Tracking Progress in Restoring the Willamette River Floodplain

Habitat Technical Team of the Willamette Action Team for Ecosystem Restoration

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About the Funders

The **Oregon Watershed Enhancement Board (OWEB)** is a state granting agency that helps protect and restore healthy watersheds and natural habitats that support thriving communities and strong economies. OWEB grants are funded with a portion of Oregon Lottery dollars, federal dollars, and salmon license plate revenue. In 2008, OWEB launched the *Willamette Special Investment Partnership (WSIP)* to make strategic restoration investments along the mainstem Willamette River. For more information, see www.oregon.gov/OWEB.

Meyer Memorial Trust (MMT) is one of the largest private foundations in the state. The mission of MMT is to work with and invest in organizations, communities, ideas and efforts that contribute to a flourishing and equitable Oregon. In 2008, MMT launched the *Willamette River Initiative (WRI)*, a ten-year program focused on protecting and improving the health of the Willamette River. For more information, see www.mmt.org.

The **Habitat Technical Team (HTT)**, administered by the federal Bonneville Power Administration (BPA), is one of several technical teams resulting from the release in 2008 of Biological Opinions (BiOps) by the National Marine Fisheries Service and the US Fish and Wildlife Service. The BiOps addressed the effects of the federal Willamette River Basin Flood Control Project ("*Willamette Project*") on the basin's fish and wildlife habitat. The role of the HTT is to provide guidance and coordination, and to identify projects, for protecting, restoring, and enhancing habitat for ESA-listed species covered under the BiOps. For more information, see www.bpa.gov.

The **Oregon Department of Fish and Wildlife (ODFW)** is a state agency that coordinates the *Willamette Wildlife Mitigation Program (WWMP)*, a habitat protection program. The program resulted from the 2010 agreement between BPA and the State of Oregon to permanently settle wildlife mitigation responsibilities for the construction and operation of the *Willamette Project* federal hydropower and flood control dams. Through the WWMP, ODFW recommends habitat protection projects for BPA funding. For more information, see http://www.dfw.state.or.us/wildlife/willamette_wmp/index.asp.

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Cover Photo: Photo taken near Harrisburg, Oregon. Courtesy of Freshwaters Illustrated.

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Along the mainstem Willamette River and its floodplain, a unique partnership has created an integrated strategy to narrow the gap between need and capacity for ecosystem restoration and to strengthen the impact of locally led conservation and restoration efforts.

The habitats that covered the Willamette Basin prior to settlement have been dramatically altered, nowhere more than in the large river floodplains. Many of the Willamette River's natural features have been changed, due largely to efforts to confine its channel, stabilize its banks, control flooding, and cultivate and develop valley bottomlands. The chronic impacts of stream degradation have led to the listing of many Willamette Basin fish and wildlife species. Addressing these problems is a complicated, expensive, and long-term undertaking—an undertaking that will be challenged over time by the pressures of population growth, which is projected to more than double in the basin by 2100.

No basin-wide river authority oversees the management and protection of the Willamette River. Instead, dozens of entities—serving a wide range of rural, urban, and suburban communities—are involved in a multitude of stewardship activities. These entities include community-based grassroots organizations (watershed councils, soil and water conservation districts), private land trusts,

A River's Long Journey Through Time

Control measures on the Willamette River and floodplain over the last 150 years have had huge impacts on the river's biological diversity and aquatic productivity.

- *Today, more than one-fifth of the river basin's native fish species are listed either by federal or state government as sensitive, threatened, or endangered.*
- *Bottomland hardwood forests, which formerly dominated much of the floodplain area, have declined by more than 70 percent; whereas riparian forests up to seven miles wide historically bordered the river, today, the treed corridor is typically just a few hundred feet wide.*
- *Total losses of the valley's wetlands have been estimated at 87 percent from historical levels. Virtually all remaining wetlands have been degraded by human activities, and most are dominated by invasive, non-native vegetation.*
- *More than half the river's 180-mile length has some form of bank armoring, which reduce flooding and bank erosion, but also limit the habitat creation and replenishment.*
- *The single largest alteration is dams, which alter the flow of water, sediment, nutrients and organisms throughout the basin. The system of 13 federal flood control dams and reservoirs is on the tributaries to the Willamette. There are also nearly 400 smaller dams in the basin, with the greatest concentration (82) found in the Tualatin River watershed.*

university natural resource departments, tribal groups, and state and federal agencies.

