Flood Control of the Willamette River

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Since the 1850s and some of the earliest European-American settlement in Oregon, the Willamette River basin has undergone anthropogenic changes to control flooding. This control has been in the form of river channelization with the use of dams and revetments. Millions of dollars have been spent to control floods, providing land for agriculture and building. Channelization of the Willamette River and tributaries has also resulted in loss of plant and animal life and their habitats, questionable water quality, increased erosion and more dramatic flood damage. On a broader scale, flood control has decreased river channel complexity and nearly destroyed floodplain function.

I will address the problems associated with flood control, and channelization specifically, as they have transpired in the Willamette River Basin. I will discuss the historical dynamic nature of the Willamette River, including channel complexities, floodplain function, riparian forests and known flood history. I will focus on how European-American settlers have influenced these natural processes, and why many of the effects are damaging. I would like to recommend the immediate halt of any further channelization efforts and a "vaya con rios" policy. This would be a gradual process of deconstructing current flood controls and allowing the river to reclaim its floodplain and meandering channels.

Early European-American surveyors and settlers in the Willamette Valley recorded most of the information that is used as "historical" or pre-settlement data about the Willamette River Basin. Discussion about the historical nature of the Willamette River then refers to processes occurring before circa 1850, presumably before European-American impacts, and throughout the long-term occupation of Native Americans. The history, then, is one of channel complexity, involving dynamic cycles of flooding and meandering. The active river basin has included a series of braided channels, multiple islands and alcoves, oxbows, shoals and a functioning floodplain (Atlas).

Fluvial geomorphic processes have determined channel and floodplain morphology. These include sediment movement by erosion and deposition, timing and degree of flooding, and movement and deposition of large materials like wood. In this way, the river acts as a sediment conveyor, inundating and depositing material downstream as well as in adjacent areas during high water flows. These adjacent areas become floodplains, or fluvial landforms built by sediment deposits from the channel's flow (Dykaar). The historical hydroperiod of regular flooding deposited new minerals and soils into the Willamette Basin's floodplains, creating complex plant and animal habitats and rich soils (Azous). The riparian vegetation composition recorded by early European-American land surveyors is an example of this historical link between land and water habitats.

In 1850, surveyors from the Federal Land Office described vegetation in the riparian area as a combination of hardwood ash-swamp forests and wet oak-savannah prairies. Black cottonwood, Oregon ash, big-leaf maple, willow, Douglas-fir and western redcedar dominated the floodplain, along with understory shrubs like Oregon grape, salmonberry, elderberry, rose, ninebark, cascara and non-woody ferns. The wet prairie was primarily composed of white oak and grasses (Habeck). The riparian area was a zone of important interrelationships. Flooding encouraged plant biological processes like nutrient uptake, while the plants themselves reduced bank erosion and helped to dissipate energy from floods. As natural flood controls, vegetation in the floodplain helped to slow water movement, allowed sediment settlement, reduced eutrophication, trapped and filtered nutrients and provided oxidation-reduction environments (class notes). The historical floodplain was dynamic; maturing, changing or being abandoned as the active channel meandered. Mechanisms of meandering and flow direction changes involved erosion on outside curves, channel cutting across bars and expansion of secondary channels as the main channel became blocked by deposited debris (Dykaar).

Historically complex channels, riparian forests, active floodplains and the dynamic connectivity between these zones contributed to the diversity and richness of plant and animal species and their habitats. In 1850, aquatic habitats alone comprised 41,000 acres of river channels and islands on the mainstream Willamette River. The floodplain habitat included up to 32,000 acres, the maximum extent of recorded floods in 1861 and 1890 (Atlas). One hundred fifty years of European-American settlement has cut this total acreage in half with the construction of 13 major dams, revetments for 96 miles of bank, logging, urbanization, agriculture, downed tree removal from the river and gravel mining. This work has often been done to limit the extent of flooding and protect human habitats.

