*Tualatin River Watershed Council*

# Gales Creek Sub-Basin


# Restoration Action Plan

**April 2015**

**Prepared for:**

## Tualatin River Watershed Council

P.O.Box 338
Hillsboro, OR  97123-0338
503-846-4810

www.trwc.org

Contact:
April Olbrich, Coordinator
e-mail: trwc@trwc.org

**Prepared by:**

**Cascade Environmental Group, LLC**

**ESA Vigil-Agrimis**

**Restoration NW, LLC**

Contact:
John Runyon, Cascade Environmental Group
e-mail: jrunyon@cascadeenv.com

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April Olbrich, Coordinator, Tualatin River Watershed Council

Tom Murtagh, OR Dept. of Fish and Wildlife

Lacey Townsend, Tualatin SWCD

Rich Hunter, Clean Water Services

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# Acronyms

Cascade – Cascade Environmental Group, LLC

cfs – Cubic feet per second

CLAMS – Coastal Landscape Analysis and Modeling Study

CWS – Clean Water Services

DEQ – Department of Environmental Quality

DO – Dissolved oxygen

DPS – Distinct Population Segment

EIS – Environmental Impact Statement

ESA – Endangered Species Act

GIS – Geographical Information System

GLO – General Land Office

IP – Intrinsic Potential

JWC – Joint Water Commission

NEPA – National Environmental Policy Act

NMFS – National Marine Fisheries Service

ODFW – Oregon Department of Fish and Wildlife

RBA – Rapid Bio-Assessment

Reclamation – Bureau of Reclamation

RM – River Mile

SWCD – Soil and Water Conservation District

TAC – Technical Advisory Committee

Tribes – Pacific Northwest Indian Tribes

TVID – Tualatin Valley Irrigation District

TVWD – Tualatin Valley Water District

TMDL – total maximum daily load

USGS – United States Geological Survey

UWR – Upper Willamette River

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# Gales Creek Sub-Basin: Restoration Action Plan

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# 1. Introduction

The Gales Creek Sub-Basin has been identified by the Tualatin River Watershed Council (Council) as a high-priority area for Upper Willamette River (UWR) steelhead spawning and rearing as well as for other native fish and wildlife. Many Tualatin River Basin partners have been active in restoration projects throughout the Gales Creek Sub-Basin. This restoration work includes wetland, riparian, and upland enhancement; large wood placement; replacement of fish passage barrier culverts; and increased stream flow.

The Restoration Action Plan builds on past restoration accomplishments by providing a framework and systematic approach to restoration throughout the Gales Creek Sub-Basin. The Restoration Action Plan evaluates the factors limiting focal fish populations (winter steelhead, coho salmon, Pacific lamprey, and cutthroat trout) and water quality and identifies approaches and activities that will address watershed health issues over time.

**The Tualatin River Watershed Council**

The Council links land, water, and people. We bring together all interests in the basin to promote and improve watershed health. We work together through cooperation, collaboration, and communication. All of our actions affect the health of our watershed. We need your help in improving our watersheds' health.

# 2. Overview of the Gales Creek Sub-Basin

The Gales Creek Sub-Basin, which resides in the upper Tualatin River Basin, covers more than 49,000 acres draining the eastern side of the Coast Range Mountains. The watershed ranges in elevation from a low of 159 feet above sea level, at the confluence with the Tualatin River near the City of Forest Grove, to over 3,000 feet above sea level in the Coast Range (Breuner 1998). The mainstem of Gales Creek is 23.5 miles long; key tributaries include Prickett Creek, Clear Creek, Iler Creek, Beaver Creek, and the North and South Forks of Gales Creek.

Almost two-thirds of the Gales Creek Sub-Basin is privately owned (Breuner 1998), either as industrial forestland (26%) or private agricultural or rural residential lands (38%). The Oregon Department of Forestry manages a significant proportion of the watershed (28%) as part of the Tillamook State Forest (Breuner 1998). Lower Gales Creek is within the City of Forest Grove's urban growth boundary.

Resident fish native to the Gales Creek Sub-Basin include cutthroat trout, redside shiners, various species of sculpin, and brook lamprey [Clean Water Services (CWS) 2005]. Anadromous coho salmon, steelhead, and Pacific lamprey spawn in the sub-basin and juveniles of these species rear in

Gales Creek and its tributaries for a period of time. The UWR steelhead population is listed as threatened under the federal Endangered Species Act (ESA). Gales Creek contains the only listed Critical Habitat for steelhead in the Tualatin River Basin.

For the purpose of the Action Plan, the Gales Creek Sub-Basin is divided into three Sub-Basin areas and seven watersheds as follows:

**Upper Gales Creek Sub-Basin Area**

- Upper Gales Creek Watershed
- Beaver Creek Watershed

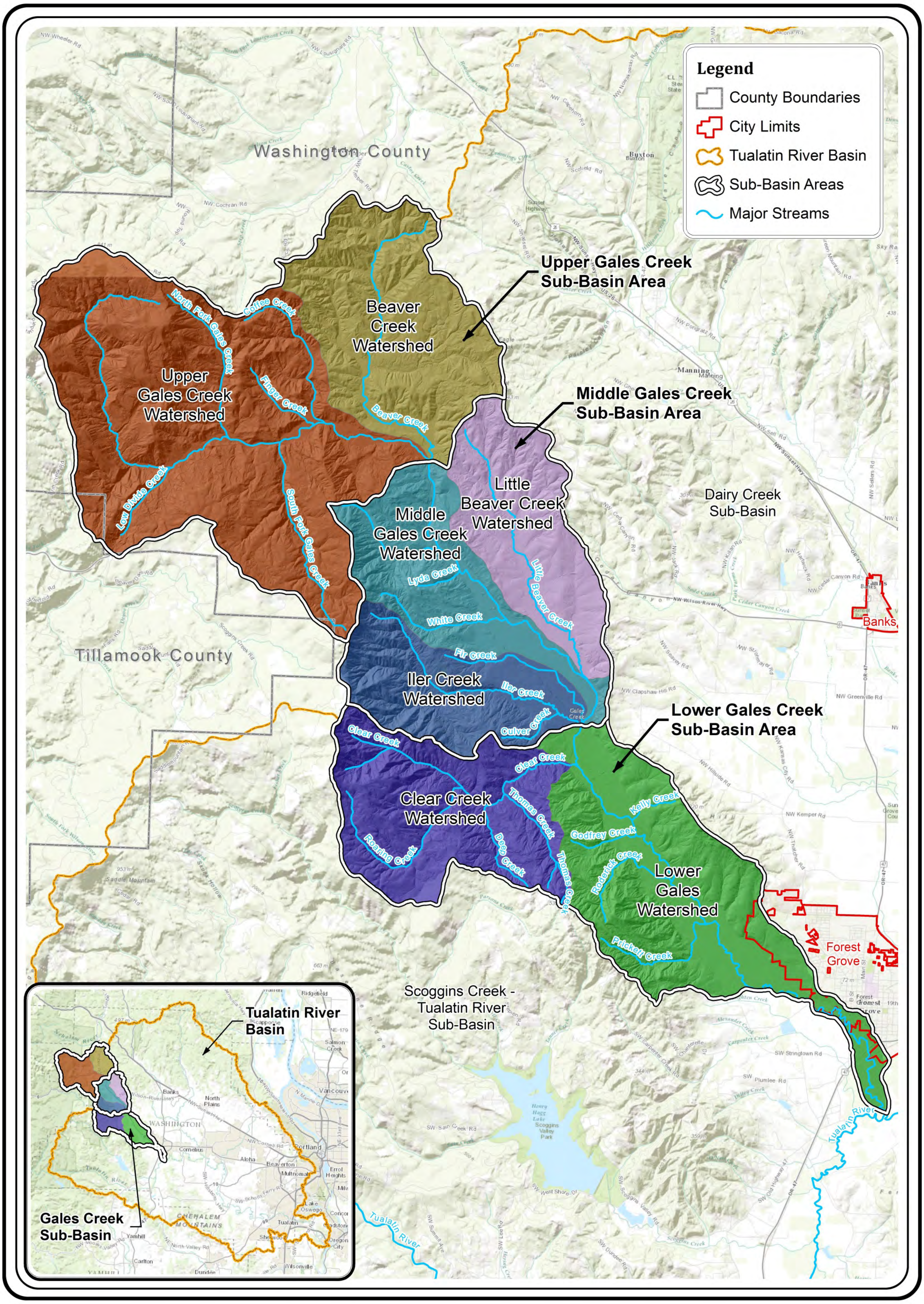
**Middle Gales Creek Sub-Basin Area**

- Middle Gales Creek Watershed
- Little Beaver Creek Watershed
- Iler Creek Watershed
- Clear Creek Watershed

**Lower Gales Creek Sub-Basin Area**

- Lower Gales Creek Watershed

The map on the following page shows the three Gales Creek Sub-Basin Areas and the seven watersheds comprising the Sub-Basin.




TUALATIN RIVER WATERSHED COUNCIL

CASCADE ENVIRONMENTAL GROUP

**Gales Creek Sub-Basin**

Tualatin River Basin

0 0.5 1 2 3 Miles

Date: 4/6/2015
Scale: 1 inch = 1 mile

Data Source: ESRI, 2015; USDA, NRCS, 2011; ODOT GIS Unit, 2012.
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# 3. Background Development of the Action Plan

## The Role of the Bureau of Reclamation and Past Restoration Action Planning

The Bureau of Reclamation (Reclamation) constructed Scoggins Dam (known as the Tualatin Project) between 1972 and 1978. The Tualatin Project has multiple functions including irrigation, flood control, municipal and industrial water use, water quality, recreation, and providing fish and wildlife habitat. The Tualatin Project provides water to irrigate 17,000 acres of land under the jurisdiction of the Tualatin Valley Irrigation District (TVID). The Tualatin River Basin also provides drinking water for more than 250,000 customers throughout Washington County. Four agencies share ownership in the Joint Water Commission (JWC) – the Cities of Hillsboro, Forest Grove, and Beaverton and the Tualatin Valley Water District. The JWC also wholesales water to the City of North Plains. Drinking water intakes are located on the Tualatin River at Cherry Grove and just below the confluence of Gales Creek and the Tualatin River. The City of Forest Grove also has drinking water intakes within Clear Creek, a tributary of Gales Creek. Water is taken directly from rivers and creeks in the winter months; during the summer the water supply is supplemented from Scoggins and Barney reservoirs. In addition to municipal water supplies, CWS calls for Tualatin Project water releases to the Tualatin River to enhance water quality. These releases, which occur primarily in the summer, help reduce high temperatures and improve dissolved oxygen (DO) levels in the Tualatin River.

Reclamation prepared a Final Environmental Impact Statement (EIS) to evaluate the environmental and social impacts of constructing the Tualatin Project pursuant to the National Environmental Policy Act (NEPA) regulations, with a supplement to the Final EIS prepared in 1973. The EIS indicated that Scoggins Dam eliminated approximately 15 miles of upstream spawning habitat for anadromous fish. This resulted in an estimated average annual loss of 9,000 pounds to the commercial salmon-steelhead catch and an average annual loss of 1,100 angler days to the sport fishery for anadromous species. The Final EIS established several fish mitigation measures which were recommended by the U.S. Fish and Wildlife Service and other resource agencies to adequately compensate for anadromous fish habitat and fishing opportunities. Reclamation subsequently agreed to implement the following fish measures identified in the Final EIS:

1. Maintain at all times a minimum flow of 10 cubic feet per second (cfs) in Scoggins Creek below Scoggins Dam and 20 cfs below the existing Oregon Iron and Steel Company (Lake Oswego) dam during October and November. These flows were established to satisfactorily maintain fish life in Scoggins Creek to its confluence with the Tualatin River and enable adequate passage flows for anadromous fish into the Tualatin River.

2. Modify the Oregon Iron and Steel Company (Lake Oswego) dam with a fish ladder to ensure adequate upstream passage. Reclamation provided funds to the Oregon State Fish Commission to construct, operate, and maintain the fish ladder.

3. Install fish screens on the Tualatin Pumping Plant to eliminate juvenile and adult fish entrainment.

4. Provide initial funding to the Oregon State Fish Commission in 1973 to construct fish rearing facilities, enlarge incubation facilities, and purchase transportation facilities for the purpose of rearing and releasing hatchery anadromous fish at the State's Big Creek Hatchery.

In 1998 the Oregon Department of Fish and Wildlife (ODFW) stopped releasing hatchery-reared anadromous fish into the Tualatin River Basin due to potential impacts on wild fish. As a result, Reclamation determined that the annual mitigation funds for its original purpose, stocking hatchery fish, were no longer appropriate and, through an Environmental Assessment, recommended using the annual mitigation funds to fund habitat restoration projects.

In 2002 the Tualatin River Watershed Council was selected by a multi-agency committee to formulate a habitat restoration plan (Plan) in a high-priority area within the Tualatin River watershed. The Plan evaluated and prioritized factors limiting salmonid production, particularly winter steelhead. The Plan outlined a five-year habitat restoration strategy for the identified high-priority area of Gales Creek, and identified a priority stream reach in lower Gales Creek for restoration actions. Subsequently, a habitat functional assessment and limiting factor analysis was completed for 13 sub-reaches (project reaches) on four miles of lower Gales Creek and two miles of two Gales Creek tributaries, Clear and Iler Creeks. Based on this Plan, Reclamation provided funding to the Council in 2005 to 2012 to implement priority restoration actions in lower Gales Creek and Reclamation funded the development of this Action Plan.

## Definitions

### Fish Population

### Limiting Factors and Threats

**Limiting Factors:** The biological and physical conditions – e.g., high water temperatures – that limit a fish species' viability for one or more of the species' freshwater life history stages (e.g., adult migration, spawning and egg incubation, early fry rearing, summer rearing, winter rearing, etc.).

**Threats:** Threats are human activities or natural processes that cause the limiting factors. For example, removing the vegetation along the banks of a stream (threat) can cause higher water temperatures (limiting factor), because the stream is no longer shaded.

From: ODFW and The National Marine Fisheries Service (NMFS ) 2011

# Action Plan Development

In 2012, the Council's Restoration Technical Advisory Committee (TAC) recommended that the Council formulate a habitat Restoration Action Plan covering the entire Gales Creek Sub-Basin.

Beginning in 2013, the Tualatin Watershed Council contracted with Cascade Environmental Group (Cascade) to review reports, studies, and other scientific literature that focused on conditions in the Gales Creek Sub-Basin. The purpose of the review was to evaluate what is known about the Sub-Basin's conditions and the factors that influence watershed health, with a specific focus on the ***limiting factors*** and ***threats*** that are affecting focal fish populations. Winter steelhead, coho salmon, Pacific lamprey, and cutthroat trout were identified by the Council as the focal fish populations.

The ***Gales Creek Sub-Basin Information Gap Analysis*** (Cascade 2014) summarized available information on the focal fish populations, fish passage barriers, stream and riparian habitat, water quality, and other watershed characteristics (Appendix A). More than 50 documents and data sets were reviewed, with a focus on information describing watershed and habitat characteristics, showing trends over time, and having relevance to Gales Creek Sub-Basin restoration action planning. The Gap Analysis identified the information and data gaps that should be addressed in order to fully assess watershed conditions and to provide the information necessary for the development of the Action Plan.

Council staff and the TAC provided input and review throughout the development of the Action Plan. Cascade worked with the TAC to incorporate the recommendations of the Information Gap Analysis and to develop a restoration strategy for the Gales Creek Sub-Basin, including identifying actions that would enhance habitat for the focal fish populations and improve watershed health.

## Fish Distribution and Abundance: The Rapid BioAssessment and other Studies

One of the key pieces of information identified in the Gales Creek Sub-Basin Information Gap Analysis is the need for information on the focal fish populations, including their distribution and abundance. To address this key data need, the Council contracted with Bio-Surveys, LLC to conduct snorkel surveys to determine the distribution and abundance of juvenile salmonids in the Gales Creek Sub-Basin, Upper Tualatin River, and the Dairy-McKay Creek Sub-Basin in the summer of 2013. The surveys were repeated in the summer of 2014, but this information was not available for the development of the Action Plan.


The Rapid Bio-Assessment (RBA) surveyed Gales Creek and key tributaries to assess the relative distribution and abundance of the focal salmonid species[1]. Most tributaries were included in the RBA survey, with the exception of Little Beaver Creek and its tributaries, which were not included because they produce few anadromous fish. Little Beaver Creek is home to resident cutthroat trout and is also important because its water temperature impacts Gales Creek water temperatures.

The areas where the RBA survey was conducted provide very high-resolution information on fish presence and distribution. The survey sampled every 5th pool, ending at the upper extent of anadromous fish distribution. The survey provides detailed and current information on fish species distribution and abundance that is specific to each stream and that can be mapped at a very high resolution (i.e., individual pools).

**Definition**

**Fish Population**

**Anchor Habitats**

**Anchor Habitats:** Habitats that provide all of the essential habitat features necessary to support the focus species' freshwater life history stages (e.g., deposition of gravels, the accumulation of large wood, complex pools and other habitats, floodplain interaction, and good water temperatures).

From: Bio-Surveys, LLC 2003

[1] The RBA observations noted salmon, steelhead, and trout species presence and abundance; Pacific lamprey were not a focus of the observations. A separate study provided information on Pacific lamprey presence and abundance.

The RBA is an important source of information for the development of the Action Plan. The RBA provides data on steelhead, coho, and cutthroat trout distributions and abundance throughout the Gales Creek Sub-Basin. In addition, the RBA provided insights into the factors affecting fish populations and key areas (***Anchor Habitats***) necessary to sustain the populations (Bio-Surveys, LLC 2003).

The RBA report draws conclusions on some of the factors that are limiting fish populations and distribution. The RBA was completed during the summer months when stream flows are low and water temperatures are the highest, which provides insights into how water temperature regimes have influenced fish distributions. The report describes stream reaches that fish have moved out of to escape high water temperatures and streams that fish reside in because they provide cool water (i.e., thermal refugia). The RBA report also provides high quality information on barriers to fish movement (e.g., dams and culverts) and the habitat types preferred by the different salmonid species.

The RBA did not collect information on Pacific lamprey distribution or abundance. Fortunately, a group of scientists with Pacific Northwest Indian Tribes (Tribes), Oregon State University, and other institutions is studying Pacific lamprey adult migration, spawning, and juvenile rearing in Willamette River tributaries, including the Tualatin River. A 2013 survey of upper and lower Gales Creek as part of this study provides recent information on the presence of juvenile Pacific lamprey in the Sub-Basin.

Because the RBA information covers most of Gales Creek and its tributaries, it provides a geographic framework for synthesizing information from other sources, including fish passage barrier inventories and water quality studies. This synthesis provides additional insights into the factors that limit focal fish populations' distribution and abundance. For the purposes of the Action Plan, the RBA data was compared to stream habitat inventories, including pre- and post-restoration project inventories, and other information such as water temperature data, in order to build understanding of how habitat and water quality characteristics are influencing salmonid abundance. The RBA also identifies habitat "hot spots"– areas where there are large numbers of fish, presumably because of the presence of high quality adult spawning and/or juvenile rearing habitat.

## Watershed Health

In addition to habitat and other factors limiting focal fish populations, the Action Plan takes into account other watershed factors that contribute to the overall health of the Gales Creek Sub-Basin. Good water quality (including water temperatures, sediment, and other factors) and quality in-stream habitat are important for thriving fish, and also for healthy amphibian populations and clean drinking water. Similarly, riparian areas, consisting of streamside vegetation and active floodplains, are important for both healthy fish populations and for wildlife. The width and length of these riparian corridors provide avenues for wildlife to travel between different parts of the landscape. Healthy riparian vegetation provides habitat for a variety of wildlife species. Riparian areas and associated wetland areas are important habitat for a number of species, including amphibians such as red-legged frogs.

The health of native riparian vegetation is influenced by a number of factors. Weeds can invade and spread quickly along rivers and streams if they go unchecked. Once invasive weeds, such as Japanese knotweed and garlic mustard, have a foothold in a riparian area, they can be extremely difficult and expensive to remove. These weeds can replace native vegetation that provides food and shelter for fish and wildlife. In addition, human activities, including home building, roads, agriculture, and timber harvest in riparian areas can reduce the number trees and other vegetation and narrow the riparian corridor.

### Landowner and Stakeholder Outreach

Part of the Council's mission is to promote communication and collaboration among Gales Creek Sub-Basin landowners and other stakeholders to improve watershed health. The Action Plan guides landowner outreach and engagement. On April 7th 2015, the Council presented the Draft Action Plan to Gales Creek Sub-Basin landowners and interested parties and solicited input. Their comments and feedback have helped improve this Action Plan. Future landowner and other stakeholder support and partnerships will be essential to help the Action Plan become reality.

# 4. Upper Willamette River and Tualatin River Basin Context

## Overview

The Tualatin River Basin comprises an area of 712 square miles situated in the northwest corner of Oregon, almost entirely within Washington County. The Tualatin River is about 80 miles long and changes dramatically from its steep headwaters in the Coast Range to the valley, where the river flattens into a slow, meandering body of water. The river enters the Willamette River near the City of West Linn, just upstream of Willamette Falls.

Seasonal rainfall accounts for most of the natural flow in the Tualatin Basin; streamflow from snowmelt is minimal. The amount of rainfall ranges from 110 inches on the eastern slopes of the Coast Range to 37 inches in the southeastern area of the drainage basin. Most of the annual streamflow in the Tualatin River typically occurs between November and March; the peak streamflow month is usually February. High flows will typically flow onto the floodplain. At the confluence of Gales Creek and the Tualatin River, the width of the flood plain frequently exceeds 1,000 feet. Low flows in the Tualatin River occur in August and September. In comparison to Willamette Valley tributaries that drain the high Cascade Mountains where snowpack can contribute to flows through much of the summer, summer and early fall stream flows in the Coast Range tributaries, including the Tualatin River, are especially low and warm because of the general absence of any substantial snowpack. Summer flows in the Tualatin River are augmented by flow releases from Barney and Scoggins reservoirs.

## Fish Populations: Status and Trends

This section describes the status and trends for the focus fish species – steelhead, coho salmon, Pacific lamprey, and cutthroat trout – with a focus on characterizing their population status in the Willamette Basin and Tualatin River Basin. Later sections will describe the focal fish species' status and trends for the Gales Creek Sub-Basin.

The Tualatin River enters the Willamette River above Willamette Falls. Historically, the Falls, which are nearly 40 feet in height, were an obstacle to fish migrating up the river and created a division between the lower and upper Willamette Basin. Spring Chinook salmon and winter steelhead, strong swimming fish with great ability to jump, were able to ascend the falls. Pacific lamprey, while not strong swimmers, were also able to pass over the falls because they could attach to the rock walls with their oral discs and then ascend slowly while attached. Coho salmon could not make it over the falls because they are weak swimmers.

Spring Chinook salmon are not a focal species for this Action Plan. Chinook salmon juveniles rear in the lower Tualatin River but historically did not have a large spawning population in the Tualatin River Basin

(Myers et al. 2006). Spring Chinook salmon prefer to spawn in colder tributaries originating from the Cascade Mountains.

It is difficult to overstate the cultural importance of steelhead, salmon, and Pacific lamprey to the Tribes. Tribal dependence on these fish as a food source pre-dates recorded history. It is estimated that, prior to the arrival of Europeans, more than a million spring Chinook salmon and steelhead returned annually to spawn in the Upper Willamette River Basin (ODFW and NMFS 2011). The limited available information on Pacific lamprey abundance trends comes from Willamette Falls harvest data. Harvest at the Falls, which is primarily conducted by the Tribes, ranged from over 500,000 in the 1940s to less than 50,000 by the 1990s, although harvest counts are a poor index of Pacific lamprey abundance because they are influenced by regulations and harvest effort (Kostow 2002).

The construction of a fish ladder at Willamette Falls in the early 1900s provided fish passage for both the historical fish runs – spring Chinook salmon, steelhead, and Pacific lamprey – as well as coho salmon, which were not present in the upper basin before the ladders. Over the course of the last two centuries, the combined effects of fish harvest, hatchery fish interactions, flood control and hydropower operations, and habitat alterations have led to drastic declines in the upper Willamette Basin's fish populations.

The pattern of declining abundance has resulted in the listing of Willamette River anadromous fish populations under state and federal sensitive species designations. Willamette River spring Chinook and winter steelhead are listed under the federal ESA. The federal listing also includes recognizing streams occupied by steelhead as critical habitat if they contain physical or biological features essential to conservation of the species. The upper Tualatin River, including Gales Creek, is listed as critical habitat for upper Willamette steelhead. Pacific lamprey are listed on the federal and State of Oregon sensitive species listings.

The lower Columbia River coho salmon population is listed as threatened under the ESA. This listing extends for coho salmon up to the Willamette Falls (e.g., including the Clackamas River), but does not include the upper Willamette Basin coho salmon, including the Tualatin River runs, because this population was not historically native to the upper basin.

