S. Gregory L. Ashkenas P. Haggerty D. Oetter
K. Wildman D. Hulse A. Branscomb J. Van Sickle

Riparian Areas: Two Prevailing Conceptions

Two distinct conceptions of riparian areas emerge from this project. The first is a science-oriented, biophysical conception. It conceives riparian areas in terms of the interdependencies among physical processes, e.g. flooding, and the strongly coupled biological processes such as food and nutrient exchanges, that link land and water habitats in these ecologically important zones. Riparian areas are delimited under this conception using ideas such as site potential tree height, regularly inundated floodplains, and vegetative species composition.

The second conception is policy oriented and is based on human uses of the land-water interface. Appropriate uses of riparian areas are conceived here in terms of ownership and parcel boundaries with riparian zones delimited under this conception using standard designated widths to ease management and tracking of policy compliance.

Policies, regulations, and incentives may differ dramatically across a boundary where different conceptions of riparian zones are in effect. The following description of riparian vegetation provides a basis for depictions used later in this Atlas of what the future may hold for these important parts of the landscape.

Riparian Vegetation of the Mainstem Willamette River, Major Tributaries, and Small Streams

The Willamette River Basin contains more than 11,000 miles of streams and rivers. The riparian forests, grasslands, and wetlands that line these streams and rivers provide critical ecological functions and habitat for aquatic and terrestrial organisms. Historical surveys of the Willamette Valley and mapping of the mainstem Willamette River provide quantitative measures of past conditions in riparian areas and the degree of change that has occurred since EuroAmerican settlement in the early 1800s. The General Land Office mapped the Willamette River and its riparian vegetation in the decade after 1850. This engineering survey of western lands recorded vegetation types and river channels along section lines and mapped the area within the section boundaries. In 1895 and 1932, the U.S. Army Corps of Engineers resurveyed the entire length of the river for navigation and noted the type of vegetation that bordered the river. Current extent and type of riparian vegetation for the mainstem river and all tributaries within the Willamette River Basin were determined from classification of riparian vegetation along smaller streams and mainstem rivers from satellite data on land cover at a resolution of 30 m x 30 m pixels (see Land Use / Land Cover ca. 1990 pp. 78-81). The surveyors in 1850 noted only major wetlands. This classification severely underestimates the historical extent of wetlands. Newer surveys such as the National Wetland Inventory provide more credible estimates of existing wetlands but cannot be used to estimate historical wetlands.

Pre-EuroAmerican scenario (PESVEG, Map 28, p. 93) and land use/land cover ca. 1990 (LULC ca. 1990, Map 24, p. 79) provide estimates of areal and linear extents of riparian forests (e.g., area of vegetation type; length of channel occupied by vegetation type). River surveys of 1895 and 1932 provide only linear estimates. For the mainstem Willamette River, historical trends are depicted for four dates as linear extents of riparian vegetation in 1850, 1895, 1932, and 1990. Comparison of historical trends in riparian vegetation for small streams, major tributaries, and the mainstem Willamette River is restricted to an areal measure of the composition of riparian vegetation within 120 m (393 ft.) of both sides of the channel in 1850 and 1990 (Fig. 53).

Current Conditions and Historical Changes in Riparian Vegetation of the Mainstem Willamette River

The Willamette Valley in 1850 was dominated by prairies and oak savanna, with patches of forest scattered across the valley floor.[55] Floodplain forests differed greatly from the patterns of upland vegetation, with extensive gallery forests of black cottonwood, Oregon ash, alder, big-leaf maple, willow, Douglas-fir, western red cedar, and Ponderosa pine. Reports of the U.S. Army Corps of Engineers described the vegetation along the river as distinctly different than the vegetation away from the river:

"The banks of the river generally are low, and heavily timbered for a distance of about half a mile in width; beyond that is fine prairie land, forming by far the most valuable farming land in the State." (U.S. Army Corps of Engineers Annual Report, 1871).

In 1850, the Willamette River was lined with riparian forests, and the prairies and oak woodlands that were major features of the larger valley floor were minor components of the streamside vegetation. Of the 276 miles (445 km) of river between Ross Island and Eugene, forests and woodlands that contained hardwoods occupied 68% of the length, mixed forests made up almost 14% and conifer forests comprised almost 7% (Table 17, Figs. 52, 53). Prairies and wetlands, which are commonly considered to be the dominant vegetation of the Willamette Valley at the time of EuroAmerican settlement, accounted for only 6% of the riparian margin. Most of the prairie and savanna habitat was located in the reaches from Salem to Albany and from Corvallis to Harrisburg.

