

Draft EDT Assessment of Aquatic Habitat in the Lower Willamette River Mainstem

Organization of the Analysis

Reach Structure and Geographic Areas

The EDT assessment of the Lower Willamette River was organized hierarchically. At the finest scale, information was developed for stream reaches that described the physical and biological environment of the stream. Twenty-three reaches were delineated based on geomorphic and land use characteristics. The reaches were grouped into 4 geographic areas described below.

- **North Segment** - The North Segment begins at the confluence of the Columbia and Willamette Rivers and extends upstream (south) 6 miles to the St. Johns Bridge. A portion of the Multnomah Channel, which runs along the south edge of Sauvie Island and joins the Columbia farther downstream, is included in this river segment. Land uses are predominantly industrial along this reach, with a large expanse of port facilities. There is some important open space along this segment (e.g., Kelley Point Park, Harborton Wetlands). The Multnomah Channel, Columbia Slough, Miller Creek, Doane Creek, and the Willamette-Columbia confluence are also some critical habitat features along this segment.
- **Industrial Segment** - The Industrial Segment extends from the St Johns Bridge to the Steel Bridge and comprises most of Portland's working harbor. Industrial land uses also dominate this segment. Nearly all of the historical tributaries draining to this reach have been piped underground. Remaining key habitat features include Willamette Park and the Swan Island Beach.
- **Downtown Segment** - The Downtown Segment extends from the Steel Bridge to the Ross Island Bridge. Land uses in this reach are a mix of commercial, industrial and high-density residential. The few streams that historically discharged to this reach have all been piped underground, and the few remaining habitat features are limited and small scale (e.g., Eastbank Crescent beach)
- **South Segment** - The South Segment extends from the Ross Island Bridge to the Urban Services Boundary south of the Sellwood Bridge. The segment has considerable open space, as well as commercial and industrial land uses. The reach has lost some historical tributaries, but Stephens Creek provides high quality tributary confluence habitat, and Ross Island, Oaks Bottom and Willamette Park provide important habitat features.

Scenario Development

Two scenarios were described by the technical team. First, the current conditions were described based on existing empirical and expert knowledge regarding physical and biological conditions in the McKenzie Subbasin. Second, a reference or template condition was described. This reference condition defined a fully restored condition for the McKenzie River, tributaries, and the downstream reaches of the Willamette River. A third scenario that is contained within the EDT model describes a fully degraded condition for the system. Placing the current condition between these two “bookends” allowed us to define good and bad conditions and to analyze how the McKenzie Subbasin and downstream Willamette River reaches function in terms of the spring chinook salmon population.

Lower Willamette River Information Sources

The tables below document the sources of data and information used to rate the condition of the environmental attributes EDT uses to evaluate habitat quality in the Lower Willamette River.

Flow Attributes:

EDT Attribute	Data Source
Confinement - Hydromodifications	Bank Design Notebook
Confinement - natural	GIS analysis of topography/shaded relief maps
Flow - change in interannual variability in high flows	USGS Flow Gauge data; Klingman and Wyrick (2001) analyses
Flow - changes in interannual variability in low flows	
Flow - Intra daily (diel) variation	
Flow - intra-annual flow pattern	
Hydrologic regime - natural	BPJ
Water withdrawals	No known unscreened diversions locally

Habitat Attributes:

EDT Attribute	Data Source
Bed scour	Hill & McLaren 2001
Channel length	GIS analysis
Channel month Maximum width (ft)	
Channel month Minimum width (ft)	
Embeddedness	Tetra Tech 1994; Hill & McLaren 2001
Fine sediment	
Gradient	GIS analysis of bathymetry and channel data
Habitat Type - Shallow Water	
Habitat Type - Deep Water	
Obstructions to fish migration	No migratory obstructions in Willamette
Bank Condition	Bank Design Notebook
Turbidity	BES WQ data

Water Quality Attributes:

