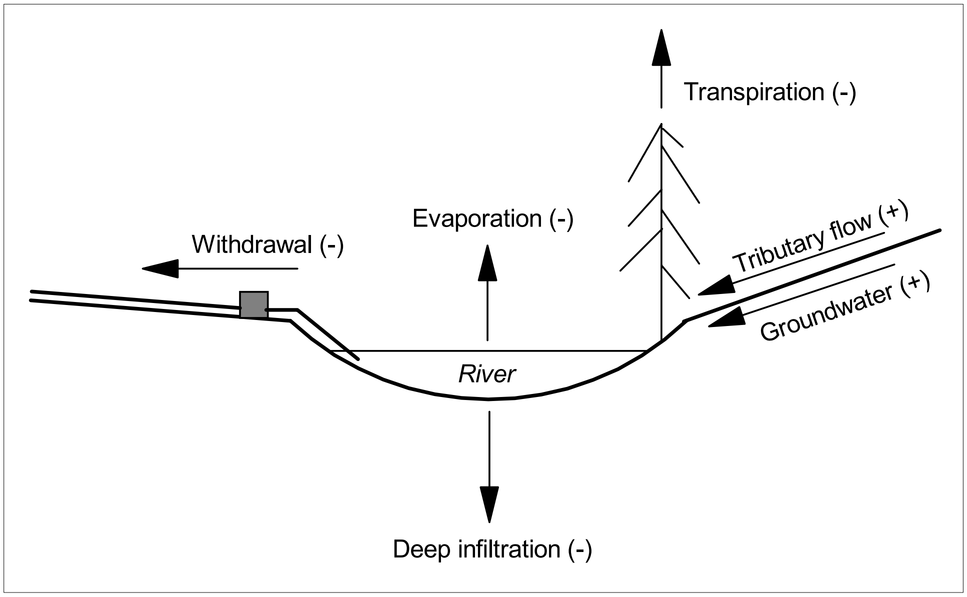


Figure 5-4. A diagram illustrating the processes influencing gains and losses of water in a river segment during the summer. A water input is designated as "+" and a water loss is designated as "-".



Peak flows

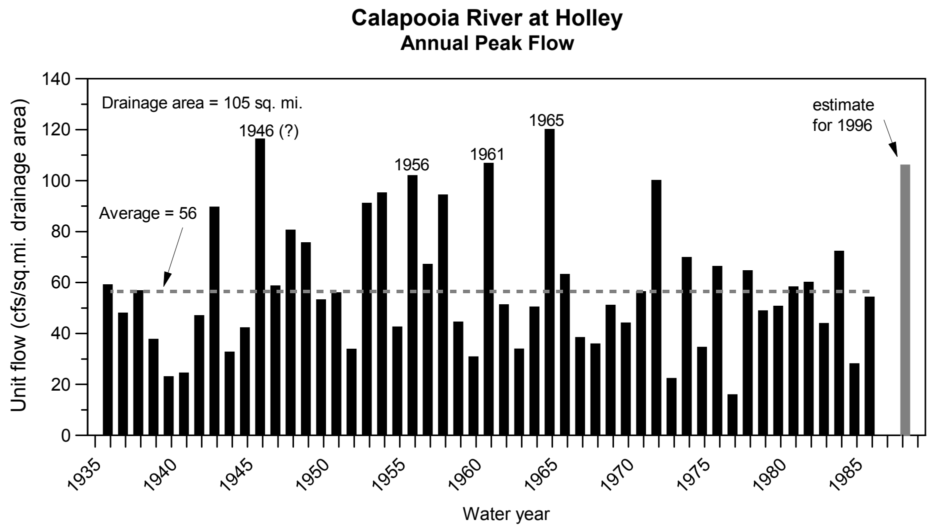
Peak flows up to a 100-year recurrence interval (also called the 100-year flood) for the Calapooia River can be evaluated using flow records from the Holley and Albany gauging stations. A 100-year recurrence interval is the same as a 1% probability of that peak flow occurring in any given year. The Holley gauge has a 51-year period of record of peak flows (water years 1936 to 1986) and the Albany gauge has a 41-year period of record (water years 1941 to 1981). A water year begins on October 1 and ends the following September 30, and is assigned the year beginning on January 1. For example, a peak flow that occurred on December 28, 1964 would be in the 1965 water year. A recurrence interval is the average frequency (over the long-term) that a flood of given magnitude occurs. For example, as shown later, peak flows of 11,300 cfs or greater occur every 25 years (on average) at Holley and this would be termed the 25-year flood.

The "log-Pearson type III extreme values" method was used to estimate flows associated with various recurrence intervals. The uncommonly high 1946 peak flow at the Holley gauge was not used in the calculations because similarly high peak flows did not occur at the downstream Albany gauge or the nearby Mohawk River gauge. At these other two gauging sites, the 1946 peak flow was only about average. Erroneous peak measurements can occur because of gauge malfunction or the temporary damming of water behind a log jam and its sudden release.

The average annual peak flow in cubic feet per second (cfs) is that flow which equaled or exceeded about every 1.5 years, on average. In order to compare peak flows between two different gauging sites, the "unit peak flow" can be calculated by dividing by the watershed area (cfs per square mile). The average annual peak flow is 56 cfs/sq.mi. at Holley where the drainage area is 105 square miles, but only 38 cfs/sq.mi. at Albany where the drainage area is 372 square miles (Figure 5-5). The magnitude of unit peak flows experienced by a river commonly decreases in a downstream direction because various sub-drainages in a watershed peak at different times. The integration of these various peaks causes the flood flow to be spread out over a longer period, resulting in a muted peak flow in downstream portions of a river. This is particularly true for the Calapooia River where slopes are steep and many tributary streams exist upstream of the Holley gauge. These conditions result in a quick routing of water to the main channel. Furthermore, the upper Calapooia River is of such sufficient elevation, that the melting of a snow pack can contribute significantly to flood flows. In contrast, much of the area upstream of the Albany gauge but downstream of the Holley gauge, is low-gradient with few tributary streams. Also, this low-elevation portion of the basin is not likely to have an extensive snow pack during heavy rainfall and the flatter terrain does not shuttle water downhill as fast.

Calculated values for the 100-year flood, expressed as cfs per square mile of drainage area, are 134 at Holley and 112 at Albany (Table 5-1, Figure 5-6). But because of the larger drainage area, the discharge at Albany (41,800 cfs) is three times greater than the Holley discharge (14,100 cfs).

Figure 5-5. Annual peak flow values for the Holley and Albany sites of the Calapooia River. Peak flow values are expressed as cfs per square mile of drainage area. The peak flow value for 1946 at Holley was not included in the average because of uncertainty over its validity.



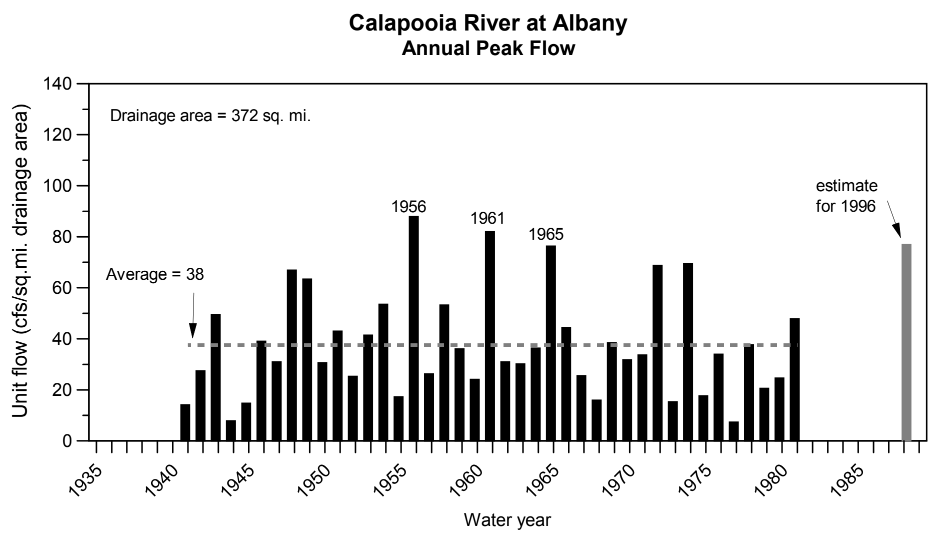
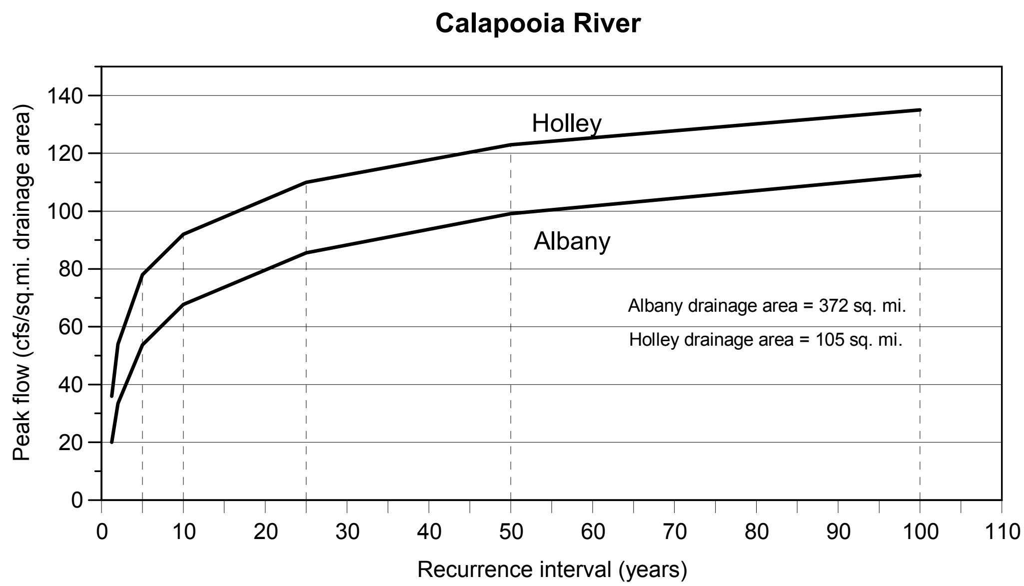


Table 5-1. Calculated peak flow values (log-Pearson Type III distribution) for various recurrence intervals for the Holley and Albany gauges on the Calapooia River. Drainage area for Holley is 105 square miles and 372 square miles for Albany.

Recurrence interval (years)	**Peak flow (cfs)**	**Unit peak flow (cfs/sq.mi.)**
Holley gauge 2	5500	52
5	7900	75
10	9400	90
25	11300	108
50	12700	121
100	14100	134
Albany gauge 2	12500	33
5	20000	54
10	25200	68
25	31800	86
50	36900	99
100	41800	112

Figure 5-6. Calculated peak flow values (log-Pearson Type III distribution) for the Holley and Albany gauging stations as a function of recurrence interval.



The three largest recorded peak flows within the Holley and Albany records (excluding the suspect 1946 peak flow at Holley) occurred in 1956, 1961, and 1965 (Table 5-2). These floods occurred when abundant warm rain quickly melted an extensive snow pack that had previously developed over much of the watershed. This is referred to as a "rain on snow" event. The 1956 flood was the highest of record for the Albany site and had a recurrence interval of 28 years. It was a smaller event (18-year) for the Holley gauge. The 1965 flood was the highest of record at the Holley site (44-year) but only a 17-year event at the Albany site.

Table 5-2. Recurrence intervals for the largest recorded Calapooia River floods and the estimated 1996 flood.

Flood	**Holley**		**Albany**	
(water year)	**Flow (cfs)**	**R.I. (yrs)***	**Flow (cfs)**	**R.I. (yrs)***
1956	10700	18	32700	28
1961	11200	22	30500	23
1965	12600	44	28400	17
1996	*11100***	*22*	*28600***	*17*

* R.I. = recurrence interval, ** = estimated

Both gauges were shut down prior to the 1996 flood so an estimate of this flood's magnitude in the Calapooia River was made using the gauge near the mouth of the nearby Mohawk River. Like the Calapooia River, a portion of the Mohawk River is higher elevation (up to 4000 feet) and a portion is broad low-elevation valley. A linear regression equation was developed for each gauging station using years of record common with the Mohawk River gauge (Figure 5-7).

The predictive equations are:

Holley $Y = 7.3 + 1.29X$

Albany $Y = -3.2 + 1.05X$

where, X is the Mohawk River peak flow value (cfs/sq.mi.) and Y is the predicted peak flow value for the Calapooia River.

The peak flow value for the Mohawk River in 1996 was 76.3 cfs so the estimated Calapooia River values are:

Holley 105.7 cfs/sq.mi. or 11,100 cfs

Albany 76.9 cfs/sq.mi. or 28,600 cfs

Consequently, the recurrence interval of the 1996 flow in the Calapooia River was about 20 years, which is similar to the 1961 flood (Table 5-2). The 1996 peak flow experienced in Brownsville may have been more extreme than indicated by estimated values for the Holley and Albany sites. A local newspaper account (*The Times* 2/23/96, p.10, as cited in Oregon Cascades West Council of Governments 1996, p.62) noted that a low-lying area in Brownsville occupied by the City Shop and other infrastructure flooded in 1996 but not during the 1965 flood.

The predictive equation presented above can be used to estimate future peak flows for the Calapooia River since the Mohawk River gauge is still operating. The annual peak flow for any year can be obtained at: http://or.waterdata.usgs.gov/nwis/current?type=flow

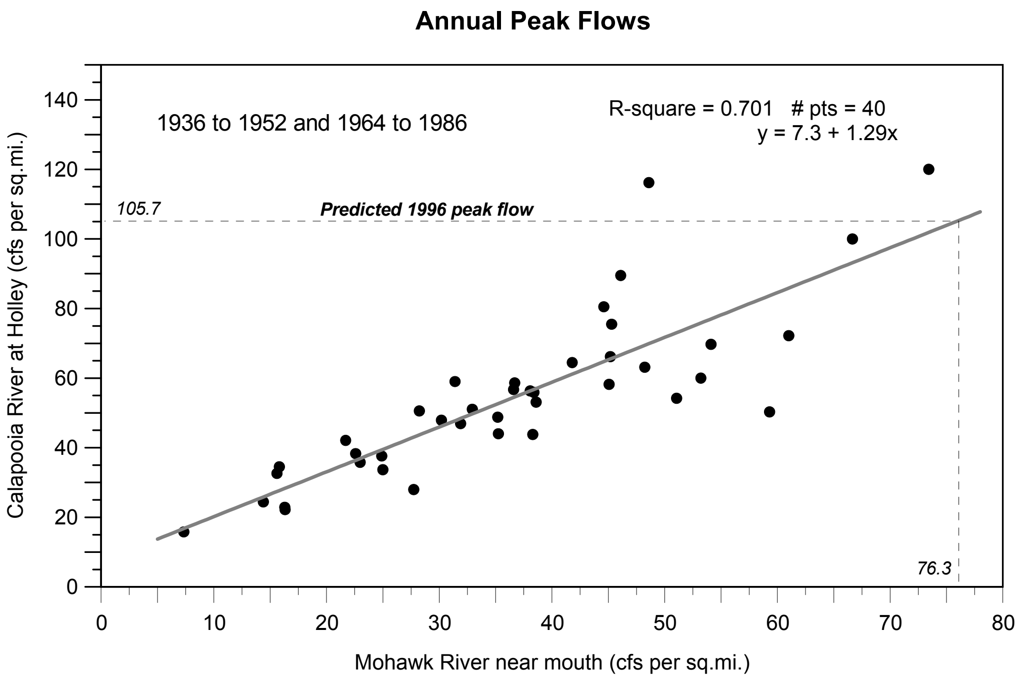
Peak flows in smaller streams can increase dramatically when much of the watershed is paved and runoff from roofs is routed into the streams. Typically, full urbanization of a small watershed in the Willamette Valley increases peak flow values about 3-fold. Encroachment of buildings and roads into the expanded floodplain can then result in floodwater damage. Peak flow increases in larger streams and rivers seldom occur because only a minor portion of an entire watershed is urbanized.

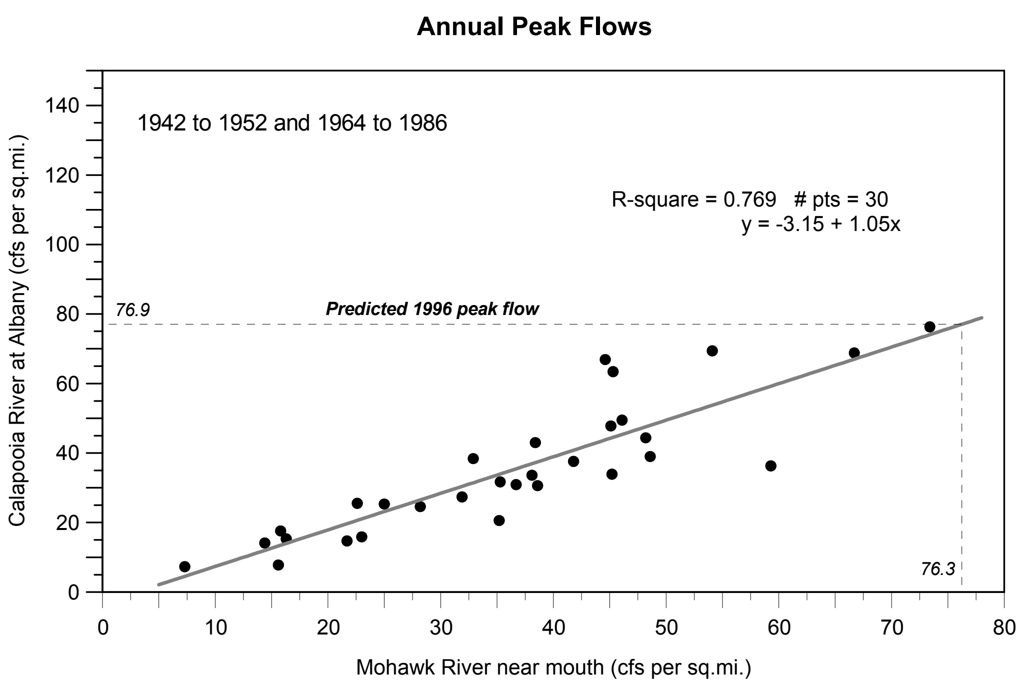
Water use

Surface water in the Calapooia River Watershed is used mainly for irrigation, power development, municipal use, and aesthetics. Water rights also exist for recreation, manufacturing, fish culture, fire protection, and instream flows for fish.

Water rights and use in the watershed are unusual because of two, large power development water rights at the Thompson's Mill site in the lower portion of the Calapooia River. One of these rights is for 35 cfs and has a priority date of 1858. The other is for 145 cfs and has a priority date of 1933. The 1858 right is the oldest of any water use permit in the basin and was granted for hydro-mechanical power (grinding grain). The 1933 right is older than most other water use rights in the basin and was granted for the generation of hydro-electric power. Because the combined rate of these two water rights exceeds natural flows during the irrigation season, the use of water for irrigation, municipal purposes, and instream flows upstream of the Thompson's Mill site, in theory, is disallowed.

Figure 5-7. Relationships between annual peak flow values measured in the lower Mohawk River versus values for the Calapooia River at Holley and at Albany for all years when gauges on both rivers were operational. Also shown are the actual 1996 peak flow values for the Mohawk River and the predicted values for the Calapooia River.





The purpose of instream water rights is to maintain flows for supporting fish and other aquatic life. Like all other rights, instream water rights are junior to all other senior water rights. Two instream water rights, each with a priority date of 1964, exist for the Calapooia River. One is for 30 cfs, measured at Holley and the other is for 20 cfs, measured at Albany. During recent droughty summers (2001 to 2003) some water rights junior to the instream rights have been shut down to help maintain the instream water rights.

Municipal water for the City of Brownville is extracted from the Calapooia River. Two water rights exist for this purpose. One is for 0.67 cfs and has a priority date of 1962. The other is for 0.58 cfs and has a priority date of 1983. Actual water use by the city during August in the last decade has averaged about 0.55 cfs. Water rights (and their transformations over time) for the City of Brownsville are summarized in Table 5-3.

Table 5-3. Surface and groundwater water rights granted to the City of Brownsville.

Permit/ Certificate	Description	Priority date	Amount (cfs)
S-27871	Municipal use; Transfer #6860 changed point of delivery to an infiltration gallery next to the river	2/3/62	0.67
S-47733	Municipal use	7/6/83	0.58
GR cert 12	Municipal use; groundwater well near river	12/31/21	0.50
G-12406	Municipal use; groundwater well near river, use limited to November through June	12/7/92	1.25

An aesthetic and irrigation water right exists for the diversion of water from the Calapooia River at the Brownsville Dam into a canal that flows through Brownsville. The water right is for 2.23 cfs and has a priority date of 1994, and because it is so recent, it occasionally gets shut down during droughty summers in order that other, more senior water rights, are satisfied. Casual observations during the summer indicate that only about 1 cfs of the diverted water flows back into the river at the downstream end. Because the canal is not lined, the remainder is lost to the ground or transpired by vegetation along the canal. In addition, there are a few small irrigation rights along the canal that diminish its flow to some extent. Because the head gate currently leaks, about 0.5 cfs flows down the canal even when the head gate is closed. The Brownsville Canal Company owns the Brownsville Dam which backs up water in the river so that water can be diverted down the canal.

A recreation water use of 4 cfs exists for Oak Creek, where the stream passes through three large man-made lakes (Freeway Lakes). Interstate highway 5 straddles these lakes, which are borrow pits from the highway construction. The priority date for this water right is 1964.

Most of the other water rights in the basin are for irrigation or a combination of irrigation, livestock watering, and domestic use (Table 5-4). Along with these water rights, each having a use rate in cubic feet per second, is another set of water rights that were issued for water storage that have a usage rate expressed as acre-feet. The summed amount of water storage in the watershed is 263.9 acre-feet and includes 22 sites. For purposes of this study, we have assumed that these ponds are filled or topped off by early summer and that little extra extraction of water from streams or the river occurs during the remainder of the summer to fill these ponds. We have also assumed that all other rights, except the recreation, instream, and power development water rights, involve consumption of water during periods of lower river flow.

Total permitted water consumption, by river or stream reach, is summarized in Table 5-4 and indicates a total permitted consumptive use of 46.03 cfs for the Calapooia River, 0.31 cfs for Oak Creek, 4.25 cfs for Courtney Creek, and 6.47 cfs for Brush Creek. Except for Oak Creek, these permitted water uses exceed normal summer flows.

We constructed a reach-by-reach budget of actual August flow and maximum permitted water use (consumptive use only) for the Calapooia River, for water rights of various priority date classes. Those with a priority date between 1926 and 1950 were considered "older", those with a priority date between 1951 and 1964 were considered "middle", and those dated after 1964 were considered "younger".

First, we evaluated Calapooia River flows in August, the month with the lowest flow. We also evaluated flows for June, the month when upstream movement of adult spring chinook salmon is most critical. Assuming normal August flows (50% exceedence), the actual measured flow from Holley (38 cfs) to Albany declined only 4 cfs to 34 cfs (Figure 5-8). If all of the older consumptive water rights along the river were to be exercised, the river would drop below 30 cfs at Albany. If all of the middle and older rights were to be exercised, the river would drop below 15 cfs at Albany. The 1964 instream water right at Albany would then limit any further use of water since the flow would be below 20 cfs. If the instream water right did not exist, and all consumptive water rights (all priority dates) were exercised, the river would be dry downstream of Butte Creek.

Table 5-4. Water rights by reach for the Calapooia River and three selected tributaries.

Main Calapooia River – permitted water use in cubic feet per second

Use	Consumptive in August?	Downstream of Butte Creek			Upstream of Butte Creek									
		1	2	3	4	5	Sodom Ditch	6	7	8	9	10	Above 10	*Total*
Irrigation, livestock, domestic	Yes									0.05				*0.05*
Irrigation, domestic	Yes												0.04	*0.04*
Irrigation	Yes	2.60	1.14	6.81	3.91	2.34	2.14	7.27	2.95	4.21	6.73	1.60	0.66	*42.36*
Supplemental irrigation	Yes												0.10	*0.10*
Municipal	Portion*								1.25					*1.25*
Aesthetics	Portion**								2.23					*2.23*
Total, consumptive uses		2.60	1.14	6.81	3.91	2.34	2.14	7.27	6.43	4.26	6.73	1.60	0.80	*46.03*
Power development	No					185.00								*185.00*

*actual use is 0.55 cfs

** actual use assumed to be 1.23 cfs

In addition to above, 263.9 acre-feet of storage occurs throughout the watershed (22 sites); assumed to not be a consumptive use in August

Selected tributaries; Oak Creek, Courtney Creek, and Brush Creek – permitted water use in cubic feet per second													
	Consumptive in August?	**Oak 1**	**Oak 2**	**Oak 3**	***Total***	**Court. 1**	**Court. 2**	**Court. 3**	**Above C3**	***Total***	**Brush 1**	**Brush 2**	***Total***
Irrigation	Yes	0.08	0.23		*0.31*	0.76	1.51	0.70	1.17	*4.14*	6.47		*6.47*
Manufacturing	Yes				*0.00*			0.11		*0.11*			*0.00*
Total, consumptive uses					*0.31*					*4.25*			*6.47*
Recreation	No	4.00			*4.00*					*0.00*			*0.00*

Repeating the analysis using an August flow typical of drought years (80% exceedence), the measured flow at Holley (29 cfs) decreases 6 cfs to 23 cfs at Albany (Figure 5-9). Ignoring the 1964 instream water right, the river would drop below 15 cfs at Albany if all of the older consumptive water rights along the river were exercised. If all of the middle and older rights were exercised, the river would be dry at Albany. If all consumptive water rights were exercised, the river would be dry downstream of the Sodom Ditch diversion.

In the above scenarios, all water use upstream of Thompson's Mill is legally subject to the senior power development rights at this site. Actual flow measurements at Holley and Albany indicate that very few consumptive water rights are being used to their fullest rate during August. Even during drought years, in August, the river declines only 6 cfs from Holley to Albany. Irrigated lands along the river are currently limited mainly to pasture and a few orchards. If the fall rains are late, water is also sometimes used to irrigate newly-planted grass seed fields. The introduction to the valley of a highly-valuable crop that requires irrigation could greatly change the water budget of the Calapooia River, as seldomly-used water rights would be exercised.

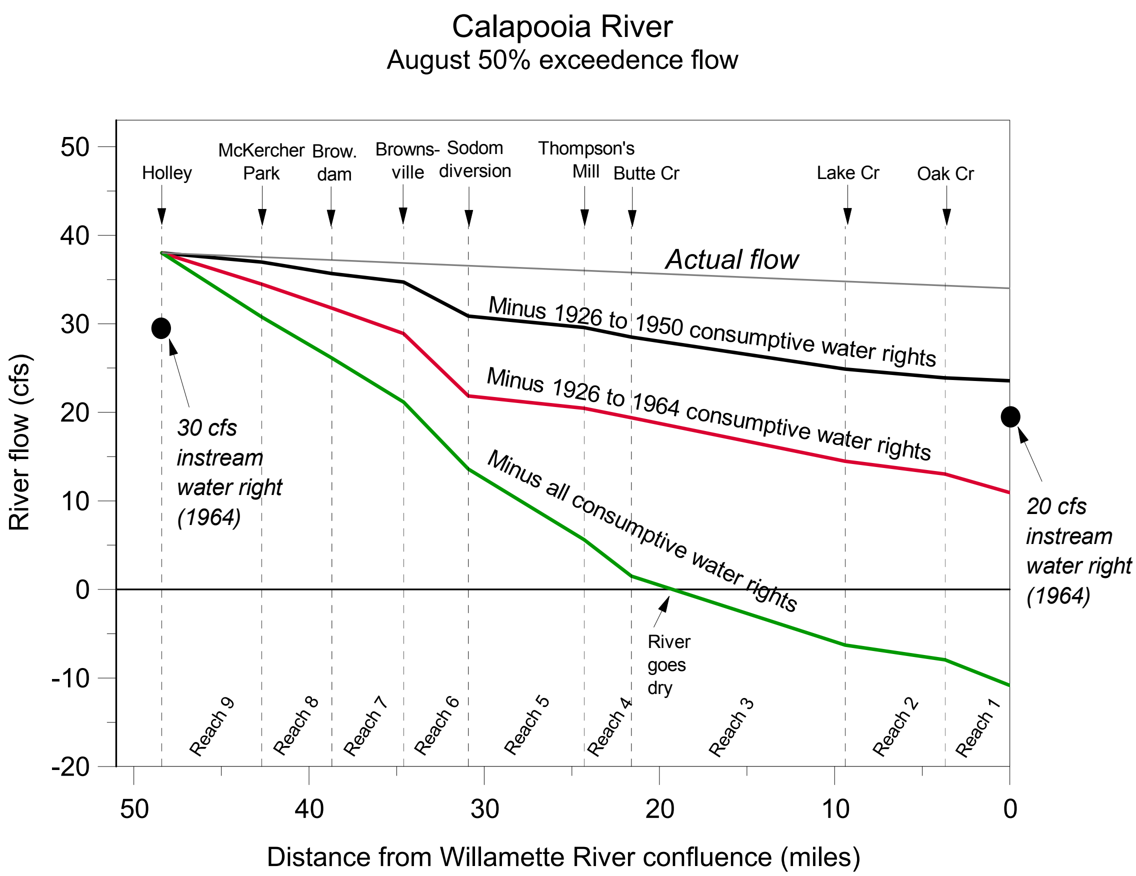
An evaluation of river flow in June, the time when upstream movement by spring chinook salmon is most important, indicates that even with full use of all consumptive water rights, there is not a significant decline in river flow. Measurements of actual flow indicate that the river increases from 144 cfs at Holley to 184 cfs at Albany for a normal June and from 94 cfs at Holley to 121 cfs at Albany for a droughty June. Even for a droughty June with all consumptive water uses being exercised at once, the river flow would not drop below 75 cfs (Figures 5-10 and 5-11). An estimate of the river's actual flow in June for two locations where fish passage is hindered by dams (Sodom Dam and Brownsville Dam) is shown in Table 5-5.

Table 5-5. Estimated actual flow for the Sodom Diversion and Brownsville Dam sites for June based on records for the Holley and Albany gauging sites from 1941 to 1981.

