S. Gregory L. Ashkenas
D. Oetter P. Minear K. Wildman

Channel Complexity

Human activities in the Willamette River and most of the larger rivers of the world tend to simplify channels and minimize flooding. Dynamic channel patterns and regular flooding are cycles of river ecosystems that enhance biodiversity and aquatic productivity. Beginning in the 1860s, the federal government invested in the clearing of large wood and other obstructions from the Willamette River and eliminating of side channels. Most of these river alterations in the 1800s were intended to improve navigability of the Willamette River, because riverboats were a primary means of transportation of people and goods, particularly in the wet winter months when valley roads were flooded and impassable for extended periods. As landowners and communities began to build closer to the river, floods became a major risk and the natural processes of erosion and deposition were a hindrance to property owners along the river. Revetments and bank armoring with riprap were used by the federal government, local communities, and private citizens to stop bank erosion and close off side channels. Eleven federal flood control reservoirs were built in the basin from 1948 to 1964 (pp. 30-31), and these reservoirs reduce peak flows of small to moderate floods by approximately 30-50%. All of these control measures over the last 150 years have simplified the channels and islands of the Willamette River, converting much of a previously complex network of mainstem, side channels, alcoves, and islands into a riverine thread with far less channel complexity (pp. 15-35).

The Data

As described in Historic Willamette River Channel pp. 18-25, maps of the river from 1850, 1895, 1932, and 1995 provide a scientifically robust basis for determining the extent and location of river channels in the Willamette River and its floodplain. The extents of flooding were combined for these major floods and depicted in a map of the total extent of known floodplain inundation since EuroAmerican settlement. The floodplain axis provides the most constant and quantifiable context for tracking changes in the river channels, because the position of the channel changes but the overall area inundated by past floods is relatively constant (pp. 28-29). We mapped 1-km slices of the Willamette River floodplain at right angles to the center axis of the floodplain (see floodplain slice map at top of facing page). Within each 1-km slice, we measured the length and area of main channel, side channel, alcoves, tributaries, and islands. The longitudinal display of the length or area of all channel types combined within the floodplain creates a linear illustration of channel complexity, a chart of the conditions of the river and its floodplain.

Patterns

To determine the potential for restoration we have compared the longitudinal patterns of channel complexity along the Willamette River in 1850 and 1995 (Figs. 174-78). Prior to settlement and river modification, the Willamette River exhibited three major geomorphic reach types. The upper (southern) river from Eugene to Albany contained the most complex river channels, with more than 100 – 400 ha of river channel within 1 km of floodplain. Floodplains within this reach of the river contained as much as 11 km of channel length within a 1-km floodplain distance, and most of the reach included 4-8 km of channel per km of floodplain (Fig. 177). The reach from Albany to Newberg flows through several volcanic mountain ranges that extend across the valley floor. The river "bounces" between these resistant lateral landforms, creating a floodplain that varies greatly in width. As a result, the section from Albany to Salem was relatively simple in 1850, and the section downstream of Salem near Mission Bottoms, one of the early settlements in the Willamette Valley, is more extensive and complex. From Newberg to Portland, the Willamette River flows within a narrow basaltic trench that developed early in the geologic formation of the basin. The floodplain in this reach is narrow and relatively unchanging.

By 1995, human attempts to control the river had eliminated large amounts of river habitat and simplified the river. Area of river channel in the upper reach was reduced by more than half compared to 1850. The length of river decreased even more through the elimination of side channels and the armoring of its banks. By 1995, the upper river remained the most complex overall, but the lengths of channels within 1 km of floodplain have been reduced to 20-30% of the length present before river modification (Fig. 174). The middle section of the river also changed, but not to the extent observed in the upper river. Area and length of river channel in the geomorphically simpler lower river remain similar to the historical patterns of channel complexity (Figs. 24-27, p. 25).

Potential for Restoration

The potential response of the river to efforts to restore channel complexity and area of riverine habitat differ along the Willamette River in relation to its geologic and hydrologic characteristics. Historical patterns of channel complexity (Figs. 175, 177) provide a context for evaluating potential gains in river complexity through restoration actions. The difference between the graphs of channel complexity in 1850 and 1995 provides a longitudinal measure of the relative loss or gain of channel complexity (Fig. 174). This graph depicts the areas of loss and gain and illustrates the analyses of the different river reaches described above. Clearly, the upper river section has the greatest potential for future recovery of channel complexity lost through past river modification. The area downstream of Salem also has been simplified and ecological function could respond with increased aquatic area and channel complexity. Some of this land is managed by the Oregon Parks and Recreation Department, and park managers are actively restoring some of the side channels and floodplain features that have been modified over the last 150 years.

