City of Salem

NATURAL FLOODPLAIN FUNCTIONS PLAN

April 2026

Prepared by

Glenn - Gibson Watershed Council

Prepared for

CITY OF Salem AT YOUR SERVICE

Community Planning and Development Department

Table of Contents

Introduction 4
- Background 4
- Floodplain Species Assessment and Natural Floodplain Functions Plan 5
- Salem and the Special Flood Hazard Area . 6
- Willamette River Flooding 8

Floodplain Species of Concern in the Salem Area 9
- Oregon Conservation Strategy 9
- Salem Area Floodplain Species of Concern 10
- Other Stream and Floodplain Species . . 11
- Selection of Species for Plan Focus 11
- Upper Willamette Chinook Salmon and Steelhead 11
- Northwestern Pond Turtle 14

Designated Critical Habitat within the Salem UGB 15

Large River Restoration Context . . . 17

Development Impacts to Willamette River Floodplain Functions 17

Restoration Concepts for the Willamette Floodplain 18
- Floodplain Forest Restoration 18
- Gravel Pit Restoration 19
- Restoring Connectivity 20
- Treating Aquatic Weeds 22

Conservation Recovery Plan Recommendations for the Salem Area Willamette River Floodplains . . 24

Mill Creek and other Tributary Floodplains 26

Conservation Recovery Plan Recommendations for Willamette Tributaries 27

Salem Floodplain Management Actions to Protect Floodplain Functions 28
- Current Natural Floodplain Function Protective Actions of Salem. 28
- Compliance with NFIP Requirements . . 28

Listed Species Habitat Restoration Potential in Salem 29
- Upper Willamette Chinook Salmon and Steelhead Restoration 29
- Willamette Floodplain Access Improvement 31
- Gravel Pit Restoration 31
- Floodplain Riparian Vegetation Restoration 31
- Remove Floodplain Fill and/or Revetments 31
- Floodplain Property Acquisition 32
- Summary of Recovery Measures 32

Recommendations 33
- Near Term Projects 33
- Mid-term Projects 33
- Summary of Recovery Projects 34

CRS Credit and Additional Credit Opportunity 35
- Activity 420 (Open Space Preservation) . 35
- Activity 510 (Floodplain Management Planning) 36

Natural Floodplain Functions Plan and Changing Floodplain Regulations 37

Bibliography 38

Glossary and Acronyms 43

Appendix A – 2015 Minto Brown Island Park Master Plan Excerpts . . . 46
- 3.2 Opportunities. 46
- 5.3 Recommendations 46

Appendix B – City of Salem Floodplain Species Assessment 47

Tables

Table 1: Land Use Designations of Undeveloped Land in the Special Flood Hazard Area 6
Table 2: Threatened and Endangered Species in the Salem Area 10
Table 3: Summary of the General Life History and Timing of Upper Willamette Chinook Salmon (NOAA, 2011) 12
Table 4: Floodplain Restoration Actions 32

Figures

Figure 1: Federal Floodplain Species Planning Guidance (FEMA) 5
Figure 2: Special Flood Hazard Area within Salem, Oregon 7
Figure 3: 1964 Salem Flood Elevation Modification by Regulation Behind Dams (USACOE, undated) . 8
Figure 4: Oregon Conservation Strategy, 2025 9
Figure 5: Upper Willamette Chinook Salmon (Left) and Upper Willamette Steelhead (Right) (From Childerhose and Trim, 1979) 12
Figure 6: Out Migration Timing Showing the Salem Area (modified from Schroeder et at., 2016) . . . 13
Figure 7: Northwestern Pond Turtle (ODFW) 14
Figure 8: Critical Habitat Areas 16
Figure 9: Floodplain Reforestation (Keith et al., 2022) 18
Figure 11: Gravel Pit Restoration for Fisheries Benefits (Wallick et.al., undated) 19
Figure 10: Floodplain Ponds (Identified in Red by USGS) (Bervid et al. 2018) 19
Figure 12: Floodplain Gravel Pit Restoration (Wallick et at., undated) 20
Figure 13: Northwestern Pond Turtle Habitat (ODFW, 2015) 20
Figure 14: 1882 Willamette River Map Overlain on Aerial Photograph Showing Channel Through Browns Island and Channel North of Eola Bend in Different Locations (ODSL) 21
Figure 15: Map of Willamette River showing Brown Island (Navigation Chart, 1895) 21
Figure 16: Restoration of Floodplain Connectivity (Wallick et.al. undated) 22
Figure 17: Aquatic Weed Treatment (Wallick et.al. undated) 22
Figure 18: Effects of Invasive Aquatic Weed Removal (Keith et al., 2022) 23
Figure 19: Revetments in the Salem Area Floodplain of the Willamette River (red lines indicate USACE revetments, yellow line indicates Salem revetment) (Hulse et al., 2013) 25
Figure 20: Willamette Slough Habitat Restoration 28
Figure 21: Penitentiary Ditch Dam (North Santiam Watershed Council, 2025) 29
Figure 22: Waller Dam at Shelton Ditch (North Santiam Watershed Council, 2025) 30
Figure 23: Floodplain Fill Area in West Salem 32
Figure 24: Community Rating System Coordinator's Manual 35

Introduction

Background

Salem has nearly 4,000 acres of regulated Special Flood Hazard Area (SFHA) and approximately 3,000 individual parcels that are partially or entirely located within the SFHA. The most significant area of the Federal Emergency Management Agency (FEMA) determined and regulated floodplains and floodways surround the Willamette River in West Salem or are within the greater Mill Creek and Pringle Creek watersheds.

The *Salem Natural Hazard Mitigation Plan*, adopted in November of 2023, identified several mitigation actions to address flood hazards. Mitigation measures of the *Salem Natural Hazard Mitigation Plan* include updating the Salem Floodplain Management Plan (completed in 2023) and improving and maintaining the City of Salem's Community Rating System (CRS) program (this project).

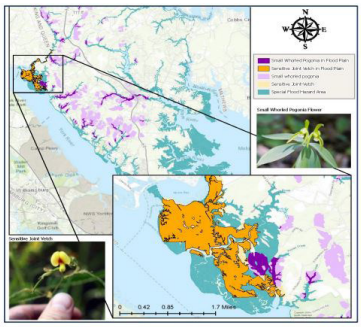
The City of Salem has completed a *Floodplain Species Assessment (Appendix B)* identifying the animals and plants of conservation concern that occur or could occur in the floodplains and floodways within the City of Salem and it's Urban Growth Boundary (UGB) (*Glenn Gibson Creek Watershed Council and Salem Public Works Department, 2025*). The potential impacts to some of those species and measures to mitigate or restore habitat for those species is the focus of this plan.

Floodplain Species Assessment and Natural Floodplain Functions Plan

Preparing a plan to address species listed as threatened or endangered under the federal Endangered Species Act (ESA) that occur or have designated critical habitat in the community has a number of purposes. First, it provides information and awareness of the potential impact development activities have on listed species. Second, adoption of the plan provides the community with CRS Credits that lower flood insurance rates in the community.

The National Flood Insurance Program (NFIP) establishes a two-step process to adopting a Natural Floodplain Functions Plan. The first step is an information gathering process of identifying federally listed and other sensitive species potentially occurring in the SHFA of the community. The Glenn Gibson Creek Watershed Council and the City of Salem Public Works Department completed a *Salem Floodplain Species Assessment* in January 2025 (Appendix B). The document was prepared using the guidance from the NFIP (FEMA, 2024) (*Figure 1)*. The draft was reviewed by state and federal natural resource agencies and provided to FEMA for review. Following all reviews, the document was completed and made available through the City of Salem.

The second step is to formally adopt a Natural Floodplain Functions Plan which establishes recovery and mitigation actions based on each species recovery plan and other information on listed and sensitive species floodplain habitat needs. The plan is built from the *Floodplain Species Assessment (Appendix B)*. The purpose of the plan is to identify restoration actions that are relevant to the selected species of concern and within the authority and capability of the community.



Preparing
A Floodplain Species Assessment or Floodplain Species Plan

for Credit under the

Community Rating System
of the
National Flood Insurance Program

NFIP/CRS

Updated May 2024

Figure 1: Federal Floodplain Species Planning Guidance (FEMA)

The plan needs to identify recovery plans for the relevant species and identify how recovery actions can be accomplished by the community.

This plan has used the *Biological Opinions on the operation of the Willamette River Basin Project* (USFWS, 2008, NOAA Fisheries, 2008) and the *Upper Willamette River Conservation and Recovery Plan for Salmon and Steelhead* (ODFW and NMFS, 2011) to identify restoration and recovery actions relevant to Upper Willamette Chinook Salmon (*Oncorhynchus tshawytscha*) and Upper Willamette Steelhead (*Oncorhynchus mykiss*). Recovery Plans for Streaked Horned Lark (*Eremophila alpestris strigata*) and Willamette Prairie Species (USFWS, 2010 and USFWS 2019) were also reviewed as well as the guidance for conservation of the Northwestern Pond Turtle (*Actinemys marmorata*) (ODFW, 2015).

Salem and the Special Flood Hazard Area

The City of Salem is bisected by the Willamette River, Mill Creek and Claggett Creek. Within the Salem city limits there are nearly 4,000 acres of SFHA and 244 acres of Interim Flood Hazard Area (IFHA). The Salem City Limits and the SFHA are shown in *Figure 2*.

Approximately 800 undeveloped acres zoned residential, mixed-use, industrial or commercial are located in the SFHA (*Table 1*).

The majority of Salem area floodplain, approximately 1,600 acres, is in Minto-Brown Island Park and Wallace Marine Park which are under public ownership.

Other streams tributary to the Willamette River have smaller reaches of SFHA. The federally listed species that use these streams and associated floodplains are described in the *Floodplain Species Assessment* (*Appendix B*).

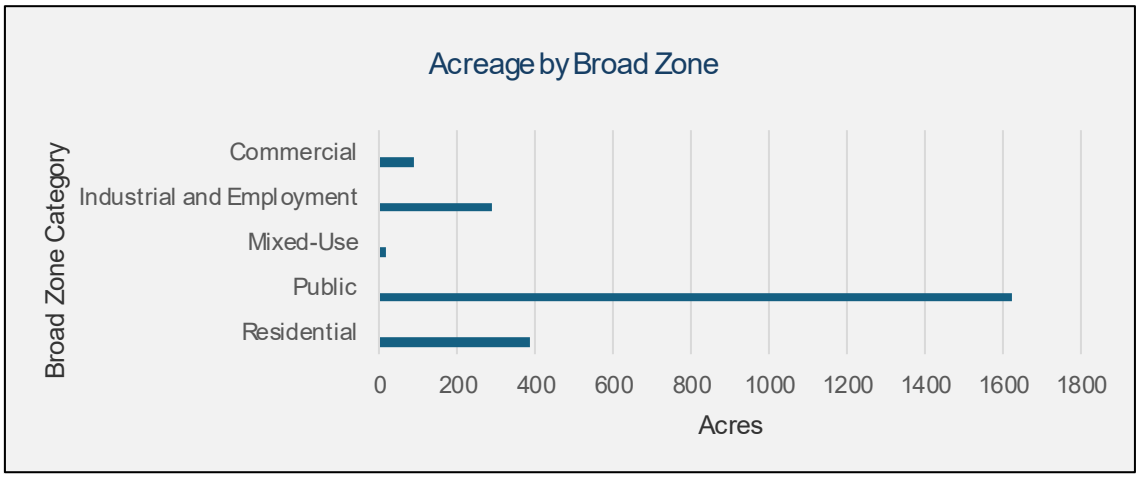


Table 1: Land Use Designations of Undeveloped Land in the Special Flood Hazard Area

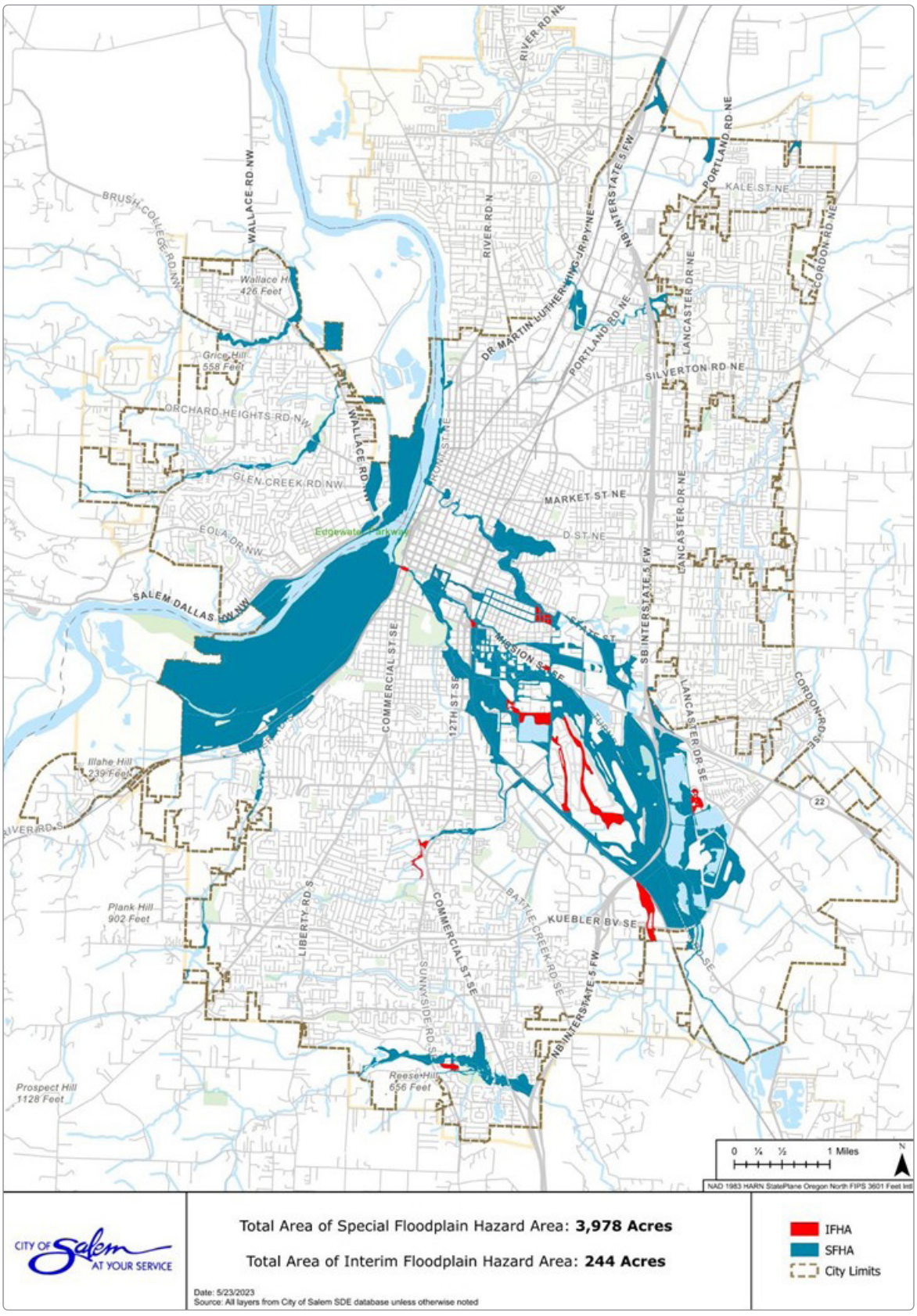


Figure 2: Special Flood Hazard Area within Salem, Oregon

Willamette River Flooding

The flood control dams on the Willamette River, completed in 1969, have changed the flood risk and floodplain connection with the river. Even before the completion of the last dam, flood elevations in Salem were reduced during the 1964 flood event (*Figure 3*). The dams reduced peak flood elevations by 6.6 feet in 1964 and with the completion of all dams in 1969 could have reduced peak flood elevations by an additional 1.9 feet. Even with the 13 upstream mainstem dams, the Willamette River in the Salem area inundates the floodplain on a regular basis.

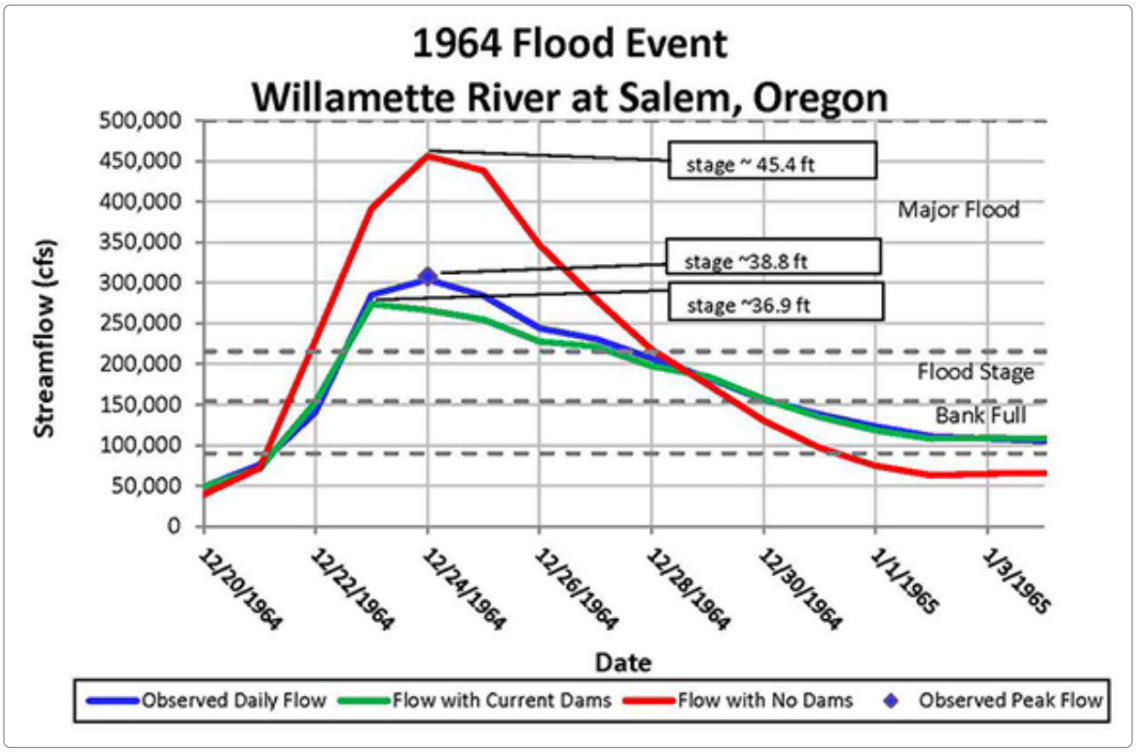


Figure 3: 1964 Salem Flood Elevation Modification by Regulation Behind Dams (USACOE, undated)

Floodplain Species of Concern in the Salem Area

Oregon Conservation Strategy

While this plan focuses on federally listed species and floodplain environments, there are other fish and wildlife species of concern in the Salem Area. The Oregon Conservation Strategy has tools to identify the species and threats throughout Oregon that are of conservation concern.

The Oregon Department of Fish & Wildlife submitted the Oregon Conservation Strategy as an update to the State Wildlife Action Plan in September of 2025. The 2025 Oregon Conservation Strategy includes information on: Key Conservation Issues, Ecoregions, Conservation Opportunity Areas, Habitats, and Species. The Strategy includes maps, tools and a monitoring approach (*Oregon Conservation Strategy, 2025*).

The Species of Greatest Conservation Need mapping tool from the Oregon Conservation Strategy identifies Streaked Horned Lark, Northwestern Pond Turtle, Chipping Sparrow, Golden Eagle, Olive-sided Flycatcher, White-breasted Nuthatch (Pacific), Western Bluebird, Willow Flycatcher, Western Meadowlark, and Northern Red-legged Frog are found within the Salem area (Oregon Conservation Strategy, 2025). While not all these species are floodplain dependent, and only Streaked horned lark is federally listed, restoration of floodplain and riparian habitats will benefit a much larger suite of species than those focused on in this plan. For the Willamette Valley as a whole, the strategy species are: Northern Red-legged Frog, Oregon Vesper Sparrow, Fringed Myotis (bat), Acorn Woodpecker, and Northwestern Pond Turtle. This plan proposes actions that can benefit Northern Red-Legged Frogs and Northwestern Pond Turtles. Fringed Myotis and Acorn Woodpecker are forest species dependent on Oak and Oregon Vesper Sparrow is a grassland bird.

Figure 4: Oregon Conservation Strategy, 2025

Within the Oregon Conservation Strategy, Salem is within the Willamette ecoregion. The Oregon Conservation Strategy identifies one Conservation Opportunity Area (COA) within the Salem urban growth boundary, the Middle Willamette River Floodplain (*COA 060, Oregon Conservation Strategy, 2025).* It is clear that from the larger context of the Oregon Conservation Strategy, a focus on the Conservation Opportunity Area in Salem will provide benefits to a broad suite of native species.

The Oregon Conservation Strategy identifies that the key conservation issues associated with the Salem area are invasive species (bullfrog, nutria, Eastern grey squirrel, black rat, European starling, etc.), impaired waterbodies (Willamette Slough) impervious surfaces, and fish passage barriers. Recommendations of this plan are consistent with improving these conditions and others within the Conservation Opportunity Area and greater Salem area.

Salem Area Floodplain Species of Concern

The Upper Willamette Chinook Salmon and Steelhead are the most significant species of concern that use the floodplains of the Willamette River and Mill Creek (and to a limited extent Glenn Creek, Claggett Creek, and West Fork of the Little Pudding River). The Upper Willamette Chinook Salmon and Steelhead have designated "critical habitat" along these waterways. While a number of other species of birds (Streaked Horned Lark, Bald Eagle), reptiles (Northwestern Pond Turtle), amphibians (Oregon Spotted Frog), and plants (Willamette Daisy) are found in the Salem area, no "critical habitat" has been designated for them that occurs within the Salem UGB. Threatened and endangered species in the Salem Area identified in the *Floodplain Species Assessment (Appendix B)* are listed in *Table 2*.

Table 2: Threatened and Endangered Species in the Salem Area

Species	Scientific Name	Federal		State		Select for Conservation Actions?
		Status	Agency	Status	Agency	
Upper Willamette Chinook Salmon	*Oncorhynchus tshawtscha*	Threatened	NMFS	Sensitive	ODFW	Yes
Upper Willamette Steelhead	*Oncorhynchus mykiss*	Threatened	NMFS	Sensitive	ODFW	Yes
Oregon Spotted Frog	*Rana pretiosa*	Threatened	USFWS	Sensitive	ODFW	No*
Streaked Horned Lark	*Eremophila alpestris strigata*	Threatened	USFWS	Species of Concern	ODFW	No**
Yellow-Billed Cuckoo	*Coccyzus americanus*	Threatened	USFWS		ODFW	No*
Northwestern Pond Turtle	*Actinemys marmorata*	Proposed Threatened	USFWS	Sensitive	ODFW	Yes
Fender's Blue Butterfly	*Icaricia icarioides fender*	Threatened	USFWS			No**
Monarch Butterfly	*Danaus Plexippus*	Candidate Species	USFWS			No**
Kincaid's Lupine	*Lupinus sulphereus ssp. kincaidii*	Threatened	USFWS	Threatened	ODA	No**
Willamette Daisy	*Erigeron decumbens*	Endangered	USFWS	Endangered	ODA	No**

** Species considered extirpated or likely extirpated from the Willamette Valley*
*** Species is wet prairie habitat limited or the floodplain habitat is not appropriate for the species.*

Table 2: Threatened and Endangered Species in the Salem Area

Other Stream and Floodplain Species

Conservation actions that benefit listed species can also have beneficial effects on other non-listed species. Results from surveys of fish in the Willamette River completed by Gregory and others (2025) and Williams and others (2024) show that the Salem area is near the inflection point where non-native species increase (in a downstream direction). The authors attribute increasing abundance of non-native fish to "warming river temperatures… flow modification, habitat degradation, and reduced connectivity." Native species of largescale sucker, threespine stickleback, peamouth, and chiselmouth are found in the river and play an important role in the aquatic ecosystem. Gregory and others (2025) stress that "Accelerated restoration efforts in the Willamette River and other rivers throughout the world are essential to protect and recover their native fish assemblages."

Williams and others (2024) conclude "this study of the Willamette River illustrates the importance of conserving both mainstem and slough habitats to provide adequate habitat for all native species". Similarly, restoration of the natural flow regime to the extent possible will improve connectivity between the floodplain and mainstem river, providing refuge from flood disturbances and thermal stress (Poff, 2018; Wallick et al., 2013). Conservation and restoration of floodplain forests contributes food resources, geomorphic stability, and flood refuge for fish and wildlife. Information about habitat relationships of non-native fishes is critical information for habitat restoration to reduce their detrimental effects on native species.

A variety of stream and wetland species are found in the floodplains of the Willamette River and tributary streams. These typically include coastal cutthroat trout, Oregon chub, Western Ridged Mussel, Western brook lamprey, Pacific lamprey, Western painted turtle, and Northern red-legged frog. Pacific Lamprey use the Middle Willamette reach as passage to spawning sites in upstream tributary streams. Mill Creek supports a Pacific Lamprey population (Poirier et al., 2023). Floodplain forests are used by Willow flycatcher, Yellow-breasted chat, and Olive-sided Flycatcher . Wet prairies are used by Chipping sparrow, Grasshopper sparrow, Western meadowlark, Horned lark, and Oregon vesper sparrow along with wet prairie plant species. Restoration of floodplains, ponds, and stream habitats will have benefits for a broad range of species within the Salem area.

Selection of Species for Plan Focus

While a number of the species in the Salem area are listed, several are not typically found in the urban environment. Oregon Spotted Frog and Yellow Billed Cuckoo are considered extirpated from the Willamette Valley and are not considered in the plan. Wet prairie habitat species such as the Streaked Horned lark, Willamette daisy, Monarch butterfly, Fender's Blue Butterfly, and Kincaid's Lupine are also not considered because of the unlikely habitat for them in the urban context. The focus of the Floodplain Plan is Upper Willamette Chinook Salmon and Steelhead with secondary consideration for Northwestern Pond Turtle.

Upper Willamette Chinook Salmon and Steelhead

The focus on Upper Willamette Chinook Salmon and Steelhead (*Figure 5*) in floodplains is because of the extensive critical habitat present and significance of floodplains during the juvenile life stages of the species. The life history of Upper Willamette Chinook Salmon outlined in *Table 3* shows that juvenile Chinook rear in freshwater for an extended time (from 2-14 months). A portion of this time is spent in

the mainstem river and can rely on floodplain resources. The mid-Willamette region that includes the Salem area supports all migratory life history stages of juvenile Willamette Spring Chinook Salmon (*Figure 6).* The figure shows that juvenile Chinook pass the mid-Willamette area year-round. Flood flows bring the juvenile fish onto the floodplain where they have the opportunity to escape high water velocities and feed. ODFW sampling and tagging data indicate that most fry and fingerlings rear in the lower reaches of spawning tributaries and in the Willamette River mainstem in late winter and early spring (Schroeder et al. 2016). In the assessment of critical habitat for Upper Willamette Chinook Salmon, the mainstem of the Willamette in the Salem area was identified as "High value rearing and migration corridor" (NOAA, 2005).

In a similar manner, Steelhead juveniles spend several months in freshwater before going to the ocean. Juvenile Steelhead rear in headwater tributaries and upper portions of the subbasins for one to four years (most often two years), then as they undergo the changes that allow them to transition from fresh water to saltwater from April through May, migrate quickly downstream through the mainstem Willamette River. Steelhead, while passing through the mid-Willamette are not as dependent on floodplain resources as Chinook but the reach is also considered "high value rearing and migration corridor" (NOAA, 2005).

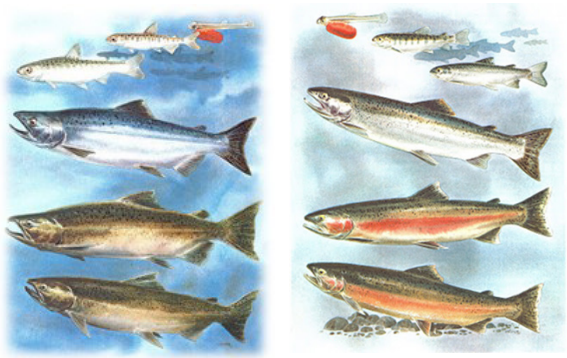


Figure 5: Upper Willamette Chinook Salmon (Left) and Upper Willamette Steelhead (Right) (From Childerhose and Trim, 1979)

Table 3: Summary of the General Life History and Timing of Upper Willamette Chinook Salmon (NOAA, 2011)

Life History Trait	Characteristic
Willamette River Entry Timing	January-April; Ascending Willamette Falls April-August
Spawn Timing	August-October, peaking in September
Spawning Habitat Type	Larger headwater streams
Emergence Timing	December-March
Rearing Habitat	Rears in larger tributaries and mainstem Willamette
Duration in Freshwater	12-14 months; sometimes 2-5 months
Estuarine Use	Days to several weeks
Life History Type	Stream
Ocean Migration	Predominately north, as far southeast Alaska
Age at Return	3-6 years, primarily 4-5 years

Table 3: Summary of the General Life History and Timing of Upper Willamette Chinook Salmon (NOAA, 2011)

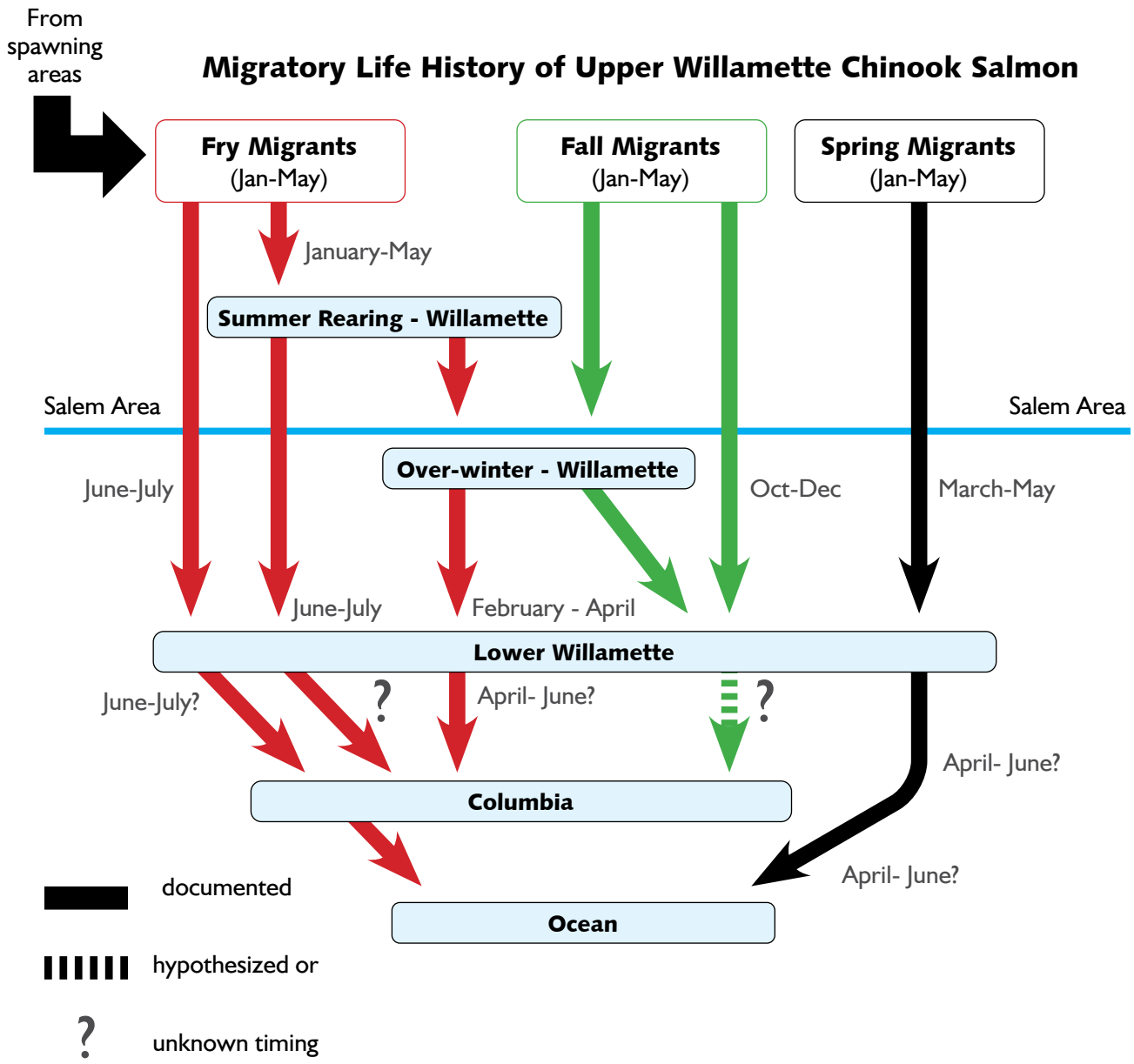


Figure 6: Out Migration Timing Showing the Salem Area (modified from Schroeder et at., 2016)

Northwestern Pond Turtle

The Northwestern Pond Turtle (*Figure 7*) has been experiencing population decline. Contributing factors to the decline include a decrease in abundance and quality of suitable habitat, introduction of exotic flora and fauna, disease, and other anthropogenic forces. Northwestern Pond Turtles are closely associated with aquatic habitat with muddy bottoms and available basking sites. They are most common in still or slow-moving water, particularly around dense vegetation, which provides a high density of invertebrate prey.