Location	50% exceedence (normal)	80% exceedence (droughty)
Brownsville Dam	153 cfs	100 cfs
Sodom Diversion	160 cfs	105 cfs

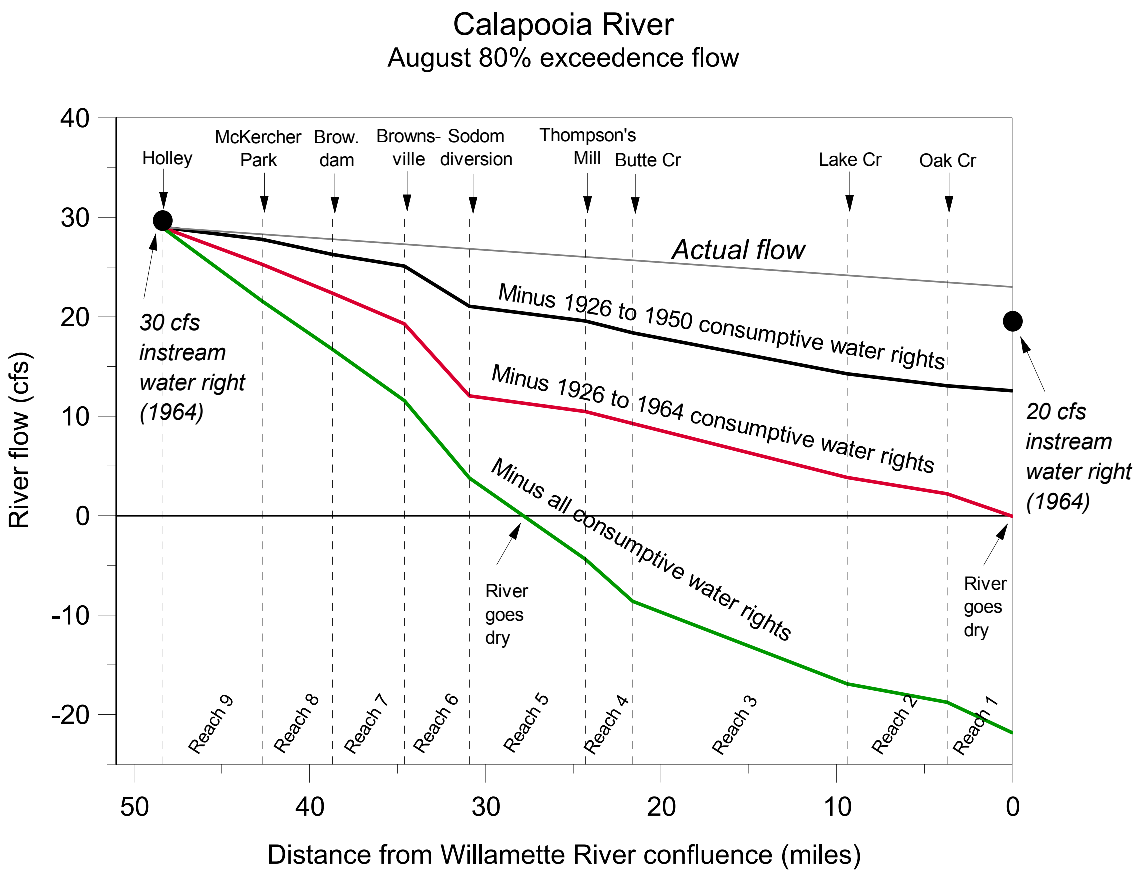
Flows in tributaries of the Calapooia River have not been systematically measured so flow declines due to water use can not be evaluated. Brush Creek, of any tributary in the watershed, has the greatest risk of incurring fish habitat degradation due to water withdrawals. Visual estimates of flow in Brush Creek during the droughty summer of 2003 indicate it dropped to about 2 cfs by August. If all of the water use permits for Brush Creek (6.47 cfs) had been exercised, it would probably have been completely dewatered. As we describe later, Brush Creek is the sole tributary in the middle and lower watershed that has water cool enough to provide thermal refuge for spring chinook salmon, trout, and mountain whitefish during the summer.

Figure 5-8. Modeled river flow in August assuming full permitted water use of three priority date age classes; for 50% exceedence interval flows (an average summer) at Holley and Albany. Actual flow based on records from 1941 to 1981.



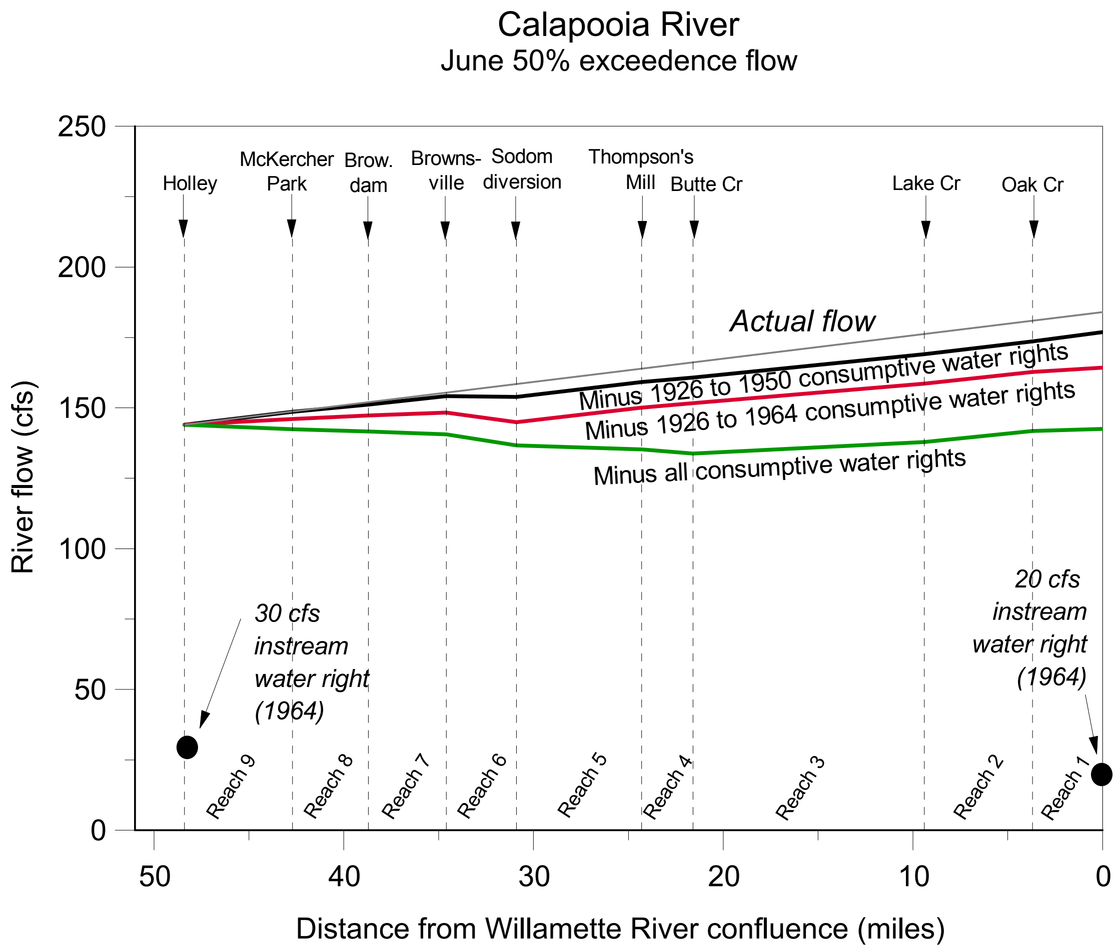
Consumptive water rights upstream of Holley:
1926 to 1950 = 1.36 cfs
1926 to 1964 = 2.37 cfs
1926 to 2003 = 2.40 cfs

Figure 5-9. Modeled river flow in August assuming full permitted water use of three priority date age classes; 80% exceedence interval flows (a droughty summer) at Holley and Albany. Actual flow based on records from 1941 to 1981.



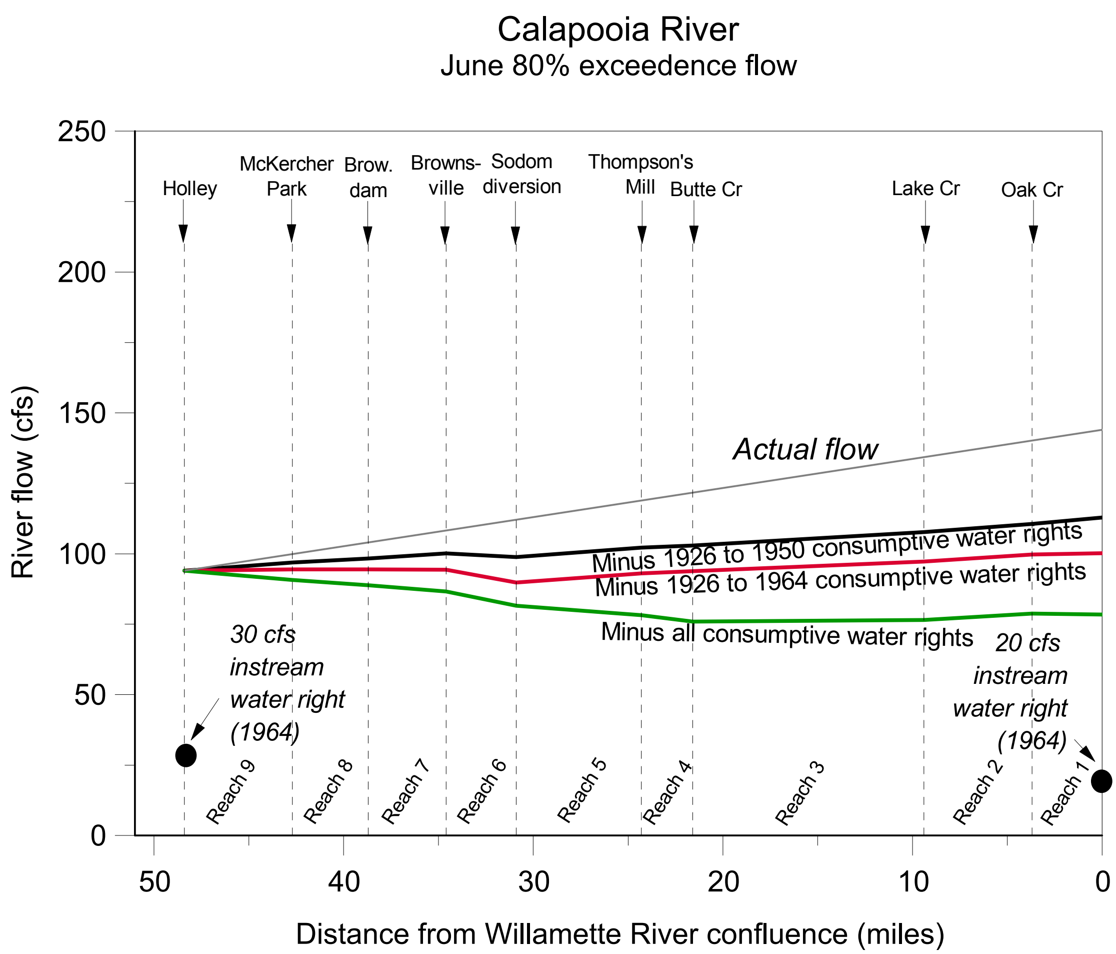
Consumptive water rights upstream of Holley:
1926 to 1950 = 1.36 cfs
1926 to 1964 = 2.37 cfs
1926 to 2003 = 2.40 cfs

Figure 5-10. Modeled river flow in June assuming full permitted water use of three priority date age classes; 50% exceedence interval flows at Holley and Albany. Actual flow based on records from 1941 to 1981.



Consumptive water rights upstream of Holley:
- 1926 to 1950 = 1.36 cfs
- 1926 to 1964 = 2.37 cfs
- 1926 to 2003 = 2.40 cfs

Figure 5-11. Modeled river flow in June assuming full permitted water use of three priority date age classes; 80% exceedence interval flows at Holley and Albany. Actual flow based on records from 1941 to 1981.



Consumptive water rights upstream of Holley:
1926 to 1950 = 1.36 cfs
1926 to 1964 = 2.37 cfs
1926 to 2003 = 2.40 cfs

Discussion

Most consumptive use of water from the Calapooia River occurs at locations downstream of areas that are cool enough to support cool-water species such as salmon, trout, and mountain whitefish during the summer months (discussed Chapter 6: Fish Populations and Habitat). Cool-water species oversummer mostly in upper portions of the watershed where water withdrawals do not occur. Consequently, where water withdrawals occur, there is not a significant reduction in living space. Neither does water use influence water temperature for these species. Furthermore, actual water use is much less than permitted amounts due, in part, to the scarcity of crops along the river that require much irrigation. Measurements of flow at the two gauging stations from 1941 to 1981 indicate that Calapooia River flow in August decreases only 20% from the upper site at Holley to the lower site at Albany during drought years.

Water withdrawals are most dire for Brush Creek, a stream that has permitted water use several times greater than its natural flow. Since Brush Creek is cool enough to support cool-water fish during the summer, reductions in flow can result in less living space for fish and warmer water. Streams with little water are more likely to warm when exposed to sunlight. Attempts to conserve water in the Calapooia River Watershed for the benefit of fish would best be focused on Brush Creek. Landowners have the option of leasing water to the state as instream water rights towards the benefit of fish. This allows them to retain their water rights without having to demonstrate periodic use of the water. Because of the nature of Oregon's water use laws, the leasing of water rights with the oldest priority dates would benefit fish the most.

References

Oregon Cascades West Council of Governments. 1996. The Cascades west region of Oregon and the February flood of 1996: A regional flood recovery plan for Benton, Lane, Lincoln and Linn Counties. Report prepared for the Economic Development Administration. Oregon Cascades West Council of Governments, Albany, OR.

Chapter 6. Fish Populations and Aquatic Habitat

Introduction

This chapter summarizes what is known about fish populations and habitat in the Calapooia River and tributary streams. The chapter examines natural and management factors that influence fish movement through streams, stream habitat quality, and changes in populations through time. The discussion will include an evaluation of the major influences on key fish populations in the Calapooia River Watershed.

Methods

Studies, inventories, and other documents produced by the Oregon Department of Fish and Wildlife (ODFW), Oregon State University (OSU), City of Albany, Weyerhaeuser, and other sources, provided information on fish habitat, spawning and rearing fish populations, and fish passage barriers (Table 6-1). We completed a field inventory of fish passage barriers at over 80 road crossing culverts and bridges in upper Courtney Creek, Brush Creek, and other tributaries to the Calapooia River upstream of Brownsville. In addition, ODFW has completed a study of fish passage at the Dams within the Thompson's Mill. Stream channels were classified and mapped based on stream gradients, to provide an overview of some channel characteristics that influence fish distributions and habitat.

Watershed overview of fish species and habitat

Native and non-native fish species

This section provides an overview of the fish species found in the Calapooia River Watershed; other portions of this chapter describe fish distribution and, for fish where there is information, their population status. There is a diversity of native fish species living in the stream, river, and pond habitats within the watershed. Four salmonid species (family *Salmonidae*), and a variety of other non-salmonid native species inhabit the watershed for at least a portion of their life cycle (Table 6-2). The fish life cycle stages include migration (by adult and juveniles), spawning, juvenile rearing, and adult residence. The salmonid fish species inhabiting the watershed are spring chinook salmon, winter steelhead, cutthroat trout, and mountain whitefish. Table 6-3 describes the habitat preferences for cutthroat trout, winter steelhead and spring chinook through-out their life cycle.

Table 6-1. Summary of primary studies and reports used in the Assessment to characterize native and non-native fish populations, distribution, and habitat in the Calapooia River Watershed.

Studies and Reports	Watershed Location	Topics
Stream Habitat Inventories (Oregon Department of Fish and Wildlife 1991)	Calapooia River (above Holley), Potts Creek, N.F. Calapooia	Inventory of stream habitat characteristics: Pools, riffles, large wood, substrate, and other data.
Santiam and Calapooia Subbasin Fish Management Plan, ODFW (Wevers et al. 1992)	Entire Calapooia River Watershed	Description of fish populations, distribution, habitat, and management recommendations.
Fish Sampling in the Willamette River and Lower Tributaries (Gregory et al. 1998)	Calapooia River at and near the Confluence with the Willamette River	Inventory of fish species, numbers and habitat.
Calapooia River Watershed Analysis (Weyerhaeuser 1998)	Upper Calapooia River Watershed	Description of fish species, stream habitat, and forest management recommendations.
Albany Fish Survey: Summary and Species Profiles (City of Albany and Oregon Department of Fish and Wildlife 2002)	Oak Creek, lower Calapooia River Watershed	Inventory of fish species presence and distributions; summary of native and non-native species characteristics and habitat needs.
Preliminary Results from Fish and Amphibian Sampling in Seasonal Streams in the Lower Calapooia River Watershed (Randy Colvin, Oregon State University, personal communication, 2003)	Tributaries in the lower Calapooia River Watershed	Study of fish species, distribution, and habitat in seasonal streams.
Thompson's Mill Flow and Habitat Assessment Project: Final Report for OWEB Grant #201-625B (Oregon Department of Fish and Wildlife 2004)	Thompson's Mill Complex (Calapooia River and Sodom Ditch), middle Calapooia River Watershed	Monitoring of fish use, and passage timing over the complex's dams; summary of stream habitat, flow and water temperature characteristics.

These salmonid species use the entire watershed for the different parts of their life cycle. Non-salmonid fish present in the watershed include Pacific lamprey, a variety of minnow and sculpin species, the largescale sucker, and other fish. There is a greater abundance of non-salmonid fish in the lower watershed, but some species, such as shiners and sculpin species are found throughout the watershed. There is also a variety of non-native fish in the watershed (Table 6-4). These fish have been "introduced" (either accidentally or intentionally) to the Willamette River and tributary streams. Most of the documented use by non-native fish is in the lower watershed where warmer water temperatures and altered habitat have provided ideal conditions for many of these fish.

Table 6-2. Names and distribution for native fish documented to be currently (or historically) residing in the Calapooia River and tributaries. Oregon chub (see note below) historically resided in the lower Calapooia River Watershed (ODFW 2002, Weyerhaeuser 1998, Scheerer 2000)

Salmonid	**Notes**
Winter steelhead, *Oncorhynchus mykiss* Spring Chinook salmon, *Oncorhynchus tshawytscha* Cutthroat trout, *Oncorhynchus clarki clark* Mountain whitefish*, Prosopium williamsoni*	Willamette spring chinook and winter steelhead (both anadromous species) were listed as threatened under the federal Endangered Species Act (ESA) in 1999. Factors contributing to their decline include habitat loss, fish passage barriers, altered flow regimes, water quality, and the negative impacts of hatchery fish.
Non-salmonid	
Lamprey Pacific lamprey, *Lampetra tridentata* Western brook lamprey, *Lampetra richardsoni*	Pacific lamprey are anadromous (adults reside in the ocean and return to rivers and streams to spawn) and brook lamprey are resident species. Pacific lamprey was listed as an Oregon state sensitive species in 1993 due to a serious decline in abundance.
Minnows Speckled dace, *Rhinichthys osculus* Longnose dace, *Rhinichthys cataractae* Nothern pikeminnow, *Ptycheilus oregonensis* Redside shiner, *Richardsonius balteatus*	Dace occur throughout the watershed, primarily in the Calapooia River and the lower portions of tributaries.
Suckers Largescale sucker, *Catostomus macrocheilus*	Most suckers occur in the lower watershed, primarily in the Calapooia River
Sculpins Mottled sculpin, *Cottus baurdi* Paiute sculpin, *Cottus beldingi* Prickley sculpin, *Cottus asper* Shorthead sculpin, *Cottus confusus* Reticulate sculpin, *Cottus perplexus* Torrent sculpin, *Cottus rhotheus*	Sculpins occupy streams throughout the watershed, with the greatest abundance in the upper Calapooia River and tributaries.
Other species Oregon chub, *Oregonichys crameri* Sand roller, *Percopsis transmontana* Three-spine stickleback, *Gastrosteus aculeatus* Chiselmouth, *Acrocheilus alutaceus* Peamouth, *Mylocheilus caurinus*	Most of these species occur in the lower watershed in the Calapooia River and permanent and seasonal tributary streams. Oregon chub, *Oregonichys crameri*, is a small minnow native to the Willamette River basin. Oregon chub were listed as endangered under the Federal ESA. Chub prefer low gradient tributaries and off-channel habitats such as side-channels and sloughs. Their decline has been attributed to loss of habitats, altered flow regimes, and predation.

Table 6-3. Habitat and water quality preferences for the Calapooia River Watershed's cutthroat trout, winter steelhead and spring chinook salmon. (Water quality issues are covered in Chapter 7, Water Quality).

Species	Habitat Needs
Winter steelhead	Migration and spawning: Returning adults enter the Calapooia River between December and April, with peak spawning in May. Spawning occurs in low/moderate gradient streams (up to 8%). Most of the winter steelhead spawning takes place in the river channel and tributary streams above Holley. Rearing: Juveniles rear in the upper river and smaller tributaries for as long as 4 years in fresh water; prefer pools with cover, large wood, and cool water temperatures (less than 64 deg. F), and high dissolved oxygen levels.
Cutthroat trout	Migration and Spawning: There are two life history forms of cutthroat residing in the Watershed: 1) Resident cutthroats grow, mature, and spawn often very close to the location from which they hatched; and 2) cutthroat residing in the Calapooia River and larger streams that migrate to smaller streams for spawning. Both forms spawn in spring. Cuthroat spawning habtiat requires connected streams (free from fish passage barriers). Rearing and adult: Juvenile and adult resident cutthroat reside in tributary streams, often in very small streams with gradients up to 12%. Cutthroat trout will move up and down the stream, particularly to escape warm water temperatures in the summer and into seasonal streams to escape high flows in the winter. Adult and juvenile cutthroat trout require cool water temperatures (less than 64 deg. F), and high dissolved oxygen levels.
Spring chinook salmon	Migration and spawning: Spring chinook enter the Calapooia River watershed in late April and May with the migration to the river continuing into July. Spawning takes place between September and mid-November. Before spawning, adult spring chinook hold in pools, preferring deep pools with cool water, abundant large wood, and undercut banks for cover. Most of the spring chinook spawning takes place in the river channel and tributary streams above Holley. Spring chinook salmon die after spawning. Rearing: Juveniles can spend up to a year rearing in the Calapooia River. Like other salmonids, juvenile spring chinook require cold water, and deep pools for feeding and cover from predators. Access to tributary streams to find refuge from high flows in the winter is also important. Juvenile spring chinook salmon require cool water temperatures (less than 64 deg. F), and high dissolved oxygen levels.

Table 6-4. Non-native fish documented in the Calapooia River and tributaries.

Non-Native Species (all non-salmonid)
Largemouth bass, *Micropterus salmoides*
Smallmouth bass, *Micropterus dolomieui*
Yellow bullhead, *Ameiurus natalis*
Bluegill, *Lepomis macrochirus*
Pumpkinseed, *Lepomis gibbosus*
Crappie (black), *Pomoxis nigromaculatus*
Brown bullhead, *Ameiurus melas*
Western mosquito fish, *Gambusia affinis*
Goldfish, *Carassius auratus*

Anadromous fish spend a portion of their lives residing in the ocean and return to the watershed for spawning and juvenile rearing. There is concern over decreased populations of resident and anadromous fish that currently or historically resided in the Calapooia River Watershed. Three anadromous fish species that reside in the Calapooia River Watershed are: spring chinook salmon, winter steelhead, and Pacific lamprey. Because anadromous fish have very complex life cycles, including migrating through the river and stream network as adults on their way to spawning areas and as juveniles moving downstream to the ocean, they are very vulnerable to predation and human-related issues such as passage barriers, fishing pressures, and changes in habitat. Upper Willamette River spring chinook salmon and winter steelhead are listed as *threatened* under the Federal Endangered Species Act. Pacific lamprey is listed as an Oregon state sensitive species.

In addition to these anadromous fish, there are reduced populations of Oregon chub, a resident fish native to the Willamette River basin. Historically, chub used side channels and other backwater areas in the lower Calapooia River Watershed, though there are no current reports of populations. Oregon chub were listed as endangered under the Federal Endangered Species Act in 1993. The population status and distribution for each of these species will be described in later sections of this chapter.

The physical setting

The Calapooia River Watershed is complex. Water flow, stream habitat, and fish populations change through the seasons and over time in response to natural and human events. Natural events such as floods and droughts help shape stream habitat, and affect fish distributions and populations. Human actions, such as construction of roads, water diversions, and land use practices, can modify stream and riparian habitat, change fish movement through the river and tributary streams, and impact fish populations.

To help understand the river and stream network and its influence on fish distributions and habitat, it is useful to think about how river and stream channels are shaped by their location in the watershed (Montgomery and Buffington 1993). Small and steep headwater streams provide very different fish habitat conditions than do the larger, meandering channels in the low gradient valley of the lower Calapooia River.

A framework for classifying the stream network was developed for this report using channel gradients derived from a digital topographic map of the watershed. The following stream types were used to classify and map the stream reaches:

Source streams: These are steep headwater streams (greater than 20% slope). These streams are usually straight, have no floodplain, and are source areas for sediment, gravels and wood that can move into lower gradient stream channels. The movement of wood, sediment, and gravels is important for creating fish habitat in downstream reaches. In the mountainous area of the upper watershed, these steep stream channels can be prone to landslides and debris torrents that move wood and sediment down to the Calapooia River channel. Many of these streams have seasonal water flows (with a dry channel by July, for example). Fish usually do not use these steep, narrow streams.

Source stream reaches are present in the upper portions of most streams. Examples include the high gradient headwaters of Courtney Creek, Brush Creek, and numerous tributaries (for example, Bigs and Potts Creeks) in the upper portions of the watershed.

Transport streams: These streams have moderate to high gradients (4 – 20% slope). They can develop small meanders in moderately narrow valleys with small floodplains. Sediment, gravels, and wood can be stored in these stream channels before they move into lower gradient streams during periodic flood events. The upper extent of fish distribution usually ends within these streams. Cutthroat trout use steep headwater streams with gradients up to 12%. Cutthroat adults will reside and spawn in these small tributaries, often using seasonal streams that are dry by June. Where there is appropriate habitat, winter steelhead will spawn and their juveniles will rear in streams with up to 10% gradients.

Transport stream reaches are present in the middle portions of tributary streams and the very upper reaches of the Calapooia River. Examples include the moderate gradient reaches of Butte Creek in the lower watershed, Warren Creek in the middle portions of the watershed, and Potts Creek in the upper watershed.

Deposition streams: These streams are low gradient (less than 4 % slope). They tend to be meandering streams in wide valleys with large floodplains. Sediment, gravels, and wood are deposited in these streams for long periods of time. Because wood and gravels are deposited in these streams, they can be very sensitive to change from natural events such as floods and human-related impacts such as removal of large wood and gravel from the channel, and trees along stream banks.

Deposition streams include the Calapooia River (RM 1 to RM 70) and the lower portions of most tributary streams. These low gradient stream reaches provide much of the important fish habitat in the Calapooia River Watershed. Spring chinook and winter steelhead migrate up the Calapooia River channel to spawning areas in the upper watershed and their juveniles will rear and then move through the low gradient reaches. Other fish, such as three-spine sticklebacks and cutthroat trout, will use the low gradient streams within the lower watershed near and within the cities of Albany and Tangent, including seasonal streams that do not have water in the summer and fall.

Figure 6-1 shows the distribution of stream channel types for the three Calapooia River Watershed areas – lower, middle, and upper (Map 2, *Shaded Relief*). The distribution of channel types varies throughout the watershed (Table 6-5). More than 50% of the channels in the Calapooia River Watershed are low gradient (less than 4% slope), with the largest number of miles located within broad valley areas of the lower watershed; the greatest proportion of high gradient streams (greater than 20% slope) is concentrated in the mountainous headwaters in the upper watershed.

Figure 6-1. The distribution of source, transport, and deposition stream reaches within the lower, middle, and upper Calapooia River Watershed.

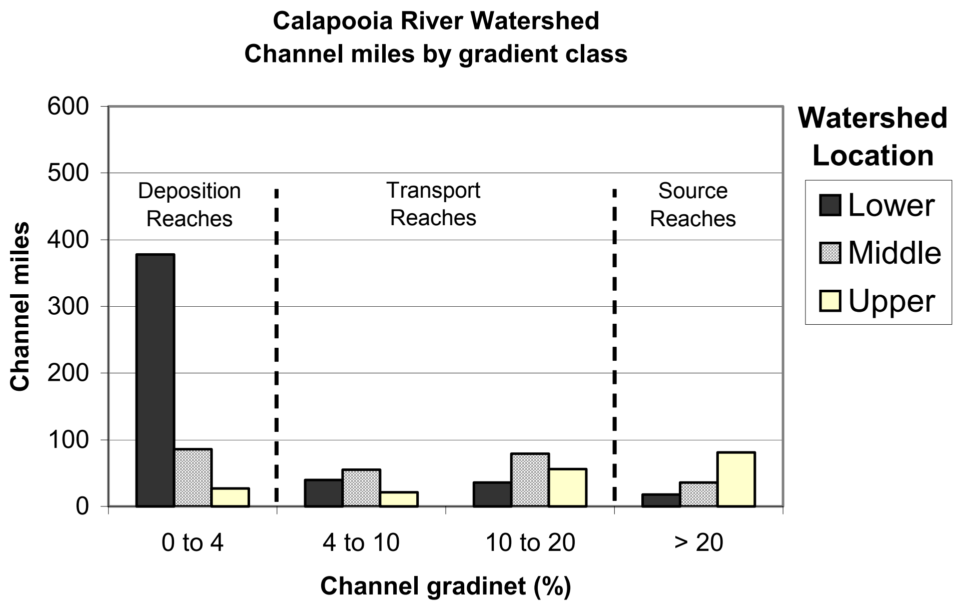


Table 6-5. Miles of stream channels by gradient class for the lower, middle, and upper Calapooia River Watershed.

Stream Channel Type	Gradient (%)	Miles of Channels for the Calapooia River Watershed Areas			Total Mi.	Percent of Watershed
		Lower	Middle	Upper		
Deposition	0 to 4%	378	86	27	491	53.8%
Transport	4 to 10%	40	55	21	116	12.7%
	10 to 20%	36	79	56	171	18.7%
Source	> 20%	18	36	81	135	14.8%
	Total	472	245	185	913	100%

Lower Calapooia River Watershed

Native and non-native fish species: distribution and status

The greatest diversity of fish species is found in the lower Calapooia River Watershed. In this portion of the watershed most of the fish present in the entire Calapooia River Watershed are found at various times of the year. The most abundant fish species are the non-salmonids, both native and non-native. Fish such as three-spine sticklebacks, redside shiners, and suckers are more numerous than trout or salmon. In the upper watershed, this pattern is reversed, with salmonids the most abundant species and non-salmonids a minor component. While the lower river has fewer salmonids, it is an essential area for salmon, trout, and other species during part of their life cycle. The lower river is important as a migration corridor for anadromous winter steelhead, spring chinook salmon, and Pacific lamprey. Winter steelhead and spring chinook salmon must pass through the river in lower and middle portions of the watershed on their way to spawning grounds in the upper watershed. In addition, the tributary streams provide important seasonal habitat during the winter and spring for juvenile salmonid species, including spring chinook salmon and winter steelhead.