Coastal cutthroat trout are the predominant resident salmonid throughout the upper Willamette Basin. Cutthroat trout are also sensitive to habitat degradation and populations are declining. The lower Columbia coastal cutthroat trout population is listed under the State of Oregon's sensitive species listing, but the Willamette Basin population is not. Some local cutthroat populations have declined in the Willamette Basin, particularly in urban and other developed areas. A study of cutthroat trout populations in the Tualatin River Basin found that cutthroat trout populations were lowest in the urban areas and stronger in areas where there is better quality habitat (Leader 2001). Table 1 describes the life history of Willamette Basin and Tualatin River Basin populations, as well as their status and trends.

**Table 1. Gales Creek Sub-Basin focal fish speices' life history overview and Willamette Basin and Tualatin River Basin population status.**

| Focal Fish Species | Life History Overview | Willamette Basin and Tualatin River Basin Population Status |
|---|---|---|
| Steelhead (*Oncorhynchus mykis*) | The run timing of UWR steelhead is a legacy of the fact that flow conditions allowed steelhead to ascend Willamette Falls only during the late winter and spring before construction of a fish ladder at Willamette Falls. As a result, the majority of the winter steelhead run return to freshwater in January through April passes Willamette Falls from mid-February to mid-May, and spawns in late March through June, with peak spawning in late April and early May. Compared to spring Chinook, steelhead typically migrate further upstream and can spawn in smaller, higher gradient (up to 8% gradient) streams [ODFW and The National Marine Fisheries Service (NMFS) 2011]. Steelhead eggs may incubate in the gravel for up to 50 days before hatching and an additional two to three weeks before emerging. Following emergence, steelhead fry will often seek refuge from fast currents by inhabiting stream margins and pool backwater habitats. As they begin to mature and grow larger, juveniles typically inhabit deeper water habitats of pools, riffles, and runs. Juvenile steelhead rear in headwater tributaries and upper portions of streams for one to four years (most often two years), then as smoltification proceeds in April through May, migrate quickly downstream through the mainstem Willamette River and Columbia River estuary and into the ocean. | NMFS designated critical habitat for UWR steelhead, including the upper Tualatin River and Gales Creek, on September 2, 2005. The UWR steelhead population includes all historically independent winter-run steelhead populations in Willamette River tributaries upstream from Willamette Falls to the Calapooia River (inclusive). Winter steelhead have been reported spawning in the west-side tributaries to the Willamette River above Willamette falls, and ODFW recognizes the Tualatin, Yamhill, Rickreall, and Luckiamute west-side tributaries as part of the Willamette Winter Steelhead population, though these tributaries were not considered to have constituted independent populations historically and are not part of the UWR steelhead Distinct Population Segment (DPS). Under current or future conditions, steelhead production from west-side tributaries may help buffer or compensate for independent populations that are not meeting recovery goals (ODFW and NMFS 2011). In future ESA assessments, ODFW is proposing to explore with NMFS the possible inclusion of these production areas within the DPS. ODFW currently uses February 15 to discriminate between native and nonnative (Big Creek Hatchery) winter steelhead ascending Willamette Falls (Myers et al. 2006). |

| Focal Fish Species | Life History Overview | Willamette Basin and Tualatin River Basin Population Status |
|---|---|---|
| Coho salmon (*O. kisutch*) | Coho salmon enter the upper Willamette Basin in November through January. Duration of coho salmon egg incubation and fry emergence is greatly affected by water temperature, but generally takes between two and three months. Emergence primarily occurs from February through April and peaks in March. Following emergence, juvenile coho salmon typically seek stream margin habitats and backwater pools for initial rearing. As they continue to grow in size, juveniles seek low-gradient, low-velocity pool and off-channel habitats for summer and winter rearing. Juvenile coho favor beaver ponds and slack water habitats with complex large woody debris for protection from winter freshets. Juvenile coho typically migrate to the ocean at about 12 to 14 months of age. The timing of juvenile coho outmigration is usually late March through June, peaking in April and May. Coho salmon in the Lower Columbia River generally rear in the ocean for two summers and return as three-year-olds. The primary exception are "jacks," sexually mature males that return to fresh water after spending one summer in the ocean (Myers et al. 2006). | Coho are not native to the upper Willamette Basin but have successfully colonized tributary systems, including the Tualatin River and Gales Creek. The population is now self-sustaining. |
| Coastal cutthroat trout (*O. clarki clarki*) | Coastal cutthroat trout spawning periods vary from late winter to summer, depending on life-history type. Female cutthroat trout commonly lay between 200 to 4,000 eggs in gravel redds. Eggs typically hatch within four to eight weeks, depending on water temperature, and fry spend one to two weeks in the gravel before emerging. Resident cutthroat trout remain for the most part in their natal streams as juveniles and adults. Some cutthroat trout will migrate into the river to reside after a year in their natal stream (fluvial population). | Cutthroat trout appear to be the predominant resident salmonid throughout the Willamette Basin. |
| Pacific lamprey (*Entosphenus tridentatus*) | After hatching, Pacific lamprey spend about 4-7 years rearing in freshwater as filter feeding larvae (ammocoetes) prior to metamorphosing and migrating to the ocean (Schultz et al. 2014). Because freshwater rearing consists of a relatively high fraction of the life cycle of the Pacific lamprey, this stage is generally viewed as critical for the viability of the species. Following the rearing period, lamprey ammocoetes undergo a physiological and morphological transformation into | The Willamette River appears to have one of the highest returns of lamprey of any of the Columbia River tributaries and also supports one of the only remaining traditional tribal harvest locations in the Columbia River Basin. Pacific Lamprey populations are declining throughout the Columbia River Basin. Willamette River lamprey populations are also declining: estimated |

| Focal Fish Species | Life History Overview | Willamette Basin and Tualatin River Basin Population Status |
|---|---|---|
| | macrophthalmia, and subsequently outmigrate to the ocean. The parasitic marine phase lasts less than 3.5 years, after which they return to freshwater. Pacific lamprey enter freshwater in the late spring and summer and hold 8-12 months in the Willamette River or larger tributaries prior to making a final migration to their ultimate spawning areas. Spawning occurs from March to July; timing varies with water temperature and location. Both sexes participate in redd construction and individual lamprey typically build multiple redds. Pacific lamprey are gregarious spawners and researchers have observed up to 12 adults within an individual redd (Schultz et al. 2014). | harvest in the Willamette River declined from ~250,000 pounds in 1943 to less than 12,000 since 2001 (Schultz et al. 2014). Recent population estimates at Willamette Falls ranged from 63,517 to 245,325 between 2010 and 2012, respectively (Schultz et al. 2014). Pacific lamprey populations are listed as “vulnerable” on the Oregon State Sensitive Species list. |

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# Water Quality and Quantity: Status and Trends

## Water Sources and Uses

Scoggins Reservoir  supplies water to the Tualatin Basin in the summer and early fall low-flow periods, through various arrangements with agencies and other organizations, including the JWC, TVID, Reclamation, and CWS, for multiple uses such as residential, industrial, agricultural, water quality, and fish and wildlife habitat. From outside the basin, a trans-basin aqueduct carries water from Barney Reservoir over a low Coast Range divide to a pipeline that discharges into the Tualatin River at RM 78. Individual irrigators also draw water from tributary streams and many rural areas rely on groundwater for drinking water and irrigation.

## Management and Monitoring

The Tualatin River Flow Management Technical Committee includes agency technical staff that monitors and coordinates the details of water flow in the Tualatin River Basin. Many of the organizations, including CWS and Washington County, are active members of the Council.  Water in the Tualatin Basin is monitored closely through stream gages along the mainstem Tualatin and all major tributaries, including Gales Creek. Flow meters exist on major diversions and wastewater treatment facility discharges. In the past, CWS has used TVID transmission lines to deliver water to several tributaries for flow restoration in the summer. For example, Gales Creek received augmented flow in 2009 to 2013 to offset low-flow conditions. CWS also releases stored water from Scoggins and Barney Reservoirs for flow augmentation during the seasonal low-flow periods to improve water quality in the Basin.

## Water Quantity Trends

CWS is collaborating with Reclamation to develop alternatives for raising Scoggins dam by 12 feet to meet future water supply needs for maintenance and improvement of water quality in the Tualatin River. The municipal and industrial water providers have decided to focus on the Willamette River as a future water source; this new source is anticipated to be online in approximately 2026.

Climate change models predict greater precipitation through rainfall and less snowpack for the Pacific Northwest. The Tualatin Basin will certainly be affected. A recent study focused on the Tualatin Basin (Chang et al. 2009) concluded that if the climate changes as expected there will be more frequent major storms. The combination of more frequent storms and warmer summer temperatures will exacerbate extreme events. Flooding is likely to be more common and summer flow is projected to decline (Franczyk and Chang 2009).

## Water Quality

The Tualatin River is well-known for its water quality problems. The combination of a naturally broad and slow-moving river with inputs of sediment and nutrients and high temperatures, resulting from various human activities, continues to challenge land and water managers.

Water quality in the Tualatin River is monitored regularly at a number of locations downstream of Wapato Lake by United States Geological Survey (USGS), CWS, and other entities. A number of water quality parameters in the river exceed state criteria, many of which have total maximum daily loads approved by the Oregon Department of Environmental Quality (DEQ) (Table 2). Much of the contribution of phosphorous is naturally occurring from the organic fluvial deposits along the valley, which are naturally high in phosphorus. Other parameters that affect water quality are generally the result of land management practices.

The lower Tualatin River from RM 3.4 to RM 30 has historically had a problem with algal growth and high pH. Because the river is so broad, streamside vegetation cannot adequately shade the full width and consequently much of the water surface is in the sun. Nutrients, both naturally occurring and anthropogenic, are ample. These conditions—slow movement, sunlight, and ample nutrients—are ideal for algal growth during summer. The growth and decline of too much algae can become harmful to fish and aquatic life. With increased summer flow due to released water from Hagg Lake and improved treatment from CWS's waste water treatment facilities, nutrients that feed algal growth have decreased in recent years. According to the 2013 Tualatin Basin Flow Report (Tualatin Flow Management Technical Committee 2013), conditions are improving in the lower Tualatin Basin: "Because the algal population has declined, high pH values have become rare. The pH is monitored hourly at RM 3.4 (Oswego Dam, year-round) and RM 24.5 (summer only). In 2012, no pH values at either site exceeded 8.5 (the state standard for high pH). In addition to pH data from continuous monitors, weekly pH measurements are taken at a number of sites during the summer by Clean Water Services."

Fish and aquatic life must take DO from water to survive. In late summer, the Tualatin River tends to be low in DO due to complex processes, sediments, and nutrients in the river. Continuous monitors are deployed at two locations (RM 3.4 and RM 24.5) in the lower section of the river. By limiting nutrient inputs to the river and increasing summer river flows, the Council hopes to see increased levels of DO in the future.

**Table 2. Water quality characteristics for the Tualatin River Basin (ODEQ 2012).**

| Water Quality Parameter | Period of Impairment | 303(d) List Status for Water Quality- Impaired Streams |
|---|---|---|
| Ammonia | June 1 – Sept 30 | TMDL-approved: Attaining, some exceedances recorded |
| Biological Criteria | Year-round | 303(d) |
| Chlorophyll a | Summer | TMDL-approved |
| DO | Jan 1 – May 15 | TMDL-approved: Some exceedances recorded |
| *E. coli* | Fall/Winter/Spring | TMDL-approved: Attaining, but some exceedances recorded |
| Iron | Year-round | 303(d) |
| Manganese | Year-round | 303(d) |
| pH | Fall/Winter/Spring | TMDL-approved: Attaining, but some exceedances recorded |
| Phosphorous | June 1 – Sept 30 | TMDL-approved |
| Temperature | Summer | TMDL-approved: Attaining, but some exceedances recorded |

## Limiting Factors and Threats to Fish Populations

This section describes the general factors that limit the focal fish populations in the Tualatin River Basin. The current and emerging threats that cause the limiting factors are also described. The next chapter will cover the factors that are limiting fish populations specifically in Gales Creek.

The scientific evidence is well established that to survive and successfully reproduce the next generation, steelhead, coho salmon, and cutthroat trout require clean water, specific ranges of water temperatures, and key stream habitat characteristics, including adequate gravel, connection to floodplains, large wood, pools, and other features. Less is known about the factors that limit Pacific lamprey, but a growing number of research studies are providing clues into the habitat, water quality, and other problems that affect Pacific lamprey populations.

In general, the factors that can limit focal fish populations can be categorized into four general categories: fish passage barriers, impaired aquatic habitat, impaired riparian and floodplain habitat and vegetation, and degraded water quality and quantity.

## Fish Passage Barriers

Fish passage barriers include obstacles that block or slow migration for adults seeking spawning areas or attempting to access different habitats or cool water areas. Barriers can also affect juveniles by slowing or blocking passage into tributaries that contain cooler water during the summer and refuge from high flows during the winter and spring. Dams that span a stream channel and road crossing culverts are examples of fish passage barriers that can totally or partially block adult or juvenile fish access.

Steelhead, coho salmon, and cutthroat trout have similar fish passage requirements. Culverts and dams commonly block or impede fish passage by creating an obstacle that fish must jump through or over. While some adult steelhead can jump to heights of over 4 feet, most fish cannot. In addition, water can move through culverts or other obstacles at very high velocities which can exceed a fish's swimming ability. The velocity of water flowing through a culvert is determined by a number of factors, but the primary factor is the gradient of the culvert. A very steep culvert (high gradient) will increase velocities more than a culvert that is very flat.

Fish passage is a concern for both adult and juvenile steelhead, coho salmon, and cutthroat trout. Most criteria for fish passage are designed to accommodate juveniles, since they are the most vulnerable life stage and are the weakest swimmers and can be stopped by a 6-inch drop. Guidelines for fish passage developed by ODFW, for example, specify that culverts need to be installed at a gradient of less than 0.5% and have no more than a 6-inch drop at the outlet.

Due to considerable differences in behavior and swimming ability between salmonids and Pacific lamprey, many fish ladders and road crossings designed to pass salmon and steelhead may impede or block passage by Pacific lamprey. For example, Pacific lamprey cannot effectively navigate culverts with excessively high water velocities, vertical drops, or sharp angles (Stillwater Sciences 2014). When confronted with high velocities, Pacific lamprey will use their oral discs to attach to substrate and rest before continuing upstream. Their ability to attach to substrate within a road crossing culvert is a key determinant of whether they can pass through the culvert. Pacific lamprey cannot jump, so even a culvert with less than a 6-inch drop at the outlet can block movement upstream. Pacific lamprey can ascend vertical walls at waterfalls if the water velocities are not extreme and there is sufficient variation in the surface to allow the oral disk to attach. Water diversion and other dams present a significant passage problem for Pacific lamprey because the surface is often too smooth for oral disk attachment, and they cannot pass over the right angles often present at the lip of the dam.

## Impaired Aquatic Habitat

Stream channels that do not provide the full range of necessary habitat features over the course of the fish's life cycle can limit populations. Key aquatic habitat factors that limit steelhead, coho salmon, and cutthroat trout populations include pools and riffles with inadequate large wood and cover to allow adult and juvenile fish to feed, rest, and hide from predators; stream channel substrate (gravels, cobbles, etc.) of inadequate quantities or distribution for spawning and egg incubation; and high sediment loads that cover eggs, leading to mortality.

For the most part, Pacific lamprey require habitat qualities similar to those that trout and salmon require, but there are differences due to their specific life cycle needs. Larval Pacific lamprey require low velocity habitats with fine sediments. Pacific lamprey larvae are most abundant in areas composed of deep, fine sediment that provide suitable burrowing habitat, particularly off-channel habitats (Schultz et al. 2014).

Pacific lamprey are spawning generalists, capable of spawning in a wide diversity of stream sizes, ranging from small streams to larger rivers, and underlying geologic types, provided there are no barriers to upstream migration. Similar to trout and salmon, spawning Pacific lamprey deposit their eggs in depressions (redds) that they construct. Pacific lamprey redds are most abundant in stream areas associated with gradient breaks (e.g., pool tailouts and run habitats) composed of gravel and cobble substrates, similar to trout and salmon spawning requirements (Schultz et al. 2014).

## Impaired Riparian and Floodplain Habitat and Vegetation

Key riparian and floodplain habitat attributes that can limit steelhead, coho salmon, and cutthroat trout populations include inadequate shade over streams, which contributes to higher temperatures and does not provide leaf litter and other organic matter necessary to support the food web; limited large wood inputs from large trees falling into channels; and levees, rip-rap, or other structures that reduce access to floodplains, side channels, alcoves, and other off-channel features that provide habitat and offer refuge to adult and juvenile fish during high water events.

Pacific lamprey larvae require floodplain connectivity for juvenile rearing. Lamprey juveniles are found in large numbers in off-channel habitats because these areas provide the deep, fine sediments that provide suitable burrowing habitat. In a survey of Willamette Basin lamprey habitats, mean Pacific lamprey density in off-channel habitats was 10 times greater than in main-channel habitats (Schultz et al. 2014).

## Degraded Water Quality and Quantity

Impaired water quality, particularly increased water temperatures, can limit coho salmon and cutthroat trout populations. Water temperatures that exceed 18°C for sustained periods during the summer and early fall can stress fish, leading to a weakened condition, increased susceptibility to disease, and mortality. Fish will move from warm water areas into cooler habitats within the stream or tributaries if access is not blocked by a culvert or other barrier. Other water quality problems that can affect fish include inadequate DO levels (caused by high water temperatures or increased nutrients), high levels of pesticides, and presence of other chemicals (e.g., copper) that affect fish behavior or reproductive success.

Reduced water quantities, from water withdrawals or other uses, can limit fish populations. Reducing stream flows can increase water temperatures in the summer and early fall because of the reduced volume of water that is subject to heating. Water diversions can dewater sections of stream, effectively blocking fish movement through the dry channel areas.

Very little is known about Pacific lamprey's water quality requirements, but it is clear that Lamprey are sensitive to water temperatures. For example, spawning is generally initiated when water temperatures are in the 10 -15°C range and seasonal hydrographs are descending (Schultz et al. 2014). It is not known if Pacific lamprey's tolerance for high water temperatures is similar to trout and salmon.

Upon entry into freshwater, Pacific lamprey do not home into their natal stream, as steelhead and salmon do. Instead, bile acid chemicals from upstream larval lamprey function as attracting pheromones to adult Pacific lamprey, drawing them into the spawning tributary. Environmental pollutants can disrupt the physiology and behavior of other fishes, but the extent to which specific chemicals affect migration of Pacific lamprey is unknown. In a recent study (Schultz et al. 2014), the Tualatin River Basin was found to contain relatively few larval Pacific lamprey relative to other Willamette Basin tributaries, but resident brook lamprey catches were consistent with other Willamette River valley basins that were sampled. The Tualatin River watershed is urbanized and contains the greatest stream length with impaired water quality of the 12 Willamette River tributaries that were sampled. The researchers hypothesized that land use practices might contribute to water quality conditions that deter adult Pacific Lamprey from migrating into the Tualatin River Basin.

## Primary Threats

Threats are human activities or natural processes that cause limiting factors. For example, removing the vegetation along the banks of a stream (the threat) can cause higher water temperatures (the limiting factor), because the stream is no longer shaded. The primary human activities that are driving current and emerging threats in the Tualatin River Basin are climate change and population increases.

Although the impacts of climate change are difficult to predict, climate change will likely increase the limiting factors affecting the focal fish populations. The effects of degraded and lost habitat quality and complexity could be amplified through climate change. Although the potential ecological responses to climate change are complex and not precisely predictable, the projected regional trajectories of increased winter flooding, decreased summer and fall stream flows (and the related effects on stream temperature), and elevated temperatures in streams are likely to compound already degraded habitat conditions. With the anticipated changes in precipitation patterns and resulting altered hydrology, particularly during the summer when flows are at their lowest, and higher seasonal water temperatures, there will likely be further losses of areas that provide cool water refugia and resting habitat important to salmonid survival. Degraded riparian habitat conditions may exacerbate altered hydrology and water temperatures by altering other important ecosystem components, including shading and cover, organic matter inputs and aquatic food production, and nutrient inputs.

Washington County's population is projected to nearly double between 2015 and 2040. The population increase, with associated development, will likely lead to more degradation of riparian and aquatic habitats, decreased water quality, and reduced fish and wildlife diversity and populations. The combined effects of climate change and urban development will further exacerbate existing water pollution problems (Praskievicz and Chang 2011) and contribute to more non-native weedy vegetation throughout the landscape, particularly in riparian areas. If late summer streamflow is reduced by climate change, and there are no improvements in riparian vegetation cover, stream temperatures may increase. However, increases in riparian cover in tributaries of the Tualatin could partly counteract these effects in the mainstem Tualatin River. This climate change scenario raises the importance of tributaries like Gales Creek as cold water and habitat refuges for the future steelhead, coho salmon, cutthroat trout, and lamprey populations.

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# 5. Gales Creek Sub-Basin Current Conditions

## Overview

This section provides an overview of Gales Creek Sub-Basin's current conditions, including fish population status. Riparian and aquatic habitat and water quality information from the RBA survey and other sources is summarized to provide insights into the factors limiting fish populations and watershed health, including fish passage barriers, aquatic habitat, riparian vegetation, and water quality.

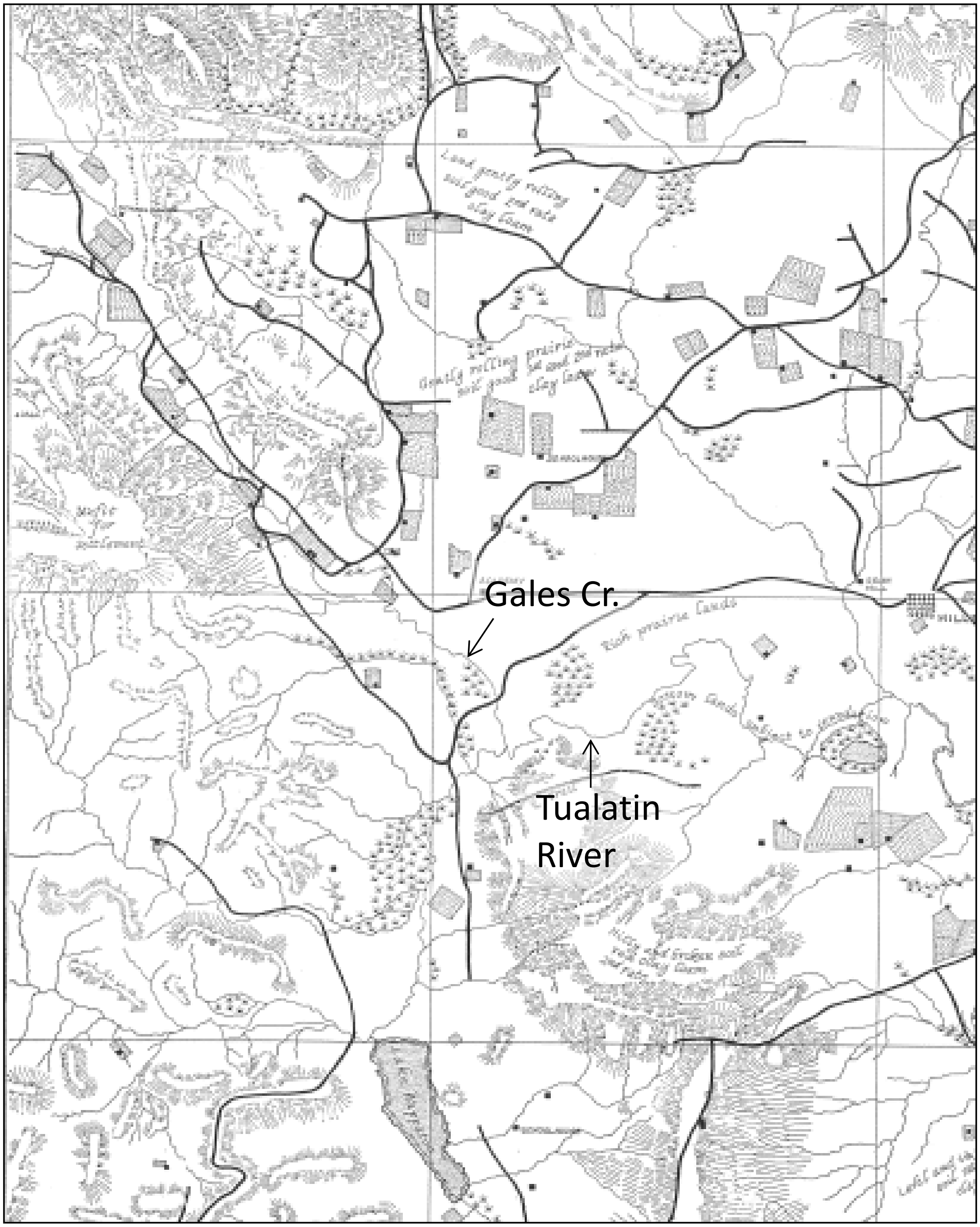
Gales Creek begins high in the coast range where Douglas fir and alders hold onto steep canyons and tower over rushing salmon streams. It also begins in small ditches near residential areas and along Gales Creek Road as rainwater runs to the creek or soaks into the ground.