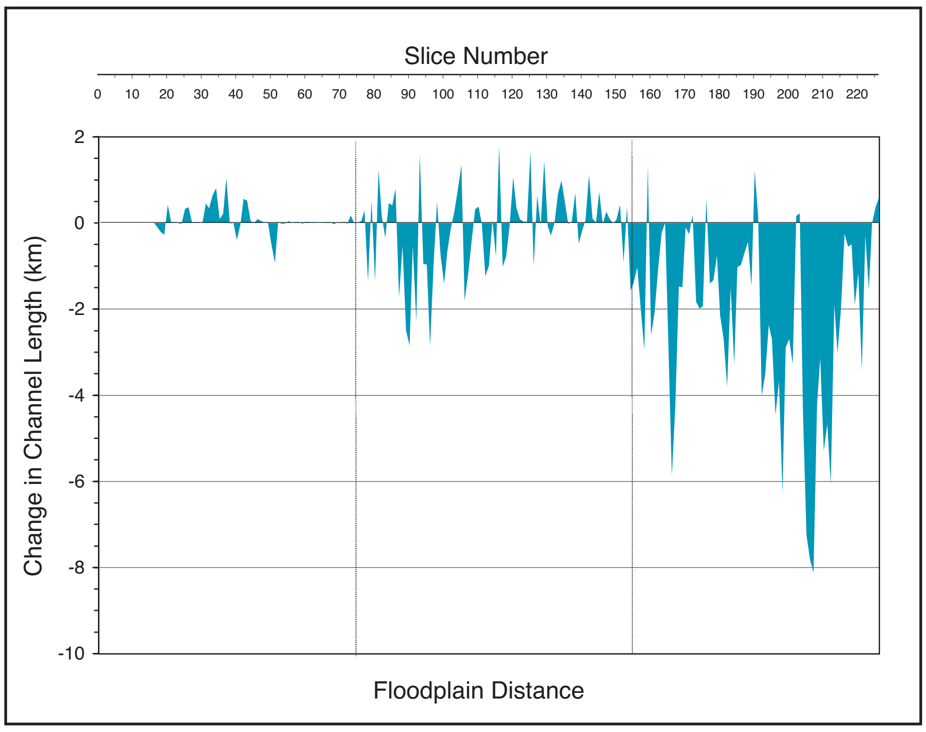
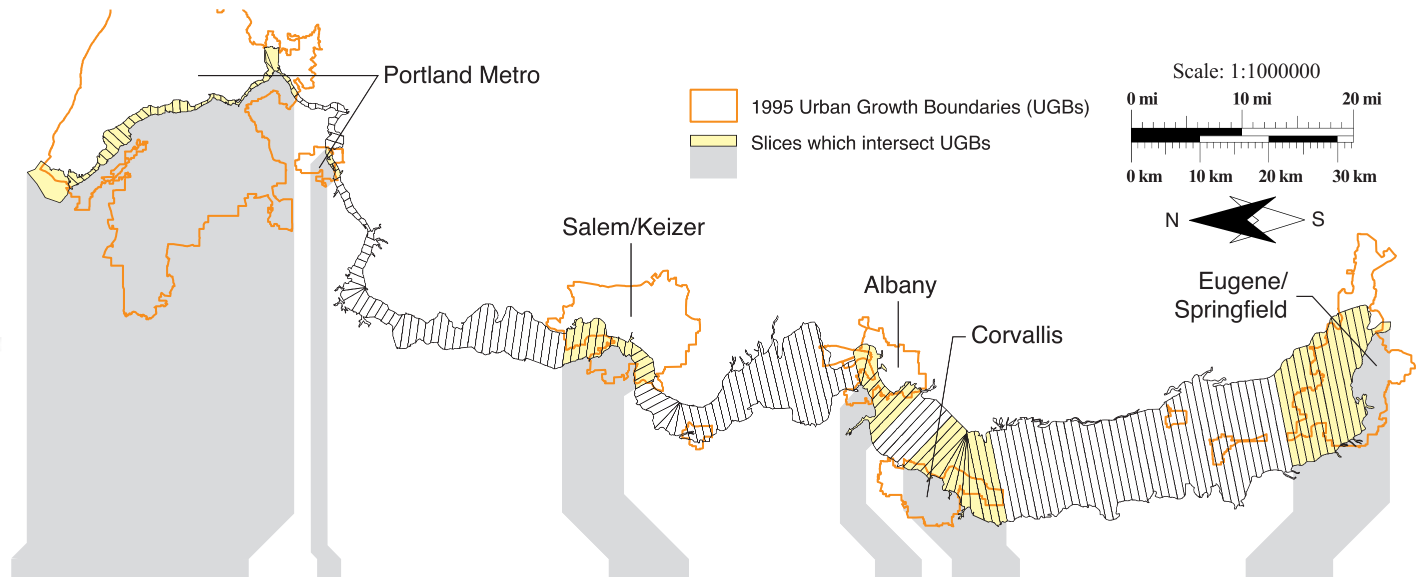
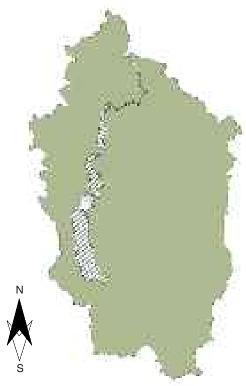