In a July 1998 study of the Willamette River, OSU scientists examined fish populations in the river and within the lowest portions of a number of tributaries, including the Calapooia River. This study identified species and tallied fish numbers in the lower Calapooia River within and just upstream from its confluence with the Willamette River. Non-salmonids were the most abundant species, with a very minor number of salmon and trout observed (Figure 6-2). Large-scale suckers were the most numerous native fish, followed by redside shiner, sculpin species, and northern pikeminnow. Significantly, they also noted a number of larval lampreys, indicating that the lower river areas are important habitat for rearing juvenile Pacific lamprey. There were very few salomonids, with one observation each of adult mountain whitefish, cutthroat trout, winter steelhead, and spring chinook salmon. These findings in the Calapooia River were also consistent with their observations for other tributary junctions with the Willamette River, such as the Marys and Santiam Rivers: areas within or near the confluence of tributaries have very high fish population numbers and diversity of species.

In addition to the native fish, the study also found a number of fish and an amphibian that are not native to the Willamette River or other Pacific Northwest streams (Figure 6-3). The non-native fish observations in the lower Calapooia River included bluegill, black crappie, and largemouth bass. Bullfrogs, a non-native amphibian species, were also found. Non-native fish and amphibians are a concern because they occupy habitats used by native species, and they can prey upon fish such as juvenile trout and salmon. For example, non-native bass and bullfrogs have been found to eat young trout and Oregon chub. Non-native fish species are also an indication of degraded habitat conditions, including elevated water temperatures.

Figure 6-2. Native fish species found in an inventory of the lower Calapooia River near its confluence with the Willamette River (data summarize from Gregory et al.1998). There was one observation each of adult winter steelhead trout, mountain whitefish, cutthroat trout, and spring chinook salmon.

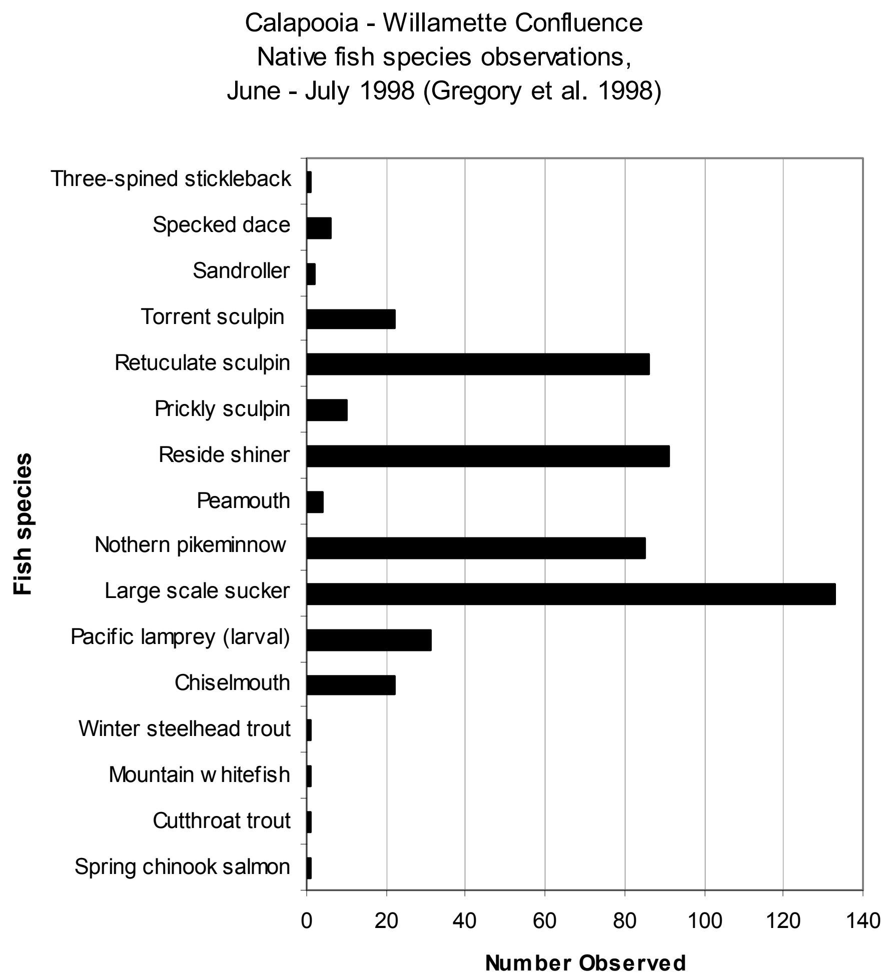
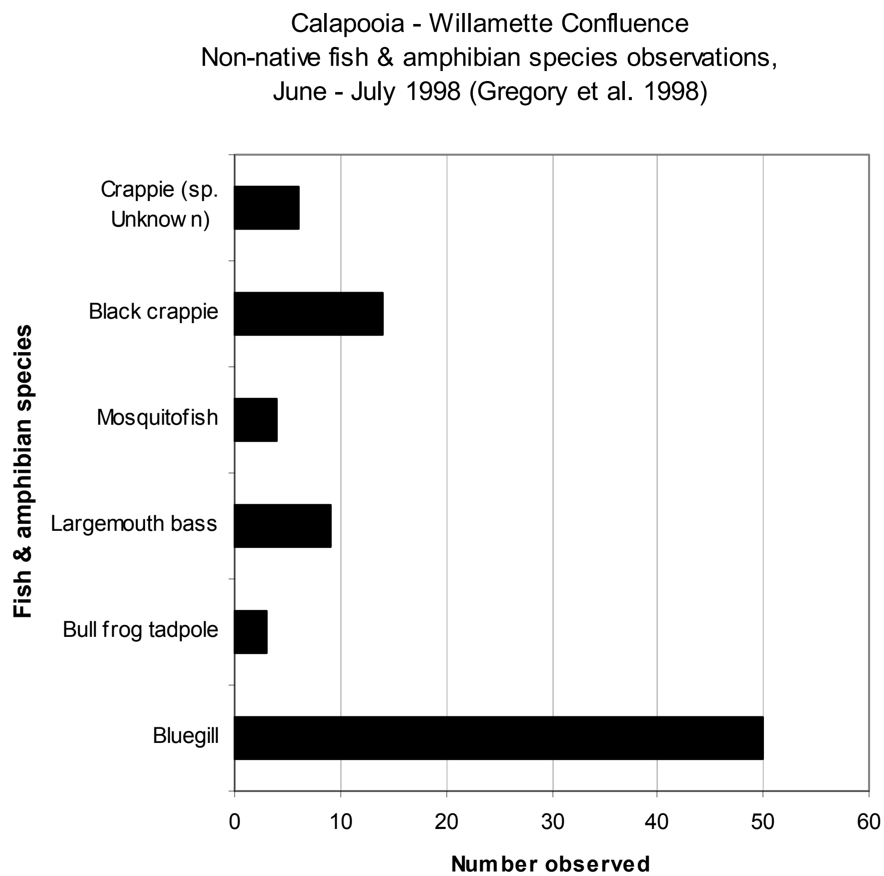


Figure 6-3. Non-native fish species found in an inventory of the lower Calapooia River near its confluence with the Willamette River (data summarized from Gregory et al.1998).



Other inventories of fish populations in the lower Calapooia River Watershed have found non-native fish in the river up to the city of Brownsville (RM 30) and in the lower portions of tributary streams such as Lake Creek, Butte Creek, Cochran Creek, Shedd, Walton and Wright Sloughs (Table 6-6). The City of Albany directed a study in which ODFW surveyed streams within and adjacent to the city for fish presence. Non-native fish species were found in most streams, including Oak Creek. Largemouth bass, smallmouth bass, bluegill, western mosquito fish, yellow bullhead, and brown bullhead were all found in Oak Creek.

Table 6-6. Non-native fish distributions in the lower Calapooia River Watershed and tributary streams (RM= river mile).

Non-native Species	Documented Distribution
Largemouth bass	Calapooia to RM 30, Lake Creek to RM 4, Butte Creek to RM 7, Sodom Ditch, Cochran Creek to RM 6, Shedd Slough to RM 2, Walton Slough to RM 3, Wright Slough to RM 1, (Wevers et al. 1992). Oak Creek through RM 1 (ODFW 2002). Calapooia-Willamette River confluence (Gregory et al. 1998).
Smallmouth bass	Calapooia to RM 9.5, Oak Creek to RM 15 (Wevers et al. 1992). Oak Creek through RM 1 (ODFW 2002).
Yellow bullhead	Oak Creek through RM 1 (ODFW 2002).
Bluegill	Calapooia to RM 30, Oak Creek RM 15 (Wevers 1992). Oak Creek through RM 1 (ODFW 2002). Calapooia-Willamette River confluence (Gregory et al. 1998). Seasonal streams (Randy Colvin, OSU, personal communication, 2003).
Pumpkinseed	Calapooia to RM 30 (Wevers et al. 1992).
Crappie (black)	Calapooia to RM 30, Lake Creek to RM 4, Butte Creek to RM 7, Sodom Ditch, Cochran Creek to RM 6, Shedd Slough to RM 2, Walton Slough to RM 3, Wright Slough to RM 1 (Wevers et al. 1992). Calapooia-Willamette River confluence (Gregory et al. 1998).
Brown bullhead	Oak Creek to RM 15, Lake Creek to RM 4, Butte Creek to RM 7, Sodom Ditch, Cochran Creek to RM 6, Shedd Slough to RM 2, Walton Slough to RM 3, Wright Slough to RM 1 (Wevers et al.1992). Oak Creek through RM 1 (ODFW 2002).
Western mosquito fish	Oak Creek through RM 1 (ODFW 2002). Calapooia-Willamette river confluence (Gregory et al. 1998). Seasonal streams (Randy Colvin, OSU, personal communication, 2003).
Goldfish	Seasonal streams (Randy Colvin, OSU, personal communication, 2003).

Many stream reaches in the watershed do not have flowing water by late spring or early summer. These seasonal streams, however, are important habitat for fish. In a study of seasonal streams flowing through agricultural lands in the southern Willamette Valley, OSU scientists studied fish, amphibian and aquatic insect populations and habitat at 22 sites, including a large number of sites in the lower Calapooia River Watershed (Randy Colvin, OSU, personal communication, 2003). Thirteen sites were examined in the lower Calapooia River Watershed, all with stream channels that were dry by June. Most of the sites were in Lake Creek near Tangent, with several other low gradient tributaries (Table 6-7).

All of the seasonal streams examined by OSU in the Calapooia River Watershed had highly variable stream flows that fluctuate with rainstorms. There were general patterns of abundance of fish and amphibian species. Amphibians (primarily roughskin newts and longtoed salamanders) were much more abundant in areas where there were no fish present. At sites where fish were present, pacific tree frogs and redlegged frogs were the most abundant amphibians. The most abundant native fish species observed in the seasonal streams were three-spine sticklebacks and redside shiners. Sticklebacks occupied the sites that were the longest distance from perennial streams – as much as seven miles. Other native species observed included northern pikeminnow, sculpins, dace, and suckers. Non-native fish and amphibians noted were bluegill, mosquitofish, goldfish, and bullfrogs.

In the OSU study, cutthroat trout were the most common salmonids observed in seasonal streams, with some observations listing rainbow trout (probably they were juvenile steelhead) and juvenile spring chinook salmon. Young spring chinook salmon were present at three sites in January and February. These small, seasonal streams provide favorable habitat during winter high flows. During this period juvenile spring chinook and winter steelhead, and adult trout escape from high velocity flows in the river by moving into these seasonal streams where there is slow water.

Fish passage is an important issue in streams that are used seasonally by fish. No fish were found at three of the seasonal stream sites where it appears that downstream fish passage barriers, such as road crossing culverts, were blocking fish access (Randy Colvin, OSU, personal communication, 2003).

Table 6-7. The thirteen seasonal stream sites where fish populations and habitat were studied in the lower Calapooia River Watershed (Randy Colvin, OSU, personal communication, 2003).

Seasonal Stream Sample sites
Southwest Fork of Lake Creek
Lower Lake Creek near Glass Drive
Middle Fork Lake Creek at west end of Tangent Loop
South Fork Lake Creek at southwest side of Tangent Loop
South Fork Lake Creek at Tanget Loop and Wirth Road
North Fork Lake Creek at Lake Creek Drive
Lower Ridge Road Creek
Upper South Fork Lake Creek at 7 Mile Lane
Tributary to Butte Creek at 7 Mile Lane
Plainview Creek at 7 Mile Lane
Spoon Creek at Falk Road
Tributary to Calapooia at Walnut Road
Tributary to Spoon Creek at Falk Road

Fish passage barriers

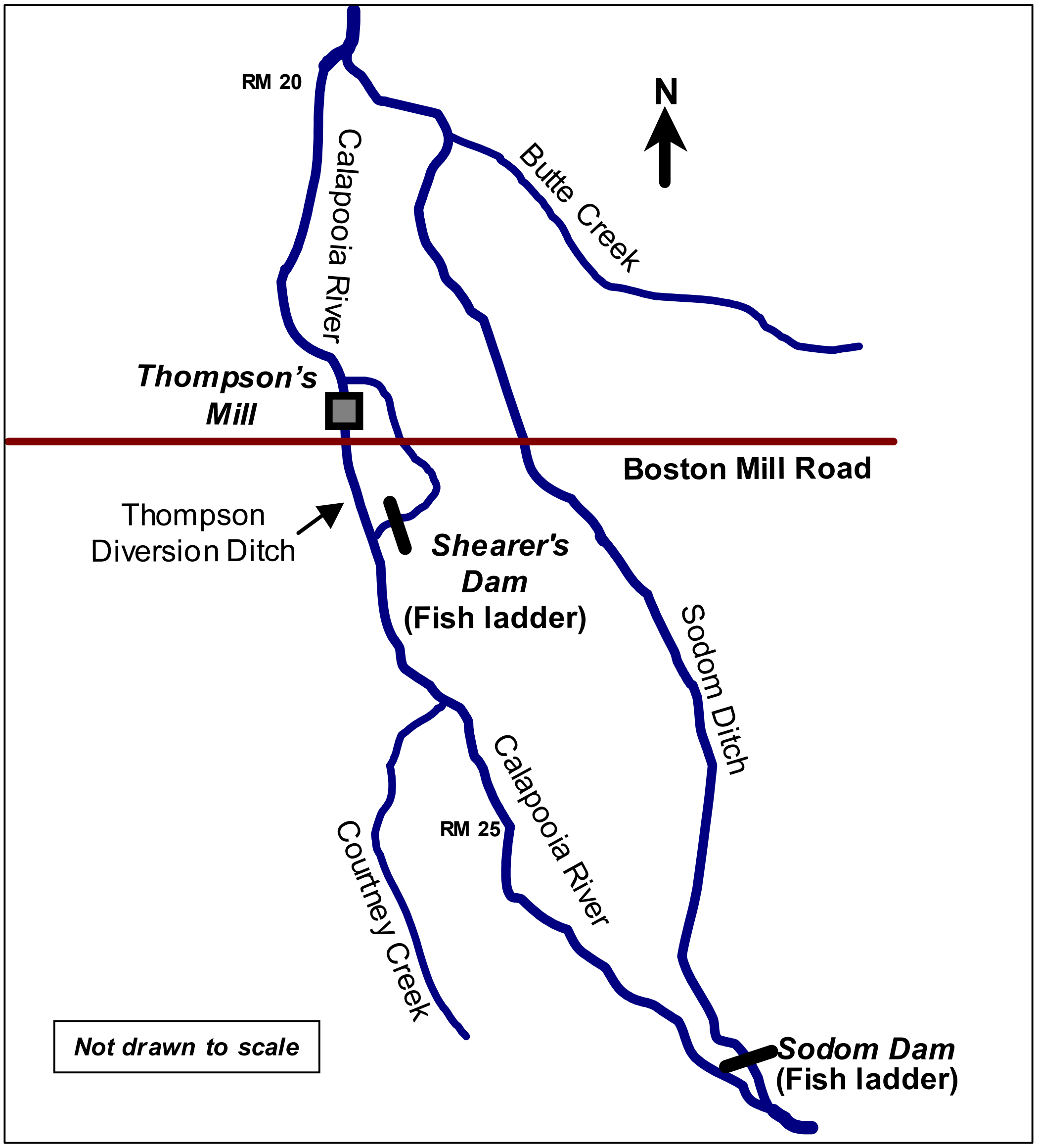
Fish passage barriers on the Calapooia River and tributary streams can pose a significant problem for fish populations. Dams and road crossing culverts are examples of potential fish passage barriers that are present in the watershed. Fish move through the river channel and tributary streams through phases of their life cycle and in response to changing conditions. When there is a barrier to fish passage fish cannot access important areas for spawning or move into cool tributary streams when the Calapooia River or other streams warm during the summer months. Fish passage barriers can totally block fish movement during all times or they can partially block movement for periods associated with high or low stream flows. Partial fish passage barriers can significantly slow the migration of spring chinook salmon and winter steelhead through the river. Fish will often hold in pools at the base of a barrier waiting for conditions to change, creating problems such as stress on the fish, delaying migration, providing opportunities for poaching and predation.

Fish passage has been assessed for dams along the lower Calapooia River corridor, but there are no comprehensive inventories of fish passage barriers for tributary streams. Some road crossings have been assessed through the inventory conducted as part of this assessment in upper Courtney Creek and the middle portions of the watershed (Brush, Pugh, and other tributaries). The results of these fish passage inventories will be covered in the next section on the middle Calapooia River Watershed.

Fish passage barriers on the lower Calapooia River: Migrating fish encounter significant passage problems between river mile 19.5 and 28.5 of the Calapooia River. At this location, there is a complex of dams and diversion ditches associated with Thompson's Mill (Figure 6-4, and Map 14, *Anadromous Fish Distribution, Dams and Habitat Inventory Areas*). Historically, water was diverted through the Mill for producing flour and, more recently, generating electricity. A series of dams and ditches (Sodom and Thompson Diversion Ditch), divert the Calapooia River's flow, which creates problems for migrating fish. During late winter and early spring high flows, more of the river's water passes through Sodom Ditch and less water flows through the natural Calapooia River channel. Migrating winter steelhead move through Sodom Ditch and pass over the fish ladder at Sodom Dam. As flows drop in late spring the Mill needs more of the water to continue generating electricity. The Mill operators manage Sodom Dam to divert more of the river's flow into the Calapooia River channel. Late migrating spring chinook salmon are delayed moving over the fish ladder at Sodom Dam. Water falling over the apron of the dam creates a "false attraction" to the base of the dam, delaying fish movement into the fish ladder.

Fish passage issues within the Thompson's Mill complex have been recognized since the 1960s. Recently, a working group formed to help identify options for addressing the fish passage problems and explore ways to maintain the historic mill. The Thompson's Mill Working Group, comprised of the Mill's owner, state and federal agencies, the Calapooia

Figure 6-4. The dams and diversion ditches associated with Thompson's Mill. Migrating fish encounter significant passage problems in this area of the Calapooia River between river mile 19.5 and 28.5.



Watershed Council, and other stakeholders, has pursued immediate actions to address fish passage issues while working to identify and study solutions. Currently, the Mill operates under a "non-generation" agreement that compensates the owner for not producing electricity during the river's low flow periods in the late spring and summer when fish passage is priority. Under this agreement, currently more water flows into Sodom Ditch, improving passage for spring chinook salmon moving through the ditch. The Working Group is seeking continued funding to maintain the non-generation agreement until a final solution can be agreed on by all stakeholders.

During recent years, the non-generation agreement has allowed the river to flow into Sodom Ditch. Typically this means approximately 2/3's of the flow goes down the Sodom and 1/3 goes down the natural Calapooia River channel. However, the channel substrate changes from year to year and impacts the shape of the Calapooia channel entrance and in some years gravel deposits at the entrance of the Calapooia channel force more of the flow down the Sodom Ditch channel.

To help understand and identify fish passage solutions and options for future operation of the Mill, the Working Group has collected information on fish habitat within the river and diversion ditches; tracked fish holding patterns and movement through the complex and over the dams; monitored water temperatures; and measured water flow rates in the river and ditches. In addition, the Working Group has developed a water distribution model that will identify options for allocation of water through the river channel and diversion ditches.

The following fish passage, spawning and river flow issues within the Thompson's Mill complex will require more investigation:

(1) Fish passage at the dams: Fish encounter problems moving over Sodom Dam. The Dam may delay winter steelhead moving upstream, and it presents significant obstacles to spring chinook salmon because they must pass over the dam in the late spring when river flows have dropped. Water flowing over the dam creates velocities that attract adult spring chinook salmon to the base of the dam, which inhibits efficient passage through the fish ladder. As a result, spring chinook will hold for a period of time in the pool at the base of the dam, delaying their migration to spawning locations in the upper watershed. The delayed spring chinook are vulnerable to harassment and poaching. The Thompson's Mill Working Group is contracting for a study to examine the fish passage problems at the dams and to identify options for improved dam and fish ladder designs.

(2) Steelhead spawning in Sodom Ditch: Winter steelhead have been observed spawning in Sodom Ditch. Pacific lamprey have also been seen spawning in the ditch. It is not known why the fish are spawning in the area when suitable gravels are present in the river reaches immediately upstream. It may be that some winter steelhead spawn in the ditch because they are delayed trying to bypass the Thompson's Mill. Spawning in the ditch is a concern because the juvenile winter steelhead probably do not survive the high summer water temperatures in this reach of the river (ODFW 2003).

(3) Calapooia River channel: During the winter and spring high flow periods, most of the River's discharge flows through Sodom Ditch. This dramatic reduction in high flows moving through the Calapooia River has changed the river channel and associated floodplain within this reach of the river. The river channel has narrowed and, because there is reduced flooding, homes have been built in the historic floodplain. With these changes, there are limited alternatives for increasing high flows through the Calapooia River channel. The Thompson's Mill Working Group is examining alternative water allocation through the river channel and Sodom Ditch and the implications for fish migration, aquatic habitat, and future operation of the Mill.

River and tributary habitat

There are no comprehensive assessments of aquatic habitat for all of the river channel and tributary streams in the lower Calapooia River Watershed. The Oregon Department of Fish and Wildlife has assessed aquatic habitat for the portion of the river channel within the Thompson's Mill complex and the diversion ditches.

The aerial photo interpretation of the lower river channel and riparian areas provides some insights into fish habitat features (See Chapter 4, *Vegetation and Other Features along the Calapooia River and Selected Tributaries*). Based on this analysis, the Calapooia River channel has the highest sinuosity downstream of Sodom Ditch. Channels with high sinuosity contain habitat features that are favorable for fish, including river-adjacent ponds, islands, alcoves, side channels, and gravel bars. Reaches 3 and 5 have the largest number of natural ponds.

Natural ponds, side channels and tributary streams in the lower Calapooia River Watershed provide important habitat for a number of fish. Salmon and steelhead juveniles use these areas as a "refuge" from high water flow velocities in the river channel during reoccurring flooding periods in the winter and early spring. There is evidence that even seasonal streams that are dry by June provide important habitat for these fish (Randy Colvin, OSU, personal communication, 2003). In addition to spring chinook salmon and winter steelhead, these habitat features provide important habitat for a number of other fish species. Three-spine sticklebacks and Oregon chub, for example, prefer side channels, ponds, and other off-channel habitats. The decline of the Oregon chub is attributed to the loss of abundant off-channel habitats and predation by non-native fish and amphibian species such as bass and bullfrogs. The text boxes on the next pages, describe the life history and habitat needs for the Oregon chub and the three-spine stickleback.

Although there is very little information documenting the loss of off-channel habitats in the lower Calapooia River Watershed, these habitats have probably been lost through various activities, including rip-rapping banks, filling wetlands, and fish passage barriers that disconnect tributary streams and sloughs from the river.

The lower Calapooia River Watershed is used by anadromous fish for migration and rearing and provides key habitat for other fish species such as sticklebacks. Habitat restoration in this portion of the watershed should focus on 1) improving fish passage at dams within the Thompson's Mill complex, 2) providing access to seasonal streams that are used by a number of fish species, including juvenile spring chinook and winter steelhead, and 3) improving riparian areas and wetland habitats along the river and tributary streams.

Oregon Chub

Oregon chub is a small minnow (<3 inches long) native to backwaters, flooded marshes, and sloughs in the Willamette Basin. The reduced populations and restricted distribution of the chub resulted in listing as *endangered* under the federal Endangered Species Act. Currently, no Oregon chub are documented in the Calapooia River Watershed. Historically, a population probably occurred in the lower watershed. Small remnant populations of chub are present in the several tributaries to the Willamette River, including the Marys, McKenzie, and Middle Fork Willamette Rivers. Chub populations have declined due to loss of backwater habitats and predation of non-native species such as smallmouth bass, bluegill, and bull frogs. Isolated habitats that do not allow access from predators have the most abundant populations. Other aquatic species sensitive to predation and habitat modification have also been noted where there are populations of chub. The native fish species found most frequently at locations containing Oregon Chub were redside shiner (91% of the sites), sculpins (77%), speckled dace (73%), northern pikeminnow (59%), three-spine sticklebacks (55%), and largescale suckers (45%). Native amphibians such as redlegged frogs, northwest salamanders and western pond turtles were more common at locations that support large populations of Oregon chub. Non-native bullfrogs, common in off-channel habitats throughout the Willamette Valley, are notably absent from three of the four locations that support the most abundant naturally occurring Oregon chub populations. The more connected the site is to adjacent water bodies, the greater the chance that non-native fish will invade the site. Oregon chub spawn in the summer months (June – August). The males court the females and become aggressive towards other males. The females spawn their adhesive eggs (147-671) in the vegetation. Young emerge within 2 weeks of spawning and are found near the surface in the shallow, warmer areas of the pond or slough. Zooplankton are the main food source.

Oregon chub

Source: Scheerer, P. 2000. Oregon Chub Research in the Willamette Valley, Oregon Department of Fish and Wildlife, Corvallis, OR.

Three-Spine Stickleback

The three-spine stickleback can be found down the Pacific coast from Alaska to southern California. There are two distinct forms or possible subspecies of the three-spine stickleback. One group is a resident of freshwater habitats. The other is an anadromous form that lives in a marine environment and migrates to freshwater to spawn. The native freshwater form of the stickleback inhabits river and tributary habitats in the Willamette River basin, including the lower Calapooia River Watershed. Sticklebacks prefer areas with slow water velocities, such as backwater areas (alcove and side channels) or small perennial or seasonal tributary streams, with abundant aquatic vegetation. They spawn in late-spring and early-summer. Stickleback nests are constructed of small twigs and plant debris, held together by mucilaginous kidney secretions emitted by the male. The male entices the female into the nest and when the nest is full of eggs the nest is loosened to allow better ventilation. The male guards and fans the nest, and continues to guard the newly hatched fish until they are able to care for themselves. Growth is rapid the first year and sexual maturity is attained during the first year. Sticklebacks feed on worms, crustaceans, larvae and adult insects, drowned aerial insects, small fishes, and on their own fry and eggs. They will eat essentially any available animal foods. They are preyed upon by other fish and by birds.

Three-spine stickleback

Source: Oregon Department of Fish and Wildlife. 2002. Albany Fish Survey: Summary and Species Profiles. Report prepared for the City of Albany and the Oregon Watershed Enhancement Board, Albany, OR.

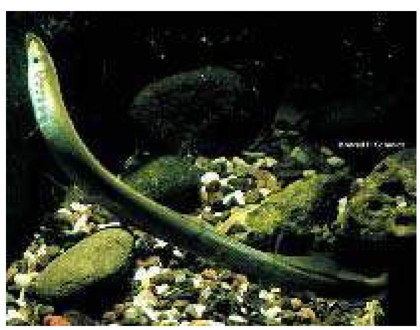
Middle Calapooia River Watershed

Native and non-native fish species: distribution and status

The middle Calapooia River Watershed includes the river channel in the vicinity of Brownsville and a number of important tributary streams such as Brush Creek. In comparison to the lower watershed, the middle watershed has a greater abundance of salmonid species and very few non-native fish above Brownsville. The river channel through this portion of the watershed continues to be an important migration corridor for adult and juvenile winter steelhead, spring chinook salmon, and Pacific lamprey (see text box on following page). Juvenile spring chinook and winter steelhead, for example, use the river and probably use the lower portions of tributaries such as Brush Creek for rearing, particularly during high flow events in the winter and early spring (Gary Galovich, ODFW, personal communication, 2003). There have been no observations of winter steelhead spawning in the tributary streams in this portion of the watershed. Many of the streams middle Calapooia River Watershed have suitable winter steelhead spawning and rearing habitat, so it is possible that there may be a small population of winter steelhead using some of the tributaries (Gary Galovich, ODFW, personal communication, 2003). Cutthroat trout also use the river and tributary streams. In addition to the cutthroat trout that reside year round in small streams (resident), there are cutthroat (a *fluvial* population) that reside in this portion of the river that move up the river and into tributary streams for spawning (see text box).

Pacific and Brook Lamprey

Pacific and brook lamprey are found within the Calapooia River watershed. Pacific lamprey are anadromous and brook lamprey are resident species. Little is known about lamprey population status or trends, but the species appear to be declining. Currently, there is a petition to list Pacific, western brook, and other lamprey as threatened under the federal ESA (Klamath-Siskiyou Wildlands Center et al. 2003). Pacific lamprey is listed as "vulnerable" on Oregon's sensitive species list. This species is native to the Willamette River watershed. Spawning adults are found in gravel riffles and runs of the river and tributary streams. Feeding adults are usually found in the ocean. Ammocoetes (larval stage) reside in the silt, mud, and sand of shallow eddies and backwaters of streams and filter feed on algae and detritus. After 4-6 years as an ammocoete, Pacific lampreys metamorphose to a second juvenile life stage called macropthalmia. The macropthalmia stage migrates out to the ocean then begins a parasitic lifestyle as an adult, growing to about 2 feet in length. Parasitic adults attach themselves to the side or undersurface of its prey, from which it draws blood and body fluids as food. Adult Pacific lamprey in the ocean prey on fish, including salmon, and whales. They stop feeding once their upstream spawning migration is underway.



Pacific lamprey

Cutthroat Trout

There are two life history forms of cutthroat trout that reside in the Calapooia River Watershed: A form (*fluvial*) that migrates between small tributaries and the river; and a form (*resident*) that lives out its life in the small streams of its birth. The fluvial cutthroat trout reside in the river and the adults migrate into smaller tributaries to spawn, returning afterwards to the river. The young may stay in the small tributary for 1 or 2 years before moving downstream to the river. Resident cutthroat reside in tributary streams, often in very small streams with gradients up to 12%. Resident cutthroat trout can spend their entire lives in a stretch of stream only 200 yards long. They will move up and down the stream, particularly to escape warm water temperatures in the summer and into seasonal streams to escape high flows in the winter. Cutthroat in small streams are seldom very large; a 3-year-old fish can average 5 inches long. These fish feed on small fishes, crustaceans, and insects. This species does not compete well with other fish and can hybridize with rainbow trout when they share the same habitat.

Cutthroat trout

Sources: Oregon Department of Fish and Wildlife. 2002. Albany Fish Survey: Summary and Species Profiles. Report prepared for the City of Albany and the Oregon Watershed Enhancement Board.

Trotter, T. 1987. Cutthroat Trout: Native Trout of the West. Colorado Associated University Press, Boulder, CO.