A Funding Partnership is Born

In the absence of a leading entity, past conservation and restoration activities along the river have been largely piecemeal. In 2007, two leading funders in Oregon — Meyer Memorial Trust (MMT) and the Oregon Watershed Enhancement Board (OWEB) — independently developed strategic initiatives along the mainstem Willamette River. MMT saw an opportunity for private philanthropy to play a catalytic role in the future health of Oregon's largest river and most populous basin, and OWEB saw an opportunity to begin a gradual shift from responsive to targeted grant making in a few key areas around the state, including along the Willamette mainstem. By the time the separate initiatives launched in 2008, both funders had become aware of the other's initiatives and began discussing ways to partner and leverage funding.

Also in 2008, the National Marine Fisheries Service and the US Fish and Wildlife Service issued separate Biological Opinions (BiOps). The BiOps established a comprehensive habitat and protection program to address the effects on fish and wildlife habitat of the federal Willamette River Basin Flood Control Project ("Willamette Project"). The Willamette Project includes 13 multi-purpose dams and reservoirs, constructed from 1948-1966, as well as 42 miles of federal bank protection projects. Responsibility for the habitat and protection program resides largely with the Bonneville Power Administration (BPA), which, as a marketer of basin hydropower, has a legal obligation to protect, mitigate, and enhance fish and wildlife affected by the Willamette Project dams. The BiOps created several technical teams to assist the federal agencies in implementing the program, one of which is the Habitat Technical Team (HTT).

Both OWEB and MMT saw an opportunity to leverage funds by offering to partner with the HTT on a joint Willamette protection and restoration program. The HTT agreed, and in 2010, the three funding partners formed a Willamette River Habitat Protection and Restoration Program. Initially, the program focused on the entire length of the Willamette River with emphasis on strategic locations, or "anchor habitats," as identified through a process developed by The Nature Conservancy. Over time, the program sharpened its focus to a narrower portion of the floodplain, known as the "two-year flood zone." This area floods essentially once every two years and so represents the lower floodplain bench.

A core feature of the partnership is that the funders work together to support one another's objectives, while at the same time, pursue their own mainstem agendas.

A Scientific Framework

Underpinning this partnership effort is a broad body of previous and ongoing scientific research explaining how the floodplain system functions. With ODEQ as lead on water quality concerns, the major funding partners in the Willamette (MMT, OWEB, BPA, ODFW and other organizations participating in the Habitat Technical Team) identified five goals to pursue in accomplishing a healthier Willamette River. Figure 1 illustrates the relationship among our current understanding of how the river system functions, how the five program goals emerge from this understanding, and what to monitor to determine whether goals are being met.