EDT Attribute	Data Source
Temperature - daily maximum (by month)	BES continuous temperature gauges
Temperature - daily minimum (by month)	
Temperature - spatial variation	Expert Opinion
Alkalinity	BES WQ data
Dissolved oxygen	
Metals - in water column	
Metals/Pollutants - in sediments/soils	Qualitative interpretation of Superfund findings ¹
Miscellaneous toxic pollutants - water column	
Nutrient enrichment	BES WQ data
Salmon Carcasses	ODFW/NMFS summaries of Willamette Salmon Populations; observation

Biological Attributes:

EDT Attribute	Data Source
Benthos diversity and production	Tetra Tech 1993; 1994
Fish community richness	Altman et al. 1997; Hughes and Gammon 1987; Tetra Tech 1993; Ward and Nigro 1993; Farr and Ward 1993
Fish pathogens	Knowledge of Willamette hatchery history
Hatchery fish outplants	
Fish species introductions	Farr and Ward 1993
Harassment	Observation
Predation risk	Fishman 2001

¹ The single most critical data "gap". A large amount of data actually exists on sediment contaminants in the Lower Willamette, but this has not yet been evaluated by formal risk assessment. Risk assessment and improving the ability of EDT to evaluate toxic contaminants are the two steps required to address this.

Ecosystem Diagnosis and Treatment Results

Overview

Because populations of target species do not spawn locally within the Lower Willamette River, the impacts of conditions in this section on target species populations are evaluated through the series of population analyses conducted through the Willamette Basin. Reference to McKenzie River, Clackamas River, Johnson Creek and Tryon Creek sections will provide information on the impact of conditions in the Lower Willamette on these populations.

Attributes Limiting Target Species Populations

Evaluation of population analyses through the Willamette Basin reveal several consistent habitat attributes that limit these populations. Impacts to a specific population are described in the section describing the basin. In general it is clear that conditions in the channel and floodplain in the lower Willamette River have been dramatically changed over the last 150 years. The channel has been deepened, narrowed and simplified; the banks have been hardened and lined. Floodplain and off-channel habitats have been filled and destroyed and banks steepened throughout the length of the river within the City. Seasonal patterns of flow have changed; winter and spring flood peaks have been reduced and summer base flows are now significantly higher than in the past. Urban pollutants have accumulated in the sediments of the lower river to levels significant enough to warrant Superfund listing.

These marked changes in habitat conditions have significant impact on populations of focal species throughout the Willamette Basin. EDT analysis of conditions in the Lower Willamette indicate the following limiting factors.

Habitat Diversity: Changes in the channel decreased habitat diversity throughout the course of the lower river through Portland.

Loss of shallow water habitat, lack of wood, bank hardening and reconfiguration and loss of off-channel habitats have been some of the factors that have reduced habitat diversity. These conditions impact the migratory and rearing stages of Chinook, coho and steelhead that use the lower river.

Historically, the Willamette River in the Portland area comprised an extensive and interconnected system of active channels, open slack waters, emergent wetlands, riparian forest, and adjacent upland forests on hill slopes and Missoula Flood terraces. Prior to