The underlying geology in the western sub-basin is primarily igneous rock and contributes a significant proportion of the gravels found in Gales Creek. Valley widths are generally narrow, unless at the mouth of the watershed. The eastern portion of the sub-basin contains more sandstone, shale, and mudstone; these areas with more sedimentary geology tend to have warmer stream temperatures because there are fewer cold groundwater inputs.

The Tualatin River meets Gales Creek at river mile (RM) 56.7, after traveling through the Wapato Valley. The Wapato Valley is surrounded by the foothills of the eastern slopes of the Oregon Coast Range and is bordered to the west by the Chehalem Ridge. Much of the landscape of the Wapato Valley is influenced by the historic Missoula floods, which deposited alluvium on the valley floor 10,000-15,000 years ago (O'Connor et al. 2001). The General Land Office (GLO) survey maps from the 1850s provide a view of this area before extensive changes in the river's condition. Historically, the Wapato Valley was characterized by the meandering Tualatin River surrounded by wet prairie, wetlands, and upland prairie-oak habitat. Today this area is dominated by agricultural land uses.

Near the confluence of Gales Creek with the Tualatin River, the floodplain is wide (average of 6,700 feet) and the valley is very flat. Due to the cohesive soils, the active channel is primarily a single thread with very few multiple channels. Historically, water flowed from the surrounding hillslopes into the valley where lakes, wet prairies, wetlands, and streams arose and formed multiple channels and drainages down to the Tualatin River. Clays and silts, deposited during the Missoula floods, underlay this wet, marshy valley environment. Today, the river's bed and bank materials remain cohesive, thus leading to a u-shaped channel with a mucky bottom covered in fine sediment. Erosion tends to be slow and massive channel change infrequent.

**Figure 1. Compiled 1852 GLO maps of the Wapato Valley (Munch 2000)**



## Stream Reaches

The RBA is designed to be a fast-moving inventory covering a large stream network to gather baseline fish distribution and abundance information (Bio-Surveys, LLC 2003). In the Gales Creek Sub-Basin, the RBA covered nearly 50 miles of stream habitat. The surveyed streams included Gales Creek and its major tributaries, with the exception of Little Beaver Creek. To provide a geographic framework for the Action Plan, stream reaches were mapped for the full extent of the RBA survey and additional areas in Little Beaver Creek where the RBA survey was not conducted. Sixty reaches covering nearly 62 miles of Gales Creek and its tributaries were mapped and entered into a geographic information system (GIS) database (Table 3). The reaches were characterized based on the following geomorphic characteristics:

**Channel gradient** – The steepness of the stream channel – e.g., low gradient (less than 2%), medium gradient (2% to 4%), etc. An individual stream reach has a relatively uniform gradient.

**Valley confinement** – The width of the valley and associated floodplain. Valley confinement ranges from a narrow "V"-shaped valley with no floodplain, to a broad "U"-shaped valley with a wide floodplain. An individual stream reach would encompass a common valley confinement.

**Geology** – The general underlying geology of the area that helps to shape stream channel morphology and contributes to the types of substrate material found in the channel (e.g., fine sediments, gravels, cobbles, etc.).

**Table 3. Gales Creek Sub-Basin mapped reaches.**

| Watershed | No. of Reaches | Total Length (Miles) |
|---|---|---|
| Upper Gales Creek | 12 | 15.20 |
| Beaver Creek | 15 | 9.57 |
| Middle Gales Creek | 8 | 8.83 |
| Little Beaver Creek | 6 | 3.36 |
| Iller Creek | 8 | 5.21 |
| Clear Creek | 5 | 5.64 |
| Lower Gales Creek | 6 | 14.03 |
| **Total** | **60** | **61.84** |

The Gales Creek Sub-Basin database provided a structure for summarizing the RBA data associated with each reach, including the following:

- Fish counts by species and numbers.
- Average density of fish by species: fish per square meter of pool surface area.
- Cover/complexity rating. This rating qualified the pool habitat sampled within the reach. The 1-5 rating is based on the abundance of multiple cover components within a sampled unit (wood, large substrate material, undercut bank, and overhanging vegetation).
- Fish passage barrier numbers and descriptions (e.g., juvenile and/or adult barriers to passage).
- Number of beaver dams.
- Presence of knotweed patches.
- Notes on stream characteristics, including water temperature, presence of large wood, riparian cover, substrate composition, and floodplain interaction.

In addition to the data collected by the RBA, the database also includes other information available for the reach, including the following:

- CWS riparian plantable area cover class:  0%-49% plantable area; 50%-74% plantable area; 75%-100% plantable area. Plantable area cover class is a broad classification of the vegetation restoration need for the site – e.g., the greater the plantable area, the greater the need to improve riparian vegetation through installation of native vegetation and other actions.
- CWS garlic mustard and knotweed presence survey data.
- Coastal Landscape Analysis and Modeling Study (CLAMS) Intrinsic Potential (IP) score for fish habitat. The IP provides a gauge of the quality of stream habitat for anadromous fish. The IP score is based on combining three key landscape-level indicators of fish habitat quality: mean annual stream flow, valley constraint, and channel gradient.

The Watershed Summary section below includes detailed maps showing the Gales Creek Sub-Basin reaches.

# Fish Populations

The Gales Creek Sub-Basin, in comparison to more urbanized sub-basins in the Tualatin River Basin, has fewer introduced non-native fish species and great diversity and numbers of native fish, including steelhead and coho salmon. Because of the presence of these anadromous species, the Council contracted to have the RBA snorkel surveys completed; the surveys were conducted between July 23 and September 18 of 2013. In addition to the Gales Creek Sub-Basin, surveys were also completed in the upper Tualatin River and the McKay and Dairy Creek Sub-Basins (Bio-Surveys, LLC 2014).

The RBA stream surveys began by selecting the first pool encountered in the tributary upstream of Gales Creek. By not randomly selecting the first sample pool in a tributary, the survey was able to identify upstream high water temperature-induced fish movement into tributaries from Gales Creek that may not have extended more than a few hundred feet. The identification of this type of migratory pattern in juvenile salmonids is critical for understanding potential limiting factors within the basin (temperature, fish passage, etc.). The survey continued sampling at a 20% frequency (every fifth pool) to the end of steelhead or coho distribution. The end of distribution was confirmed by the observation of at least two pools with no steelhead or coho salmon presence. Cutthroat trout, which can live in small, high-gradient streams, usually extend beyond steelhead and coho distribution areas; thus the survey did not describe the upper limits of native cutthroat distribution.

The distribution of juveniles and their observed rearing densities for each of the RBA-surveyed reaches provide a basis for understanding how each reach is functioning in relation to the Tualatin River Basin and the Gales Creek Sub-Basin. The information on fish presence and abundance can help identify adult spawning locations, identify potential barriers to upstream adult and juvenile migration, and may also indicate how juvenile salmonid populations are responding to environmental variables such as increased temperature.

The current range of anadromous fish distribution repeatedly fell substantially short of the range of stream miles exhibiting high-quality anadromous potential. This was likely the result of low numbers of adults accessing spawning habitat and producing too few offspring to adequately seed the available juvenile rearing habitat. It is important to note that the RBA survey data represent a snapshot in time of the current conditions and numbers of adult fish accessing spawning areas. The stream environment and adult spawning numbers and success will vary over time.

The RBA estimates provide a framework for comparing fish presence and numbers for the surveyed Tualatin River streams. Table 4 summarizes the 2012 RBA estimates for the number of steelhead, coho salmon, and cutthroat trout estimated for each of the surveyed Tualatin River Basin streams. The largest number of steelhead and coho were observed in the East Fork Dairy Creek system, followed by the Gales Creek Sub-Basin. No steelhead were observed in West Fork Dairy Creek or McKay Creek. Gales Creek had the largest estimated population of cutthroat trout.

**Table 4. Estimated numbers of steelhead, coho salmon, and cutthroat trout in the Tualatin River Basin streams surveyed in 2013 with the RBA protocol (Bio-Surveys, LLC 2014). Gales Creek fish number estimates in bold.**

| Tualatin River Basin Sub-Basin | Steelhead | Coho Salmon | Cutthroat Trout |
|---|---|---|---|
| Tualatin | 132 | 3,938 | 640 |
| EF Dairy | 1,965 | 37,124 | 3,776 |
| **Gales** | **650** | **26,805** | **4,055** |
| McKay | 0 | 8,855 | 1,984 |
| WF Dairy | 0 | 13,369 | 1,565 |
| **Total** | **2,747** | **90,090** | **12,020** |

General RBA observations from the Gales Creek Sub-Basin RBA survey:

- When steelhead were present, they were observed in low densities.
- Deep channel entrenchment and inadequate riparian buffers were consistently documented in lower Gales Creek and its tributary reaches in the lower portions of the Sub-Basin.
- A number of water temperature-related fish distributions were noted. Temperature is probably the most significant driver of upstream (and tributary-entry) juvenile salmonid migrations during summer flow regimes.
- Coho are by far the most abundant salmonid species and have succeeded in capitalizing on habitat niches not well utilized by steelhead and cutthroat trout.
- Cutthroat trout were observed throughout Gales Creek and its tributaries. The highest densities of Cutthroat were observed rearing in headwater reaches with no steelhead or coho present. Gales Creek had the largest estimated number of cutthroat trout.
- The tributaries contain 91.5% of all coho observed. The opposite was true for steelhead: most steelhead were found in upper Gales Creek, with only 33.8% observed rearing in the tributaries.
- Coho and steelhead distribution exhibited a strong preference for the siltstone/sandstone of the Yamhill formation in the Upper Gales Creek Watershed. The 3 mile stream segment of

Gales Creek that interfaces with this formation rears 56% of all coho and 55.8% of all steelhead documented in the Gales Creek Sub-Basin (Figure 2).

- Upstream juvenile temperature-dependent migrations in Gales Creek are terminated at RM 12.7, where they are blocked by a 3-foot-high concrete dam (Balm Grove). A density spike of steelhead and cutthroat trout was observed at the base of the dam (Figure 2). The large number of fish assembled below the dam is an indicator of the unsuccessful attempts for juveniles to migrate past the vertical obstruction to reach cooler stream temperatures upstream.

- In a separate study, 66 larval Pacific lamprey were observed in lower Gales Creek and no lamprey were observed in upper Gales Creek (Schultz et al. 2014). It appears that Balm Grove dam is an obstruction to adult Pacific lamprey migration to spawning areas in upper Gales Creek. Pacific lamprey larvae have been observed across the Willamette Basin tributaries, but its distribution appears to be limited by the ability of adults to access spawning habitats. All locations where researchers failed to collect Pacific lamprey larvae in the Willamette Basin were associated with anthropogenic migration barriers, including dams (Schultz et al. 2014). Partial fish passage barriers, including seasonal barriers, also influence larval lamprey abundance by limiting adult returns. Oswego dam in the lower Tualatin Basin appears to be a partial barrier.

Table 5 shows the relative steelhead, coho salmon, and cutthroat trout densities for each of the watersheds within the Gales Creek Sub-Basin. The table also shows the number of Pacific lamprey. The Upper Gales Creek Watershed contains the highest densities of steelhead and cutthroat trout. Most of the steelhead were observed in upper Gales Creek and not its tributaries (e.g., the North Fork of Gales Creek). Clear Creek has the highest densities of steelhead and cutthroat trout in the tributaries. Coho densities are highest in the Beaver Creek Watershed, followed by the Upper Gales Creek Watershed. The Clear Creek Watershed also has significant coho densities. The following maps illustrate Gales Creek fish densities and stream locations. Table 6 summarizes the RBA survey observations for fish numbers, habitat quality, and water temperatures for Gales Creek and its tributaries.

**Figure 2. Gales Creek Steelhead Counts. A concrete dam (Balm Grove) blocks juvenile migration. The greatest numbers of steelhead were found within the Yamhill geologic formation corresponding with the Upper Gales Creek Watershed (Bio-Surveys, LLC 2014).**

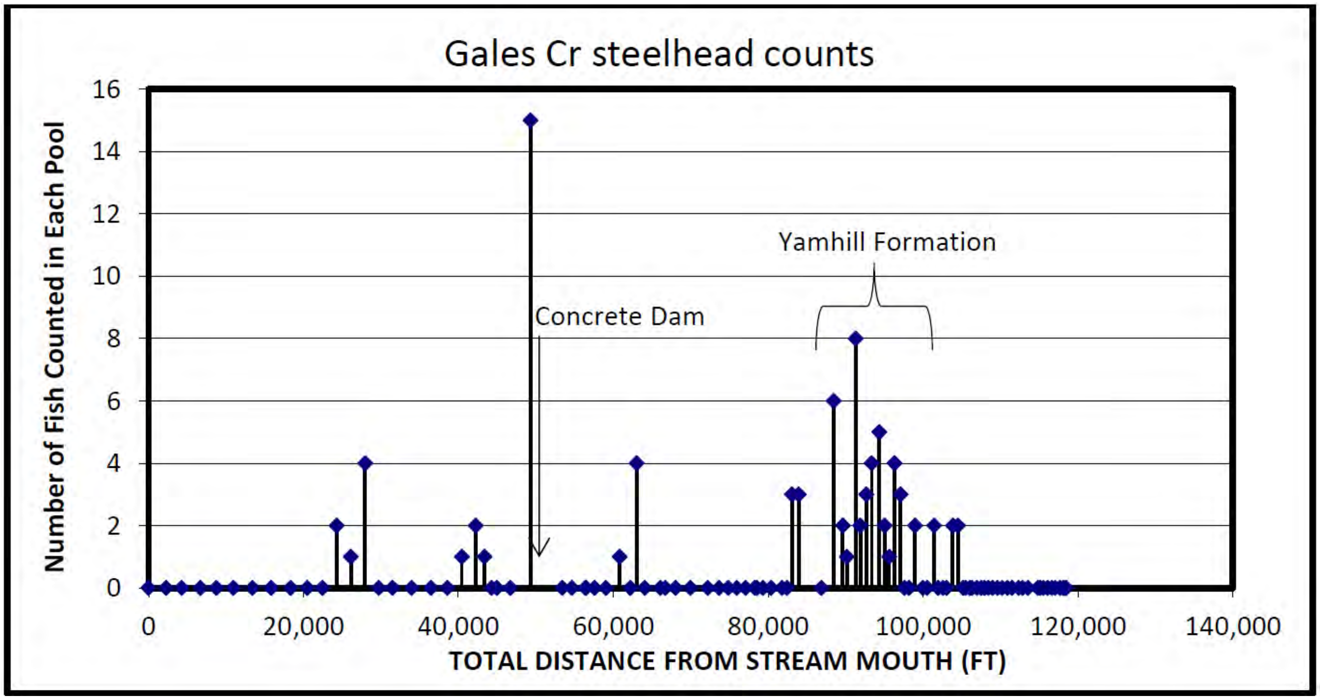



**Table 5. Relative fish densities[2] averaged across each of the Gales Creek Sub-Basin watersheds (Bio-Surveys, LLC 2014), and Pacific lamprey survey numbers (Schultz et al. 2014). RBA data was not collected for Little Beaver Creek. Pacific lamprey were surveyed in two locations: Lower Gales Creek and Upper Gales Creek.**

| Watershed | Average Steelhead Density | Average Coho Density | Average Cutthroat Density | Pacific Lamprey Numbers |
|---|---|---|---|---|
| Upper Gales | 2.12 | 18.12 | 15.15 | 0 |
| Beaver | 0.00 | 53.69 | 2.30 | ND |
| Middle Gales | 0.19 | 16.04 | 3.79 | ND |
| Little Beaver | ND | ND | ND | ND |
| Iler | 0.11 | 12.40 | 5.95 | ND |
| Clear | 1.01 | 25.94 | 5.78 | ND |
| Lower Gales | 0.04 | 0.06 | 0.91 | 66 |

[2] Relative densities based on the number of fish observed per mile of stream habitat surveyed for fish abundance.

**Table 6. Fish and habitat / water quality observations from the 2013 RBA survey (Bio-Surveys, LLC 2014).**

| Watershed | Fish Observations | Habitat / Water Quality Observations |
|---|---|---|
| **Upper Gales** | Gales Creek: The low salmonid abundance observed in all of mainstem Gales Creek continues to persist to the confluence with Coffee Creek. The largest numbers of steelhead in the Sub-Basin were observed above the confluence with Coffee Creek. Steelhead have a strong preference for the upper portions of Gales Creek and less of a preference for the tributaries. Coho and steelhead distribution exhibited a strong preference for the siltstone/sandstone of the Yamhill formation. The 3 mile stream segment that interfaces with this formation rears 56% of all coho and 55.8% of all steelhead documented in the Gales Creek Sub-Basin. Cutthroat and juvenile trout densities both exhibited an increase in abundance within the Yamhill formation but peaked in the Tillamook volcanics observed in the headwaters. NF Gales Creek: The inventory extended to RM 1.5. Steelhead and coho were present. Steelhead numbers were low and sporadic. SF Gales Creek: A span of only 10 pools that extended approximately 1,100 feet were observed rearing coho. No steelhead were observed. | Gales Creek: Steelhead distribution extended to RM 24 with no barriers to adults observed blocking access to the additional 2.5 miles of habitat available to anadromous migrants. Coho distribution extended to RM 22.5 and not above, leaving some of the highest quality fish habitat in the basin underutilized, with no barriers to passage observed. This is an unusual distribution pattern; both coho and steelhead are known to push high in the basin to access spawning habitats. It is likely that during higher abundance years of adult steelhead and coho available for spawning, these headwater habitats would be more completely utilized for spawning and rearing. NF Gales Creek: The confluence is within a large wood treatment reach on mainstem Gales Creek. Treatment extends up the NF Gales Creek from the confluence to RM 0.6. |
| **Beaver** | Beaver Creek has the highest coho numbers, accounting for 47.4% of all coho observed rearing in the Gales Creek Sub-Basin. The peak densities spanned the middle half of the distribution with more than twice as many fish per mile observed | Beaver Creek enters Gales Creek with a similar warm summer temperature profile as the mainstem of Gales Creek, rendering it not a likely destination for upstream migrants in search of thermal refugia. The habitats in Beaver Creek favored coho and cutthroat. The large cobbles and higher gradients preferred by steelhead were not present. The system has the largest |

| Watershed | Fish Observations | Habitat / Water Quality Observations |
|---|---|---|
| | between RM 1.8 and RM 5.2. No steelhead were observed rearing in the Beaver Creek system. | number of beaver ponds in the Gales Creek Sub-Basin. |
| **Middle Gales** | Gales Creek: Channels scoured to bedrock and deep basalt trench pools continue to a 4-foot-high bedrock falls at USGS RM 19.75 (just below Coffee Creek). The low salmonid abundance observed in all of mainstem Gales Creek continues to persist to the confluence of Coffee Creek. Bateman Creek: Coho were observed in low densities for 0.5 mile and ended at a 3-foot-high sill log pour. This was most likely not an adult barrier. | Iler Creek enters at RM 11.4 cooler than the mainstem contribution. Upstream juvenile temperature-dependent migrations in Gales Creek are terminated at RM 12.7 at a 3-foot-high concrete dam (Balm Grove). White Creek enters at RM 14.4 with notes indicating cold water. A 1-foot-high perch created by a concrete sill on the Highway 8 culvert that crosses White Creek was terminating upstream temperature-dependent migrations into White Creek from the mainstem of Gales Creek. Bateman Cr enters at RM 16.25 as a cold water contribution to the mainstem. Coho appear to also be utilizing Bateman Creek as a source of cold water refugia from the mainstem of Gales Creek. Bateman Creek: Two culverts in Bateman Creek were observed that definitively terminate upstream temperature-dependent juvenile migrations. The first was observed at RM 0.42 and was perched 1.5-feet. The second exhibited a 1-foot perch and was above the current end of coho distribution at RM 0.6. The lack of sorted gravels in Bateman Creek, combined with heavy sediment loading, suggest that it is not a productive target for adult escapement. Its importance lies in its location near the top end of a known upstream temperature-dependent migration route. White Creek: Cool summer temperature profile and spatial location within the temperature-limited reach of mainstem Gales Creek suggests that it has the potential to function as thermal refugia during summer flow regimes. |
| **Little Beaver** | The RBA was not conducted in the Little Beaver Watershed. | No Data |
| **Iler** | Iler Creek contributed 9.9% of all coho observed in the Gales Creek Sub-Basin. At RM 1.9 Coho population estimates exhibited a defined spawning | 580 feet above its confluence with Gales Creek, a series of concrete steps impedes any further upstream juvenile migration. Coho distribution extended for 2.5 miles at an average gradient of 1.5% and was terminated |

| Watershed | Fish Observations | Habitat / Water Quality Observations |
|---|---|---|
| | peak with a density spike and the highest pool count (59). Expanded population estimates suggest an adult escapement of 12 pairs of adult coho. Steelhead were observed in sporadic distribution and very low densities for 1.5 miles. | at a natural log jam. With the log jam classified as an ephemeral barrier, the inventory continued to the end of anadromous potential. An additional 1 mile of stream habitat was described as having a sinuous channel, an interactive low floodplain, high wood complexity, excellent gravel sorting in pool tailouts, and a mature coniferous riparian corridor. |
| **Clear** | The Clear Creek inventory extended 3.3 miles to just above a steep 10-foot bedrock cascade that terminates anadromous access. Clear Creek contains steelhead and coho and was one of the top 3 producers of salmonids within the Sub-Basin. | A 2012 restoration project where a section of stream habitat treated with large wood in the channel extends from RM 1.3 to 2.3. This section had a pre-treatment RBA survey in 2012. No steelhead were observed in 2012. In 2013, 33 steelhead were observed; juvenile trout numbers increased by 143%; and Coho numbers increased by 323%. The confluence of Clear Creek is within the temperature-limited reach of the Gales Creek mainstem. Clear Creek is an important source of thermal refugia for juvenile salmonids during the summer periods when water temperatures are limiting. |
| **Lower Gales** | The survey began at RM 3.6. No salmonids were observed in the lower 3 miles. Pike minnow, red sided shiners, dace, and suckers were all abundant in the lower reaches of mainstem Gales. Coho, steelhead, and cutthroat are first observed in significant numbers around RM 8. | The first 3 miles of the mainstem was characterized by low gradient (0.2%); warm water; entrenched banks; deep, silty alluvial deposits; and large debris jams. Beginning at RM 5 the next several miles exhibit an increase in gradient to 0.45% as well as higher flows and improved pool/riffle ratios as the channel rises out of the alluvial deposits and into a siltstone/sandstone-dominated substrate. Notes indicated clean sorted gravel in pool tailouts and long cobble riffles in between pools. Pricket Creek enters at RM 6.5, cooler than the mainstem with a seasonal irrigation dam just above the first pool blocking any upstream temperature-dependent migration of salmonids. Roderick Creek enters at RM 7.7 through a broad solar-exposed wetland with temperatures higher than Gales Creek (no thermal refugia currently present). Clear Creek enters at RM 10.66 with the first pool exhibiting coho and cutthroat densities among the highest observed in the entire Tualatin Basin – behavior exhibiting a desire to seek cooler water temperatures. |

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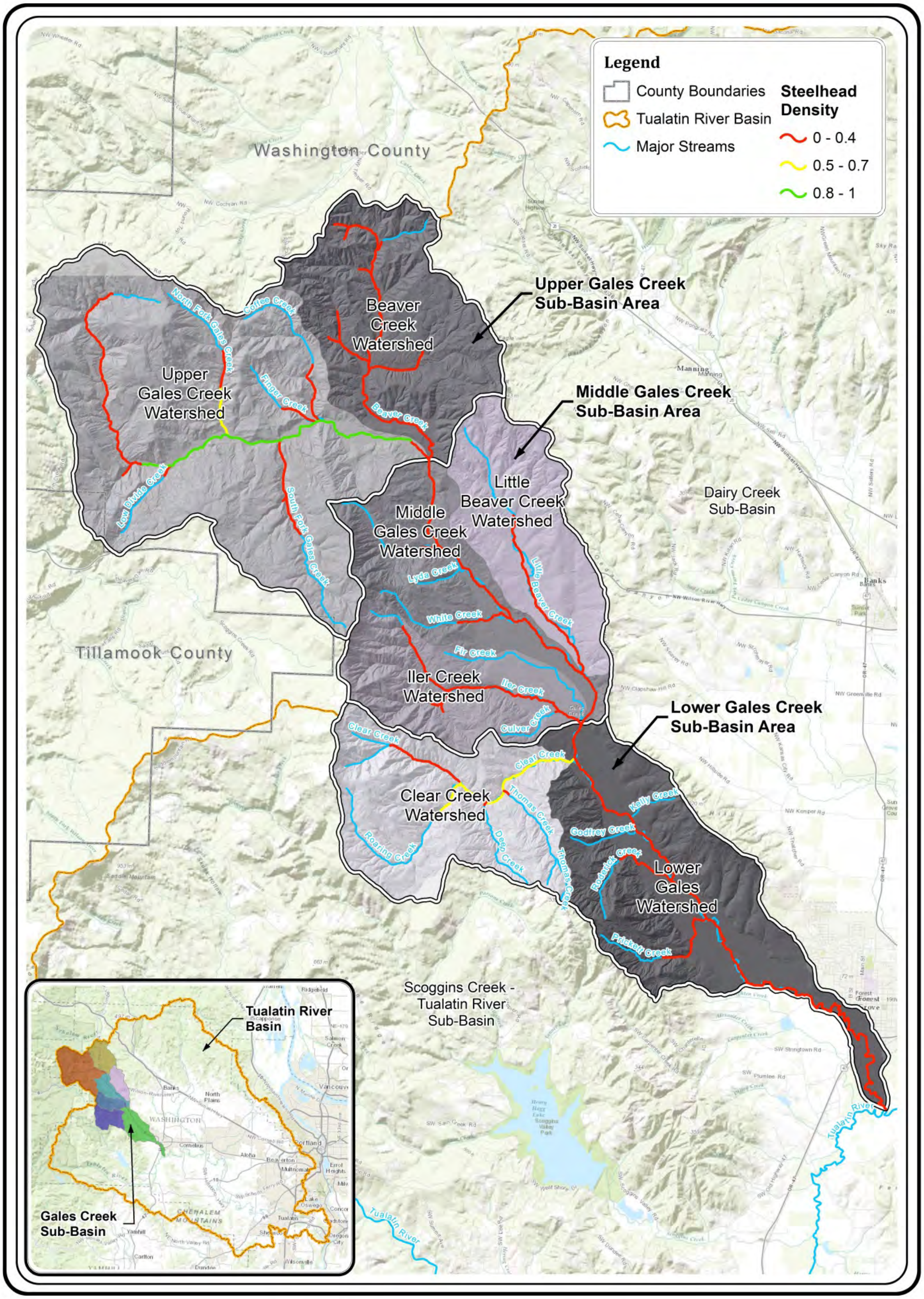


Steelhead Trout Density

Gales Creek Sub-Basin

0 0.5 1 2 3 Miles

Date: 4/7/2015
Scale: 1 inch = 1 mile

Data Source: ESRI, 2015; USDA, NRCS, 2011; BLM, RBA, 2013.

