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Introduction

The stereotype of western Oregon is that it's rainy and wet — and thus water is plentiful. However, 70-80 % of the annual precipitation in the Willamette Basin falls between October and March; less than 5% in July and August (Fig. 47).[42] Low levels of rainfall during summer result in low stream flows and constrained water supplies at the time of the year when demands are often highest. Thus, even in a region of the state known for its abundant rainfall, water is scarce at certain times of year and at certain locations. This section provides an overview of water supplies and current uses in the Willamette Basin. Bastasch (1998)[43] and the Oregon Water Resources Department (http://www.wrd.state.or.us) provide more in-depth discussions.

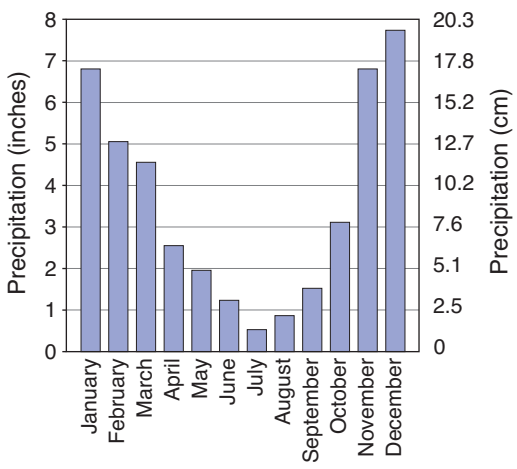

Figure 47. *Seasonal variations in precipitation. Average precipitation per month for the period 1961-1990 at the Oregon State University site near Corvallis, Oregon. (Source: Oregon Climate Service, http://www.ocs.orst.edu).*

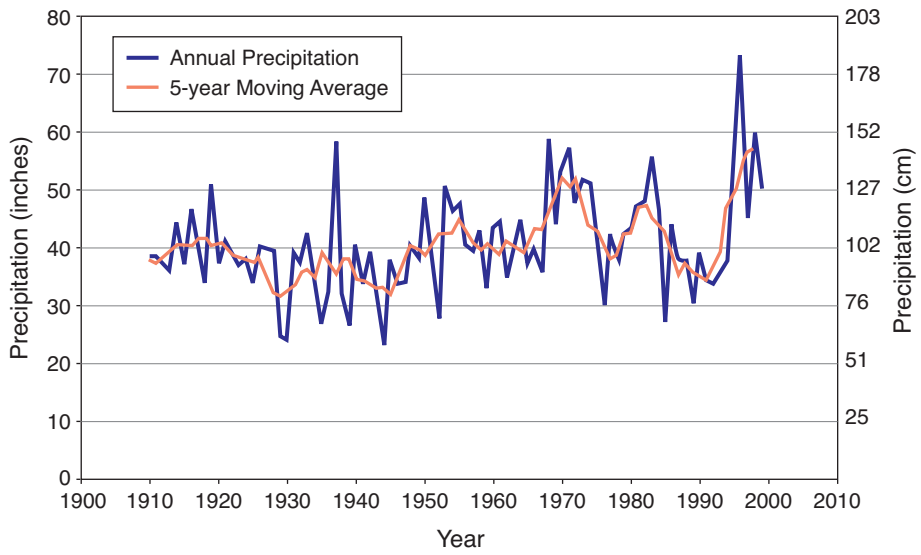

Figure 49. *Long-term patterns in annual precipitation. Total annual precipitation and the 5-year moving average of annual precipitation 1910 to 1999 at the Oregon State University site near Corvallis, Oregon. (Source: Oregon Climate Service, http://www.ocs.orst.edu).*

Water Supply

Precipitation is the ultimate water source. The amount of precipitation increases sharply with elevation (Fig. 48), ranging from 40-50 inches (100-130 cm) per year in the valley to almost 200 inches (500 cm) near the crests of the Coast and Cascades Ranges. In addition to the seasonal variations illustrated in Figure 47, the area is also prone to longer-term wet and dry cycles and pronounced annual variability (Fig. 49). The end result is seasonal, annual, and spatial variations in water supplies.