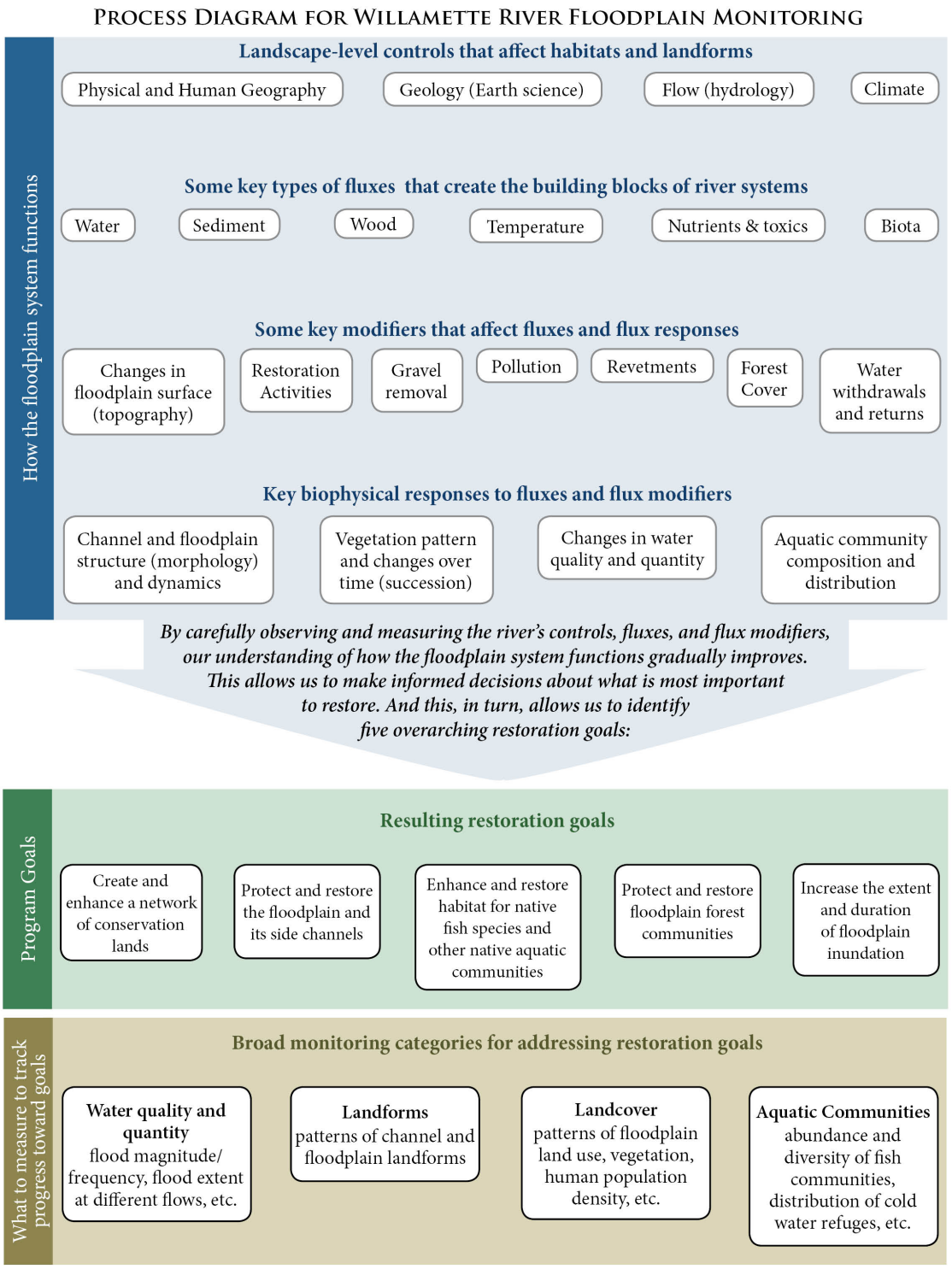

Figure 1. Process diagram showing current understanding of how the Willamette River system functions and how that understanding has resulted in: 1) the program's five goals (see Appendix), and 2) what to measure and track over time to ensure progress toward all goals.

An integral component of the scientific framework is a spatial template and corresponding database known as “SLICES” created jointly by the University of Oregon and Oregon State University. The SLICES Framework (http://ise.uoregon.edu/SLICES/Main.html) uses a simple mapping approach of dividing the mainstem into 229 1-km “SLICES” of the floodplain orthogonally to the floodplain’s center axis (see Figure 2). Information is gathered and reported for each slice on key indicators of river and floodplain health, corresponding to the goals listed above: complexity of the river channel and its habitats, number of native and non-native fish species, extent of floodplain forest, number and location of cold water areas (“refugia”) for the benefit of salmon, and flood inundation.

A series of calculations results in a color-coded map showing locations that have a high potential for increased ecological benefit and comparatively few socioeconomic obstacles to restoration. Contiguous green slices represent locations where high potential for increased ecological benefit (green) occurs next to places that are already functioning relatively well ecologically and have less likelihood of future pressure for development (pale orange). These calculations are based on quantities of key characteristics of each slice, such as the number of acres of floodplain forest lost in the recent past that could be restored, or the amount of socially-important infrastructure like roads and bridges that are important to protect from flood damages.