By 1895, human activities along the Willamette River had changed the nature of the riparian forests. More than half of the hardwood forests and woodlands had been converted, and almost all of the mainstem riparian conifer forests were lost. Mixed forests increased as a result of the conversion. Agricultural lands now occupied one-fifth of the river margin, and cities and towns accounted for an additional 13%. Agriculture and development made up one-third of the former floodplain forests of the Willamette. Prairies and wetlands were essentially eliminated. The majority of the remaining prairie habitat was found in the reach from Corvallis to Harrisburg.

Land conversion along the Willamette River continued to change the riparian forests through 1932. Hardwood forests were reduced to only 14% of the length. Mixed forests increased as a result of the conversion. Agriculture grew to occupy 43% of the total former riparian habitat, and urban lands remained at 11% of the former riparian habitat along the Willamette River.

Total River Percent Composition as Percent of Length									Total	
	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	km	miles
1850	0.0	0.0	5.0	6.2	67.6	13.5	6.6	1.1	444.5	276.2
1895	12.8	20.8	0.3	0.0	34.8	26.6	0.7	0.0	479.3	297.8
1932	10.8	43.5	3.0	14.5	13.5	2.2	5.8	0.1	480.2	298.4
1990	16.4	29.5	0.6	8.9	17.4	18.2	1.5	3.6	421.5	261.9

Table 17. *Percent composition of streamside vegetation along the mainstem Willamette River for 1850, 1895, 1932, 1990. Categories are defined as: "Devlp" = Developed urban or rural residential lands; "Ag" = Agriculture; "NatGrass" = Natural Grasslands, such as prairie; "NatShrub" = Natural Shrublands, such as willow thickets; "Hdwd" = forests dominated by deciduous species; "Mix For" = forests with a mixture of hardwoods and conifers: "Conif For" = predominantly coniferous forests.*

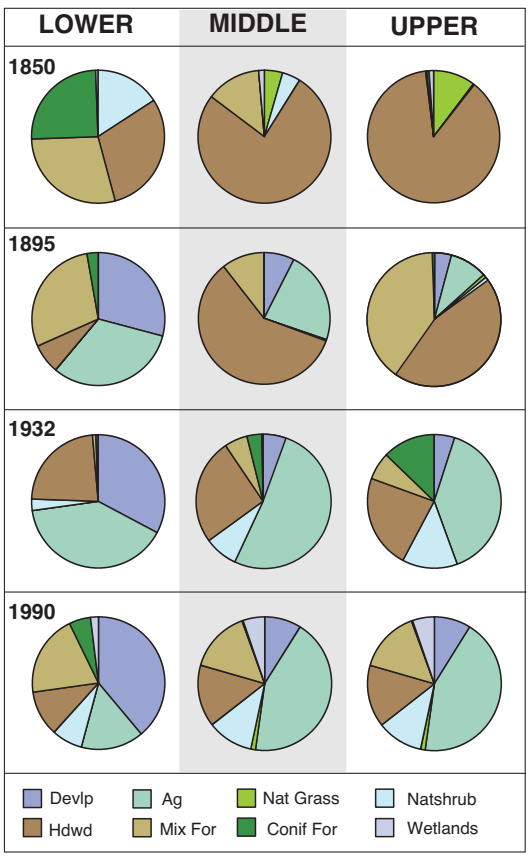


Figure 52. *Percent composition of streamside vegetation on the mainstem Willamette River. Land cover type is shown for 1850, 1895, 1932, and 1990 and for three sections of the river. The lower reach stretches from Portland to Newberg, the middle from Newberg to Albany, and the upper from Albany to Eugene.*

By 1990, hardwood forests and mixed forests were roughly equal, making up 17% and 18% of the riparian length, respectively. Conifer forests comprise less than 2% of the riparian plant community. Wetland habitats increased but natural grasslands remain extremely scarce. Agricultural lands decreased to 30% of the riparian lands, but development increased to 16%, so that almost half of the riparian habitat along the mainstem is made up of agricultural or urban land use.