Submergent and emergent aquatic vegetation are important habitat components that provide safe nursery habitat for young turtles with plenty of food and cover. Underwater refugia such as submerged logs and cut banks provide protection from underwater predators. Overwintering sites are along stream banks, and nesting sites are typically within 200 yards of water in areas with little vegetation and abundant sunlight. Nesting sites are in sparse vegetation with sandy, silt, or gravel soils, and good solar exposure.

One of the biggest threats to the species is the American Bullfrog (*Lithobates catesbeianus*) and introduced warmwater fish such as bass. Both of which prey on small juvenile turtles. In addition, native turtles face threats from non-native turtles like Red-Ear Sliders (*Trachemys scripta elegans*) who complete for the same food, basking, and nesting sites as the Northwestern Pond Turtle. The Northwestern Pond Turtle is listed "Sensitive-Critical" on Oregon's State Sensitive Species List. The species has been petitioned to be listed but is not listed under the federal ESA.

Figure 7: Northwestern Pond Turtle (ODFW)

Designated Critical Habitat within the Salem UGB

As described in the *Floodplain Species Assessment (Appendix B)*, the only areas of critical habitat designated in the Salem UGB area are the Willamette River, Mill Creek, Glenn Creek, Claggett Creek, and the West Fork of the Little Pudding River (*Figure 8*).

The Willamette River is habitat for all life stages of Upper Willamette Chinook and Steelhead, while the tributaries are only habitat for juvenile fish during high water conditions. Adult Upper Willamette Steelhead have been seen in lower Glenn Creek but are blocked from upstream passage by a dam at Salemtowne Golf Course. Likewise, with the placement of a screen at the confluence of the Mill Race and Mill Creek there is limited access by adult Upper Willamette Chinook Salmon and Steelhead in the Mill race. Juvenile passage in Mill Creek is hindered by dams at Shelton Ditch and the State Penitentiary Ditch, also known as Penitentiary Dam (*ODFW Fish Passage Data Base April 2025*).

In partnership with the Santiam Water Control District, the North Santiam Watershed Council currently has grant funding to review Waller Dam at Shelton Ditch and consider alternatives to the structure including replacement. Claggett Creek only provides habitat for juvenile fish during high water periods. The Little Pudding River, tributary to the Molalla River, supports both Upper Willamette Chinook Salmon and winter Steelhead but is limited by water quality and low flows.

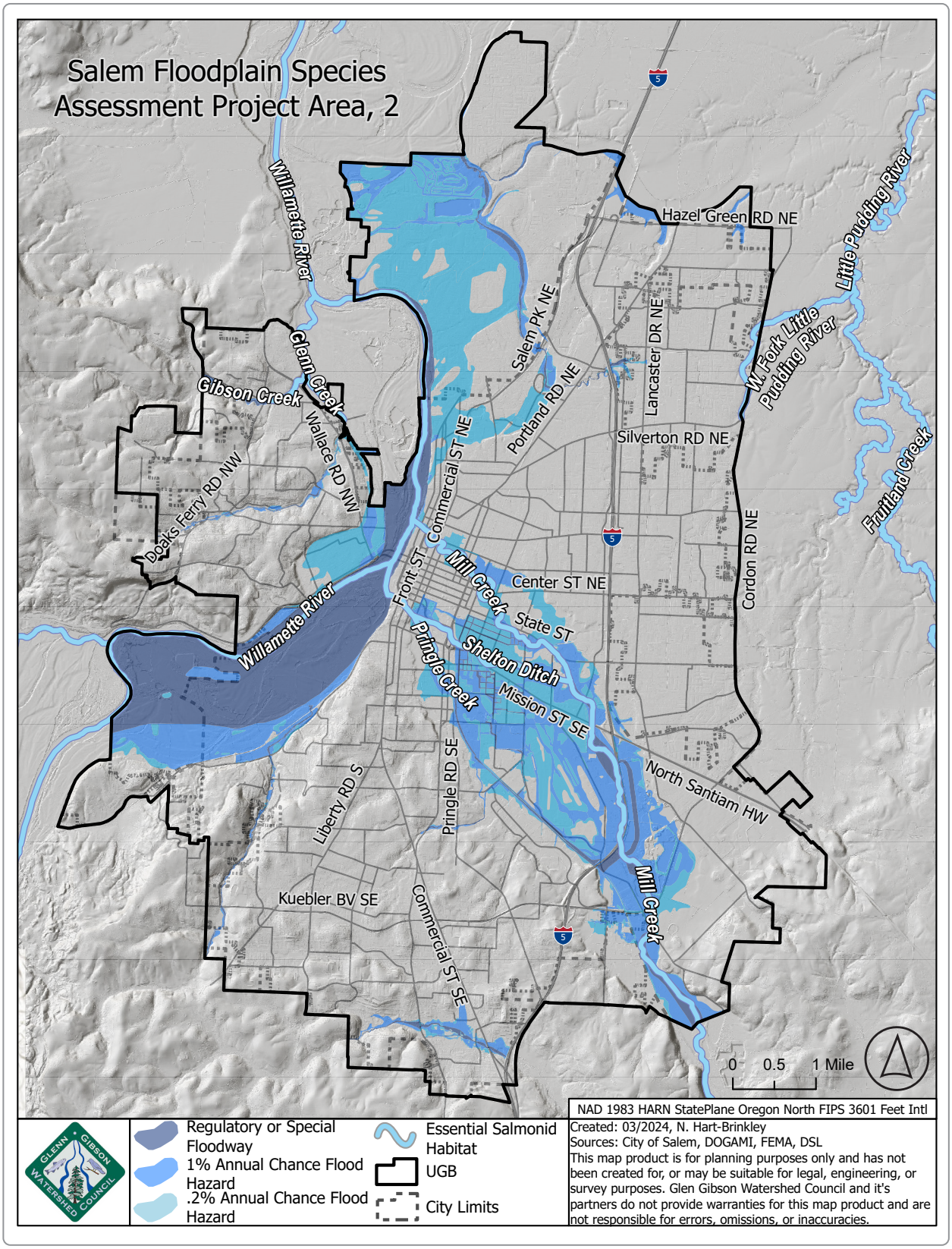


Figure 8: Critical Habitat Areas

Large River Restoration Context

River restoration has become a significant undertaking in the United States and other countries (Serra-Llobet et al., 2022). Principles of floodplain connection to rivers that help to direct restoration have been articulated by Wohl and others (2021). The unique challenges of large river restoration have been described as a function of conceptualization and physical factors such as land use and historical development (Whol and others 2015). Experience from other regions and rivers with different development histories (Eros and Banyai, 2020, Serra-Llobet et al., 2022) helps to inform the restoration opportunities and limitations available in the Salem area which are described later in this plan.

Development Impacts to Willamette River Floodplain Functions

European settlement of the Willamette Basin brought with it many structural changes to the Willamette River. During the European settlement period of the Willamette Valley, the river was the major north south transportation route. The river system has been simplified, narrowed, and straightened (Sedell and Froggatt 1984, Benner and Sedell 1997). Between 1880 and 1950, federally funded "clearing and snagging" projects removed more than 65,000 dead trees (snags) from the river. The historic Willamette floodplain forest has been described by Johannessen and others (1970) and Towle, 1984) as being 1-2 miles wide and up to 7 miles wide in some areas. Mapping of Willamette Valley historic vegetation (circa 1850) shows a broad floodplain forest (Christie and Alverson, 2011).

There has been significant recent evaluation of the floodplain structure and functions of the Willamette River (Flitcroft et al.,2023) that builds upon the work of Hulse and Gregory (see Hulse et al, 2002, Gregory et al., 2012). These and other recent studies of floodplain development (Wallick et al, 2013) and juvenile fish use (Hansen et al., 2023) of the mainstem Willamette River help to identify appropriate restoration strategies for the Willamette River.

NOAA Fisheries describes current habitat for Upper Willamette Chinook Salmon and Steelhead in the Willamette River mainstem and lower reaches of all the tributaries to the Willamette River as moderately to severely degraded (NOAA 2008). Specific habitat concerns vary by subbasin but include reduced habitat complexity, reduced access to off-channel habitat, reduced floodplain function and connectivity, loss of holding pools, elevated water temperatures, insufficient stream flows, toxic water pollutants, and altered substrate compositions (NOAA 2008).

Ongoing and future development in floodplains of the Willamette River, Mill Creek, and other tributary streams has the potential to further adversely affect habitats used by listed species. Historic development has significantly reduced floodplain functions by past clearing of riparian vegetation, river channelization, gravel extraction, filling, revetment and channel hardening, waste disposal, and other actions.

Restoration Concepts for the Willamette Floodplain

Building from the focused research on the Willamette River, restoration strategies specific to the river have been developed with consideration of their appropriateness for local conditions. Four restoration strategies have been developed and are considered to enhance the floodplain functions of the Willamette River through the Salem area. These strategies include floodplain forest restoration, gravel pit restoration, aquatic weed treatment, and reconnection of the river to floodplain habitats.

Floodplain Forest Restoration

Floodplain forest restoration involves planting native floodplain tree and shrub species in historically cleared areas (*Figure 9*). The historic Willamette River floodplain had a broad forested area, in places more than four miles wide (Christie and Alverson, 2011). The City is currently undertaking these restoration actions within the Minto Island Conservation Area and have plans to continue into the future (*Minto Island Conservation Area Land Management Plan, 2025-2035*).

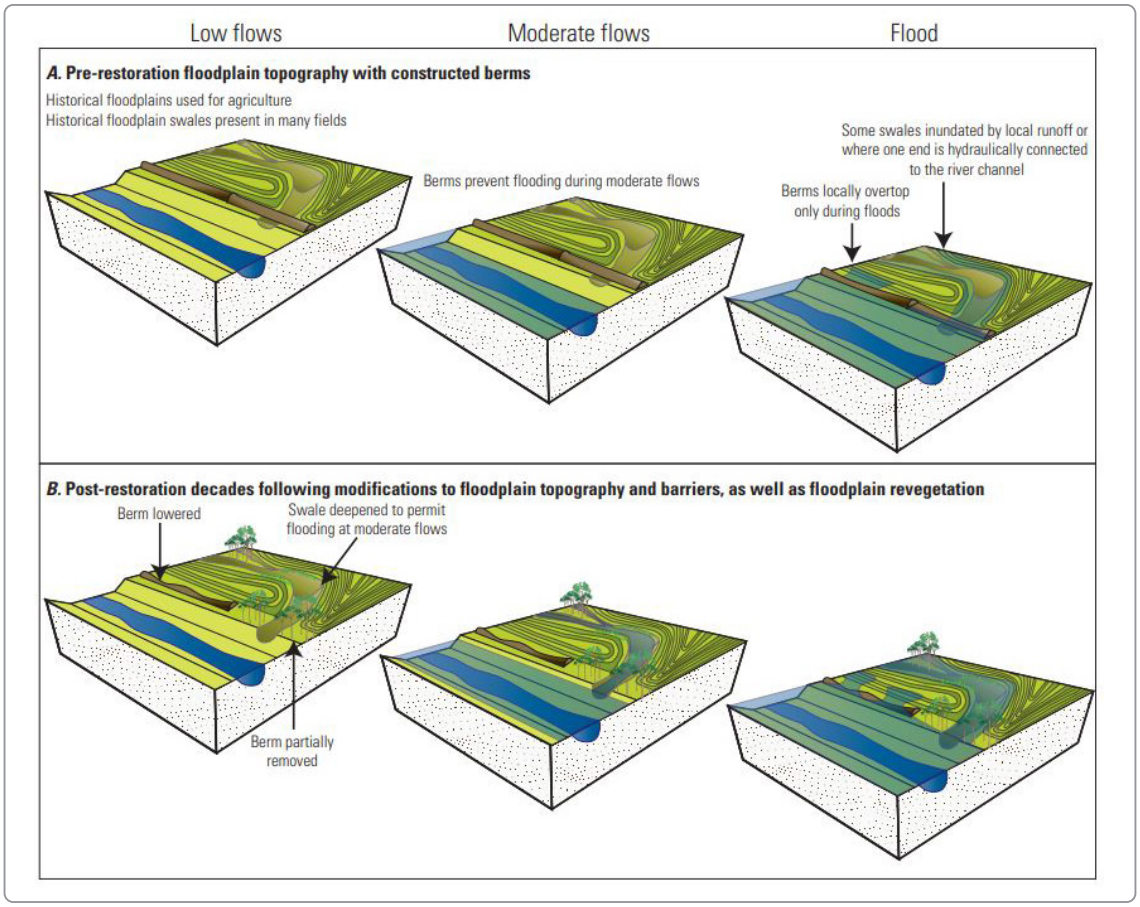


Figure 9: Floodplain Reforestation (Keith et al., 2022)

Additional restoration is being implemented at Oxbow Slough in Minto-Brown Island Park. Restoration of floodplain forest conditions on city owned lands is a collaborative process between a number of different departments including Parks, Urban Forestry, Natural Resources Planning, and Stormwater. Restoration of floodplain forest conditions on city owned lands is complimented by the City program that provides riparian plants to private landowners.

Gravel Pit Restoration

There are two active gravel/aggregate operations in the Willamette River floodplain in the Salem area. River Bend Sand and Gravel, and Wilsonville Concrete on the west and east side of the Willamette floodplain. The Eola Bend site is the primary active gravel mining site within the UGB. Willow Lake is an older and closed aggregate pond in the Willamette floodplain in north Salem. The U.S. Geologic Survey has identified human-modified ponded features mapped within the Willamette River floodplain, Oregon, in 2018 (*Figure 10*).

Several concepts for restoring gravel pits to benefit floodplain functions for juvenile salmon have been developed,

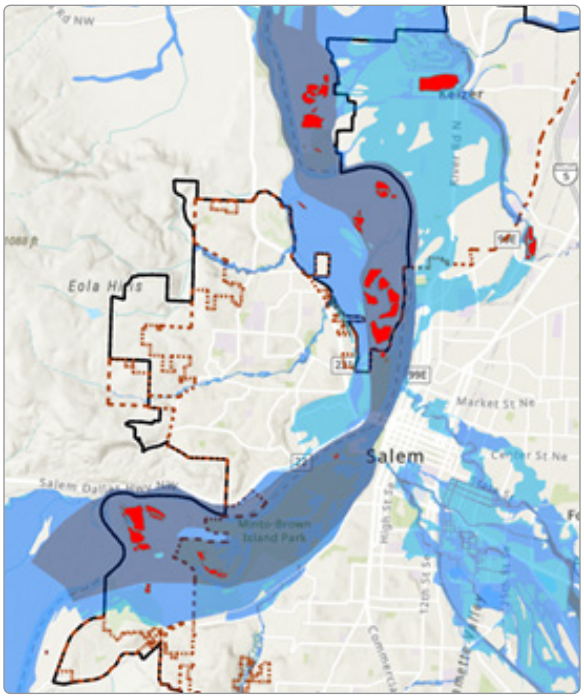


Figure 10: Floodplain Ponds (Identified in Red by USGS) (Bervid et. al. 2018)

while recognizing that all ponds cannot be effectively connected. The primary actions to enhance gravel pits are to reconnect the river at least at high flows (*Figure 11*). The necessary actions include evaluating elevations, channel construction, and other activities that would allow native fish access and escape.

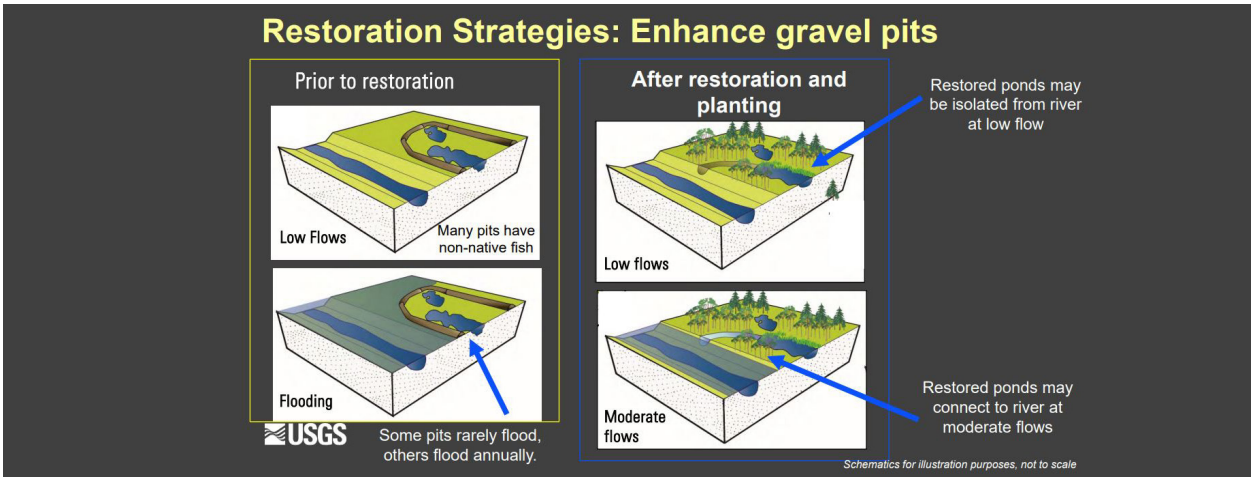


Figure 11: Gravel Pit Restoration for Fisheries Benefits (Wallick et.al., undated)

Careful consideration of the final elevations of the pits and surrounding site relative to the floodplain and river stages is critical for planning to enhance fish access (*Figure 12*). Some pits are located in areas where reconnection to the river is impractical. Reclamation plans for each gravel pit operation should be developed to ensure successful floodplain and habitat restoration.

Restoration of isolated pits for pond turtle habitat (*Figure 13*) requires consideration of nesting opportunities, water levels, and basking structures (ODFW, 2015).

Restoring Connectivity

Many of the side channels and abandoned channels of the Willamette River have been cut off by revetments or other actions. The changes to the channel around Minto-Brown Island are excellent examples of where these activities have occurred (*Figures 13 and 14*). There has been significant hardening of the banks (revetments) to prevent such changes in the future. The U.S. Army Corps of Engineers constructed approximately 94 miles of revetments in 230 project locations

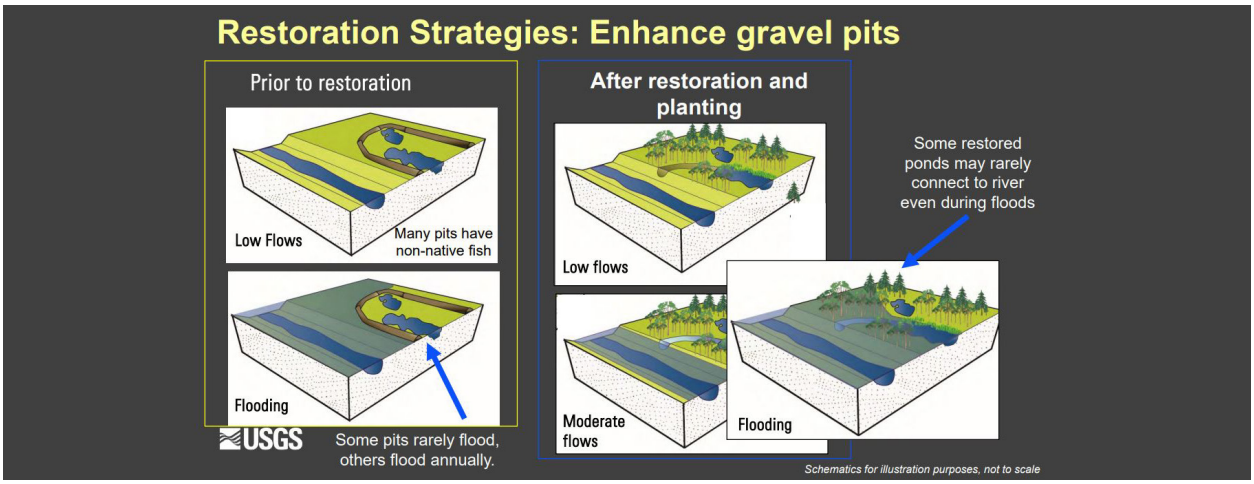


Figure 12: Floodplain Gravel Pit Restoration (Wallick et at., undated)

Characteristics of Suitable Turtle Nesting Habitat:

- Plenty of Potential Sun Exposure
- No or Little Overhead Tree or Shrub Canopy Cover
- Suitable Aquatic Habitat Nearby
- Low Stature, Patchy Vegetation
- Bare Ground

(ODFW, 2015)

Figure 13: Northwestern Pond Turtle Habitat (ODFW, 2015)

Figure 14: 1882 Willamette River Map Overlain on Aerial Photograph Showing Channel Through Browns Island and Channel North of Eola Bend in Different Locations (ODSL)

along the mainstem Willamette River (Hulse et al., 2013; USACE, 1989). The Minto Brown revetment was constructed in 1985 to ensure the Willamette channel does not undermine the embankment supporting Highway 22 (USACE, 1989). The Gray Eagle Bar revetment was constructed in 1939, and the Eola Bend (Eyerly) revetment was constructed in 1948. The early revetments were constructed to protect agricultural land. The Eola Bend revetment was initially intended to protect the mouth of Rickreall Creek. The Willamette and Rickreall Creek have moved away from the revetment built in 1939 and much of the revetment is embedded in the floodplain. Restoration of connectivity to historic channels creates a more diverse aquatic environment for juvenile salmon and steelhead as well as other native fish species (*Figure 16*).

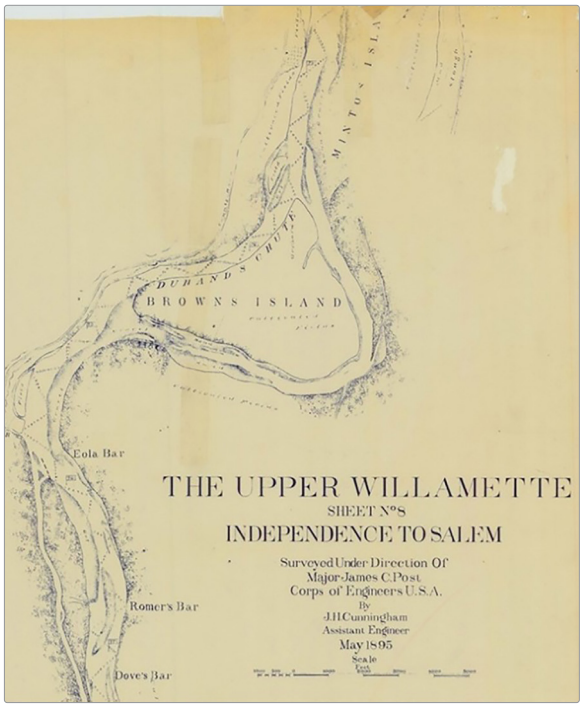


Figure 15: Map of Willamette River showing Brown Island (Navigation Chart, 1895)

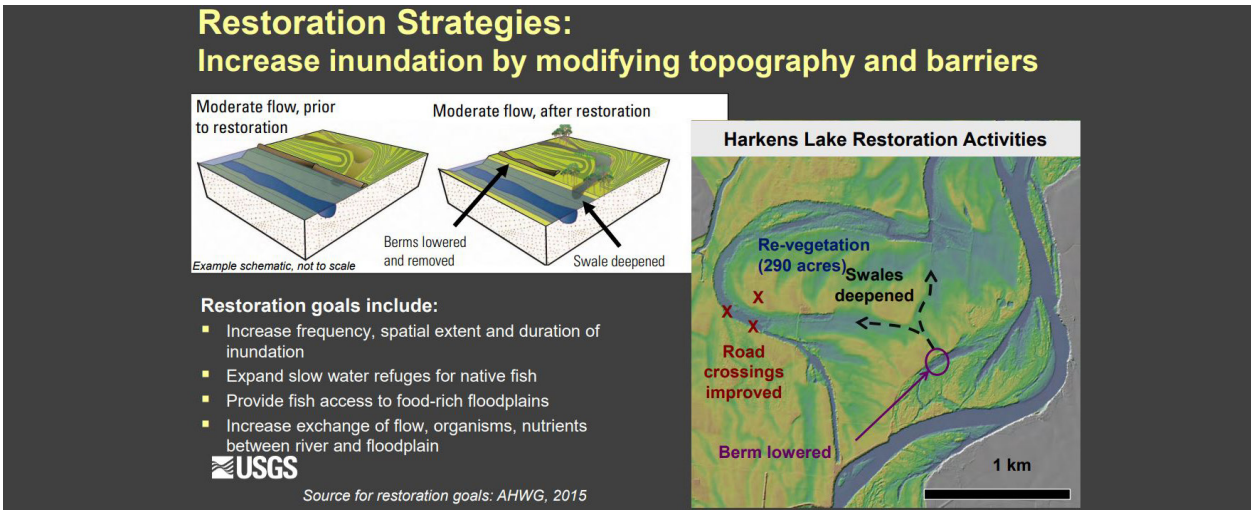


Figure 16: Restoration of Floodplain Connectivity (Wallick et.al. undated)

Treating Aquatic Weeds

Aquatic weeds such as *Ludwigia* can choke backwater areas and sloughs. Treatment by chemical and physical removal can be implemented to restore backwater habitats (*Figure 17*). The City of Salem has been cooperating with Willamette Riverkeeper since 2019 to clear the Willamette and Oxbow Sloughs of *Ludwigia*. These kinds of activities improve juvenile fish habitat by creating open water with native emergent and submergent vegetation. These projects will increase the amount and quality of habitat for use by salmonids during migration and provide improved shallow-water refugia and rearing habitat for juvenile fish due to the increase in the quality and complexity of vegetation onsite as well as improved water quality conditions (*Figure 18*). Restored shallow-water habitat will provide cover for fish to hide from predators and a higher abundance of terrestrial and aquatic insects that form the basis of the diet of juvenile Chinook and steelhead. Native turtles also benefit from the availability of more open water.

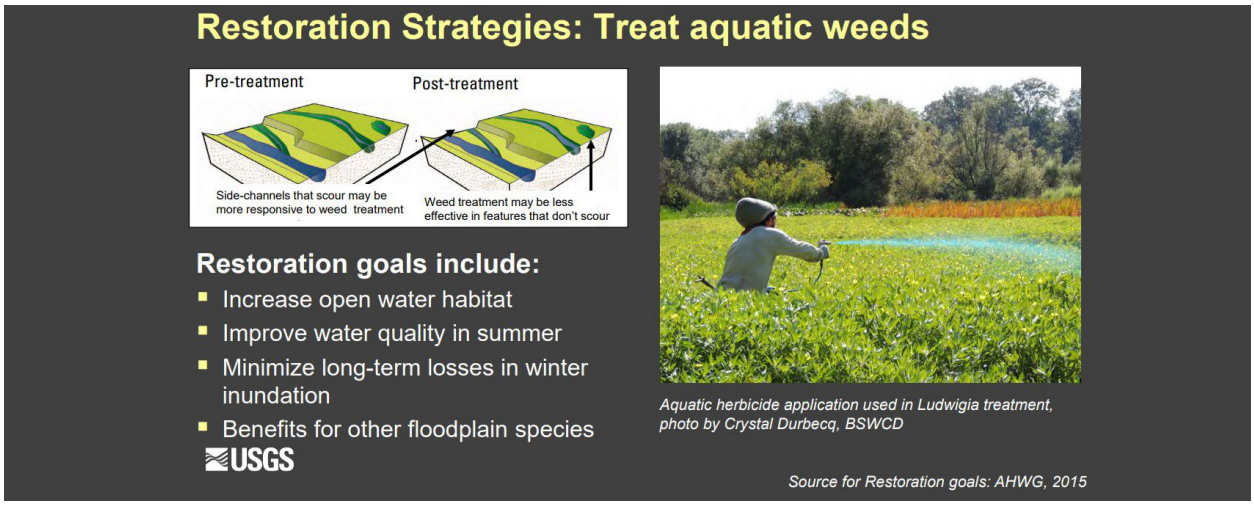


Figure 17: Aquatic Weed Treatment (Wallick et.al. undated)

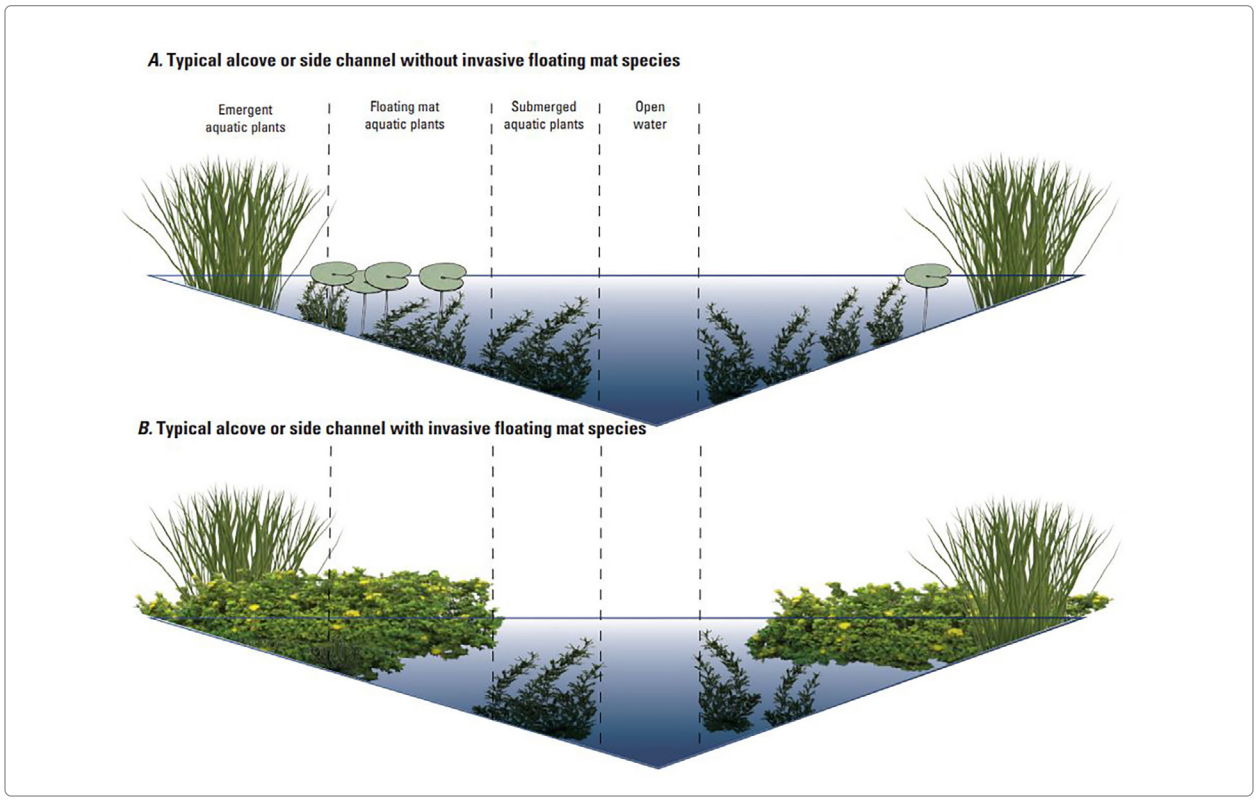


Figure 18: Effects of Invasive Aquatic Weed Removal (Keith et al., 2022)

Conservation Recovery Plan Recommendations for the Salem Area Willamette River Floodplains

Upper Willamette Chinook Salmon and Steelhead spawn in tributaries to the Willamette River. The Willamette River within Salem is used by these species to access upstream spawning areas and downstream to the estuary and ocean. While passage of high dams to spawning habitat is a major limit for these species' survival, their use of floodplain habitats along the Willamette River has also been significantly altered by floodplain development. Upper Willamette Chinook Salmon juveniles typically leave their natal streams and enter the mainstem as fry from late winter to early spring, as fingerlings from fall to early winter, and as yearlings from late winter to spring. Most juveniles overwinter in the mainstem Willamette River. The mainstream and floodplains of the Willamette River have been designated as "critical habitat" for the listed Upper Willamette Chinook Salmon and Steelhead.