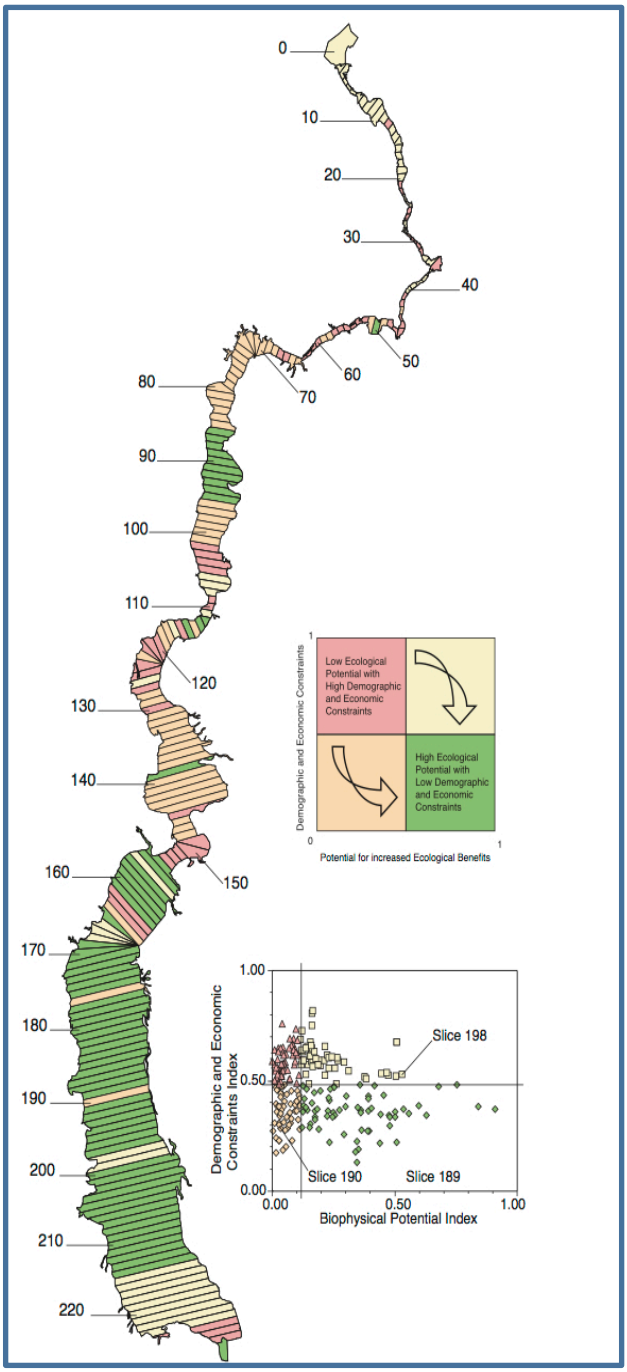

Figure 2. The SLICES framework uses numbered transects, or ‘slices,’ drawn at right angles to the floodplain axis. These slices span both banks of the river, and provide an unchanging frame of reference for tracking qualities of the river and its adjacent lands as they change over time. The chart at lower right shows the use of the framework to prioritize individual slices for floodplain restoration. Used by permission, Willamette River Basin Planning Atlas *2002.*

Restoration Opportunities and Partnership Goals

Drawing from the scientific framework, the partners recognize that river and floodplain

health reflects a myriad of influences — many of which are beyond their control. For example, floodplain habitats are mainly created by channel shifting during floods. However, flood magnitude is substantially controlled by the system of federal dams. Additionally, extensive revetments along the length of the mainstem further constrain habitat formation.

Despite these constraints, the partners recognize there are opportunities where strategic restoration efforts can yield substantial improvements to river and floodplain health. The five goals, shown in Fig. 1, represent such opportunities and are described in greater detail in the Appendix.

Boots on the Ground

With a funding partnership and scientific framework in place, the partners next turned to program implementation. As a private foundation, MMT was able to provide critical and flexible funding to enhance the capacity of local groups to carry out the partnership's goals. BPA, through its Willamette Wildlife Mitigation Program (administered by the Oregon Department of Fish and Wildlife), focused its funding on working with willing landowners to protect floodplain property; and through the Willamette River Habitat Protection and Restoration Program, to restore public and private lands having clear benefits for salmon. OWEB administers an annual grant cycle on behalf of the partnership and focuses its funds on restoration. In supporting each other's goals, each partner on occasion has provided funding support beyond their focus areas.

