What Are Off-Channel Habitats?

As the prior descriptions of the Willamette River show, the aquatic habitats of the river are not limited to the main channel; they also include off-channel habitats (p.18). Off-channel habitats (OCH) are those bodies of water adjacent to the main channel that have surface water connections to the main river channel at summer discharge levels. Figure 28 shows several types of OCH and other river features.

Side channels are flowing water bodies with clearly identifiable upstream and downstream connections to the main channel. In some cases, side channels are miles long and define the boundaries of big islands in the active floodplain; in other cases, they define small islands and are relatively short. Water in side channels is mostly derived directly from the main channel at the upstream connection and, therefore, the water characteristics of side channels are very similar, often identical, to the main channel.

Alcoves are water bodies that maintain a downstream connection to the main channel at summer low flow, but have no upstream connection during low flow. They exhibit either no downstream flow or only very low flow derived entirely from groundwater. The proportion of surface water to groundwater in alcoves can vary widely from year to year as the normal processes of erosion and deposition alter gravel bars. Alcoves are often formed when a mid-river gravel bar enlarges and connects to one side of the riverbank forming a point bar. As time passes, the point bar often elongates downstream and vegetation begins to develop. Older alcoves have stream-side point bars that support mature woody vegetation. Alcoves are highly diverse and dynamic habitats, particularly since their attributes vary considerably as they age. Alcoves are a unique resource to the river that are generally very different from the main channel in many important ways.

Figure 28. *Riverine features at river mile 171 as seen from a 1998 aerial photograph: This section of the Willamette River is upstream from Marshall Island. Visible in the photo are the main channel; two smaller, flowing side channels; a large wooded island; two alcoves; and a riprapped revetment. This section of the river has been very active since this photo was taken and by 2000 the main channel occupied the side channel on the right of the photo. The main channel has filled with gravel and is no longer navigable.*

We studied alcoves on a 44-mile reach of the river between Corvallis and Eugene from 1996 to 2000. We determined that there were 43 alcoves in the study reach and we randomly selected 16 alcoves for further detailed study. We added three more randomly selected alcoves from the population during the study when some of the selected sites were breached or filled in. Figure 29 shows the study reach, the location of the population of alcoves, and those alcoves selected randomly for additional study.

What Has Been Lost That Needs To Be Restored

The degree to which OCH are linked to the main channel via surface water connections is generally termed connectivity. There are many types of connectivity. As river height increases with flow, more OCH become connected to the main channel. When connectivity increases more aquatic habitat is created. Groundwater connectivity or hyporheic flow (literally "below river") is also important and is discussed on the following page.

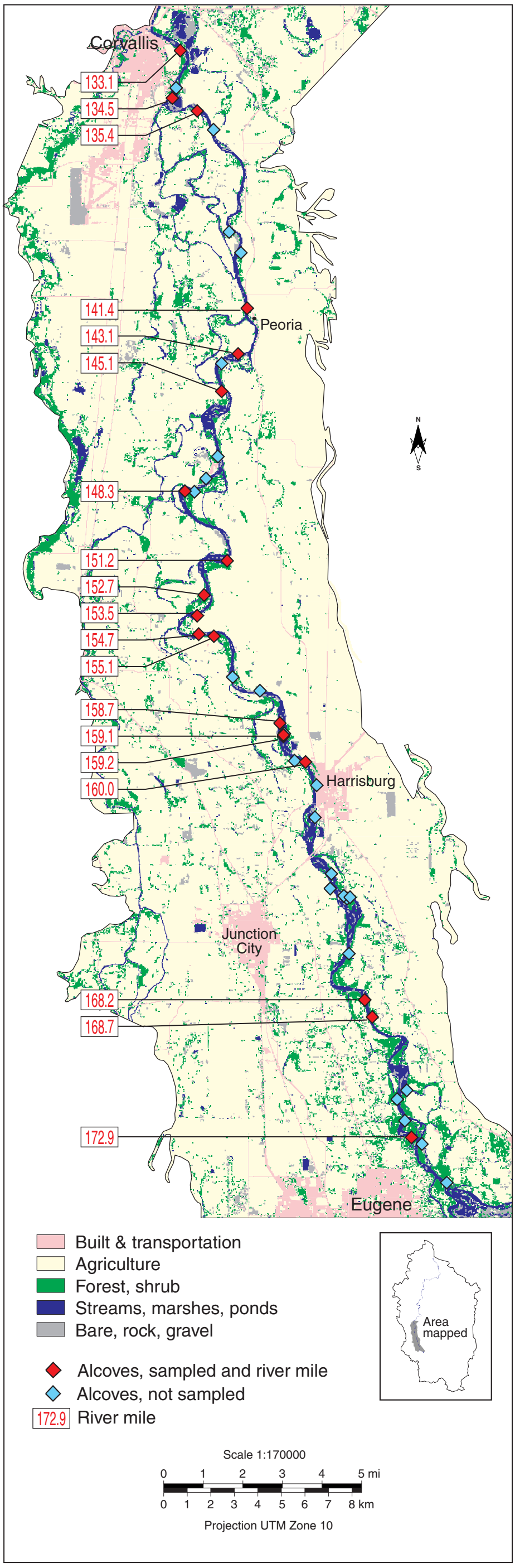

Figure 29. *A map of the southern portion of the Willamette River historical floodplain between Corvallis and Eugene showing the total population of alcoves and the alcoves sampled for intensive study.*