Major Changes in Lower Willamette River Channel and Streamside Vegetation: Portland to Newberg

Though the channel of the Willamette River has remained relatively constant in this reach over the last 150 years, composition of the streamside vegetation has changed markedly. An example of vegetation change in this portion of the Willamette River is illustrated in Figure 20 pp. 20-21. In 1850, most of the riparian forest was evenly mixed between hardwood, conifer, and mixed forests, collectively representing almost 75% of the length of the river (Table 18, Fig. 52). By 1895, almost all of the hardwood and conifer forests were converted, but mixed forests remained at levels similar to that observed in 1850. Agriculture and development were roughly equal and accounted for more than half the riparian area along the river. By 1932, agricultural lands alone made up 46% of the riparian area, and development increased to 30%, so that more than 75% of the riparian margin had been converted to human-dominated land uses. By 1990, we find that forests—mixed, hardwood, conifer—occupy roughly one-third of the riparian margin in the lower river. Agriculture has declined to less than 15% but urbanization has increased to 37% of the riparian lands. These two land uses still occupy more than half of the riparian area along the river.

Lower River Composition as Percent of Length									Total	
	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	km	miles
1850	0.00	0.00	0.05	15.90	29.85	28.75	25.03	0.42	114.53	71.17
1895	26.82	29.32	0.00	0.00	6.62	26.39	2.56	0.00	118.61	73.70
1932	30.03	45.64	0.00	1.47	16.22	0.06	0.79	0.00	112.71	70.03
1990	36.97	14.55	0.10	7.11	10.41	19.03	5.07	1.91	105.10	65.31

Table 18. *Streamside land use and vegetation along the lower Willamette River, from Portland to Newberg. Development and agriculture were presumed by The Nature Conservancy to not exist at the time of the 1850 survey, though areas such as Portland were small towns. Vegetation was extrapolated based on professional judgment.*

Major Changes in Middle Willamette River Streamside Vegetation: Newberg to Albany

In 1850, riparian vegetation along the Willamette River from Newberg to Albany was similar to floodplain forests between Corvallis and Harrisburg, though mountains near Newberg and Salem limited development of wide floodplains. An example of vegetation change in the middle portion of the Willamette River is illustrated in Figure 21, p. 22. In 1850, more than 75% of the riparian forest in this reach was made up of hardwood forests, with mixed forests occupying another 13% (Table 19, Fig. 52). Conifer forests were absent from this reach. Natural grasslands made up 5% of the riparian area. By 1895, hardwood forests occupied only half the riparian length, but mixed forest area remained unchanged. Agricultural lands were almost one-quarter of the riparian lands, and urban areas occupied another 8%. As a result, one-third of the riparian area in this reach was human dominated by 1895. By 1932, agricultural lands alone made up 47% of the riparian area, and development decreased to 5%, so that more than 50% of the riparian margin had been converted to human-dominated land uses. By 1990, hardwood and mixed forest types each account for 23% and 20% of the riparian lands, respectively. Agricultural lands have decreased to 30% of the riparian margin, but urban lands now occupy 10% of the riparian lands. In this reach of the river, combined agricultural and urban lands make up 40% of the riparian system.

Middle River Composition as Percent of Length									Total	
	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	km	miles
1850	0.00	0.00	4.50	4.44	76.23	13.42	0.00	1.41	198.14	123.12
1895	8.42	23.15	0.05	0.00	52.56	12.83	0.17	0.00	203.26	126.30
1932	5.20	47.43	0.00	7.33	23.69	5.05	3.36	0.26	199.36	123.88
1990	10.19	29.69	0.49	8.84	23.13	20.02	0.41	3.42	192.14	119.39

Table 19. *Changes in streamside vegetation and land use patterns in the middle Willamette River, from Newberg to Albany. Increases in Natural Shrubland ("Natshrub") may reflect increasing dominance of Himalayan blackberry, an introduced plant species common in unforested riparian areas.*

Major Changes in Upper Willamette River Streamside Vegetation: Albany to Eugene

Loss of secondary channels, sloughs, and islands was accompanied by changes in the floodplain forests upstream from Albany (see p. 82 for illustration). This section of the Willamette River was predominantly lined by hardwood forests in 1850, but it also contained areas of prairie at the river's edge. An example of vegetation change in the upper portion of the Willamette River is illustrated in Figure 22, p. 23 at upper left. In 1850, more than 85% of the riparian forest in this reach was made up of hardwood forests, and mixed and conifer forests were a minor component of the riparian area (Table 20, Fig. 52). Natural grasslands made up 10% of the riparian area. By 1895, hardwood forests occupied only one-third of the riparian length, but mixed forest area increased to more than 40% of the riparian system. Agricultural lands were 11% of the riparian lands, and urban areas occupied another 8%. Almost one-fifth of the riparian area in this reach was human dominated by 1895. By 1932, agricultural lands alone made up 37% of the riparian area, and development decreased to 5%, so that more than 40% of the riparian area was converted to non-forest conditions. By 1990, hardwood and mixed forest types each account for 15% of the riparian lands, respectively. Agricultural lands have increased and now occupy more than 40% of the riparian lands, but urban areas now occupy almost 9% of the riparian area. In the upper river, combined agricultural and urban lands account for approximately half of the riparian system.