Five years into this unique public-private partnership, the funders have supported more than two dozen locally based entities in building staff capacity and implementing habitat

Figure 3. Aerial view of the Confluence Project where the Coast and Middle Forks join to form the Willamette River, south of Eugene-Springfield. Photo courtesy of The Nature Conservancy.

protection and restoration activities. As of 2014, the partnership has funded more than $10 million of restoration and related activities (outreach, capacity, monitoring, and technical assistance) at prioritized areas along the mainstem Willamette River. In the Upper Willamette, near Eugene, large investments have been made at the Willamette Confluence Project (see Figure 3) and Green Island where The Nature Conservancy and McKenzie River Trust are addressing all five goals. In the Mid-Willamette, the Willamette Mainstem Cooperative — a diverse group of landowners, businesses, and local implementers — has joined together to combat invasive plants choking key off-channel habitats from Albany to Corvallis. In the Lower Willamette, where opportunities are fewer, the City of Portland has opened and lengthened two side channels at Stephens and Tryon creeks to provide much-needed "rest stops" for migrating salmon.

In addition to work along the mainstem, MMT, OWEB, and the Bonneville Environmental Foundation jointly support a "Model Watershed Program" on 13 sub-watersheds in the Calapooia, Long Tom, Luckiamute, Marys, Middle Fork Willamette, and North and South Santiam drainages. Support for restoration in these areas recognizes the interconnectedness of the tributaries to the mainstem. By improving water quality and habitat conditions along the tributaries, practitioners are able to make the tributaries more hospitable to migrating salmon and resident fish while at the same time improving the quality of water inputs to the mainstem.

Looking to the Future

With more and more projects being implemented, the need to measure progress is gaining momentum. The SLICES framework not only identifies and prioritizes potential areas along the mainstem for restoration, it also tracks progress toward goals and measures change over time of the river and its floodplain.

Recognizing that not every project can be or needs to be monitored, the partners opted for a large-scale "status and trends" approach, to be applied at recurring intervals (e.g., once every five years). While the effectiveness of individual restoration projects can be assessed over short time periods at site scales, practical approaches to assessing effectiveness of large scale restoration for rivers the size of the Willamette are still in their infancy. The status and trends approach provides a cost-effective and scientifically defensible way to track progress toward the restoration goals shown in Figure 1.

In addition to the status and trends approach at the river system extent, the partners also plan to track restoration effectiveness related to key issues at individual restoration projects. For example, restored side channels could be monitored over time to evaluate the rates at which they begin to fill with fine sediment and macrophytes that favor non-native fish.

As information about key metrics of restoration success are available in more places, restoration practitioners and funders will have a firmer understanding of what works where and why, as the picture emerges of our progress towards meeting restoration goals.

In coming months, the partners will draw on the scientific framework and lessons learned from previous floodplain monitoring efforts to develop a pragmatic approach for measuring the success of conservation and restoration activities along the Willamette River. This monitoring approach will address the questions and considerations shown below. Answering

these questions will take time and commitment. The partners are looking to their major stakeholders to refine these and other key questions.

How do we define progress?

1. How do we identify the highest priorities for reach-scale objectives for ecological outcomes and for key questions about the river ecosystem and potential restoration practices?

2. How can SLICES be used to identify and prioritize projects, in addition to measuring progress?

How do we measure progress?

3. Within SLICES, what are the most rigorous contexts for establishing benchmarks for determining progress?

4. What are measurable metrics for each of the four broad monitoring categories — water quantity and quality, landforms, land cover, aquatic communities (from Fig. 1)?

5. At what temporal and spatial scales should Willamette River floodplain monitoring occur?

6. What are complementary roles for status and trends monitoring relative to site--specific effectiveness monitoring?

7. What baseline monitoring information remains to be added to SLICES that will contribute to measuring progress?

8. Should we develop a SLICES interface to update restoration accomplishments as they are completed?

How do we learn from past successes and failures?

9. What information needs most limit practitioners in their design and implementation of restoration activities and how can the SLICES Framework be used or strengthened to meet these needs?