Previously we documented the historical condition of the Willamette River (pp. 18-25) and demonstrated that much of the complexity (~80%) of the active channel has been reduced over the last 150 years. These changes have resulted in a loss of connectivity between the river main channel and OCH. In the reach of the river between Albany and Eugene from 1850 to 1995, about 80% of the area of islands, 41% of the area of side channels, 80% of the area of riparian forest, and 74% of the area of alcoves and sloughs has been lost (Table 8).

Prior to EuroAmerican settlement OCH were naturally created, destroyed, and maintained by uncontrolled riverine processes such as high water events (i.e., bank full flows, Fig. 30), gravel movement, large wood recruitment, sediment erosion, and deposition. Collectively, these actions are referred to as fluvio-geomorphic processes. Settlement of the Willamette Valley resulted in the implementation of a variety of controls on normal river system function: 13 major dams, extensive (96 miles) bank stabilization by installing revetments, removal of riparian forests (thus reducing large wood recruitment), and in-river and near-shore gravel mining. Together these actions have reduced the fluvio-geomorphic processes, causing simplification of the river, reduced connectivity, and a loss of OCH. All of these actions have contributed to an overall loss of ecological functions and important reductions in aquatic habitat in the Willamette River.

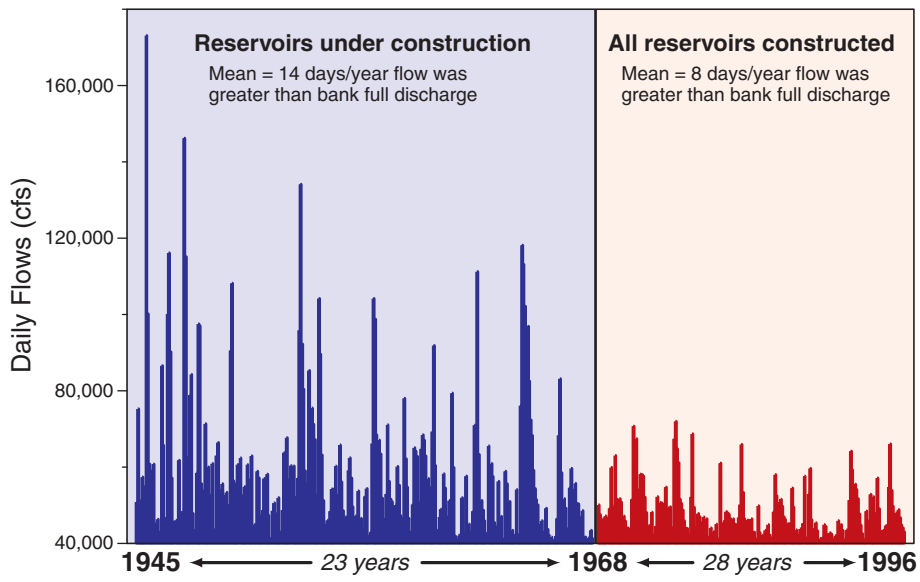

Figure 30. *The U. S. Army Corps of Engineers has determined that bank full flow of the Willamette River at Harrisburg is 42,000 cubic feet per second (cfs). This figure shows the number and magnitude of flows greater than bank full on a per day basis before and after the closure of the last dam upstream of Harrisburg, which occurred in 1968.*

What About Groundwater?

Hyporheic flow occurs when river water moves into the spaces in gravels below and on the margins of the river (Fig. 31). As hyporheic flow brings surface water into contact with riverine sediments, changes take place in the chemical nature of the water. These changes alter the nutrient balance of the water as well as the amount and type of dissolved gases and minerals in the water. These natural processes are reduced as the amount of gravels associated with the river bed is reduced. Reduction in fluvio-geomorphic processes that deposit new sediments and rework older sediments adversely affect the hyporheic connectivity, resulting in less natural conditioning of riverine water quality.

At current summer low-flow conditions a volume of water equal to about 70% the volume of water flowing from the McKenzie River to Corvallis on a daily basis will enter the hyporheic zone. Recall that the river has lost about 80% of the area of islands since 1850. Therefore, historic hyporheic connectivity may have been five times as great as the current measured value. In summer, new gravel bars are very effective at cooling water flowing into OCH, particularly alcoves. During the hottest time of day, the uppermost portion of some alcoves are 3.6-9°F (2-7°C) cooler than the main channel. Bank-hardening structures such as riprap appear to strongly limit groundwater connectivity by decreasing porosity of the substrate. Restoring groundwater connectivity by increasing fluvio-geomorphic processes could contribute to reducing the temperature of the main channel of the river.