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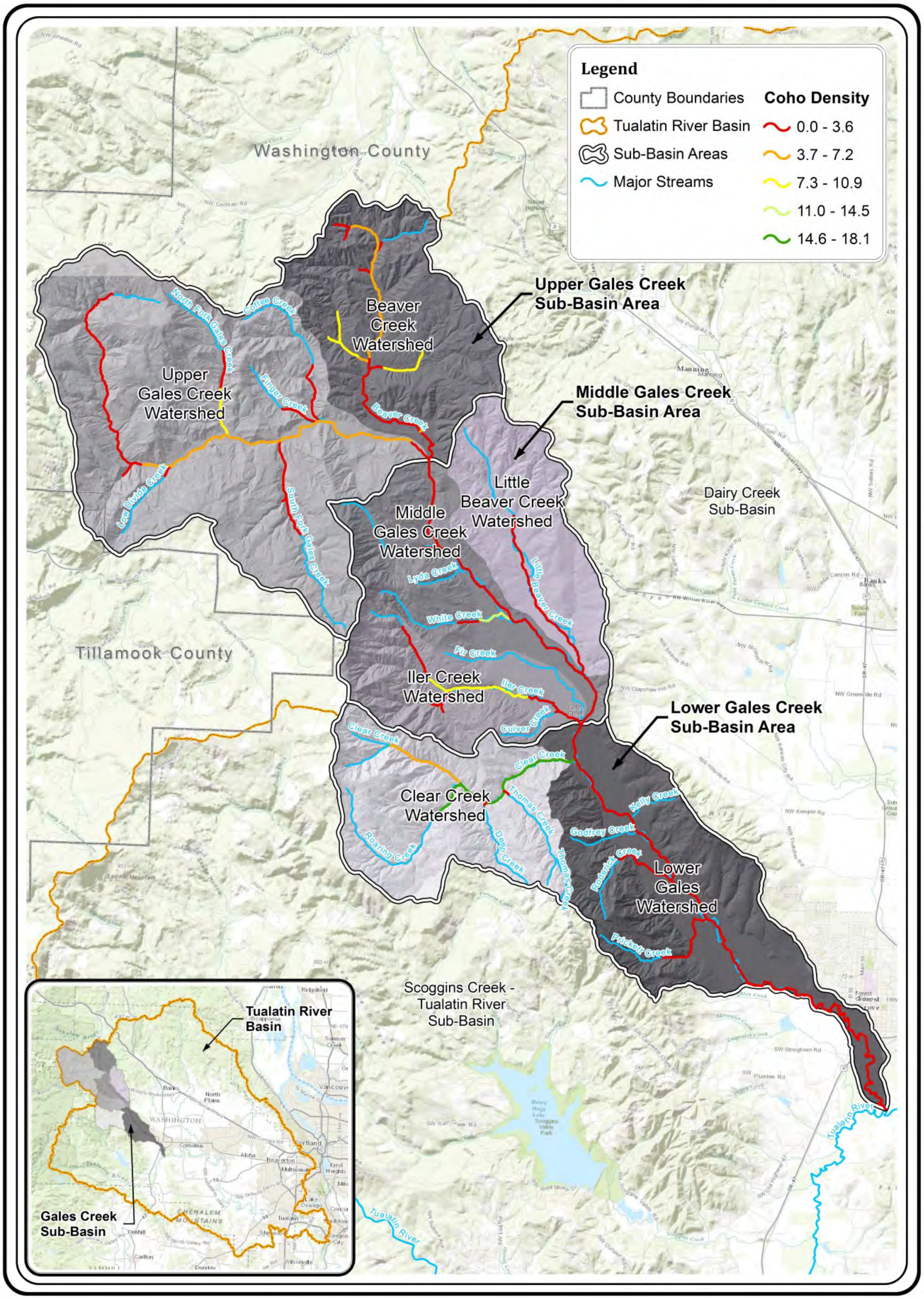


**Coho Salmon Density**

Gales Creek Sub-Basin

0 0.5 1 2 3 Miles

Date: 4/7/2015
Scale: 1 inch = 1 mile

Data Source: ESRI, 2015; USDA, NRCS, 2011; BLM, RBA, 2013.

Tualatin River Watershed Council — Cascade Environmental Group

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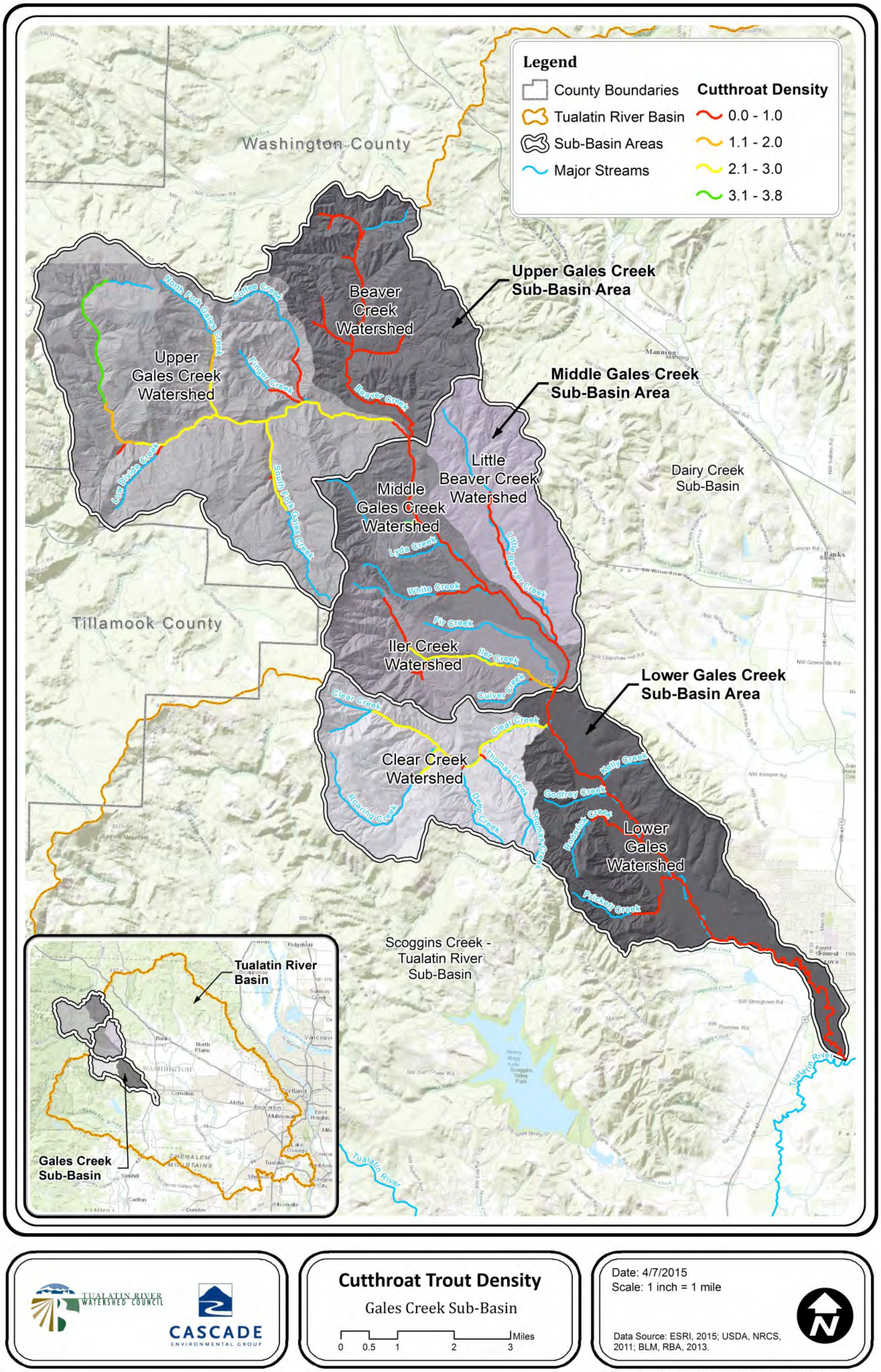
Legend
County Boundaries
Tualatin River Basin
Sub-Basin Areas
Major Streams
Cutthroat Density
0.0 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 3.8
Washington County
Tillamook County
Upper Gales Creek Sub-Basin Area
Middle Gales Creek Sub-Basin Area
Lower Gales Creek Sub-Basin Area
Beaver Creek Watershed
Upper Gales Creek Watershed
Little Beaver Creek Watershed
Middle Gales Creek Watershed
Iler Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Dairy Creek Sub-Basin
Scoggins Creek - Tualatin River Sub-Basin
Tualatin River Basin
Gales Creek Sub-Basin
Cutthroat Trout Density
Gales Creek Sub-Basin
0 0.5 1 2 3 Miles
Date: 4/7/2015
Scale: 1 inch = 1 mile
Data Source: ESRI, 2015; USDA, NRCS, 2011; BLM, RBA, 2013.
TUALATIN RIVER WATERSHED COUNCIL
CASCADE ENVIRONMENTAL GROUP
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## Fish Passage

A list of potential fish passage barriers was compiled from existing inventories, including Washington County, ODFW, and the 2013 RBA survey. The barriers were mapped in GIS and each barrier was given a unique identification number and cross-referenced with other sources to remove duplicates. Field notes were compiled from each of the above documents and those barriers identified in the RBA were reviewed closely as it was the most recent information on barriers and passage status for juvenile and adult fish. Not all identified barriers have all the necessary information to determine the fish passage characteristics, including evaluating if they are partial or complete barriers to juvenile and adult fish. For that reason, some of the identified passage barriers should only be considered potential barriers until further information is collected. Table 7 summarizes the number of known and potential fish passage barriers in each of the Gales Creek Sub-Basin watersheds. The Watershed Summary section below includes detailed maps showing the location of potential fish passage barriers in the Gales Creek Sub-Basin. Information on fish passage barriers, along with habitat and water temperature data, will provide the foundation for prioritizing which barriers to address.

**Table 7. Potential fish passage barriers in the Gales Creek Sub-Basin.**

| Watershed | Number of Identified Fish Passage Barriers |
|---|---|
| Upper Gales Creek | 25 |
| Beaver Creek | 33 |
| Middle Gales Creek | 11 |
| Little Beaver Creek | 10 |
| Iler Creek | 10 |
| Clear Creek | 14 |
| Lower Gales Creek | 19 |

## Aquatic Habitat

Steelhead, coho salmon, cutthroat trout, and Pacific lamprey have specific habitat needs for each part of their life stage cycles: adult migration and movement in the stream system; spawning and egg incubation; juvenile summer and winter rearing; and juvenile movement in the stream system and outmigration for the anadromous species. The focal fish species can utilize different parts of the watershed at each life stage. Gales Creek and its tributaries all play a role in the life cycles of the focal species. For example, steelhead and coho salmon will spawn in the Upper Gales Creek Watershed. Successful spawning requires clean, well-sorted gravels and cobbles and clean, well-oxygenated water for egg incubation. Lamprey, which currently cannot access the upper watershed because of a fish passage barrier, have similar spawning habitat requirements. After spawning, the juvenile fish will reside for a period of time (up to several years in the case of steelhead) as juveniles in the upper watershed. During this rearing period, the juvenile fish require complex habitats with large wood in the stream to provide cover for feeding and avoiding predators, cool water temperatures, and other habitat elements. After this rearing period in the higher-gradient spawning and rearing habitat in the upper Sub-Basin and tributaries such as Clear Creek, the fish slowly move into the lower-gradient migratory and foraging areas in lower Gales Creek. These fish require access to the floodplain and associated off-channel habitats, particularly to escape high velocity waters during high flow periods. Healthy stream and floodplain habitat provides refuge during these periods and vegetation provides shade and organic matter inputs. Larval Pacific lamprey have a specific need for habitats that are composed of deep, fine sediment that provide suitable burrowing habitat, particularly in off-channel habitats.

The following summarizes the status of aquatic habitat in the Gales Creek Sub-Basin from the RBA observations and other studies:

- There is inadequate large wood in streams to create necessary cover, create pool habitats, and retain spawning gravels. Past land management actions removed wood from streams and did not leave adequate riparian trees to provide future inputs of wood. Studies in Gales Creek, including the RBA, that have evaluated fish numbers before and after large wood placement have seen dramatic increases in fish numbers.
- For the most part, there are adequate sources of spawning gravels and other substrate to the stream system. However, limited channel complexity, particularly lack of large wood in the channels, has reduced channel structure and the creation of pool habitats that are necessary to trap gravels. Steelhead, coho salmon, cutthroat trout, and Pacific lamprey primarily spawn in well-sorted gravels and cobbles at the transition between pools and riffles (pool tailouts).
- The 2013 RBA survey and other assessments have observed that the channel of lower Gales Creek is deeply incised. Removal of wood from the stream, flood-protection berms, vegetation removal, and other activities have resulted in a channel that is now lower than it was historically. In many areas, the entrenched channel does not connect to the floodplain and off-channel features, such as side channels, that provide important fish habitat.
- Beaver ponds provide habitat for adult and juvenile fish, particularly coho salmon and cutthroat trout. The RBA survey observed beaver ponds in many of the Gales Creek tributaries. Beaver Creek, in particular, has abundant beaver ponds, which helps to account for the high abundance of coho salmon in that system.

## Riparian and Floodplain Vegetation

Riparian vegetation provides shade, large wood inputs, and organic matter to the aquatic system. Continuous riparian corridors also provide wildlife habitat and migration routes between the valley bottoms and the upland areas. CWS has inventoried riparian vegetation throughout the Gales Creek Sub-Basin. These inventories focus on the extent and type of riparian vegetation and the presence of two key invasive species, Japanese knotweed and garlic mustard. The riparian information is classified based on the extent of area that could benefit from planting native trees and shrubs. This "plantable area" cover classification, in addition to the invasive species information, provides a framework for identifying impaired riparian conditions and targeting restoration.

Table 8 summarizes the riparian plantable area cover classifications for the Gales Creek Sub-Basin watersheds. In general, riparian cover is higher in the watersheds and stream areas where forestry is the dominate land use: Upper Gales Creek Watershed, Beaver Creek Watershed, and Clear Creek Watershed. Riparian cover is lower in the watersheds and stream areas where agriculture, rural residential, and urban land uses are present. Lower Gales Creek Watershed, which includes Forest Grove's urban area and extensive agriculture, has the highest proportion of riparian plantable areas. Other watersheds with a high proportion of riparian plantable area (>50%) are Middle Gales Creek Watershed, Little Beaver Creek Watershed, and Iler Creek Watershed. Japanese knotweed and garlic mustard have infested much of the length of Gales Creek and some portions of its tributaries. The Watershed Summary section below includes detailed maps showing the location of Gales Creek Sub-Basin riparian plantable area cover classes and the extent of Japanese knotweed and garlic mustard.

## Water Quality and Quantity

The key water quality and quantity issues in the Gales Creek Sub-Basin are high temperatures and low stream flows.

### Water Quantity

Flow is continuously monitored in Gales Creek by the District 18 Watermaster at one station at RM 2.36. Summer stream flows can drop to very low levels. From 2009 to 2013, CWS partnered with the TVID to augment stream flows at RM 5.0 by releasing 287 acre feet of water from early July to the end of August at an average flow of 2 cfs. There are currently no flow monitors on the Gales Creek tributaries.

### Water Quality

The USGS has partnered for many years with CWS to fund continuous water quality monitoring (temperature, DO, conductivity, and pH) at RM 2.36. CWS also monitors water temperatures at RM 6.98. Low flows, which usually occur in the summer and early fall, affect water temperatures, especially in reaches where there is little or no canopy cover to shade the stream. Gales Creek temperatures begin to warm up as they exit the upper basin at Timber Rd. By the time water arrives at Little Beaver Creek (RM 12), the 7-day average maximum temperature exceeds state temperature criteria during the summer months (Table 9). The combination of low flows and summer water temperatures in Gales Creek stresses juvenile fish.

**Table 8. CWS riparian plantable area cover classifications for the Gales Creek Sub-Basin watersheds.**

| Watershed | Riparian Plantable Area Cover Class | Percentage | Percentage >50% Plantable Area |
|---|---|---|---|
| Upper Gales Creek | 0%-49% | 94.9% | 5.1% |
| | 50%-74% | 4.3% | |
| | 75%-100% | 0.9% | |
| Beaver Creek | 0%-49% | 96.1% | 3.9% |
| | 50%-74% | 3.9% | |
| | 75%-100% | 0.0% | |
| Middle Gales Creek | 0%-49% | 55.9% | 44.1% |
| | 50%-74% | 24.4% | |
| | 75%-100% | 19.8% | |
| Little Beaver Creek | 0%-49% | 36.6% | 63.4% |
| | 50%-74% | 30.5% | |
| | 75%-100% | 32.9% | |
| Iler Creek | 0%-49% | 68.5% | 31.5% |
| | 50%-74% | 21.6% | |
| | 75%-100% | 9.9% | |
| Clear Creek | 0%-49% | 99.0% | 1.0% |
| | 50%-74% | 1.0% | |
| | 75%-100% | 0.0% | |
| Lower Gales | 0%-49% | 24.3% | 75.7% |
| | 50%-74% | 43.1% | |
| | 75%-100% | 32.6% | |

**Table 9. Gales Creek water temperature patterns.**

| Gales Creek Location | Period when 7-Day Moving Average Exceeds Water Quality Standard* | Maximum Temperature (deg. C) |
|---|---|---|
| Timber Rd: just upstream of Beaver Creek | 7/21/2006 – 7/27/2006 | 18.7 C |
| Clapshaw Hill Rd: at mouth of Little Beaver Creek** | 6/24/2006 – 8/29/2006 | 22.9 C |

* Oregon Department of Environmental Quality water quality standards for temperature: 16 deg. C – core juvenile rearing habitat; 18 deg. C – salmon and trout migration. **The Clapshaw Hill Road site has been monitored every year since 1998

The summer 2014 RBA survey collected water temperature data to provide a snapshot of tributary temperature patterns. In each tributary, the survey measured water temperatures just above each tributary's confluence with Gales Creek and then again at the end of the survey. Because the temperature samples were taken once, the observations are less valuable than those based on continuous measurements collected over the course of the warm summer period would be. Water temperatures collected as part of the RBA survey did demonstrate that the tributaries tended to be colder than the mainstem of Gales Creek and thus support the potential for cold water refugia if fish can access them.

# 6. Watershed Descriptions

The following section provides watershed condition summaries for each of the Gales Creek Sub-Basin watersheds. Accompanying maps show reach locations, geologic setting, riparian conditions, and the location of potential fish passage barriers and beaver ponds.

# Upper Gales Creek Watershed

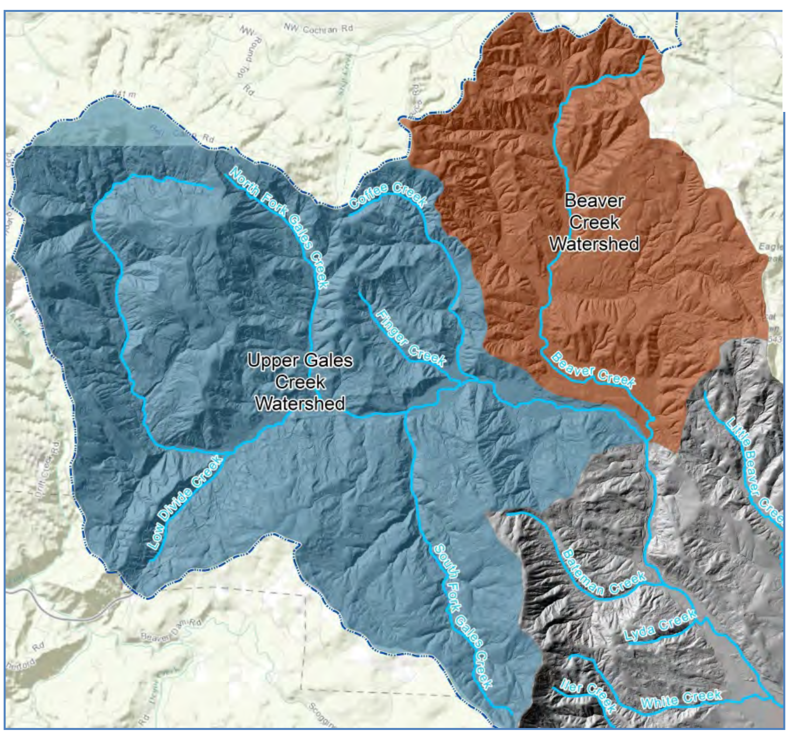
Upper Gales Creek Watershed is primarily managed as working forest land (publicly and privately owned) with some residential and recreation use. Riparian habitat is in relatively good condition and the watershed is considered an anchor habitat for winter steelhead.

## Watershed Area and Land Uses

- 14,783 acres
- 51% State Forest lands
- 49% private, primarily working forest lands

## Riparian and Upland Conditions

- Riparian area relatively intact
- Fairly continuous cover/shade, except where recent harvest may be near stream
- Knotweed and garlic weed present in small patches




## Physical Conditions

- Steep tributaries
- Ample sediment and gravel sources from the tributaries
- Relatively wide valley downstream of Low Divide Creek
- Stream temperatures tend to be cool

## Watershed Impacts

- 270 stream crossings; 25 potential fish passage barriers
- 2.53 miles of road per square mile
- Highway 6 adjacent to Gales Creek in floodplain
- Limited instream large wood due to past forest practices

## Fish and Habitat

- More than 13 miles of stream are accessible to anadromous fish
- Coho and steelhead extend into the upper mainstem, North Fork, South Fork, Finger, and Coffee Creeks
- Highest density of winter steelhead in the Sub-Basin
- High density of cutthroat trout
- No Pacific lamprey found
- Complexity ratings tend to be moderate to high in upper Gales Creek and tributaries, but moderate to low along the valley

# Beaver Creek Watershed

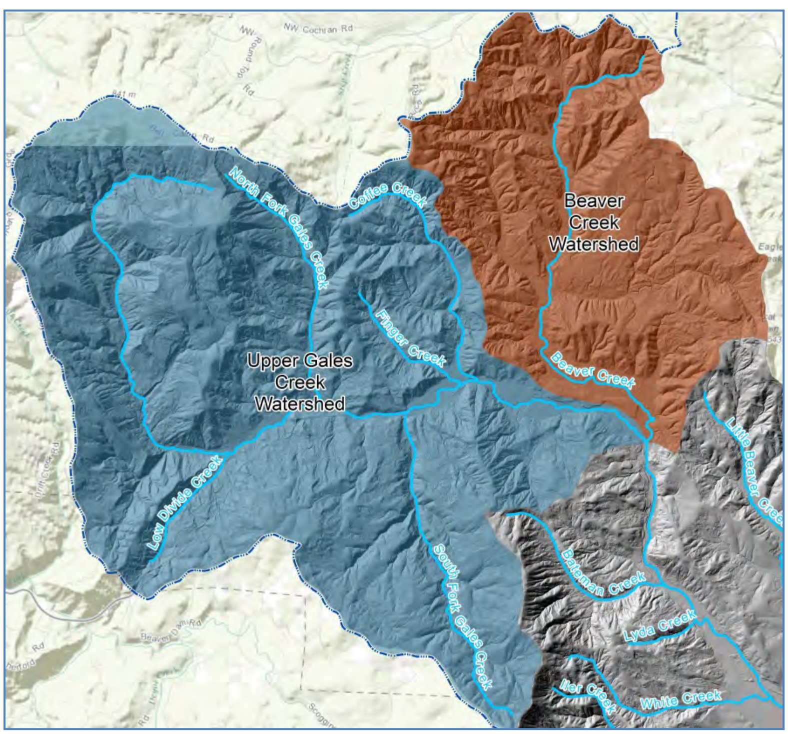
The majority of Beaver Creek Watershed is privately owned and managed as working forest, with some rural residential use. Riparian habitat is in relatively good condition, stream gradient is moderate, beaver ponds are abundant, and the stream tends to be relatively warm, due to geology, making this prime habitat for coho.