10. What venues or approaches for peer-to-peer sharing would best disseminate and improve restoration practices?

11. Should the Willamette River Initiative and Focused Investment Partnership develop standard protocols for long-term measurements in the monitoring program?

APPENDIX

Willamette River Floodplain

Enhancement and Restoration Goals

Create and enhance a network of conservation lands

Human use of the landscape around the Willamette River has occurred for nearly 10,000 years. Large numbers of Euro-American settlers were drawn to the area starting in the early 1800s, and subsequently developed major north-south transportation corridors and population centers in the Willamette River Valley. By 1990, about 2 million people lived in the Willamette Basin, and the population is expected to nearly double by 2050.

The level of population growth and development has led to a mix of contrasting land uses, including agricultural and timberlands, as well as population centers. The river and its associated floodplain have been extensively modified since 1850 by construction of dams and revetments, elimination of side channels, clearing of large wood and other obstructions from the river, and conversion of bottomland forests to agriculture, urban, and rural development. As a result, the quantity and quality of river habitat have declined.

In many cases, efforts to restore such habitats are based on opportunities (willing landowners, public lands, and short term funding sources), but a more strategic and long-term effort is necessary to restore a large river ecosystem with a self-sustaining network of functional habitats. This effort needs to consider both the ecological potential of a large river network, as well as the patterns of human activity in the river corridor.

The 371-acre Harkens Lake property, located north of Monroe along the Willamette River, was acquired through a conservation easement from a willing seller in 2011 by the Greenbelt Land Trust. Photo courtesy of Greenbelt Land Trust.

Since 2010, Willamette floodplain partners have collaborated to strategically protect functioning habitat, or potentially functioning habitat, along the mainstem Willamette River. These efforts have included conservation through acquisition from willing landowners, granting of conservation easements to protect habitat, as well as through existing land use regulations. These protection efforts allow restoration activities to occur at a broader scale, with greater assurance that restoration will be successful in the long-term. The resulting network of functioning habitat, including public lands and privately held protected property will ensure habitat values are maintained into the future.

Progress toward this goal can be evaluated annually by assessing the total acreage of land that has moved into conservation status. Spatial connectivity among these sites can be evaluated using the SLICES Framework, so that public lands and areas managed for conservation can be reported for each 100m floodplain slice.

Protect and restore the floodplain and its side channels

The geomorphic floodplain of the Willamette River encompasses a diverse array of landforms that have been formed by fluvial processes during the Holocene climatic regime of the last 10,000 years. The geomorphic floodplain can be divided into two main zones: the active channel where gravel transport and channel shifting occurs during annual flooding and floodplain areas where fine sediment is deposited during higher magnitude floods. Key features within the active channel include the primary channel along with side channels, gravel bars and alcoves. Floodplain surfaces range from relatively high areas, inundated only during large-magnitude floods, to annually flooded, lower-elevation surfaces. A network of sloughs, swales and natural levees that support unique assemblages of soils and vegetation bisects floodplain surfaces. Together, the diverse array of features within active channel and floodplain areas form a mosaic of habitats used by a wide array of species during different parts of the year and different periods of their life histories.

In 2003, Willamette Partners acquired Green Island at the confluence of the McKenzie and Willamette rivers. Since then, much restoration has occurred, including this engineered connection between South Pond and the historic McKenzie River channel.

Photo courtesy of McKenzie River Trust.

The channels and floodplains of the Willamette River have changed substantially over time. Early maps and accounts of the Willamette River from the mid-nineteenth century describe expansive large wood jams, and extensive networks of continually shifting side channels and gravel bars. The combination of flood control dams, bank stabilization, streamside logging, large wood removal, systematic closure of side channels and dredging has resulted in greatly reduced channel and floodplain habitat complexity. More than one-third of alcoves and sloughs have been lost and the area of islands has diminished by roughly two-thirds. Losses in channel and floodplain complexity have implications for habitat availability for a range of species.