Willamette River mainstem habitat characteristics that limit the viability of salmon and steelhead include severed floodplain connectivity and function, simplified channel structure and complexity, changed channel morphology, reduced riparian condition, and loss of large wood recruitment. The land management limiting factor is described as potentially destroying or degrading the ecosystem functions by altering habitat characteristics. The *Recovery Plan* identified the mainstem Willamette as providing the following life stages and functions: fry (rearing, migration), parr (rearing), smolt (migration, some rearing) adults (migration) (ODFW & NOAA, 2011). Recovery actions recommended for the mainstem include increasing off channel habitat (floodplain) connections, improving riparian forest vegetation, eliminating barriers to cool water rearing habitat for escape from high flow conditions.

The Recovery Plan recommends the following mitigation strategies:

> *"Increase overall channel complexity, floodplain connectivity, and flood storage to the mainstem Willamette River to increase and improve salmonid rearing and migration habitat"*

> *"Restore structure and function to strategic natural riparian reaches in the mainstem Willamette River, "Look for opportunities to remove unnecessary revetments or increasing setbacks in the mainstem Willamette…"*

> *"Protect remaining high-quality off-channel habitat from degradation and restore degraded areas with high intrinsic potential for high quality habitat."*

> *"Restore natural riparian communities and their function."*

Under the authority of the 1936 Flood Control Act and subsequent amendments, the U.S. Army Corps of Engineers (USACE) constructed approximately 42 miles of revetments for control of floods and preventing bank erosion as a part of the Willamette Project. In 2007 the USACE proposed to identify and prioritize those USACE-maintained revetments where removal or modification may be feasible to restore natural river function, particularly as such actions could improve habitat for

fish listed under the federal ESA. The 2008 Biological Opinion (BiOp) required by the federal ESA, directs USACE to prioritize revetments for modification or removal to restore natural river functions in the Willamette (NMFS 2008, USFWS 2008).

A team from the University of Oregon, Oregon State University, and River Design Group developed an approach to prioritizing the system of USACE-maintained Willamette Project revetments for future consideration for removal or modification to enhance natural river function (Hulse et al., 2013). The team identified 15 high priority revetment zones from five different river reaches. Salem is within the Albany to Newberg Reach (Middle Willamette) and a group of three revetments were identified as high priority in the Middle Willamette Reach. The Hayden, Brown, and Minto Island revetments include four US Army Corps of Engineers Revetments (Budd's Chute, Eola Bend, Gray Eagle Bar, and Eyerly) totaling some 11,515 feet of revetment (*Figure 19*). The Gray Eagle Bar revetment was developed to prevent channel migration into the Brown's Island area and divert flow towards the high bank at Eola Bend. The Eola Bend revetment was constructed in 1938 and more than half of it is no longer subject to erosion since the Willamette River migrated to the east and accreted sediment outside the revetment (*Figure 19*).

The Minto-Brown Island revetment is a non-Corps revetment. Its design was modified to protect riparian trees and provide a minimal "bench" for juvenile fish passage (Corps of Engineers, 1985). Two 48-inch concrete outlet pipes from backwater sloughs were replaced by 6-foot culverts. No consideration was given to fish access in the design.

Figure 19: Revetments in the Salem Area Floodplain of the Willamette River (red lines indicate USACE revetments, yellow line indicates Salem revetment) (Hulse et al., 2013).

Mill Creek and other Tributary Floodplains

The Willamette River tributary streams of Glenn Creek, Mill Creek, and Claggett Creek are all designated as "critical habitat" for Upper Willamette Chinook Salmon and Steelhead. The Glenn Creek floodplain is designated critical habitat within the Willamette floodplain which extends to approximately the confluence with Gibson Creek where fish passage is blocked by a dam. Likewise, Claggett Creek is a small tributary with limited flow and little fish habitat for use by juvenile salmon and steelhead during high water periods.

Mill Creek originates in the foothills of the Cascade Mountain Range. The watershed varies in elevation from approximately 116 feet at the confluence of Mill Creek with the Willamette River to approximately 2,200 feet along its eastern boundary and has a mean elevation of 530. Mill Creek drains a total area of about 111 square miles. The upper watershed hills are forested, and the central flat portion of the watershed is primarily used for agriculture with some residential and commercial development. The lower portion of the watershed is located in the City of Salem and is mostly developed. Major tributaries of Mill Creek include Beaver Creek, McKinney Creek, and Battle Creek. Salem Ditch (also known as Stayton Ditch) diverts water from the Santiam River to Mill Creek. The diversion provides water for irrigation and water supply and is managed by the Santiam Water Control District. The middle and lower parts of the basin have relatively flat floodplains and low gradient streams which result in broad inundation areas and complex braided flow paths during major floods. Mill Creek's broad floodplain is a remnant alluvial fan from the North Fork Santiam River, which at one time flowed through what is now part of the middle and lower Mill Creek Basin.

Mill Creek and its tributaries are the source of frequent flooding including the cities of Salem, Turner, Stayton, and Aumsville. Significant floods occurred in February 1996 and January 2012. Shelton Ditch diverts flows from Mill Creek and conveys floodwaters away from flood prone portions of downtown Salem; and the Turner Bypass channel, diverts flood waters away from downtown Turner. Although these facilities provide some flood control benefits, Turner, Salem, and Aumsville still face significant flood risk from Mill Creek.

In 2021 West Consultants conducted a Mill Creek Basin Flood Risk Analysis that looked at flooding conditions and evaluated flood mitigation measures. They identified alternative flood abatement projects with modification of Waller Dam as having the potential to "significantly reduce the number of structures inundated during more frequent floods". The reduced flood storage from the proposed change could "create a small increase in flood risk for areas downstream of Court Street".

While Mill Creek is designated as "critical habitat" for Upper Willamette Chinook Salmon and Steelhead, it is primarily refuge for juveniles of these species. The City of Salem invested between $700,000-$800,000 in fish screening for the Mill Race and fish passage improvements to Waller Dam in 2004.

Conservation Recovery Plan Recommendations for Willamette Tributaries

The Conservation Recovery Plan for Upper Willamette Spring Chinook Salmon and Steelhead identified the following limiting factor to the North Santiam populations (ODFW and NMFS, 2011):

> *"Road crossings and other land use related passage impediments restrict steelhead access to spawning and rearing habitat on wadable-sized tributaries"*

Partial barriers include unscreened diversions, Santiam Water Control District power and irrigation canals, road culverts, Salem ditch, and Sidney ditch (WRI, 2004). The Conservation and Recovery Plan for Upper Willamette Chinook Salmon and Steelhead has the general recommendation to "Reconnect floodplains to channels."

The Oregon Department of Fish and Wildlife (ODFW) recommended that the land use management practices surrounding Salem Ditch be evaluated to determine upstream passage and habitat access effectiveness for salmonids (ODFW and NMFS, 2011).

Other recommended restoration actions include, modifying dam operations for multiple diversions at Geren/Stayton Island, including Upper and Lower Bennett dams; modifying Santiam Water Control District spill dams; and improving fishway function and efficiency at Lower Bennett dams for both juvenile and adult fish. The recovery plan also mentions evaluating the headgate at the confluence of Mill Creek and North Santiam River for fish passage effectiveness. Recovery actions include: "Evaluate juvenile fish passage efficiency at the Mill Creek/ Mill Race diversion dam (Waller Dam) and modify the existing fishway if necessary" and "As needed, evaluate effectiveness of success of upstream passage of adults at the Salem Ditch/Mill Creek headgate structure."

Salem Floodplain Management Actions to Protect Floodplain Functions

There are both small scale and larger scale projects that could address the natural floodplain functions of fish access, riparian vegetation, and water quality. The City of Salem has a strong Floodplain Management Program that includes many actions protective of floodplain functions.

Current Natural Floodplain Function Protective Actions of Salem

Several current City of Salem activities are consistent with natural floodplain functions. The planting and restoration of floodplain vegetation in the Minto Island Conservation Area adds floodplain vegetation to areas previously altered for industrial uses. Joint projects with Willamette Riverkeeper to remove *Ludwigia* from Willamette and Oxbow Sloughs (*Figure 20*) help to provide and improve habitat for juvenile salmon and steelhead and other native fish species. The City Floodplain and Stormwater Management Plans and activities under those plans address stream debris in tributary streams and water quality treatment. The Salem Floodplain Management Plan was originally adopted in 2013 and subsequently updated in 2015, 2018, and 2023. The most current version was adopted by the Salem City Council in December 2024.

Compliance with NFIP Requirements

FEMA consulted with the National Marine Fisheries Service (NMFS) on potential effects of the implementation of the NFIP in Oregon on listed species under NMFS authority. In 2016, NMFS issued a BiOp, which recommended changes to the implementation of the NFIP in Oregon within the plan area. Participating communities were given three options for compliance:

1. Adoption of a FEMA proposed model ordinance,
2. Prohibition of all new development in the SFHA; or,
3. Permit-by-permit approach, which requires evaluation of the effect on fish accessible space, riparian habitat, and water quality of each development proposal within the SFHA.

In June 2025, the City adopted an ordinance establishing a permit-by-permit approach to evaluate development proposals within the SFHA to ensure no-net-loss of key floodplain functions for floodplain species. As FEMA continues to evaluate the NMFS BiOp, Salem will consider additional code amendments that comply with NFIP requirements for ESA protections.

Figure 20: Willamette Slough Habitat Restoration

Figure 21: Penitentiary Ditch Dam (North Santiam Watershed Council, 2025)

Listed Species Habitat Restoration Potential in Salem

There are several potential habitat restoration actions that could benefit listed Upper Willamette Spring Salmon and Steelhead in Salem. Additionally, there are restoration actions that could benefit Northwestern Pond Turtle, Horned Lark and Willamette Daisy populations. The plan emphasis will be on floodplain restoration actions to benefit Upper Willamette Chinook Salmon and Steelhead with secondary consideration for the Northwestern Pond Turtle.

Upper Willamette Chinook Salmon and Steelhead Restoration

Ensuring access for juvenile salmon and steelhead by removing barriers to habitat provides increased rearing potential for juvenile fish. Two barriers to juvenile salmonid passage are identified in the ODFW passage database. Dams on Mill Creek at State Penitentiary Ditch, owned by Santiam Water Control District, and Shelton Ditch Dam (owned by

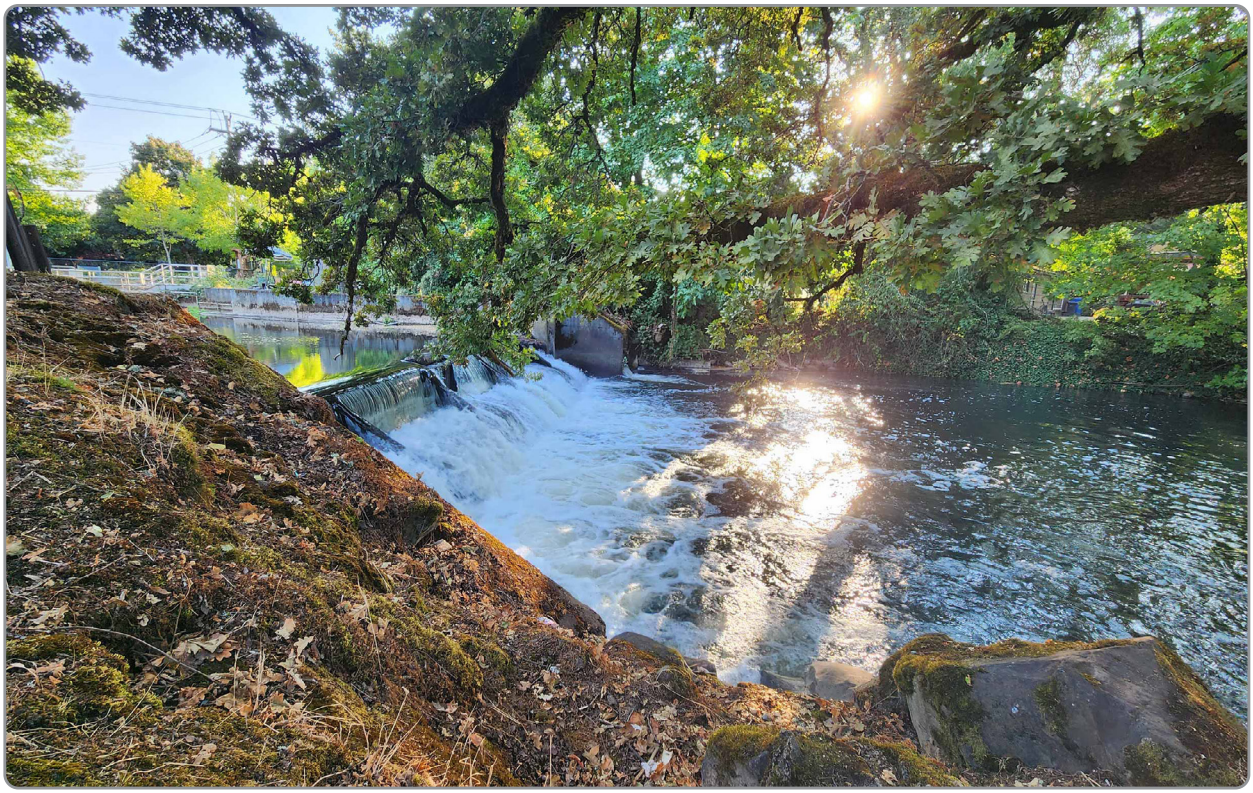


Figure 22: Waller Dam at Shelton Ditch (North Santiam Watershed Council, 2025)

the City of Salem) both are documented as potential barriers to "all native migratory fish juveniles". Shelton Dam was built in the 1930's and diverts water into Pringle Creek.

Penitentiary Ditch dam is a full fish passage barrier. Removal of the Penitentiary Ditch dam (*Figure 21*) is being explored utilizing federal grant funding. Waller Dam (*Figure 22*) on Mill Creek is also being evaluated to review potential alternatives for the dam complex that is not currently a barrier, but struggles with flooding, sedimentation, water quality, and habitat. Funding for the project is being managed by the North Santiam Watershed Council on behalf of a group of mid-Willamette watershed councils.

Modification of the Waller Dam (*Figure 22*) was proposed as a flood abatement potential for Mill Creek (West Consultants, 2021). Evaluating the conditions of the fish ladder under low flow conditions and consideration of the sediment accumulation behind the dam will be necessary before proposing changes.

The provision of adequate fish passage could also be extended to the North Santiam River that includes the Salem Ditch headgate, Lower Bennett Dam, Stayton Ponds diversion, and North Santiam Overflow Dam which are all listed on the ODFW fish passage barrier list (ODFW, 2025). These projects require significant funding which makes them difficult to complete.

Willamette Floodplain Access Improvement

Improving fish passage to Oxbow Slough, an old channel of the Willamette River, partially blocked by the Minto Brown revetment could increase escape and rearing habitat for juvenile salmon and steelhead. Currently the connection between Oxbow Slough and the Willamette River is restricted by a culvert that was placed in 1985 without consideration of fish access. Evaluating the potential to improve fish access and providing volitional fish passage to the slough would improve fish access to the Willamette floodplain. This action is an element of the *Minto-Brown Island Park Master Plan (Appendix A)*. Improvements in this area would also enhance the opportunity for Pacific Lamprey (*Entosphenus tridentatus*) spawning.

Gravel Pit Restoration

The Eola Bend gravel operation is the primary active gravel operation within the UGB. Planning with the operating company to restore the site with juvenile salmon and steelhead benefits in mind should be a priority for the City. Gravel site reclamation is required by the Oregon Department of Geology and Mineral Industries. Working collaboratively with stakeholders will be critical for effective habitat and floodplain restoration. The floodplain of the site could be revegetated to riparian habitat and the remaining ponds could be configured to be connected to the river at moderate flows or if isolated from the river, developed for Northwestern Pond Turtle habitat.

The Riverbend Materials gravel operation in West Salem also provides the potential for rehabilitation for salmonid benefit. While this site is outside the City of Salem UGB, acquisition and restoration could benefit floodplain functions through restoration actions for off channel juvenile fish access. The site is expected to be depleted of commercial gravel in the near future and planning to address the future of this portion of the floodplain will be critical for habitat and floodplain restoration.

These projects would require long-term planning and significant funding sources. One way to consider the use of these projects is to explore the development of restoration actions such as a mitigation banking approach where restoration would be conducted and credits made available to cover the costs of restoration from approved development elsewhere in the floodplain.

Floodplain Riparian Vegetation Restoration

There has been significant riparian habitat restoration on Minto-Brown Island and Eola Bend County Park. Riparian habitat restoration along Mill Creek could benefit salmonid habitat by preventing heating from solar radiation.

Remove Floodplain Fill and/or Revetments

Floodplain fill has been placed on the west bank of the Willamette River over several decades (*Figure 23*). While the fill remains, the area is still within the floodplain. Removal of the fill, restoration of riparian vegetation, and daylighting of Turnage Brook would enhance Willamette River floodplain functions. The property in question is within the SFHA and fill removal would restore lost floodplain functions. Development requirements have presented difficulties that may be a challenge to overcome, particularly regarding access restrictions to the Oregon Department of Transportation owned portion of Edgewater Street NW, the sole access point for the property. Future discussions with the property owner should be considered to explore options for partial or full acquisition.

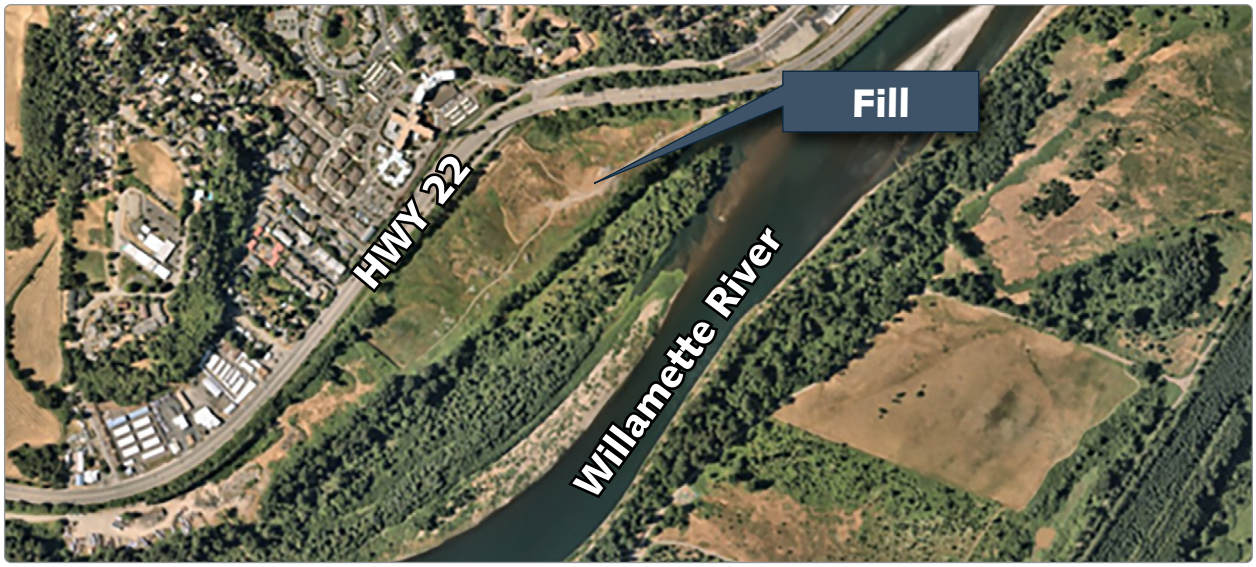


Figure 23: Floodplain Fill Area in West Salem

Floodplain Property Acquisition

Other sites within the regulated floodplain that are challenging to develop should also be considered for property acquisition and restoration activities. As mentioned previously, creation of mitigation banking could be an option for financing property acquisition.

Summary of Recovery Measures

The previous discussion identifies opportunities to provide additional access to floodplain environments for juvenile salmon and steelhead. The identified restoration actions available to the City of Salem are provided in *Table 4*.

	Table 4: Floodplain Restoration Actions
	Measures Benefiting Salmon and Steelhead
	Provide volitional access (access without assistance like a ladder or other device) to cool water habitats in tributaries.
	Provide backwater channel access during high water times in the Willamette River.
	Restore floodplain areas by removing floodplain fill.
	Cooperatively restore gravel pit sites to benefit juvenile salmon and steelhead.
	Restore riparian forest areas.
	Acquire and protect privately owned floodplain habitats.
	Measures Benefiting Northwestern Pond Turtle
	Cooperatively restore gravel pits and other ponds that are above flood elevation with basking logs and protected nesting area.
	Measures Benefiting Streaked Horned Lark and Willamette Daisy
	Restore floodplain prairie habitats along Mill Creek.

Table 4: Floodplain Restoration Actions

Recommendations

The City has potential options that range from conditioning development proposals to active restoration. The following are prioritized by activities that most directly reflect City authority to those that have broader implications and will require partnerships or significant funding to employ.

Near Term Projects

1. **Development Dedication:** Revise the Floodplain Overlay Zone to establish requirements for conservation easements over floodplain areas that provide, or have the potential to provide, beneficial natural floodplain functions. Code revisions could require development proposals that are partially within the floodplain to dedicate conservation easements to protect the existing or proposed natural floodplain portions of the site. Alternatively, the City could establish a program to negotiate acquisition of the natural floodplain portion of affected properties. Given the City's extensive floodplain and numerous overland flow areas, any such requirements should carefully balance the protection of habitat and floodplain functions with the potential loss of developable land. As part of this action item, staff should evaluate incentive programs that allow increased development density on the portion of a site located outside the SFHA. This could be achieved through Planned Unit Developments or other zoning provisions.
2. **Public Facilities Location:** When planning public facilities such as roads and utility lines, the City should consider their placement in relation to floodplain areas. When acquiring right-of-way on properties that include both upland and floodplain areas, the City should consider acquiring the entire floodplain area along with the required right-of-way. This approach was recently used during right-of-way acquisition for the Marine Drive Project in West Salem.
3. **Fish Passage Design:** Develop a long-term plan and designs that address fish passage at City managed Shelton Ditch Dam and other City owned barriers to fish passage.
4. **Minto Island Revetment:** Develop design plans for improved fish passage through the Minto Island revetment and work to acquire grant funds to match City funds to complete projects identified in the Minto-Brown Island Park Master Plan.

Mid-term Projects

5. **Willamette River Floodplain Mitigation Bank:** Establish a Floodplain Mitigation Bank Program. This program would include acquisition of floodplain property such as West Salem floodplain property along the Willamette River. The program would establish criteria for charging future developers to offset fill placed in other portions of the floodplain by paying into the mitigation bank for areas where the City has removed fill from the floodplain or completed restoration projects.
6. **Mill Creek Fish Passage:** Work with Marion County and other stakeholders to develop a plan and designs to remove or remediate fish passage barriers along Mill Creek.
7. **Mill Creek Floodplain Restoration:** Partner with the State of Oregon and other stakeholders to develop a plan for floodplain protection on State-owned properties in the Mill Creek Floodplain and restore native prairie habitat suitable for listed prairie species such as the Streaked Horned Lark.

8. **Gravel Pit Reclamation Plan:** Develop a gravel operation reclamation plan that incorporates salmon and steelhead habitat enhancement. The plan would be cooperatively produced between RiverBend Materials, Oregon Department of Geology and Mineral Industries, and the Oregon Department of Fish and Wildlife.
9. **Gravel Pit Property Acquisition:** Consider acquisition gravel pit properties, such as the RiverBend Materials property, following completion of gravel mining operations and reclamation plan establishment.

Summary of Recovery Projects

Table 5 lists the potential floodplain protection and restoration actions available to the City of Salem. The City Agency that could be responsible for taking the action and potential funding for the project is identified in the table. The projects are listed by relative priority. Some of the projects are being actively implemented and/or planned. For example, the City negotiated purchase of a floodplain property while acquiring right-of-way for the Marine Drive project in West Salem. Additionally, the City of Salem is cooperating with the North Santiam Watershed Council in evaluating the removal of Penitentiary Dam and evaluating Waller Dam. The City of Salem has unsuccessfully applied for grant funds to acquire the RiverBend aggregate site for restoration purposes.

Table 5: Potential City of Salem Species Recovery Actions in the Floodplain

No.	Potential City Action	Agency Responsible	Potential Funding	Priority
1.	Development Dedication	Development Services	N/A	High
2.	Public Facilities Location	Public Works	N/A	High
3.	Fish Passage Design	Public Works, Natural Resources Planning	OWEB, USFWS, NMFS	Medium
4.	Minto Island Revetment	Parks, Public Works	OWEB	Medium
5.	Willamette River Floodplain Mitigation Bank	City Council, Public Works, Planning	OWEB, FEMA	Medium
6.	Mill Creek Fish Passage	City Council, Public Works, Planning	OWEB, FEMA	Medium
7.	Mill Creek Floodplain Restoration	Public Works, Natural Resources Planning, State of Oregon	OWEB	Medium
8.	Gravel Pit Reclamation Plan	Public Works, Natural Resources Planning, ODFW, DOGMI	OWEB	Low
9.	Gravel Pit Property Acquisition	Public Works, Natural Resources Planning, ODFW, DOGMI	OWEB, City	Low

Priority: High = 1-2 years, Medium = 3-5 years, Low = 5 years+

CRS Credit and Additional Credit Opportunity

The City of Salem is an active participant in the National Flood Insurance Program (NFIP) Community Rating System (CRS). The CRS program is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. The CRS program recognizes a community's efforts to reduce flood risk, facilitate accurate insurance ratings, promote the awareness of flood insurance, and preserve the natural beneficial functions of floodplains.

FEMA has awarded the City of Salem a Class 3 rating under the Community Rating System, which allows residents to receive a 35 percent discount on federally backed flood insurance premiums. The City continues to implement improvements through the CRS program and strives to further enhance its rating over time. The Natural Floodplain Functions Plan provides an additional opportunity to earn CRS credit. The following summarizes additional CRS credit opportunities:

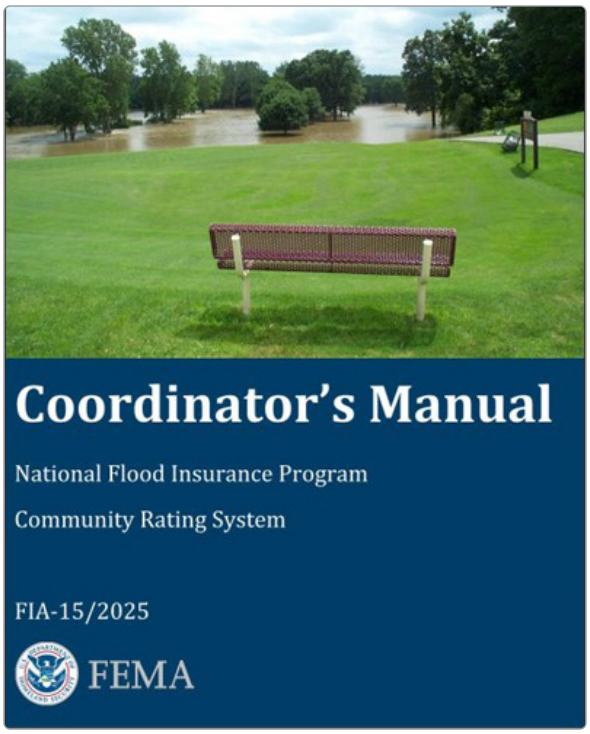


Figure 24: Community Rating System Coordinator's Manual

Activity 420 (Open Space Preservation)

Currently Salem has 876 points out of 2,870 points available for Open Space Credits under CRS Activity 420. This activity awards points for keeping floodplain lands vacant through land acquisition, zoning restrictions, and conservation easements. Credit is provided for preserving approximately 47 percent of the Special Flood Hazard Area (SFHA) as open space, protecting open space land with deed restrictions, and preserving open space land in a natural state.

Additional CRS credit opportunities remain available to the City of Salem for the acquisition of undeveloped floodplain land. Action items within this plan include establishing a program to acquire floodplain properties in conjunction with right-of-way acquisition and development activities. Providing formal protection of these floodplain areas could contribute additional CRS credit by evaluating the potential to:

- Amend the Salem Revised Code (SRC) to allow legal units of land to be divided at the Special Flood Hazard Area (SFHA) boundary, including consideration of:
  - » The potential for SFHA parcels to be donated to the City or a non-profit land trust.
  - » Whether SRC 205.045 (Special Platting Standards for Conserva-

tion Lots or Parcels) should be modified to accommodate the creation of SFHA parcels.

- Allow increased development density on the portion of a site located outside the SFHA, which could be achieved through Planned Unit Developments or other zoning provisions.

The above considerations could add to up to 250 CRS credit points under CRS Activity 422.f, offering incentives to developers to keep the floodplain areas undeveloped. Adoption of such provisions could also get credit for CRS Activity 422 which includes other regulations to protect natural floodplain functions not specifically listed in the Coordinator's Manual. Additionally, credit is available for adoption of higher regulatory standards, under CRS Activity 430.

Removal of the Penitentiary Ditch Dam and modification of Waller Dam to facilitate fish passage could also provide CRS credit under CRS Activity 432.o, which provides credit opportunity for providing beneficial floodplain functions.

Activity 510 (Floodplain Management Planning)

Currently Salem has 233 points out of 762 points available for Floodplain Management Planning Activities under CRS Activity 510. This activity provides credit for the production of planning documents with an overall strategy of programs, projects, and measures that will reduce the adverse impact of the hazard on the community and help meet other community needs. Activity 510 credits communities for the preparation and adoption of four kinds of plans: Floodplain Management Plans; Repetitive Loss Area Analysis; Natural Floodplain Functions Plans; and Substantial Damage Management Plans.