## Watershed Area and Land Uses

- 6,447 acres
- 67% private, primarily working forest lands
- 33% State Forest lands

## Riparian and Upland Conditions

- Riparian area relatively intact
- Fairly continuous riparian cover/shade
- Knotweed and garlic mustard are probably present in small patches, but not surveyed




## Physical Conditions

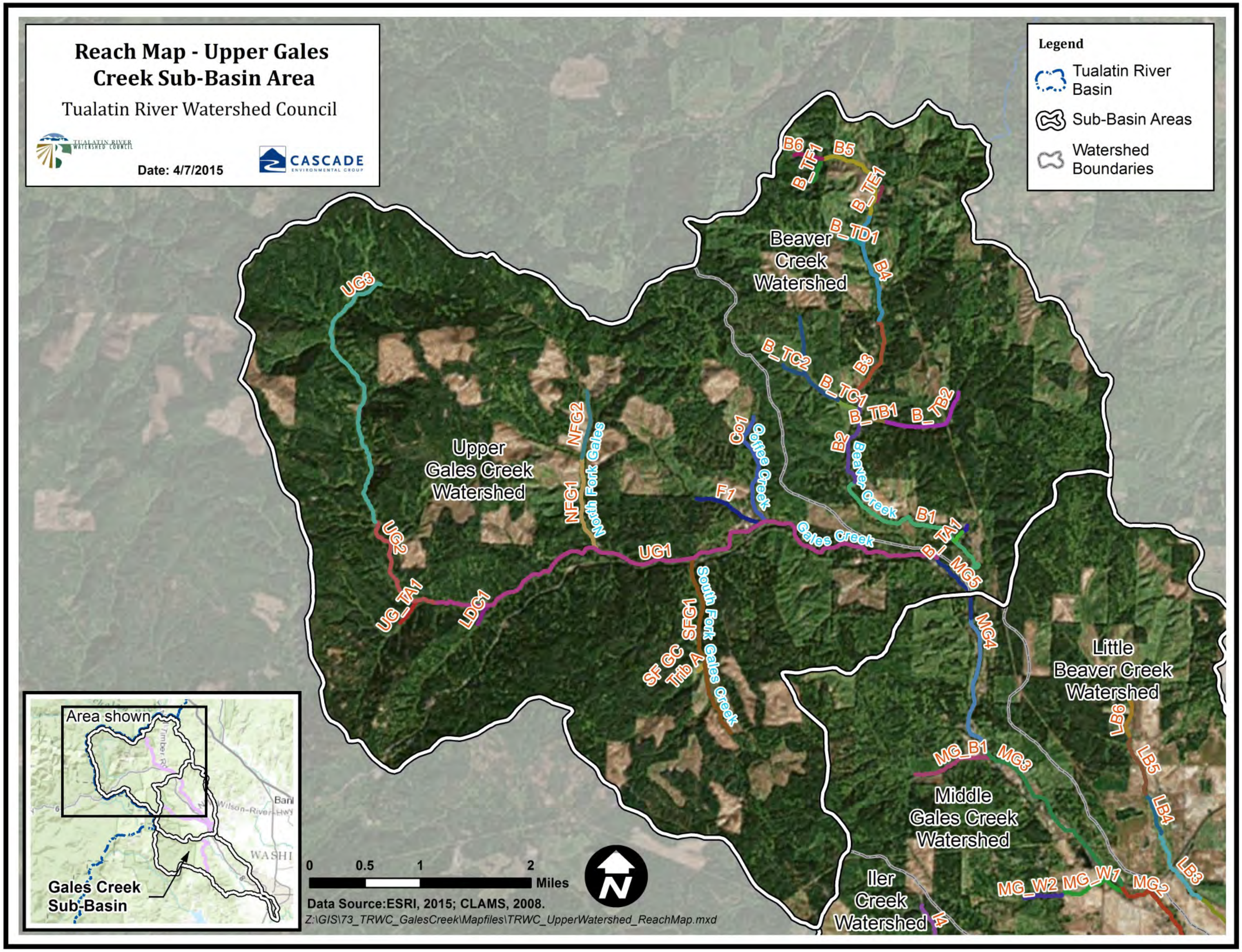
- Tributaries low to moderate gradient, but some tributaries are perched above mainstem
- Adequate sediment supply from tributaries
- Valley width varies, with floodplain pockets
- Stream temperatures tend to be warmer

## Watershed Impacts

- 102 stream crossings; 33 potential fish passage barriers
- 2.26 miles of road per square mile
- Timber Road is adjacent to Beaver Creek and in floodplain, creating constraints on channel movement

## Fish and Stream Habitat

- More than 9 miles of stream are accessible to anadromous fish
- Coho salmon extend along the mainstem and into several tributaries
- Highest density of coho in the Sub-Basin
- No juvenile winter steelhead or Pacific lamprey observed
- Cutthroat trout found throughout the watershed, but at very low densities
- Moderate complexity in the middle and upper watershed, low complexity in the lower portions of Beaver Creek
- Numerous beaver ponds


Reach Map - Upper Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/7/2015
CASCADE ENVIRONMENTAL GROUP
Legend
Tualatin River Basin
Sub-Basin Areas
Watershed Boundaries
Upper Gales Creek Watershed
Beaver Creek Watershed
Little Beaver Creek Watershed
Middle Gales Creek Watershed
Iler Creek Watershed
Gales Creek
North Fork Gales
South Fork Gales Creek
Coffee Creek
Beaver Creek
UG3
UG2
UG_TA1
LDC1
UG1
NFG1
NFG2
F1
Co1
SFG1
SF GC Trib A
B6
B5
B_TF1
B_TE1
B_TD1
B4
B3
B_TC2
B_TC1
B_TB1
B_TB2
B2
B1
B_TA1
MG5
MG4
MG_B1
MG3
MG_W2
MG_W1
MG2
LB6
LB5
LB4
LB3
I4
Area shown
Gales Creek Sub-Basin
0 0.5 1 2 Miles
N
Data Source:ESRI, 2015; CLAMS, 2008.
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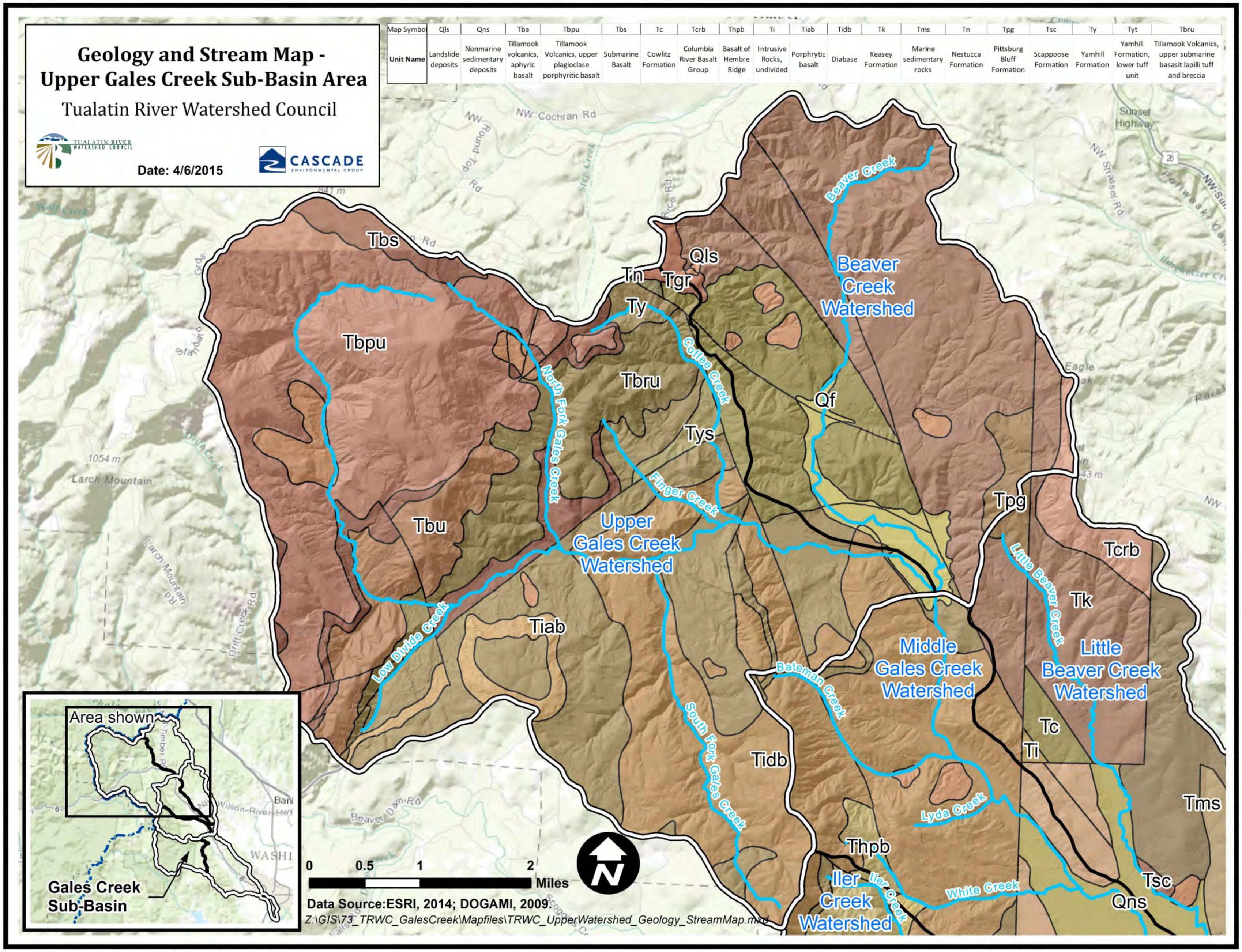
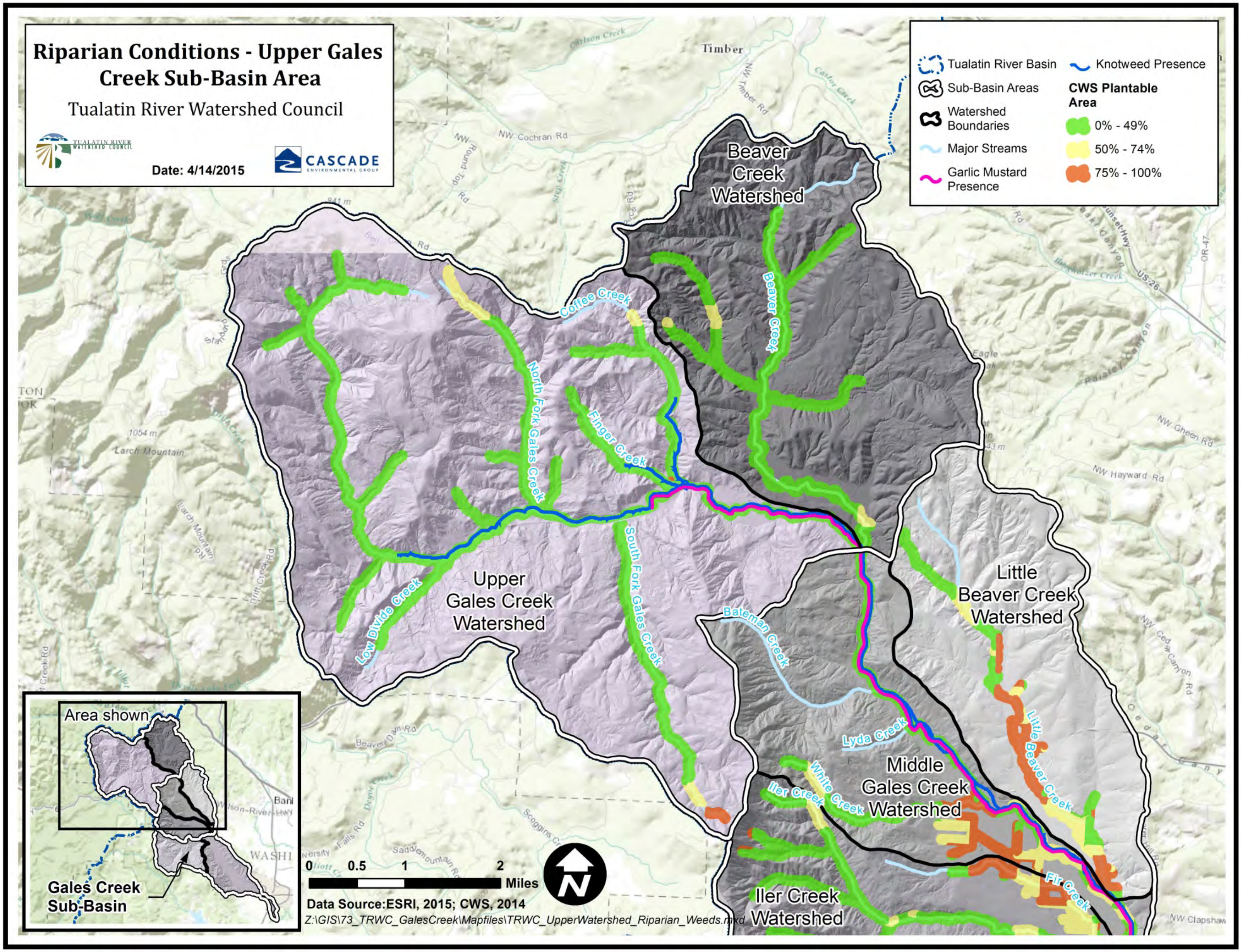
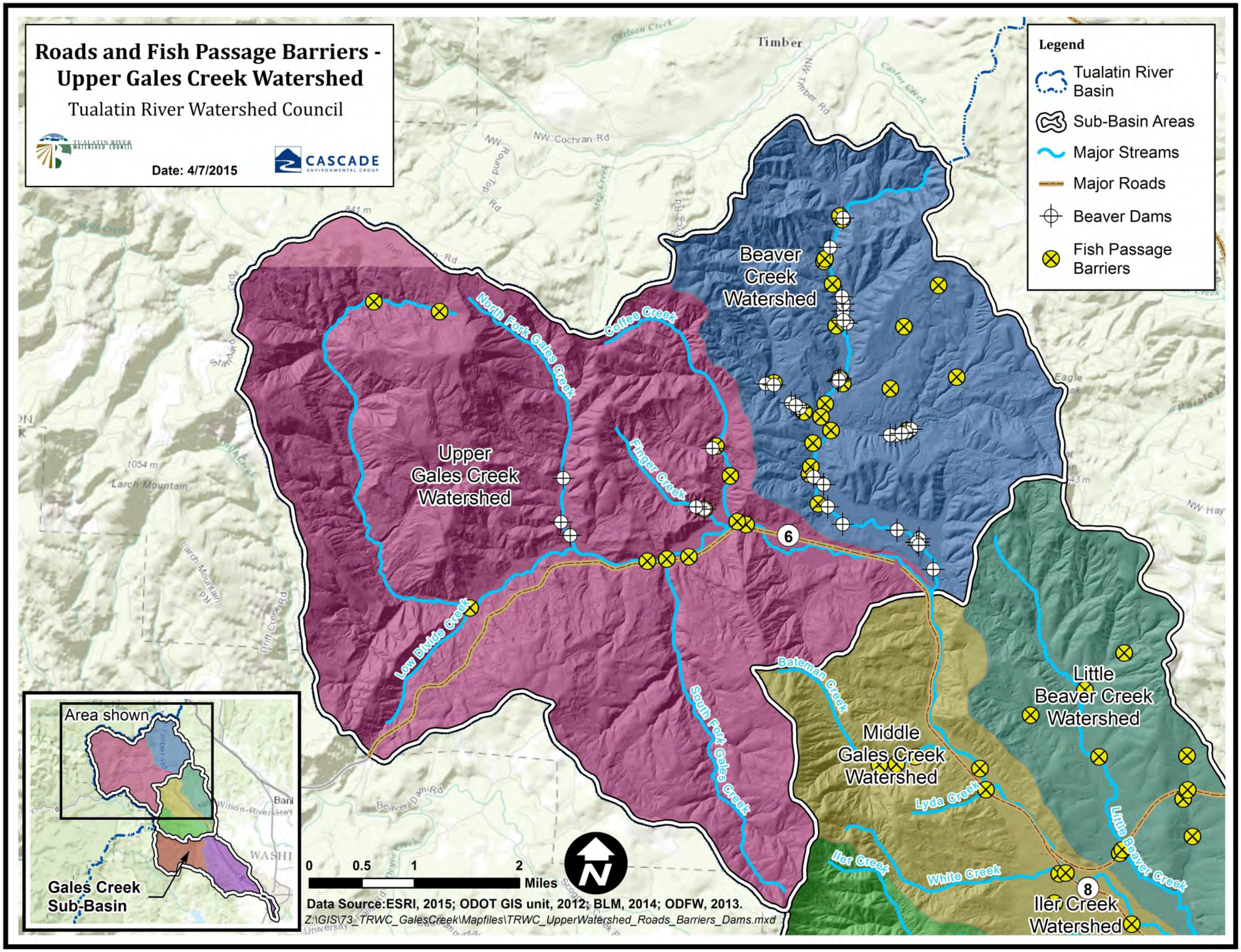



| Map Symbol | Unit Name |
|---|---|
| Qls | Landslide deposits |
| Qns | Nonmarine sedimentary deposits |
| Tba | Tillamook volcanics, aphyric basalt |
| Tbpu | Tillamook Volcanics, upper plagioclase porphyritic basalt |
| Tbs | Submarine Basalt |
| Tc | Cowlitz Formation |
| Tcrb | Columbia River Basalt Group |
| Thpb | Basalt of Hembre Ridge |
| Ti | Intrusive Rocks, undivided |
| Tiab | Porphrytic basalt |
| Tidb | Diabase |
| Tk | Keasey Formation |
| Tms | Marine sedimentary rocks |
| Tn | Nestucca Formation |
| Tpg | Pittsburg Bluff Formation |
| Tsc | Scappoose Formation |
| Ty | Yamhill Formation |
| Tyt | Yamhill Formation, lower tuff unit |
| Tbru | Tillamook Volcanics, upper submarine basaslt lapilli tuff and breccia |


Riparian Conditions - Upper Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/14/2015
CASCADE
Tualatin River Basin
Sub-Basin Areas
Watershed Boundaries
Major Streams
Garlic Mustard Presence
Knotweed Presence
CWS Plantable Area
0% - 49%
50% - 74%
75% - 100%
Beaver Creek Watershed
Upper Gales Creek Watershed
Little Beaver Creek Watershed
Middle Gales Creek Watershed
Iler Creek Watershed
Coffee Creek
Beaver Creek
North Fork Gales Creek
Finger Creek
South Fork Gales Creek
Low Divide Creek
Bateman Creek
Lyda Creek
White Creek
Iler Creek
Little Beaver Creek
Fir Creek
Area shown
Gales Creek Sub-Basin
0 0.5 1 2 Miles
Data Source:ESRI, 2015; CWS, 2014
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_UpperWatershed_Riparian_Weeds.mxd



Roads and Fish Passage Barriers - Upper Gales Creek Watershed
Tualatin River Watershed Council
Date: 4/7/2015
CASCADE
Legend
Tualatin River Basin
Sub-Basin Areas
Major Streams
Major Roads
Beaver Dams
Fish Passage Barriers
Beaver Creek Watershed
Upper Gales Creek Watershed
Middle Gales Creek Watershed
Little Beaver Creek Watershed
Iler Creek Watershed
North Fork Gales Creek
Coffee Creek
Finger Creek
Low Divide Creek
South Fork Gales Creek
Bateman Creek
Lyda Creek
Iler Creek
White Creek
Little Beaver Creek
Timber
Area shown
Gales Creek Sub-Basin
0 0.5 1 2 Miles
Data Source:ESRI, 2015; ODOT GIS unit, 2012; BLM, 2014; ODFW, 2013.
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_UpperWatershed_Roads_Barriers_Dams.mxd

# Middle Gales Creek Watershed

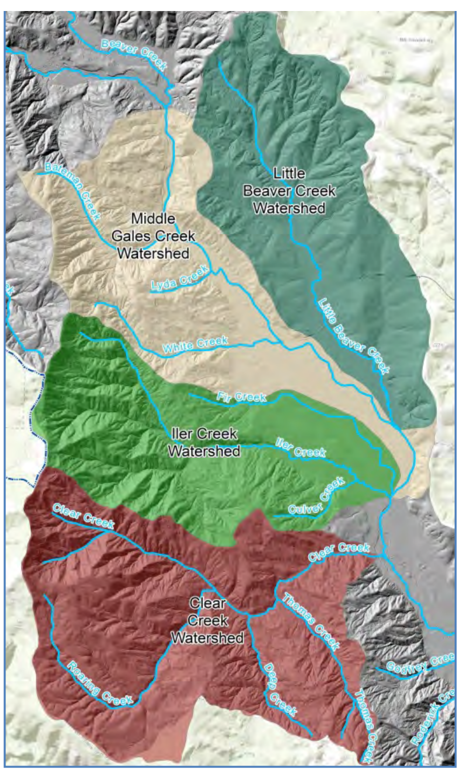
Middle Gales Creek Watershed is primarily privately owned with agricultural areas in the downstream area and some rural residential use. Balm Grove Dam on Gales Creek is a significant fish passage barrier. Riparian habitat along the mainstem is in relatively good condition, but due to geology and the entry of warm tributary water, stream temperatures are moderate to high.

## Watershed Area and Land Use

- 4,299 acres
- 99% Private; mix of working forest lands, rural residential, and agricultural
- < 1% State Forest lands

## Riparian and Upland Conditions

- Majority of mainstem riparian areas are relatively intact
- Downstream reach of mainstem, segments of White Creek and unnamed tributary near southern end of watershed have lower levels of riparian cover
- Knotweed and garlic mustard present along Gales Creek




## Physical Conditions

- Bedrock channel with limited large wood; spawning gravels not easily retained
- Gales Creek and tributary gradients relatively steep and valleys narrow
- Stream temperatures determined by geology; tends to be too warm for steelhead

## Watershed Impacts

- Balm Grove Dam limits passage of lamprey and juvenile salmonids to upper Sub-Basin
- 48 stream crossings; 11 potential fish passage barriers

## Fish and Habitat

- More than 8 miles of stream are accessible to anadromous fish
- Coho and steelhead extend along the mainstem and into Bateman and White Creeks
- Coho density higher than other surveyed focal fish species
- Moderate complexity throughout the watershed

# Little Beaver Creek

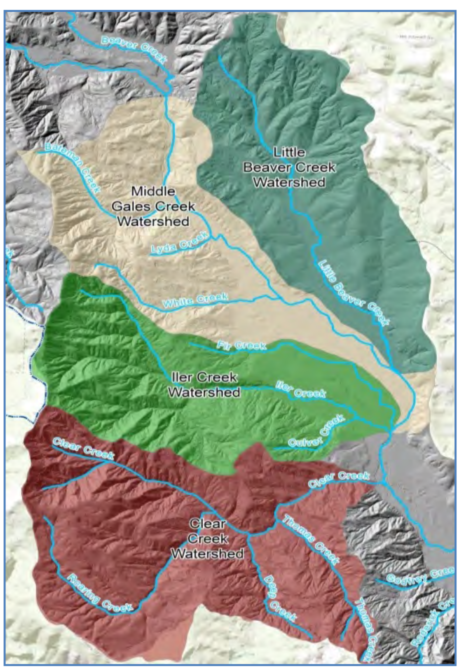
The majority of Little Beaver Creek Watershed is privately owned, with agriculture and rural residential as the dominant land uses. Canopy cover along the mainstem is minimal and temperatures tend to be warm. Fish extent was not surveyed due to limited habitat.