Fish passage barriers

Fish passage issues have been examined for at the Brownsville Dam and on selected tributary streams in the middle Calapooia River Watershed.

Fish passage barriers at Brownsville Dam: Brownsville Dam[*] is located approximately 3 miles upstream of the City of Brownsville at river mile 36 of the Calapooia River (Map 14, *Andromous Fish Distribution, Dams, and Habitat Inventory Areas*). The dam was constructed to divert water from the river into the Brownsville Canal, which diverges from the river several feet upstream from the dam. The canal flows just over three miles, passing through Brownsville and then to the site of a now abandoned woolen mill before returning to the Calapooia River. The

[*] This information was provided by Gary Galovich, Oregon Department of Fish and Wildlife, Corvallis, OR.

canal has been screened at the upstream end to prevent fish from entering the diversion. The dam is a fish passage obstacle for adult and juvenile fish.

The dam is a concrete structure that spans the width of the river. Water is impounded behind several tiers of wooden boards that are seasonally installed (during low flow periods) to close the 110-foot gap between the dam's retaining walls located on each bank. The boards rest against the upstream side of the metal support beams that rise vertically from the dam sill. With the boards in place, the height of the dam from the sill to the top of the boards is approximately 5 feet. With the boards removed, the water "sheet flows" across the sill's length of 14 feet before falling over 5 feet into a plunge pool below. Streambed erosion on the downstream side of the sill has caused this drop height to increase over time. In addition, there is also erosion back under the sill. Large boulders have been placed at the base of dam to halt the erosion, which, left unchecked, could threaten the dam by eroding the streambed beneath the structure.

During the fall, winter, and spring, the dam boards are removed and the river flows between the retaining walls and across the sill. Because the concrete surface is smooth, velocities across the sill are a problem for adult and juvenile fish migrating upstream. During moderate or low flows, the drop at the downstream end of the sill poses an additional challenge to fish passage. These velocity and jump barriers present passage problems to juvenile steelhead and cutthroat trout and to the migration of adult fluvial cutthroat trout and adult winter steelhead.

The Brownsville Canal Company who operates the diversion installs the dam boards in late spring, prior to the irrigation season. Beginning in spring and continuing through much of the summer, adult spring chinook are migrating past the dam to spawning locations in the upper watershed. With the dam boards in place, partial passage is provided for adult spring chinook through an 8-foot wide and approximately 70-foot long cascading channel cut into the bedrock on the north side of the channel. The dam boards are removed each fall at the end of the fish migration season and before the fall rains, usually in mid-October. Except for very high winter flows, this channel does not carry water unless the dam boards are in place. While some spring chinook do pass through the channel, it does not meet ODFW's standards for adult passage. In addition, the upstream end of this channel as it joins the river above the dam is extremely shallow (less than 1 foot) and exposed. During the low flow periods in the late spring and summer, adult spring chinook below and above the dam are vulnerable to harassment and poaching.

There is a clear need for improved adult and juvenile fish passage at Brownsville Dam. The Calapooia Watershed Council is working with the Brownsville Canal Company to identify funding sources to address fish passage at the dam.

Fish passage barriers on tributary streams: Potential fish passage barriers were assessed for most of the tributary streams in the middle Calapooia River Watershed and middle and upper reaches of Courtney Creek in the spring of 2003. Over 80 road crossings were inventoried on county, federal, and private lands (Map 15, *Inventoried Culverts*). Stream and culvert information collected at the road crossings included culvert diameter, gradient, and drop to pool from the lip of the culvert. Stream gradient, bankfull width, and pool depth below the culvert were also recorded. Photographs were taken of the culvert and stream habitat. (The complete culvert inventory is in the separate report, *Road Crossing Inventory for Fish Passage in the Middle Calapooia River Watershed*.)

The culverts were evaluated for their ability to provide fish passage. Culverts commonly block fish passage by creating a drop at the outlet that is higher than fish can jump. While some adult trout and salmon can jump obstacles greater than 3 feet, most fish cannot jump to these heights. In addition, water can travel through culverts at very high velocities, which can exceed a fish's swimming ability. The velocity of water moving through the culvert is determined by a number of factors, but the major one is the gradient of the culvert. A very steep culvert (high gradient) will increase velocities more than a properly installed culvert that is placed nearly flat.

Fish passage is a concern for both adult and juvenile fish. Small juvenile fish are the weakest swimmers and can be stopped by less than a 6-inch drop at a culvert outlet. For this reason, most criteria for fish passage are designed to accommodate juveniles, since they are the most vulnerable life stage. Guidelines for fish passage developed by ODFW specify that culverts need to be installed at a gradient of less than 0.5% and have no more than a 6-inch drop at the outlet.

Fish passage at the road crossings was evaluated based on the ODFW criteria. A majority of the evaluated crossings in the watershed do not meet the fish passage criteria (Map 15, *Inventoried Culverts*). Many of the culverts that did not meet the criteria had jump heights of less than 6-inches but they were too steep, exceeding 0.5% gradient, creating a water velocity barrier for juvenile trout and salmon. Although fish use was not assessed, most of the evaluated streams have resident and fluvial cutthroat trout populations.

It would be difficult and expensive to address all of the potential fish passage barriers in this portion of the watershed. It would not be possible to address all of the inventoried culverts that do not meet the criteria. For example, there are culverts on high gradient streams that are at or near the end of cutthroat trout distribution. Since addressing fish passage at these culverts would gain access to very little habitat, addressing passage problems would be a lower priority.[*] For this reason, criteria were developed to help the Calapooia Watershed Council identify high priority opportunities to correct potential fish passage problems.

[*] Most of the inventoried culverts in small streams with high gradients were on forest lands. The Oregon Forest Practices Act requires that forest landowners provide fish passage for road crossings when they are replacing culverts or building new roads. Many of the forest landowners in the watershed have replaced culverts with installations that provide for fish passage.

The fish passage evaluation criteria used information about the culvert (jump height and gradient) to assess fish passage issues and the stream characteristics (size of the stream and gradient) to characterize fish habitat quality. This information can be used for working collaboratively with landowners to identify and correct fish passage problems. Culverts were ranked according to the following criteria:

Status for action	Criteria	Rational
(1) Exceeds (no action)	Jump < 6”, culvert gradient ≤ 0.5%	Meets ODFW criteria for juvenile passage
(2) Culverts that do not meet the ODFW criteria: Jump ≥ 6” and/or culvert gradient > 0.5%		
Low priority	Stream gradient > 10%	These streams are at or near the end of fish distribution.
Medium priority	Stream gradients ≥ 4% and ≤ 10%	Although these streams usually have fish during at least part of the year, they do not provide the highest quality habitat and many of the culverts are near the end of fish distribution.
High priority	Stream gradients < 4%; culvert jump heights < 6” and/or bankfull widths < 10 feet	Most of these streams are in the lower portions of the watershed and have significant fish habitat above the culvert
Highest priority	Stream gradients < 4%; culvert jump heights ≥ 6” and bankfull widths ≥ 10 feet	Most of these streams are in the lower portions of the watershed and have significant fish habitat above the culvert; because the culverts have excessive jump heights, many of these barriers are also barriers to adult fish movement.

Table 6-8 lists the highest priority culverts for exploring opportunities to address fish passage issues. These culverts are on county, BLM and private lands. Most of the identified culverts are in streams that are in the lower portions of the watershed and have significant fish habitat above the culvert. Because the culverts have excessive jump heights, many of these culverts are also barriers to adult fish movement. These barriers can block passage by adult and juvenile cutthroat trout and juvenile winter steelhead and spring chinook salmon.

Table 6-8. Highest priority culverts for pursuing opportunities to address fish passage problems. All of these stream channels have gradients less than 4 percent and bankfull widths greater than 10 feet. The drop from the culvert to the pool was greater than 0.5 feet. The map identification numbers are displayed on Map 15, Inventoried Culverts.

Stream	**Barrier ID (# of culverts)**	**Culvert Diameter or width (ft)**	**Drop of water from culvert bottom to pool (ft)**	**Culvert slope (%)**	**Stream Bankfull width (ft)**	**Upstream gradient (clinometer) (%)**	**Priority ranking**
Trib. to Calapooia	91 (4)[1]	3.0	1.3	1.3	16	1	Highest
Trib. to Calapooia	129 (2)	3.5	1.3	1.6	17	0.5	Highest
Trib. to Calapooia	203 (2)	2.3	1.5	1.0	14	1.5	Highest
Trib. to Courtney Ck	314	6.0	0.6	4.5	17	2.5	Highest
Trib. to Courtney Ck	366 (3)	4.0	0.9	0.4	20	2	Highest
Trib. to Brush Ck	418	4.5	5.5	8.5	15	2	Highest
Brush Ck	419	3.0	2.4	5.7	11	1	Highest
Trib. to Brush Ck	420	7.0	0.6	6.2	27	2.5	Highest
Brush Ck	434 (2)	4.0	0.6	0.1	27	2	Highest
Brush Ck	435A	9.0	1.7	0.8	33	1	Highest
W. Brush Ck	435B (4)	4.0	0.9	0.3	40	1	Highest
Trib. to Brush Ck	BC1	6.0	0.9	2.1	33	2	Highest
Trib. to Brush Ck	BC2	3.8	3.6	6.1	20	1	Highest
Trib. to Calapooia	BC3	5.8	4.1	0.8	10	0.5	Highest
Trib. to Pugh Ck	BC7	3.0	3.7	3.6	15	2	Highest
Trib. to Courtney Ck	BC13	3.0	1.4	-7.5	11	3	Highest

In addition to culverts at road crossings on tributaries in the middle Calapooia River Watershed and Courtney Creek, there is a private water diversion dam on the West Fork of Brush Creek (Map 14, *Anadromous Fish Distribution, Dams, and Habitat Inventory Areas*). Although this dam has not been inventoried for fish passage, it is probably a barrier to fish movement. This dam should be evaluated for fish passage. If fish passage issues are identified at the dam, the Council could work in collaboration with the landowner to address the problem.

Identification of fish passage barriers is the first step in working cooperatively with landowners to identify opportunities to address fish passage in the watershed. To provide the most access for fish, it is recommended that fish passage issues be addressed for culverts and other barriers lower

[1] For crossings with multiple culverts, values given are calculated averages.

in the watershed before implementing remedies in upper reaches. Because the culvert assessment did not include an inventory of fish use or an extensive inventory of upstream habitat, additional fieldwork will be necessary to evaluate these factors.

River and tributary habitat

ODFW has inventoried stream habitat for the river above Holley. This inventory will be summarized in the section on the upper watershed. In addition, ODFW has examined fish habitat for the river between Holley and the Sodom Dam. The aerial photo interpretation of the river channel and riparian areas provides some information on fish habitat features in the middle portion of the watershed (See Chapter 4, *Vegetation, Wetlands and Other Features*). Based on this analysis, the Calapooia River channel through this section still has considerable sinuosity, particularly reaches 6 and 7. Above reach 7, the channel is less sinuous and constrained by areas of bedrock. The river channel through the bedrock cascades near McKercher Park is an example of the constrained channel in this part of the river. Reaches 6 and 7, from Sodom Ditch diversion to Brownsville Dam, have the greatest amounts of gravel deposition in the river channel. These areas of gravel deposition provide opportunities to improve fish habitat. Since this is a depositional area where gravel settles out, large trees and logs in the channel through these reaches would help create pools and hiding cover for fish.

There are no comprehensive assessments of stream habitat for the tributary streams in this part of the watershed. The lower portions for the tributary streams are important access points for fluvial cutthroat trout and winter rearing areas for spring chinook salmon and winter steelhead. For this reason, habitat improvement actions in the tributaries should focus on the lower portions of the streams by addressing fish passage barriers, riparian habitat enhancement, and stream restoration actions, such as the placement of large wood.

Upper Calapooia River Watershed

Native and non-native fish species: distribution and status

The upper Calapooia River Watershed includes the river channel and tributary streams in the forest lands above Holley. The river in this section flows through the Western Cascade Mountains with a narrow valley often paralleled by a road. There are numerous tributary streams, many with high gradient channels. Salmonid species are the most common fish found in this part of the watershed. The upper watershed is the key area for spring chinook salmon and winter steelhead spawning and juvenile rearing. Cutthroat trout and mountain whitefish are also common. The non-salmonid species inhabiting the upper watershed are listed in Table 6-9.

Because this upper watershed is the key area for spawning and rearing Willamette Basin winter steelhead and spring chinook salmon, both of which are listed as threatened species under the Federal Endangered Species Act, the discussion will focus on the status of these fish.

Table 6-9. Non-salmonid species known to inhabit or likely to occur in the upper Calapooia River Watershed (Weyerhaeuser 1998).

Non-salmonid
Lamprey
Pacific lamprey, *Lampetra tridentata*
Western brook lamprey*, Lampetra richardsoni*
Minnows
Speckled dace, *Rhinichthys osculus*
Longnose dace, *Rhinichthys cataractae*
Nothern pikeminnow, *Ptycheilus oregonensis*
Redside shiner, *Richardsonius balteatus*
Suckers
Largescale sucker, *Catostomus macrocheilus*
Sculpins
Mottled sculpin, *Cottus bairdi*
Paiute sculpin, *Cottus beldingi*
Shorthead sculpin, *Cottus confusus*
Reticulate sculpin, *Cottus perplexus*
Torrent sculpin, *Cottus rhotheus*

Winter steelhead: The upper Willamette River winter steelhead population occupies the Willamette River and its tributaries above Willamette Falls at Oregon City. The Calapooia River defines the upper extent of winter steelhead distribution in the Willamette River basin. Historically, most of the winter steelhead in the Willamette Basin spawned in the Santiam River watershed. There were smaller spawning populations in the Molalla, Pudding, and Calapooia watersheds, and possibly the Tualatin River watershed (ODFW 1992).

Most winter steelhead spend two years in the ocean before spawning and they can spawn multiple times. Winter steelhead begin moving above Willamette Falls in the winter months, with peak movement in December and January. Approximately 85% of the run passing Willamette Falls is natural spawning, with the remainder hatchery fish (ODFW 1992).

Adult winter steelhead are present in the Calapooia River February through May, with peak spawning in April and May (ODFW 1992). Most of the winter steelhead spawning takes place in the river channel and tributary streams above Holley. Winter steelhead cannot access the upper 2 miles of the Calapooia River due to a natural waterfall on Forest Service Land above United States Creek (Map 14, *Andromous Fish Distribution, Dams, and Habitat Inventory Areas*). The North Fork Calapooia River, and Biggs, McKinley, Potts, and King Creeks are important tributary streams for spawning.

ODFW has been conducting annual winter steelhead spawning surveys in the upper Calapooia River Watershed since 1985. Most of the spawning surveys take place in May. The spawning surveys count winter steelhead egg nests called *redds*. While the spawning surveys do not look at the entire length of suitable spawning habitat, they do cover most of the high quality spawning areas. Since 2000, the spawning surveys have covered 9.5 miles of habitat in the Calapooia River channel and the lower portions of key tributary streams:

- Calapooia River: River miles 65 to 72.5
- North Fork Calapooia River: The lower 1 mile
- Potts Creek: The lower 1 mile

Counts of winter steelhead redds have varied widely, ranging from a high of over 16 redds per mile in 1985 to a low of 1 redd per mile in 1996 (Figure 6-5). The variation in redd counts in the upper Calapooia River watershed generally follow the trends for adult fish counted at Oregon Falls (Figure 6-6).

Juvenile winter steelhead spend considerable time rearing in the Calapooia River and tributary streams, usually residing for two years in the watershed before moving downstream to the ocean (Wevers et al. 1992). Juvenile winter steelhead require cold water, and deep pools for feeding and cover from predators. Access to tributary streams to escape high water temperatures in the summer, and to find refuge from high flows in the winter, is also important.

To protect young winter steelhead (which often cannot be distinguished from cutthroat trout), ODFW has restricted fishing to catch and release with barbless hooks. There is no river harvest allowed for adult winter steelhead. There are winter steelhead harvest records in the Calapooia River from 1977 through 1988. During this period, the maximum catch was 122 adult fish in 1979 (ODFW 1992).

Figure 6-5. Counts of upper Willamette River winter steelhead redds in the upper Calapooia River and selected tributaries between 1985 and 2002 (data supplied by Wayne Hunt, ODFW, Salem, 2003). Redds are counted in the Calapooia River (RM 65 to 72.5), and the lower 1 mile sections of the North Fork Calapooia River and Potts Creek. Winter steelhead redds were not inventoried in 1986.

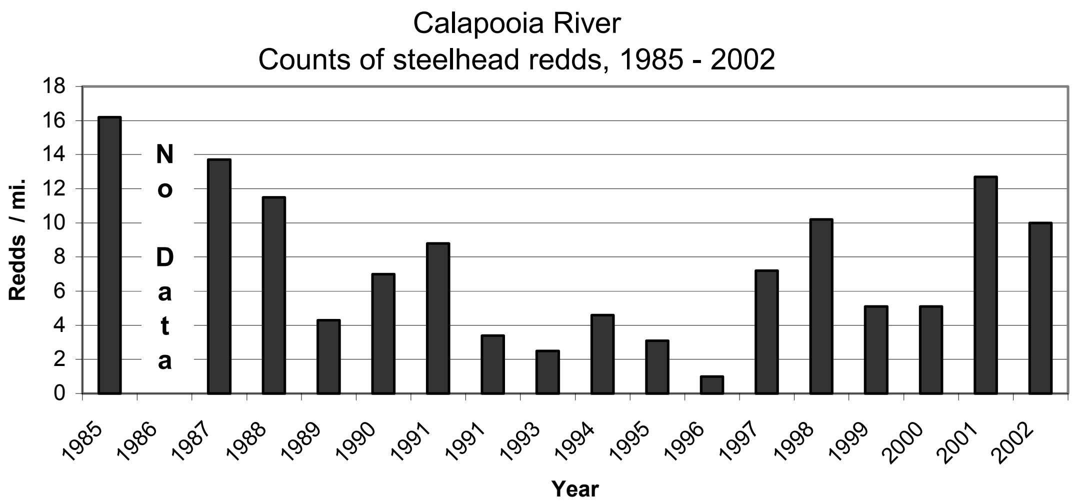
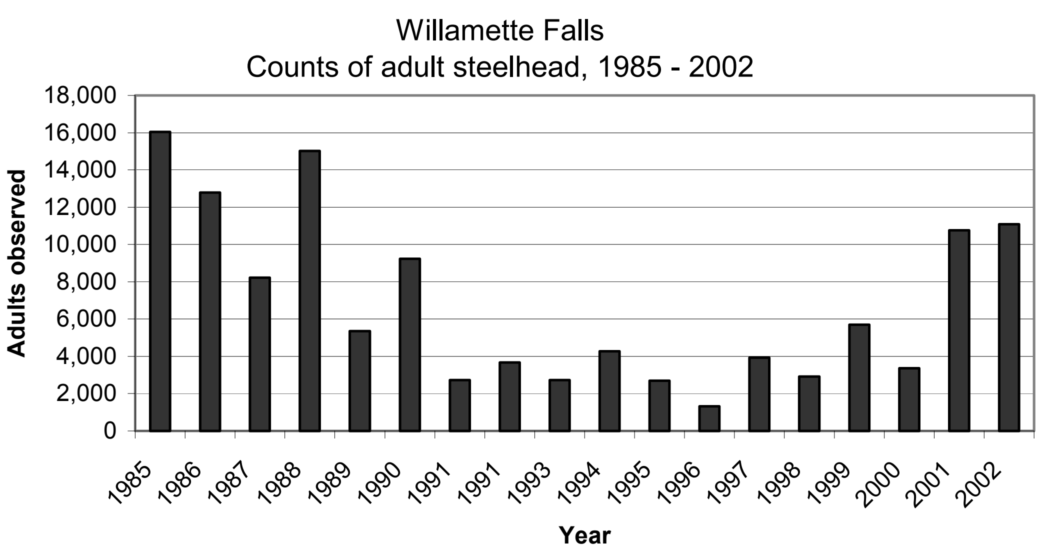


Figure 6-6. Counts of upper Willamette River winter steelhead adults at Willamette Falls between 1985 and 2002 (data supplied by Wayne Hunt, ODFW, Salem, 2003).



The Oregon Department of Fish and Wildlife has developed objectives for recovering the Calapooia River winter steelhead population (Wevers et al. 1992). The long-term objective by year 2020 is 1170 adults returning to the watershed (25 redds per mile); the interim objective by year 2006 is for 15 redds per mile (Wevers et al. 1992). Since 1997 the redd counts have averaged about 7 redds per mile.

Spring chinook salmon: Most of the spring chinook salmon in the Willamette Basin spawn above Willamette Falls at Oregon City. Upper Willamette River spring chinook are one of the most genetically distinct groups of chinook salmon in the Columbia Basin. Before the construction of fish ladders at Willamette Falls, passage by returning adults was only possible during the winter and spring high flow periods. The early run timing of the Willamette River spring chinook relative to other lower Columbia spring-run populations is an adaptation to flow conditions at the Falls. High river flows in the late winter and early spring provide the best conditions for passage over the Falls. Spring chinook enter the Willamette as 3, 4, or 5-year old fish with some jacks (young 2-year-old male fish). The run begins to enter the Willamette River in February, with the majority of the run ascending the Falls in April and May.

Once above Willamette River Falls, adult spring chinook migrate upstream at an average rate of 10 to 20 miles per day (Snelling et al. 1993). Chinook enter the Calapooia River Watershed in late April and May with the migration to the river continuing into July. In observations of adult spring chinook at Sodom Dam over several seasons, peak counts occurred in early June and fish continued to be observed at the dam until early July (ODFW 2003).

The Santiam and Calapooia runs of spring chinook are considered to be one sub-population. Access to most of the historical spawning habitat in the Santiam River watershed has been lost because of Foster and Green Peter dams. The majority of the current natural production of spring chinook in the Willamette Basin occurs in the McKenzie River watershed. There is also significant natural production in the Santiam and Clackamas River watersheds. Limited natural production occurs in the Molalla and Pudding Rivers, where hatchery spring chinook have been released to reestablish naturally reproducing populations. There is no evidence that these populations are self-sustaining (Wevers et al. 1992).

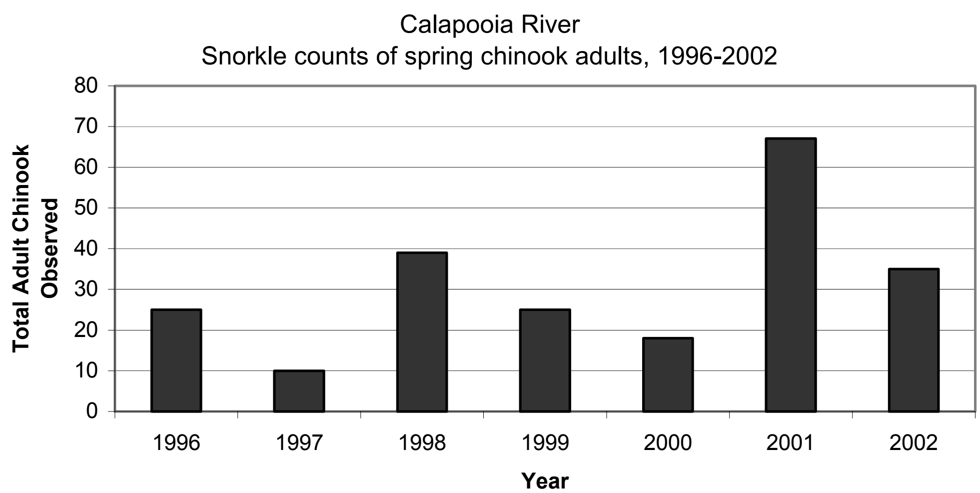
Spawning surveys in the 1960s and 1970s indicated that very few spring chinook were returning to the Calapooia River. The 1969 to 1974 average run size was estimated to be 18 fish, and in 1975 and 1976 no redds were found (Wevers et al. 1992). By the 1970s the Calapooia River population of spring chinook probably was no longer viable (Wayne Hunt, ODFW, personal communication, 2003). Since that time hatchery spring chinook (from the South Santiam River) have been released to reestablish naturally reproducing populations. In addition, fish straying from other river populations are probably entering the river.

Historically spring chinook salmon used the Calapooia mainstem between Holley (RM 45) and just upstream from the confluence with United States Creek (RM 80) for spawning and rearing (Wevers et al. 1992). Today, most of the spring chinook spawn in the upper river above the

Weyerhauser property boundary (RM 50). The adults will hold over the summer in pools. Spawning takes place in late August, peaking in September, though activity can extend into November (Wevers et al. 1992).

Since 1996, ODFW has been conducting annual counts of spring chinook adults, redds, and juveniles in the upper Calapooia River. Adult and juvenile counts are done in August and redd counts are completed in September. In August 2002, 19.8 miles were surveyed and 35 adults were observed (Figure 6-7). Adult counts range from a maximum of 66 fish in 2001 to a minimum of 10 fish in 1997. In a survey preceding the current effort, 13 adult fish were counted in 1971.

Figure 6-7. Snorkel survey counts of upper Willamette River spring chinook adults in the upper Calapooia River between 1996 and 2002 (data supplied by Wayne Hunt, ODFW, 2003).



Counts of spring chinook redds have varied widely, ranging from a maximum of over 5 redds per mile in 1998 to a minimum of nearly 1 redd per mile in 2001 (Figure 6-8). There is also considerable variation in the number of juveniles encountered (Figure 6-9). Juvenile counts are usually very low, with one to seven fish observed in most years and no fish observed in 1996. In 2001, 1765 juvenile spring chinook were counted. These high numbers may be from the offspring of the 371 adults stocked the year before.

Much of the variation in the observed numbers of spring chinook juveniles may be due to the variability in the juvenile migration timing. Most of the young spring chinook may be leaving the system. There appears to be a range of ages for juvenile spring chinook migration (Schroeder et al. 2002). There are fry (age 0) that migrate in the late winter through early spring;

fingerlings (age 0+) that migrate in the fall; and yearling smolts (age 1+) that migrate in early spring.

Because adult spring chinook hold in the upper Calapooia River over the summer months, they have specific habitat needs and they are vulnerable to poaching and harassment. Spring chinook prefer cool, deep pool habitat with abundant large wood and undercut banks for cover. Juvenile spring chinook can spend considerable time rearing in the Calapooia River. Like other salmonids, juvenile spring chinook require cold water, and deep pools for feeding and cover from predators. Access to tributary streams to find refuge from high flows in the winter is also important.

Figure 6-8. Counts of upper Willamette River spring chinook salmon redds in the upper Calapooia River and selected tributaries between 1996 and 2002 (data supplied by Wayne Hunt, ODFW, 2003). There were no redds counted in 1997 due to high water.

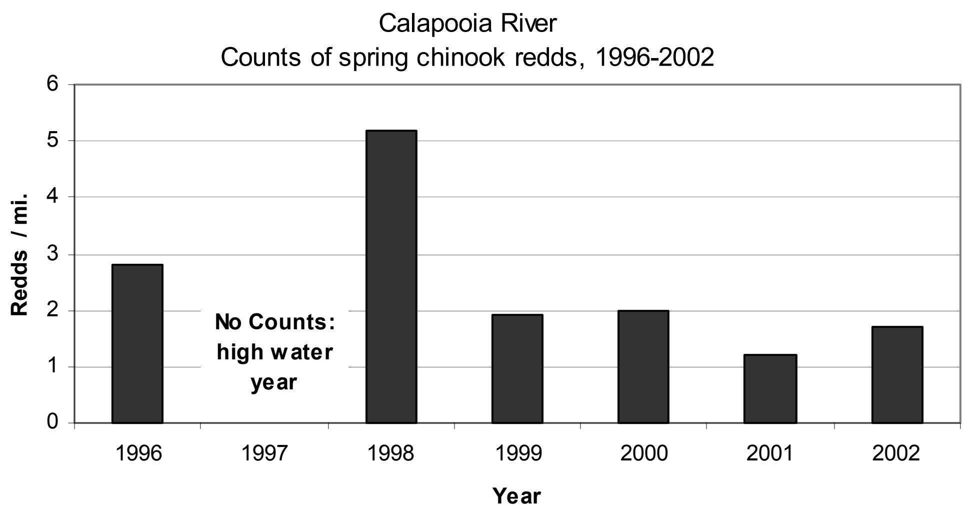
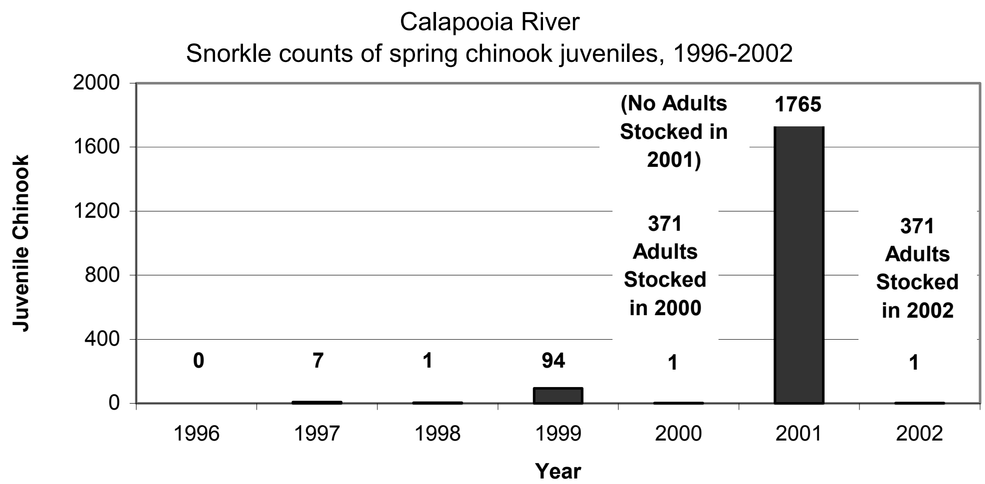


Figure 6-9. Snorkel counts of upper Willamette River spring chinook juveniles in the upper Calapooia River between 1996 and 2002 (data supplied by Wayne Hunt, ODFW, 2003).



In the past, there was very little documented sport catch of adult spring chinook in the Calapooia River. The average annual catch during 1963 to 1974 was 13 fish with a range of 0 to 34 fish (Wevers et al. 1992). The watershed has been closed to chinook angling since 1988, although there is evidence of continued illegal harvest (Gary Galovich, ODFW, personal communication, 2003).

ODFW has developed objectives for recovering the Calapooia River spring chinook population. The long-term objective (2020) is 650 adults returning to the watershed; the interim objective (2006) is for 100 adults. In 2002, 35 adults were counted (Wayne Hunt, ODFW, personal communication, 2003).

River and tributary habitat

In 1991, ODFW completed aquatic habitat inventories for the river and important tributaries in the upper Calapooia River Watershed (Map 14, *Andromous Fish Distribution, Dams, and Habitat Inventory Areas*). The inventories covered the upper Calapooia River (three reaches), the North Fork (one reach), and Potts Creek (three reaches). The inventories used ODFW's standard methods, which focus on collecting data on key fish habitat features, including active channel width, number of pools, pool depth, gravels, and pieces of large wood.