As European-Americans moved into the Willamette Valley, rich floodplain soils were taken up for agriculture and grazing. Settlers generally avoided the floodplains at high water levels but, soon, increasing populations, boat travel and commerce and the strong desire to maintain consistent and safe farming on rich soils gave rise to flood control measures (Atlas). Beginning in the 1860s, downed trees and other deposited materials were removed and side channels were eliminated so as to increase river navigability. Within 100 years, over 65,000 snags and streamside trees were pulled from the river (Sedell). Flood control measures began as early as 1894, when the City of Portland constructed the first three dams in the Willamette basin. Pressure from local towns across the country with similar flood concerns eventually resulted in the National Flood Control Act of 1938. Section I of the act reads:

> It is hereby recognized that destructive floods upon the rivers of the United States, upsetting orderly processes and causing loss of life and property, including the erosion of lands, and impairing and obstructing navigation, highways, railroads, and other channels of commerce between the states constitute a menace to national welfare; that it is the sense of Congress that flood control on navigable waters or their tributaries is the proper activity of the Federal Government in cooperation with the States (Section I of the Flood Control Act of 1938, quoted from Anderson, 32).

Within a period of 30 years following the Act, the US Army Corps of Engineers (USACE) constructed a system of reservoir projects comprising 13 dams on principal tributaries of the Willamette River. Fern Ridge was the first of these and became operational in 1941. The dams are considered multipurpose but flood control is the primary function. Other purposes and uses include power production, recreation, navigation, irrigation, fish and wildlife, water quality and municipal and industrial uses (Larson). In addition to the construction of flood control dams, USACE has been responsible for building and maintaining revetments along 96 miles of riverbank, or 25% of the mainstream river length. Most of these were constructed between 1938 and 1968 and are composed of hard material (stone, concrete, metal, wood) placed in riprap or levees to redirect flows and prevent bank erosion. Revetments on the Willamette River are located along meandering bends where flooding, erosion, deposition and flow changes would cause high amounts of damage along urban, commercial, industrial and agricultural lands (Atlas).

Channel control revetments have protected lands from river meandering and flood control dams have effectively prevented many small-scale floods in the Willamette Basin. To an extent, both anthropogenic controls have provided more immediately habitable and profitable land for humans. Unfortunately, our perception of the river's flow is limited and not consistent with the river's dynamic flooding and meandering history (Atlas). River controls implemented in the mid-1990s perhaps gave a false sense of security to the increasing amount of people living and building on the floodplain. Floods of 1964 and 1996 flowed over dams and inundated part of the historical floodplain, surprising people living in the basin and damaging property. The February 1996 flood caused over $34 million in damage and killed five people (Flood Recovery Plan).

Interestingly, these more recent floods inundated substantially less floodplain than historical floods but caused dramatic flood damage. This is partly a result of the dampening of peak flows by flood control reservoirs and channelization by revetments. Dams in the Willamette Basin have reduced peak flows 30-50%. Revetments have straightened channels and hardened banks, tending to increase the river's energy during floods and potentially accelerating erosion at other places (Atlas). The isolation of the Willamette Basin floodplain from its river, and manipulation of this floodplain has decreased the extent to which floodplains function to dissipate energy from floods, slow water down and filter sediments (class notes).

Flood control and channelization have effectively decreased the river channel complexity and floodplain function that once maintained a fluvial geomorphic process dependent on regular flooding.

> The development of the Willamette River Basin reservoir system permanently altered the physical, chemical, and biological features of the river, and established two general types of aquatic environments throughout the developed portion of the basin: reservoirs and flow-regulated reaches of the river downstream of the dams (Larson, 13).