## Land Use

- 4,407 acres
- 82% private; mix of working forest lands, rural residential, and agricultural
- 18% State Forest lands
- Primarily agricultural with some forest lands and rural residential

## Riparian and Upland Conditions

- Canopy cover minimal for the majority of the mainstem
- Narrow riparian area widths; dominated by Armenian blackberry




## Physical Conditions

- Stream gradient moderately high
- Valley widths not very wide or confined

## Watershed Impacts

- 38 stream crossings; 10 potential fish passage barriers
- 2.55 miles of road per square mile
- Warm stream temperatures

## Fish and Habitat

- Anadromous fish are not expected in this watershed
- No information on fish presence and densities
- The stream was not included in the 2013 RBA survey

# Iler Creek

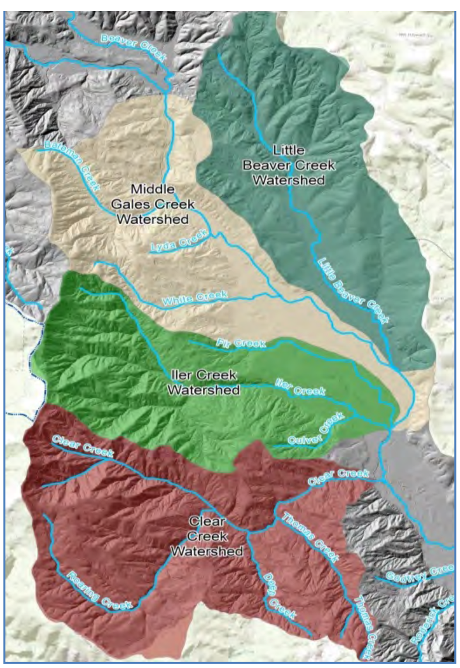
Iler Creek Watershed is primarily privately owned with working forests in the upper watershed and agriculture and rural residential use in the lower watershed. Riparian cover is good and stream temperatures are relatively cool, but barriers restrict salmonid access.

## Land Use

- 3,909 acres
- 98% Private; mix of working forest lands, rural residential, and agricultural
- 2% State Forest lands

## Riparian and Upland Conditions

- Canopy cover relatively continuous
- Some opportunity to provide wider buffers in the lower watershed




## Physical Conditions

- Lower mainstem and tributaries are low-gradient with wide valley widths
- Floodplain connectivity is relatively low
- Upstream extent steeper with narrower valley widths

## Watershed Impacts

- 31 stream crossings; 10 potential fish passage barriers
- 2.34 miles of road per square mile
- Limited instream wood

## Fish and Habitat

- Coho and cutthroat present at moderate densities
- Moderate complexity rating throughout the watershed
- Beaver dams present on the mainstem

# Clear Creek

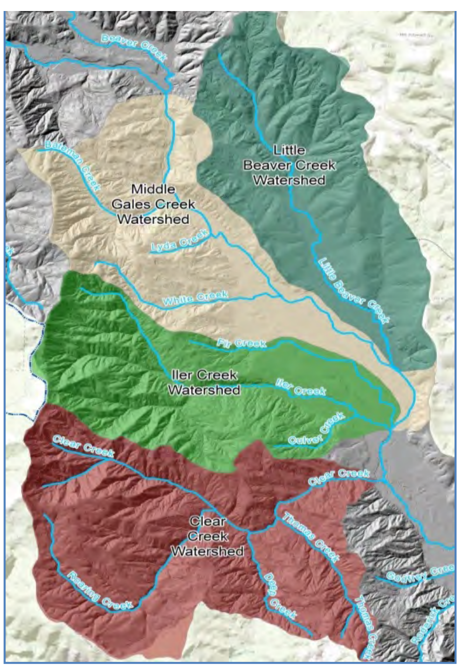
Clear Creek Watershed, which contains the City of Forest Grove's municipal watershed, is primarily publicly owned with working forests in the upper watershed and agriculture and rural residential use in the lower watershed. Riparian cover is good and stream temperatures are relatively cool.

## Land Use

- 5,970 acres
- 73% (4,345 acres) owned by City of Forest Grove
- 7% State lands
- Primarily working forest land with some rural residential use and agriculture in the lower watershed

## Riparian and Upland Conditions

- Stream canopy cover continuous throughout mainstem and tributaries
- Diversity of tree species in the buffer relatively low




## Physical Conditions

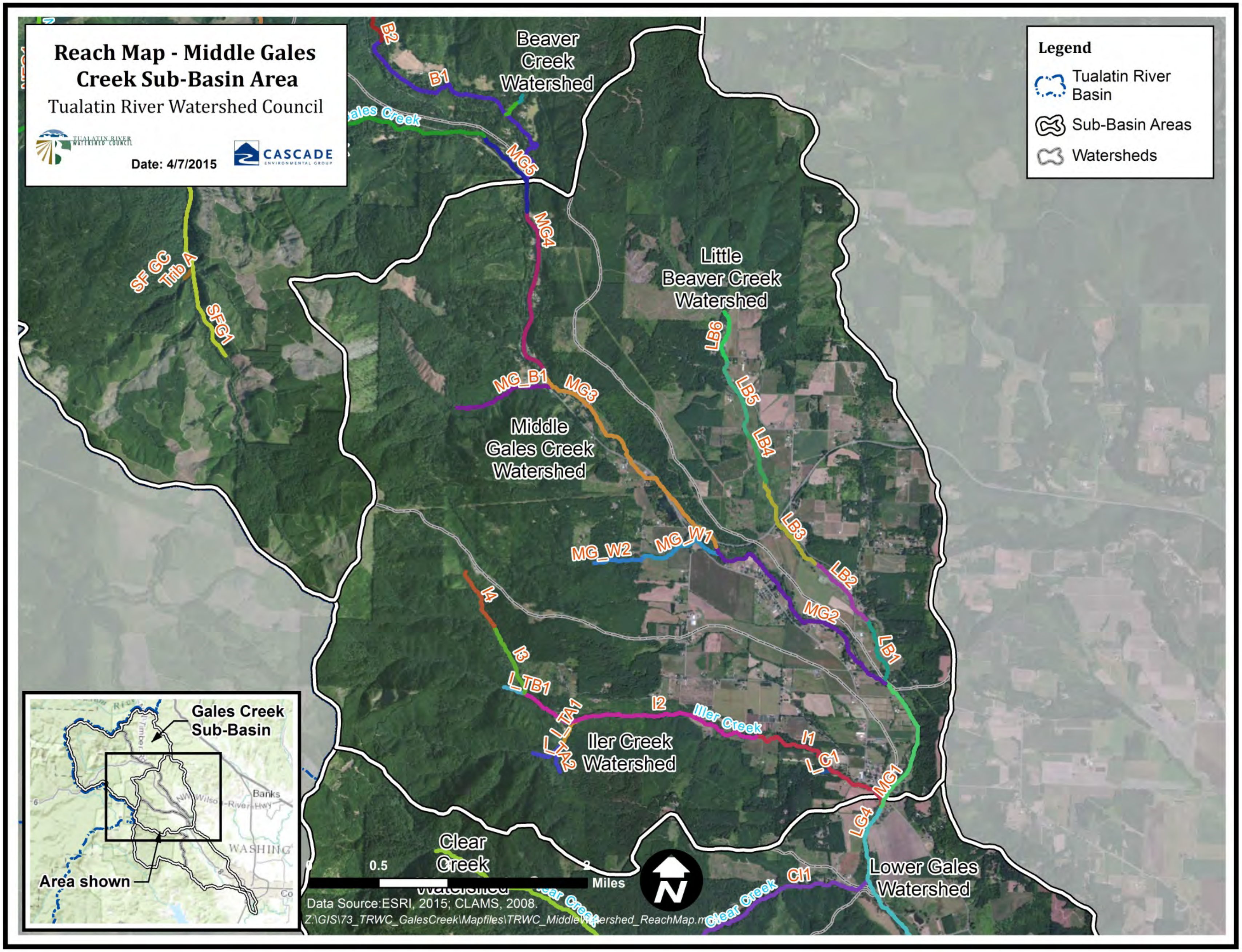
- Valley generally confined with narrow floodplains
- Adequate supply of sediment from upper basin
- Upper basin steep with high steps and cascades
- Cool stream temperatures

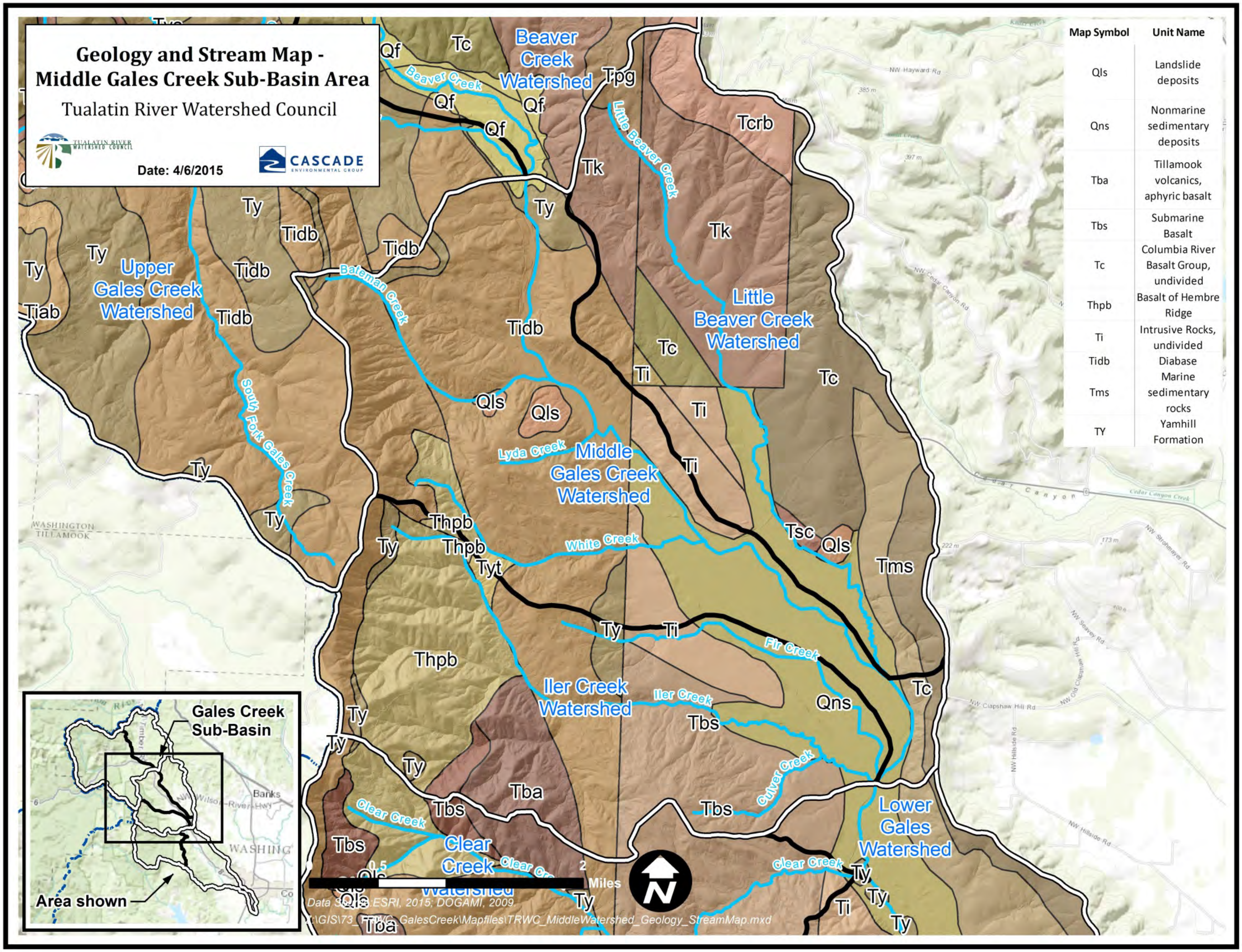
## Watershed Impacts

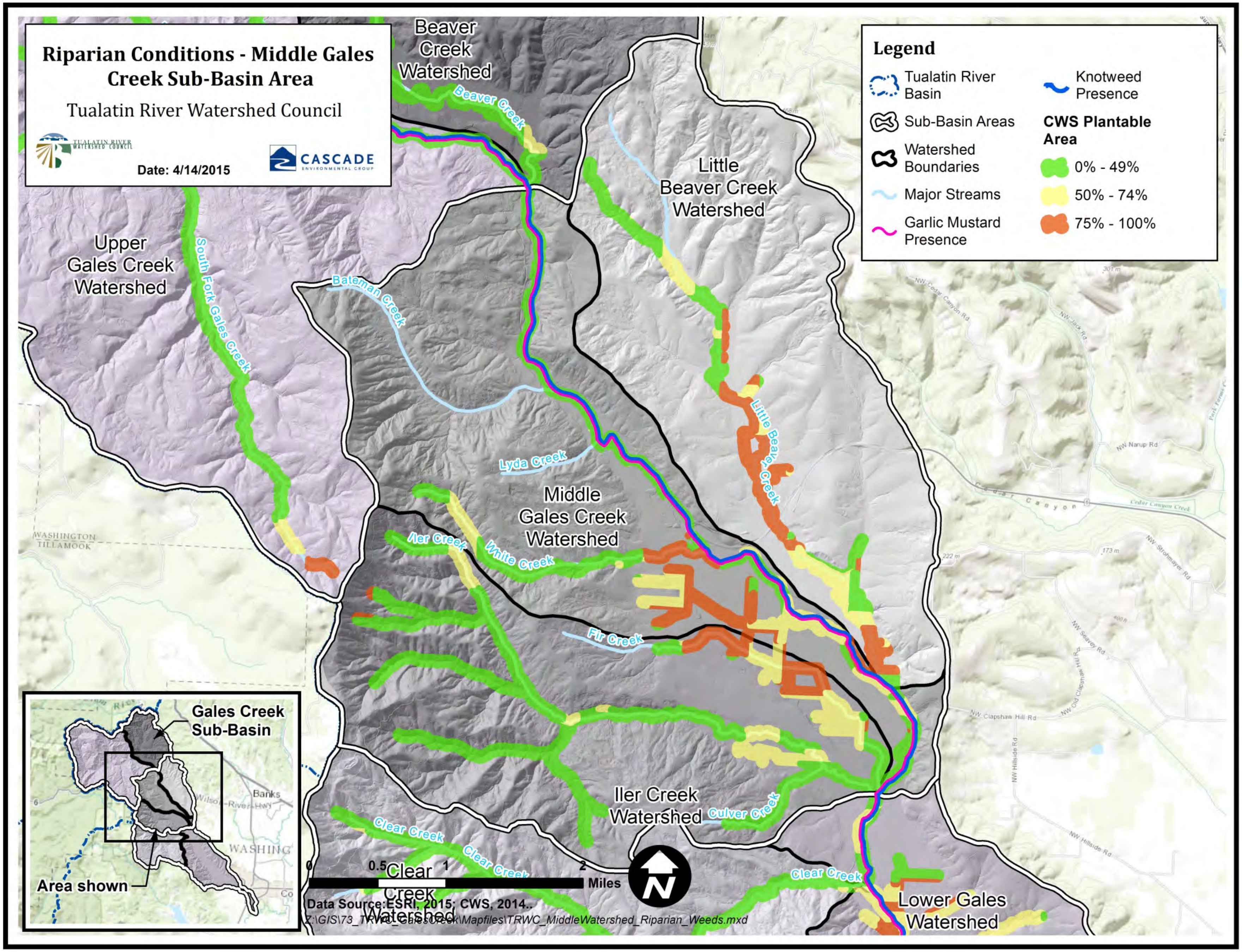
- 105 stream crossings, 14 potential fish passage barriers
- 2.33 miles of road per square mile
- Natural barriers prevent access to upper tributaries

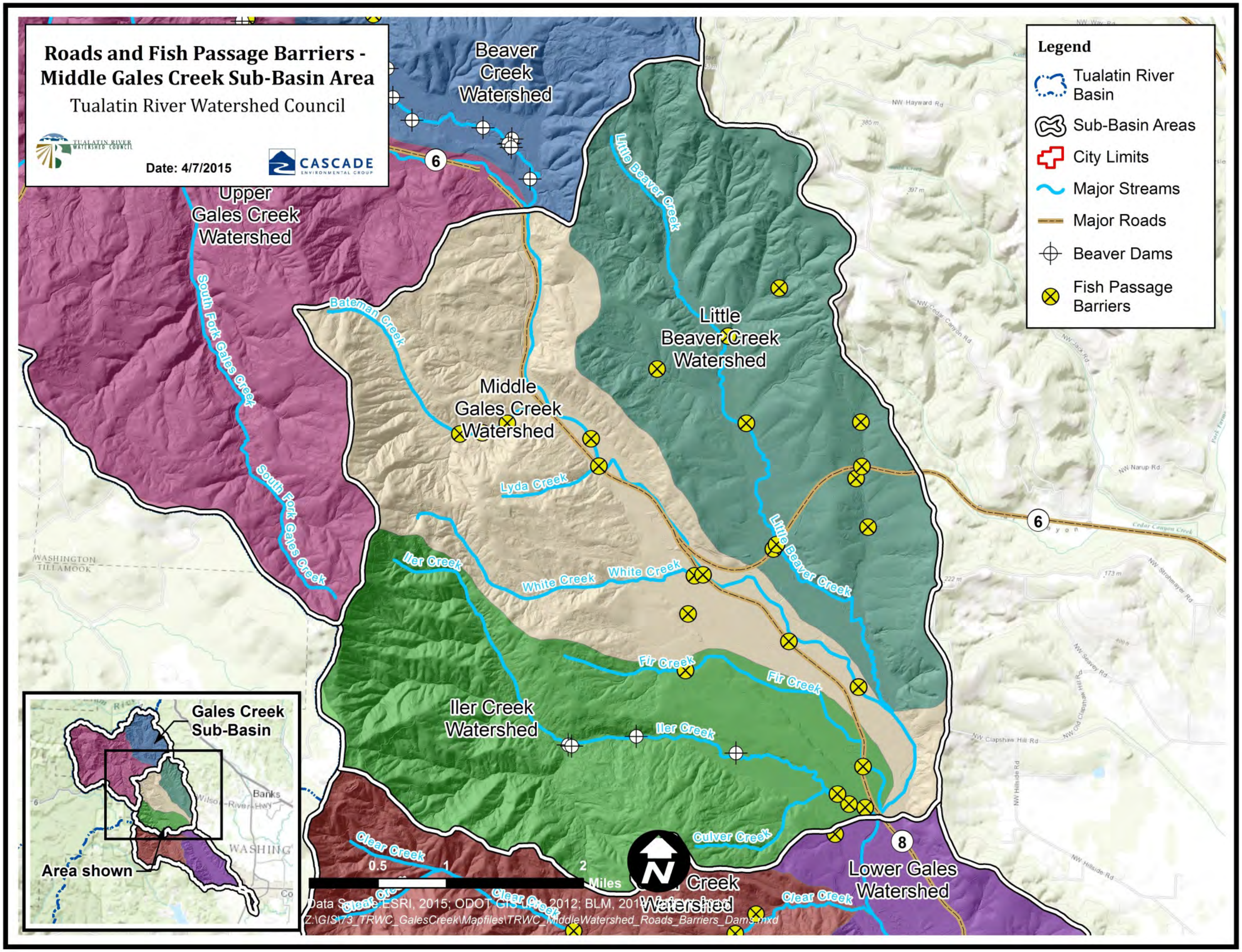
## Fish and Habitat

- Anadromy extends through the mainstem to the natural barriers
- Relatively high densities of winter steelhead, coho, and cutthroat
- Moderate complexity rating throughout the watershed


Reach Map - Middle Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/7/2015
CASCADE
Legend
Tualatin River Basin
Sub-Basin Areas
Watersheds
Beaver Creek Watershed
Little Beaver Creek Watershed
Middle Gales Creek Watershed
Iler Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
B2
B1
MG5
MG4
MG_B1
MG3
MG_W1
MG_W2
MG2
MG1
SF GC Trib A
SFG1
LB6
LB5
LB4
LB3
LB2
LB1
I4
I3
I_TB1
I_TA1
I_TA2
I2
I1
I_C1
Iler Creek
LG4
Cl1
Clear Creek
Gales Creek
Gales Creek Sub-Basin
Area shown
Banks
0.5
Miles
Data Source:ESRI, 2015; CLAMS, 2008.


Geology and Stream Map -
Middle Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/6/2015
CASCADE
Map Symbol | Unit Name
Qls | Landslide deposits
Qns | Nonmarine sedimentary deposits
Tba | Tillamook volcanics, aphyric basalt
Tbs | Submarine Basalt
Tc | Columbia River Basalt Group, undivided
Thpb | Basalt of Hembre Ridge
Ti | Intrusive Rocks, undivided
Tidb | Diabase
Tms | Marine sedimentary rocks
TY | Yamhill Formation
Beaver Creek Watershed
Little Beaver Creek Watershed
Upper Gales Creek Watershed
Middle Gales Creek Watershed
Iler Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Beaver Creek
Little Beaver Creek
Bateman Creek
South Fork Gales Creek
Lyda Creek
White Creek
Fir Creek
Iler Creek
Culver Creek
Clear Creek
Gales Creek Sub-Basin
Area shown
Miles
Data Sources: ESRI, 2015; DOGAMI, 2009


Riparian Conditions - Middle Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/14/2015
CASCADE
Legend
Tualatin River Basin
Sub-Basin Areas
Watershed Boundaries
Major Streams
Garlic Mustard Presence
Knotweed Presence
CWS Plantable Area
0% - 49%
50% - 74%
75% - 100%
Beaver Creek Watershed
Little Beaver Creek Watershed
Upper Gales Creek Watershed
Middle Gales Creek Watershed
Iler Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Beaver Creek
South Fork Gales Creek
Bateman Creek
Lyda Creek
Little Beaver Creek
Iler Creek
White Creek
Fir Creek
Culver Creek
Clear Creek
Gales Creek Sub-Basin
Area shown
Banks
0 0.5 1 2 Miles
Data Source:ESRI, 2015; CWS, 2014..
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_MiddleWatershed_Riparian_Weeds.mxd


Roads and Fish Passage Barriers - Middle Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/7/2015
CASCADE ENVIRONMENTAL GROUP
Legend
Tualatin River Basin
Sub-Basin Areas
City Limits
Major Streams
Major Roads
Beaver Dams
Fish Passage Barriers
Beaver Creek Watershed
Upper Gales Creek Watershed
Middle Gales Creek Watershed
Little Beaver Creek Watershed
Iler Creek Watershed
Lower Gales Watershed
Little Beaver Creek
South Fork Gales Creek
Bateman Creek
Lyda Creek
White Creek
Iler Creek
Fir Creek
Culver Creek
Clear Creek
6
8
Gales Creek Sub-Basin
Area shown
0.5 1 2 Miles

# Lower Gales Creek

Lower Gales Creek Watershed is the downstream-most reach, closest to urban boundaries and with the most intensive human use, within the Gales Creek Sub-Basin. It is mostly privately owned, with agricultural and residential use. Riparian cover is minimal, the channel is incised, and the stream is considered temperature-limited.