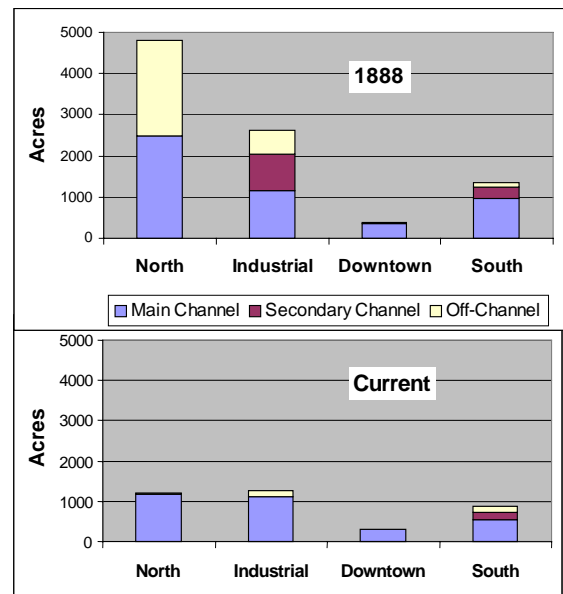
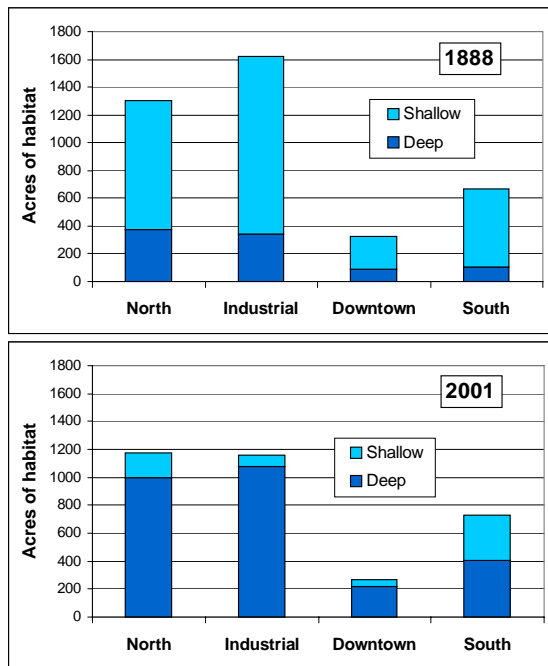


Figure 1: Changes in the amount of mainstem, secondary and off-channel habitat in the Lower Willamette River through Portland; 1888 – 2001.

settlement, the river was embedded in the regional forest network, and intricately connected to the Columbia floodplains. Areas along the riverbank were probably difficult to distinguish from the surrounding green forested environment.

Significant dredging, diking, and channeling of the mainstem Willamette has altered many of these historical conditions. The mainstem has been narrowed and deepened, and off-channel habitat has been virtually eliminated. The river's banks have been hardened precluding important naturally caused channel changes and minimizing the interaction between the river and riparian and floodplain vegetation. Habitat has been simplified and large tracts of riparian vegetation have been cleared. As a result of these actions, significant amounts of shallow water, floodplain and off-channel habitats have been lost.

Figure 2: Changes in the proportion and total amount of shallow and deep water habitat in the Lower Willamette River through Portland.



to the channel and ostensibly to provide “flood control”. As a result, the channel has been deepened, narrowed and its banks steepened over time. Seventy-nine percent of the shallow water habitat through the lower river was lost through channel deepening (Figure 2). Similar to the pattern in changes in off-channel habitat, these losses were most extensive in the North and Industrial sections which historically had the most extensive amount of shallow water habitats, and the South segment retains the highest proportion of its historical shallow water habitat.

To maintain these changes in channel configuration and support the infrastructure for port, industrial and other urban uses, the banks of the lower river were “hardened” with riprap, sheet pile and other human-made structures. These features alter the velocity and timing of river and stream flows, disconnect rivers and streams from their floodplains, and limit the

The Lower Willamette River historically had a number of large off-channel lakes that provided high quality rearing and refuge areas (e.g., Guilds, Kitteredge, Doane and Ramsey lakes). Over time floodplain fill, vegetation removal, bank alterations, and channel clearing destroyed floodplain, off-channel and riverine habitats and altered their physical structure. Guilds Lake and Ramsey Lake were filled to provide land for downtown and port development, while Doane Lake was reduced in size and its connection to the river severed. Eighty-nine percent of the historical off-channel was destroyed. These losses have been most extensive in the North and Industrial sections which historically had the highest amount of off-channel habitat (Figure 1). The South Segment is the only segment which retains a percentage of its former off-channel habitat because of the presence of Ross Island.