Table 6-10 provides summaries of the river and stream habitat characteristics. With the exception of Reach 3 in the Calapooia River, all of the river reaches have very few pieces of large wood (greater than 30 feet long and 24-inches in diameter). There was no large wood found in Potts Creek and the North Fork Calapooia. Large wood from trees and logs is an important component of high quality fish habitat. When large trees fall into the river and tributaries, they create hiding areas for fish, capture spawning gravels, and help create deep pools. For example, adult spring chinook salmon, which must hold in the Calapooia River over the summer, require deep pools and the hiding cover that large trees in the channel provide. Significantly, all of the inventoried reaches had low to moderate pool numbers and percentages of area in pools (Figure 6-10). Pool areas of more than 25% are an indication of high quality habitat. Potts Creek was the only inventoried stream with pool areas exceeding 25%. Pool area and depth would increase with increasing amounts of wood in the system.

The ODFW inventory was completed before the 1996 flood. The 1996 flood event created a number of landslides and debris torrent in the upper Calapooia River Watershed. Many of these torrents delivered wood to the lower portions of tributary streams and the river channel (Weyerhaeuser 1998). As a result, there is probably more wood in the river and stream channels than is reflected in the 1991 surveys. A separate aquatic habitat inventory was completed for the Calapooia River on Forest Service Land in 1998. The lower portions of the Forest Service inventory overlapped Reach 3 of the ODFW inventory. The 1998 inventory found large numbers of wood pieces in the river, much of it in large log jams that were delivered in the 1996 flood (Siskiyou Research Group 1998). Significantly, many of these large log jams created side

Table 6-10. Summaries of the ODFW Aquatic Habitat inventory information for the upper Calapooia River, Potts Creek, and the North Fork Calapooia River. See map 14, Anadromous Fish Distribution, Dams and Habitat Inventory Areas*, for reach locations. Habitat data were collected in 1991 (source: Streamnet web site: http://www.streamnet.org/).*

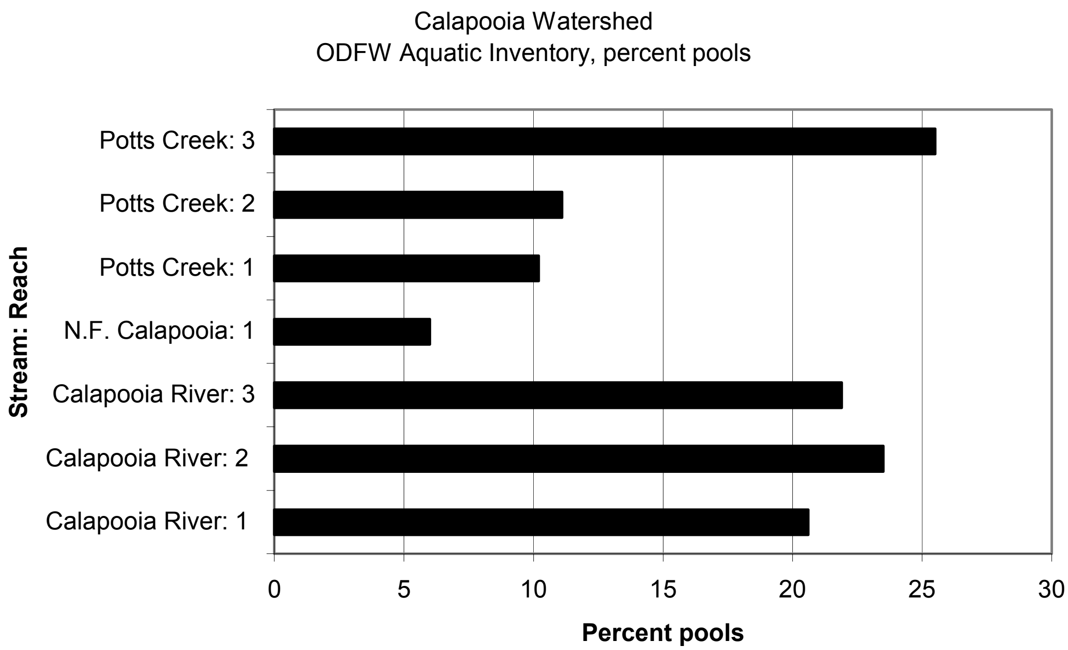
Stream	Reach	Survey date	Distance (mi)	Percent channel gradient	Active channel width (ft.)	Pool number (#/mi)	Percent pools	Riffle gravel	Pieces of large wood	Fish observations*
Potts Creek	1	9/10/91	0.84	7.7	25	25	10	34	0	RB, CT
Potts Creek	2	9/10/91	0.46	2.8	9	5	11	22	0	RB, CT
Potts Creek	3	9/11/91	0.59	3.3	11	13	26	33	0	RB, CT
N.F. Calapooia	1	9/12/91	4.27	11.3	37	7	6	16	0	CT
Calapooia River	3	7/17/91	7.97	10.1	33	207	22	37	1062	CHS, RB, CT
Calapooia River	2	7/17/91	7.32	16.9	55	148	24	45	259	CHS, RB, CT
Calapooia River	1	7/17/91	11.77	0.9	63	156	21	13	116	CHS, RB, CT

* Fish observed: CHS = Juvenile spring chinook salmon; RB = Rainbow trout/steelhead; CT = Cutthroat trout.

channels. Side channels create high quality fish habitat by providing backwater areas for fish feeding and refuge from high flows.

Gravels in riffle areas are an indication of spawning habitat for winter steelhead, spring chinook, and cutthroat trout. Riffle gravels range from 45% in Reach 2 to 16% in the lower portions of the North Fork Calapooia River. Riffle gravels occupying over 30% of the channel area is a good indication of high quality spawning habitat. To improve habitat, Weyerhaeuser has added large wood to the channel in the North Fork to increase wood volumes, create pools, and capture spawning gravels (Jay Christensen, Weyerhaeuser, personal communication, 2003).

Figure 6-10. Percent pools for the Upper Calapooia River and tributary reaches inventoried in 1991 using the ODFW's standard methods.



Fish passage barriers

In comparison to the lower and middle watershed areas, fish passage is not a significant issue in the upper Calapooia River Watershed. There are no dams in the river channel, so this is not an issue. Weyerhaeuser and the Forest Service in the upper watershed have inventoried culverts at road crossings for fish passage. Many culverts were replaced after the 1996 flood, and Weyerhaeuser has corrected most of the identified fish passage problems in the streams identified to have the highest quality habitat (Jay Christensen, Weyerhaeuser, personal communication, 2003).

Key factors limiting fish populations in the Calapooia River Watershed

The major factors impacting fish habitat and populations in the Calapooia River Watershed are fish passage barriers, limited large wood in the river and stream channels, and water quality issues. This section will summarize fish passage barriers and large wood issues. Water quality issues will be covered in Chapter 7, *Water Quality*. The final Chapter of the assessment (see Chapter 9, *Recommendations for Restoration and Protection*) provides a comprehensive look at all of the factors constraining fish habitat and populations.

Fish passage

There are two components constraining the passage of fish in the Calapooia River Watershed: fish passage barriers at dams in the river channel, and fish passage issues at road crossing culverts. Dams are the most pressing fish passage issue. The Calapooia River, in comparison to tributary streams, provides most of the important fish habitat, particularly for spring chinook salmon and winter steelhead trout. The river is the primary corridor for migrating fish and the river channel provides most of the important spawning and rearing habitat. The river's dams – within the Thompson's Mill complex and Brownsville Dam – delay fish moving upstream to spawning areas in the upper watershed and may prevent the movement of adult and juvenile fish during parts of the year. Delaying the migration of spring chinook and winter steelhead stresses the fish, leading to reduced spawning success, and provides opportunities for poaching and harassment.

Fish passage at road crossings is important for two reasons. First, adult salmon, trout and steelhead need to move around the watershed to access spawning areas. Second, juvenile fish need to move through streams to escape unfavorable conditions such as warm water temperatures in the summer and high flows in the winter. Fish use most of the lower gradient stream channels in the watershed, even in seasonal streams. Juvenile winter steelhead and spring chinook salmon use the lower portions of seasonal and perennial tributary streams. It is important to provide appropriate fish passage at road crossings, particularly in the lower portions of tributaries.

Large wood in stream channels and complex habitat

Historically, there were frequent and large log drives down the lower Calapooia River (See Chapter 2, *Historical Conditions*). These log drives and the associated removal of wood and log jams, probably continue to affect the river channel by limiting the current quantity of wood in the channel. The reduced number of logs and other wood in the river's channel limit the creation of pools and hiding habitat for fish. The loss of wood from the river channel further exacerbated by current wood removal: Logs continue to be removed from the Calapooia River and tributary streams. Logs are removed to prevent bank erosion, reduce damage to property and bridges, and, in some cases, to allow recreational boaters to pass down the channel (Robert Singleton, Corvallis Canoe and Kayak Club, personal communication, 2003). In addition, the lack of large trees growing along some sections of the river and streams contributes to the long-term shortage of wood in channels. The status of streamside forests and the wood removal actions have cumulatively impacted the river channel and fish habitat quality, reducing the formation of pools, limiting hiding cover, and slowing the trapping of spawning gravels. More wood throughout the river and stream system would be helpful. A targeted approach to in-channel wood restoration and riparian area enhancement would be to target the most responsive reaches of the river and the lower portions of tributary streams. The river reaches near Brownsville (reaches 6 and 7) are areas of active gravel deposition that would be especially responsive to short-term actions to protect current wood in the channel and promote future activities that support enhanced riparian areas.

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Chapter 7. Water Quality

Introduction

The quality of the water throughout the Calapooia River Watershed influences its use by fish, wildlife, and humans. Excessive values for water temperature, suspended sediment, nitrogen, phosphorus, and pesticides can make portions of the watershed unfavorable for some species of fish and wildlife, especially during the summer when these species are most stressed and water levels are low. Excessive bacteria levels in the water can make the water more difficult to treat for drinking and increase the risk of infection for those who swim and angle in the river.

Distinguishing between natural and human-caused patterns in these water quality parameters is difficult, since no water quality information is available prior to pioneer settlement. Nevertheless, an understanding of the primary forces that cause a water quality parameter to increase and an examination of variation across a watershed (and between watersheds), can help isolate what is due to human actions. An equally difficult task is determining how fish and wildlife are affected by changes in water quality since little is known about how animals react to incremental changes in water quality. Rarely are human-caused changes in water quality catastrophically fatal to animals. Rather, the changes are more likely to decrease the amount of desirable habitat available throughout the watershed or decrease reproductive success, thereby gradually reducing a population. Even those fish in the Calapooia River listed under the federal Endangered Species Act are not monitored closely enough to detect such patterns.

Methods

This chapter covers the following water quality parameters; water temperature, bacteria and other organisms, nitrate, phosphorous, suspended sediment, and pesticides / herbicides. Information on data sources is covered in the individual sections.

For lack of concrete understanding between changes in water quality and species populations, water quality standards developed by the State of Oregon or the federal government are often applied to rivers and streams. For example, the state water quality standard for water temperature that currently applies to the Calapooia River Watershed indicates that no human-caused increases are allowed if the maximum water temperature (averaged over 7 days) already is 64 °F or more. Similarly, the maximum allowed level of the bacteria, *Escherichia coli* (abbreviated as *E. coli*), in the river is 406 colonies per milliliter. These water quality standards can create confusion since salmon and trout routinely live in water between 64 and 70 °F, and correlations between *E. coli* measured in rivers and outbreaks of human bacterial infection are very weak. In this document, we rely mostly on values that are clearly impediments to fish and wildlife populations rather than state water quality standards to make sense of water quality measurements in the Calapooia River Watershed.

Water temperature

Complex interactions between shading, river substrate, and channel geometry result in water temperatures that continually vary along the length of a river. Nevertheless, in general, rivers warm from their headwaters to mouth. The maximum summer temperature for any given reach of stream also varies annually, depending on the timing of maximum air temperature and low flows for the year. But usually, maximum water temperatures occur from mid-July to mid-August, a time when the sun is high in the sky, flows are relatively low, and air temperature is the highest.

When groundwater enters into a stream channel, its temperature immediately begins to change. Sunlight striking the water surface and interaction with the air causes warming. This warming is moderated to some extent by heat lost to the channel bottom, by water evaporating, and by vegetation intercepting sunlight. Many streams have a subsurface component that flows through the sand and gravels parallel to the surface flow. This subsurface component is not exposed to sunlight and therefore is cooler than what flows over the surface. Where the two stream components intermix (such as in a deep pool), the net result is a cooling of the aboveground component of stream flow. The subsurface component of stream flow does not exist for streams with a bedrock or clay bottom. The Calapooia River has a predominantly clay bottom downstream of where the Sodom Ditch begins. Extensive lengths of bedrock can be found in the upstream portion of the river that flows through forest land.

Maximum water temperature is commonly expressed as the greatest 7-day running average of daily maximum temperatures that occur during a summer. Hereafter, this is referred to as the 7-day maximum. The 7-day maximum, in contrast to the annual daily maximum, better reflects the response of fish to high water temperature. Fish can often endure one day of 75 °F water by eating more or moving to zones of cooler water. However, if the water peaks at 75 °F for a period of a week, these survival strategies are less effective. The annual maximum water temperature is usually 2-3 °F higher than the 7-day maximum for Willamette Valley streams.

State water quality standards for water temperature also are expressed as the 7-day maximum. The water temperature standard adopted by the Department of Environmental Quality for the Calapooia River Watershed streams is 64 °F. Most activities that increase the temperature of a stream above 64 °F are prohibited. This is not to suggest that all streams are naturally cooler than this standard; streams with abundant shade commonly exceed 64 °F, the state standard for temperature, which is an incomplete indicator of what fish can tolerate. Salmon and trout commonly live in streams that exceed 64 °F. However, physiological changes and behavior will often occur in fish when temperatures approach 70 °F. Being cold-blooded, fish must consume more food when the water is warmer or they will lose weight. Warm water also can lead to sluggish movement and to fish congregating around pockets of cooler water. This further limits their ability to search for food, as well as making them more prone to predation, poaching, and disturbance by swimmers. Adult spring chinook salmon in the Calapooia River have an additional problem with warm water. Since they must reside in the river throughout the summer prior to spawning in the fall, they are vulnerable to diseases. Warm water promotes these diseases and can lessen the fish's ability to resist disease.

Available information

Water temperature information suitable for evaluating basin-wide patterns is limited for the Calapooia River. In 2001, monitoring by the Oregon Department of Environmental Quality yielded information on 6 river sites and 10 tributary sites (located from Albany to the beginning of USFS ownership). Monitoring by the Calapooia Watershed Council in 2002 yielded information on 6 river sites (located from Linn West Road to the confluence with the North Fork Calapooia River), along with 5 tributaries in the upper watershed. Additional monitoring by the authors of this assessment was conducted in August, 2003 and yielded information on 6 river sites from Albany to the Weyerhaeuser Company boundary and on 5 sites on lower Oak Creek, the Brownsville Canal, and Brush Creek (Table 7-1). The warmest water temperatures in 2001 occurred during 7-day periods centered on August 10 and on July 23 in 2002. The 2003 data were restricted to a single hot spell centered on August 17, which probably did not yield the warmest temperatures of that summer. Judging by the temperature of the Calapooia River measured at the McClun Wayside, water temperatures for the 2002 data set were about 3 degrees warmer than the 2003 data set. Water temperatures in 2001 were about 2 degrees cooler than they were in 2002.

Findings

The maximum temperature of the Calapooia River for the three years of monitoring exceeded 70 °F throughout much of the river's length (Figure 7-1). Only upstream of the Potts Creek confluence at river mile 65 did the temperature dip below this threshold. Salmon and trout commonly show signs of stress or will move out of segments of streams that exceed 70 °F. The water temperature of the river at Brownsville exceeded 80°F in 2002 and was even greater than the temperature measured near Albany in 2003. The temperature of the Calapooia River at West Linn Road was about 3 degrees cooler than Sodom Ditch in 2003. The majority of flow during the monitoring period was in Sodom Ditch, which is less shaded than the natural Calapooia River channel.

The only tributary in the lower watershed that had flow during August, 2003 was Oak Creek downstream of Interstate Highway 5. Its maximum temperature in 2003, measured at Lochner Road, was 6 degrees cooler than the Calapooia River (Figure 7-1). Downstream of Lochner Road near the railroad bridge, Ore-Met (a metals manufacturer in Albany) discharges about 1.8 cubic feet per second (cfs) of cool water into Oak Creek. This water originates from wells and the discharge water is about 62 °F, or about 9 degrees cooler than Oak Creek at Lochner Road. The discharge water is of much greater volume than the natural flow of Oak Creek during the summer, and so, the stream is cooled considerably. Hundreds of fish congregate in the pools downstream of the Ore-Met outfall during the summer (Era Lewis, Ore-Met Environmental Coordinator, personal communication, 2003).

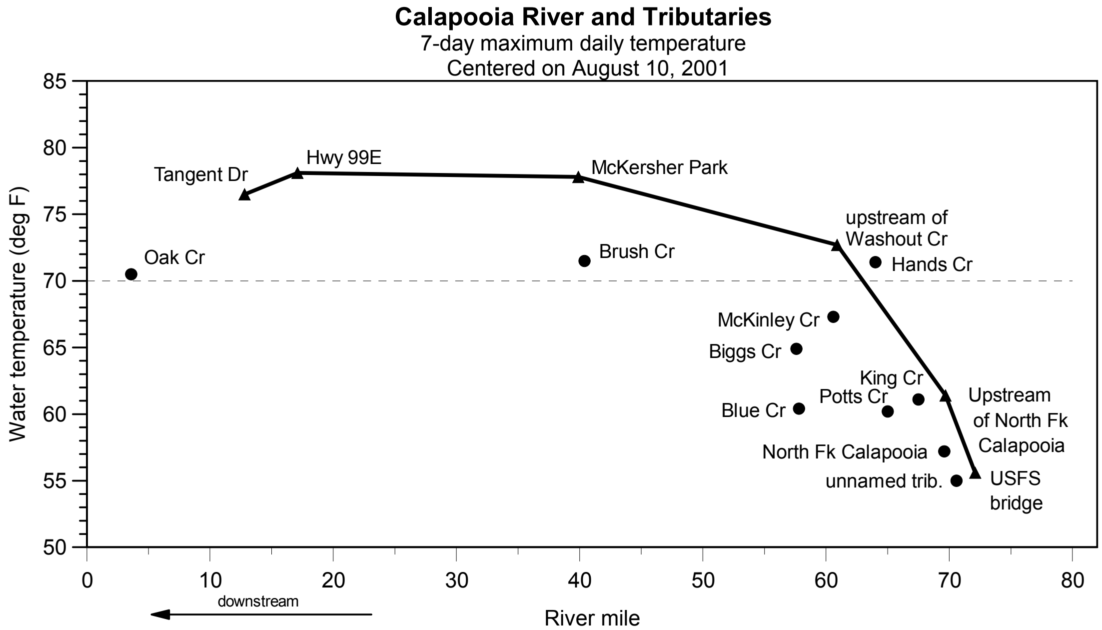
Of the upper watershed tributaries monitored in 2001 and 2002, all but Hands Creek had maximum temperatures less than 70 °F (Figure 7-1). Potts Creek and North Fork Calapooia River were particularly cool at 61 °F and 63 °F, respectively. It is unclear why Hands Creek was warmer than the other tributaries.

Brush Creek, a larger tributary that flows northward out of the hills above Crawfordsville, had a maximum temperature at its confluence with the Calapooia River that was about 6 degrees cooler than the river (Figure 7-2). The heavily-shaded west fork of Brush Creek was even cooler than lower Brush Creek. The lesser-shaded east fork of Brush Creek was about 5 degrees warmer than the west fork. Nevertheless, at all three monitoring sites, Brush Creek was 70 °F or less in 2003, and therefore, has the potential of being an important summer refuge area for spring chinook salmon, winter steelhead, and trout that flee the relatively warm Calapooia River.

Table 7-1. Summary of maximum water temperatures for the Calapooia River Watershed from 2001 to 2003 from data collected at various main channel and tributary sites. Temperatures shown are the greatest 7-day maximum temperatures in degrees Fahrenheit.

Calapooia River Sample Location	River mile	7-day maximum temperature (deg F)		
		2001	**2002**	**2003**
Calapooia R at Albany	3.0	-	-	78.9
Calapooia R at Tangent Dr	12.8	76.5	-	-
Calapooia R at Hwy 99E	17.1	78.1	-	-
Calapooia R at Linn West Rd	25.8	-	75.1	73.6
Sodom Ditch at Linn West Rd	25.8	-	-	75.7
Calapooia R at Brownsville	33.0	-	80.8	-
Calapooia R at Brownville Dam	35.9	-	-	75.3
Calapooia R at McKercher Park	39.9	77.8	-	-
Calapooia R at McClun Wayside	48.0	-	76.3	72.4
Calapooia R at river mile 53.6	53.6	-	-	72.9
Calapooia R at river mile 56.6	56.6	-	76.3	-
Calapooia R upstream of Washout Cr	60.9	72.7	74.3	-
Calapooia R upstream of North Fork	69.7	61.4	63.1	-
Calapooia R at USFS bridge	72.1	55.6	-	-
Tributaries				
Oak Cr near mouth	3.6	70.5	-	-
Oak Cr at Lochner Rd	-	-	-	73.1
Brownville Canal (downstream end)	33.1	-	-	71.5
Brush Cr near mouth	40.4	71.5	-	68.4
East Fork Brush Cr	-	-	-	70.4
West Fork Brush Cr	-	-	-	65.3
Biggs Cr near mouth	57.6	64.9	-	-
Blue Cr near mouth	57.8	60.4	-	-
McKinley Cr near mouth	60.6	67.3	67.7	-
Washout Cr near mouth	60.9	-	64.5	-
Hands Cr near mouth	64.0	71.4	-	-
Potts Cr near mouth	65.0	60.2	60.7	-
King Cr near mouth	67.5	61.1	-	-
North Fork Calapooia R near mouth	69.7	57.2	62.6	-
Unnamed tributary near mouth	70.6	55.0	-	-

Figure 7-1. 7-day average of maximum temperatures for a hot spell in mid-August, 2001 (first graph), mid-July, 2002 (second graph) and mid-August, 2003 (third graph) for the main channel (points connected by a line) and the mouths of selected tributaries.



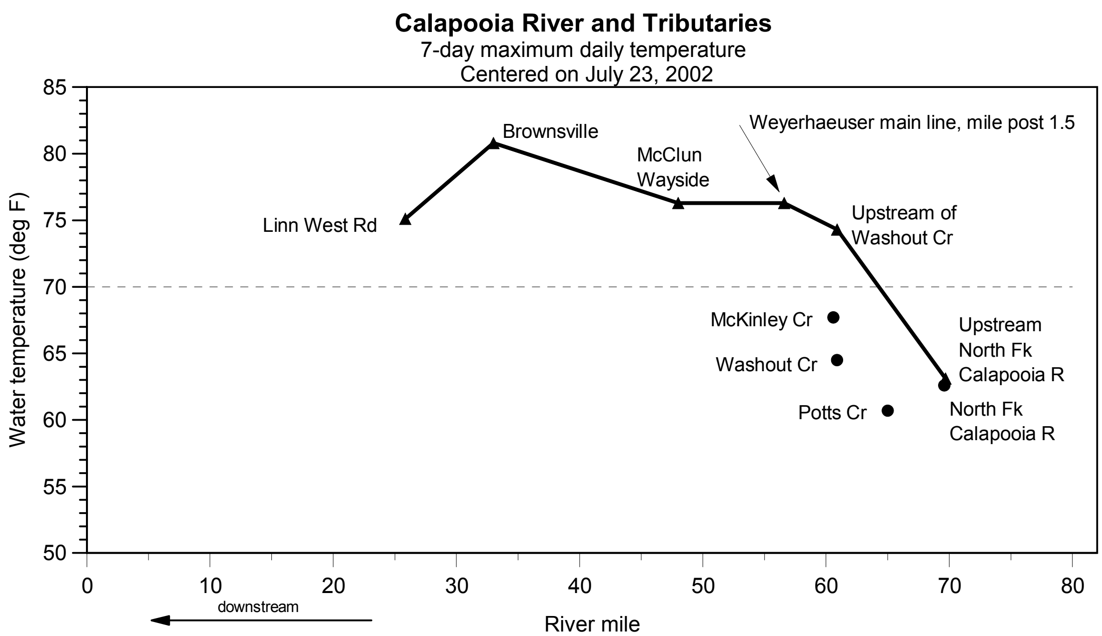
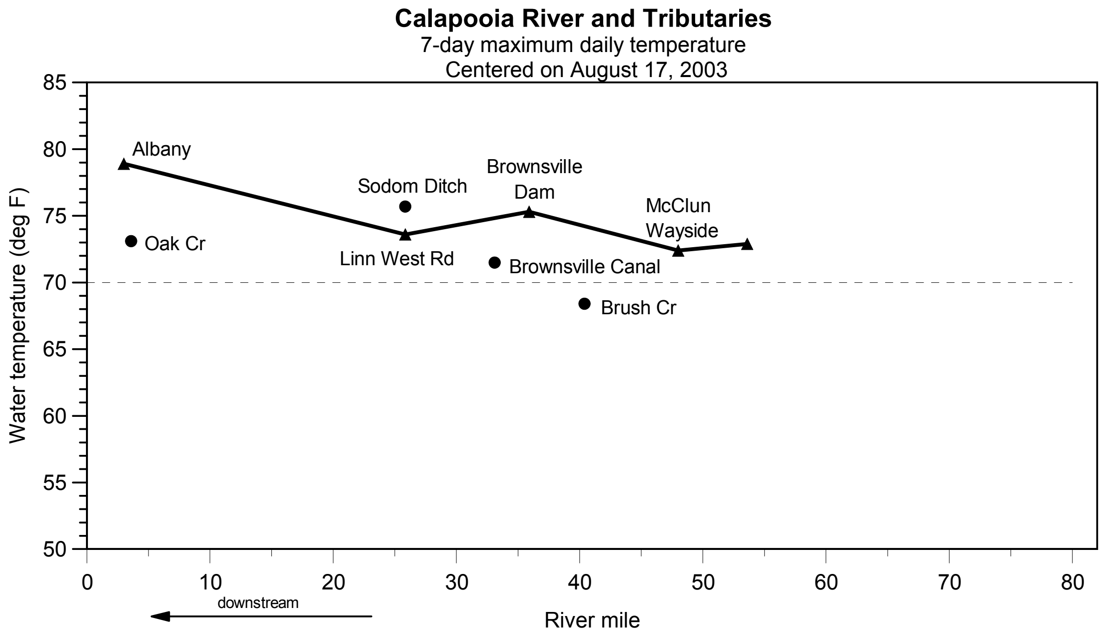
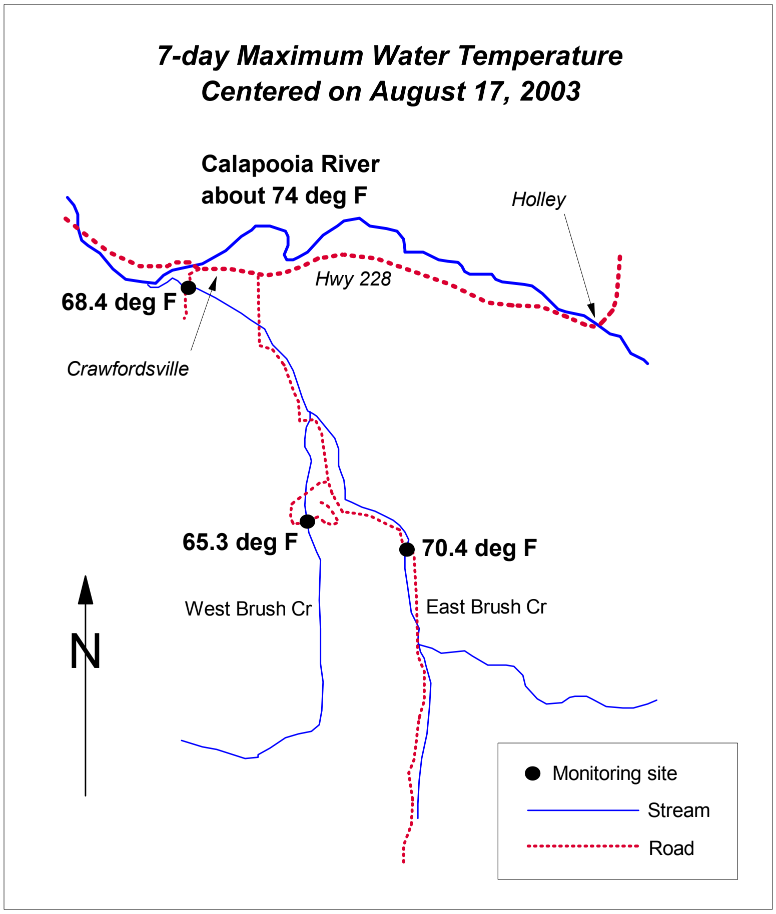


Figure 7-1 continued.



Monitoring sites at the downstream end of the Brownsville Canal and at the Brownsville Dam indicate that the water cooled nearly 5 degrees as it flowed through the length of the canal. In contrast, the Calapooia River remained warm downstream of the dam (Figure 7-1). The canal is shaded throughout much of its length while the river is fully exposed to sunlight. The monitoring of water temperature in the Brownsville Canal happened to coincide with a reduction in canal flow from about 2 cfs to about 0.5 cfs. The canal head gate was closed in the evening on August 18 in order to provide water to satisfy the more senior instream water right at Albany. The head gate would normally shut off all flow to the canal but gaps in the concrete now allow about 0.5 cfs to bypass the gate. The reduction in flow caused the maximum water temperature in the canal to drop by about 1 degree.

Figure 7-2. 7-day mean of maximum water temperatures for Brush Creek during a hot spell in mid-August, 2003.



Discussion

The main channel of the Calapooia River from Albany to Potts Creek is too warm to provide much summer habitat for fish that need cooler water such as cutthroat trout, spring chinook salmon, winter steelhead, and mountain whitefish. Aerial photographs indicate that streamside trees provide little shade to the main channel upstream of the Sodom Ditch and downstream of Potts Creek because of the river's wide channel. Even where mature stands of trees exist, shade is sparse. It is likely that most parts of the Calapooia River never had much shade, even when the streamside trees were not influenced by human activities. The Calapooia River upstream of Sodom Ditch and downstream of Holley has extensive deposits of gravel that allow some of the river flow to go subsurface and cool. Yet, this cooling mechanism is not dominant enough to prevent the river from warming in a downstream direction through this section. It is likely that there are cool pockets of water in this section of the river, especially within deep pools, that allow fish to find some thermal refuge, although this has not been investigated.