## Land Use

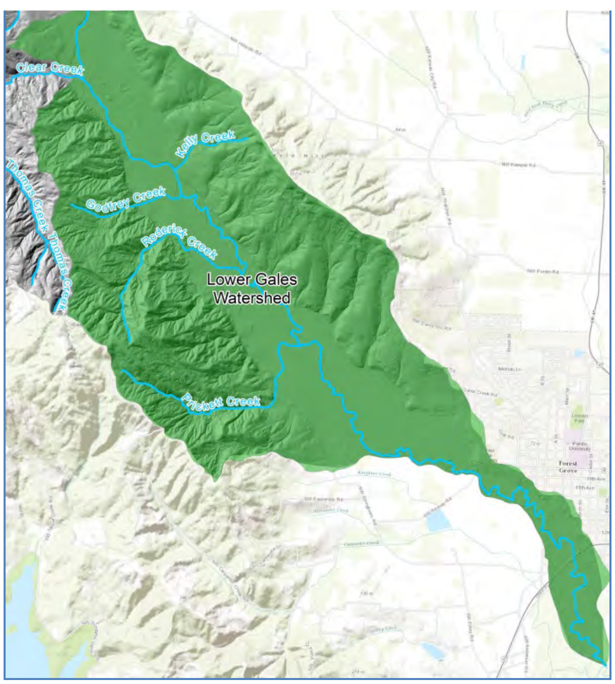
- 8,178 acres
- Mostly privately owned, with some public ownership
- Urban growth boundary for the City of Forest Grove extends into the watershed
- Majority of property near the mainstem channel is agricultural

## Physical Conditions

- Wide valley, especially near confluence with Tualatin
- Sediment passes through channel due to lack of wood to trap coarse sediment coming from upstream

## Riparian and Upland Conditions

- Riparian canopy cover fair to poor for the majority of the mainstem and tributaries
- Large planting programs have begun to improve riparian areas




## Limiting Factors

- 48 stream crossings, 19 potential fish passage barriers
- 3.99 miles of road per square mile
- Lack of instream wood in upper reaches

## Fish and Habitat

- Anadromy extends through the mainstem, though conditions are not favorable
- Very low densities of winter steelhead, coho, and cutthroat
- Pacific lamprey present
- Moderate complexity rating throughout the watershed
- A few beaver dams found along the mainstem and Roderick Creek

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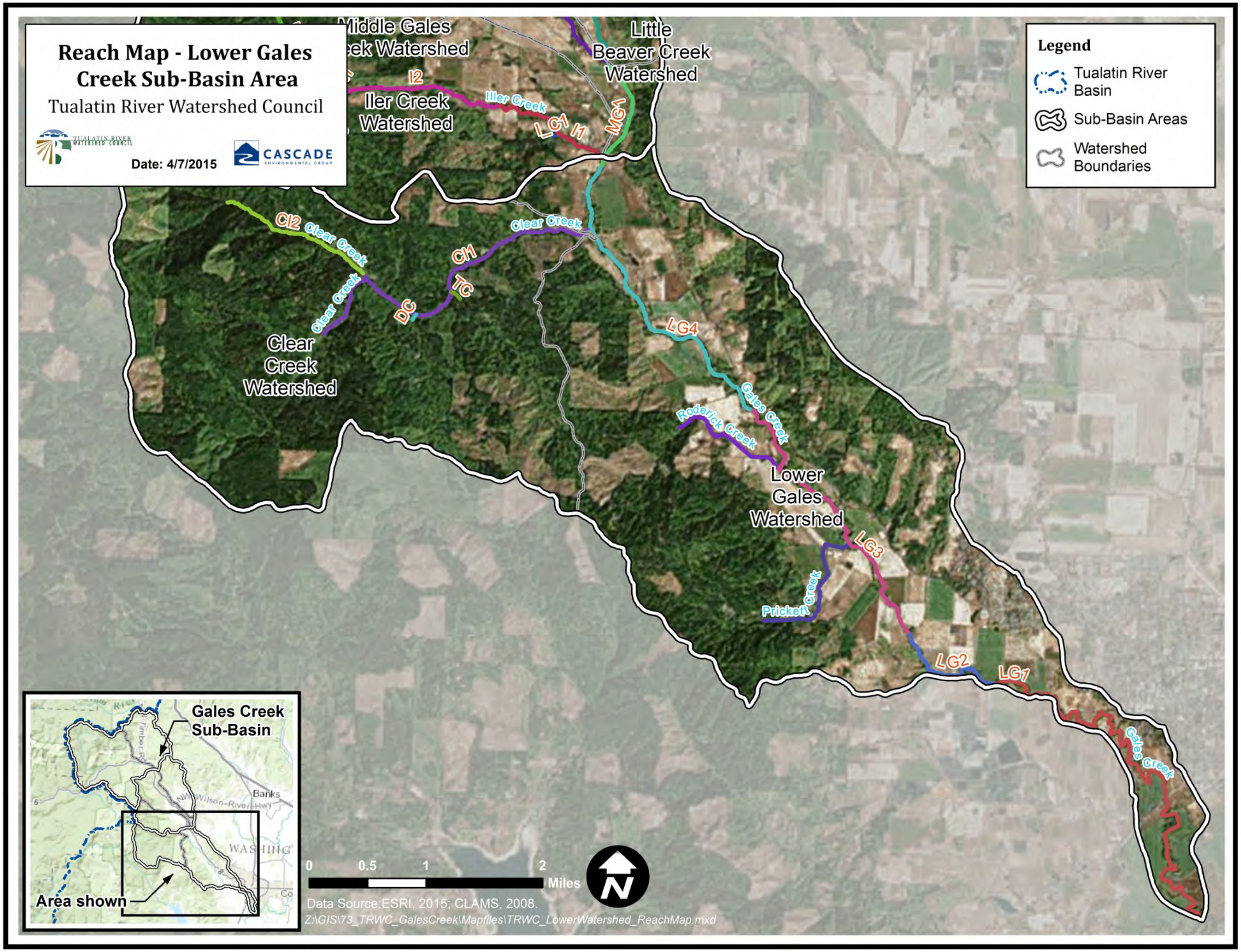
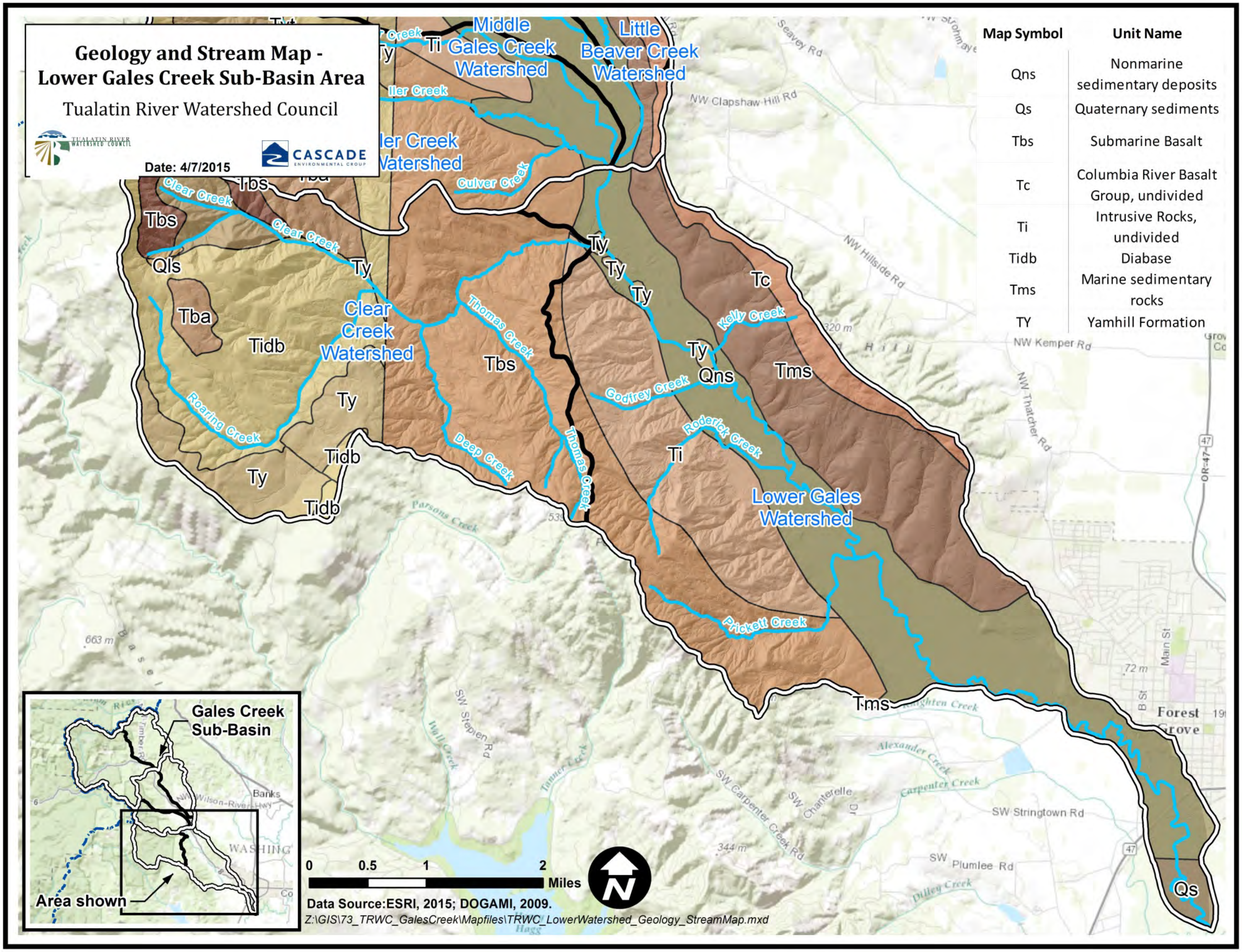
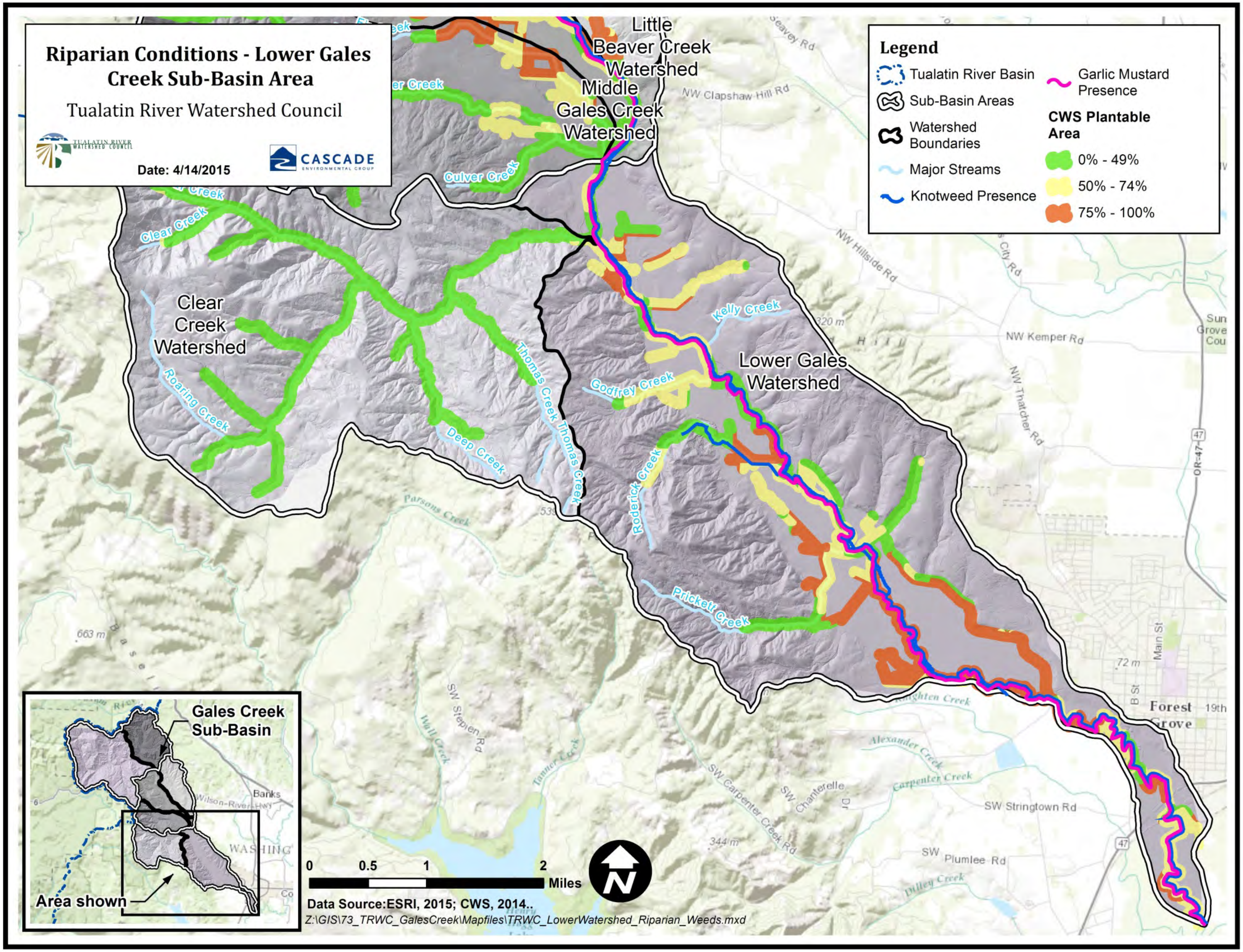
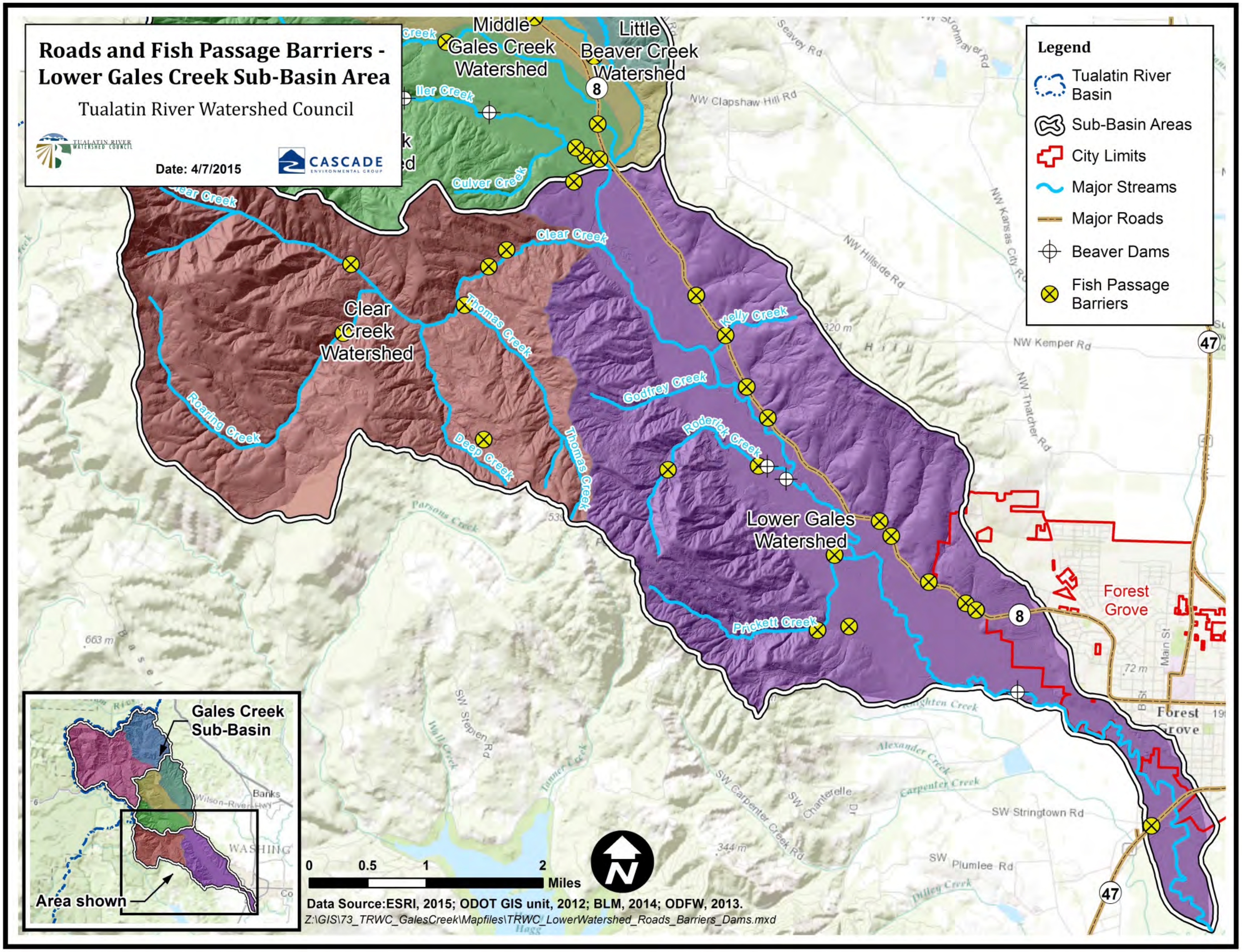


Reach Map - Lower Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/7/2015
CASCADE
Legend
Tualatin River Basin
Sub-Basin Areas
Watershed Boundaries
Middle Gales Creek Watershed
Little Beaver Creek Watershed
Iler Creek Watershed
Iler Creek
I2
I1
L_C1
MG1
Clear Creek Watershed
Clear Creek
Cl2
Cl1
TC
DC
Lower Gales Watershed
Gales Creek
Roderick Creek
Prickett Creek
LG4
LG3
LG2
LG1
Gales Creek Sub-Basin
Area shown
0 0.5 1 2 Miles
Data Source:ESRI, 2015; CLAMS, 2008.
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_LowerWatershed_ReachMap.mxd


Geology and Stream Map -
Lower Gales Creek Sub-Basin Area
Tualatin River Watershed Council
CASCADE
Date: 4/7/2015
Map Symbol
Unit Name
Qns
Nonmarine sedimentary deposits
Qs
Quaternary sediments
Tbs
Submarine Basalt
Tc
Columbia River Basalt Group, undivided
Ti
Intrusive Rocks, undivided
Tidb
Diabase
Tms
Marine sedimentary rocks
TY
Yamhill Formation
Middle Gales Creek Watershed
Little Beaver Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Clear Creek
Culver Creek
Roaring Creek
Thomas Creek
Deep Creek
Kelly Creek
Godfrey Creek
Roderick Creek
Prickett Creek
NW Clapshaw Hill Rd
NW Hillside Rd
NW Kemper Rd
NW Thatcher Rd
SW Stringtown Rd
SW Plumlee Rd
SW Carpenter Creek Rd
Forest Grove
Gales Creek Sub-Basin
Area shown
0
0.5
1
2
Miles
Data Source:ESRI, 2015; DOGAMI, 2009.
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_LowerWatershed_Geology_StreamMap.mxd



Riparian Conditions - Lower Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/14/2015
CASCADE ENVIRONMENTAL GROUP
Legend
Tualatin River Basin
Sub-Basin Areas
Watershed Boundaries
Major Streams
Knotweed Presence
Garlic Mustard Presence
CWS Plantable Area
0% - 49%
50% - 74%
75% - 100%
Little Beaver Creek Watershed
Middle Gales Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Clear Creek
Culver Creek
Roaring Creek
Deep Creek
Thomas Creek
Kelly Creek
Godfrey Creek
Roderick Creek
Prickett Creek
Parsons Creek
Alexander Creek
Carpenter Creek
Tanner Creek
Wall Creek
NW Clapshaw Hill Rd
NW Hillside Rd
NW Kemper Rd
NW Thatcher Rd
SW Stringtown Rd
SW Plumlee Rd
SW Carpenter Creek Rd
SW Stepien Rd
Main St
B St
Forest Grove
19th
OR-47
Gales Creek Sub-Basin
Area shown
Banks
0 0.5 1 2 Miles
Data Source:ESRI, 2015; CWS, 2014..
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_LowerWatershed_Riparian_Weeds.mxd


Roads and Fish Passage Barriers - Lower Gales Creek Sub-Basin Area
Tualatin River Watershed Council
Date: 4/7/2015
CASCADE ENVIRONMENTAL GROUP
Legend
Tualatin River Basin
Sub-Basin Areas
City Limits
Major Streams
Major Roads
Beaver Dams
Fish Passage Barriers
Middle Gales Creek Watershed
Little Beaver Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Clear Creek
Culver Creek
Thomas Creek
Roaring Creek
Deep Creek
Kelly Creek
Godfrey Creek
Roderick Creek
Prickett Creek
Forest Grove
NW Clapshaw Hill Rd
NW Kemper Rd
NW Hillside Rd
NW Thatcher Rd
SW Stringtown Rd
SW Plumlee Rd
Gales Creek Sub-Basin
Area shown
0 0.5 1 2 Miles
Data Source:ESRI, 2015; ODOT GIS unit, 2012; BLM, 2014; ODFW, 2013.
Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_LowerWatershed_Roads_Barriers_Dams.mxd

# 7. Summary of Watershed Council Accomplishments

The Tualatin River Watershed Council, landowners, timber companies, the Oregon Department of Forestry, CWS, Washington County, Tualatin Soil and Water Conservation District (SWCD), and others have worked on habitat restoration. This restoration work includes improving roads to minimize peak flows and sediment delivery to streams; wetland, riparian, and upland enhancement; large wood placement in stream channels; and replacement of culverts that are fish passage barriers. Table 10 and the accompanying map summarize some of the restoration projects completed by the Council, landowners, and partner organizations.

**Table 10. Projects completed by the Council, landowners, and partner organizations. The identification number corresponds to the map location number.**

| Map ID | Project Name | Activity | Year | Description |
|---|---|---|---|---|
| 1 | Roderick Creek 96-21030 | road | 1996 | Legacy road improvements, surface drainage improvements |
| 2 | Road Drainage Ditch Diversion 1998 | road | 1997 | Surface drainage improvements |
| 3 | Storey Burn Thin No. 2 | road | 1997 | Peak flow passage improvements, surface drainage improvements |
| 4 | Storey Burn Thin No. 2 | road | 1997 | Peak flow passage improvements, surface drainage improvements |
| 5 | High Five | road | 1999 | Surface drainage improvements |
| 6 | Prickett Cr R/W | road | 1999 | Peak flow passage improvements, surface drainage improvements |
| 7 | Roderick R/W | road | 2002 | Surface drainage improvements |
| 8 | Little Beaver Creek Riparian Enhancement | riparian | 2003 | Riparian tree planting |
| 9 | Rippling Water Enhancement Demonstration Project | riparian | 2007 | Invasive plant removal and native plantings |
| 10 | North Fork Gales Creek Large Wood Placement Project | instream | 2009 | Instream habitat (not anchored): Large wood placement. |
| 11 | North Fork Gales Creek Large Wood Placement Project | riparian | 2009 | Riparian planting |
| 12 | Gales Creek - Sahnow Property Enhancement Project | instream | 2008 | Anchored habitat structures placed |
| 13 | Gales Creek - Sahnow Property Enhancement Project | riparian | 2008 | Riparian planting and invasive control |

| Map ID | Project Name | Activity | Year | Description |
|---|---|---|---|---|
| 14 | Soda Springs Rocking | road | 2010 | Road durable rocking or quality hard road rocking prior to haul |
| 15 | Upper Gales Creek Large Wood Placement Project | instream | 2010 | Instream habitat enhancement: Large wood placed; Riparian tree planting |
| 16 | Upper Gales Creek Large Wood Placement Project | instream | 2010 | Instream habitat enhancement: Large wood placed; riparian tree planting |
| 17 | Upper Gales Creek Large Wood Placement Project | riparian | 2010 | Instream habitat enhancement: Large wood placed; riparian tree planting |
| 18 | Upper Gales Creek Large Wood Placement Project | riparian | 2010 | Instream habitat enhancement: Large wood placed; riparian tree planting |
| 19 | Clear Creek Large Wood Placement Project | instream | 2012 | Large wood placement: 86 pieces of large wood within the ~1 mile steam reach. |
| 20 | Wolfkin Thin | road | 1995 | Peak flow passage improvements, surface drainage improvements |
| 21 | Storey Burn | riparian | 1999 | Voluntary riparian tree retention |
| 22 | Logging | riparian | 2000 | Voluntary riparian tree retention |
| 23 | Bateman Creek Culvert Replacement | fish passage | 2006 | Culverts removed, replaced with bridge` |
| 24 | Fish Passage Culverts | fish passage | 2001 | Culvert improvement |
| 25 | Fish Passage Culverts | fish passage | 2004 | Culvert replaced |
| 26 | Fish Passage Culverts | fish passage | 2005 | Culvert improvement |
| 27 | Fish Passage Culverts | fish passage | 2008 | Culvert replaced |
| 28 | Fish Passage Road Projects | fish passage | 2000 | Crossing improvement |
| 29 | Fish Passage Road Projects | fish passage | 2000 | Crossing improvement |
| 30 | Fish Passage Road Projects | fish passage | 2000 | Crossing improvement |
| 31 | n/a | road | 2000 | Surface drainage improvement |
| 32 | n/a | road | 2000 | Surface drainage improvement |
| 33 | n/a | road | 2000 | Surface drainage improvement |
| 34 | n/a | road | 2000 | Surface drainage improvement |
| 35 | n/a | road | 2000 | Surface drainage improvement |
| 36 | n/a | road | 2000 | Surface drainage improvement |
| 37 | n/a | road | 2000 | Road stabilization |
| 38 | n/a | road | 2000 | Road stabilization |
| 39 | n/a | road | 2000 | Road stabilization |

| Map ID | Project Name | Activity | Year | Description |
|---|---|---|---|---|
| 40 | n/a | road | 2000 | Road stabilization |
| 41 | n/a | road | 2000 | Road stabilization |
| 42 | Clear Creek Large Wood Placement Project | fish passage | 2012 | Removal of the obsolete water gauging structure to enable juvenile fish conducting temperature dependent upstream migrations to pass upstream to reach summer temperature refugia |
| 43 | Clear Creek Large Wood Placement Project | fish passage | 2012 | The creation of the graded riffle to improve access for migratory adult fish over the fish ladder located at the Clear Creek intake dam and enable greater utilization of upstream habitats |