Upper River Composition as Percent of Length									Total	
	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	km	miles
1850	0.00	0.00	10.14	0.35	87.58	0.31	0.51	1.11	131.84	81.92
1895	7.91	11.19	0.71	0.00	33.01	44.60	0.00	0.00	157.43	97.82
1932	4.63	37.43	0.00	12.39	21.73	6.13	12.04	0.08	168.09	104.45
1990	8.70	41.82	1.14	10.59	14.52	14.70	0.04	5.20	124.30	77.24

Table 20. *Streamside land use and plant community type along the upper mainstem Willamette River, from Albany to Eugene. Note decline in overall riparian length due to channel simplification.*

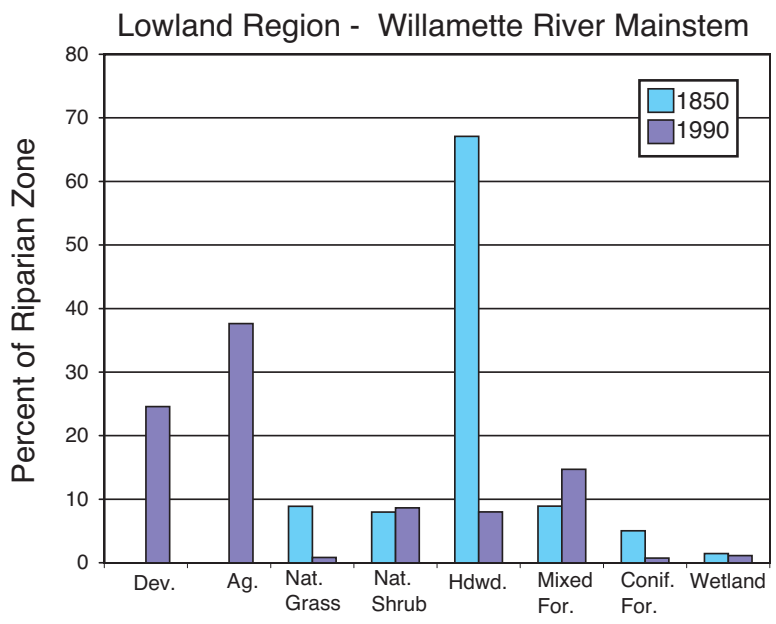


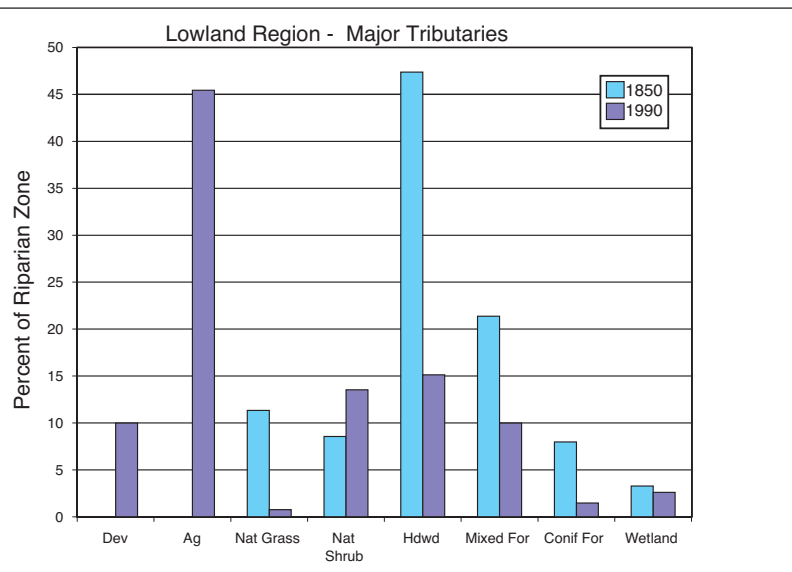
Figure 53. *Comparison of percent composition of land use / land cover in the riparian zone of the mainstem Willamette River (Portland to Eugene) between 1850 and 1990. Data presented are for a riparian zone of 120 m (393 feet) on each side of the river (240 m total width). The 120 m distance was selected because it represents 2 site-potential tree heights (the height of a mature over story tree), and is also four 30 meter pixels in width, a horizontal dimension corresponding to mapping detail used throughout PNW-ERC work.*