Under CRS Activity 510, Salem receives credit for its adopted Floodplain Management Plan (CRS Activity 512.a. Adoption of this Natural Floodplain Function Plan and Floodplain Species Assessment could add up to 100 credit points under CRS Activity 512.c. This plan has been drafted utilizing NFIP guidance for preparing a Floodplain Species Assessment or Floodplain Species Plan and the FEMA CRS Coordinators Manual (*Figure 23*). The City also has the opportunity to progress the Repetitive Loss Area Analysis to City council for adoption to receive additional CRS credit points under Activity 512.b.

Natural Floodplain Functions Plan and Changing Floodplain Regulations

As the Natural Floodplains Function Plan was being reviewed, FEMA issued a Draft Environmental Impact Statement for the Draft Oregon Implementation Plan for NFIP-ESA Integration in August of 2025 (FEMA, 2025). It is important to distinguish the regulatory requirements proposed in the draft documents from the voluntary actions proposed in the Natural Floodplain Functions Plan. The Natural Floodplain Functions Plan provides additional CRS credits, thus lowering flood insurance for the citizens of Salem. The adoption of such a plan is a discretionary action available to all participants in the NFIP The adoption of this plan is **not required** to be a part of the NFIP.

The Requirements for communities under the NFIP-ESA Integration being proposed in the Environmental Impact Statement include required NFIP elements of:

- A no-action alternative
- No net loss with exception for project-specific ESA compliance alternative
- No net loss without exceptions for project-specific ESA compliance

Along with the no-net-loss standards, a 170-foot riparian buffer zone is proposed to apply the no-net-loss standard. There is a high likelihood that a no-net-loss standard for flood storage impacts, water quality impacts (permeable surfaces), and riparian trees (greater than 6" DBH) will be adopted in order to comply with NFIP requirements. The Floodplain Functions Plan can help to meet the future requirements. For example, a floodplain mitigation bank could develop credits in terms of the no-net-loss parameters and use the mitigation ratios required to satisfy the regulatory requirements of the adopted NFIP Implementation approach.

In June 2025, the City adopted an ordinance establishing a permit-by-permit approach to evaluate development proposals within the SFHA to ensure no-net-loss of key floodplain functions for floodplain species. As FEMA continues to evaluate the NMFS BiOp, Salem will consider additional code amendments that comply with NFIP requirements for ESA protections.

Bibliography

Bayley, P. B., and C. F. Baker. 2000. Floodplain restoration in off-channel habitats used for gravel mining in the Willamette River Basin: fish population observations in Endicott and Truax ponds. 1998/00 Report to Willamette River Gravel Removal Restoration Fund Program. Oregon State University, Corvallis.

Bayley, P.B., P.C. Klingeman, P.J. Pabst, and C.F. Baker. 2001. Restoration of aggregate gravel mining areas in the Willamette River floodplain, with emphasis on Harrisburg site. Final report to Oregon Watershed Enhancement Board

Benner, P. A. and J. R. Sedell. 1997. Upper Willamette River landscape: A historic perspective. Pages 23-47 in Laenen, A. and D. Dunnette, editors. River quality: dynamics and restoration. CRC Lewis Publishers, Boca Raton, Florida.

Bervid, H.D., Wallick, J.R., Keith, M., and Maher, A., 2025, Human-modified ponded features mapped within the Willamette River floodplain, Oregon, in 2018: U.S. Geological Survey data release, *https://doi.org/10.5066/P13BDEHG*.

Childerholm, R.J. and Marj Trim. 1979. Salmon and Steelhead Trout. University of Washington Press. 158 p

Christy, J.A., Alverson, E.R., 2011. Historical vegetation of the Willamette Valley, Oregon, circa 1850. Northwest Sci. 85, 93–107.

City of Salem. 2023. City of Salem Floodplain Management Plan. Report from the Public Works Department. October 2023. 168 p.

City of Salem. 2023. City of Salem Natural Hazards Mitigation Plan. 266 p.

Dykaar, B.B. and R.J. Wigington, Jr. 2000. Floodplain formation and cottonwood colonization patterns on the Willamette River, Oregon, USA. Environmental Management 25(1): 87-104.

Erős, T., and Bányai, Z. (2020). Sparing and Sharing Land for Maintaining the Multifunctionality of Large Floodplain Rivers. Sci. Total Environ. 728, 138441. doi:10.1016/j.scitotenv.2020.138441

Federal Emergency Management Agency. 2023. National Flood Insurance Program Community Rating System CRS Credit for Habitat Protection. 34 p.

Federal Emergency Management Agency. 2025. Coordinators Manual National Flood Insurance Program Community Rating System. *https://www.fema.gov/sites/default/files/documents/fema_crs_coordinators-manual_082025.pdf*

Federal Emergency Management Agency. 2025. Draft Environmental Impact Statement Draft Oregon Implementation Plan for NFIP-ESA Integration. August 2025. Federal Emergency Management Agency Region 10. 247 p.

Fernauld, A.G., P.J. Wigington, and D.H. Landers. 2001. Transient storage and hyporheic flow along the Willamette River, Oregon: Field measurements and model estimates. Water Resources Research 37: 1681-1694.

Flitcroft, Rebecca, Luke Whitman, James White, Rose Wallick, Laurel Stratton Garvin, Cassandra Smith, Robert Plotnikoff, Michael Mulvey, Tobias Kock, Krista Jones, Peter Gruendike, Carolyn Gombert, Guillermo Giannico, Andrew Dutterer, Daniel Brown, Hannah Barrett, Brian Bangs, and Robert M. Hughes. 2023. Science to support conservation action in a large river system: The Willamette River, Oregon, USA. Water Biology and Security. v. 2 no.4 *https://www.sciencedirect.com/science/article/pii/S2772735123000896*

Flitcroft, R, Whitman, L, White, J, Wallick, R, Straton Garvin, L, et al. 2023. Science to support conservation action in a large river system: the Willamette River, Oregon, USA. Water Biology and Security, 2, 100203.

Glenn Gibson Creeks Watershed Council and Salem Public Works Department. 2025 Salem Floodplain Species Assessment. January 2025 Report. 49 p.

Gregory, S, Wildman R, Hulse D, Ashkenas L, Boyer K. 2019. Historical changes in hydrology, geomorphology, and floodplain vegetation of the Willamette River, Oregon. River Res Applications. 35: 1279–1290. *https://doi.org/10.1002/rra.3495*

Gregory, Stan Brooke Penaluna, Guillermo Giannico, Kathryn Boyer. 2025. Decadal trends in native and non-native fish assemblages in a large floodplain river in the Pacific Northwest, USA. Conférence internationale I.S.Rivers 2025, Jun 2025, Lyon, France. ffhal-05178595f

Hansen, G.S., Perry, R.W., Kock, T.J., White, J.S., Haner, P.V., Plumb, J.M., and Wallick, J.R. 2023. Assessment of habitat use by juvenile Chinook salmon (Oncorhynchus tshawytscha) in the Willamette River Basin, 2020–21: U.S. Geological Survey Open-File Report 2023–1001, 20 p., *https://doi.org/10.3133/ofr20231001*

Hemesath, Lisa and Tina Nunez. 2002. Pringle, Glenn-Gibson, Claggett, and Mill Creeks Watershed Assessment. Report for Greater Salem-Keizer Area Watershed Councils. January 2002.

Hulse, D., S.V. Gregory, and J. Baker, editors. 2002. Willamette River Basin: a planning atlas. Prepared for the Pacific Northwest Ecosystem Research Consortium by Oregon State University Press, Corvallis.

Hulse, David W., Gregory, Stanley V., Wright, Scott, Branscomb, Allan, Brehm, Christo, and Enright, Chris. 2013. Assessment of potential for improving ESA-listed fish habitat associated with operations and maintenance of the U.S. Army Corps of Engineers Willamette Project: an approach to prioritizing revetments for removal or modification to restore natural river function. Report to U.S. Army Corps of Engineers, Portland District. June 14, 2013. 59 p.

Johannessen, C. L., W. A. Davenport, A. Millet, and S. McWilliams. 1970. The vegetation of the Willamette Valley. Annals of the American Society of Geographers 61:286-302.

Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems, p. 110-127. In: D. P. Dodge [Ed.], Proceedings of the International Large River Symposium (LARS), Toronto, Ontario, September 14-21, 1986. Canadian Special Publication of Fisheries and Aquatic Sciences.

Keith, M.K., Wallick, J.R., Flitcroft, R.L., Kock, T.J., Brown, L.A., Miller, R., Hagar, J.C., Guillozet, K., and Jones, K.L. 2022. Monitoring framework to evaluate effectiveness of aquatic and floodplain habitat restoration activities for native fish along the Willamette River, northwestern Oregon: U.S. Geological Survey Open-File Report 2022–1037. 116 p., *https://doi.org/10.3133/ofr20221037*

McCabe, C.L., Matthaei, C.D. & Tonkin, J.D. 2025. The ecological benefits of more room for rivers. Nat Water 3, 260–270. *https://doi.org/10.1038/s44221-025-00403-0*

National Flood Insurance Program. 2024. Preparing a Floodplain Species Assessment or Floodplain Species Plan for credit under the Community Rating System of the National Flood Insurance Program. Updated May 2024. 24 p.

NOAA Fisheries Protected Resources Division. 2005. Final Assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams For 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. August 2005. 116 p.

NOAA Fisheries. 2008. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation on the "Willamette River Basin Flood Control Project". NOAA Fisheries Log Number: FINWR12000/02117. July 11, 2008. 1271 p.

North Santiam Watershed Council. 2025. NOAA Fish Passage Improvements to Mill Creek Barriers, and Panther Creek. *https://northsantiam.org/portfolio-items/noaa-fish-passage-improvements-to-mill-creek-barriers-and-panther-creek/#*

Oregon Conservation Strategy. 2025. Oregon Department of Fish and Wildlife, Salem, Oregon. *https://dfw.state.or.us/SWAP-Revision/*

Oregon Department of Fish and Wildlife. N.D. Oregon Conservation Strategy Northwestern Pond Turtle. N.D. *https://www.oregonconservationstrategy.org/strategy-species/northwestern-pond-turtle/*

Oregon Department of Fish and Wilflide. 2025. Fish Barrier Passage Inventories. *https://www.dfw.state.or.us/fish/passage/inventories.asp*

Oregon Department of Fish and Wildlife and NOAA Fisheries. 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. August 5, 2011.

ODFW. 2015. Guidance for Conserving Oregon's Native Turtles including Best Management Practices. Oregon Dept. of Fish and Wildlife. 99 pp.

Penaluna, Brooke E.; Gregory, Stanley V.; Wildman, Randall; Giannico, Guillermo R.; Pollock, Amanda M. 2025. Willamette River decadal assessment fish dataset. Forest Service Research Data Archive. Dataset. *https://doi.org/10.2737/RDS-2024-0057*

Poff, N. L. 2018. Beyond the natural flow regime? Broadening the hydroecological foundation to meet environmental flows challenges in a non-stationary world. Freshwater Biology, 63, 1011–1021.

Poirier, Jen, Ann Gray, and Ben Clemens. 2023. FINAL Pacific Lamprey 2022/2023 Regional Implementation Plan for the Willamette Sub-Unit of the Lower Columbia/Willamette Regional Management Unit. Submitted to the Willamette RMU Team in June 2023. 60 p.

Robbins, William G. 1978. The Willamette Valley Project of Oregon: A Study in the Political Economy of Water Resource Development. Pacific Historical Review 47:4: 585–605.

Schreck, C.B., J.C. Snelling, R.E. Ewing, C.S. Bradford, L.E. Davis, and C.H. Slater. 1994. Migratory characteristics of juvenile spring Chinook salmon in the Willamette River. Completion report. Bonneville Power Administration, Portland, Oregon.

Schroeder, R. Kirk, Luke D. Whitman, Brian Cannon, and Paul Olmsted. 2016. Juvenile life-history diversity and population stability of spring Chinook salmon in the Willamette River basin, Oregon. Canadian Journal of Fisheries and Aquatic Sciences.73(6): 921–934.

Sedell, J.R. and J.L. Froggatt. 1984. Importance of streamside forests to large rivers: the isolation of the Willamette River, Oregon, U.S.A., from its floodplain by snagging and streamside forest removal. Verh. Internat. Verein. Limnol. 22:1828-1834.

Serra-Llobet A, Jähnig SC, Geist J, Kondolf GM, Damm C, Scholz M, Lund J, Opperman JJ, Yarnell SM, Pawley A, Shader E, Cain J, Zingraff-Hamed A, Grantham TE, Eisenstein W and Schmitt R. 2022. Restoring Rivers and Floodplains for Habitat and Flood Risk Reduction: Experiences in Multi-Benefit Floodplain Management from California and Germany. Front. Environ. Sci. 9:778568. doi: 10.3389/fenvs.2021.778568

Towle, J.C. 1982. Changing geography of Willamette Valley woodlands. Oregon Historical Quarterly 83: 67-87.

U.S. Army Corps of Engineers. 1985. Willamette River Basin Bank Protection and Channel Improvement. January,1985. Design Memorandum Bank Protection and Channel Improvement Willamette River, Oregon Minto-Brown Location. USACE, Portland District, Portland, Oregon.

U.S. Army Corps of Engineers. 1989. Willamette River Bank Protection Programs Summary. Portland District. Electronic document obtained from USACE, Portland District Office, January 1989. 58 pgs.

U.S. Army Corps of Engineers. Undated. Portland District and a history of floods. *https://www.nwp.usace.army.mil/Missions/Flood-Risk-Management/1964-Flood/*

U.S. Fish and Wildlife Service. 2008. Biological Opinion on the Continued Operation and Maintenance of the Willamette River Basin Project and Effects to Oregon Chub, Bull Trout, and Bull Trout Critical Habitat Designated Under the Endangered Species Act. As Proposed by: U.S. Army Corps of Engineers (Department of Army) Bonneville Power Administration (Department of Energy) and Bureau of Reclamation (Department of Interior).

U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.

U.S. Fish and Wildlife Service. 2017. Willamette Valley Conservation Study. Pacific Region, Portland, Oregon. 148 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Draft Recovery Plan for the Streaked Horned Lark (Eremophila alpestris strigata). U.S. Fish and Wildlife Service Portland, OR. 28pp.

U.S. Fish and Wildlife Service (USFWS). 2023. Western pond turtle habitat illustration. *https://www.fws.gov/media/western-pond-turtle-habitat-illustration*

Wallick, J.R., Grant, G., Lancaster, S., Bolte, J.P. and Denlinger, R. 2022. Patterns and Controls on Historical Channel Change in the Willamette River, Oregon USA . In Large Rivers, A. Gupta (Ed.). *https://doi.org/10.1002/9781119412632.ch25*

Wallick, J.R., Lancaster, S.T., and Bolte, J.P. 2006. Determination of bank erodibility for natural and anthropogenic bank materials using a model of lateral migration and observed erosion along the Willamette River, Oregon— USA: River Research and Applications, v. 22, p. 631–649.

Wallick, J.R., Jones, K.L. O'Connor, J.E., Keith, M.K., Hulse, David, and Gregory, S.V. 2013. Geomorphic and vegetation processes of the Willamette River floodplain, Oregon—Current understanding and unanswered questions: U.S. Geological Survey Open-File Report 2013-1246., 70 p., *http://dx.doi.org/10.3133/ofr20131246*.

Wallick, J.R., M. Keith, T. Kock, G. Hansen, J. Hagar, L. Brown, K. Guillozet, B. Flitcroft, R. Miller, and M. Sytsma. Undated presentation. Effectiveness Monitoring to Inform Willamette River Restoration Programs. Power Point Presentation. *https://public.crohms.org/tmt/documents/FPOM/2010/Willamette_Coordination/WFSR/Day%201_1545_Wallick_Effectiveness%20Monitoring%20to%20Inform%20Willamette%20River%20Restoration%20_WFSR%202020_FINAL.pdf*

Wallick, J. R., Jones, K. L., O'Connor, J. E., Keith, M. K., Hulse, D., and Gregory, S. V. 2013. Geomorphic and vegetation processes of the Willamette River floodplain, Oregon—Current understanding and unanswered questions. U.S. Geological Survey Open-File Report, 2013-1246, 70. *https://doi.org/10.3133/ofr20131246*

Williams, J. E., Gregory, S., and Wildman, R. 2024. Fish assemblage structure and habitat relationships of a large floodplain river in western North America. River Research and Applications, 40(5), 809–820. *https://doi.org/10.1002/rra.4273*

Wohl, E., S. N. Lane, and A. C. Wilcox. 2015, The science and practice of river restoration, Water Resources Research 51:5974–5997, *https://doi:10.1002/2014WR016874*.

Wohl, E. 2021. An integrative conceptualization of floodplain storage. Reviews of Geophysics, 59, e2020RG000724. *https://doi.org/10.1029/2020RG000724*

WEST Consultants, Inc. 2021. Mill Creek Basin Flood Risk Reduction Study. Report to City of Turner January 25, 2021. 56 p.

Willamette Restoration Initiative (WRI). 2004. Draft Willamette Subbasin Plan. May 28, 2004

Glossary and Acronyms

Biological Opinion (BiOp): A formal document prepared by the U.S. Fish and Wildlife Service (USFWS) or National Oceanic and Atmospheric Administration (NOAA) Fisheries, under Section 7 of the Endangered Species Act (ESA), to determine whether a proposed federal action is likely to jeopardize a listed species or adversely modify its critical habitat.

Community Rating System (CRS): A voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the National Flood Insurance Program (NFIP).

Critical Habitat: A federally designated specific geographic area as defined in federal rule under the Endangered Species Act containing physical or biological features essential for the conservation of a threatened or endangered species.

Endangered Species: Any species designated under the Endangered Species Act to be in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA): A U.S. Law that establishes protections for fish, wildlife, and plants that are listed as threatened or endangered; provides for adding species to and removing them from the list of threatened and endangered species, and for preparing and implementing plans for their recovery; provides for interagency cooperation to avoid take of listed species and for issuing permits for otherwise prohibited activities; provides for cooperation with States, including authorization of financial assistance; and implements the provisions of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Essential Fish habitat (EFH): The waters and substrate that are necessary for fish to spawn, breed, feed, and grow to maturity as identified under the Magnuson–Stevens Fishery Conservation and Management Act.

Federal Emergency Management Agency (FEMA): The US federal agency responsible for coordinating the federal government's response to disasters, both natural and man-made.

Floodplain: An area of low-lying land near a river, stream, or coast that is prone to flooding during periods of heavy rainfall, snowmelt, or high tides. These areas are formed by the natural processes of erosion and deposition, where water carries sediment and debris, creating flat, low-lying landscapes.

Floodplain Species Assessment: A document that lists all the listed species found or likely to be found within a local jurisdiction that use the special flood hazard area.

Floodway: The portion of a floodplain that is designated as the primary channel for carrying floodwaters during extreme events. It's the area where the bulk of the floodwater flows and is typically characterized by high water velocities and forces.

Habitat: The natural components of an ecosystem that are essential for a species' survival, including food, cover, and water. Within this plan, "habitat" is used to mean all such areas needed by species in general.

Listed Species: Species designated as threatened or endangered under the federal Endangered Species Act.

Magnuson Stevens Fishery Conservation and Management Act: The primary law that governs marine fisheries management in U.S. federal waters. The Act requires fishery management councils to identify and describe Essential Fish Habitat and to protect, conserve, and enhance EFH for the benefit of fisheries.

National Flood Insurance Program (NFIP): A voluntary program authorized by the National Flood Insurance Act (NFIA) to provide access to federally underwritten flood insurance and require the purchase of flood insurance as a condition of receiving federally underwritten loans and federal assistance in the Special Flood Hazard Area (SFHA).

Natural Floodplain Functions Plan: A document that is adopted by the local government that contains a plan of action focused on those species identified as most likely to benefit from community actions. Also known as Floodplain Species Plan.

NOAA Fisheries (also known as the National Marine Fisheries Service): An office of the National Oceanic and Atmospheric Administration within the Department of Commerce that is the agency responsible for the stewardship of the nation's ocean resources and their habitat including works to recover protected marine species while allowing economic and recreational opportunities under the Endangered Species Act.

Oregon Department of Fish and Wildlife (ODFW): The Oregon State agency with the mission to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations.

Proposed Species: Any species of fish, wildlife, or plant that is proposed in the Federal Register to be listed pursuant to Section 4 of the Endangered Species Act (16 U.S.C. §1533). In this plan, species proposed for listing and listed species are all treated as "listed."

Range: The general geographical area within which a species can be found at the time either the U.S. Fish & Wildlife Service or the National Marine Fisheries Service makes a status determination. The range includes those areas used throughout all or part of the species' life cycle.

Recover: The ultimate goal is for a species to meet goals so that it no longer needs protection under the Endangered Species Act or similar state or local laws. These goals are described in a Recovery Plan.

Recovery Plan: A document that outlines the necessary research, management actions, and habitat strategies to restore a threatened or endangered species to a healthy, self-sustaining level where it may no longer need legal protection.

Revetment: Atructures placed along the riverbank to stabilize or protect the bank from erosion, usually constructed out of stone.

Salmonids: A fish of the Salmonidae family such as salmon or trout.

Sensitive Species: Plants and animals that are given special management attention and/or legal protections because of their vulnerability to population declines or extinction but not determined to be "threatened" or "endangered" under the Endangered Species Act.

Special Flood Hazard Area (SFHA): The land in the floodplain within a community subject to a one-percent or greater chance of flooding in any given year. The SFHA is shown on the Flood Insurance Rate Map (FIRM) as zone A, AO, AH, A1-30, AE, A99, or AR.

Species of Concern: Any plant or animal species that is not currently officially designated as endangered or threatened but is still at risk due to various factors.

Threatened Species: Any species designated under the Endangered Species Act to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Urban Growth Boundary (UGB): A line drawn on a map to manage growth over a 20-year period and to separate areas designated for urban development from areas intended for rural uses such as forestry or farming.

US Fish and Wildlife Service (USFWS): The federal agency dedicated to the conservation, protection, and enhancement of non-migratory fish, wildlife, plants, and their habitats.

Appendix A – 2015 Minto Brown Island Park Master Plan Excerpts

3.2 Opportunities

Invasive Species Management

Invasive species are prevalent and actively managed by Park Operations staff and community volunteers in some areas of the park. Removal of invasive plants and replanting with native species will reduce regrowth potential of undesirable species and restore wildlife habitat. Management of invasive and non-native wildlife species, such as red-eared slider turtles, will help support existing native turtle populations present in the sloughs and ponds.

Habitat Restoration

There are many opportunities to restore wildlife habitat throughout the park. The sheer size and diversity of ecosystems within the park allows for a variety of restoration approaches and habitat types to be explored.

Oxbow Slough Reconnection and Willamette Riparian Restoration

Restoration and habitat improvements in Oxbow Slough have been discussed in prior master plans. Reconfiguring the confluence between the slough and the Willamette River provides a great opportunity for improving off-channel juvenile salmonid rearing and refuge habitat, and may be eligible for grant funding.

Restoration and naturalization of the rip rap section of the Willamette River bank could provide valuable in-stream habitat improvements for salmonid species if large wood and other natural bank stabilization methods are incorporated. Restoration plantings can improve water quality by providing shade to reduce water temperature, and providing wood for recruitment into the river system.

5.3 Recommendations

Oxbow Slough Reconnection

Oxbow Slough was the historic main channel of the Willamette River. An undersized culvert (36-inch diameter) perched 6 to 8 feet above seasonal low water provides the only connection between Oxbow Slough and the Willamette River. The slough and river are only connected during high winter flows. During the summer the water level in the slough drops and temperatures increase, with minimal freshwater inputs from Pettijohn and Grey Oak Creeks, allowing introduced warm water fish species (largemouth and smallmouth bass, bluegill, sunfish, black crappie, yellow perch) to thrive. A feasibility study should be conducted to investigate the potential hydrologic and wildlife habitat benefits and impacts of improving the connection between the Oxbow Slough and the Willamette River.

Appendix B – City of Salem Floodplain Species Assessment

City of Salem Floodplain Species Assessment

January 2025

ABSTRACT

This Floodplain Species Assessment identifies listed species and their floodplain habitats within the City of Salem urban growth boundary. The Assessment helps to provide credit under the Community Rating System of the National Flood Insurance Program.

Prepared by

Glenn - Gibson Watershed Council

Prepared for

City of Salem At Your Service
Public Works Department
APWA ACCREDITED AGENCY

Table of Contents

Introduction **3**

Floods and Floodplains in Salem 3

Floods and Floodplains as a River Feature 6

The Ecology of Salem Area Floodplains 7

Floodplain Regulation and Regulatory Boundaries 8

Salem's Floodplain Management Plan 10

Salem Floodplains and their Watersheds 10

- Willamette River 11
- Mill Creek 12
- Glenn Creek 12
- Claggett Creek 12
- Pringle Creek 12
- Smaller Tributaries 12

Floodplain Development 13

Current Floodplain Conditions 16

Floodplain Species **18**

Threatened and Endangered Species 18

- Range and Critical Habitat Salmon and Steelhead 19
- Essential Fish Habitat, under the Magnuson-Stevens Fishery Conservation and Management Act 21
- Oregon Essential Indigenous Anadromous Salmonid Habitat 21

Range, Habitat and Recovery Plan for Streaked Horned Lark 24

Range, Habitat and Recovery Plan for Willamette Prairie Species 24

Bald and Golden Eagle Protection Act of 1940 . 25

Floodplain Habitats and Associated Species . . . 26

- Riparian Forest and Shrubland 26
- Ponds 26
- Wetlands 26
- Prairies 26
- Creeks and Streams 26

Species of Concern 27

Community Rating System Credit for Conservation and Recovery 29

References **31**

Appendix A: Species Profiles **35**

Upper Willamette River Chinook Salmon (*Oncorhynchus tshawytscha*) 35

- Description 35
- Life cycle 35
- Habitat 36
- Threats 36
- ESA Listing Status 36
- Critical Habitat 36
- Protective Regulations 36
- Recovery Plan 36
- Habitat use in Salem Area 36

Upper Willamette River Steelhead *(Oncorhynchus mykiss)* 37

- Description 37
- Life Cycle 37
- Habitat 37
- Threats 37
- ESA Listing Status 38
- Critical Habitat 38
- Protective Regulations 38
- Recovery Plan 38
- Habitat use in Salem Area 38

Streaked Horned Lark (*Eremophila alpestris strigata*) 39

- Description 39
- Life Cycle 39
- Habitat 39
- Threats 39
- ESA Listing Status 40
- Critical Habitat 40
- Recovery Plan 40
- Habitat use in Salem Area 40

Northwestern Pond Turtle *(Actinemys marmorata)* *41*

Willamette daisy *(Erigeron decumbens)* *43*

Peacock larkspur *(Delphinium pavonaceum)* . . . *47*

Introduction

The Glenn Gibson Creeks Watershed Council in cooperation with the City of Salem has developed this information on the floodplains and threatened, endangered and other species of concern that inhabit the floodplain environment within the urban growth boundary of Salem. An assessment of floodplain species and a plan of action based on that assessment are credited under the Community Rating System (CRS) of the National Flood Insurance Program (NFIP) to encourage and recognize community actions to protect species listed pursuant to the Endangered Species Act. Providing protection to critical habitat and habitat in general and help those listed and sensitive species recover can be accomplished by knowing what species use what aspects of Salem's floodplains. This "floodplain species assessment" is the first step. It starts the process of learning which species are listed or proposed for listing by the National Marine Fisheries Service and U.S. Fish and Wildlife Service (Services) and which associated critical habitats may be present in the floodways and floodplains in Salem. While the Services have independent authority under the Endangered Species Act, providing information and advice to private and public landowners of floodplain properties can help to avoid regulatory actions or allow for consideration of alternative approaches to the use of such properties.

Figure 1 shows the Study Area with City Limits (dashed line) Urban Growth Boundary (solid black line) Floodway (dark blue) and Floodplain (light blue).

Floods and Floodplains in Salem

Floodplains are the dynamic and diverse areas adjacent to rivers and streams that are inundated during high water periods but may not be underwater during Oregon's dry summer conditions. They are often low-lying areas adjacent to a stream or river channel and can vary in width from a narrow fringe to extensive and expansive reaches, depending on the landform constraints and stream gradient. Historically, floodplains in the Salem area were complex and had a natural ability to absorb and diminish floods. Streams and rivers often had a complex of small side channels that changed and rearranged seasonally. Salmon and other fish and aquatic animals used these side channels as refugia during high water periods and native fish such as cutthroat trout were abundant in the tributary streams. Beaver ponds were abundant and created wetlands for a diversity of fish, reptiles, amphibians, and waterfowl. In addition, wetlands fed by groundwater and springs provided rich soil nutrients and cool, clean water to the streams and rivers.

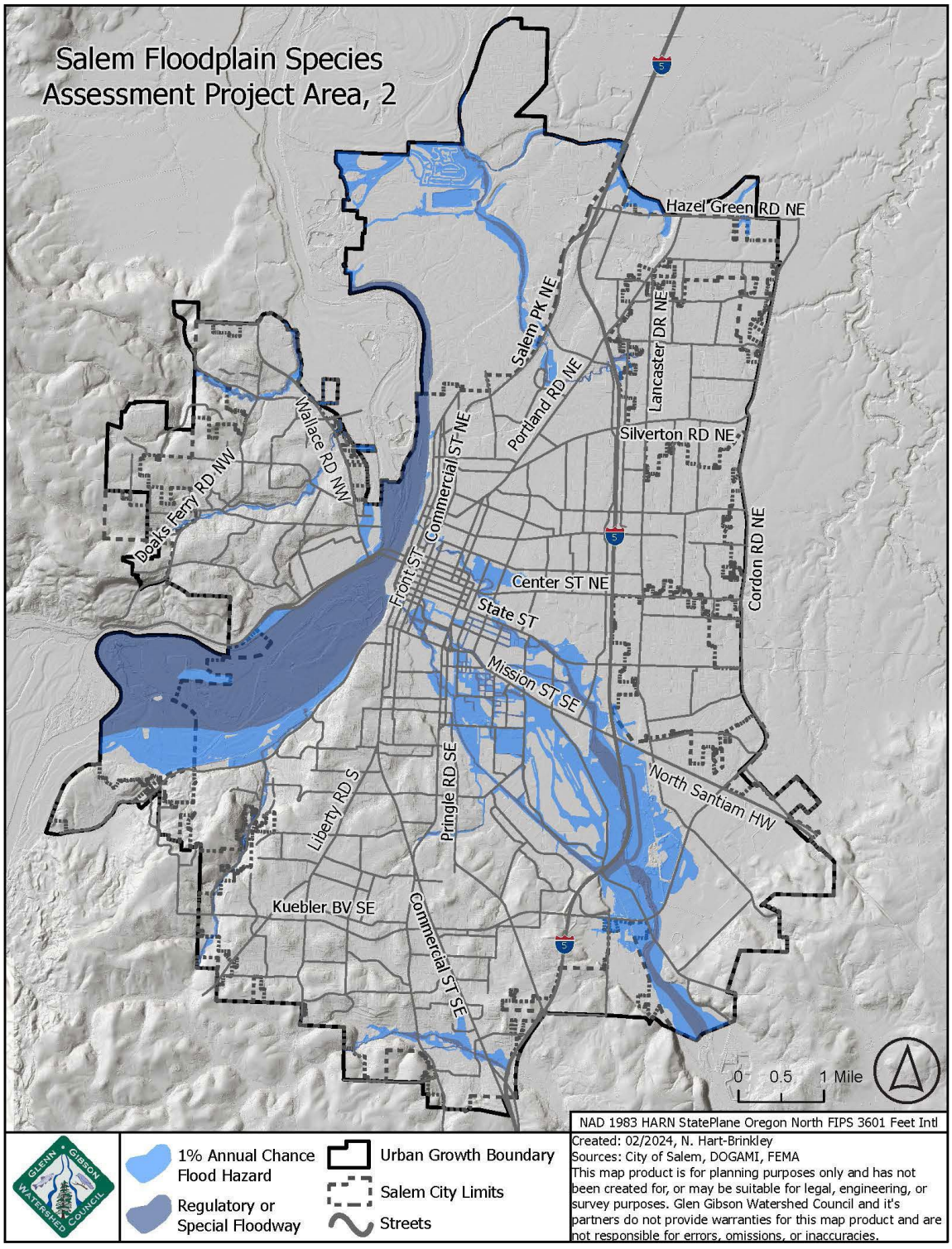


Figure 1: Salem Floodplain Species Assessment Study Area

Figure 2: Flooding in Downtown Salem 1964

Over the last nearly two centuries the floodplains of Salem's waterways have been extensively altered. Modification of the Willamette River and its floodplain has been well documented in the Willamette River Planning Atlas (Hulse et al., 2003). The modification of tributary streams and their floodplains is less well documented. Development along the edges of our rivers, streams, and sloughs has eliminated or greatly reduced floodplain area and thus the ability of our floodplains to absorb, retain, and slow floodwaters. In addition, floodplains have been stripped of their native vegetation, drained for agriculture, filled to accommodate development, and covered by pavement for transportation. Increasing stormwater runoff from impervious areas, and the loss of available storage in the floodplain cause more frequent and larger floods.