While conservation efforts seek to protect lower-elevation floodplain lands along the mainstem Willamette River channel, restoration activities are focused on side channels and floodplain areas where strategic habitat enhancements are likely to generate the greatest net increases in habitat complexity for a range of species. Examples of activities that meet these criteria include recent efforts with willing landowners to enhance former gravel mining areas by re-contouring shallow gravel pits and creating side channels to connect these ponds with the nearby river channel. Channel complexity has also been enhanced by re-connecting side channels with the main channel through the modification or removal of barriers to flow such as revetments and levees. Another approach has been to conserve and enhance a longitudinal network of cold water habitats (‘stepping stones’) so that salmonids can move through reaches that exceed their thermal tolerances.

Progress toward this goal could be evaluated by periodic repeat mapping of the Willamette River floodplain from aerial photographs or LiDAR remote sensing to track changes over time in channel and floodplain features. Metrics like side-channel length and gravel-bar area can be used to compute channel complexity, which serves as a pragmatic indicator of habitat availability. Over time, changes in channel complexity that result from floods, restoration efforts or other influences can be compared against existing maps, and program goals, from and reported in the Slices Framework.

Enhance and restore habitat for native fish species and other native aquatic communities

Native fish communities are excellent indicators of the biological integrity of the Willamette River and are highly valued by the public. The Willamette River basin supports 36 native fish species, and 33 non-native fish species have been introduced. Currently, 26 native and 19 non-native species are common in the mainstem. Four of the 36 native species, Coho salmon, spring Chinook salmon, steelhead and Oregon chub are currently protected under the Endangered Species Act. In addition to having legal protections, several of these fish species also have complex life histories that require specific habitat conditions during different stages of their lives.

The middle and upper Willamette River historically were a mosaic of complex channels and regularly inundated floodplains. Below Willamette Falls, the river was a geomorphically simple but critical corridor for fish migration. Floodplain forest surrounded more than 85% of the length of the mainstem river. Agriculture, industry, and urbanization have altered the river network through flood control, navigation improvement, agricultural land conversion, and urban development. Channel straightening, wood removal, bank hardening, wetland filling, land drainage, and closure of side channels further reduced aquatic habitats. Several species of non-native fish were introduced and have expanded their ranges, negatively impacting some native fish species.



Photos courtesy of Freshwaters Illustrated

During 2011-2013, the partnership monitored fish distributions from the McKenzie River downstream to the confluence of the Columbia River to assess fish communities and relationships between native and non-native fish species. Over the three years of sampling, 41 fish species were collected, including 22 native and 19 non-native species. Overall, native fish represented 93% of the fish sampled. Higher numbers of fish were collected in the upper river, and higher proportions of those fish were native species. Richness and abundance decreased significantly from Eugene to the mainstem's confluence with the Columbia River. Native species were associated with both mainstem or slough sites, but non-native species were significantly associated only with slough habitats.

Progress toward this goal can be evaluated by periodic repeat monitoring of the native and non-native fish communities in the mainstem Willamette River and its major tributaries. Metrics of healthy fish communities include richness of native fish species, longitudinal patterns of abundance of native fish, proportions of native fish in mainstem and slough habitats, abundance of salmonids and listed fish species. In addition, fish habitat relationships can serve as pragmatic indicators of the benefits of restoration efforts. Fish abundance and species richness are reported in the SLICES Framework and the publicly available Willamette River Fish Database http://ocid.nacse.org/wrfish_test/).

Protect and restore floodplain forest communities

Historically, the Willamette River floodplain was characterized by extensive galleries of hardwood (e.g., alder, ash, maple, cottonwood), conifer (e.g., Douglas fir,) and mixed forests. These forests provided important habitat for native fish and wildlife, as well as Neotropical migrating birds. The forests also supported aquatic and riparian ecosystems by contributing nutrients and large wood to the river system and by enhancing water quality.

Beginning in the 19th century, human activities along the mainstem began to change the nature of Willamette River riparian forests. Agriculture, channel straightening, dam building, gravel mining, stream bank armoring and urban development are just a few of the many activities that narrowed the forested corridor from several kilometers to today's narrow ribbon of streamside vegetation that is typically dominated by an understory of invasive plants, such as reed canary grass and Himalayan blackberry. While flood control is and will remain important, it threatens the health of current and future floodplain forests because a diverse forest mosaic is maintained by periodic flooding, channel change, and vegetation succession. Historically, some forested patches were eroded during floods, which contributed large wood and gravel to the river system and enhanced the formation of bare gravel bars colonized by pioneer species like black cottonwood and willow. Subsequent channel shifting allowed young stands to evolve through seral succession until they were re-set by erosion. Currently though, many forested areas are largely aging in place and channel stability created by flood reduction and revetments has led to a paucity of suitable sites that support stand initiation and succession.