Current Conditions and Historical Changes in Riparian Vegetation Along Major Tributaries of the Willamette River Basin

Riparian forests along the major tributaries of the Willamette River represent transitions from the bottomland forests of the Willamette River floodplain to the riparian forests of the smaller streams in the valley and mountains. They include lowland forests of black cottonwood, Oregon ash, alder, big-leaf maple, and willow but they also include more of the coniferous forests of the uplands, such as Douglas-fir and western red cedar.

In 1850, wooded forests comprised 75% of the riparian area along major tributaries to the Willamette River. Hardwood forests made up the majority of riparian forests along both the mainstem Willamette and its larger tributaries, comprising more than 65% of the area within 120 m of the channels in the mainstem and slightly less than 50% in the tributaries (Fig. 54, Table 21). Almost one-third of the riparian area of the tributaries of the Willamette River was either mixed or coniferous forests, reflecting the role of larger lowland tributaries as transitions between the upland forests and the floodplain of the Willamette River. Natural grasslands and shrublands made up an additional 20% of the riparian area.

By 1990, forests along major tributaries were reduced to a third of their 1850 extent, occupying 26% of the riparian area (Fig. 54, Table 21). Hardwood forests and mixed forests are dominant, making up 15% and 10% of the riparian area, respectively. Conifer forests comprise less than 2% of the riparian plant community. Wetland habitats remained low but natural grasslands almost disappeared. Agricultural and developed lands occupy the majority of the riparian area along major tributaries, comprising 45% and 10% of the area within 120 m of the channels, respectively. Agricultural and developed lands make up even more (62%) of the riparian areas within 120 m of the mainstem Willamette tributaries.



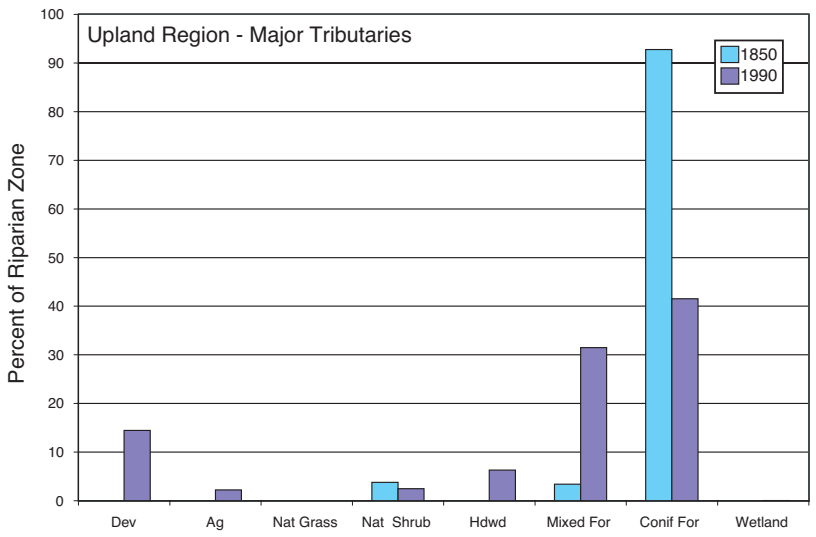


Figure 54. *Percent composition of 120 m riparian zones along major tributaries of the Willamette River in 1850 and 1990. These rivers start in the Cascade and Coast Range mountains, and then travel across the Willamette Valley to join the Willamette River. The types of vegetation and land use between the valley (Lowland) and the mountains and foothills (Upland) are potentially very different. Therefore, riparian percentages are presented separately for each of these ecoregions (see pp. 48-49 for a discussion of Biotic Systems, Ecoregions).*