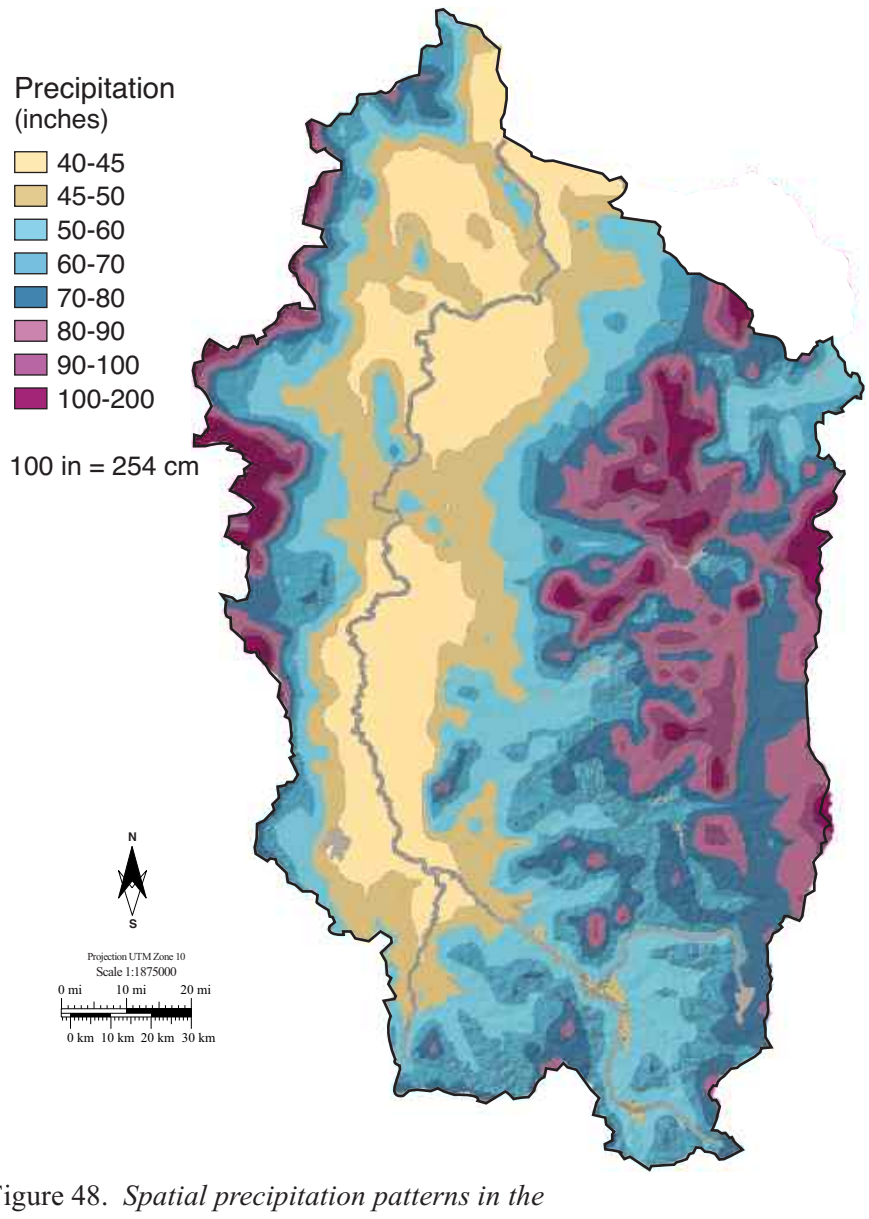

Figure 48. *Spatial precipitation patterns in the Willamette Basin. Average annual precipitation 1961-1990 derived from the PRISM model.[44] Map courtesy of Donita Parker, U.S. Geological Survey, Water Resources Division, Portland, Oregon.*

Within any given watershed in the basin, the two major factors that determine stream discharge are precipitation amount and the watershed area over which that precipitation falls. Thus, streams with larger watersheds draining higher elevations tend to have higher discharge (Table 14). The four largest rivers (Santiam, McKenzie, Middle Fork Willamette, and Clackamas), with the largest water supplies, drain the western Cascades portion of the basin.

Not all precipitation runs off directly as surface flow. Some portion seeps into soils and rocks, as groundwater. While groundwater supplies are also affected by precipitation amount, also important is the physical capacity of the soil and rock to store and transmit water (called porosity and permeability, respectively). As illustrated on pages 8-9, the Willamette Basin contains several quite different geological settings. The Cascades are largely volcanic in origin, with highly variable water-bearing characteristics. Some parts are very porous and permeable. For example, well yields from the basalt flow that underlies part of the Clackamas watershed, as well as other areas in northern Oregon, may exceed 1000 gallons per minute (3.8 m^3/minute), although 100 gpm is more typical. Much of the Coast Range, in contrast, consists of sedimentary sandstone and siltstone. Recharge of these tight-grained rocks is low and well yields relatively small (5-20 gpm). The valley consists of more recent deposits of sand and gravel with well yields 50 to 300 gpm, increasing from south to north. [43]