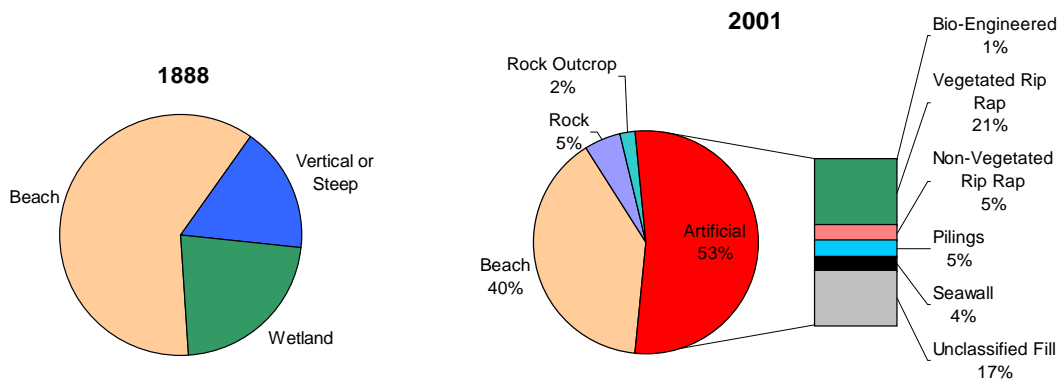
Over the same time period, the mainstem channel was undergoing many changes to improve conditions for navigation, port access

establishment of native vegetation and the natural maintenance of gravel beds and other important habitats. River banks were historically dominated by beach, with significant components of wetland and vertical steep banks (Figure 3). Currently, the majority of the banks are comprised of artificial substrates of one type or another. Although beach habitats are still a significant component, riparian wetlands have been completely eliminated.

There is no historical information on the amount of wood in the Lower Willamette, and there have not been any quantitative surveys to assess current levels. It is likely that current levels of wood are dramatically lower than historical levels. The mouths of large rivers often accumulated huge debris jams. These debris jams were cleared to support river navigation, and the channels and banks have continued to be cleared over time to protect urban infrastructure and maintain navigation.

Key Habitat Quantity: While habitat diversity refers to the *quality* of habitat available, it is also clear that the *quantity* of habitat available for key life history stages is limiting. Lack of off-channel habitat, low levels of wood and shallow water habitat, and lack of channel and bank complexity all result in insufficient amounts of key habitat available for migration and rearing stages of chinook, coho and steelhead using the lower river.

Figure 3: Changes in bank types along the North Segment of the Lower Willamette River.



Chemical Contamination: Because of the level of pollution in lower Willamette River sediments, the Portland Harbor was added to the federal Superfund cleanup list in December 2000. The Portland Harbor Superfund Site currently covers a 5.7 mile section of the Willamette River from the upstream end of Sauvie Island (RM 3.5) and Swan Island (RM 9.2), so the northern 2.5 miles of the site are in the North Segment of the study area and the southern 3.2 miles of the site are in the industrial segment of the study area. Pollutants introduced through industrial discharges, toxics carried by stormwater, and other sources have contributed to elevated levels of many urban pollutants. Preliminary assessments indicate that DDT, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals are some of the key risk drivers in lower Willamette River sediment. More extensive analyses of patterns of chemical contamination are described in Weston (1998?).

The Oregon 303(d) list divides the Willamette River into segments, including one that covers river mile (RM) 0 to RM 24.8. The current 303(d) listings for that river segment are summarized below:

Parameter	Season(s)	Sample Matrix	Year Listed	Notes
Fecal Coliform	Winter/Spring/ Fall	Water column	1998	
Dieldrin	All	Fish tissue	2002	
DDT	All	Fish tissue Water column	2002	
DDE	All	Fish tissue	2002	
PAHs	All	Water column	2002	
Biological Criteria	Not specified	Water column	1998	Listing based on skeletal deformities in juvenile squawfish.
Mercury	All	Fish tissue	1998	
Aldrin	All	Fish tissue	2002	
Temperature	Summer	Water column	1998	
PCBs	All	Fish tissue	2002	
Manganese	All	Water column	2002	
Iron	All	Water column	2002	
Pentachlorophenol	Not specified	Sediment	1998	Listing basis is OSHD alert regarding fishing & swimming near Baxter & McCormick Superfund site.