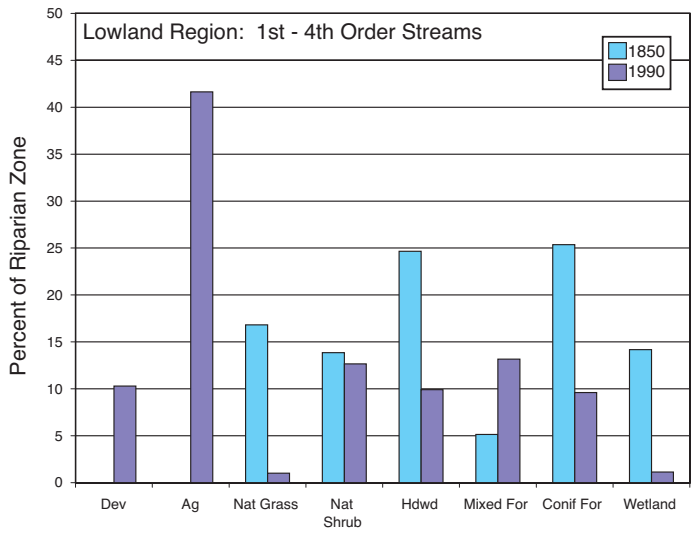
Current Conditions and Historical Changes in Riparian Vegetation Along Small Streams of the Willamette River Basin

Riparian conditions along smaller streams throughout the Willamette Basin were determined from the Land Use / Land Cover ca. 1990 map (pp. 78-81). Small streams were defined as 1st through 4th order streams (1:100,000 scale; see Aquatic Life pp. 118-123). Small streams differ greatly between the steeper channels and coniferous forests in the mountains surrounding the basin and the lower gradient streams that flow through the hardwood and mixed forests of the Willamette Valley floor. Results of analysis of the area within 120 m zones along both sides of small streams are presented separately for the Uplands and Lowlands to clearly describe the attributes of these different riparian systems.

Lowlands

In 1850, coniferous and hardwood forests were almost equal in area, followed by mixed forests. These forests collectively occupied roughly 55% of the riparian area (Fig. 55, Table 21). Wetlands, grasslands, and natural shrublands each accounted for approximately 15% of the riparian area along smaller streams in the Lowlands, collectively comprising 45% of the area. The riparian plant communities of the small lowland streams were more evenly distributed between major types of vegetation than any other riparian system in the Willamette River Basin. This is largely a result of these small streams cutting through the mosaic of forests, grasslands, and wetlands of the Willamette Valley, reflecting their fire history and more heterogeneous patterns.

By 1990, more than half of the riparian areas along small streams had been converted to agricultural and developed lands in the Willamette Valley, with most of those converted lands in agriculture. Forests now make up one-third of the riparian area along small streams in the lowlands, and the amounts of hardwood, mixed, and coniferous forests are roughly equal (Fig. 55, Table 21). Natural grasslands and wetlands have declined sharply.



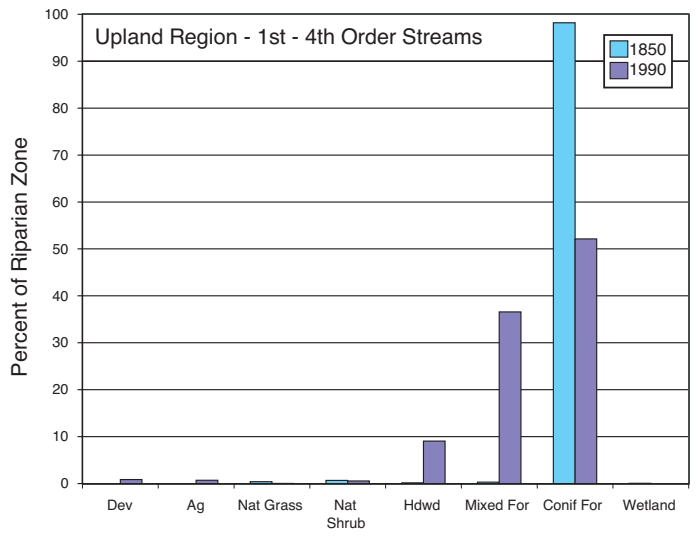


Figure 55. *Percent composition of 120 m riparian zones along small streams of the Willamette Basin in 1850 and 1990. Lowland and Upland ecoregions are presented separately (see text for explanation). These areas were not surveyed by the USACE in 1895 and 1932, so unlike the mainstem Willamette River, a more detailed temporal sequence is not possible.*

Uplands

In contrast to the Lowlands, coniferous forests occupied 98% of the Upland riparian area in 1850 (Fig. 55, Table 21). Riparian areas reflected the dominant Upland forests, and hardwood and mixed forests were minor riparian components. By 1990, coniferous forests were reduced to only half of the Upland riparian areas along small streams. Conversion of coniferous forests to mixed and hardwood forests through commercial forestry accounted for most of this change. Agricultural and developed lands make up less than 2% of the riparian area along smaller streams in the Uplands of the Willamette Basin.