River	Mean elev. (feet)	Avg. annual discharge (mgd)[a]	Highest flow occurrence		Lowest flow occurrence		Flow factor range[c]
			Mo.	%[b]	Mo.	%[b]	
Willamette	1,790	21,542	Dec	18.7	Aug	2.1	9
Santiam	2,369	5,041	Dec	18.2	Aug	2.0	5
McKenzie	3,110	3,826	Feb	13.1	Sep	2.8	5
M. Fk. Will.	3,303	2,661	Dec	16.6	Jun	5.5	3
Clackamas	2,811	2,372	Jan	16.2	Aug	2.3	7
Yamhill[d]	705	1,291	Jan	21.7	Aug	0.2	109
Coast Fk. Will.	1,913	1,061	Dec	18.8	Jul	1.5	13
Tualatin	639	990	Jan	24.1	Aug	0.1	241
Pudding	810	788	Jan	18.7	Aug	0.5	37
Molalla	1,811	752	Jan	17.8	Aug	0.8	22
Luckiamute	771	585	Jan	21.4	Aug	0.4	54
Long Tom	627	498	Jan	23.2	Sep	0.2	116
Marys	748	299	Jan	22.2	Aug	0.3	74

[a]Million gallons per day. One million gallons per day = 3785 cubic meters per day.
[b]Percentages of total annual discharge.
[c]Ratio of annual discharge percentage in highest month to that of lowest month.
[d]Combines North Yamhill near Pike with South Yamhill near Whiteson; monthly data reflect South Yamhill.

Table 14. *Flow regimes for major tributaries in the Willamette Basin.[43,45] Flows are adjusted to exclude the influence of upstream dams. Spatial units are watersheds and should not be confused with HUCs used in Table 3, p. 16.*

Like surface water, groundwater flows down gradient, although more slowly, and may eventually reemerge as surface water. Groundwater discharge plays an important role in sustaining summer stream flows. Larger groundwater discharge, as well as the gradual melting of deep snowpacks at high elevations, helps moderate seasonal flow variations in streams draining Cascade watersheds, compared to those draining the Coast Range or lower elevations (Table 14). The federal reservoirs, as well as other artificial impoundments (see pp. 30-31), modify these seasonal variations even further. By holding back a portion of spring runoff for gradual release over summer, the federal reservoirs increase downstream summer flows and water supplies in certain locations. Future changes imposed to protect anadromous fish runs may alter the timing and magnitude of these reservoir releases.

Water Rights

Water in Oregon is publicly owned. With a few exceptions, anyone who wants to use water (both surface water and groundwater) must first obtain a permit, or water right, from the Oregon Water Resources Department. A water right defines the amount of water that can be withdrawn from a specified location (stream reach or well) for a particular use. Oregon's water laws are based on the principle of prior appropriation. The first person to obtain a water right on a stream or groundwater aquifer has priority over rights issued at a later date. During times when water is in short supply, the water right holder with the oldest permit date (also referred to as the priority date) will be the last to be shut off. If there is a surplus beyond the needs of the senior right holder, the person with the next oldest priority date can take as much water as allowed by their water right, and so on down the line until the water supply is fully used. Thus, junior (more recent) water rights take the full brunt of a water shortage, rather than the shortfall being shared among all water users.

Water rights are issued for both in-stream and out-of-stream uses. Out-of-stream uses include municipal and industrial water supplies, irrigation, and livestock. In-stream uses include fish protection and recreation. The water associated with in-stream water rights is not physically removed from the stream, but is protected from withdrawal for other uses over the length of stream for which the water right has been issued. Most in-stream water rights for fish and recreation have fairly recent priority dates; 75% are dated 1960 or later (see pp. 114-16).

The Oregon Water Resources Department cannot issue more water rights than there is water available in most years. Specifically, the water consumed by surface water rights cannot total greater than the "80% exceedance" stream flow for a given month. The 80% exceedance flow is defined for August, for example, as the flow exceeded in 80% of August days over the 30-year period 1957 to 1987. Because the stream flow will be less than this value 20% of the time, once flows have been fully allocated, it's a given that the most junior water right will not be satisfied 20% of the time. The spatial unit used by the Water Resources Department for assessing surface water availability is termed a Water Availability Basin (WAB), designed to reflect both the distribution of water rights and drainage patterns (see Fig. 50).

In most areas of the Willamette Basin, surface water supplies have been fully allocated (Fig. 50)[46] — no further water is available for new surface water rights and in dry years more junior water rights are not satisfied. The only exceptions are areas below the federal reservoirs and a portion of the high Cascades.