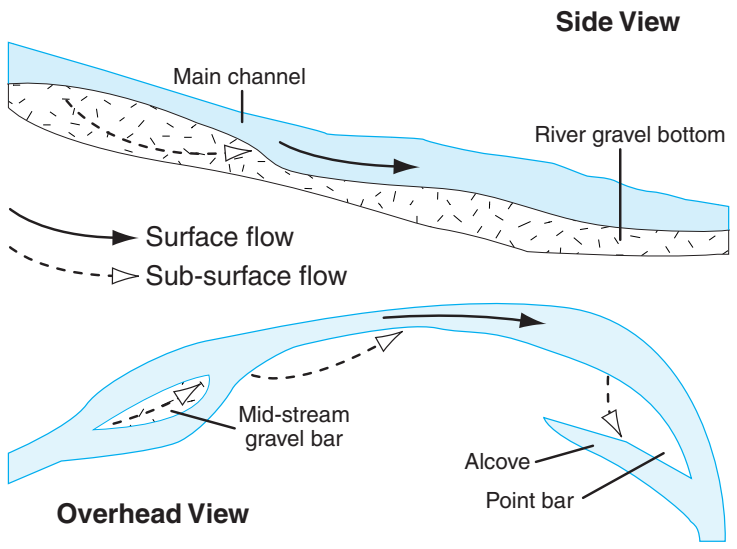

Figure 31. *Hyporheic flow is depicted here as river water that flows into the bottom and lateral gravel comprising the bed of a large river. During summer low flow, hyporheic waters in the upper Willamette River are derived from the main channel river water rather than from floodplain groundwater.*

Alcoves Are Important to Fish

Alcoves are important habitat for fish. Small fish use alcoves preferentially to the main channel. We found about ten times more young native fish per unit area in alcoves than in the adjacent main channel area (Fig. 32). Larger fish tend to migrate into alcoves at night, whereas the young fish did not show any clear evidence of day/night migration. It is not absolutely clear why many large fish (i.e., five times the daytime population) migrated into alcoves but we suspect it is a combination of factors: avoiding expending energy associated with living in flowing water; feeding on small fish, invertebrates, and algae; seeking shelter because of illness or injury. Avian predation (i.e., osprey and kingfisher) may be a deterrent to fish occupying alcoves in the daytime since the non-flowing and shallow alcoves make fish more visible from above.

In late winter we obtained ample evidence from electrofishing studies that juvenile Chinook salmon use alcoves as they migrate to the sea. There have been no studies directed at the reason that they use these OCH but we can speculate that they are seeking food and/or refugia from the current. Whatever the reason, it is apparent that OCH systems are used by native fish in both summer and winter. Simplification of the river and loss of OCH and the connectivity they provide has affected the abundance and quality of habitat available to native fish in the Willamette River. The ecological functions provided to the river ecosystem by the OCH are vitally important to the overall health of the entire Willamette River and should receive important consideration in any future management and restoration plans.

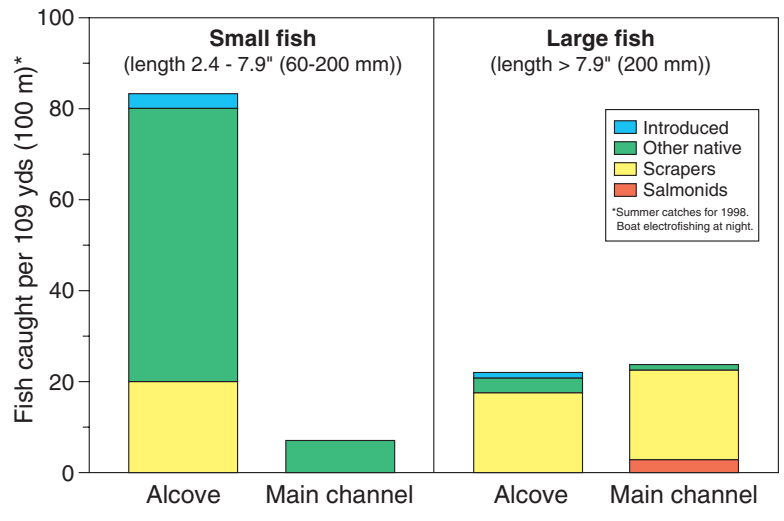

Figure 32. *Fish catches during summer 1998 by group for alcove and main channel sites for small (fork length greater than 2.4 - 7.9" (60 - 200 mm)) and large (greater than 7.9" (200 mm)) fish. Group categories include salmonids (cutthroat trout, rainbow trout, juvenile Chinook salmon, and mountain whitefish), scrapers (largescale sucker, mountain sucker, and chiselmouth), other native (peamouth, northern pikeminnow, sculpin, redside shiner, sandroller, and dace), and introduced (largemouth bass, bluegill, white crappie, yellow bullhead) fish.*