All Streams

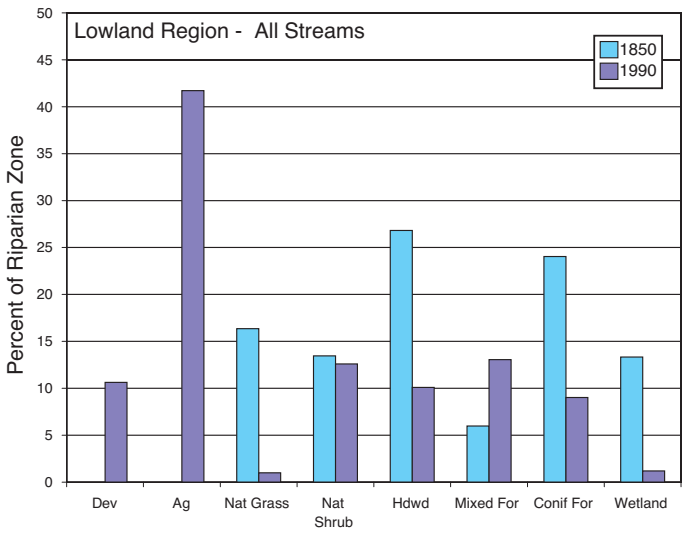
Overall, riparian areas along small streams account for 96% of the riparian areas of the entire Willamette River Basin (Table 21). As a result, the overall changes in plant communities in riparian areas within the basin largely reflect the consequences of land uses along small streams. Upland small streams, Lowland small streams, major tributaries, and the mainstem Willamette River differed greatly in composition prior to EuroAmerican settlement (Fig. 56, Table 21). Coniferous forests dominated Upland streams, while Lowland riparian areas were mosaics with relatively equal representation of the major vegetation types. Major tributaries contained riparian forests that were intermediate between the coniferous forests of the Uplands and the hardwood-dominated floodplain forests along the mainstem Willamette River. In 1850, forests accounted for 57% of all riparian area in the Lowlands of the Willamette River Basin, but now these forests make up only 32% of the riparian area. Now more than half of the Lowland riparian areas are in urban, rural residential, or agricultural lands. In addition, natural grasslands and wetlands have been reduced to less than 10% of the area they occupied in Lowland riparian areas in 1850. In the Uplands, almost half of the coniferous forests in riparian areas in 1850 have been converted to mixed forests (Fig. 56).

Riparian Areas in the Future

This characterization of riparian areas in the WRB illustrates the effects of past choices on present conditions in this zone of acknowledged ecological and social importance. It also raises important questions about future riparian alternatives. While the list of questions below is not exhaustive, it does include some of the most commonly encountered issues and choices that affect and are affected by riparian zone management. These questions are addressed variously in the alternative futures described in Chapter 7, Trajectories of Change.

What are the critical riparian zone gradients that merit attention in agricultural, urban, and forest use areas in the future? Some of the more important are: width and continuity of woody vegetation, presence of native vs. non-native species of vegetation, the extent to which natural processes (e.g. historical levels and timing of stream flows) are active in the area, and the location and extent of bank hardening on major streams and rivers.

Given the large proportion of the total stream network that is composed of small streams, how large must a stream be before it is recognized in policy as deserving protection for riparian vegetation? How important is the accuracy of contemporary maps of stream networks in answering this question? To what extent are zones of riparian vegetation considered primarily as protective buffers for streams as opposed to key habitats?