Larson points to the loss of complex aquatic habitats as an effect of human manipulation of historical fluvial geomorphic processes. Greg Taylor provided a more specific example of how USACE dams have altered biological processes in the Willamette in his discussion about water quality and fish. General effects from dams include altered flow, inadequate fish passage, altered sediment and wood processes, downstream habitat loss and modification and questionable water quality. Some specific impacts from altered flow regimes on fish include delayed juvenile outmigration, decreased aquatic invertebrate production and reduced habitat complexity (Taylor). The reduction of multiple channels and loss of shoreline due to channelization has also had implications on floodplain habitats. These "changes have affected how the river builds and modifies sedimentary landforms and incorporates these into floodplain, and thus the amount and suitability of primary successional habitat to native species" (Dykaar). Dykaar addresses the loss of habitat and subsequent decline of the native cottonwood species along the Willamette River. These riparian area trees have historically adapted to fluvial geomorphic processes and depend on the bars and islands created by channel meandering and regular flooding. Dams and revetment have contributed to channel simplification and effectively limited cottonwood reproduction and affected other riparian habitats. "By disrupting the fluvial geomorphic regime – the principal organizing force creating and maintaining floodplain and riverine habitats – we pose a major, perhaps the single most important, impediment to riparian forest regeneration" (Dykaar, 101).

"Flashy hydroperiod," or the increased severity of cycles of flooding and drought is another component of the fluvial geomorphic process that has been altered by channelization. A study done by Kern Ewing discussed the tolerance of wetland plant species to flooding. "Continued reliance on reserves in response to cycling could weaken the plants in an environment in which cycles of extreme flooding and drying replace a less variable hydroperiod" (Ewing, 142). On the Willamette, the average number of overbank flow days have been cut in half since 1950, an indicator that the diversity and richness of plants and animals that are adapted to historic hydroperiods have also been cut.

Agricultural and urban expansion has also encroached on floodplain and riparian habitats. Eighty-five percent of riparian forests along the river have been converted to agricultural and urban lands since 1850 (Atlas). Logging, gravel mining, road building and downed tree extraction from the river are other factors that have negatively impacted historic river channel complexity and floodplain function. Focusing on flood controls, I have chosen not to discuss these other factors, but they are important to consider when discussing recent floods and the anthropogenic changes to the channels of the Willamette River.

> Channel dynamics in large rivers influence riparian resources. Over multiple decades or centuries, meandering of lowland rivers and formation of lateral channels during major floods extends well beyond the boundaries of the river at any single point in time. If the people in Oregon want to maintain the ecological health of the Willamette River or restore its floodplains and riparian forests, future development of the lands surrounding the Willamette River must consider carefully the dynamic nature of large rivers (Atlas, 23).

Increasingly, large-scale building projects on the floodplains are creating pressure for continued channel control. Growing populations continue the urban sprawl into the floodplain and subsequent damage from large-scale floods is more costly than ever. Even more costly are the losses of plant and animal life and their habitats in the Willamette River Basin as a result of flood controls. The problem is complex and involves the relationship that humans maintain with the surrounding environment. The notion of land ownership seems to complicate our understanding of river dynamics and flood history. Oregon's Statewide Planning Goals by the Land

Conservation and Development Commission outline part of this relationship by controlling local land use. Goal seven addresses development in areas subject to Natural Disasters and Hazards: "It requires that jurisdictions apply appropriate safeguards (floodplain zoning, for example) when planning for development there" (Atlas, 72). Other controls on building and development require that individuals in "Special Flood Hazard Areas" (SFHA's, as designated by FEMA) purchase flood insurance. Controls other than those maintaining river flow and flooding seem to be limited. However, many organizations, such as the Nature Conservancy in Eugene, have recognized the need to restore the historic floodplain.

Correcting the problems associated with dams and revetments is complex. I would like to suggest a pre-European-American settlement conservation trend. This trend would immediately halt any further channelization efforts and implement a "vaya con rios" policy in the Willamette River Basin. The solution is not easy and would require *de*-settlement of the flood zones and riverbanks. Stricter policies regarding floodplain settlement and an increase in general awareness of river dynamics are some initial steps in attempting to solve this problem. Specifically, urban expansion should be limited, riparian vegetation and habitats should be restored, the multi-channel river and its floodplain should be restored and the river's natural dynamism should be allowed. "Restoration often fails when underlying abiotic dynamism of river-riparian ecosystems is given too little weight" (Dykaar, 87). Developing awareness of river dynamism should be a primary goal in conservation efforts. Education about the river's history and dynamic nature should be mandatory for anyone using or manipulating the river's floodplain and channels.

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