Floods and Floodplains as a River Feature

While rivers and creeks are often viewed as only the summer flowing areas of water through a channel at the bottom of a valley, the amount of stream flow and thus the area of the valley floor interacting with the stream varies in time. It is easy to recognize the area that is regularly inundated by higher flows by their low-lying topography and vegetation adapted to frequent inundation. The area of the valley floor that is less frequently inundated remains a part of the river and can be an active part of the river providing significant ecological functions (***Figure 3*** taken from Wohl, 2021). The regularly active channel reflects the low flow and high velocity area of the river. The river interacts with the floodplain during less frequent but regular higher flows. The river also interacts with the sediments of the river valley through what is called the hyporheic zone.

Floodplains are typically flat lands with relatively fertile soil and have been used for agriculture and other forms of development needing to be close to the river channel. The impact of these activities on the floodplain ecological functions and on the infrequent flooding on human activities has led to the development of regulations to reduce the economic and social impacts from flooding. As summarized by Wohl (2021): "…a floodplain is intimately connected to the river channel and the underlying hyporheic zone." She continues: "This basic scientific understanding is commonly lost in a societal context, however, in which floodplains are treated separately from channels and subsurface water." She further explains that the channel is regulated while the floodplain is often treated as private property. Wohl (2021) concludes: "Many communities around the world also do not effectively recognize the connectivity of floodplains and channels. The easy access to water, navigation, and waste disposal in the channel, and to fertile soils and flat topography on floodplains, have encouraged human settlement on floodplains for millennia. When inundation, bank erosion, or channel avulsion occur as a result of flooding, a common response is to "put the river back in its place," engineer the channel for greater conveyance and stability, and block water from the floodplain with artificial levees."

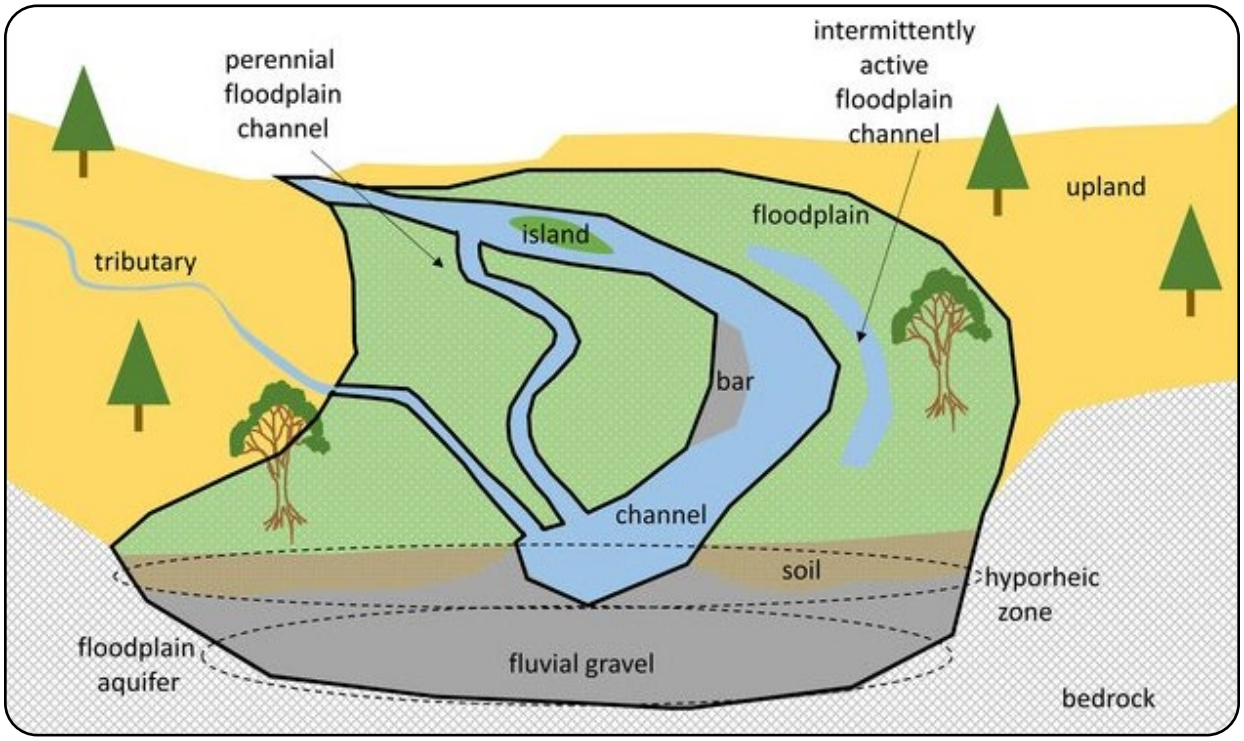


Figure 3: Floodplain characteristics and the relationships between the stream channel, floodplain, and floodplain aquifer (from Wohl, 2021)

The Ecology of Salem Area Floodplains

Flowing water and frequent disturbance by high flows causing channel changes and sedimentation create the geomorphic environment of the floodplain. Establishment of tree species adapted to recently deposited sediment and declining water availability characterizes the floodplain environment. There is a wealth of information on the floodplain dynamics and ecological relationships of the Willamette River. Much recent focus on the role of stream flow, species assemblages, water temperature relations and other factors affecting fish habitats in the Willamette River has been summarized by Flitcroft and others (2023).

Evaluation of the geomorphic and vegetation processes of the Willamette River is summarized by Wallick and others (2013). This work follows previous studies of cottonwood (Populus trichocarpa) colonization of gravel bars in the Willamette (Dykaar and Wingington, 2000; Cline and McAllister, 2011). The historic floodplain of the Willamette is described by Hulse and others (2003) as: "When the first EuroAmerican settlers arrived in the Willamette Valley, they found the valley clothed in tall grasses, so tall that cattle were hidden from view. The appearance was that of a "park" with wide swaths of grass punctuated by groves of spreading oak trees (Oregon white oak, and in Lane County some California black oak). Dense gallery forests lined the Willamette and its tributaries with associations of Douglas-fir, Oregon ash, black cottonwood, alder, bigleaf maple, western red cedar, and willows." The historical vegetation of the Willamette Valley is constructed from General Land Office records (Christy and Alverson, 2011). Mapping from the 1850's shows a continuous riparian forest along the floodplain surrounded by wet prairie and savanna. Riparian forest up to 8 km wide is documented along the Willamette River (Christie and Alverson, 2011). Johannessen and others (1971) describe the changes from settlement, fire reduction and forest harvest.

As Described in the Willamette Valley Conservation Study (USFWS, 2017): "It takes time for species to adjust to changed conditions, and from an ecological and evolutionary standpoint, 150 years is just the blink of an eye. Significant habitat loss and fragmentation coupled with the invasion of noxious, non-native plants and animals and the loss of the fires and floods that rejuvenated and maintained the habitats has had pronounced effects on the wildlife and plants they support, or once supported.

Today, species are still adjusting and for many, the adjustment isn't going particularly well. Evidence of this is found in the fact that there are now 12 species of fish, wildlife, and plants native to the valley whose population numbers are so low that they are listed as threatened or endangered under the federal Endangered Species Act (USFWS 1993a, 1997, 1998a, 2000, 2013b). Two other federally-listed species, the Oregon spotted frog and yellow billed cuckoo, historically bred in the valley, but are now extirpated. Many other species including western meadowlark, Oregon vesper sparrow, and yellow-breasted chat are considered by the State of Oregon to be threatened with extirpation from the valley (ODFW 2008). Grassland-dependent birds have suffered steep population declines and severe range contractions as they adjust to the new realities of the valley (Altman 1999, ODFW 2010). ODFW found that "In Oregon's Willamette Valley, many grassland species have exhibited steady downward trends in distribution and abundance, with some likely having been extirpated as a breeding species" (ODFW 2010)."

Agricultural and urban development has reduced the wet prairies of the floodplains of the Willamette and tributary streams. The native prairies of western Oregon and southwestern Washington are among the most endangered ecosystems in the United States (Noss et al. 1995). Six native prairie species in the region – one butterfly and five plants – have been added to the Federal List of Endangered and Threatened Wildlife and Plants since 1988 pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531, et seq.). The dependence on regular flooding and fire has led to significant reductions in the range of these species and extirpation from significant areas of developed land.

A broader view of the geomorphological and ecological processes that create floodplains are often more extensive than regulatory floodplains (***Figure 4***).

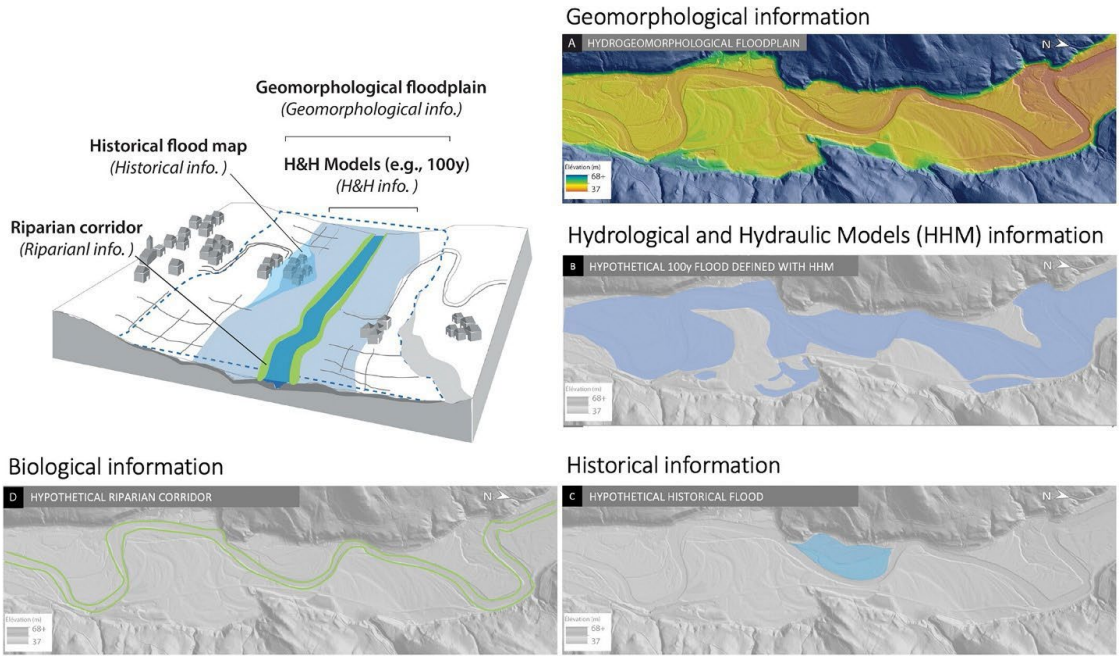


Figure 4: Comparison of Geological and Ecological Floodplain with Regulatory Floodplain (from Serra-Llobet et al., 2022a)

Floodplain Regulation and Regulatory Boundaries

The regulation of structures and development in floodplains is managed by local governments, however in Oregon, floodplain development regulations are required to comply with Oregon's land use planning goals and uniform floodplain regulations have been required. The National Flood Insurance Program of the Federal Emergency Management Agency has developed minimum requirements for floodplain development that most communities have adopted. The minimum requirements for floodplain development are based on risk reduction from engineering analysis of the potential for flood rise effects. Floodplains are mapped and categorized according to the level of risk to development. The critical distinctions are between the floodway and floodplain (***Figure 5***).

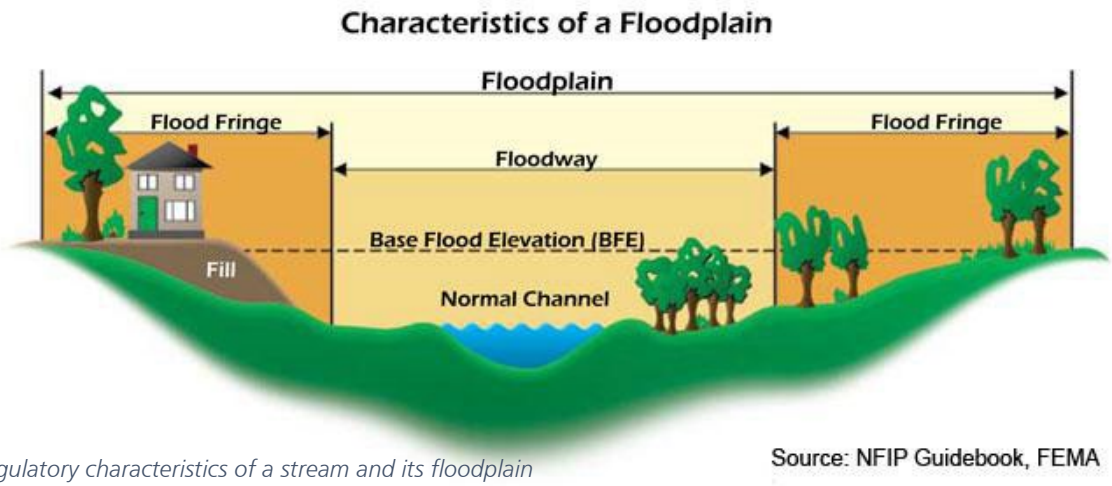


Figure 5: Regulatory characteristics of a stream and its floodplain

FEMA administers the National Flood Insurance Program (NFIP), a nationwide program that reduces future flood damage by requiring minimum floodplain management standards and provides protection for property owners against potential flood losses through insurance. The NFIP was established by the United States Congress in 1968 with the passage of the National Flood Insurance Act (NFIA) (42 United States Code [U.S.C.] §4001 et seq.). This law mandated that FEMA identify the nation's flood-prone areas and make insurance available to participating communities (local, tribal, and state governments) that implement floodplain management requirements that meet or exceed the minimum standards of the program. The NFIP is the primary source of flood insurance coverage for residential properties in the United States. Recent estimates of present and future flood risk (Wing et al., 2018) conclude: "Our analysis shows that both FEMA flood maps and previous large-scale risk estimates likely significantly underestimate population exposure, while the latter simultaneously overestimates flood risk."

The Flood Insurance Rate Maps (FIRM) are developed under FEMA guidelines and standards as the official regulatory flood maps for a community (***Figure 6***). FEMA has delineated both the Special Flood Hazard Area (SFHA), and the risk premium zones applicable to the community. Within the SFHA insurance is obligatory for structures with federally backed mortgages and outside the SFHA insurance is recommended. The 1% NFIP standard was intended to be a standard for flood insurance rating and not a national standard for flood protection or land use planning. The FIRM mapping is available on the City of Salem website at *https://www.cityofsalem.net/community/safety/flooding/salem-s-local-floodplain-map.*

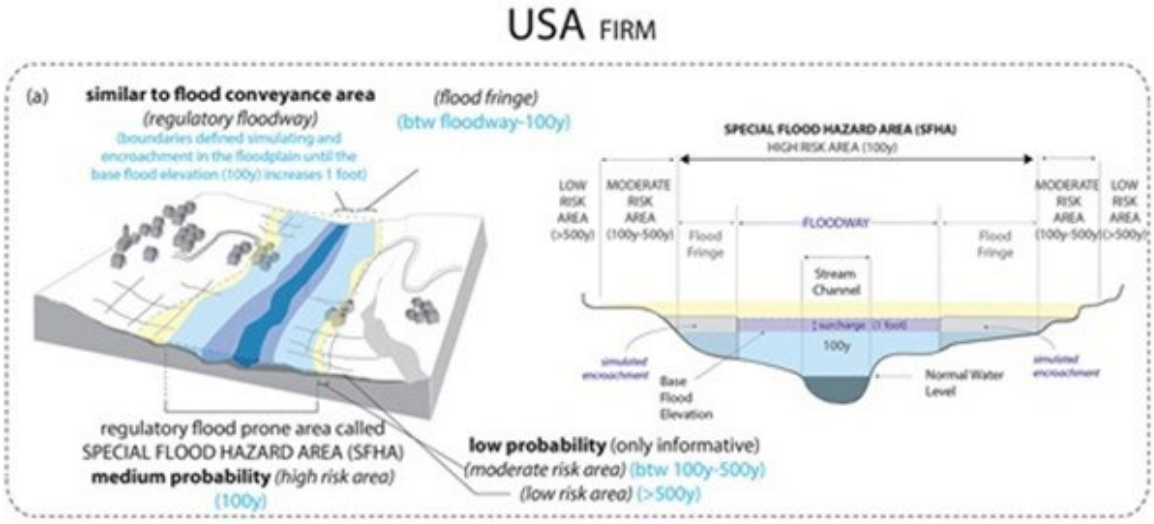


Figure 6: Flood Insurance Rate Map (FIRM) description (from Serra-Llabet et al., 2022a)

Salem's Floodplain Management Plan

The city of Salem has a strong history of planning for flood management. The City of Salem adopted a Floodplain Management Plan in 2013 and updated it in 2018. In October of 2023, the City of Salem completed the second update of the City of Salem Floodplain Management Plan. The plan was adopted by City Council on December 4, 2023. The objective of the City of Salem Floodplain Management Plan is to create an overall strategy of programs, projects and measures that will help reduce the adverse impact of flood hazards on the community. The plan includes a review of the action activities from the 2018 plan and identifies 42 action activities as either ongoing or scheduled for some timeframe in the future (either 0-2 or 3-5 years).

The plan includes the proposed action (Action Activity NR-4) to: "Prepare a Flood Species Assessment in conformance with CRS Activity 510" scheduled for 0-2 years from the adoption of the 2023 plan. This document "Salem Floodplain Species Assessment" is intended to complete that proposed action of the Salem Floodplain Management Plan 2023.

The City of Salem has a website that provides excellent information on the City Floodplain Management Program (*https://www.cityofsalem.net/community/safety/flooding*). The site has information on the importance of floodplains, flood preparedness, flood response, flood insurance and access to real time stream stage information.

Salem Floodplains and their Watersheds

Within the urban growth boundary of the City of Salem floodplains of the Willamette River and Mill Creek provide the greatest area of risk. Flooding also occurs in Battle Creek, Cinnamon Creek, Claggett Creek, Clark Creek, Croisan Creek, Davidson Creek, Gibson Creek, Glenn Creek, Golf Creek, Jory Creek, Laurel Creek, Little Pudding, Mill Race, Pettijohn Creek, Powell Creek, Pringle Creek, Scotch Creek, Shelton Ditch, Waln Creek, and Winslow Creek. FEMA has only mapped floodplains in relatively small areas of the tributary streams to the Willamette, except for the extensive floodplain of Mill Creek. Evaluating floodplains for this assessment looks at the mapped floodplains and areas that experienced flooding in the last few major flood events (2012, 1996, and 1964).

Each creek in the Salem area is affected by the watershed conditions outside the City urban growth boundary. Each tributary system has distinct characteristics, ecology and hydrology. The following is a general description of each contributing stream and their watershed conditions affecting flooding in Salem.

THE DEFINITION OF FLOOD RISK (from Lane, 2017)

The probability that exposure to a hazard will lead to a negative consequence…'; and thus we can think of flood risk as being the probability of being exposed to flooding (the hazard) in a way that has negative consequences. The negative consequences can be broadly defined (e.g., the full range of impacts, economic, social, health and wellbeing, etc.) or narrowly defined (e.g., just the economic losses that would result from the exposure). Commonly, the term vulnerability can be used to represent this broadest sense. This definition is important because it emphasizes that flooding does not necessarily lead to a flood risk, as for that to happen there has to be a negative consequence. Floods can have positive consequences (e.g., for ecosystems) as well as negative ones.

Willamette River

The Willamette River watershed is fed by an approximately 11,478 square mile catchment. At Salem nearly all the major tributary flow has been contributed. The Willamette River is highly regulated by 13 federal flood control dams. The management of these dams results in less variable flows and reduced peak flows. Construction and operation of flood mitigation/hydropower dams have largely confined peak flows to the bankfull channel, decreasing the magnitude of large floods and the magnitude and frequency of small floods (***Figure 7***). The post dam flows are significantly below historic flows. Flow regulation in the mainstem Willamette River has been implemented through the construction and integrated management of dams in its tributaries, that also serve as sources of hydropower. The last large flood of record occurred in the Willamette River system in 1964, as completion of upstream dams to regulate flow in the late 1960s effectively reduced high-flow events in the following decades. River flow modification alters habitat for in-stream species, and for floodplain species that depend on periodic inundation.

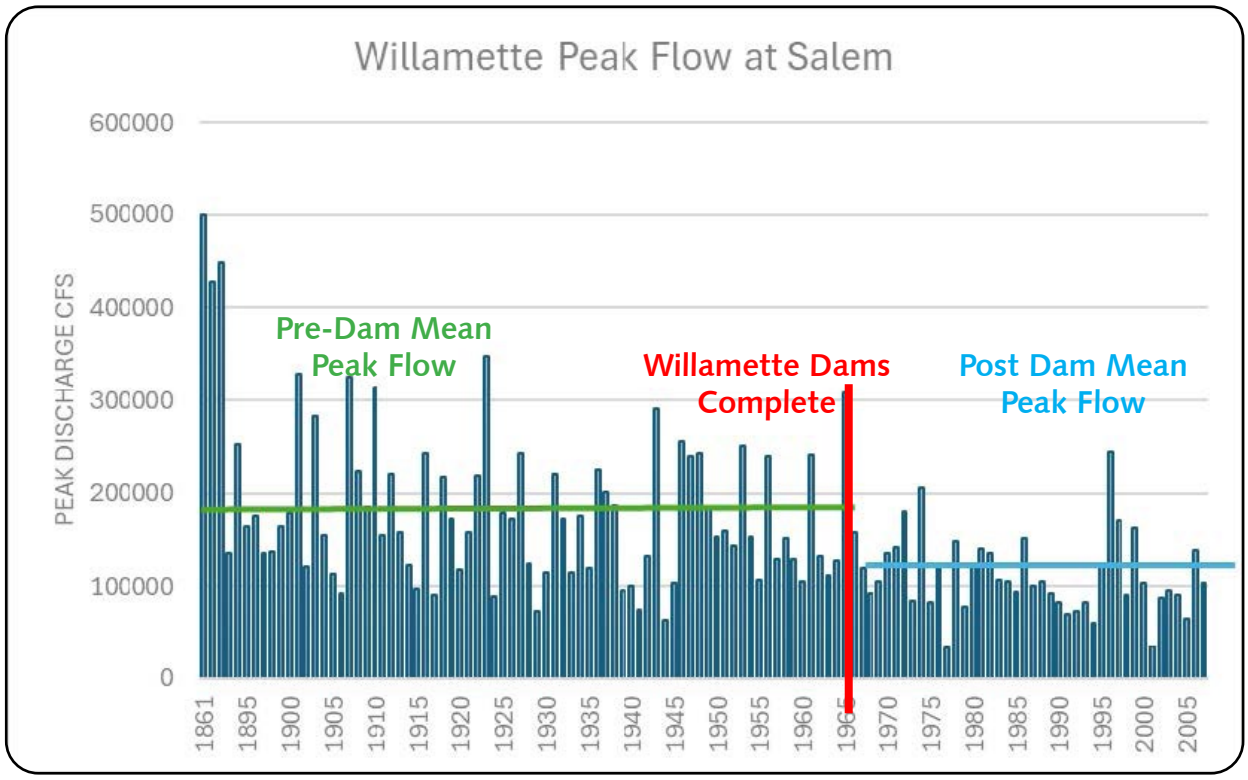


Figure 7: Peak annual discharge for the Willamette River at Salem showing the effect of dams on the upper river.

Mill Creek

Mill Creek is a 26-mile (42 km) tributary of the Willamette River that drains a 111-square-mile (290 km2) area of Marion County. Flowing generally west from its source south of Silver Falls State Park, it passes through the cities of Aumsville, Stayton, Sublimity, and Turner before emptying into the Willamette in Salem. Near river mile (RM) 18 or river kilometer (RK) 29, the creek receives Salem Ditch from the left; the ditch transports water from the North Santiam River to Mill Creek. Cutting through central Salem, the creek intersects Mill Race or Mission Ditch (another artificial channel diverting water to Pringle Creek) at RM 2.3 (RK 3.7). Most of the land in the watershed is privately owned. As of 2006, about 75 percent was used for farming, 13 percent for forestry, and 12 percent was urban. Artificial structures built in the mid-19th century altered the course of the original lower reaches of Mill Creek. Waller Dam, built around 1864 and modified in 1915, split Mill Creek into a millrace and what is sometimes referred to as North Mill Creek. The millrace, which originally powered a woolen mill, flows through the Willamette University campus.

Another diversion canal, Shelton Ditch, built in the mid-1800s, runs from Mill Creek near the municipal airport through the southern edge of downtown Salem. It empties into Pringle Creek near Pringle Park. Mill Creek has the most extensive floodplain through the City of any of the tributary streams to the Willamette.

Glenn Creek

The Glenn Gibson basin is located in Polk County and drains 10.4 square miles of west Salem. Approximately half of the basin is within the Urban Growth Boundary (UGB). The basin terrain is steep, particularly in the upper reaches, with flatter slopes near the basin outlet. There are over 20 small tributaries in the basin. The two main drainage channels are Glenn Creek and Gibson Creek. The Glenn Gibson basin is experiencing rapid growth in the upper-western reaches inside the UGB. Some development is also occurring outside the UGB in Polk County. Glenn Creek originates outside the UGB, and flows east through agricultural areas and residential developments. It eventually flows into the West Willamette Slough. Gibson Creek is a tributary of Glenn Creek. It originates outside the UGB near Eagle Crest Road NW and flows east through primarily agricultural and rural residential areas to a confluence with Glenn Creek near Wallace Road NW.

Claggett Creek

The Upper Claggett Creek basin drains 7.4 square miles, all of which are within the Urban Growth Boundary. The Upper Claggett basin drains into Claggett Creek, which flows through the city of Keizer and is a tributary of the Willamette River. The basin slope is very flat. The Upper Claggett Creek basin is highly developed, with land use including single and multi-family residential, industrial, commercial, rural, and agricultural areas. Two existing city-owned regional detention facilities are located in the basin: (1) the 37th Place NE facility; and (2) the Eastgate Soccer Field.

Pringle Creek

Pringle Creek Basin is a drainage area located in the City of Salem between the Battle Creek Basin to the south and the Mill Creek Basin to the north. The majority of Pringle Creek Basin is developed residential, commercial, and industrial land use. The southwest portion of the basin contains undeveloped agricultural land, forest, and grassland. The outlet for Pringle Creek Basin is the Willamette Slough, a backwater area of the Willamette River next to Minto Brown Island. Prior to its confluence with the Willamette Slough, two Mill Creek diversion channels, Shelton Ditch and Mill Race, discharge into Pringle Creek. Since the primary source of these diversion channels is Mill Creek, the channels and their contributing drainage areas are part of the Mill Creek Basin.

Smaller Tributaries

Portions of the Little Pudding River, Battle Creek, Croisan Creek, Pettijohn Creek, Willamette Slough and small drainages on the Willamette floodplain are all within the urban growth boundary of Salem.

Floodplain Development

The floodplains of the Salem area have changed significantly over time. Salem in 1862 was a small outpost community with a mill on Mill Creek (***Figure 8***). Goulder (1909) visited the Salem area in 1845-1846 and noted: "On Mill Creek, not far from the "Institute," there were a grist-mill, a saw-mill, and a boarding-house." He further observed that "The greater part of the area upon which the city of Salem was afterwords built, was then a well-cultivated wheat-field..."

As the community grew, the floodplain was altered to fit the growing city. Thirty years later the city of Salem occupied the east bank of the Willamette River with mills on the tributary creeks (***Figure 9***). At that time the population of Salem was some 3,400 residents.

Early development in Salem was laid out on a rectangular grid of ownership with only limited recognition of floodplain conditions. Through time the watershed was significantly altered (***Figure 10***) by urbanization, flood control, road and railroad construction, agriculture, and channel modification (clearing and snagging, revetment, channel simplification, etc.) as illustrated by Flitcroft and others (2023). The modern floodplain reflects the geomorphological template, biological conditions and socio-economic footprint of Salem.