Restoration and Protection Strategies

Habitat complexity and key habitat quantity consistently ranked as the most significant factors limiting the survival of salmonids. One of the key hypotheses guiding restoration is that increasing habitat complexity will be one of the most important approaches to improving the status of salmonid populations. For this approach to be successful, it should be focused on restoring the processes that maintain habitat complexity as well as re-introducing the structural components that contribute to complexity (City of Portland 2004). Normative hydrology and healthy riparian and floodplain vegetative assemblages are key components that maintain habitat complexity. Although introducing wood and restructuring channels, banks and floodplains are likely to improve conditions for salmonids, it is unlikely that these improvements will persist over the long term if the components maintaining these features such as normative hydrology and appropriate floodplain vegetation are lacking. The hypotheses and strategies below thus focus on features that are related to the key limiting factors as well as the limiting factors themselves.

Restore Normative Hydrology – Hydrology is one of the most basic and critical forces shaping the structure, dynamics and function of riverine habitat (Poff et al. 1997, Stanford

et al. 1996, ISG 2000). Restoring habitat will require restoring at least some degree of the habitat forming and maintaining functions that are strongly dependent on normative hydrologic conditions. The Willamette River is a regulated river in which dam operations have reduced peak flows and substantially increased base flows from their historical condition. Habitat restoration throughout the system will be dependent on managing the dams to more closely mimic historical seasonal patterns of flow.

Seasonal variability in flow is one of the major environmental cues to which plant and animal life histories respond. Seasonal changes in water level define the patterns of inundation and exposure that create seasonal wetlands, and are important signals for the onset of critical biological processes such as emergence, migration and reproduction. Wetland plants, salmon, aquatic insects and other plants and animals have adapted to the seasonal patterns of flow over thousands of years, and their life histories reflect this ecological history. The rapid, human-induced changes in flow patterns mean that many native species are no longer adapted to the range and timing of flow conditions, adversely affecting their productivity, behavior and survival. Floodplain areas that normally would be exposed during the summer and develop into seasonal wetlands as exposure stimulates wetland plant growth are now no longer exposed in the amounts, frequencies, or timing that they were in the past because dry season water levels are considerably higher than they were historically. Many plants (for example, wapato *Sagittaria latifolia*) are critically dependent on this seasonal pattern and timing of exposure.

Reduction in the magnitude and frequency of peak flow events alters habitat-forming and -maintaining processes. Floods are critical for maintaining many elements of riverine habitat, including channel and floodplain morphology, substrate composition, and wood accumulations (Junk and others 1989; Regier and others 1989; Poff and others 1997). Reducing the frequency and size of floods affects a number of important ecological processes including transport of sediment and wood, the frequency of channel-forming flows, and the disturbance events needed to create a mosaic of diverse habitat patches that provide habitat suitable for a wider range of species.

Hypothesis: ***Managing dam regulation to more closely mimic normative seasonal hydrologic patterns will improve habitat conditions by improving habitat forming and maintaining processes, re-creating a pattern of seasonal water level variability that favors the development of seasonal wetlands, and more closely approximating the conditions to which plants and animals have evolved over millennia.***

Strategy Hydr1: Work with the Corps of Engineers during Section 7 consultation to identify measures that restore normative seasonal patterns in flow. Implement the flow management strategies described throughout this subbasin plan.

Increase Habitat Complexity and Key Habitat Quantity - Changes in the channel decreased habitat diversity throughout the course of the lower river through Portland. Loss of shallow water, low velocity habitats, lack of wood, bank hardening and reconfiguration and loss of off-channel habitats have been some of the factors that have reduced habitat

diversity. These conditions impact the migratory and rearing stages of Chinook, coho and steelhead that use the lower river.

Hypothesis: *Increasing the amount of shallow water and off-channel habitat in the Lower Willamette River will improve survival during migration and will provide additional rearing habitat for yearling and subyearling Chinook and coho.*

Strategy Chem1: Identify sites along the river where bank hardening structures can be removed, the banks can be pulled back and bank slopes can be lowered to increase the amount of shallow water habitat.