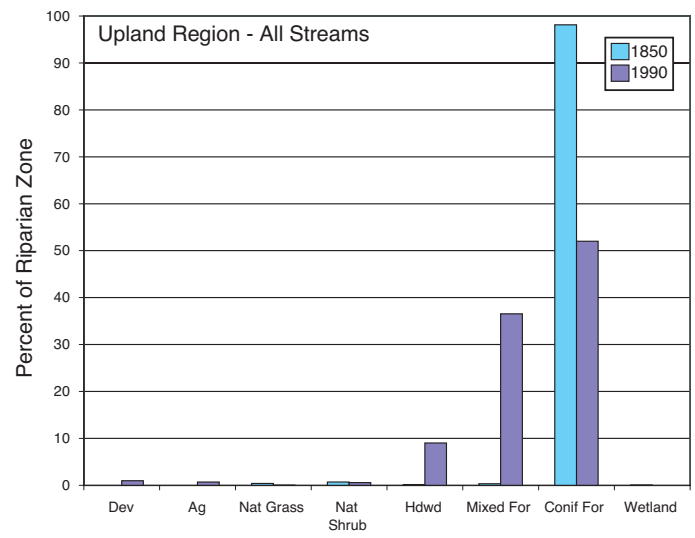


Figure 56. *Percent composition of 120 m (393 ft) riparian zone for all streams and rivers in the Willamette Basin. This combines data from small streams, major tributaries, and the Willamette River mainstem. Note that the Willamette River is present only in the Lowland Ecoregion.*

Once a set of desired future riparian conditions is determined, by what means are these conditions achieved? In what way do these means respond to important biophysical, social, and cultural variations, e.g., the differences in appropriate riparian practices in large cities vs. small towns, public vs. private forests, valley vs. montane streams, agricultural and rural residential areas?

These and other riparian questions address important variables in the three alternative futures mapped, described, and evaluated in the Trajectories of Change chapter.

LOWLAND ECOREGION - 120 meter Riparian Area										
	Percent composition								Total	
1990	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	ha	ac
1-4th Order Streams	10.3	41.6	1.0	12.7	9.9	13.2	9.6	1.1	190235	470071
Major Tributaries	10.0	45.4	0.8	13.5	15.1	10.0	1.5	2.6	9182	22691
Willamette River	24.6	37.6	0.8	8.6	8.0	14.7	0.9	1.1	5071	12531
All Streams	10.6	41.7	1.0	12.6	10.1	13.1	9.0	1.2	204489	505292
PESVEG										
1-4th Order Streams	0.0	0.0	16.8	13.9	24.7	5.1	25.4	14.2	189273	467693
Major Tributaries	0.0	0.0	11.3	8.6	47.4	21.4	8.0	3.3	9302	22986
Willamette River	0.0	0.0	8.9	8.0	67.1	8.9	5.0	1.4	5383	13300
All Streams	0.0	0.0	16.3	13.5	26.8	6.0	24.0	13.3	203958	503979

UPLAND ECOREGION - 120 meter Riparian Area										
	Percent composition								Total	
1990	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	ha	ac
1-4th Order Streams	0.9	0.7	0.0	0.6	9.0	36.6	52.1	0.0	237942	587954
Major Tributaries	14.0	2.2	0.0	2.5	6.3	31.5	41.5	0.0	2242	5539
All Streams	1.0	0.7	0.0	0.6	9.0	36.5	52.0	0.0	240183	593493
PESVEG										
1-4th Order Streams	0.0	0.0	0.4	0.7	0.1	0.3	98.2	0.1	238981	590522
Major Tributaries	0.0	0.0	0.0	3.8	0.0	3.4	92.8	0.0	2234	5521
All Streams	0.0	0.0	0.4	0.7	0.1	0.4	98.1	0.1	241215	596043

WILLAMETTE BASIN (LOWLAND & UPLAND ECOREGIONS COMBINED) - 120 meter Riparian Area										
	Percent composition								Total	
1990	Devlp	Ag	NatGrass	Natshrub	Hdwd	Mix For	Conif For	Wetlands	ha	ac
1-4th Order Streams	5.0	18.9	0.5	5.9	9.4	26.2	33.2	0.5	428177	1058025
Major Tributaries	10.9	37.0	0.6	11.4	13.4	14.2	9.3	2.1	11424	28230
Willamette River	24.6	37.6	0.8	8.6	8.0	14.7	0.9	1.1	5071	12531
All Streams	5.4	19.6	0.5	6.1	9.5	25.7	32.2	0.6	444673	1098786
PESVEG										
1-4th Order Streams	0.0	0.0	7.7	6.5	11.0	2.5	66.0	6.3	428254	1058215
Major Tributaries	0.0	0.0	9.1	7.6	38.2	17.9	24.4	2.6	11537	28507
Willamette River	0.0	0.0	8.9	8.0	67.1	8.9	5.0	1.4	5383	13300
All Streams	0.0	0.0	7.7	6.5	12.4	2.9	64.2	6.1	445173	1100022

Table 21. *Summary of riparian land use and land cover within a 120 m (393 ft) distance each side of streams and rivers of the Willamette Basin. Both ecoregions as well as totals are presented.*