Left: Willamette Mission State Park, north of Salem-Keizer, where the Willamette Partners have funded reforestation on over 600 acres of the 1,329-acre park and along 2.6 miles of river front. Right: Water primrose, an invasive aquatic plant, has choked the park's side channels, destroying important fish habitat. Photos courtesy of Willamette River-keeper (left) and the Oregon Watershed Enhancement Board (right).

Since 2010, the Willamette floodplain partners have worked to restore floodplain forests on public and private lands along the mainstem. Some private floodplain properties, as well as some conservation easements have been acquired from willing landowners and their floodplain forests are beginning to be restored. The partnership has been particularly involved helping to restore floodplain forests on State Parks lands along the Willamette River. Mature forest recovery will take many decades, but investments taken at the start of the 21st century will have enormous dividends for fish and wildlife in decades to come.

Progress toward this goal can be evaluated by periodic repeat mapping from LiDAR remote sensing to track the extent of conservation and restoration activities on floodplain forest communities. The repeat mapping will enable the partnership to track spatial and temporal changes in land use and associated changes in forest area. Future mapping could also track changes in stand age and composition, so as to assess the future status of floodplain forest recruitment and invasive species. Information on floodplain forests will be reported in SLICES.

Increase the extent and duration of floodplain inundation

The rich mosaic of landforms, habitats, and riparian vegetation that comprise the Willamette River floodplain is created and maintained by myriad physical and biological processes that all depend on the movement of water across the floodplain. Seasonal patterns of water distribute sediment, nutrients, and aquatic organisms longitudinally through the river system and laterally across its active channel and floodplain. For example, high flows during winter months enable juvenile Chinook salmon to access food-rich floodplain swales, where they can thrive in preparation for their outward migration to the Pacific Ocean.

In 2010, the Willamette Partnership helped the McKenzie River Trust acquire a former aggregate site near Green Island at the confluence of the McKenzie and Willamette rivers. Gravel pits were disconnected from the natural river floodplain, resulting in fish stranding after high-flow events. In 2013, the Willamette Partnership funded the Coburg Aggregate Reclamation Project, which reconnected the gravel pits to a backwater channel to provide entry and exit points for native fish. Photos courtesy of McKenzie River Trust.

The physical and biological processes influencing Willamette River floodplains have been substantially altered by human activities. The system of flood control dams has enabled the Willamette Valley to support a rich agricultural economy, thriving urban centers, and key industrial sectors. But dams also interrupt the transfer of sediment, wood, water, nutrients and organisms on which healthy floodplains depend. Bank stabilization, used to protect farmland and urban areas, has greatly diminished meander migration, which historically led to floodplain formation. Today, in many cases, revetments and levees limit overbank flooding critical for a healthy floodplain. This has resulted in a less dynamic river channel having fewer side channels and gravel bars and also limits the availability of floodplain habitats like sloughs and swales. These habitat losses, in conjunction with changes in land use and reductions in flooding, have implications for current and future distribution of native species dependent on complex channel and floodplain habitats.

Since 2010, the Willamette floodplain partners have been working with willing landowners to implement restoration actions that moderately increase the extent and duration of contact between the river and its floodplain. For example, restoration activities have included levee modifications and road crossing replacements to allow water to flow more easily and for longer periods across unproductive areas of the floodplain with no impact to neighboring farms. The flow of water across these areas enables aquatic organisms to access important off-channel areas and also deposits nutrients and sediment essential for the development of healthy floodplain habitat.

Progress toward this goal can be evaluated by monitoring changes in the depth and extent of overbank flooding at restoration sites. Hydrologic and hydraulic monitoring could also be coupled with surveys of fish communities, sediment deposition, and riparian vegetation to track broader ecosystem benefits associated with restoring hydrologic connectivity at these sites.