Most of the lower watershed tributaries are dry during the summer so thermal refuge for fish is available only for Brush Creek, lower Oak Creek, and the upper watershed tributaries. The temperature of Brush Creek approaches 70 °F in some reaches and so it is at the limit of providing favorable summer habitat. Increasing shade along the channel, especially in West Brush Creek, would make this stream more favorable. Cattle grazing along portions of Brush Creek have resulted in reduced shade. Fencing of streamside areas that are currently grazed would allow for the natural regeneration of brush and trees and an increase in shade. The removal of irrigation dams and the replacement of inadequate culverts that prevent small fish from moving upstream would allow fish to access the coolest water in this tributary.

The upper watershed tributaries and the main channel upstream of river mile 65 are the primary cool water refuge areas for salmon and trout in the Calapooia River Watershed. Recent improvements of culverts along the Weyerhaeuser mainline road allow fish to easily access these tributaries. The primary limitation of these tributaries during the summer is probably the lack of large wood essential to creating deep pools (Weyerhaeuser 1998). During summer low flows, the deep pools provide fish protection from birds and other predators.

The Oregon Department of Environmental Quality oversees a process, as required by section 303(d) of the federal Clean Water Act, of listing certain streams and lakes that are deemed to be water quality limited. This list is commonly referred to as the 303(d) list. Data for an individual stream, lake, or estuary can be submitted by agencies or individuals to the 303(d) list. If the data suggests that a water body does not meet water quality standards, the water body is identified on the 303(d) List as water quality limited. A water quality limited stream is not necessarily one impaired by human activity, but its designation simply means that a water quality standard has been exceeded. The question of whether or not human activities actually cause the standard to be exceeded is dealt with through a subsequent Total Maximum Daily Load (TMDL) process, whereby pollutant loads are allocated according to each source. The 303(d) list was last updated on March 24, 2003. Since many streams exist throughout Oregon for which information on basic water quality has never been collected, the 303(d) list is not complete.

The Calapooia River is included in the 303(d) list as water quality limited for temperature, as a result of the river exceeding the water quality standard of 64 °F in its lower reaches. The TMDL process for the Calapooia River and other rivers in the Willamette River will be conducted by the Department of Environmental Quality using information they and others have collected. In past TMDL processes, this information has been fed into various computer models for the purpose of calculating how much the water could be cooled under various scenarios. Stakeholders in the basin (landowners along streams and rivers, those who extract water from the river, and those who dispose of warm water into the river) are allocated a heat "load" and guidelines are issued for reducing that heat load. The timeline for completion of the water temperature TMDL for the Calapooia River is unknown.

Bacteria and other microorganisms

Runoff from areas grazed by cattle, failed septic systems, and high concentrations of geese, ducks, and other animals are sources of microorganisms in the water. In addition, urban stormwater runoff is a conduit for concentrations of microorganisms to reach waterways. While bacteria in streams generally have no effect on aquatic organisms or wildlife, certain types and strains of bacteria may pose a health risk to people through contact with the water and can increase the difficulty of treating water for human consumption. In addition to bacteria, other water-borne protozoa and disease-causing microorganisms can adversely affect human and animal health. Because of the number of various organisms that have the potential to affect human health, monitoring commonly focuses on easily-detected but relatively harmless bacterium, which frequently occurs with the other more harmful varieties.

Currently, *Escherichia coli* (abbreviated as *E. coli*) is the bacteria widely used to evaluate the level of harmful bacterial in water and it resides in the guts of humans and many other animals. The presence of *E. coli* and other kinds of bacteria within intestines of people is necessary for them to physically develop and to remain healthy. Along with other species of bacteria, *E. coli* provide many necessary vitamins. The bacteria make the vitamins (such as vitamin K and B-complex) and these are absorbed by the human digestive system. However, in addition to the "good" *E. coli* in the world, there are some strains of *E.coli* that create a toxin that causes severe damage to intestinal cells. The damage can result in a loss of water, salts, and lead to heavy bleeding. Other harmful microorganisms live in the guts of humans and animals, so the presence of the gut-residing *E. coli* (both good and bad strains) in the water, can mean that other harmful microorganisms are present. In Oregon, the water quality standard for *E. coli* is 406 organisms/100 mL (milliliter), to protect public swimming and aquatic life.

Available information

Long-term monitoring of bacteria in the Calapooia River at the Queen Avenue Bridge (in Albany downstream of Oak Creek) by the Oregon Department of Environmental Quality, has indicated chronic high levels of *E. coli*. Yet, until recently, little was known about how *E. coli* concentrations varied throughout the watershed or of likely sources of bacterial contamination. Watershed-wide monitoring by the Calapooia Watershed Council in 2002 and 2003 and of specific locations in Oak Creek by the City of Albany and the Calapooia Watershed Council has provided some missing information.

Monitoring in 2002 and 2003 occurred during the wet season from November to June. Samples were collected by members of the Watershed Council or by City of Albany employees. Sites were selected upstream of Brownsville to investigate the possibility that cattle and failed septic systems from houses near the river contributed to bacteria in the river and streams. Sites along Oak Creek within and upstream of Albany were selected to understand how stormwater runoff from developed areas and rural areas contributed to bacteria concentrations. Most sites were sampled at least three times during a 2-year period, although some of the Oak Creek sites were sampled only once.

Findings

E. coli concentrations in the Calapooia River are very low where the river exits the forested upper watershed and increase only slightly in a downstream direction as far as Brownsville (Table 7-2a, Figure 7-3). Concentrations in selected tributaries (Brush Creek, Warren Creek, and Courtney Creek) are higher than the river but median values are well below the state water quality standard of 406 colonies per milliliter (#/mL). During one sampling period, Courtney Creek did exceed the standard. The median value rather than the average value was used in this analysis in order to describe the "most common" condition. The median is determined by listing the numbers in decreasing order and selecting the value halfway down the list.

Between Brownsville and Albany, there were no regular sampling locations on the Calapooia River, so it is unclear if bacterial contamination is occurring within this segment. Nevertheless, sampling of the river immediately upstream of the Oak Creek confluence on May 9, 2003, indicated that *E. coli* concentrations were only 26 organisms per mL and a second sampling on June 26, 2003 had a value of 8 per mL. Sampling of Oak Creek at the Highway 99E Bridge indicated high levels of bacteria that commonly exceeded the water quality standard (Table 7-b, Figure 7-4). Downstream of Oak Creek at the Queens Avenue Bridge, the Calapooia River also frequently has *E. coli* concentrations that exceed the state water quality standard. It is unclear whether the source of this contamination is only Oak Creek or a combination of Oak Creek and other sources along the Calapooia River downstream of Oak Creek.

Limited sampling of Oak Creek suggests that *E. coli* concentrations are highest in the portion of Oak Creek that flows through Albany (Figure 7-4). In particular, the section of stream between Lochner Road and Columbus Street seems to have elevated values. Two stormwater pipes (A and B) were sampled in June, 2003 but values were low (Table 7-b). A ditch into which stormwater pipe B flows into had very high bacteria counts. A source of bacterial contamination also seems to exist upstream of Fry Road, which is outside the developed portion of Albany. Further upstream at Tangent Road, the water is relatively free of bacteria.

Discussion

The limited monitoring done to date suggests that chronically high *E. coli* values measured by the Oregon Department of Environmental Quality in the lower Calapooia River may have their source mainly within lower Oak Creek. Nevertheless, additional monitoring would be needed to rule out contributions along the Calapooia River downstream of Brownsville.

Currently, the evidence points to Oak Creek as the likely center of contamination. The sources could include leaking sanitary sewer pipes, failed septic systems, runoff from streets, and/or livestock and wildlife in the area. Focused sampling in the areas with high contamination will be needed to understand the nature of these sources. Sampling will need to be done a number of times throughout the wet season because the temporal variability of bacteria in urban streams can be quite high.

Past monitoring indicates that high values of *E. coli* concentration that exceed the state water quality have occurred once in Courtney Creek and once in the Calapooia River immediately downstream of Brownsville. So, even though median values are relatively low, the upper watershed is not immune to bacterial contamination. Likely sources of bacteria include stormwater from Brownsville, cattle grazing near streams, and failed septic systems of houses located near streams. Contact with the water is most common in the summer when people swim in the river. Sampling of bacteria during the summer at favorite swimming holes that are downstream of possible sources of contamination (Brownsville Dam, Brownsville Park, mouth of the river) would provide information on exposure.

The Calapooia River is on the 303(d) list for bacteria, as well as temperature. Consequently, it is subject to a TMDL process for bacteria. As with the temperature TMDL process, the Department of Environmental Quality will compile data that they and others have collected and determine a contamination “load” that contributors to the load will need to address through changes in their practices.

Table 7-2a. Summary of bacteria data (E. coli) for the Calapooia River and various tributaries (excluding Oak Creek).

Stream	Site	Median (#/mL)	Range (#/mL)	Number of samples	# Samples exceeding 406/mL
Calapooia River	Queen Ave, Albany	723	21-1733	4	2
	Upstream of Oak Cr	17	8-26	2	0
	Brownsville Park	47	10-435	4	1
	McKercher Park	34	8-58	4	0
	Crawfordsville	34	6-59	4	0
	Holley	16	13-59	4	0
	Weyerhaueser MP 1.5	2	1-29	3	0
Courtney Creek	Truck stop	73	17-921	4	1
Warren Creek	Brownsville Dam	67	23-88	3	0
Brush Creek	At mouth	99	30-167	2	0

Table 7-2b. Summary of bacteria data (E. coli) for the lower Calapooia River and Oak Creek for seven sampling dates.

Site	11/10 2002	12/18 2002	2/10 2003	4/25 2003	5/29 2003	6/19 2003	6/26 2003
1. Calapooia R, at mouth	62				41		
2. Calapooia R, downstream of Oak Cr at Riverside Dr		**1414**	21	**1733**	33		25
3. Calapooia R, immediately upstream of Oak Cr					26		8
4. Oak Cr, lower					387		
5. Oak Cr, Hwy 99 E	83	**1986**	41	**2419**	**1414**	300	**1120**
6. Oak Cr, Lochner Rd					**1414**	300	204
7a. Oak Cr, downstream of stormwater A						130	
7b. Oak Cr, upstream of stormwater A						50	
8. Stormwater A						2	
9. Stormwater B							4
10. Oak Cr, downstream stormwater B						**500**	
11. Ditch (stormwater B)						**5000**	**2419**
12. Oak Cr, Columbus St. (upstream of ditch, stormwater B)					173	**600**	276
13. Oak Cr, Freeway Lakes					20		
14. Oak Cr, Fry Rd				387			**921**
15. Oak Cr, Tangent Rd				60			21

Values greater than 406 organisms per mL are shown in bold.

Figure 7-3. Bacteria levels (E. coli) in the Calapooia River and tributaries for sites with 2 to 4 sampling periods. Main river channel sites are connected by solid line. Tributaries are indicated by squares.

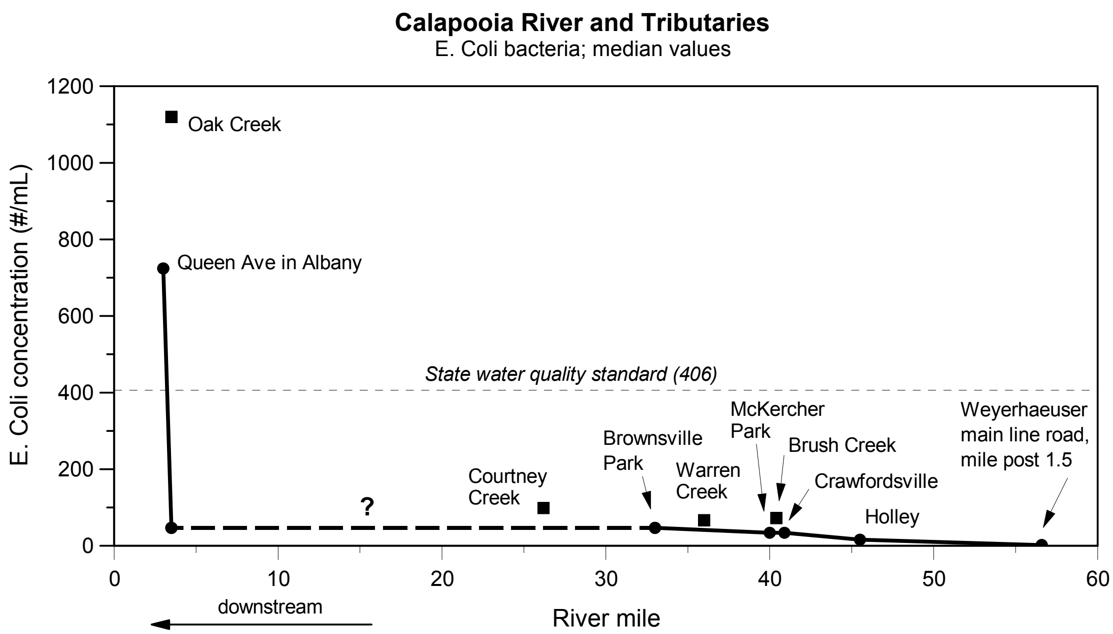
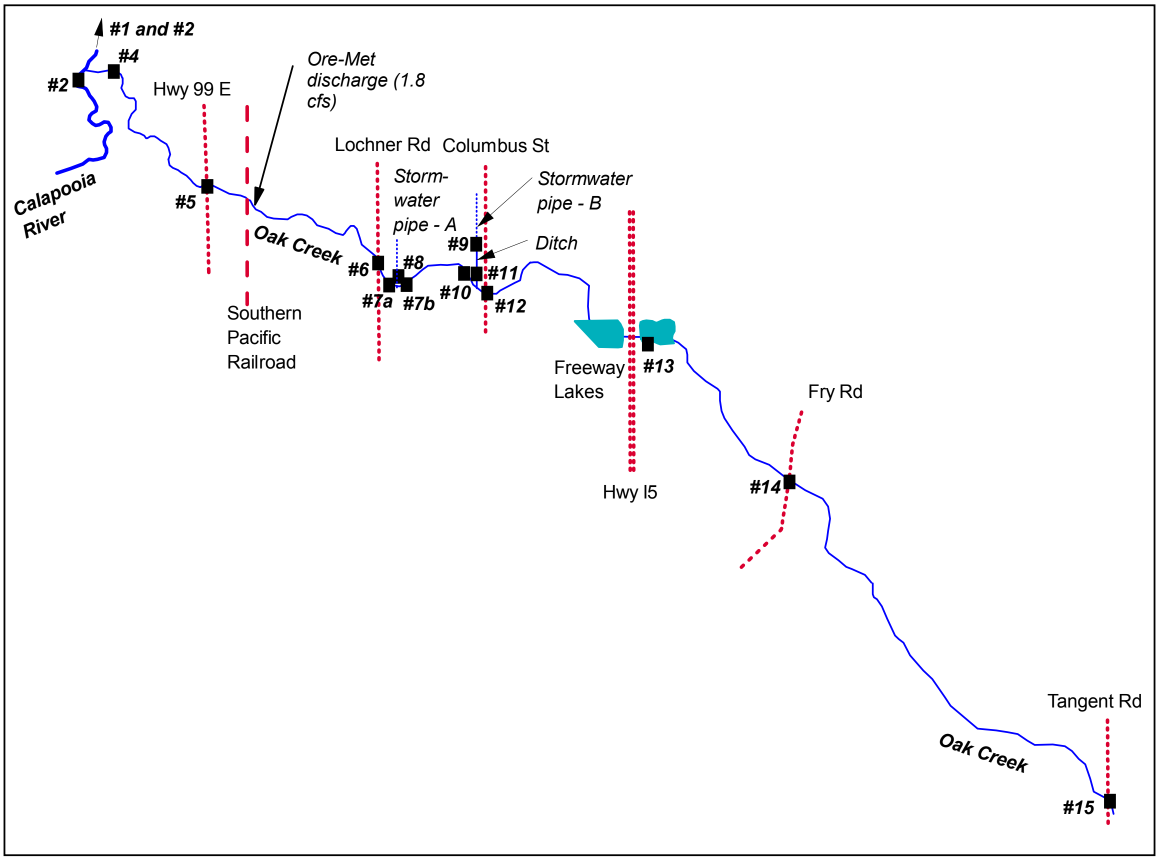


Figure 7-4. E. coli bacteria monitoring sites along lower Calapooia River and Oak Creek.

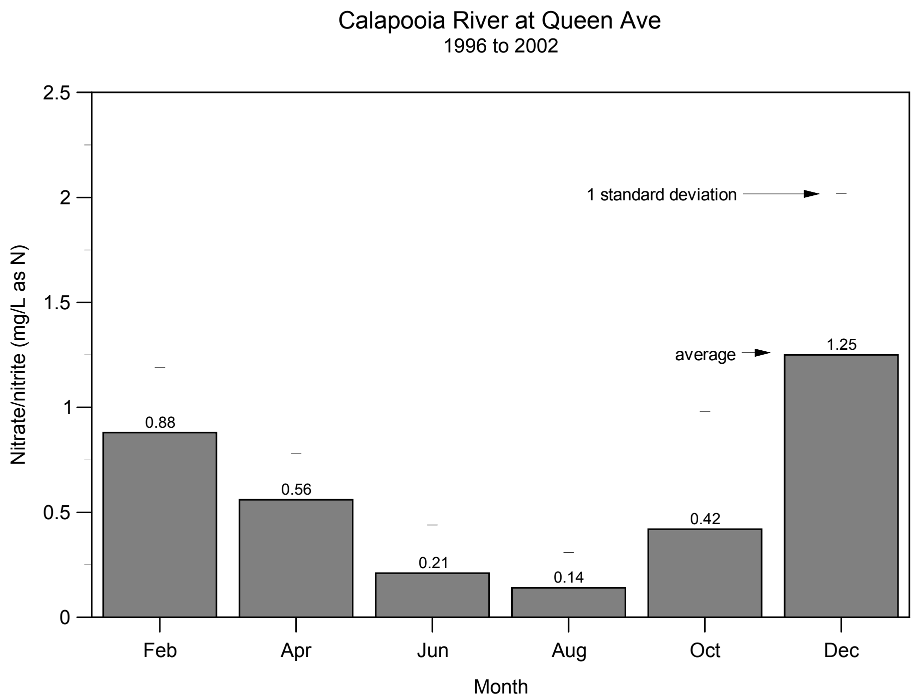


Nitrate

Nitrate and nitrite are the common forms of nitrogen in western Oregon streams that are available for uptake by algae and other aquatic organisms. Nitrogen is one of the two important nutrients that control the amount of algae that is either attached to the stream bottom or suspended in the water. Nitrogen, including that which originates from fertilizer, is mobile in soils and flushes out readily during heavy rainfall. Consequently, the concentration of nitrate/nitrite in the water is highest during the winter and lowest in the summer (Figure 7-5). Uptake of nitrogen by algae and other aquatic organisms occurs in spring and summer, further leading to lower levels of nitrogen.

Nitrate/nitrite concentrations in the lower Calapooia River (at Albany) are typical of most rivers and streams in the Willamette Valley that originate in the Cascade Mountains. Fall, winter, and spring values may be somewhat higher than natural, due to application of fertilizer to grass seed fields during the spring and the decay of grass seed residue in the fall and winter. Residue includes the chaff that is not harvested in the summer and the roots within those grass seed fields which are plowed.

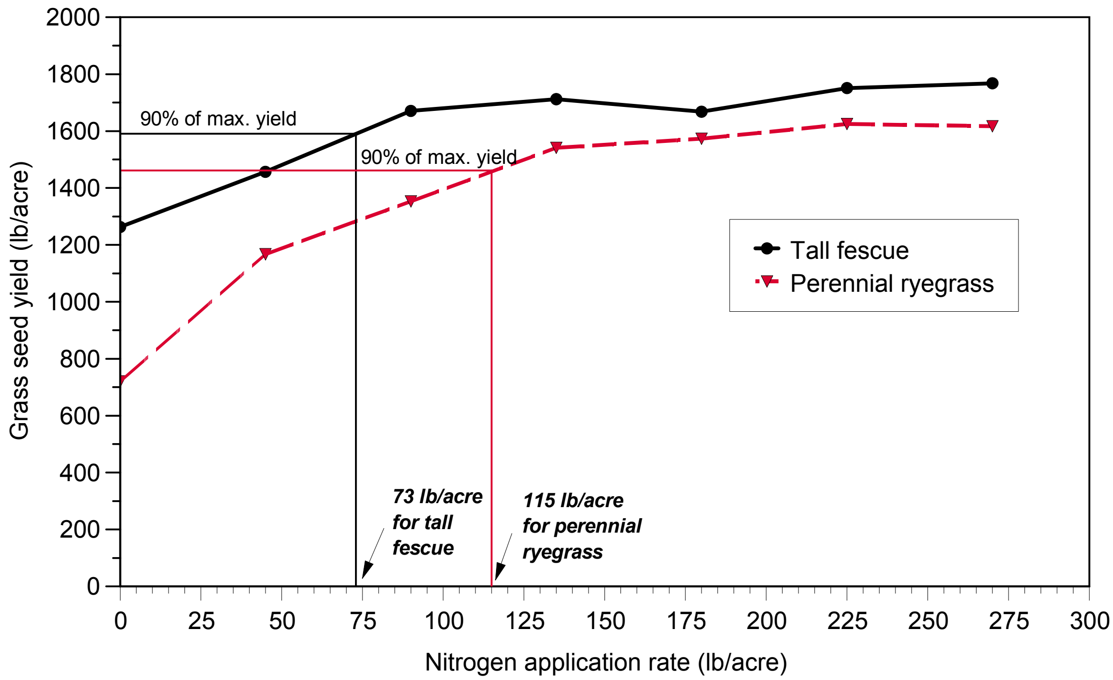
Figure 7-5. Nitrate/nitrite concentration (as nitrogen) by month for the Calapooia River at Albany from 1996 to 2002 (from DEQ ambient monitoring).



In order to obtain high crop yields of grass seed, nitrogen in the form of fertilizer pellets are applied to fields in the spring. Nitrogen application rates are typically 75 to 150 lb/acre for Willamette Valley grass seed fields. Excessive fertilizer use can result in leaching of nitrogen into streams, pollution of shallow groundwater, and unnecessary costs to the farmer. Nitrogen is applied to grass seed fields in the spring, a time when soils are wet and heavy rainfall can cause surface flow in fields and overland transfer of nitrogen-laden water into nearby waterways. Since grass seed fields occupy a major portion of non-forested areas in the Calapooia River Watershed, nitrogen fertilizer use is widespread.

Plot studies designed to examine the relationship between grass seed yield and nitrogen fertilizer application rates suggest that some grass seed farmers apply more fertilizer than is necessary to ensure high crop yields (Young et al. 1999). Spring fertilizer treatments of 0, 45, 90, 135, 180, 225, and 270 lb of nitrogen per acre were applied twice (one-half of the treatment each time) to plots at three Willamette Valley farm fields with a two-year old crop of perennial ryegrass and at three other farm fields with a two-year old crop of tall fescue. The results of the study showed that about 90% of the possible maximum perennial ryegrass yield could be obtained with a fertilizer application rate of 115 lb/acre (Figure 7-6). For the tall fescue, the 90% maximum yield could be obtained with a fertilizer application rate of only 73 lb/acre.

Figure 7-6. Relationship between grass seed yield and nitrogen fertilizer application rate for perennial ryegrass and tall fescue in the Willamette Valley (Young et al. 1999).



The environmental consequences of excessive nitrogen runoff are not fully known. Since most runoff occurs in the spring when stream levels are high, much of the excess nitrogen is quickly transported to the Willamette River and then out to the ocean. The lower portion of the Calapooia River, where grass seed fields are dominant, seems to have little groundwater inflow during the summer and therefore, not much nitrogen seeps into the river at that time of year to foster nuisance growths of algae. Probably the most obvious consequence of nitrogen leaching is the polluting of shallow groundwater areas, some of which are tapped by residents in the valley for drinking water. Nitrogen concentrations for 14 shallow groundwater wells in the Calapooia River Watershed (only a very small portion of wells in the watershed) are shown in Figure 7-7. None exceed the state water quality standard (10 mg/L of nitrogen), but some exceed 1 mg/L and are likely high because of fertilizer applications. The Oregon Health Division recommends that pregnant women not consume water that has a nitrogen concentration greater than 10 mg/L. All of the tested wells with values greater than 1 mg/L were located among grass seed fields, but not all tested wells in grass seed fields had detectable levels of nitrogen. The Oregon Department of Environmental Quality recently declared a large area centered on the Willamette River between Harrisburg and Eugene as a groundwater protection area, because a number of shallow private wells had nitrogen levels exceeding the state water quality standard. Fertilizer, failed septic systems, and animal manure are suspected causes of the groundwater pollution in this case. Soil conditions are somewhat different than those found in the Calapooia River; soils along the Willamette River are more permeable than the heavy clay soils typically found along the Calapooia River.

A study of nitrogen movement from grass seed fields into a small Willamette Valley stream (Lake Creek within the Calapooia River Watershed) indicated that, compared to cultivated riparian zones, noncultivated riparian zones were very effective at removing nitrogen from subsurface water draining into a stream (Wigington et al. 2003). Nevertheless, most of the water flowing off of the grass seed fields traveled over the surface and so had little interaction with the riparian vegetation. Most of the flow came from saturated swales that fed into small channels and then into the stream. Consequently, most of the nitrogen in the runoff water also ended up in the stream. The authors concluded that while retaining riparian vegetation is generally beneficial to streams, the benefits do not include mitigating nitrogen runoff. Instead they suggest that effective means to control nitrogen runoff from grass seed fields begin with applying only the minimum amount of fertilizer needed to grow a crop and that the timing of the fertilizer coincide with periods of drier weather.

April monitoring of nitrogen concentrations within 18 streams of the Pudding and Mollala Watersheds to the north of the Calapooia River Watershed (Rinella and Janet 1998), indicates that nitrogen values increased with increasing percentages of agricultural use within the watershed (Figure 7-8). The predictive equation indicates that the Calapooia River at Albany, with 47% of its watershed in agricultural use, should have a nitrogen concentration of 0.93 mg/L as nitrogen (N). The average value that was measured for the Calapooia River in February between 1996 and 2002 (0.56 mg/L as N) was slightly lower than the predicted value (Figure 7-5). The percentage of agricultural land in the Pudding and Mollala watersheds in 1993 that consisted of row crops, was higher than in the Calapooia River Watershed and could be the reason that measured values were lower than predicted. Another reason for the lower-than-predicted values is that most nitrogen fertilizer applications occur after February but prior to April.

Figure 7-7. Nitrogen concentrations in 14 shallow groundwater wells for the Calapooia River Watershed near Brownsville (from DEQ monitoring).

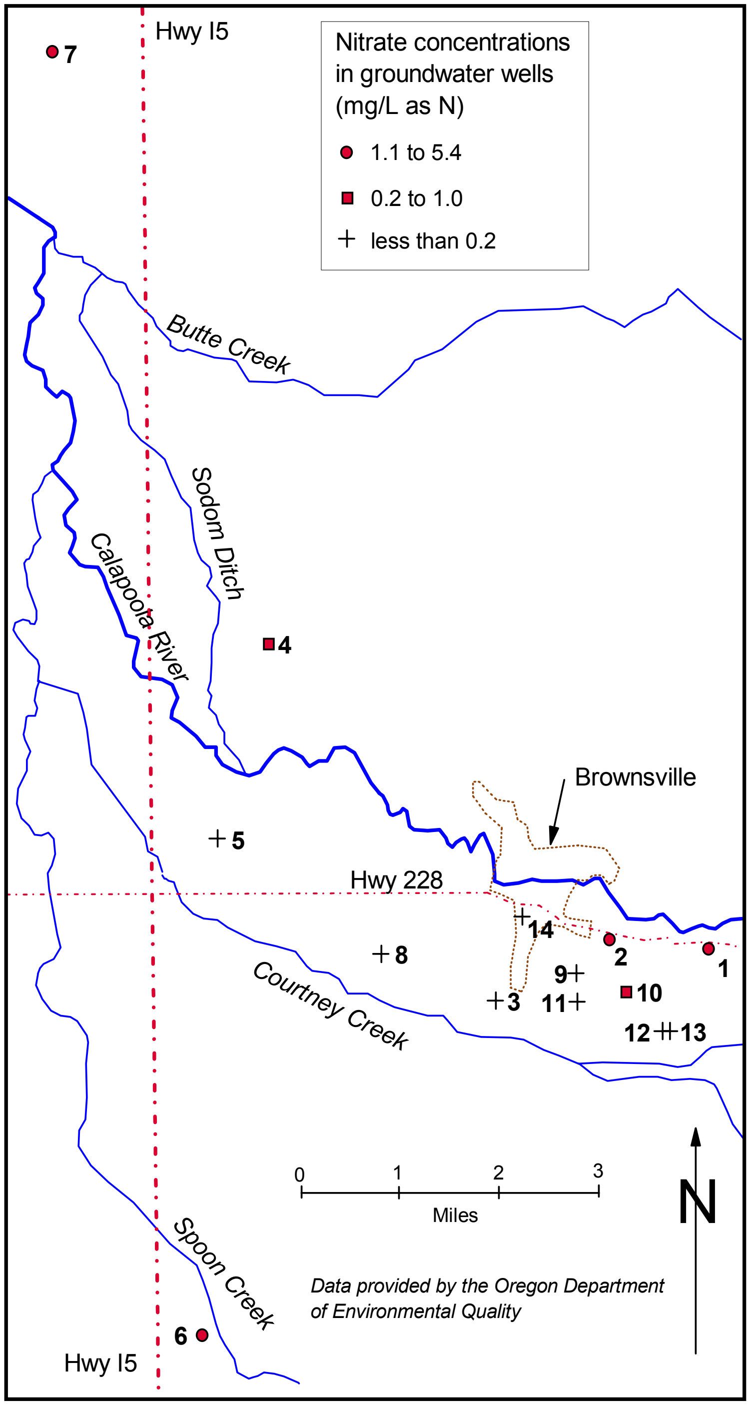
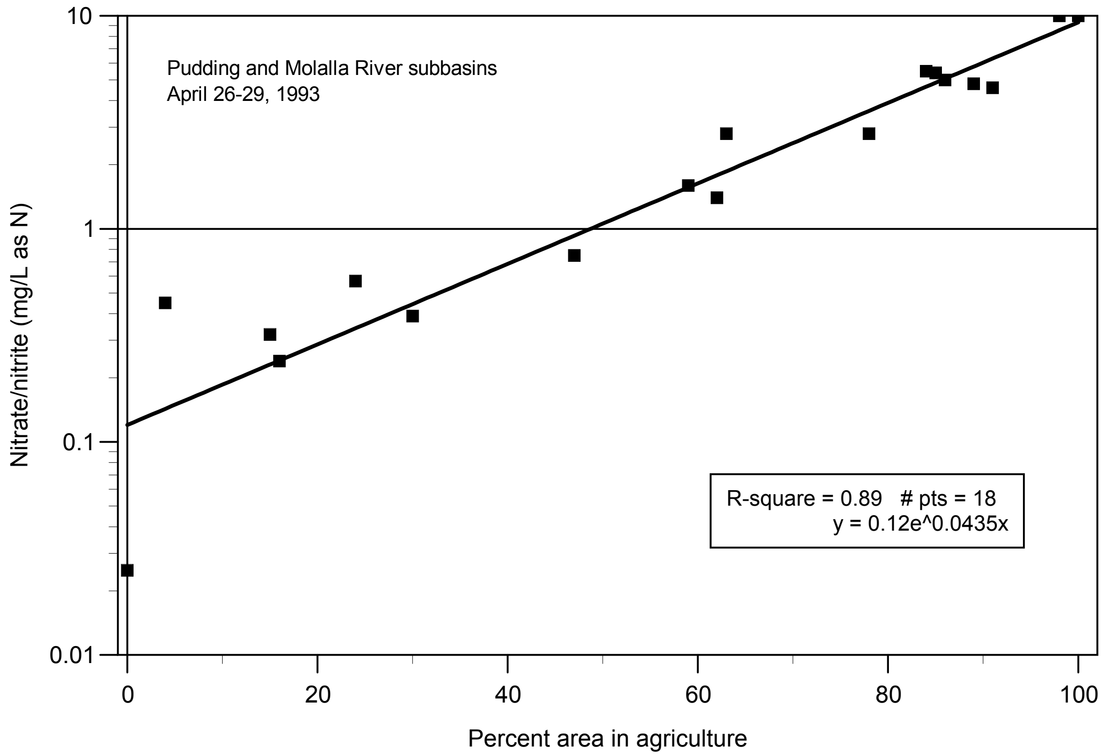


Figure 7-8. Nitrogen concentrations in Pudding and Molalla River streams in April as a function of percent area in agriculture (from Rinella and Janet 1998).