Strategy Chem2: Identify vacant or unused lands within the floodplain that can be excavated or otherwise restructured to provide off-channel habitat.

Strategy Chem3: Daylight at least the confluence (if not the entire piped section) of the piped tributaries (e.g., Saltzman Creek, Doane Creek) to create high quality tributary confluence habitat.

Riparian and floodplain have largely been filled, developed and disconnected from the main channel. The inability of the river to access the floodplain diminishes potential wintering habitat for fish communities, most notably, wetlands and off-channel pools. Riparian and floodplain connectivity helps moderate stream temperatures (via subsurface and hyporheic flows), filters sediments, supplies nutrients (organics), and supplies bed-form substrate materials (gravels and cobbles).

Hypothesis: *Increasing the amount of floodplain habitat accessible to the river will improve Chinook, coho and steelhead yearling and subyearling survival during rearing and migration in the lower river.*

Strategy Chem4: In conjunction with Strategy Hab1 & 2, identify areas where the banks can be restructured and lands adjacent to the river configured to function as floodplain habitat during winter high flows. Remove impervious surfaces, remediate soil contamination, remove any remaining structures, recontour topography to allow seasonal submergence, remove invasive plants and plant native floodplain vegetation.

Strategy Chem5: Protect high quality riparian, floodplain and wetland habitats through property acquisition and conservation easements.

Strategy Chem6: Identify opportunities to remove relict anthropogenic structures along the banks and in the floodplain. Work in partnerships with property owners, acquire vacant properties, and evaluate existing public properties to remove or move back any structures along the bank or in riparian and floodplain areas.

Habitat and channel complexity are highly influenced by large wood. Large wood complexes provide important overwintering habitat to salmon. Adding large wood instream and buried pieces in the floodplain will improve channel roughness. Benefits include attenuated erosive flows (e.g., reduce flood flow energy), it will aid habitat-forming

processes, and add instream refugia. Indirect positive effects include capturing sediments, reclaiming (or enhancing) riparian and floodplain connectivity, and providing substrate (and detritus) for macroinvertebrate production.

Hypothesis: *Increase in the number of large pieces and densities of wood will improve Chinook, coho and steelhead yearling and subyearling survival during rearing and migration in the lower river.*

Strategy Chem7: Add large wood in the form of rootwads, log jams, single key pieces, and similar structure that mimic natural functions provided by embedded and dynamic wood clusters.

Strategy Chem8: Develop City policy to retain existing wood in and along the river.

Strategy Chem9: Increase the density of woody vegetation in riparian and floodplain areas to provide long-term source material. Focus Revegetation Program efforts in riparian and floodplain areas along the river.

Strategy Chem10: Enforce City land use protection codes that impact riparian and floodplain areas.

Reduce Chemical Contamination - Pollutants introduced through industrial discharges, toxics carried by stormwater, and other sources have contributed to elevated levels of many urban pollutants. Preliminary assessments indicate that DDT, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals are some of the key risk drivers in lower Willamette River sediment.

Hypothesis: *Reducing levels of key ecological risk drivers will improve Chinook, coho and steelhead yearling and subyearling survival during rearing and migration in the lower river.*

Strategy Chem1: Implement the source identification and control strategies identified through Portland Harbor Superfund efforts. Implement measures identified through the City of Portland Outfall Pilot Project and expand pilot to other high priority outfalls throughout Portland Harbor.

Strategy Chem2: Remediate sediment hot spots presenting significant ecological risks according to strategies identified through the Portland Harbor Sediment Management Plan. Continue existing efforts in site discovery, remedial actions/feasibility studies, and remedial actions.

Strategy Chem3: Implement TMDL provision to or reduce localized and system-wide sediment and toxic chemical sources.

Strategy Chem4: Implement City's Stormwater Management Manual and Stormwater Program Best Management Practices.

Strategy Chem5: Implement CSO control strategies to reduce combined sewer overflows to the river.

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