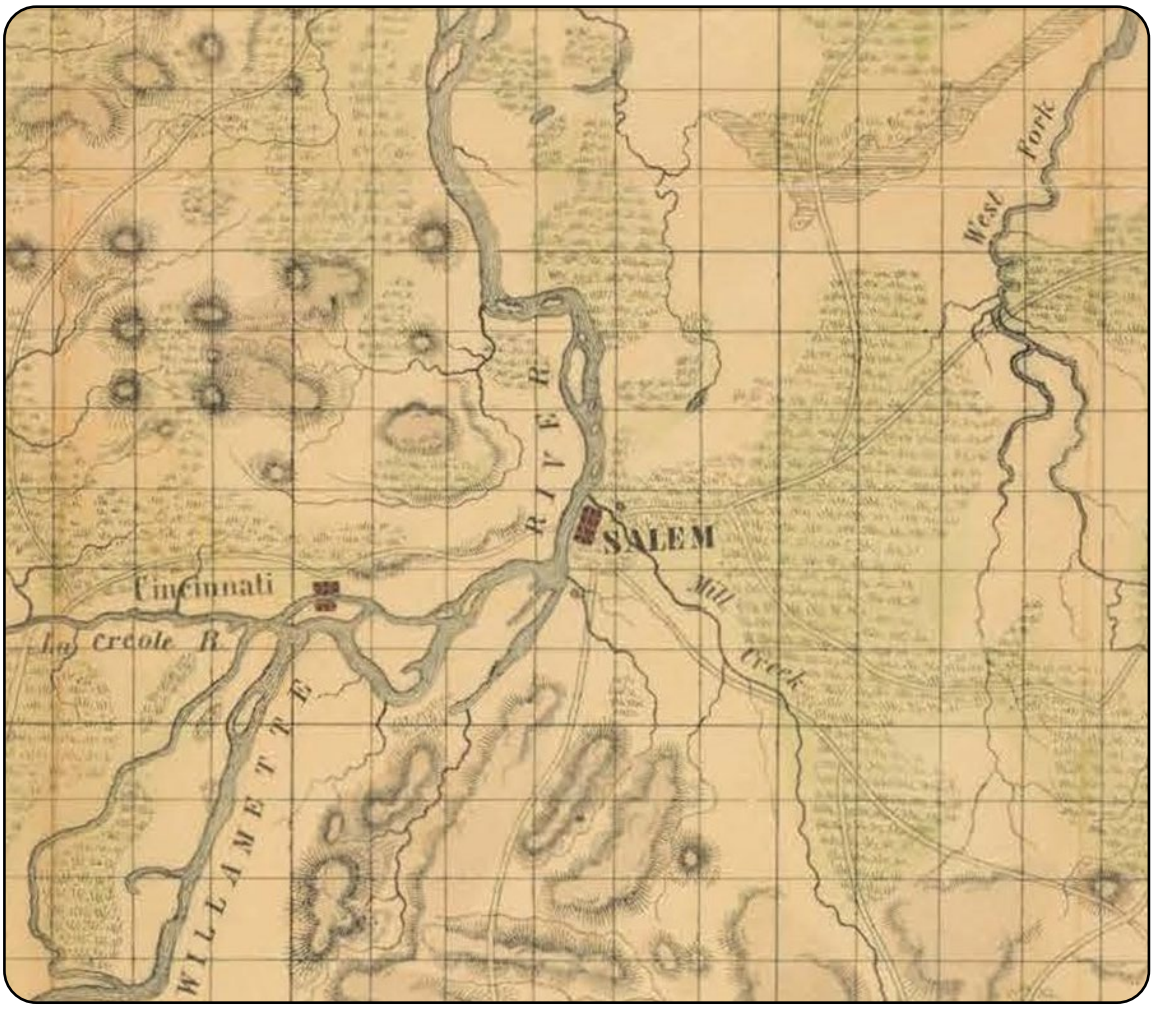


Figure 8: Salem Area 1862 from Map of the Surveyed Portions of Oregon Territory 1862

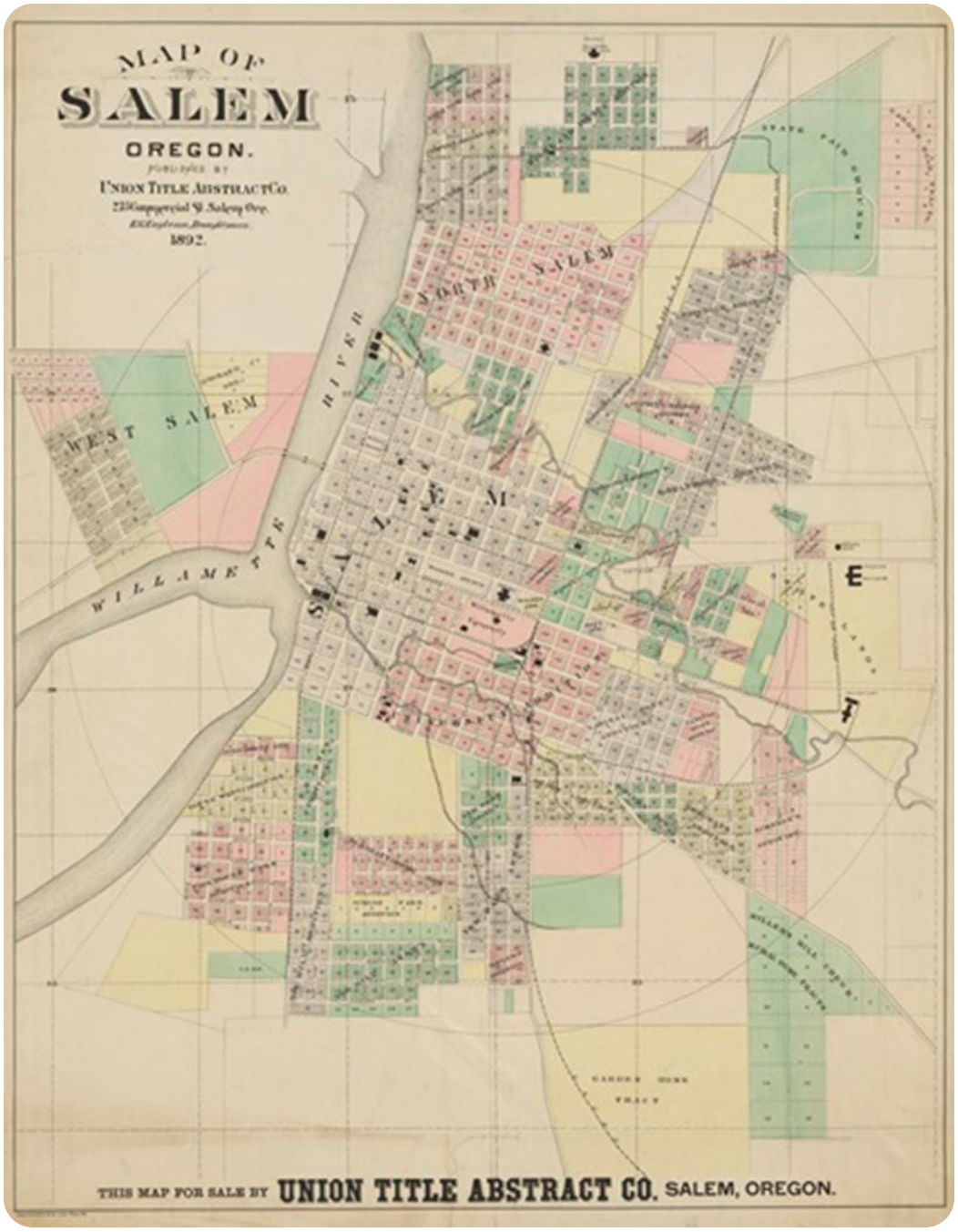


Figure 9: Salem 1892

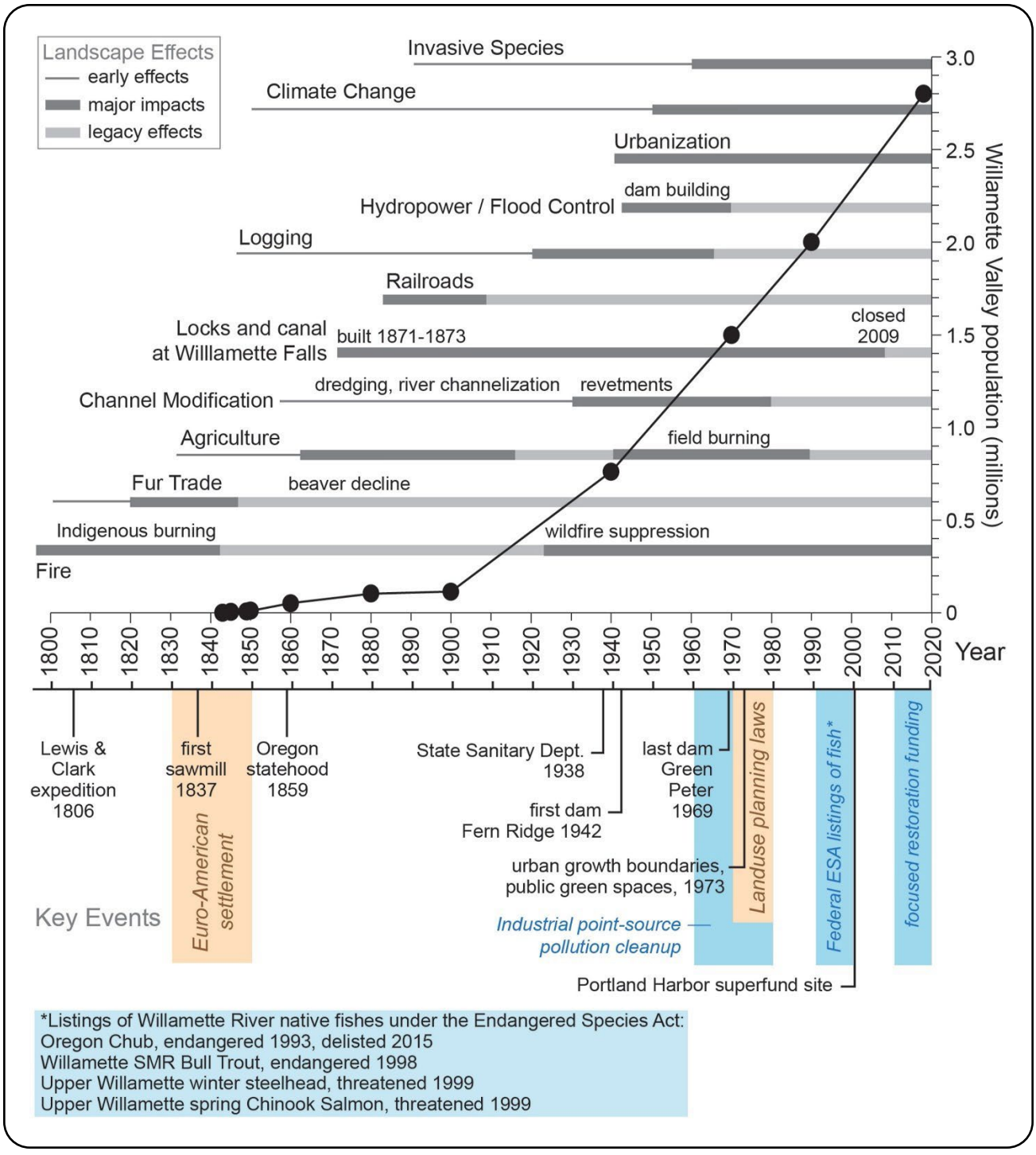


Figure 10: Watershed development chronology in the Willamette Basin (from Flitcroft et al., 2023)

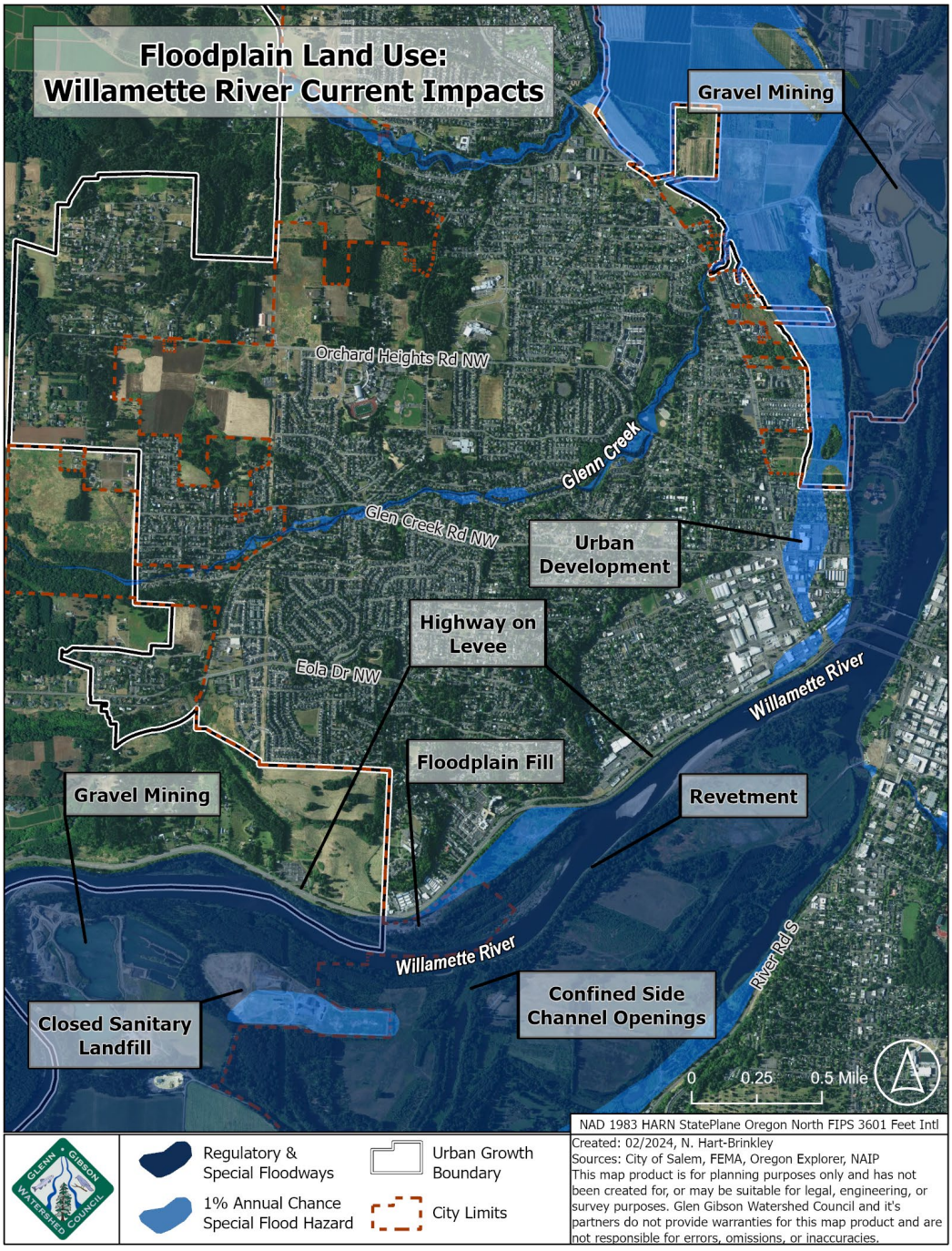


Figure 11: Willamette floodplain development and 1964 flood conditions.

Current Floodplain Conditions

Major alterations to the floodplains in the Salem area include urban development, gravel mining, fill, sanitary landfill, forest clearing, industrial development, riprap, and other conditions that define the current regulatory floodplain (***Figure 11***). These historic decisions affect the ability to prevent impacts and make flood impact management more difficult.

Similarly, the Mill Creek floodplain has been significantly developed by industrial, residential and gravel extraction over time. The result is a significant area of at-risk properties (***Figure 12***).

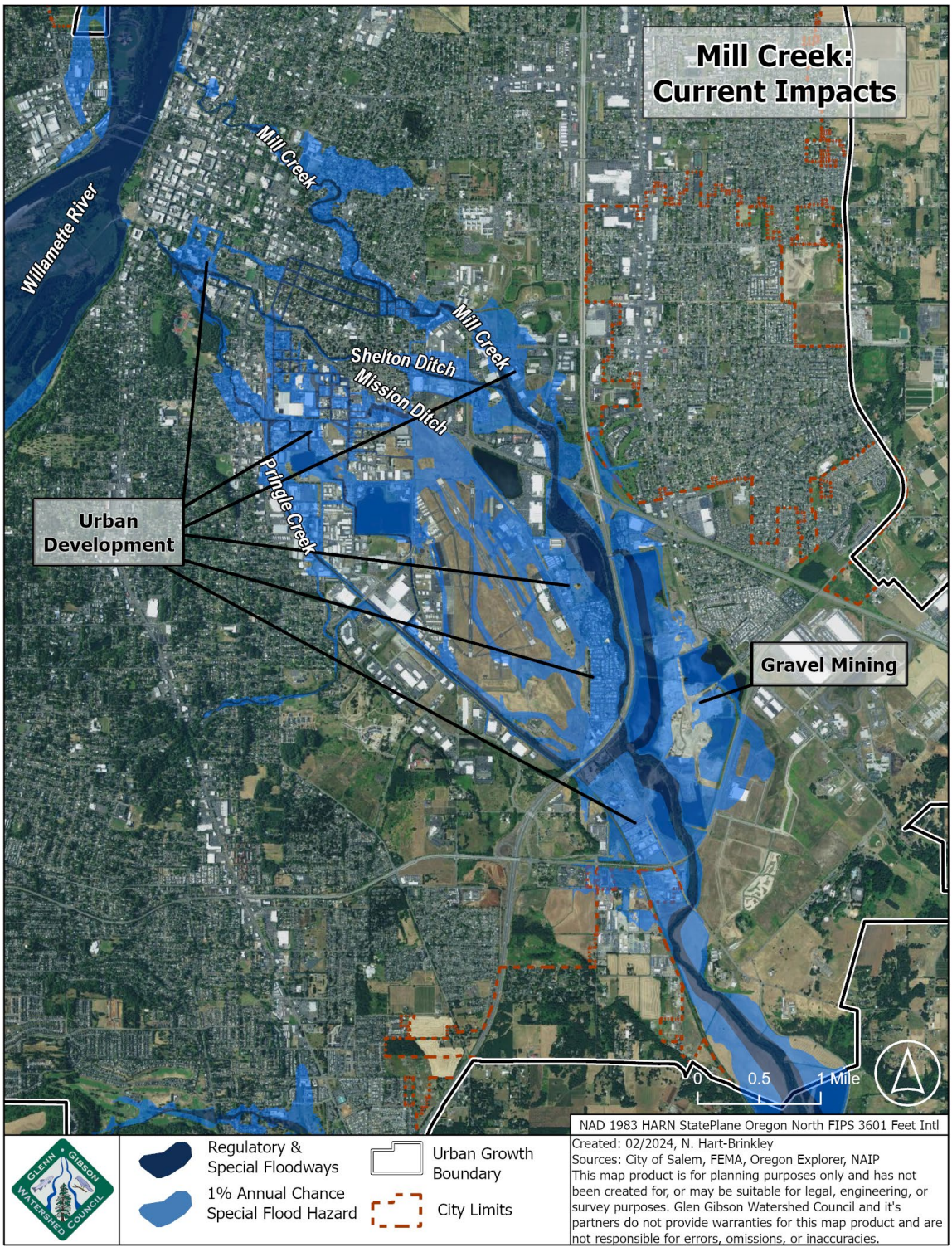


Figure 12: Mill Creek Floodplain showing current development affecting floodplain conditions.

Floodplain Species

Threatened and Endangered Species

The cumulative development of the Willamette Valley has resulted in simplification of the Willamette River and its floodplain reducing its capacity to support native fish. Conversion of the valley floor floodplain to agriculture and urban uses has led to the listing of wetland and wet prairie species under the federal Endangered Species Act. A review of FEMA's Flood Risk and Endangered Species Habitat (FRESH) website found seven species federally listed as threatened, one listed as endangered and two proposed for listing having their range in the Salem area. Marbled murrelet, a threatened species was identified as a species in proximity to Salem in the FRESH data. Suitable habitat for murrelet is not found in the Salem area so it was not further considered. These are shown in ***Table 1***. While the Upper Willamette Chinook salmon, and Upper Willamette steelhead are anadromous and spend most of their lives in salt water, this assessment focuses on their freshwater habitat in the waterways in Salem's jurisdiction. While not directly affected, Upper Columbia, Middle Columbia, Lower Columbia, and Snake River salmon and steelhead listed species could be affected by downstream effects of both floodplain development and conservation actions. There is an abundance of information on the Willamette River as habitat for salmon and steelhead.

Threatened and Endangered Species in Salem

Species	Scientific Name	Federal		State	
		Status	Agency[1]	Status	Agency[2]
Upper Willamette Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened	NMFS	Sensitive	ODFW
Upper Willamette Steelhead	*Oncorhynchus mykiss*	Threatened	NMFS	Sensitive	ODFW
Oregon spotted frog	*Rana pretiosa*	Threatened	USFWS	Sensitive	ODFW
Streaked Horned Lark	*Eremophila alpestris strigata*	Threatened	USFWS	Species of Concern	ODFW
Yellow-billed Cuckoo	*Coccyzus americanus*	Threatened	USFWS		ODFW
Oregon Vesper Sparrow	*Pooecetes gramineus affinis*	Petitioned for Review	USFWS	Sensitive	ODFW
Northwestern Pond Turtle	*Actinemys marmorata*	Proposed Threatened	USFWS	Sensitive	ODFW
Fender's Blue Butterfly	*Icaricia icarioides fenderi*	Threatened	USFWS		
Monarch Butterfly	*Danaus plexippus*	Candidate Species	USFWS		
Kincaid's Lupine	*Lupinus sulphureus ssp. kincaidii*	Threatened	USFWS	Threatened	ODA
Willamette Daisy	*Erigeron decumbens*	Endangered	USFWS	Endangered	ODA

Table 1: Salem Floodplain Threatened and Endangered Species

1 NMFS = National Marine Fisheries Service, USFWS = U.S. Fish & Wildlife Service
2 ODFW = Oregon Department of Fish & Wildlife, ODA = Oregon Department of Agriculture

Range and Critical Habitat Salmon and Steelhead

Critical habitat for Upper Willamette River (UWR) Chinook (*Oncorhynchus tschawytscha*) Evolutionarily Significant Unit (ESU) and Upper Willamette River steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) was designated by Federal Regulations on September 2, 2005 (FR notice: 70 FR 52630). The National Marine Fisheries Service uses the following definition for critical habitat boundaries (from 70 FR 52630). *"Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (33 CFR 319.11). In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation.*

Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge which generally has a recurrence interval of 1 to 2 years on the annual flood series.

(c) Primary constituent elements. Within these areas, the primary constituent elements essential for the conservation of these ESUs are those sites and habitat components that support one or more life stages, including:

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

(2) Freshwater rearing sites with:

(i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;

(ii) Water quality and forage supporting juvenile development; and

(iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;"

The stream reaches listed as critical habitat for Upper Willamette River Chinook salmon winter steelhead includes the estimated two-year flood zone of the Willamette River as displayed in ***Figure 13***. Critical habitat on the Willamette is shown to the two-year flood extent and designation of critical habitat includes Mill Creek, Shelton Ditch, lower Glenn Creek, and West Fork Little Pudding River within the Salem urban growth boundary.

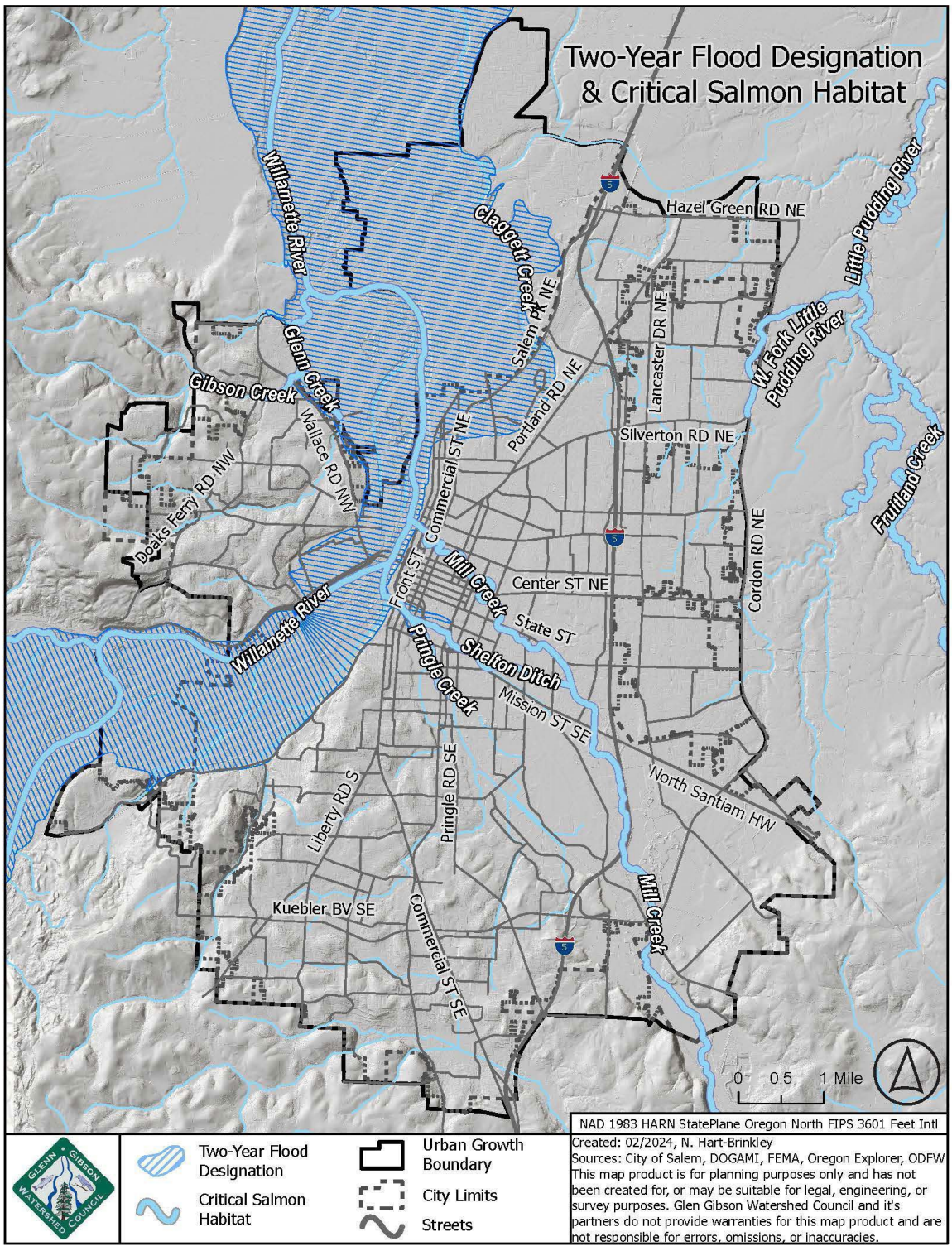


Figure 13: Salmon and Steelhead Critical Habitat and estimated Willamette River two-year flood level (critical habitat from NMFS, two-year flood mapping from River Design Group)

Essential Fish Habitat, under the Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Act requires the Secretary of Commerce to coordinate with, and provide information to, other Federal agencies regarding the conservation and enhancement of Essential Fish Habitat. Essential fish habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle. Essential fish habitat must be described and identified in Fishery Management Plans. In 2002, NMFS began to require that the plans also contain maps of EFH. The Magnuson Stevens Act requires NMFS to work with other Federal agencies to conserve and enhance EFH. As a result, whenever Federal agencies authorize, fund, or carry out actions that may adversely impact EFH, they must consult with NMFS regarding the impact of their activities on EFH. NMFS must provide the consulting Federal agency with EFH conservation recommendations for any action that would adversely affect EFH. Within 30 days of receiving these recommendations, the consulting action agencies must provide a detailed response in writing to NMFS that includes measures proposed to avoid, minimize, or offset the impact of proposed activities on EFH. There is a good deal of overlap between designated EFH and Critical Habitat in the freshwater environment (***Figure 14***). To streamline the consultation process, NMFS attempts to conduct EFH and ESA Section 7 consultations in conjunction with each other whenever possible.

Oregon Essential Indigenous Anadromous Salmonid Habitat

Under ORS 196.810(1)(g)(B) "Essential indigenous anadromous salmonid habitat" means the habitat that is necessary to prevent the depletion of indigenous anadromous salmonid species during their life history stages of spawning and rearing, and196.810(1)(g) (C) "Indigenous anadromous salmonid" means chum, sockeye, Chinook and Coho salmon, and steelhead and cutthroat trout, that are members of the family Salmonidae and are listed as sensitive, threatened or endangered by a state or federal authority. The Oregon Department of State Lands in consultation with Oregon Department of Fish and Wildlife has identified the extent of stream reaches that these definitions apply to. These stream reaches have additional state regulatory review for the placement of fill or removal of material under Oregon law (ORS 197.810). Essential Indigenous Anadromous Salmonid Habitat (***Figure 15***) is found in the Willamette River, Mill Creek, West Fork of the Pudding River and lower Glenn Creek.

Figure 14: Salmon and Steelhead Critical Habitat and estimated Willamette River two-year flood level (critical habitat from NMFS, two-year flood mapping from River Design Group)

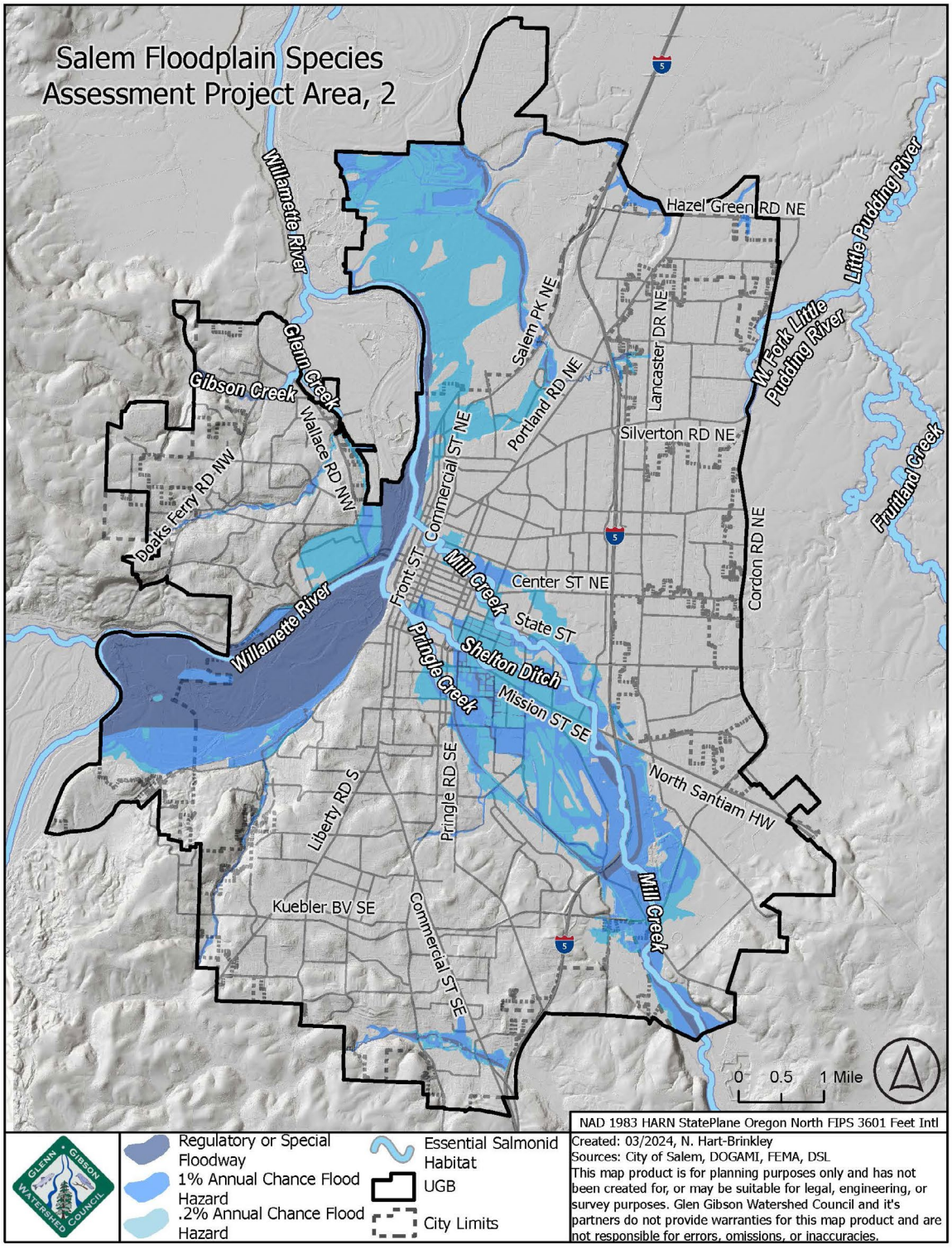


Figure 15: Essential Indigenous Anadromous Salmonid Habitat in the Salem area.

Range, Habitat and Recovery Plan for Streaked Horned Lark

In the 2021 Federal Register notice on the review of the Threatened listing of Streaked Horned Lark (*Eremophila alpestris strigata*) were described as: "Streaked horned larks historically selected habitat in relatively flat, open areas maintained by flooding, fire, and sediment transport dynamics. The interruption of these historical processes due to flood control dams, fire suppression, and reduction of sediment transport by dams resulted in a steep decline in the extent of historical habitat for the lark.