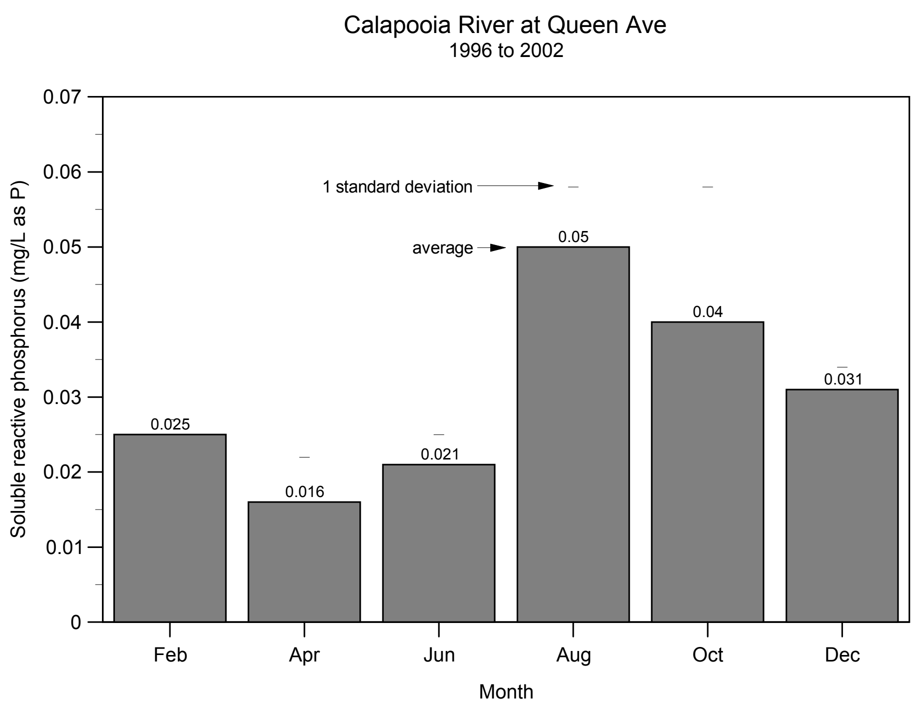


Phosphorus

Phosphorus, along with nitrogen, controls the amount of algae found in the Calapooia River and its tributaries from spring through fall. Phosphorus is usually the scarcer of the two nutrients, especially from April to June when algae growth is most rapid (Figure 7-9). Only the soluble reactive phosphorus component of total phosphorus is available for plant uptake. The remaining phosphorus attaches itself to soil particles and is held tightly within Willamette Valley soils, even during heavy rainfall. It is one reason that phosphorus fertilizer is rarely used on grass seed fields in the Willamette Valley. Very little is available for uptake by the grass after the fertilizer binds to the soil.

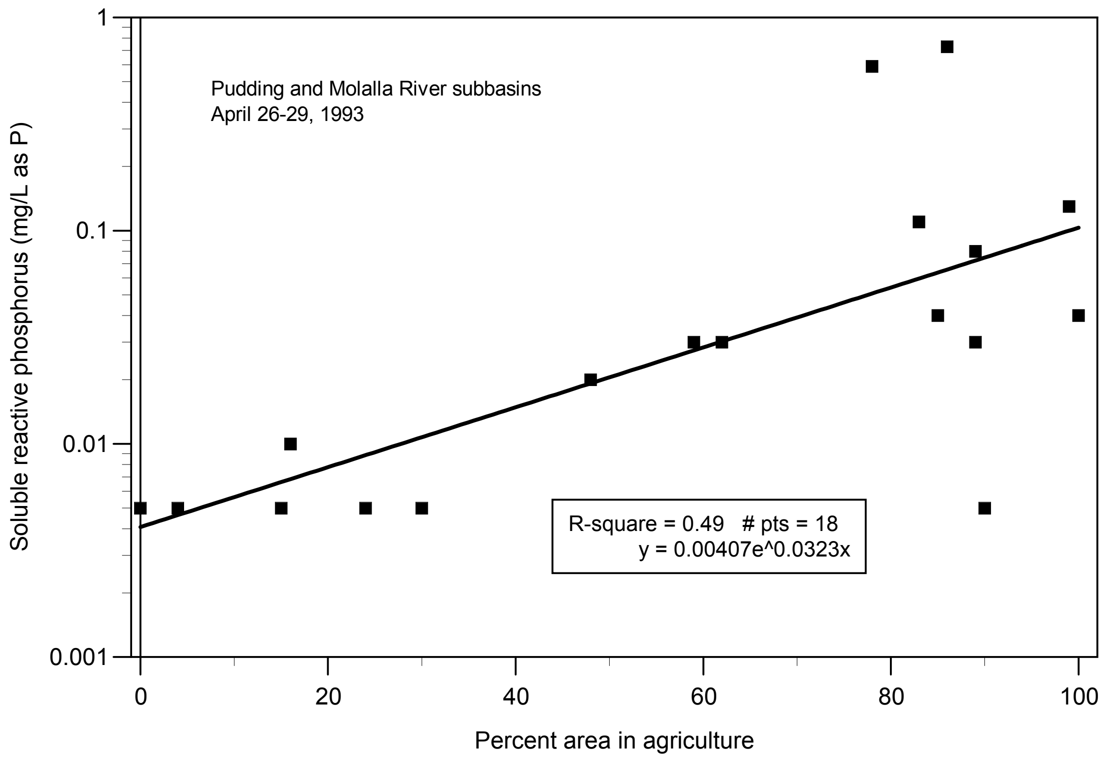
Soluble reactive phosphorus concentrations in the lower Calapooia River are very low during the summer and this probably explains why the Calapooia River tends to be relatively clear and free of nuisance growths of algae. Any further growth of algae would be limited by a lack of available phosphorus, even though some nitrogen still does remain available for uptake.

Figure 7-9. Soluble reactive phosphorus concentration (as phosphorus) by month for the Calapooia River at Albany from 1996 to 2002 (DEQ ambient monitoring).



As was true for nitrogen, soluble reactive phosphorus concentrations measured for 18 streams in the Pudding and Mollala watersheds increased with increasing percentage of land in agricultural use (Rinella and Janet 1998) (Figure 7-10). The predictive equation indicates that the value for the Calapooia River at Albany with 47% of the watershed in agricultural use, should be 0.019 mg/L in April, which is about the same as the measured value (0.016) between 1996 and 2002 (Figure 7-9).

Figure 7-10. Soluble reactive phosphorus concentrations in Pudding and Molalla River streams in April as a function of percent area in agriculture (from Rinella and Janet 1998).



Sediment

The amount of sediment transported each year out of the Calapooia River Watershed depends on that year's stream flow and the amount of sediment ready to be transported. During low flow years sediment transport is small and sediment continues to accumulate at numerous locations within and near channels. During wet years, much of that accumulated sediment is carried away. In addition, years with many intense runoff periods can create landslides in steep terrain and cause the streams to meander widely across their flood plains, thereby making even more sediment available for downstream transport.

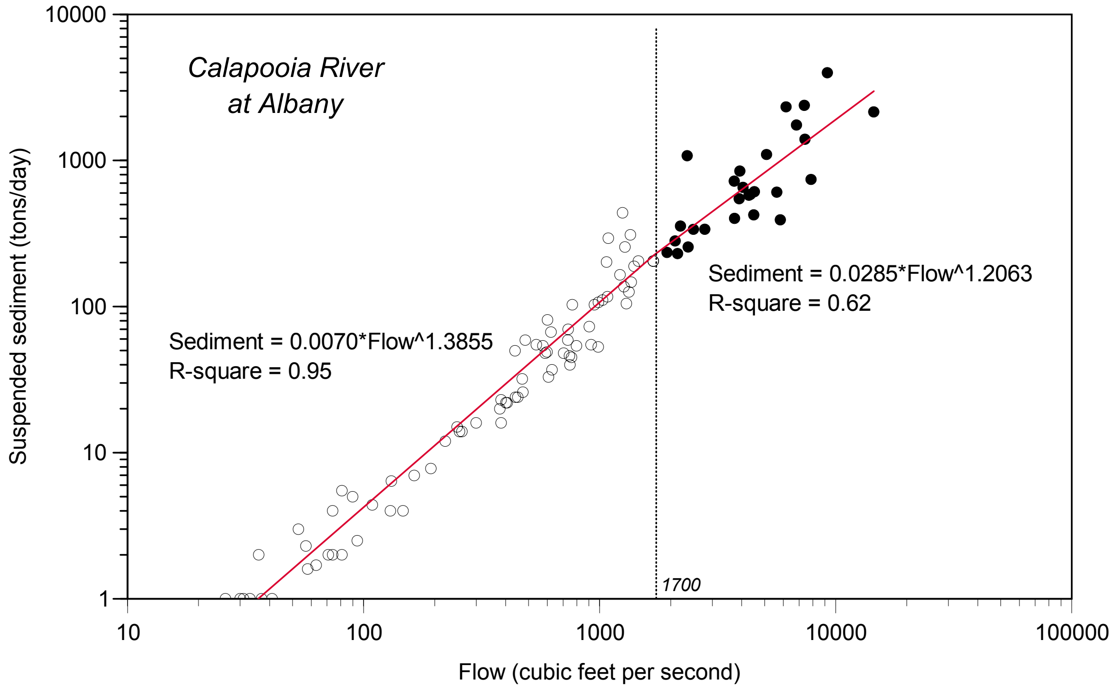
The two geologies present in the Calapooia River Watershed, the old volcanic hills and the recent silt and clay deposits in the Willamette Valley bottom, create differing amounts and types of sediment. Much of the sediment transported from the hills is coarse-grained with a sizable component of gravel and cobbles. Most of the sediment derived from the Willamette Valley bottom soils is silt and clay. The silt and clay is what gives the Calapooia River its brown color that can be seen increasing from headwaters to the Willamette River confluence on rainy days. The water turbidity increases significantly once it enters the Willamette Valley bottom. The sediment shuttled downstream by a river that consists of fine sands, silt, and clay is called suspended sediment, and the remainder, that which bumps along the channel bottom is called bedload (coarse sands, gravels, cobbles, and boulders).

The amount of suspended sediment transported by the Calapooia River can be estimated by applying sediment and flow data gathered by the Corps of Engineers in Albany from 1949 to 1951. When plotted on a log-log scale, the relationship between suspended sediment (tons/day) and flow increases linearly, with a slight decrease in the slope of the relationship for flows greater than 1700 cfs (Figure 7-11). While these data were gathered over 50 years ago, they are probably still applicable. Measurements by the U.S. Geological Survey in 1990 and 1991 for eight other rivers in the Willamette Valley indicated no differences in the relationship for suspended sediment and flow between the 1950s and the 1990s (Laenen 1995).

When the equations in Figure 7-11 are applied to the daily flow records for the Albany gauge (between 1940 and 1980), the average annual suspended sediment load is 44,500 tons per year. This is equivalent to 120 tons per year per square mile of watershed area. Results of a similar analysis for the neighboring McKenzie Watershed (Alsea Geospatial 2001) indicates that, prior to reservoir construction, the suspended sediment load in the McKenzie River was slightly higher than the Calapooia River at 138 tons per year per square mile. After the reservoirs were installed and peak flows subsequently muted, the annual suspended sediment load for the McKenzie River declined by 41 percent.

Projects to prevent the river from meandering by installing riprap at the outside banks of bends in the river have been completed at various locations along the Calapooia River in order to protect property. Often, these projects have been justified and funded with claims that the riprap will also result in sizable reductions in river sediment loads. However, an examination of the amount of river bank typically kept in place by a riprap project, relative to the river's total sediment load, suggests that these reductions are not great. For example, if riprap were installed along a 500-foot-long section of river bank that was retreating 10 feet a year, the yearly amount of material kept in place by the riprap would be 50,000 cubic feet, assuming a 10-foot-high bank height. Assuming that about one-half of the material was sand, silt, and clay (the suspended sediment size component) and that this material weighed 125 pounds per cubic foot, the riprap would have kept 1562 tons per year from becoming entrained by the river. However, 1562 tons is only 3.5% of the 44,500 tons of suspended sediment transported downstream by the river each year. Therefore, the riprap project would make little difference to the overall suspended sediment load in the Calapooia River. Riprap applied to one section of eroding bank can cause either the adjacent bank of a downstream bank to erode.

Figure 7-11. Relationship between suspended sediment load and river flow for the Calapooia River at Albany (from Laenen 1995).



Pesticides

Pesticides used in the Willamette Valley include herbicides, fungicides, and insecticides. The pesticide reporting system established by the Oregon Legislature in 2000 was never funded to the point of yielding results so little is known about pesticide use and application rates within the Calapooia River Watershed. But, it can be assumed that most pesticide use in the watershed is related to the dominant agricultural crop; grass seed. Pesticides are also commonly used on other crops grown in the watershed such as corn and fruit and filbert orchards.

A study of 51 Willamette Valley streams by the US Geological Survey from 1993 to 1995 indicated that pesticides of various types could be detected in most streams, except where a high proportion of the watershed was forest land (Rinella and Janet 1998). The total number samples ranged from 141 to 193, depending on the pesticide. Atrazine and simazine, common herbicides used to eliminate broad-leaf and grassy plants, were found in 94% and 84% of samples, respectively (Table 7-3). Metolachlor, a selective herbicide, was found in 79% of samples. Diuron, a broad-based herbicide commonly used to prepare grass seed fields prior to replanting, was found in 59% of samples. The insecticide, diazinon, commonly used to kill a wide variety of sucking and leaf eating insects, was found in 54% of the samples. The concentrations of these pesticides in streams were far below the values associated with trout mortality (Table 7-3). The usage of these common pesticides in Benton, Lane, and Linn counties (combined) during 1987 is shown in Table 7-4.

The concentration of atrazine, like many of the herbicides detected in Willamette Valley streams during the U.S. Geological Survey study, increased with increasing percent of the watershed in agricultural use (Figure 7-12). However, in the case of atrazine, this relationship existed only in the late spring. Sampling in the summer, a time when overland and shallow groundwater movement rarely occurs, indicated no correlation between atrazine and extent of agriculture.

During the last decade as field burning has been greatly curtailed, diuron use has increased to eliminate vegetation in grass seed fields prior to replanting. Diuron is a pesticide of concern because it is often detected in shallow and deep ground water (Barbash et al. 1997). Diuron's presence is a result of it being moderately soluble in water, having a moderately low tendency to attach to soil particles, and having a moderately long half-life in the soil. A study of diuron movement in soil and water was conducted in a field that bordered an intermittent stream (Lake Creek in the Calapooia River Watershed) following an application rate of 2.2 lb/acre in late October (Field et al. 2003). Monitoring over the next 8 months indicated that most of the diuron remained on-site in the surface layers of soil.

Table 7-3. The five most common pesticides found in samples from Willamette Valley streams from 1993 to 1995 (from Rinella and Janet 1998). Total number of samples for each pesticide ranged from 141 to 193.

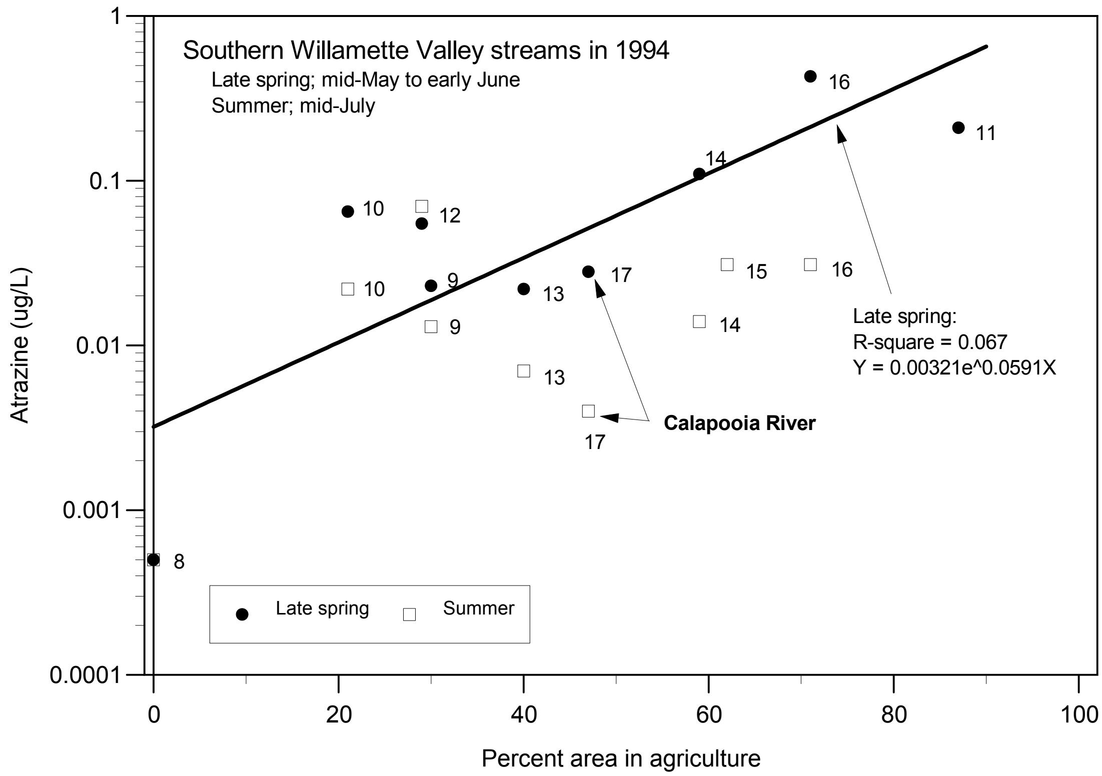
Pesticide	**Type**	**Percent detections**	**Detection limit *u*g/L**	**Median concentration *u*g/L**	**Maximum concentration *u*g/L**	**96-hour LC50* for rainbow trout (*u*g/L) / relative toxicity**
Atrazine	herbicide	94	0.001	0.072	4.500	9900 / slight toxicity
Simazine	herbicide	84	0.005	0.770	5.800	2800 / low toxicity
Metolachlor	herbicide	79	0.002	0.022	3.300	2000 / low toxicity
Diuron	herbicide	59	0.020	0.540	14.000	3500 / low toxicity
Diazinon	insecticide	54	0.002	0.016	1.200	90-140 / high toxicity

* Pesticide concentration at which 50% of rainbow trout will die when exposed for 96 hours.

Table 7-4. Usage of five common pesticides in the southern Willamette Valley (Benton, Lane, and Linn counties) during 1987 (Rinella and Janet 1998).

Pesticide	**Usage (pounds)**
Atrazine	145,000
Simazine	65,700
Metolachlor	24,100
Diuron	240,000
Diazinon	22,500

Figure 7-12. Atrazine concentrations in southern Willamette Valley streams in late spring and summer as a function of percent area in agriculture (from Rinella and Janet 1998).



#	Stream
8	Upper Ferguson Cr. near Junction City
9	Bear Cr. near Junction City
10	Lower Ferguson Cr. near Junction City
11	Flat Cr near Monroe
12	Long Tom R near Monroe
13	Upper Muddy Cr near Harrisburg
14	Middle Muddy Cr near Halsey
15	Little Muddy Cr near Halsey
16	Lower Muddy Cr near Peoria
17	Calapooia R at Albany

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Chapter 8. Key Wildlife Habitats and Populations

Introduction

This chapter summarizes information about key wildlife species, habitats and populations within the Calapooia River Watershed. The chapter does not examine all wildlife species or habitats present in the watershed. The emphasis is on wildlife habitats that have been lost due to human impacts, riparian and aquatic dependent amphibian and turtle species, and wildlife species in which populations have declined. This summary will help highlight opportunities to protect and restore wildlife habitats within the watershed.

Methods

Studies and inventories by the Oregon Department of Fish and Wildlife, Oregon State University, and a number of other secondary sources, provided information on wildlife habitats and populations. An overview of the status and distribution of important and declining wildlife habitats are summarized from the Pacific Northwest Ecosystem Research Consortium's Willamette Basin Planning Atlas (2003). The Oregon Natural Heritage Program provided information on species that are listed under the state and federal Endangered Species Acts.

Important wildlife habitats

The Willamette Valley has a rich variety of wildlife species and habitats. Among the native species currently breeding in the valley there are (Pacific Northwest Ecosystem Research Consortium 2002):

18 amphibians

15 reptiles

154 birds

69 mammals

Table 8-1 lists the mammals currently breeding in the Willamette Valley.

Table 8-1. Mammals currently breeding in the Willamette Valley (Pacific Northwest Ecosystem Research Consortium 2002).

Vagrant Shrew	Camas Pocket Gopher
Pacific Shrew	American Beaver
Water Shrew	Deer Mouse
Pacific Water Shrew	Dusky-Footed Woodrat
Trowbridge's Shrew	Bushy-Tailed Woodrat
Baird's Shrew	Western Red-Backed Vole
Fog Shrew	White Footed Vole
Shrew-Mole	Red Tree Vole
Townsend's Mole	California Vole
Coast Mole	Townsend's Vole
Little Brown Myotis	Long-Tailed Vole
Yuma Myotis	Creeping Vole
Long-Eared Myotis	Gray-Tailed Vole
Fringed Myotis	Water Vole
Long-Legged Myotis	Muskrat
California Myotis	Pacific Jumping Mouse
Silver-Haired Bat	Common Porcupine
Big Brown Bat	Coyote
Hoary Bat	Gray Fox
Townsend's Big-Eared Bat	Black Bear
Pallid Bat	Raccoon
Brazilian Free-Tailed Bat	American Marten
Pika	Fisher
Brush Rabbit	Ermine
Snowshoe Hare	Long-Tailed Weasel
Black-Tailed Jackrabbit	Mink
Mountain Beaver	Wolverine
Townsend's Chipmunk	Western Spotted Skunk
California Ground Squirrel	Striped Skunk
Golden-Mantled Ground Squirrel	Northern River Otter
Western Gray Squirrel	Mountain Lion
Douglas' Squirrel	Lynx
Northern Flying Squirrel	Bobcat
Western Pocket Gopher	Deer Mouse

All of the species native to the Willamette Valley evolved with the natural patterns of vegetation and disturbances, such as fire and floods. Human settlement, and the associated changes in vegetation and disturbance patterns, has altered wildlife habitats within the Willamette Valley. As a result of habitat changes and hunting, a number of species are no longer present in the valley, including the grizzly bear, gray wolf, white-tailed deer, fisher, spotted frog, black-crowned night heron, yellow-billed cuckoo, and the California condor. (These extirpated species are not included in the count of animals currently breeding in the Willamette Valley.) Other wildlife populations are reduced to very low numbers from habitat loss and competition or predation by introduced species, include the camas pocket gopher, Townsend's big-eared bat, grasshopper sparrow, pallid bat, loggerhead strike, Lewis's woodpecker, northern goshawk, golden eagle, burrowing owl, long-eared owl, and the western meadowlark (Pacific Northwest Ecosystem Research Consortium 2002). Through conservation efforts, other species that had become rare in the Willamette Valley, such as the bald eagle (see below for a discussion), are now increasing in numbers.

Wildlife Observations

Native and non-native wildlife observations made by a watershed resident near the junction of Brush Creek and the Calapooia River in 2002 -2003 (Bob Bostedt, Calapooia River Watershed Resident, personal communication, 2003)

Great blue heron	American robin
Canada goose	European starling
Mallard	American goldfinch
Wood duck	Wild turkey
Hooded merganser	Black-tail deer
Common merganser	Rabbit
Turkey vulture	Raccoon
Red-tailed hawk	Coyote
Bald eagle	Gray squirrel
Osprey	Flying squirrel
California quail	Hummingbird
Ring-neck pheasant	Red-shafted flicker
Mourning dove	Steller's jay
Violet-green swallow	Common crow
Black-capped chickadee	House wren

Recently, a group of scientists and ODFW identified the important habitats which have been lost through human actions. The demise of these habitats is a contributing factor to the loss of wildlife species within the Willamette Valley (Defenders of Wildlife 2002). Riparian forests, wetlands, oak woodlands and prairies are all important wildlife habitats. Though greatly reduced in number from their original coverage, all of these habitats are currently present within the Calapooia River Watershed and they provide key opportunities to protect and restore wildlife habitat.

Riparian forests

Riparian forests occupy the wide flood plains of the Willamette River and tributaries such as the Calapooia River. These diverse forests contain extensive stands of bigleaf maple, Oregon ash, black cottonwood, red alder, Douglas-fir, ponderosa pine, and diverse understory plants. Forested areas adjacent to the river help form ponds, side channels and wetlands that are important for a number of species. Side channels and other back channel areas provide habitat for western pond turtles, a number of amphibian species, and other wetland dependent wildlife. The slow water areas created during floods are important high water refuge areas for juvenile spring chinook salmon and other fish species. The once large expanse of riparian forests along the Willamette River and tributaries have been reduced and fragmented. It is estimated that over 80% of these habitats within the Willamette Valley lowlands have been lost since the beginning of pioneer settlement in the 1800s. The Calapooia River Watershed along the river and the lower portions of tributaries, particularly in the areas below Brownsville, has some of the largest expanses of riparian forests remaining in the Willamette Valley (Pacific Northwest Ecosystem Research Consortium 2002, and see Chapter 4, *Vegetation, Wetlands, and Other Features*). These intact areas of riparian forest within the Calapooia River Watershed offer opportunities to protect key areas and, where appropriate, restore riparian vegetation in areas where it has been lost.

Wetlands

Wetlands can be permanent or seasonal. Seasonal wetlands, those wetland which often have standing water during the winter and early spring months, are the most common type of wetlands in the Willamette Valley. Wetlands help absorb and store water, regulating stream flows, and they play an important role in filtering and cleaning the water. Wetlands are biologically productive, often have unique plant species, provide habitat for frogs, salamanders and turtles, and are areas for fish to escape from floodwaters. Migrating birds such as sandhill cranes, tundra swans, and geese all use wetlands. More than half of the Willamette Valley's wetlands have been lost through urban development and conversion to agricultural lands (Pacific Northwest Ecosystem Research Consortium 2002). Despite these losses, there are still significant wetland areas in the Calapooia River Watershed, particularly in the lower watershed, and in areas surrounding the river and tributaries such as Lake and Oak Creeks (See Chapter 4, *Vegetation, Wetlands, and Other Features*).

There are also opportunities to restore existing wetlands within the watershed. The Oak Creek Wetland Mitigation Bank, located in upper Oak Creek near Lebanon, is an example of wetland restoration. The bank is 88 acres of floodplain forest, scrub, shrub and wet prairie and uplands along the creek (Duane Smith, personal communication, 2003). New and restored wetlands in the area provide key wetland functions and wildlife habitat. Land developers can purchase credits in the Oak Creek Mitigation Bank to compensate for areas where wetlands have been impacted or lost from new housing or other development, as required by state law.

Oak woodlands

Oak woodlands have an understory dominated by grass and other herbaceous plants, with widely spaced Oregon white oaks. These woodlands provide key habitat for gray squirrels, western bluebirds, grasshopper sparrows, acorn woodpeckers, and the Oregon vesper sparrow. Oak woodlands have been lost through changes in forest management and habitat loss due to rural development. Because of fire suppression within the Willamette Valley, trees (primarily invading conifers) grow more densely in woodlands, reducing grassy areas and often leading to conversion from oaks to conifer forests. Oak woodlands were estimated to cover 1.5 million acres historically but have been reduced to about 200,000 acres today (Pacific Northwest Ecosystem Research Consortium 2002). There are oak woodlands within the Calapooia River Watershed, particularly along the hillsides in the lower watershed below Brownsville. Through proper fire management and control of invasive plants, there are opportunities to protect and restore these habitats.

Prairies

The Willamette Valley's prairies are grassland habitats. Prairies can occupy wet areas or dry uplands. These areas are one of the most imperiled habitats in the valley, mostly due to conversion to accommodate housing, commercial development, farming, and grazing. Over 97% of the upland prairies and 99% of the wet prairies have been covered to other land uses, primarily agriculture. Upland prairies have bunch grasses, oat grass, and numerous wildflowers, including golden paintbrush, white rock larkspur, camas, Willamette daisy and Kincaid's lupine. Several of these wildflowers are now listed as threatened or endangered. Dry prairies are an important habitat for the peregrine falcon, western bluebird, western meadowlark, and Fender's blue butterfly.

Wet prairies are also grassland habitats, but these areas tend to collect water, thus remaining saturated during the winter and early spring months and remain dry during the summer months. These seasonal wetlands are important habitats for salamanders and frogs. Bird species that use wet prairies include the American peregrine falcon and the western meadowlark.

Upland and wet prairies historically occupied extensive areas in the lower Calapooia River Watershed. As with all of the declining habitats within the Willamette Valley, there are opportunities to restore wet and upland prairies within the watershed. There are several examples of prairie restoration in the mid Willamette Valley (A good example is Bald Hill park, just west of Corvallis and Finley National Wildlife Refuge located South of Corvallis). Currently, Oregon State University's Prairie Research Group is studying methods for restoring these habitats (Oregon State University 2003).

Invasive plants

Invasive plant species (also called exotics, or weed species) are plant species not native to the Willamette Valley. These plants, when introduced to a watershed, reproduce prolifically, and can dominate vegetation cover over large areas. Left unchecked, many invasive plants have the potential to impact wildlife populations and distribution by transforming the native vegetation that species depend on for food and habitat. Invasive plant species that have invaded habitats, particularly riparian areas, include Himalayan blackberry, reed canary grass, English ivy, Scotch broom, and Japanese knotweed (Oregon Department of Agriculture 2003).