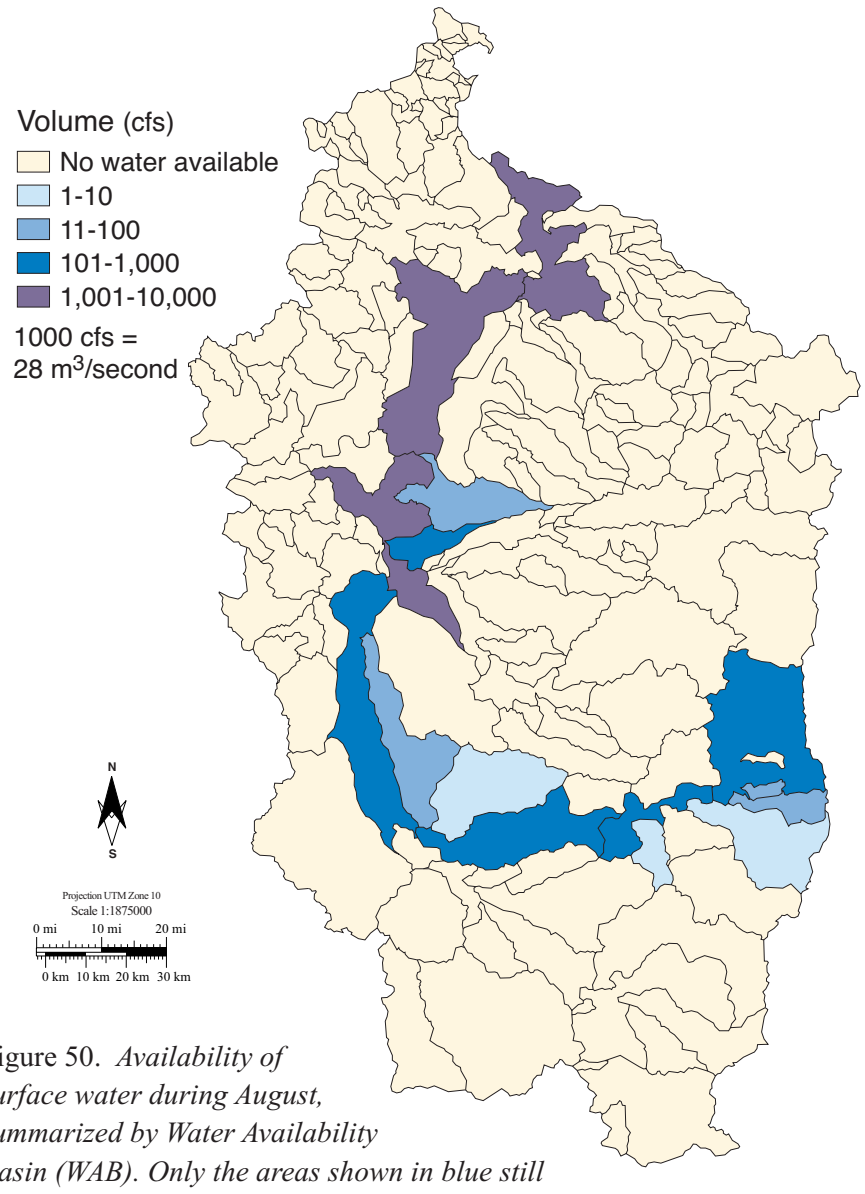

Figure 50. *Availability of surface water during August, summarized by Water Availability Basin (WAB). Only the areas shown in blue still have available surface water rights. In all other areas, water supplies have been fully allocated. (Source: Oregon Water Resources Department, http://www.wrd.state.or.us).*

Current Water Withdrawals

Every five years, the U.S. Geological Survey estimates the amount of water withdrawn from surface water and groundwater supplies for each major category of out-of-stream use (Table 15). In 1995, 77% of the total withdrawals in the Willamette Basin were derived from surface flow; 23% from groundwater. Across all out-of-stream uses, about 40% of the water withdrawn was consumed, that is, lost in the process and never returned to the stream. Even water that is not consumed may be delayed in its return or returned to areas different from where it was withdrawn. The largest water withdrawals were for irrigation, representing 49% of the total withdrawals. Withdrawals for domestic use represented 15% of the total water withdrawn; industrial use 13%; and commercial use 19.5%. Forty-two percent of the domestic, industrial, and commercial withdrawals were provided via public water supplies, of which 88% was derived from surface water.

Type of Use	Total withdrawals (mgd)[a]	Percent Surface water	Percent Consumed	Total consumed (mgd)[a]
Domestic	243.0		21.7	52.7
Public supplies	212.7	87.8		
Other	30.4	6.9		
Industrial	213.6		3.6	7.7
Public supplies	51.3	87.8		
Other	162.2	100.0		
Commercial	315.0		0.1	0.24
Public supplies	57.8	87.8		
Other	257.1	99.4		
Public use and loss from public supplies	45.0	87.8	unknown	unknown
Irrigation	793.6	63.2	72.4[b]	574.5[b]
Livestock	4.0	61.4	100.0	4.0
Mining	0.4	0.0	41.7	0.2
Total	**1614.5**	**77.2**	**39.6**	**639.2**

[a]Million gallons per day. One million gallons per day = 3785 m^3 per day.
[b]Includes consumption plus 115 million gallons per day lost during the transport of water for irrigation.

Table 15. *Water withdrawals and consumption in 1995 in the Willamette Basin. (Source: U.S. Geological Survey).*[47]