Currently, larks are found in open areas free from visual obstructions like grasslands, prairies, wetlands, beaches, dunes, and modified or temporarily disturbed habitats (such as agricultural or grass seed fields, airports, dredged material placement sites, and gravel roads). Streaked horned larks need relatively flat landscapes with sparse vegetation, preferring habitats with an average of 17 percent bare ground for foraging and 31 percent of bare ground for nesting (Altman 1999, p. 18). Typically, preferred habitats contain short vegetation, contain forbs and grasses that are less than 13 inches (in) (33 centimeters (cm)) in height, and have few or no trees or shrubs (Altman 1999, p. 18; Pearson and Hopey 2005, p. 27). The large, open areas used by populations of larks are regularly disturbed via burning, mowing, herbicide application, crop rotation, dredging material placement, and/or other anthropogenic regimes."

Specific to the Salem area the review noted: "One historical site for a local population in this region (Salem Municipal Airport) has no positive records since 2013 and appears to be extirpated. The Willamette Valley regional population appears to be well distributed and increasing, but the limited surveys of accessible sites may not accurately reflect the trend in the whole region."

Salem is in the North Willamette recovery zone as identified in the draft recovery plan (USFWS, 2019).

Range, Habitat and Recovery Plan for Willamette Prairie Species

The Willamette Valley Upland Prairie and Savanna is recognized as one of the most critically endangered ecosystems of the United States (Noss et al. 1995). Native species and ecosystems may be at an ecological tipping point due to the diminished and fragmented native habitats in the Valley, as evidenced by the declining populations and range contractions of many native fish, wildlife, and plant species. Eleven species native to the valley have been listed under the federal Endangered Species Act (ESA). Many other species have been extirpated and many more are threatened with extirpation, including western meadowlark, the Oregon State Bird (ODFW 2021). Extirpation refers to a species of plant or animal that ceases to exist in a given geographic area (e.g., the Willamette Valley), though it still exists elsewhere. A focus on grasslands (prairies and oak savannas) and oak woodlands is justified by the fact that very little of these habitats remain, and what does remain now occurs as remnant patches scattered across the valley (ODFW 2016).

Eleven species of fish, wildlife, and plants native to the valley have been listed as threatened or endangered under the federal Endangered Species Act (USFWS 1993, 1997, 1998, 2000, 2013). Three other federally listed species, the Columbian white-tailed deer (*Odocoileus virginianus leucurus*), Oregon spotted frog (*Rana pretiosa*), and yellow-billed cuckoo (*Coccyzus americanus*) historically bred in the valley but are now extirpated.

The prairie species recovery plan was developed for the following five prairie species native to the Willamette Valley:

- Fender's blue butterfly (*Icaricia icarioides fenderi*) Endangered
- Willamette daisy (*Erigeron decumbens*) Endangered
- Bradshaw's lomatium (*Lomatium bradshawii*) Endangered
- Kincaid's lupine (*Lupinus sulphureus ssp. kincaidii*) Threatened
- Nelson's checker-mallow (*Sidalcea nelsoniana*) Threatened

Willamette Daisy and Nelson's checker-mallow have been documented in the Salem area and occupy floodplain areas. An additional goal of the recovery plan is to focus on the restoration of both native upland and wet prairie ecosystems in the valley. This ecosystem approach takes into consideration the needs of non- listed species that are endemic to prairie habitats. Consequently, many of the recovery actions proposed in the plan may help to stabilize and enhance populations of species such as pale larkspur (*Delphinium leucophaeum*), Willamette Valley larkspur (*Delphinium oreganum*), peacock larkspur (*Delphinium pavonaceum*), shaggy horkelia (*Horkelia congesta ssp. congesta*), white-topped aster (*Sericocarpus rigidus*), and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*). Implementing management actions toward these species of conservation concern may preclude the need to extend the protections of the Endangered Species Act to other prairie species in the future (USFWS 2010).

Since the listing decision in the 1990's, Bradshaw's lomatium achieved recovery objectives in terms of protected populations of sufficient size and distribution across the valley's recovery zones to allow the species to be delisted. Golden paintbrush, once extirpated in Oregon, has met recovery objectives and also has been delisted. The same can be said for Nelson's checker-mallow – recovery objectives have been met and the species has been delisted. Fender's blue butterfly is also on the path to recovery. While the Service is proposing to reclassify the species from endangered status to threatened status, additional actions, including protecting its habitat, are still needed to fully recover this species.

The closest known populations of Fender's blue butterfly and Kinkade's lupine are at Basket Slough, west of the Salem area outside the Salem UGB.

Bald and Golden Eagle Protection Act of 1940

This federal law prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald or golden eagles, including their parts (including feathers), nests, or eggs. The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." Regulations further define "disturb" as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior". In addition to immediate impacts, this definition also covers effects that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death or nest abandonment. Since Bald eagles have become more abundant along the Willamette River, the prohibitions of the act are important to be aware of.

Floodplain Habitats and Associated Species

While identifying the presence of threatened or endangered species often requires biological expertise, recognizing the habitats that they are most likely to occupy can help to determine if they could be present. The following is a general description of floodplain habitats, how to identify them and what species may be associated with them. The typical floodplain habitats in the Salem area include riparian forest and shrublands, wet prairie, marsh, pond, and stream channel.

Riparian Forest and Shrubland

Cottonwood Oregon Ash and other forest species can provide a dense gallery along streams in the Willamette Valley. There has been significant study of the changes in Willamette Valley Floodplain forests (Christy and Alverson, 2011; Benner and Sedell, 1997; Gregory et al., 2019; Hulse et al., 2003; Johansen et al., 1971; Sedell and Froggatt, 1984; Wallick et al., 2013). These forests are often multistoried (have ground covering plants, shrubs, and trees) and typically dense.

While not likely to occur in the Salem area this is the habitat that supports yellow-billed cuckoo. Great Blue Heron, Osprey, Bald Eagles and willow flycatcher among other species use riparian forests for nesting and perching.

Ponds

Floodplain depressions from flood scour or gravel removal or other activities that intercept the groundwater table and hold water year-round are considered ponds. This is a unique habitat that can be found both on the Willamette floodplain and the Mill Creek floodplain. Ponds provide habitat for Western Grebe, Oregon spotted frog and northwest pond turtles. Howellia can also be found on pond edges.

Wetlands

Wetlands that are dominated by grass like and grass plants (sedges, reeds, etc.) are often found in floodplain locations. These habitats have standing water or are saturated to the surface for prolonged periods in the dry season. Species typically found there could be lesser yellowlegs, and possibly White-topped aster.

Prairies

Slightly up slope and on sloping portions of the floodplain are grassy prairies often with scattered Oregon White Oak. The Willamette Valley prairie habitat supports streaked horned lark, Willamette daisy, Kincaid's lupine the host plant for Fender's blue butterfly. These sites also support golden paintbrush, Peacock larkspur. Thin-leaved peavine and Bradshaw's lomatium are often found in areas of ground disturbance or along ditch banks with meadow checkermallow. These sites are typically outside the floodplain.

Creeks and Streams

The tributary streams to the Willamette River and the Willamette River are important habitats for a number of species. It is well recognized that fish are dependent on streams for their life histories. The streams that constitute

and cross the floodplains of the Salem area support Chinook salmon, steelhead, cutthroat trout, Pacific lamprey, Western brook lamprey, and western pearlshell mussels. Western brook lamprey spawn in the small streams tributary to the Willamette. It should be noticed that the flooded forest and marshes are used by juvenile salmon and steelhead during flood stage of the rivers. It is important to understand that critical habitat for salmon and steelhead extends across the floodplain in it's regular flood range (usually 2-year flood).

Species of Concern

There are other species that occur or occupy habitats found in Salem's floodplains that, while not federally listed, are species of concern (***Table 2***).

Species of Concern in Salem				
Species	**Scientific Name**	**Status**	**Listing Agency**	**Salem Observation**
Fish				
Pacific lamprey	*Entosphenus tridentatus*	SoC, S	NMFS, ODFW	X
Western brook lamprey	*Lampetra richardsoni*	S	ODFW	X
Coastal cutthroat trout (Upper Willamette River ESU)	*Oncorhynchus clarkii*	SoC, Sentitive	NMFS, ODFW	X
Birds				
Bald Eagle	*Haliaeetus Leucocephalus*		Eagle Act	X
California Gull	*Larus Californicus*	BCC		X
Evening Grosbeak	*Coccothrauthes vespertinus*	BCC		X
Lesser Yellowlegs	*Tringa flavipes*	BCC		Nearby
Olive-sided Flycatcher	*Condopus cooperi*	BCC		X
Rufous Hummingbird	*Selasphorus rufus*	BCC		X
Western Grebe	*Aechmorphous occidentalis*	BCC		X
Oregon Vesper Sparrow	*Pooecetes gramineus*	SoC	Under Review	
Great Blue Heron	*Ardea herodias*			X
Willow Flycatcher	*Empidonax traillii*			X
Yellow-breasted Chat	*Icteria virens*	BCC		X

Table 2: Sensitive Species in the Salem Floodplain Area (continues on next page)

(continued from previous page)

Table 2: Sensitive Species in the Salem Floodplain Area

Invertebrates				
Western pearlshell (mussel)	*Margaritifera falcata*			
Oregon giant earthworm	*Driloleirus macelfresh*	SoC	USFWS	
Foliaceous lace bug	*Derephysia foliacea*			
Taylor's checkerspot (butterfly)	*Euphydryas editha taylori*	E	USFWS	
Sonora skipper (butterfly)	*Polites sonora siris*			
Valley silverspot (butterfly)	*Speyeria zerene bremnerii*			
Franklin's bumble bee	*Bombus franklini*	SoC	ODFW	
Plants				
Tall bugbane	*Cimicifuga elata Nutt. var. elata*	C	ODA	X
Willamette Valley larkspur	*Delphinium oreganum T.J. Howell*	SoC	USFWS, ODA	
Peacock larkspur	*Delphinium oreganum T.J. Howell*	SoC, E	USFWS, ODA	
Western wahoo	*Euonymus occidentalis Nutt. ex Torr*			
Shaggy horkelia	*Horkelia congesta Dougl. ex Hook. ssp. congesta*	SoC, C	USFWS, ODA	X
Howellia	*Howellia aquatilis Gray*	Delisted, T	USFWS, ODA	X
Thin-leaved peavine	*Lathyrus holochlorus (Piper) C.L. Hitchc.*	SoC, E	USFWS, ODA	X
Bradshaw's lomatium	*Lomatium bradshawii*	Delisted, E	USFWS, ODA	
Loose-flowered bluegrass	*Poa laxiflora Buckl*			
Weak bluegrass	*Poa marcida A.S. Hitchc.*			
Narrow-flower bluegrass	*Poa stenantha Trin*			
White-topped aster	*Sericocarpus rigidus*	SoC, T	USFWS, ODA	X
Meadow checkermallow	*Sidalcea campestri Greene*			X
Nelson's sidalcea	*Sidalcea nelsoniana Piper*	Delisted, T	USFWS, ODA	X
Golden paintbrush	*Castilleja levisecta*	Delisted, E	USFWS, ODA	X

Community Rating System Credit for Conservation and Recovery

A good number of the conservation and recovery actions that local governments can implement can be credited under the Community Rating System (CRS). The CRS provides reduced flood insurance premiums in communities that undertake activities to prevent or reduce flood losses and protect natural floodplain functions. Salem is currently a CRS Class 3 as of April 1, 2024. It means that starting April 1, 2024, Salem residents in flood-prone areas can get a 35% discount on most federal flood insurance premiums. Salem is currently in the top 1% of communities in the U.S. to achieve this designation. Implementing more activities, such as threatened and endangered species recovery actions, could help the City move to a better class. The current credit score for Salem is 3,644. To obtain CRS Class 2 with a 40% discount on flood insurance, the City needs to achieve a score of 4,000 CRS credit points. This Floodplain Species Assessment will provide an additional 15 CRS credit points towards that improved class rating.

Table 3 reviews general CRS-credited recovery actions that are applicable to most threatened and endangered species. The "Doing" column identifies whether the City is implementing what is or could be a CRS credited activity. If the City is getting credit, the "Credited" column shows the current CRS credit points and the maximum credit available. The "Feasible" column identifies if it would be feasible to start an activity or increase the credit points.

CRS-Credited Conservation and Recovery Actions					
Activity/Element	**Page[1]**	**Section in Manual[2]**	**Doing?**	**Credited?**	**Feasible?**
300 Public Information Activities					
Providing information on areas that serve natural floodplain functions, such as wetlands (MI7)	11	322.g	YES	20/20	YES
Outreach projects (OP) with messages on protecting natural functions	11	332.a	YES	200/200	YES
Designing and disseminating messages on protecting natural floodplain functions in a program for public information (PPI)	12	332.c	YES	80/80	YES
Having materials in the local public library (LPD) on protecting local natural floodplain functions	13	352.b	YES	10/10	YES
Having materials on protecting local natural floodplain functions in the community's website (WEB)	13	352.c	YES	77/77	YES
420 (Open Space Preservation)					
Preserving open space in the floodplain (OSP)	15	422.a	YES	681.5/1450	YES
Preserving open space in the floodplain in its natural state (NFOS)	16	422.c	YES	180/350	YES
Preserving open space on eroding shorelines (CEOS[3])	16	422.e	N/A	N/A	N/A
Offering incentives to developers to keep the floodplain open (OSI)	16	422.f	NO	0/250	NO
Zoning floodprone areas for large lot sizes to preserve low density uses (LZ)	17	422.g	NO	0/600	NO
Preserving stream banks and shorelines in their natural state (NSP)	17	422.h	NO	0/120	YES
430 (Higher Regulatory Standards)					
Prohibiting filling in the floodplain (DL1a)	18	432.a(1)	NO	0/280	NO
Regulating development in areas subject to coastal erosion (CER[3])	20	432.n	N/A	N/A	N/A
Other regulations to protect natural floodplain functions not specifically listed in the Coordinator's Manual	20	432.o	NO	0/100	YES
450 (Stormwater Management)					
Requiring new developments in the watershed to account for the total volume of runoff released (SMR-DS)	21	452.a(2)	YES	225/225	YES
Requiring new developments to use low impact development techniques (SMR-LID)	21	452.a(3)	NO	0/25	YES
Setting stormwater management standards based on an overall plan for the watershed (WMP)	21	453.b	YES	63/315	YES
510 (Floodplain Management Planning)					
Adopting one or more plans that address protecting natural floodplain functions (NFP)	23	512.c	NO	0/100	YES
540 (Drainage System Maintenance)					
Having a habitat-friendly program to clear debris in drainageways (CDR)	27	542.a	YES	198/200	YES

Table 3: Community Rating System Credited Conservation and Recovery Actions

1. Page numbers refer to CRS Credit for Habitat Protection.
2. This column lists the section(s) of the CRS Coordinator's Manual in which more information can be found.
3. These elements are appropriate only for species dependent on beaches, such as sea turtles and shore birds.
4. Credits were derived from detailed results from previous verification visits and most recent results from the 2023 Class 3 CRS Cycle Visit, which include sum totals for each activity category. Some assumptions were made without detailed results from the ISO office (no longer provided to communities).

References

Altman, B. 1999. Status and conservation of state sensitive grassland bird species in the Willamette Valley. A report to the Oregon Department of Fish and Wildlife.

Altman, B. 2011. Historical and current distribution and populations of bird species in prairie-oak habitats in the Pacific Northwest. Northwest Science 85:194-222.

Benner, P.A., Sedell, J.R., 1997. Upper Willamette River landscape: a historic perspective. In: Laenen, A., Dunnette, D.A. (Eds.), River Quality: Dynamics and Restoration. Lewis Publishers, Boca Raton, USA, pp. 23–47.

Bond, M., Nodine, T., Sorel, M., Beechie, T., Pess, G., Myers, J., and Zabel, R. 2017. Estimates of UWR Chinook and steelhead spawning and rearing capacity above and below Willamette Project dams: Portland, Oregon, U.S. Army Corps of Engineers, Study Code APH-15-04-DET, 77 p.

Christy, J.A., Alverson, E.R., 2011. Historical vegetation of the Willamette Valley, Oregon, circa 1850. Northwest Sci. 85, 93–107.

City of Salem Public Works Department. 2023. Salem Floodplain Management Plan. October 2023. 156 p.

Colvin, R., Giannico, G.R., Li, J., Boyer, K.L., Gerth, W.J., 2009. Fish use of intermittent watercourses draining agricultural lands in the upper Willamette River valley, Oregon. Trans. Am. Fish. Soc. 138, 1302–1313.

Gregory, S., Wildman, R., Hulse, D., Ashkenas, L., Boyer, K. 2019. Historical changes in hydrology, geomorphology, and floodplain vegetation of the Willamette River, Oregon. River Res. Appl. 35, 1279–1290.

Hulse, D.S., Gregory, S., Baker, J. (Eds.) 2002. Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change. Oregon State University Press, Corvallis, USA.

Kock, T.J., Perry, R.W., Hansen, G.S., White, J., Stratton Garvin, L., and Wallick, J.R. 2021. Synthesis of habitat availability and carrying capacity research to support water management decisions and enhance conditions for Pacific salmon in the Willamette River, Oregon: U.S. Geological Survey Open-File Report 2021–1114, 24 p.

Flitcroft, Rebecca, Luke Whitman, James White, Rose Wallick, Laurel Stratton Garvin, Cassandra Smith, Robert Plotnikoff, Michael Mulvey, Tobias Kock, Krista Jones, Peter Gruendike, Carolyn Gombert, Guillermo Giannico, Andrew Dutterer, Daniel Brown, Hannah Barrett, Brian Bangs, and Robert M. Hughes. 2023. Science to support conservation action in a large river system: The Willamette River, Oregon, USA. Water Biology and Security. v. 2 no.4 *https://www.sciencedirect.com/science/article/pii/S2772735123000896*

Friesen, T.A. 2005. Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River—Final Report to the City of Portland: Oregon Department of Fish and Wildlife, 246 p.

Friesen, T.A., Vile, J.S., and Pribyl, A.L. 2007. Outmigration of juvenile Chinook salmon in the lower Willamette River, Oregon: Northwest Science, v. 81, no. 3, p. 173–190.

Gerth, William J. Judith Li, Guillermo R. Giannico. 2017. Agricultural land use and macroinvertebrate assemblages in lowland temporary streams of the Willamette Valley, Oregon, USA. Agriculture, Ecosystems & Environment. 236: 154-165.

Goulder, William Armistead. 1909. Reminiscences Incidents in the life of a pioneer in Oregon and Idaho. University of Idaho Press reprint edition. 1989.376 p.

Gregory S, Wildman R, Hulse D, Ashkenas L, Boyer K. 2019. Historical changes in hydrology, geomorphology, and floodplain vegetation of the Willamette River, Oregon. River Res Applications. 35: 1279–1290. *https://doi.org/10.1002/rra.3495*

Hansen, G.S., Perry, R.W., Kock, T.J., White, J.S., Haner, P.V., Plumb, J.M., and Wallick, J.R. 2023. Assessment of habitat use by juvenile Chinook salmon (Oncorhynchus tshawytscha) in the Willamette River Basin, 2020–21: U.S. Geological Survey Open-File Report 2023–1001, 20 p., *https://doi.org/10.3133/ofr20231001*.

Hauer, F.R., H. Locke, V. J. Dreitz, M. Hebblewhite, W. H. Lowe, C. C. Muhlfeld, C. R. Nelson, M. F. Proctor, and S. B. Rood. 2016. Gravel-bed river floodplains are the ecological nexus of glaciated mountain landscapes. Sci. Adv. 2, e1600026.

Hulse, D., Gregory, S., and Baker, J., eds. 2013. Willamette River Basin Atlas: Corvallis, Oregon State University Press, p. 44-45, accessed August 23, 2013, at http://oregonstate.edu/dept/pnw-erc/.

Hulse, D., & Gregory, S. 2004. Integrating resilience into floodplain restoration. Urban Ecosystems, 7, 295–314. https://doi.org/10.1023/B:UECO.0000044041.94705.52

Johannessen, C.L., Davenport, W.A., Millet, A., McWilliams, S., 1971. The vegetation of the Willamette Valley, Oregon. Ann. Assoc. Am. Geogr. 61, 286–302.

Lane, Stuart N. 2017. Natural Flood Management. WIREs Water 4:e1211.doi: 10.1002/wat2.1211

National Marine Fisheries Service West Coast Region. 2024. 2024 5-Year Review: Summary & Evaluation of Upper Willamette River Steelhead, Upper Willamette River Chinook Salmon. 79 pp. *https://www.fisheries.noaa.gov/s3//2024-07/uwr-steelhead-chinook-5yr-review-2024.pdf*

Noss, R.F., E.T. LaRoe III, and J.M. Scott. 1995. Endangered Ecosystems of the United States: a preliminary assessment of loss and degradation. U.S. Department of the Interior. Biological Report 28. Feb. 1995.

Oregon Department of Fish and Wildlife (ODFW). 2010. Declining and state sensitive bird species breeding in the Willamette Valley Grasslands: 2008/09 status update. Salem, OR.

Oregon Department of Fish and Wildlife (ODFW). 2016. Oregon Conservation Strategy. Salem, OR.

Oregon Department of Fish and Wildlife (ODFW) and the National Marine Fisheries Service (NMFS) Northwest Region. 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. August 5, 2011. 722 p.

Orr, Elizabeth and William Orr. 2019. An Environmental History of the Willamette Valley. History Press. Charleston, SC. 255 p.

Pearson, S., and M. Hopey. 2005. Streaked horned lark nest success, habitat selection, and habitat enhancement experiments for the Puget lowlands, coastal Washington, and Columbia River Islands. Natural Areas Report 2005-01. Washington Department of Natural Resources, Olympia, Washington. 49 pp.

River Design Group, Inc. 2012. Willamette River floodplain inundation mapping—Eugene to Oregon City, Oregon: Completed for the Meyer Memorial Trust, Corvallis, Oregon, 55 p.

Santelmann, M., McDonnell, J., Bolte, J., Chan, S., Morzillo, A.T., Hulse, D., 2012. Willamette Water 2100: River basins as complex social-ecological systems. WIT Trans. Ecol. Environ. 155, 575–586.

Scheerer, P.D., 2007. Improved status of the endangered Oregon chub in the Willamette River, Oregon. Am. Fish. Soc. Symp. 53, 91–102.

Schroeder, R. K., Whitman, L. D., Cannon, B., & Olmsted, P. 2016. Juvenile life-history diversity and population stability of spring Chinook salmon in the Willamette River basin, Oregon. Canadian Journal of Fisheries and Aquatic Sciences, 73(6), 921–934. *https://doi.org/10.1139/cjfas-2015-0314*

Sedell, J.R., Froggatt, J.L., 1984. Importance of streamside forests to large rivers—the isolation of the Willamette River, Oregon, U.S.A., from its floodplain by snagging and streamside forest removal. Internat. Verein.TheoretAngewandte Limnol. Verhand. 22, 1828–1834.

Serra-Llobet, A., Tourment, R., Montané, A., & Buffin-Belanger, T. 2022a. Managing residual flood risk behind levees: Comparing USA, France, and Quebec (Canada). Journal of Flood Risk Management, 15(2), e12785. *https://doi.org/10.1111/jfr3.12785*

Serra-Llobet A, Jähnig SC, Geist J, Kondolf GM, Damm C, Scholz M, Lund J, Opperman JJ, Yarnell SM, Pawley A, Shader E, Cain J, Zingraff-Hamed A, Grantham TE, Eisenstein W and Schmitt R. 2022b. Restoring Rivers and Floodplains for Habitat and Flood Risk Reduction: Experiences in Multi-Benefit Floodplain Management from California and Germany. Front. Environ. Sci. 9:778568. doi: 10.3389/fenvs.2021.778568

U.S. Fish and Wildlife Service (USFWS). 1993. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Plant "Sidalcea nelsonianna" (Nelson's checkermallow). 58 FR 8235.

U.S. Fish and Wildlife Service (USFWS). 1997. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Castilleja levisecta (Golden Paintbrush). 62 FR 31740.

U.S. Fish and Wildlife Service (USFWS). 1998. Endangered and Threatened Wildlife and Plants; Final Endangered Status for Lomatium bradshawii (Bradshaw's lomatium). 53 FR 38448.

U.S. Fish and Wildlife Service. 2006. Endangered and threatened wildlife and plants: Designation of critical habitat for the Fender's blue butterfly (Icaricia icarioides fenderi), Lupinus sulphureus ssp. kincaidii (Kincaid's lupine), and Erigeron decumbens var. decumbens (Willamette daisy); final rule. Federal Register 71:63862-63977. October 31, 2006.

U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.

U.S. Fish and Wildlife Service (USFWS). 2013. Determination of Endangered Status for the Taylor's Checkerspot Butterfly and Threatened Status for the Streaked Horned Lark; Final Rule. 78 FR 61451.

U.S. Fish and Wildlife Service. 2017. Willamette Valley Conservation Study. Pacific Region, Portland, Oregon. 148 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Draft Recovery Plan for the Streaked Horned Lark (Eremophila alpestris strigata). U.S. Fish and Wildlife Service Portland, OR. 28pp.

U.S. Fish and Wildlife Service. 2020. Monarch (Danaus plexippus) Species Status Assessment Report. V2.1 96 pp + appendices.

U.S. Fish and Wildlife Service. 2022. Oregon Spotted Frog (Rana pretiosa) Species Biological Report. December 2022, Version 1. Portland, Oregon. xi + 23 pages.

U.S. Fish and Wildlife Service. 2023. Draft Recovery Plan for the Oregon Spotted Frog (Rana pretiosa). Portland, Oregon. 99 pp +appendices.

Wallick, J.R., Grant, G., Lancaster, S., Bolte, J.P. and Denlinger, R. 2022. Patterns and Controls on Historical Channel Change in the Willamette River, Oregon USA . In Large Rivers, A. Gupta (Ed.). *https://doi.org/10.1002/9781119412632.ch25*

Wallick, J.R., Lancaster, S.T., and Bolte, J.P. 2006. Determination of bank erodibility for natural and anthropogenic bank materials using a model of lateral migration and observed erosion along the Willamette River, Oregon— USA: River Research and Applications, v. 22, p. 631–649.

Wallick, J.R., Jones, K.L. O'Connor, J.E., Keith, M.K., Hulse, David, and Gregory, S.V. 2013. Geomorphic and vegetation processes of the Willamette River floodplain, Oregon—Current understanding and unanswered questions: U.S. Geological Survey Open-File Report 2013-1246., 70 p., *http://dx.doi.org/10.3133/ofr20131246*.

White, J.S., Peterson, J.T., Stratton Garvin, L.E., Kock, T.J., and Wallick, J.R. 2022. Assessment of habitat availability for juvenile Chinook salmon (Oncorhynchus tshawytscha) and steelhead (O. mykiss) in the Willamette River, Oregon: U.S. Geological Survey Scientific Investigations Report 2022–5034, 44 p., *https://doi.org/10.3133/sir20225034*.

White, J. S., Kock, T. J., Penaluna, B. E., Gregory, S., Williams, J., & Wildman, R. 2024. Expansion of smallmouth bass distribution and habitat overlap with juvenile Chinook salmon in the Willamette River, Oregon. River Research and Applications, 40(2), 251–263. *https://doi.org/10.1002/rra.4228*

Whitman, L.D., Schroeder, R.K., and Friesen, T.A. 2017. Evaluating migration timing and habitat for juvenile Chinook salmon and winter steelhead in the mainstem Willamette River and major spawning tributaries: Portland, Oregon, U.S. Army Corps of Engineers, 32 p.

Wing, Oliver EJ, Paul D Bates, Andrew M Smith, Christopher C Sampson, Kris A Johnson, Joseph Fargione, and Philip Morefield. 2018. Estimates of present and future flood risk in the conterminous United States. Environ. Res. Lett. 13(3) *https://iopscience.iop.org/article/10.1088/1748-9326/aaac65/pdf*

Appendix A: Species Profiles

Upper Willamette River Chinook Salmon (*Oncorhynchus tshawytscha)*

Description

The Chinook salmon (Oncorhynchus tshawytscha) is the largest and most valuable species of Pacific salmon. Its common name is derived from the Chinookan peoples. Other vernacular names for the species include king salmon, Quinnat salmon, Tsumen, spring salmon, chrome hog, Blackmouth, and Tyee salmon. Chinook salmon are the largest Pacific salmon species and, on average, grow to be three feet (0.9 meters) long and approximately 30 pounds (13 kilograms). However, some Chinook salmon can reach more than five feet (1.5 meters) long and 110 pounds (50 kilograms). The salmon are blue-green on the head and back and silver on the sides. The fish's tail, back, and upper fin have irregular black spots, and black markings also are present around the gums. Male Chinook salmon have a distinctive hooked nose at the top of the mouth and a ridged back. During the mating season, both male and female salmon develop a reddish tint around their back fins and tail.

Life cycle

As anadromous fish, salmon live in streams that drain to the ocean. The Willamette River drains to the Columbia in the Portland area and then connects to the Pacific Ocean at the mouth as Astoria. Chinook salmon lay their eggs and spend their first few months in fresh water. In less than a year, they migrate to saltwater where they spend most of their lives. They come back to the streams they were born in to lay their eggs and die. The Upper Willamette River (UWR) Chinook (Oncorhynchus tschawytscha) Evolutionarily Significant Unit (ESU) includes all naturally spawned populations of spring Chinook salmon in the Clackamas River and in the Willamette Basin upstream of Willamette Falls.

ODFW sampling and tagging data are starting to indicate that most fry and fingerling rear in the lower reaches of spawning tributaries and in the Willamette River mainstem in late winter and early spring (Schroeder et al. 2005, 2007). Some fish grow quickly in this area and migrate as subyearling

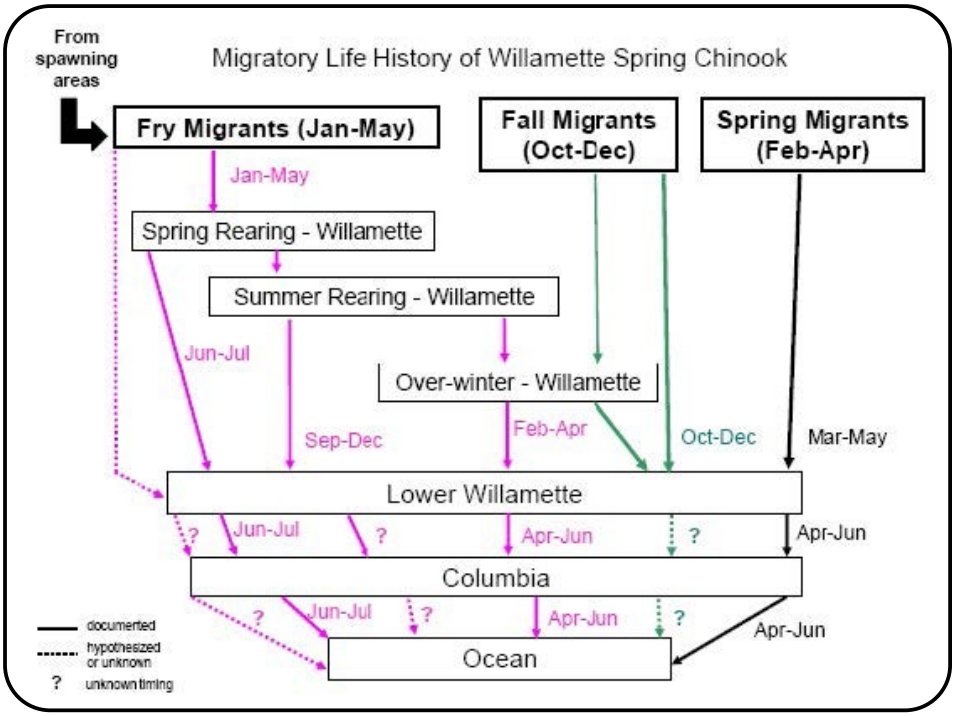


Illustration of variation in outmigration timing and use of different river regimes of Upper Willamette River Spring Chinook Salmon (modified from Schroeder et al., 2016)

Return to TOC

smolts out of the Willamette River basin, probably beginning in early to mid-May for the larger fish and continuing into mid-July in most years.