Figure 174. *Net increase or decrease in channel length per 1 km of floodplain distance, between 1850 and 1995. Channel length provides a measure of river habitat complexity.*

The maps and longitudinal illustrations of channel complexity can also be used to project future restoration potential through alternative futures. We examined aerial photographs for remnant channels and river features and identified historical channels that could be reconnected to the river in the future. In the mainstem Willamette River from Eugene to Portland, approximately 200 km of river channel could be reconnected. These reconnected channels are incorporated into the Conservation 2050 alternative future (pp. 90-91, Fig. 173 p.133). If we continue to simplify the channel at the same rate of loss that has occurred since 1932, we will lose additional riverine habitat, an alternative depicted in Development 2050 (pp. 88-89, Fig 173 p.133).

Figures 175-178. (Facing page). *Longitudinal patterns of channel complexity along the mainstem of the Willamette River.*





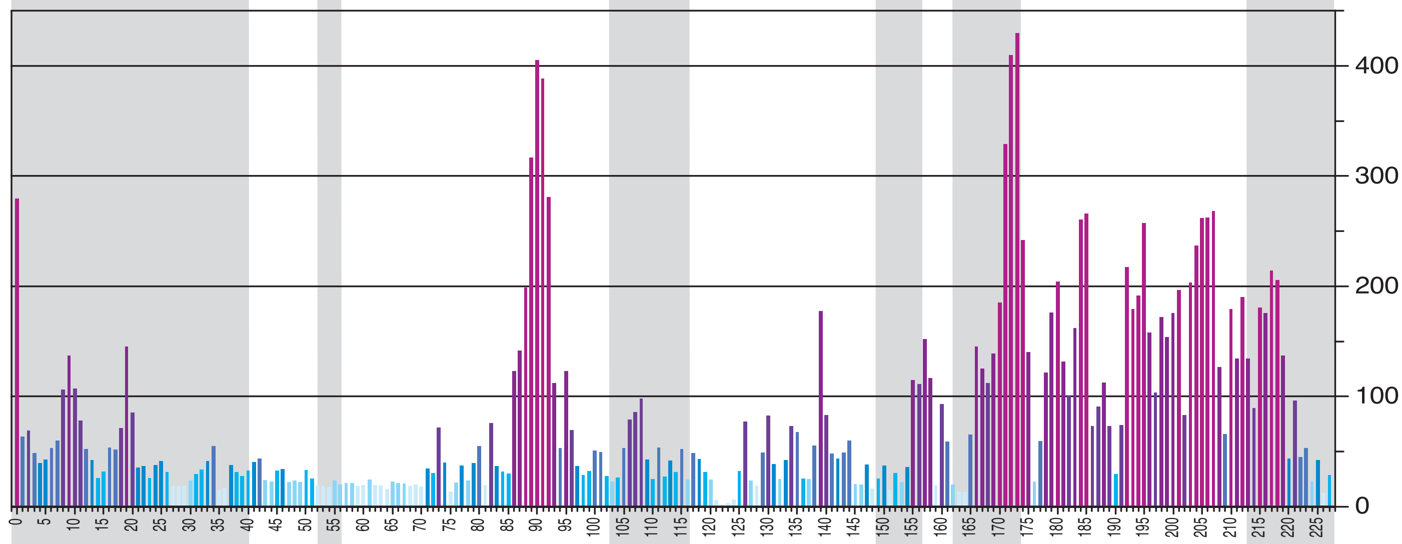


Figure 175. *Area of river channel ca. 1850.*

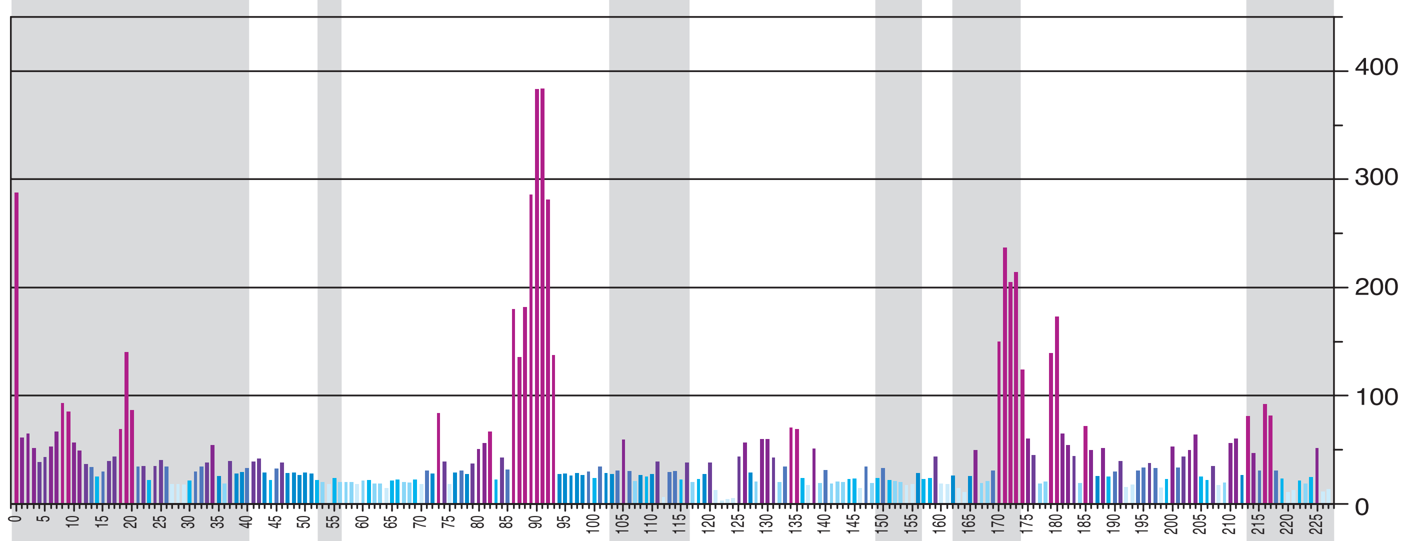


Figure 176. *Area of river channel 1995.*

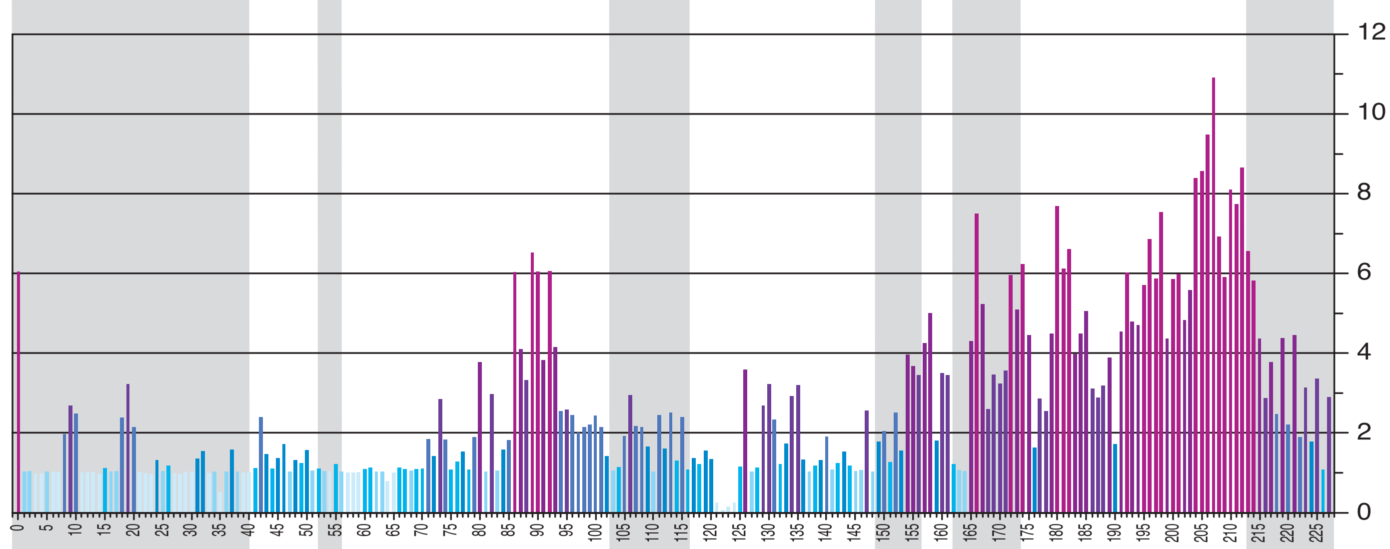


Figure 177. *Length of river channel ca. 1850.*

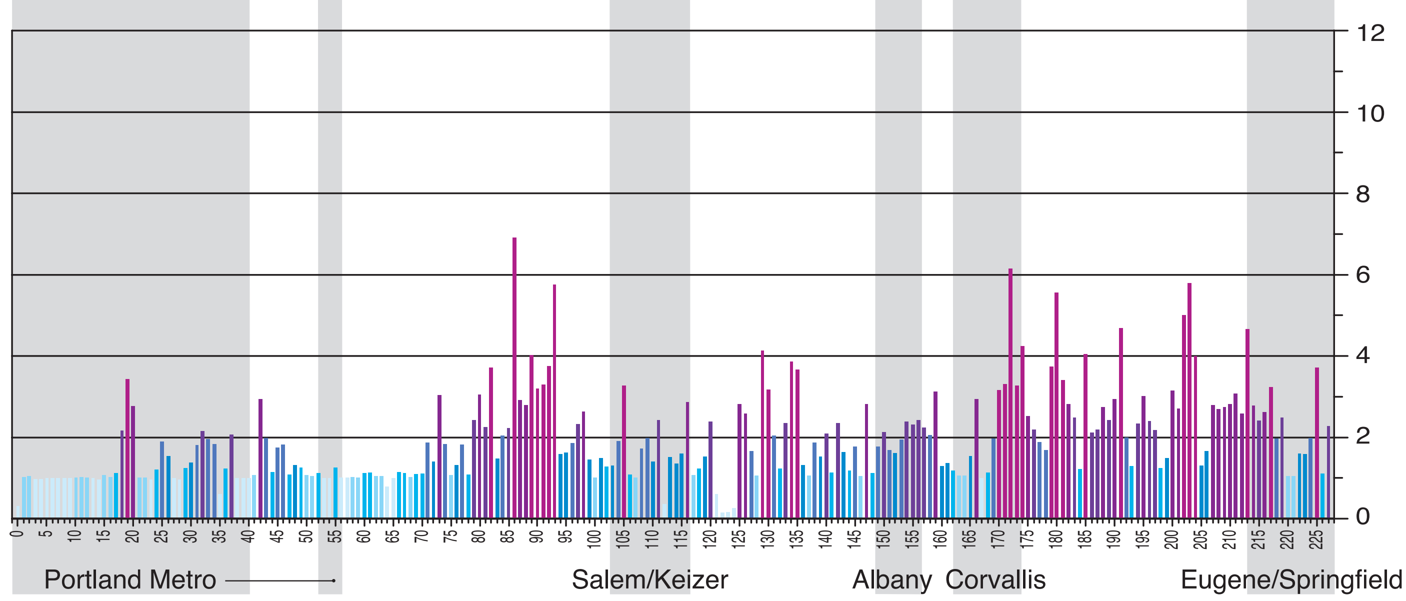


Figure 178. *Length of river channel 1995.*

Note: 1 hectare equals 2.47 acres, 1 kilometer equals .62 mile