Japanese knotweed has recently gained a foothold in the Calapooia River Watershed (Duane Smith, Oak Creek Wetland Mitigation Bank, personal communication, 2003). This plant is an escaped ornamental that is becoming increasingly common along stream corridors. Japanese knotweed forms dense stands that crowd out all other vegetation, degrading native plant and animal habitat. This perennial plant is difficult to control because it has extremely vigorous rhizomes that form a deep, dense mat. In addition, the plant can resprout from fragments; along streams, plant parts may fall into the water to create new infestations downstream. Because Japanese knotweed has recently been introduced to the Calapooia River Watershed with scattered plants growing in areas along the river and tributaries, there is still a window of opportunity to control this species before the infestation spreads.

The Calapooia Watershed Council is working with willing landowners to control invasive plant species and re-establish native riparian plants. In addition, the Council is planning to inventory invasive plants in the watershed, including Japanese Knotweed.

Aquatic dependant amphibians and reptiles

There are a number of native amphibians and reptiles with reduced populations in the Willamette Valley. The species that are dependant on streams, rivers and ponds for a portion of their lives are especially vulnerable to habitat loss and predation. Table 8-1 outlines species of frogs, salamanders and turtles that are dependent on aquatic and riparian areas within the Calapooia River Watershed (terrestrial amphibians and reptiles are not listed). Many of these species are listed under Oregon's sensitive species program. Red-legged frogs, torrent salamanders, and western pond turtles are among the aquatic-dependent species that are declining in the Willamette Valley. These species are currently listed as *critical* or *vulnerable* under the state's program. Spotted frog populations have declined to the point that they are candidate species for listing under the federal Endangered Species Act. There are no known spotted frog populations in the Willamette Valley.

Table 8-1. Native aquatic and riparian-dependent amphibians and turtles found within the Calapooia Watershed. Status refers to whether the species is listed under the Oregon Department of Fish and Wildlife's Threatened and Endangered Species Program or under review by the US Fish and Wildlife Service for possible listing under the federal Endangered Species Act (ESA). Under the state listing, the critical category is for species for which listing as threatened *or* endangered *is pending or for those for which listing as* threatened *or* endangered *may be appropriate if immediate conservation actions are not taken. The* vulnerable *category is for species for which listing as* threatened *or* endangered *is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures. The federal categories are similar.*

Species	**Distribution and Preferred Habitats by Life History Stage (Leonard et al. 1991)**	**Status (ONHP 2001)**
Frogs and Toads		
Tailed frog, *Ascaphus truei*	Aquatic and riparian. Larvae usually found in cold, rocky streams. Adults prefer areas along the aquatic margins and cool, moist forests in the vicinity of streams. Tadpoles, especially during the first year, do not tolerate warm water.	State: *vulnerable* Federal: *species of concern*
Pacific tree frog, *Pseudacris regilla*	Aquatic and riparian. Very common throughout Oregon. Requires slow, open water for breeding. Observed in Lake Creek drainage by R. Colvin during seasonal stream sampling, 2002-2003.	---
Red-legged frog, *Rana aurora aurora*	Aquatic and riparian. Adults use areas adjacent to streams. Eggs laid in marshes, bogs, swamps, ponds, lakes, and slow moving streams. Observed in Lake Creek drainage by R. Colvin during seasonal stream sampling, 2002-2003.	State: *vulnerable* Federal: *species of concern*
Foothill yellow-legged frog, *Rana boylii*	Aquatic and riparian. Confined to the vicinity of permanent streams; most common near streams with rocky, gravelly, or sandy bottoms. Breeding occurs in the quiet parts of streams.	State: *vulnerable* Federal: *species of concern*
Cascades frog, *Rana cascadae*	Aquatic and riparian. Occur in the Cascade Mountains above 2000 feet. Most common in pools adjacent to streams flowing through meadows.	State: *vulnerable* Federal: *species of concern*
Oregon spotted frog, *Rana pretiosa*	Aquatic and riparian. Found in or near springs, ponds and lakes, or sluggish streams. Prior to 1940, they were found in the Willamette Valley, but now they appear to be absent. Most populations occur in the Cascade Mountains.	State: *critical* Federal: *candidate species*
Salamanders		
Northwestern salamander, *Ambystoma gracile*	Aquatic and terrestrial. During dry months, adults seek refuge in rotting logs and moist crevices. Larvae are adapted to ponds and slow moving streams.	---
Long-toed salamander, *Ambystoma macrodactylum*	Aquatic and terrestrial. Requires quiet water for breeding and feeding. Adults use downed logs or rock for cover and resting. Observed in Lake Creek drainage by Randy Colvin during seasonal stream sampling, 2002-2003.	---
Dunn's salamander, *Plethodon dunni*	Aquatic. Usually found in the Cascade Range associated with streams or seeps in the splash zone or under rocks, or occasionally woody debris. Eggs deposited in rocks near stream margin.	---

Species	Distribution and Preferred Habitats by Life History Stage (Leonard et al. 1991)	Status (ONHP 2001)
Rough-skinned newt, *Taricha granulosa*	Aquatic and terrestrial. Adults range throughout the Willamette Valley, particularly near forested areas. Eggs are deposited along the vegetated fringes of lakes, beaver ponds, and slow moving streams. Very common. Observed in Lake Creek drainage by Randy Colvin during seasonal stream sampling, 2002-2003.	---
Pacific giant salamander, *Dicamptodon tenebrosus*	Aquatic and riparian. Adults range through cool, moist forest areas in the vicinity of cold streams and lakes. Larvae are stream-adapted and common. Trout feed heavily on salamander larvae and adult salamander feed on small fish.	---
Southern torrent salamander, *Rhyacotriton variegatus*	Aquatic and riparian. Adults live in close proximity to cold streams, splash zones and seeps and are uncommon. Larvae may be abundant in gravel with water percolating through it.	State: *vulnerable* Federal: *species of concern*
Cascade torrent salamander, *Rhyacotriton cascadae*	Aquatic. Usually found in the Cascade Range associated with cold, clear streams, seeps, or waterfalls. Larvae usually found in gravel with water percolating through it.	State: *vulnerable*
Turtles		
Northwestern pond turtle, *Clemmys marmorata marmorata*	Aquatic and riparian/floodplain. Adults require quiet water and floating logs or other platforms for resting and basking at the water's surface. These turtles nest on land where there is appropriate substrate and a sunny location close to water. Juveniles are especially vulnerable to mortality from aquatic and nest predation and destruction of nesting areas. Pond turtles have been sighted in number of ponds and lakes in the lower watershed and Courtney Creek drainage.	Federal: *critical*
Painted turtle, *Chrysemys picta*	Aquatic and riparian/floodplain. This is the most common turtle in Oregon. Most of the pond turtle populations in the Valley are north of Salem, although some do occur in the southern valley. It has habitat needs similar to pond turtles.	

The dramatic decline of spotted frogs is a good example of why many native amphibian populations are in trouble. Spotted frogs are found in or near springs, ponds and lakes, or sluggish streams and used to be widespread in the lowlands of western Oregon and Washington. A single spotted frog population near Olympia, Washington is the last known population in the heavily developed lowlands of Puget Sound and the Willamette Valley (US Geological Survey 2003). Introduced species, such as bullfrogs, are a major predator of spotted frogs, and are probably the primary cause of the declining numbers in this native species. Introduced fishes, particularly warm-water fish such as largemouth bass, sunfishes, perch, and bullhead catfishes, also prey on spotted frog tadpoles and adults. In addition, human development has altered or eliminated wetlands and backwater habitats along rivers, which has also contributed to declining populations.

The western pond turtle is in trouble, especially in the Willamette Valley. Pond turtles are declining due to habitat loss and predation by bull frogs and other animals. Adult western pond turtles have dark brown or dull olive shells, ranging from four-and-a-half to eight inches in length. They have brown heads without stripes. Adults take 10-12 years to reach reproductive size. The western pond turtle is listed as *critical* on the state sensitive species list. Because most of its range is on land that is privately owned, landowners are key for the restoration of this species. A number of pond turtles have been sighted within the Calapooia River Watershed, particularly in the Courtney Creek area (Paul Adamus, private consultant, personal communication, 2003).

Pond Turtles: Habitat Needs

According to the Oregon Department of Fish and Wildlife's (2003) *Turtle Habitat Checklist*, pond turtles need habitat on both land and water including:

A permanent water body. The turtles prefer a pond, river back channel, or slow moving water with good sun exposure; there should be some areas at least six feet deep; and there should be no predators such as bullfrogs or bass.

Basking and hiding sites. Turtles use logs, root wads or large rocks to bask in the sun; they also prefer a diversity of aquatic vegetation and underwater hiding areas.

Hatchling habitat. Newly hatched turtles need aquatic vegetation and small root wads to hide from predators and shallow areas of water with gradually sloping sides, less than a foot deep. Young turtles take three years to attain a size that predators, like bullfrogs and bass, can't easily eat them.

Nesting habitat. Nesting areas are the most critical requirement for pond turtles in the Willamette Valley. The best areas for nest digging are within 500 feet of a water body, south or southwest-facing, and with sparse vegetation and bare soil that is undisturbed by plowing, grazing or flooding.

Travel corridors. Turtles require free access between nest areas and a water body. Many turtles die crossing roads. Intact riparian areas, and connected, barrier-free streams are crucial for movement for breeding and between populations, which helps to maintain genetic diversity.

Spotted Owls

The northern spotted owl (*Strix occidentalis caurina*) is a dark brown owl with spots, that inhabits forests within the Pacific Coast region from British Columbia to central California. There is a moderately large population of owls in Oregon, but studies suggest that adult survival has declined in recent years and the population is dwindling at an accelerating rate (Forsman 2000). In 1990, the species was federally listed as *threatened*.

Spotted owls can be found in many types and age-classes of forests, but most use older conifer forests for nesting and foraging. Spotted owl population declines have been attributed to the loss and fragmentation of older forest habitat and expanding populations of barred owls, a close relative (Forsman 2000). The range of barred owls has been expanding from the eastern United States since the early 1900s and has now expanded into most of the Pacific Northwest. Barred owls can displace spotted owls and there are instances where the two species have bred and produced hybridized offspring (Forsman 2000).

Because of the spotted owl's threatened status, private and government forest landowners must protect a portion of the bird's habitat. On private lands, there are restrictions on timber harvest and other disturbance around active owl nests. At this time there are 3 known nest sites located on private timber lands within the Calapooia River Watershed (Virgil Morris, USFS, personal communication, 2003).

On Forest Service and BLM lands, there are special land designations in place that restrict forest harvest or promote growth into older forests in order to protect the owls and their habitat and to promote increases in population. Late-successional and old-growth forests are retained around nest sites and in connecting corridors to provide habitat for breeding, feeding, dispersal, and movement of owls and other species dependant on this forest type. Red tree voles, an important prey of spotted owls, are present in the watershed (Western Watershed Analysts 1999). Because spotted owls are a threatened species, surveying and monitoring these owls is a high priority on federal forest lands. The Forest Service portion of the watershed currently has 3 known active nest sites, and the population appears to be stable (Virgil Morris, USFS, personal communication, 2003). There are 5 known spotted owl nest sites on BLM land within the watershed (Western Watershed Analysts 1999).

Christmas Bird Count

The Audubon Society has been collecting annual bird census information since 1900. The Christmas Bird Count is the longest running database in ornithology. Volunteers observe bird species in a three-week period centered around the Christmas holiday. The number and variety of bird species counted during this census helps to track long-term trends on bird species distribution and status. All counts take place within a series of 15-mile diameter circles. In 2003 (the 103rd year of the count) there were counts conducted within 1,891 circles from the Arctic north to the tip of South America. All of the data from these counts are available online at: http://www.audubon.org/bird/cbc/index.html.

Since the Christmas season of 1993-94, Audubon volunteers have been counting birds in a circle centered around Brownsville. Bird count data (species and number of observations) for this area provide~~s~~ information on how local bird populations have changed over time. A wide range of common, and a few rare bird species, were observed in the counts. Two notable species will be described here, Lewis's woodpeckers and bald eagles. Detailed information on the Brownsville bird counts is available on the web or from the Calapooia Watershed Council.

Lewis's woodpeckers

"I saw a black woodpecker (or crow) today about the size of the lark woodpecker," wrote Meriwether Lewis in the summer of 1805, marking one of his most famous discoveries. Lewis's woodpecker (*Melanerpes lewis*) has markings of a bright, red face and a pink chest, unlike the markings of a crow; however, its flight with slow flaps, closely resembles the flight of a crow. It lives in large dead or burned trees where it can easily excavate or find a hole for a nest. Years of fire suppression have turned the Willamette Valley's open forests of oak, favored by Lewis's woodpecker, into dense thickets of Douglas-fir and other trees. This woodpecker is now largely absent from the Willamette Valley (Pacific Northwest Ecosystem Research Consortium 2002), and it is listed as *critical* on the state sensitive species list and *species of concern* on the federal species list (Oregon Natural Heritage Program 2001). Since the Brownsville area Christmas Bird Count began in 1993, 2003 has been the only year in which this woodpecker has been sighted. Two observations were recorded in that year.

Bald eagles

In 1963 there were only 417 nesting pairs of bald eagles (*Haliaeetus leucocephalus*) in the continental United States (US Fish and Wildlife Service 2003). This bird was one of the first species listed as *endangered* under the federal ESA. Today, however, bald eagle populations have made a dramatic recovery, after significant conservation efforts nationwide. Many biologists believe that the species may no longer require the special protection measures afforded by the ESA.

There has been an increase in the Oregon population of bald eagles. Until the mid-1970s, bald eagles were absent from their historic range in the Willamette Valley, with populations confined to the Cascade Lakes, Lower Columbia River, Klamath Lake and the coast. In 1978, there were only 57 breeding pairs within Oregon (including the Willamette Valley) and along the lower Columbia River in Washington. In 2002, 441 nesting pairs were counted in the same area (Oregon State University 2002).

Within the Willamette Valley, a small concentration of bald eagles winter in the vicinity of the Coburg Hills (Chintimini Wildlife Rehabilitation Center 2003). A portion of this population resides in the Calapooia River Watershed, with 3 confirmed roosting areas in the Courtney Creek drainage (Western Watershed Analysts 1999). Of the 287 bald eagles observed in the Eugene District of the BLM during a three-month winter period in 1997, 182 eagles (63%) were counted in the Courtney Creek area. Eagle nests have also been observed in the Cochran Creek drainage (Bud Baumgartner, watershed resident, personal communication, 2003). In addition, bald eagles were observed each year (1994-2003) during the annual Audubon Christmas Bird Count within the Brownsville circle. Based on these and other observations, the local bald eagle population appears to be expanding (Chintimini Wildlife Rehabilitation Center 2003). Domestic sheep carcasses and afterbirth compose the majority of southern Willamette Valley bald eagle diets, based on a study of eagle castings collected at roost sites (DellaSala et al. 1989). The dominance of dead sheep in the eagle's diet appears to be due to reduction in the bird's traditional diet of fish and small animals.

Conclusion

There are opportunities within the Calapooia River Watershed to restore and protect key wildlife habitats that have been lost throughout the Willamette Valley. Riparian forests, wetlands, oak woodlands and prairies are all important wildlife habitats. The watershed contains significant remnants of the Willamette Valley's historic floodplain riparian forests, particularly along the lower Calapooia River. In the lower and middle watershed there are significant opportunities to restore habitats for amphibians and pond turtles in areas where riparian vegetation and wetlands have been lost or modified.

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Chapter 9. Recommendations for Restoration and Protection

Introduction

This chapter contains a summary of the major findings discussed in previous chapters and a listing of restoration opportunities prioritized according to Calapooia Watershed Council interests and expected benefits to fish, wildlife, and water quality. First, we describe how the Calapooia River Watershed functioned prior to pioneer settlement and then explain how humans have changed these processes over time.

Natural features

Historically, The Calapooia River Watershed had many natural features that benefitted fish and wildlife. In the upper watershed, the fractured basalt geology provided cool water, ample flow, and deep bedrock pools that created important summer holding areas for adult spring chinook salmon. These same features also created important rearing areas for other native fishes such as cutthroat trout, mountain whitefish, and winter steelhead. Because the main stem of the Calapooia River was naturally warm even 60 miles from its confluence with the Willamette River, fish moved into these cool headwater tributaries during the summer.

Bedrock pools in the upper Calapooia River

The middle watershed is where the channel gradient decreased and the river meandered freely across the wide floodplain created by its deep deposits of gravel. Here, features that favor native fish during non-summer months were abundant. The wide river meanders created zones of lower-velocity water and gravel bars for spawning and production of aquatic organisms which are food for fish. During high flows, the river spread out across a wide floodplain, which

Gravel deposition and river meandering in the Calapooia River below Brownsville

also allowed the fish to spread out and feast on terrestrial sources of food. The water had unusual clarity because the sediments were derived from basalt rocks and the silt and clay component was readily flushed downstream. The streamside areas consisted of well-drained, fertile alluvium that grew both hardwood and conifer trees. Log jams derived from streamside trees were abundant along the river and tributaries, further contributing to channel complexity and high quality fish habitat. Cool tributaries with summer water were rare in the middle portion of the watershed, except for Brush Creek which offered one such refuge for fish to escape the warm river.

The river and its tributaries changed character downstream of where the Sodom Ditch diversion now exists. The channel gradient slackened as the river traversed across the silt-rich Willamette River Valley. The slack gradient caused the river to meander often and it readily flooded beyond its banks during high flows. Channels that were dry during the summer months filled with water during the winter and immediately became used by fish. The low-lying ground along the river supported a dense and diverse forest that contributed large wood and leaf litter to the channel. Such inputs supported a productive environment for fish, birds, western pond turtles, and other wildlife. Fish and wildlife had access to abundant food, except during the summer months, when cool-water fishes needed to move upstream to avoid the high water temperatures. Also, because the river spread out during high flows, the water velocity was low and the fish did not need to expend much energy fighting downstream displacement. The river meandered frequently and created oxbow lakes, much to the benefit of turtles, water fowl, and other native wildlife. Depressions scattered throughout this poorly-drained landscape were seasonal wetlands and heavily used by water fowl. Annual burning by the Native Americans created expansive areas of open grass adjacent to the corridors of riverine forests, and promoted successful nesting by pond turtles, due to the fact that the turtle nests needed to be exposed to full sunlight in the spring for the eggs to develop. Whitetail deer by the thousands fed on the grassy plains.

The low gradient channel of the Calapooia River below Brownsville

The extensive floodplain forests along the lower Calapooia River

Alterations to the watershed

Sodom Dam

Brownsville Dam

Fish passage barrier on a tributary to Brush Creek

Many of these natural processes still operate well within the watershed. However, pioneer settlement in the Calapooia River Watershed initiated changes in some of these processes, affecting fish and wildlife productivity. Probably the most important impact on migrating fish was the construction of dams and other barriers that prevented the fish from migrating. Of those barriers that persist, the most significant are the dams on the Calapooia River and Sodom Ditch near Thompson's Mill and the Brownsville Dam upstream of Brownsville. Both sites negatively affect the ability of spring chinook salmon spawners to access cool holding pools in the upper watershed during early summer. The dams also impede upstream movement of juvenile spring chinook salmon and adult winter steelhead, as well as cutthroat trout and mountain whitefish, as they attempt to move upstream into cooler water during the summer. Some culverts on the tributaries, many of which pass streams under county roads, impede fish movement also. In a few cases, small irrigation diversion dams keep fish from using high quality reaches of stream.

The spring chinook salmon spawners that reach their traditional summer holding pools in the upper reaches of the watershed, are faced with an additional challenge. Many of these deep pools are used by people for swimming on hot days. This disturbance displaces the fish and forces them into the few remaining pools not used by swimmers. Crowding spawning salmon makes them more vulnerable to passing diseases among each other. An additional threat to the adult spring chinook salmon is poaching. The clear water and lack of logs in the deep pools make the fish easy to detect, thus making them vulnerable to poaching.

The road paralleling the upper Calapooia River

The removal of trees along the edges of the river and its tributaries, especially along middle and upper portions of the watershed over the last century, has left a streamside forest that is young or absent and dominated by many hardwoods. Without a steady supply of long-lived and large conifers to a stream, the channel can become starved of the logs that would normally create the pools and high water refuges so critical to fish. Intentional removal of logs from channels over the decades has also contributed to this lack of wood. While a common restoration activity elsewhere in Oregon, only a few streams in the Calapooia River Watershed have been rehabilitated by adding logs back to the channel. Most of this restoration work in the Calapooia River Watershed has been done on land managed by Weyerhaeuser Company in the upper watershed.

Water temperatures recently measured throughout the watershed are probably similar to natural patterns, except along some tributaries. The main channel of the river is wide throughout much of its length, and even if mature conifers and hardwoods again grew along the banks, the trees would still not provide much shade to the summer channel. Rapid regrowth of trees along those upper watershed forest streams that were once harvested of trees, combined with current regulations for retaining wide buffers of trees during timber harvest, means that shading levels are high on forest land. Shade is sparser along streams in agricultural and urban areas, and is most critical to providing cool water refuge for fish during the summer months. Brush Creek is an example of a year-round stream that is suitable, to some extent, for supporting winter steelhead and trout during the summer, but could be made cooler and more productive if streamside vegetation was restored along selected reaches that are currently grazed by cattle and horses.

The state has granted many water rights to landowners along the Calapooia River and its tributaries. The amount of permitted water use far exceeds the natural summer low flow of the river. Nevertheless, the existence of a large and old (non-consumptive) water right at the Thompson's Mill site in the lower watershed, in combination with an agricultural industry currently devoted to growing non-irrigated grass seed, has meant that the river flow is not greatly influenced by the use of these water rights. Water use is more critical for small streams in the middle watershed, such as Oak Creek, that have low natural flows in the summer. In contrast, the headwater streams that provide most of the cool water habitat in the watershed during the summer, have very little consumptive water use.

Currently, soil erosion within the watershed is probably higher than it was historically, although erosion levels are naturally high due to steep headwater terrain and entrainment of the Willamette Valley silt deposits as the river meanders widely downstream of the Sodom Ditch diversion. A flood in 1996 washed out a number of roads in the upper watershed and led to a concerted effort to upgrade sections of roads to make them less vulnerable during future floods. The extensive grass seed fields in the middle and lower portion of the watershed exhibit some accelerated erosion, especially due to the fact that much of the previous field burning has been replaced by tilling to deal with chaff, weeds, and diseases. Nevertheless, the degree of soil erosion does not seem to influence overall water characteristics of the lower watershed much. Most accelerated erosion in grass seed fields originates from the practice of tilling through and filling of intermittent channels during planting, followed by removal of this material by water during the winter high flows.

Farming has influenced lower-watershed tributaries the most by the practice of excavating the streams to promote water drainage and straight-line tilling. Much of the length of Oak Creek and upper Courtney Creek consists of trapezoid-shaped channels that were excavated within the fields. These stream channels also commonly lack streamside vegetation. Overall, they provide little fish habitat and contribute to degraded water quality.

A major source of sediment in the Calapooia River is from channel meandering in the middle and lower portions of the watershed. This is a natural process that has little consequence in the lower watershed since little human infrastructure exists in active areas. The fish have evolved with this level of sedimentation. However, conflicts between river meandering and landowners sometimes occur in the middle and lower sections of the watershed. Landowners with farm fields, houses, or barns at the edge of the river occasionally request financial support from federal agencies to construct riprap or other devices to keep the river from meandering at certain locations. So far, this has been done at only a limited number of sites along the Calapooia River. Nevertheless, the consequences of extensive meander controls on a river can be observed elsewhere in the Willamette basin. Where rivers have been treated in such a way, conflicts among landowners and declines in fish habitat invariably occur. In addition, stopping the meandering on one segment of river usually causes an upstream or downstream increase in meandering and erosion, often creating problems for neighboring landowners. By decreasing the meandering of a river, water velocity increases, the river bottom downcuts, gravel bars become coarser, and zones of still water decrease; all of which are detrimental to fish. Treating a bank to control meandering can not be justified on the grounds of decreasing overall river sediment loads, since the amount of bank material is so small compared to the river's overall sediment load.

Farming and grazing in the Calapooia River Watershed have not led to elevated levels of nutrients in the water during the summer and fall, the two times of year when added nutrients can lead to nuisance levels of algae and murky water. Nitrogen is added to grass seed fields in the spring and some leaching of that nitrogen does occur when it rains. However, by summer, little nitrogen can be detected in the water column. More importantly, phosphorus available for the algae to use is scarce throughout the watershed. There are no major sources of phosphorus created by human activities, such as effluent from sewage treatment plants or from confined animal feed lots. There is some evidence that nitrogen fertilizer from farm fields is entering shallow wells that are used for drinking water.

One human-created water quality problem is fecal bacteria. Basin-wide monitoring suggests that water is relatively free of harmful levels of bacteria from human or animal sources in most of the watershed during winter and spring. However, sources exist in Oak Creek; especially within that portion of the stream which flows through the Albany area. Bacteria concentrations in Oak Creek exceed state water quality standards and influence the Calapooia River at its confluence with the Willamette River. Bryant Park at the confluence is a favorite swimming area.

Oak Creek near Albany

Pond turtle habitat and their populations have been especially altered by human changes in the watershed. Decades ago, largemouth bass and bullfrogs were introduced to the Willamette River and have since been a constant threat to the survival of young turtles. More importantly, pond turtles no longer have much habitat that allows for successful nesting. Now, blackberry and other introduced weeds quickly invade bare or natural grass areas and block the sunlight needed for warming the soil and fostering egg development. Farm fields can provide open space, but tilling can dice up the eggs or collapse the shallow burrows. An increase in turtle egg predators (opossums, coyotes, raccoons, and dogs) due to a lack of top predators, combined with the other above-mentioned factors, has lead to dismal turtle reproduction rates in the Willamette Valley.

Restoration and protection opportunities

The Calapooia Watershed Council is a community organization that promotes voluntary actions to improve the watershed. Since the Council has limited ability to control land use and the treatment of streams in the watershed. Most improvement opportunities in the watershed need to be voluntary. Nevertheless, the Council's ability to coordinate actions, provide information, and secure funding can lead to significant gains in restoring degraded habitat and protecting existing high-quality habitat. The challenge is usually one of where to start.

While there have been significant loss of habitat within the Calapooia Watershed many natural features that historically promoted high fish and wildlife productivity are still intact. The river's current environmental health can be best described as a string of pearls (high quality habitat) with a few of the links between adjacent pearls missing or altered. Many of the processes that have been altered by humans over the years are reversible.

In this section, we provide a summary of specific restoration and protection activities suitable for the Calapooia Watershed Council to pursue, to address the most important missing links. The issues are listed in order of importance. For each issue, the specific actions are rated (*High, Medium, and Low*) according to their relative importance. Where appropriate, locations within the watershed where the activities would be the most effective are noted. Map 16, *Protection and Restoration Action Opportunities*, illustrates emphasis areas for the recommended protection and restoration activities.

1. **Improve upstream passage of fish.**

    a. Continue to work with agencies and private parties for a solution on the passage of adult spring chinook salmon over the dams associated with the Thompson's Mill site. ***[High]***

    b. Continue to work with the US Army Corps of Engineers and ODFW on improving fish passage at the Brownsville Dam. ***[High]***

    c. Replace or modify selected culverts that hinder fish movement in cool tributary streams (especially Brush Creek). ***[Medium]***

    d. Modify the irrigation water diversion dam near the mouth of West Fork Brush Creek to allow fish passage. ***[High]***

2. **Improve some of the adult spring chinook holding pools in the upper Calapooia River to discourage swimming and to provide areas for adult fish to hide from poachers.**

    a. Identify deep pools in the upper Calapooia River where water temperature is below 70 degrees (upstream of Hands Creek) and add multiple large logs with rootwads. Engineer for log stability during flood flows. ***[High]***

    b. Eliminate parking areas along main line roads near those pools where investments in spring chinook holding pools have been made to minimize disturbance to the fish. ***[Medium]***

3. **Add large wood to selected tributaries in order to improve channel conditions for fish, especially in cool tributaries.**

    a. Select cool streams with gradients less than 4 % and add large wood jams capable of creating habitat features that offer fish refuge during high flows (Brush Creek is a good example of this). Focus first on streams with year-round flow. ***[High]***

4. **Increase shade along selected streams to expand cool water zones.**

    a. Use fencing, weed control, and native plantings to increase shade along stream sections that have maximum temperatures close to 70 degrees, for purposes of expanding the zone of cool water (such as Brush Creek). ***[Medium]***

    b. Work from a downstream to upstream direction, eliminating even small breaks in shading. ***[Medium]***

5. **Protect intact riparian areas and restore other areas to increase the number of conifers along the Calapooia River to improve large wood for the channel and wildlife habitat.**

    a. Work with landowners to protect (through fencing, proper land use management and other methods) existing intact riparian areas along the Calapooia River and tributaries. ***[High]***

    b. Use fencing, weed control, and planting of native conifers at appropriate sites. Focus most of the conifer restoration efforts on the middle portion of the watershed. ***[Medium]***

6. **Improve pond turtle reproduction and habitat in downstream portions of the watershed.**

    a. Improve nesting habitat along the lower Calapooia River by removing exotic vegetation near ponds along the river and converting it to low native grasses. ***[Medium]***

    b. Add tethered floating logs to ponds to increase basking opportunities and protect turtles from predators. ***[Medium]***

7. **Explore options with landowners along selected tributaries for leasing their water rights to the state for purposes of having more water in the stream during the summer for fish.**

    a. Focus on cooler streams with higher quality habitat (such as Brush Creek). ***[Medium]***

    b. Consider setting up a flow monitoring program to make sure that flow from leased water rights is not being used by holders of junior water rights. ***[Low]***

8. **Provide outreach and education on the importance of channel meandering for maintaining healthy habitat for fish. Work with landowners on alternatives to installing riprap along the banks of rivers and streams.**

    a. Focus outreach and education efforts on the middle portion of the watershed. ***[Medium]***

9. **Restore wetlands by encouraging farmers and other landowners to restore non-functioning wetlands on marginally productive land through the use of wetland banks or other measures.**

    a. Best suited for former wetland areas located near streams. ***[Low]***

10. Work with the City of Albany, City of Brownsville, and others to monitor bacteria in streams and rivers and identify sources of bacteria.

a. Focus on Oak Creek, where previous bacteria monitoring has identified problem areas. ***[Medium]***

b. Monitor popular swimming holes in the Calapooia River during the summer (Brownsville Dam, park at Brownsville, and Bryant Park in Albany). ***[Low]***

11. Conduct watershed education activities for landowners and in schools.

a. Set up demonstration sites where landowners can view the results of various types of restoration efforts. Focus on demonstration sites where the landowner was active in the restoration activity. ***[High]***

b. Involve middle school and high school classes in monitoring and restoration efforts within the watershed. ***[Low]***

c. Provide elementary teachers with printed materials about the ecology of fish and wildlife in the watershed. Help arrange field trips to interesting sites along the river, streams, and wetlands. ***[Low]***