Habitat

Chinook salmon needs colder water with stable stream channels, clean spawning and rearing gravel, diverse cover, and unblocked migratory corridors. Because of their large body size, Chinook generally prefer to spawn in mainstems with higher water flows and deep holding pools and are able to spawn in larger gravel than most other salmon. The Willamette River in the Salem area is dominantly in the area for upriver migration of adult spawning fish and downriver migration of juvenile fish. Habitat use by juvenile Chinook salmon undergoes a seasonal shift that was likely driven by the increasing size of fish over time. Juvenile Chinook salmon were only observed in 7 percent of the alcove habitats sampled compared to approximately 40 percent of the main channel and side channel habitats.

Threats

The factors threatening naturally spawned Chinook salmon throughout its range are numerous and varied. The present depressed condition is the result of several long-standing, human induced factors (e.g., habitat degradation, water diversions, harvest, and artificial propagation) that serve to exacerbate the adverse effects of natural environmental variability from such factors as drought. In the Salem area floodplain development that adds to impervious surface cover can have detrimental impacts to a wide range of aquatic species including Chinook salmon. Actions taken to reduce or minimize impervious surface cover and reduce stormwater runoff and pollutants can include: preservation of areas as "open space", sustainable or "green" development practices that incorporate nature based solutions, and conversion of impervious to pervious (porous) surfaces.

Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries, and in the absence of effective passage programs will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are generally the highest. Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG). Given current climatic conditions and the prospect of long-term climatic change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future.

ESA Listing Status

Threatened on March 24, 1999 (64 FR 14308) and June 28, 2005 (70 FR 37159); updated April 14, 2014 (79 FR 20802)

Critical Habitat

Designated September 2, 2005 The designation of critical habitat includes stream reaches up to the two-year flood elevation. In the Willamette River that covers a significant portion of the floodplain.

Protective Regulations

Issued June 28, 2005 (70 FR 37159)

Recovery Plan

Upper Willamette River Chinook and Steelhead Conservation & Recovery Plan (2011)

Habitat use in Salem Area

With their complex life history strategies, juvenile Chinook salmon are likely to be found in the mid-Willamette area any time of the year under any flow conditions. Juvenile fish typically move downstream along the edge of the river, avoiding the main flow, thus occupying fringe habitats in the floodplain.

Upper Willamette River Steelhead
(Oncorhynchus mykiss)

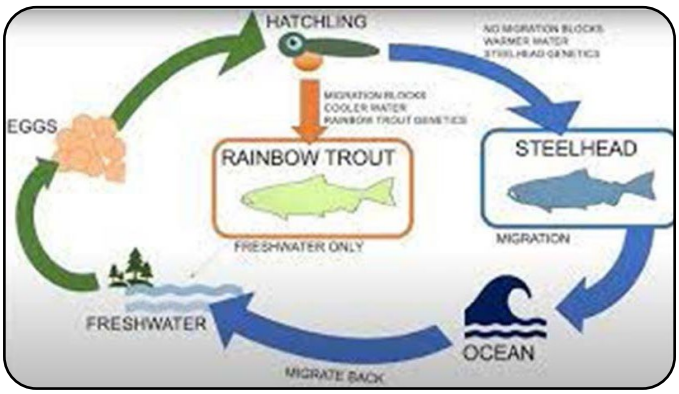
Description
Steelhead and rainbow trout are the same species, but rainbow are freshwater only, and steelhead are anadromous, or go to sea. Unlike most salmon, steelhead can survive spawning, and can spawn in multiple years. Steelhead can weigh 30 pounds or more, but average between 8 and 11 pounds. The body of the steelhead trout is silvery and streamlined with a rounder head. This silver color and round head is what gives the steelhead its name. There are black dots that are more concentrated on the back of the fish and become sparser closer to the lateral line of the fish. Steelhead also develop a pink horizontal stripe. When steelhead return to freshwater to spawn, their color begins to more closely resemble that of a normal rainbow trout.

Life Cycle
Steelhead can spend from 1 to 4 years in the ocean before traveling to their spawning grounds. There are two general types of steelhead runs, named for the season when most of the fish run return from the ocean: winter and summer.

Winter-run Steelhead return from the ocean at age 4 or 5 years, and travel to their spawning grounds from November to April. Winter-run steelhead are very mature fish and begin spawning soon after they arrive.

Summer-run Steelhead usually return from the ocean at age 3 and migrate to their spawning grounds from April to September. The summer-run steelhead are typically immature fish and need several months of maturing in the freshwater before spawning. Both steelhead stocks spawn from winter to early spring (January to April). The lifespan of steelhead varies from 5 up to 11 years.

Steelhead are different from Pacific salmon because steelhead do not all die once they spawn. Steelhead can survive after spawning and can migrate to the ocean and back to their spawning grounds again in the future, laying eggs more than once in their lifespan. The seasonal differences in steelhead migrations and multiple trips to spawning grounds are considered when predictions are made about the number of returning steelhead for the season and their fisheries management.



Habitat
The listed population includes naturally spawned anadromous winter-run steelhead originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls, to and including the Calapooia River.

Threats
Like the threats to Chinook salmon, steelhead are affected by historic land use change, dam and diversion construction, stream simplification, bank hardening, riparian forest cutting and other factors

affecting the stream environment. Like Chinook salmon, steelhead are likely affected by impervious surface development and loss of riparian habitats from urban development in the Salem area.

ESA Listing Status

Threatened on March 25, 1999 (64 FR 14517) and January 5, 2006 (71 FR 833); updated April 14, 2014 (79 FR 20802)

Critical Habitat

Designated September 2, 2005

Protective Regulations

Issued June 28, 2005 (70 FR 37159)

Recovery Plan

Upper Willamette River Chinook Salmon and Steelhead Conservation and Recovery Plan (2011) includes the recommendations to:

1. Implement the suite of Willamette basin TMDL water quality actions, rural and urban best management practices (BMPs), and other land use actions to address multiple (and somewhat related) limiting factors. Actions include:
    - Willamette basin temperature TMDL Water Quality Management Plan actions that increase the amount of riparian vegetation to improve shade function of riparian zones.
    - Strengthen and implement BMPs that reduce nonpoint sourcing of inputs and runoff of agricultural and urban chemicals (pesticides).
    - Willamette basin pesticide and nutrient TMDL Water Quality Management Plan actions that reduce point and non-point sourcing of runoff from urban, industrial, rural, and agricultural practices.
    - Promote incentives to private landowners to protect intact riparian areas, floodplains, and high-quality off-channel habitats that are not covered by actions in other plans and restore areas that are degraded.
2. Implement the suite of Willamette Project BiOp flow actions to address multiple (and somewhat related) limiting factors. Actions include:
    - Willamette Project BiOp revetment modification/reduction and habitat restoration actions that improve the amount, complexity, diversity, and connectivity of riparian, confluence, and off-channel habitats.
    - Willamette Project BiOp flow actions that increase the occurrence of peak flows that maintain and create habitat, thereby contributing to increased channel complexity and habitat diversity.
    - Willamette Project BiOp flow actions to meet salmon and steelhead rearing and migration flow targets in the mainstem Willamette River.

Habitat use in Salem Area

Steelhead juveniles use similar habitats to Chinook and use the floodplain during high water periods. Steelhead have been documented in lower Glenn Creek and Mill Creek as well as the Willamette floodplain.

Streaked Horned Lark
(*Eremophila alpestris strigata*)

Description
The streaked horned lark is a slender, long-winged passerine about 7 inches long. Adults are marked with a dark facial mask and breast band that contrasts with a pale face and throat. These features are especially clear and distinctive in adult males, which have a yellow throat. The "horns" for which the species is named are tiny, black feather tufts on the sides of the head in adult males. Adult females are similar to males, but duller, smaller, and lack horns.

Life Cycle
Streaked horned larks forage on the ground in bare fields or among short vegetation. They eat seeds and grass but feed their young insects, exclusively. Streaked horned larks nest on the ground, where a clutch of three to five eggs is placed next to a tuft of vegetation or a small object. They may rear two to three broods per season. Nest building in southern Puget Sound generally begins in mid-April to early May, and concludes by mid-August. Nomadic in the fall and winter, streaked horned lark form territories when breeding. Eggs are greenish or grayish with brown speckles. Larks typically lay four or five eggs which are incubated 11 days; young are able to fly 9 to 12 days after they hatch. Like meadowlarks and grasshopper sparrows, the species prefers large patches of contiguous grassland habitat in the landscape."

Habitat
The largest area of potential habitat for streaked horned larks is the agricultural land base in the Willamette Valley. Larks are attracted to the wide, open landscape context and low vegetation structure in agricultural fields, especially in grass seed fields, probably because those working landscapes resemble the historical habitats formerly used by the subspecies when the historical disturbances associated with floods and fires maintained a mosaic of suitable habitats. In any year, some portion of the 920,000 ac (372,311 ha) of agricultural lands in the Willamette Valley will contain patches of suitable streaked horned lark habitat, but the geographic location of those areas may not be consistent from year to year, nor can their occurrence due to variable agricultural practices (crop rotation, fallow fields, etc.), and the changing and dynamic locations of those areas be predicted.

Threats
The primary driver of the status of streaked horned lark has been the scarcity of large, open spaces with very early seral stage plant communities with low-statured vegetation and substantive amounts of bare or sparsely vegetated ground. Historically, the lark's habitat was maintained by disturbances such as flooding or fire. The loss of these natural cycles has made them depend on artificially maintained habitats, including agricultural lands, airports and dredged material placement sites. Other factors contributing to the bird's decline are its small population size, and recreational and land management activities that disturb the bird during nesting. Unfortunately, because they nest in vulnerable locations, their nests are often accidentally destroyed by farm machinery, ATVs and traffic.

ESA Listing Status

Threatened on October 3, 2013, 78 FR 61451 61503, April 13, 2022. 87 FR 21783 21812

Critical Habitat

October 3, 2013 78 FR 61505 61589

Critical habitat includes the following "primary constituent elements":

"The primary constituent elements specific to the streaked horned lark are areas having a minimum of 16 percent bare ground that have sparse, low-stature vegetation composed primarily of grasses and forbs less than 13 in (33 cm) in height found in:

(1) Large (300-ac (120-ha)), flat (0–5 percent slope) areas within a landscape context that provides visual access to open areas such as open water or fields, or

(2) Areas smaller than described in (1), but that provide visual access to open areas such as open water or fields."

Recovery Plan

October 30, 2019, 84 FR 58170 58171

Habitat use in Salem Area

Streaked horned larks have been identified in the Salem floodplain. Locations in the Mill Creek floodplain have been documented. Habitat at the Salem airport has supported larks historically, but the airport population is now considered extripated.

Northwestern Pond Turtle *(Actinemys marmorata)*

Photo Credit: Keith Kohl

Range and Distribution

The range of the northwestern pond turtle is primarily west of the Sierra Nevada and Cascade Mountains, stretching from Puget Sound, Washington to Baja California, at elevations ranging from sea level to about 5,000 ft. There are small populations that persist in watersheds east of the Sierra Nevada and Cascade Mountains.

In Oregon, they primarily are found west of the Cascades at elevations lower than 6,000 feet. The largest populations are located in the drainages of the Willamette, Umpqua, Rogue, and Klamath Rivers, but smaller populations are scattered throughout lowland aquatic habitats of western Oregon and the east Cascades.

Habitat Characteristics

Northwestern pond turtles are closely associated with aquatic habitat with muddy bottoms and available basking sites. They are most common in still or slow-moving water, particularly around dense vegetation, which provides a high density of invertebrate prey. Submergent and emergent aquatic vegetation are important habitat components that provide safe nursery habitat for young turtles with plenty of food and cover. Underwater refugia such as submerged logs and cut banks provide protection from underwater predators.

Overwintering sites are along stream banks, and nesting sites are typically within 200 yards of water in areas with little vegetation and plenty of sunlight. Nesting sites are in sparse vegetation with sandy, silt, or gravel soils, and good solar exposure.

Species Description

The northwestern pond turtle is a mid-sized, semi-aquatic freshwater turtle and is one of Oregon's two native turtle species. They have a smooth, broad carapace (upper shell) that is drab brown to olive in color and low in profile. The plastron (lower shell) is typically light yellow in color, sometimes with a variable number of darker blotches. Their head and limbs are variable in color, typically gray to black with yellow speckling. Males have a lighter colored chin and throat than females, and a longer, thicker tail than females. Adults may grow up to ten inches in length. They are usually seen basking on rocks or floating logs or vegetation in slow-moving bodies of water.

Similar species in Oregon are the western painted turtle and the red-eared slider (a non-native species). All three species can sometimes be found in the same bodies of water, or even on the same log. From a distance, all three species can look similar. Red-eared sliders and western painted turtles are more vibrantly marked than northwestern pond turtles. It may be difficult to distinguish between native northwestern pond turtles and older red-eared sliders whose red markings have faded. A key characteristic to focus on is the shape of marginal scutes (plates that make up the shell); red-eared sliders have serrated marginal scutes above their tail, while northwestern pond turtles' are smooth.

Approximate range of *Actinemys marmorata*

Diet and Foraging

Northwestern pond turtles are omnivores and dietary generalists, with a variable diet that consists mainly of aquatic invertebrates and larvae, as well as some plants, small fish, frogs, and carrion. They are opportunistic feeders, and forage exclusively in water. They have sharp ridges on their jaws that help them tear their food.

Life History and Ecology

Northwestern pond turtles are a long-lived species that mature slowly. Individuals have been recorded living over 40 years. They have a low reproductive rate and delayed sexual maturity. Male northwestern pond turtles typically reach reproductive maturity at five to nine years, while females reach reproductive maturity after seven to ten years.

In Oregon, the nesting season occurs from May through mid-July. Breeding takes place underwater and occurs from late spring to mid-summer. When female turtles are ready to lay their eggs, they fill their bladder with water and emerge from the water to find a suitable nesting spot. Suitable sites are found near their aquatic habitat in areas with sparse vegetation and good solar exposure. Once they select a site, they empty their bladder on the soil and dig with their back legs to create a shallow nesting cavity where they will deposit their eggs. Clutches have been recorded with one to thirteen eggs, with an average of six eggs per clutch. Multiple clutches can be laid in a season. After depositing their eggs, they use the moist soil to create a nest plug which they use to seal their eggs into the chamber for incubation. Eggs receive no parental care, and nests are vulnerable to predation. After the eggs hatch in fall, the young may overwinter in the safety of the nests.

Northwestern pond turtles bask on floating logs, vegetation, or on muddy stream banks to maintain body temperature. Like most reptiles, they rely on the environment to maintain their body temperature (they are ectothermic, or "cold-blooded"). During the winter when it is cool and their metabolism slows down, they become semi-dormant and will overwinter in moist terrestrial and aquatic habitats. They bury themselves in mud, under stream banks, or in leaf litter. In warm weather, they will come out to bask or move to different locations.

They are primarily aquatic, but may move overland when ephemeral waterbodies dry up, to find nesting habitat, and to seek out sites for overwintering. They are not territorial, and often are found sharing basking surfaces with turtles from the same species as well as other species. Home range size for individuals is highly variable, and depends on the size of the aquatic system. They are capable of long distance seasonal movements between aquatic and terrestrial habitats, and long distance dispersal. Overland distance between aquatic and terrestrial habitat can be more than one mile.

Predators of northwestern pond turtles include raccoons, otters, ospreys, coyotes. Hatchlings are eaten by a variety of predators, including corvids, American bullfrogs, weasels, and large fish.

Fun Facts

- If they run out of basking sites on logs or rocks, northwestern pond turtles sometimes conserve warmth by stacking on top of one another.
- Hatchlings are only about the size of a quarter, making them very vulnerable to predators for the first few years of their lives.
- Similar to a fingerprint, turtles have a unique pattern on their plastron that can be used to identify unique individuals.
- At the first sign of danger, basking turtles will dive for cover under water. When threatened, pond turtles can retract their head and legs into the protection of their hard shell

Conservation

Northwestern pond turtles are an Oregon Conservation Strategy Species (Species of Greatest Conservation Need), a state Sensitive Species, and a Federal Species of Concern. Factors influencing northwestern pond turtle populations include loss or alteration of habitat, increased predation of nests and hatchlings from historical levels, invasive species, and road mortality. Introduced species, including bullfrogs and smallmouth bass, predate young turtles. Released pet turtles are a threat to native species because they compete for limited resources and can transmit diseases.

During the breeding season, be on the lookout for turtles crossing the road. If you choose to help a turtle cross the road, be sure to bring it in the direction of travel and leave it on the side of the road; females are driven to get to nesting habitat and deposit their eggs, and they know where they want to go! Wash your hands after you handle any turtles. Otherwise, don't disturb turtles when you see them.

Many of Oregon's northwestern pond turtle populations occur on private land. If you have northwestern pond turtles or their habitat in your backyard, you can take simple steps to enhance the habitat to encourage more turtles to make their home there. You can create basking habitat in waterbodies by putting out logs or branches, remove invasive plants around ponds, and create sunny places.

For more information about the conservation status of northwestern pond turtles including special needs, limiting factors, data gaps, and conservation actions, refer to the Oregon Conservation Strategy.

Willamette daisy (*Erigeron decumbens*)

ENDANGERED

Flowers (left), habit (center), and habitat (right) of Willamette daisy. Photos by Melissa Carr (left and right) and ODA staff (center). If downloading images from this website, please credit the photographer.

Family
Asteraceae

Taxonomic notes
Synonyms: *Erigeron decumbens* var. *decumbens**

*This taxon was formerly recognized as variety *decumbens.* Recent treatment of the genus in *Flora of North America North of Mexico* elevated the other variety of *E. decumbens* (var. *robustior*) to species rank, and consequently, there is no longer need to recognize Willamette daisy at the varietal level.

Plant description
Willamette daisy is a tap-rooted perennial species growing from a crown or slightly branched caudex. Stems are decumbent, moderately strigose, 15-70 cm tall, and often purplish at the base. The leaves are numerous, sparsely to moderately strigose, linear or linear-lanceolate, the basal leaves and most of the cauline leaves triple-nerved. Basal leaves are up to 25 cm long, including the long petiole, and 1 cm wide, with cauline leaves becoming gradually reduced above. Flowering heads number from 1-20, the disk 0.8-1.5 cm wide, the involucre 0.35-0.6 cm high, and the 20-50 blue-purple to pale pink ray flowers 0.6-1.2 cm long by 0.1-0.2 cm wide. The pappus consists of 12-16 fragile bristles.

Distinguishing characteristics
Willamette daisy is the only species of *Erigeron* with pink-purple rays that occurs in Willamette Valley prairies. It is further distinguished by its gradually reduced cauline leaves, triple-nerved basal leaves, and decumbent, spreading habit. *Erigeron eatonii* is morphologically similar, but occurs east of the Cascade Mountains. *Symphyotrichum hallii* co-occurs with Willamette daisy at many sites, but its rays are usually white (although sometimes pale violet), it flowers later in the summer (July to August), and it is more branched than Willamette daisy. Small vegetative individuals of these two species are very similar, but are distinguishable based on stem color: *S. hallii* typically

has reddish stems, while Willamette daisy has green stems.

When to survey
Surveys for this species should be conducted when the plants are flowering, from June through early July.

Habitat
Willamette daisy inhabits both seasonally flooded bottomland prairies and well-drained upland prairies at elevations ranging from 70-290 m (240-950 ft).

Commonly associated species include *Achillea millefolium, Allium amplectens, Anthoxanthum odoratum, Brodiaea hyacinthina, Bromus carinatus, B. japonicus, Carex* spp.*, Camassia leichtlinii, Crataegus douglasii, Danthonia californica, Deschampsia caespitosa, Elymus glaucus, Eriophyllum lanatum, Festuca arundinacea, F. roemeri, Fragaria virginiana, Fraxinus latifolia, Grindelia integrifolia, Holcus lanatus, Juncus* spp.*, Lomatium bradshawii, Panicum occidentale, Poa nevadensis, Potentilla gracilis, Prunella vulgaris, Quercus garryana, Ranunculus occidentalis, Rosa* spp.*, Saxifraga integrifolia, Sericocarpus rigidus, Sidalcea campestris, Spiraea douglasii,* and *Symphyotrichum hallii.*

Range
Willamette daisy is known only from the Willamette Valley in northwestern Oregon. Though once found throughout the valley, the species is now restricted to scattered habitat remnants. Historic populations in Clackamas, Washington, and Yamhill Counties have not been relocated, and the species may no longer occur in these counties. The majority of extant populations are located on private lands vulnerable to development.

Oregon counties
Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, Yamhill

Federal status
Endangered

Threats
Habitat loss due to urban and agricultural development is the primary threat to this species. Successional encroachment by trees and shrubs, competition from invasive weeds, and possible inbreeding depression due to small population sizes also pose serious threats to Willamette daisy. Road construction and maintenance and grazing pose additional risks.

Conservation planning
A Critical Habitat Designation (pdf document, 2.60 MB) for Willamette Daisy was issued by the U.S. Fish and Wildlife Service in 2006.

A U.S. Fish and Wildlife Service Recovery Plan for prairie species of western Oregon and southwestern Washington (pdf document, 9.63 MB) was released in 2010 and addresses conservation needs of Willamette daisy.

Did you know?
From 1840 (when Willamette daisy was first described) to 1934, this species was collected from throughout the Willamette Valley. However, it was not observed for decades after this period and was thought to be extinct until its rediscovery in 1980 at two locations in Lane and Benton counties.

Current/Recent ODA projects
Developing population density estimates for nine rare Willamette Valley prairie species

References
Clark, D. L., K. K. Finley, and C. A. Ingersoll. 1993. Status report for *Erigeron decumbens* var. *decumbens*. Unpublished report prepared for the Conservation Biology Program, Oregon Department of Agriculture, Salem, Oregon.

Cronquist, A. 1947. Revision of the North American species of Erigeron, north of Mexico. Brittonia 6:173-174.

Currin, R., M. Carr, and R. Meinke. 2008. Developing population density estimates for nine rare Willamette Valley prairie species. Report prepared for U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. Oregon Department of Agriculture, Salem, Oregon.

Meinke, R.J. 1982. Threatened and endangered vascular plants of Oregon: An illustrated guide. Unpublished report for the U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. Oregon Department of Agriculture, Salem, Oregon.

Nesom, G. L. 2006. *Erigeron*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 16+ vols. New York and Oxford. Vol. 20, pp. 256-348. Available at http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=112000. Accessed September 20, 2010.

OFP (Oregon Flora Project). 2010. Oregon Plant Atlas. http://www.oregonflora.org/atlas.php. Accessed September 20, 2010.

ORBIC (Oregon Biodiversity Information Center). 2010a. Rare, threatened and endangered species of Oregon. Institute for Natural Resources, Portland State University, Portland, Oregon. 105 pp. Available at http://orbic.pdx.edu/documents/2010-rte-book.pdf (pdf document, 971 kB). Accessed December 13, 2010.

ORBIC (Oregon Biodiversity Information Center). 2010b. ORBIC element occurrence database. Portland, Oregon.

USFWS (U.S. Fish and Wildlife Service). 2000. Endangered Status for *Erigeron decumbens* var. *decumbens* (Willamette daisy) and Fender's blue butterfly (*Icaricia icarioides fenderi*) and Threatened Status for *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine). Federal Register 65:3875-3890. Available at http://ecos.fws.gov/docs/federal_register/fr3502.pdf (pdf document, 192 kB). Accessed September 19, 2010.

USFWS (U.S. Fish and Wildlife Service). 2006. Designation of critical habitat of the Fender's blue butterfly (*Icaricia icarioides fenderi*), *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine), *and Erigeron decumbens* var. *decumbens* (Willamette daisy); Final Rule. Federal Register 71:63861-63910. Available at http://www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/FR2006Oct31WVCHFinal.pdf (pdf document, 2.60 MB). Accessed September 19, 2010.

USFWS (U.S. Fish and Wildlife Service). 2010. Recovery Plan for the prairie species of western Oregon and southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp. Available at http://ecos.fws.gov/docs/recovery_plan/100629.pdf (pdf document, 9.63 MB). Accessed September 9, 2010.

Peacock larkspur (*Delphinium pavonaceum*)

ENDANGERED

Flowers (left), habit (center), and habitat (right) of peacock larkspur. Photos by Melissa Carr. If downloading images from this website, please credit the photographer.

Family
Ranunculaceae

Taxonomic notes
The *Flora of North America North of Mexico* treats peacock larkspur as a hybrid between *Delphinium menziesii* ssp. *pallidum* and *D. trolliifolium*. However, based on its unique morphology and fertile, self-sustaining populations, peacock larkspur is treated here as a distinct species (*D. pavonaceum*), following the Oregon Flora Project treatment of the taxon.

Peacock larkspur has been reported to produce viable hybrid seeds when crossed with *Delphinium leucophaeum, D. menziesii*, *D. oreganum*, and *D. nuttallii*.

Plant description
Peacock larkspur is a leafy perennial 30-90 cm tall that grows from a cluster of globose tubers. The deeply cleft leaves are mostly cauline, becoming bract-like above, the lowest leaves with petioles up to 22 cm long. Flowers are arranged in a pyramidal raceme, with lower pedicels much longer than the upper ones. The sepals are white to cream, sometimes slightly greenish blue on the back and greenish at the tip, and more or less reflexed to spreading. The lower petals are white or faintly bluish tinged toward the base and glandular-pubescent with a hairy tuft at the base of the blade. The upper petals are bluish to lavender-tipped. The follicles are up to 1.6 cm long and often glandular-pubescent.

Distinguishing characteristics
Peacock larkspur is distinguished from *Delphinium leucophaeum*, the only other white-flowered larkspur west of the Cascades, by its taller habit (30-90 cm versus 20-60 cm in *D. leucophaeum*), its larger flower parts (lateral sepals 12-18 mm long versus 9-14 mm in *D. leucophaeum*, spur 14-20 mm long versus 10-14 mm), its reflexed to spreading sepals (versus cupped forward in *D. leucophaeum*), pyramidal raceme (versus narrow), and lower petals that are usually glandular with a hairy tuft at the base (versus non-glandular and long-hairy over the entire surface). Peacock larkspur is

also very similar to *D. menziesii*, but the white sepals of the former species readily distinguish it from its blue-sepaled congener.

When to survey
Surveys for peacock larkspur should be completed from late April through June when the species is flowering and is distinguishable from other delphiniums.

Habitat
Peacock larkspur inhabits low, nearly flat areas in moist, silty soils of the Willamette River floodplain at elevations ranging from 45-120 m (150-400 ft). It occurs in native wet prairies, on the edges of ash and oak woodlands, and along roadsides and fence rows.

Associated species include *Achillea millefolium*, *Alepocuris pratensis*, *Allium amplectens*, *Camassia quamash*, *Delphinium menziesii*, *Deschampsia caespitosa, Fraxinus latifolia*, *Geum macrophyllum*, *Geranium oreganum*, *Holcus lanatus*, *Hypericum perforatum*, *Lomatium bradshawii*, *L. utriculatum*, *Lupinus polyphyllus*, *Phlox gracilis*, *Plectritis congesta*, *Poa pratensis*, *Potentilla gracilis*, *Quercus garryana*, *Rosa* spp., *Sidalcea* spp., *Symphoricarpos albus*, *Toxicodendron diversilobum*, *Vicia* sp., and *Wyethia angustifolia*.

Range
Peacock larkspur is a localized endemic restricted to the middle Willamette Valley of Oregon. The species is found primarily within Benton and Polk counties, its largest occurrences located at William L. Finley National Wildlife Refuge in Benton County.

Oregon counties
Benton, Clackamas, Lane, Marion, Multnomah, Polk

Federal status
Species of Concern

Threats
A major threat to peacock larkspur is habitat loss due to urban expansion and agricultural development. Road maintenance and herbicide application from adjacent agricultural fields pose significant threats, as well. In addition, habitat degradation due to weed invasions and successional encroachment of shrubs negatively impact this species. Herbivory of peacock larkspur by rodents, deer, and slugs has been documented, and hybridization with other *Delphinium* species (especially *D. menziesii*) poses a potential threat to the genetic integrity of peacock larkspur.

Conservation planning
A U.S. Fish and Wildlife Service Recovery Plan for prairie species of western Oregon and southwestern Washington (pdf document, 9.63 MB) was released in 2010 and addresses conservation needs of peacock larkspur.

Did you know?
Scientists have hypothesized that peacock larkspur evolved in the wake of the Pleistocene epoch floods of the Columbia River (the Bretz Floods) that occurred between 12,800 and 15,000 years ago. These floods scoured the north end of the Willamette Valley and created a temporary lake that extended south to the present-day city of Eugene. The lake repeatedly filled and drained, creating massive habitat disturbance and laying new deposits of silt and gravel in the valley. New forms of *Delphinium* were likely produced through hybridization and/or mutation in these

disturbed areas and evolved into our localized Willamette Valley larkspur endemic species. Peacock larkspur appears to have derived from *D. menziesii*.

Current/Recent ODA projects
Developing population density estimates for nine rare Willamette Valley prairie species

References
Chambers, K.L. 2000. Oregon delphiniums—easy to collect but hard to identify, Parts I and II. Oregon Flora Newsletter 6(2) and 6(3). Oregon State University, Corvallis, Oregon.

Currin, R., M. Carr, and R. Meinke. 2008. Developing population density estimates for nine rare Willamette Valley prairie species. Report prepared for U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. Oregon Department of Agriculture, Salem, Oregon.

Goodrich, G.O. 1983. Rare and common species of *Delphinium* in Western Oregon and Washington: A systematic and ecological study. M.S. thesis, University of Oregon, Eugene, OR.

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1964. Vascular plants of the Pacific Northwest. Part 2: Salicaceae to Saxifragaceae. University of Washington Press, Seattle.

Karoly, K. 2002. Summary of research findings from field and greenhouse studies of the pale rock larkspur, *Delphinium leucophaeum*. Unpublished memo. Reed College, Biology Department, Portland, Oregon.

Meinke, R.J. 1982. Threatened and endangered vascular plants of Oregon: An illustrated guide. Unpublished report for the U.S. Fish and Wildlife Service, Region 1, Portland, Oregon. Oregon Department of Agriculture, Salem, Oregon.

OFP (Oregon Flora Project). 2010. Oregon Plant Atlas. http://www.oregonflora.org/atlas.php. Accessed September 19, 2010.

ORBIC (Oregon Biodiversity Information Center). 2010a. Rare, threatened and endangered species of Oregon. Institute for Natural Resources, Portland State University, Portland, Oregon. 105 pp. Available at http://orbic.pdx.edu/documents/2010-rte-book.pdf (pdf document, 971 kB). Accessed December 13, 2010.

ORBIC (Oregon Biodiversity Information Center). 2010b. ORBIC element occurrence database. Portland, Oregon.

U.S. Fish and Wildlife Service. 2010. Recovery Plan for the prairie species of western Oregon and southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp. Available at http://ecos.fws.gov/docs/recovery_plan/100629.pdf (pdf document, 9.63 MB). Accessed September 9, 2010.

Warnock, M. J. 1997. *Delphinium*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 16+ vols. New York and Oxford. Vol. 3, pp. 196-240. Available at http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=109521. Accessed September 16, 2010.