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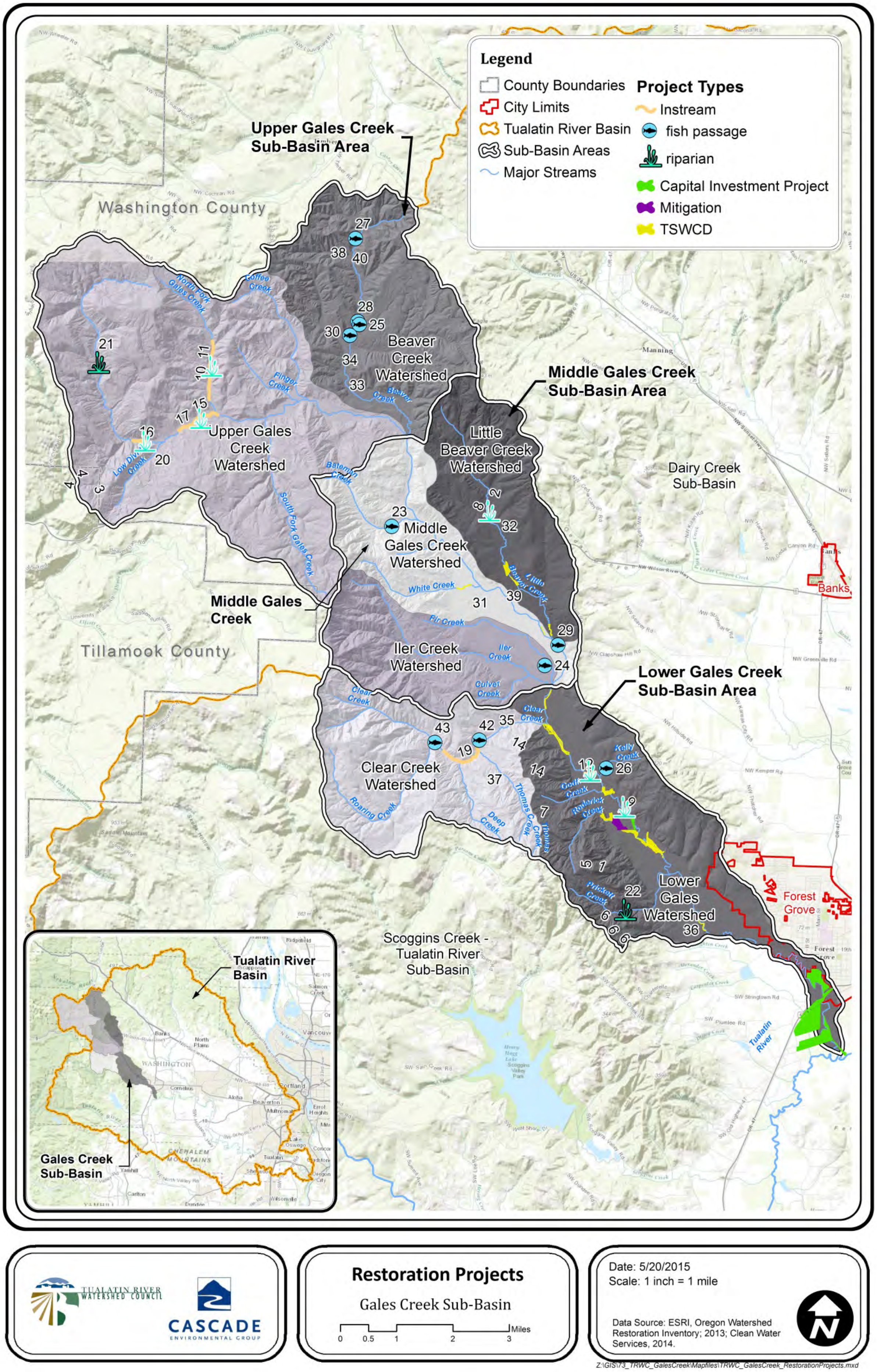
Legend
County Boundaries
City Limits
Tualatin River Basin
Sub-Basin Areas
Major Streams
Project Types
Instream
fish passage
riparian
Capital Investment Project
Mitigation
TSWCD
Upper Gales Creek Sub-Basin Area
Middle Gales Creek Sub-Basin Area
Lower Gales Creek Sub-Basin Area
Washington County
Tillamook County
Beaver Creek Watershed
Upper Gales Creek Watershed
Little Beaver Creek Watershed
Middle Gales Creek Watershed
Middle Gales Creek
Iler Creek Watershed
Clear Creek Watershed
Lower Gales Watershed
Dairy Creek Sub-Basin
Scoggins Creek - Tualatin River Sub-Basin
Banks
Forest Grove
Tualatin River
Tualatin River Basin
Gales Creek Sub-Basin
Restoration Projects
Gales Creek Sub-Basin
Miles
0 0.5 1 2 3
Date: 5/20/2015
Scale: 1 inch = 1 mile
Data Source: ESRI, Oregon Watershed Restoration Inventory; 2013; Clean Water Services, 2014.
TUALATIN RIVER WATERSHED COUNCIL
CASCADE ENVIRONMENTAL GROUP

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# 8. Restoration Goals and Strategies

## Goal 1: Restore aquatic connectivity to benefit fish and wildlife populations

### Description

Steelhead, coho salmon, cutthroat trout, Pacific lamprey, and other aquatic organisms migrate through the stream system during the different phases of their life cycles. Culverts and other barriers in Gales Creek and its tributaries can block passage by juvenile and adult fish and other organisms. In some cases, barriers prevent fish from accessing tributaries and other areas that provide relatively cool water temperatures for juvenile rearing in summer months.

#### Strategies

- Address passage barriers, including dams and culverts, to provide access to habitat requirements through the full life cycle for steelhead, coho salmon, cutthroat trout, Pacific lamprey, and other aquatic organisms.
- Remove passage barriers, such as steps, dams, and culverts, to provide access for juvenile and adult fish into upper Gales Creek and tributaries that provide cold water refuge.
- Study and ascertain passage status of unknown barriers, particularly in Coffee Creek and Little Beaver Creek.

## Goal 2: Restore aquatic and floodplain habitat to benefit fish and wildlife populations

### Description

Inadequate quantities of large wood in stream channels are limiting steelhead, coho salmon, and cutthroat trout populations. Large wood provides cover, creates pools, contributes to habitat complexity, and traps spawning gravels. Impaired floodplain connectivity, particularly in entrenched stream segments and where there are berms or other structures, prevent fish from accessing side-channels and other off-channel habitats. In addition, larval lamprey rear in the deep sediments contained in off-channel habitats.

#### Strategies

- Improve riparian conditions through planting native vegetation and removing invasive species.
- Improve stream channel complexity through placement of large wood and other actions.

- Work with the Oregon Department of Forestry and forest landowners to opportunistically place wood in stream channels associated with forest harvest operations.
- Improve floodplain connectivity and off-channel habitat features by removing flood control berms, rip-rap, and other features, and adding wood, improving floodplain vegetation, and implementing other actions.

# Goal 3: Restore riparian habitat to benefit fish and wildlife populations

## Description

Impaired riparian vegetation conditions are limiting steelhead, coho salmon, and cutthroat trout populations. Invasive weeds, including Japanese knotweed and garlic mustard, replace native vegetation and degrade riparian habitats. Riparian trees provide streams with shade, large wood, and the organic matter that is the foundation for the food web. During flood events, floodplain vegetation can create low velocity areas for fish to hide in and feed.

### Strategies

- Plant native trees and shrubs in degraded riparian areas.
- Identify and control weeds in riparian areas.
- Plant native trees and shrubs in degraded floodplain habitats.

# Goal 4: Provide information and outreach to landowners and stakeholders on watershed conditions and restoration opportunities

## Description

Implementing the Action Plan relies on local landowners and stakeholders understanding and supporting restoration priorities. As the community becomes aware of opportunities and resources become available for restoration, landowners can engage in projects on their land.

### Strategies

- Provide information at community gathering places and events. Contact local groups such as churches, schools, and civic organizations.
- Hold occasional Council meetings or project tours in the Gales Creek watershed.
- Interview landowners about their restoration needs.

- Provide opportunities for all ages to engage in watershed activities and education, especially school-age children and university students.
- Publish and distribute annual updates on Council activities.
- Maintain a database of interested landowners.
- Develop an interactive website and clickable map with project opportunity areas and their justification based on this Action Plan.

# Goal 5: Engage landowners and stakeholders in restoration actions

## Description

Landowners are the local experts on their own land and given adequate resources and support can efficiently restore and maintain habitat on their property. Developing and leveraging partnerships that support landowners will deliver services more efficiently.

### Strategies

- Develop strategic demonstration projects with willing landowners.
- Host regular volunteer work parties in target watersheds.
- Develop a model for financial, organizational, and technical assistance to engage and support landowner involvement.

# Goal 6: Monitor and track watershed conditions, track aquatic organism population status and trends, and evaluate restoration actions

## Description

A critical component of the implementation of the Action Plan is the assessment of actions through the analysis of monitoring data. A strategic approach to monitoring and assessment will provide a framework for the Council to track and examine watershed conditions over time, assess restoration opportunities, and evaluate restoration outcomes to determine if activities are achieving the goals of supporting healthy fish and wildlife populations and improving water quality.

### Strategies

- Develop a monitoring program to evaluate the effectiveness of actions described in the Action Plan.

- Monitor and track stream flows.
- Continue and expand water temperature monitoring and conduct other water temperature monitoring where needed.

# 9. Prioritized Restoration Actions and Locations

## Introduction

Properly functioning watersheds are characterized by connected stream systems and healthy processes that link upland areas, riparian habitats, and stream channels. Watershed processes create, maintain, and enhance upland and aquatic habitat, shape stream channels, and help define the factors that limit steelhead, coho salmon, cutthroat trout, Pacific lamprey, and other aquatic organisms. Upland and stream linkages include surface- and groundwater conveyance and sediment movement and delivery to channels. Riparian and floodplain vegetation is connected to stream channels through multiple processes and functions, including shading the water's surface, delivering wood to channels to create cover and complex habitats, and providing organic matter that supports aquatic insects and other parts of the food web. In addition, upland and riparian habitats have been impaired as a result of noxious weeds replacing native vegetation and historical land use practices.

Priorities for Gales Creek Sub-Basin restoration actions should focus first on improving habitat connectivity and watershed processes that support and sustain healthy habitats and fish and wildlife populations over the long-term. Restoring habitats through structural fixes, such as the placement of large wood in stream channels, should be considered as a short-term measure that is taken in combination with actions that are focused on restoring watershed connectivity and processes, such as functional riparian areas, that create and sustain habitats over the long term.

Prioritizing restoration actions should take into account five important questions:

- Is the action restoring stream or riparian connectivity? An example is addressing fish passage barriers.

- Is the action improving watershed processes or disturbance regimes? For example, increasing low stream flows, reducing sediment delivery to stream channels, and improving riparian areas to provide large wood delivery or shade.

- Is the action addressing a problem that will rapidly degrade habitat and expand in scope if not addressed? An example is taking an action that quickly eliminates the first infestation of an aggressive noxious weed that, if not addressed, would spread quickly and be very difficult and expensive to control.

- Is the action addressing a key habitat type or other factor that is limiting the focal fish species or wildlife populations or water quality-limited streams? An example is improving stream habitat complexity through the placement of wood to address a factor that limits steelhead populations or addressing an Oregon Conservation Strategy priority upland habitat, such as oak woodlands.

- Is the action based on good information and data? For example, is a proposed riparian or channel restoration project based on a stream reach assessment or other inventories that evaluate and identify key issues affecting fish populations, and outline prioritized restoration approaches to address the identified issues.

Finally, a framework to help prioritize restoration actions takes into account three important components:

- The response time of the system to the action;
- The probability and variability of success; and
- The longevity of the restoration action.

For example, watershed restoration actions that have a high probability of success, low variability among projects, and relatively quick response time should be implemented before other techniques. Removing fish passage barriers, for example, has a high probability of success and a fast response because fish and other aquatic organisms can quickly recolonize the habitat. While it is important to be opportunistic with actions (for example, when there is funding and willing landowners), this framework provides guidance for planning future projects.

## The role of RBA and Other Reach-Specific Data

The sections below describe general priority areas and specific projects focused on the restoration goals. This is just the beginning. The Gales Creek Sub-Basin reach database provides a framework for prioritization. The database contains detailed information on fish distribution and abundance from the 2013 RBA and additional information on stream and riparian habitat quality. The reach database provides a source of information that can be used opportunistically or strategically to identify restoration actions. An example of an opportunistic approach is summarizing the data to describe fish and stream habitat restoration needs for a specific property where a landowner has approached the Council to explore project ideas. A strategic use of the database could entail identifying specific riparian areas in a watershed (e.g., Little Beaver Creek) that are impaired and using this information to reach out to a group of landowners about pursuing riparian restoration projects.

# Goal 1: Restore aquatic connectivity to benefit fish and wildlife populations

## Description

The highest priority actions for restoring aquatic connectivity are in the Middle Gales Creek Watershed. Balm Grove dam blocks passage to all juvenile fish and adult Pacific Lamprey. The dam prevents fish from accessing the upper watershed where cold water and ample cover provide good habitat, especially for steelhead. The dam prevents Pacific lamprey from accessing spawning and rearing areas in the upper portions of the Sub-Basin. Besides Balm Grove Dam, the most important restoration opportunities are located in the lower reaches of the Middle Gales Creek Watershed tributaries: Bateman, White, and Iler Creeks. As water temperatures rise in the mainstem of Gales Creek during the summer, the lower and relatively cold reaches of tributary streams become essential to juvenile survival. Restoring the riparian areas adjacent to barriers will help to improve long term conditions. Table 11 and the following map summarize the priorities for addressing fish passage barriers. The priorities were determined based on: 1) length of fish habitat accessible above the barrier, 2) index habitat quality above the barrier, and 3) access to cool water temperatures (thermal refugia). Appendix A outlines the method for prioritizing fish passage barriers.

### Priorities and Actions

- Remove or modify Balm Grove dam to provide for fish passage.
- Remove fish passage barriers in Middle Gales Creek Watershed tributaries that provide critical summer juvenile rearing habitat.

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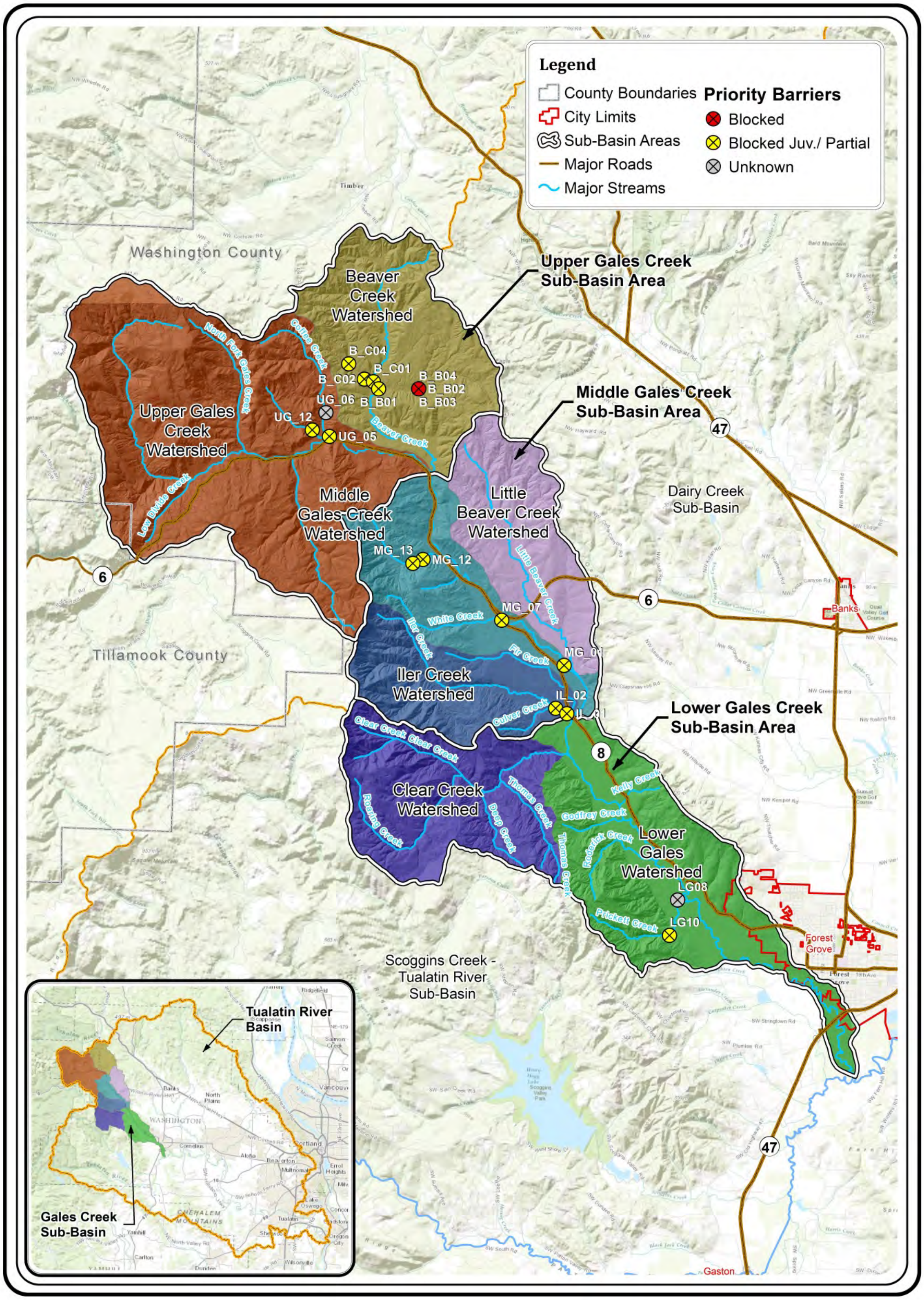


Priority Fish Passage Barriers

Gales Creek Sub-Basin

0 1 2 4 Miles

Date: 4/6/2015
Scale: 1 inch = 1 mile

Data Source: ESRI, Oregon Department of Fish & Wildlife, 2012; Clean Water Services, 2014.

Z:\GIS\73_TRWC_GalesCreek\Mapfiles\TRWC_GalesCreek_PriorityFishPassageBarriers.mxd

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**Table 11. Prioritized fish passage barrier projects. Appendix A describes the prioritization methods. HIGH = High Priority to Address; MED = Medium Priority to Address.**

| Watershed | Action | ID # | Reach | Description | Status | Stream Name | Rationale/ Benefit | Sub-Basin Priority |
|---|---|---|---|---|---|---|---|---|
| Middle Gales Creek | Remove Dam | MG_01 | MG2 | Dam 3-Foot Drop | Blocked Juv. | Gales Creek Main | 21.93 miles of upstream habitat; barrier to adult lamprey and all juvenile salmonids; blocks juvenile access to temperature refugia | HIGH |
| Iler Creek | Remove Step | IL_01 | I1 | Concrete 1-Foot Step | Blocked Juv. | Iler Creek | 9.72 miles of upstream habitat; temperature refugia | HIGH |
| Middle Gales | Remove Culvert | MG_07 | MG_W1 | Full Box Culvert | Blocked Juv. | White Creek | 2.55 miles of upstream habitat; temperature refugia | HIGH |
| Iler Creek | Remove Step | IL_02 | I1 | Concrete 8-Inch Step | Possible Juv. | Iler Creek | 9.51 miles of upstream habitat; high quality habitat | HIGH |
| Beaver Creek | Remove Culvert | B_B01 | B_TB1 | Round Culvert | Blocked Juv. | Beaver Creek Trib. B | 5.32 miles of upstream habitat | HIGH |
| Upper Gales Creek | Remove Culvert | UG_05 | Co1 | Round Culvert | Partial Juv. | Coffee Creek | 4.07 miles of upstream habitat | HIGH |
| Beaver Creek | Remove Culvert | B_C01 | B_TC1 | Round Culvert | Partial Adult | Beaver Creek Trib. C | 2.67 miles of upstream habitat; high quality coho habitat | HIGH |
| Beaver Creek | Remove Culvert | B_C02 | B_TC2 | Round Culvert | Blocked Juv. | Beaver Creek Trib. C | 2.48 miles of upstream habitat; high quality coho habitat | HIGH |
| Upper Gales Creek | Remove Dam | UG_06 | Co1 | Dam | Unknown | Coffee Creek | 3.49 miles of upstream habitat | HIGH |
| Beaver Creek | Remove Culvert | B_B02 | B_TB2 | Round Culvert | Blocked | Beaver Creek Trib. B | 4.53 miles of upstream habitat | MED |

| Watershed | Action | ID # | Reach | Description | Status | Stream Name | Rationale/ Benefit | Sub-Basin Priority |
|---|---|---|---|---|---|---|---|---|
| Beaver Creek | Remove Culvert | B_B03 | B_TB2 | Round Culvert | Blocked | Beaver Creek Trib. B | 4.53 miles of upstream habitat | MED |
| Beaver Creek | Remove Culvert | B_B04 | B_TB2 | Round Culvert | Blocked | Beaver Creek Trib B | 4.53 miles of upstream habitat | MED |
| Middle Gales Creek | Remove Culvert | MG_12 | MG_B1 | Round Culvert | Blocked Juv. | Bateman Creek | 2.28 miles of upstream habitat | MED |
| Lower Gales Creek | Remove Culvert | LG_08 | LG_P1 | Pipe Arch Culvert | Blocked Juv. | Prickett Creek | 1.42 miles of upstream habitat | MED |
| Middle Gales Creek | Remove Culvert | MG_13 | MG_B1 | Round Culvert | Blocked Juv. | Bateman Creek | 2.1 miles of upstream habitat | MED |
| Middle Gales Creek | Remove Dam | UG_12 | F1 | Dam | Possible Juv. | Finger Creek | 1.06 miles of upstream habitat | MED |
| Beaver Creek | Remove Culvert | B_C04 | B_TC2 | Round Culvert | Blocked Juv. | Beaver Creek Trib C1 | 1.46 miles of upstream habitat | MED |
| Middle Gales Creek | Remove Step | LG_10 | LG_P1 | Constructed Log Step | Possible Adult | Prickett Creek | 0.73 miles of upstream habitat | MED |

# Goal 2: Restore aquatic and floodplain habitat to benefit fish and wildlife populations

## Description

Stream areas with the highest densities of steelhead and coho salmon are the highest priority for placing large wood in stream channels. Improving floodplain connectivity and off-channel habitat is a priority in areas where the channel is incised and where there are berms or other structures.

### Priorities and Actions

- Large wood placement in channels is a priority in the Upper Gales Creek, Beaver Creek, and Clear Creek Watersheds.
- Address floodplain connectivity in areas where the channel is incised or there are structures preventing connectivity, particularly in lower Gales Creek and its tributaries, and lower Clear Creek. Clear Creek and Gales Creek Confluence: Reconnect the floodplain terrace which is blocked by a berm along Clear and Gales Creeks. Excavate the berm to allow water to overtop and flow into the floodplain and install wood in locations to create deep scour.
- Gales Creek at B Street Trail: Remove 50-foot berm to expose 1.5 acres of floodplain to historical flood flows, while increasing high flow floodplain connection to another 36 acres of wetlands where fish can forage or seek low velocity cover. Create 310 feet of off-channel habitat for fish and install three large wood assemblages.
- Gales Forest Grove Natural Area: Restore floodplain habitats, including fifteen acres of riparian forest, fifteen acres of scrub-shrub wetlands, seven acres of wet prairie, and four acres of oak woodland.

# Goal 3: Restore riparian habitat to benefit fish and wildlife populations

## Description

The highest priority for addressing degraded riparian habitat is in areas where CWS has identified a high proportion of plantable area or the presence of invasive weeds, particularly Japanese knotweed and garlic mustard.

### Priorities and Actions

- Target riparian restoration along lower Gales Creek and in the watersheds with the largest proportion of riparian plantable area: the Middle Gales Creek, Little Beaver Creek, Iler Creek, and Lower Gales Creek Watersheds.

- Treat known locations of Japanese knotweed and garlic mustard along Gales Creek and its tributaries. Continue to monitor and assess infestations.

## Restoration Project Prioritization Example

**Table 12. Example of a restoration project prioritization approach for the Gales Creek Sub-Basin that applies the prioritization framework described above. The approach accounts for improvements across multiple watersheds and multiple focal fish species by evaluating the following: The extent the action addresses focal fish species' habitat priorities; benefits to watershed processes; project-specific response and success criteria (e.g., action response time, probability of success, urgency of implementation); and the extent that the action affects each of the focal fish species.**

**All criteria are scored as follows: 0 = not applicable; 1 = low response or improvement in project criteria; 2 = medium response or improvement in project criteria; 3 = high response or improvement in project criteria.**

**Habitat restoration project priority ranking based on the sum of the scores: 1 – 10 = Low Priority to Address; 11 – 20 = Medium Priority to Address; greater than 21 = High Priority to Address.**

| | | | Project Location | | Extent Action Addresses Habitat Priorities and Watershed Processes and Issues | | | | | | Project Response and Success Criteria | | | Extent Action Addresses Focal Fish Species' Limiting Factors | | | | Action Prioritization | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Goal | Strategy | Proposed Action | Watershed(s) | Reach | Habitat Connectivity | Habitat Complexity | Access to Thermal Refuge | Riparian Shade (Water Temperature) | Watershed Processes | Urgency | Action Response Time | Probability of Success | Longevity of Action | Steelhead | Coho | Lamprey | Cutthroat | Final Score | Priority | Notes |
| Goal 1: Restore aquatic connectivity to benefit fish and wildlife populations | Address passage barriers, including dams and culverts, to provide access to habitat requirements through the full life cycle for steelhead, coho salmon, cutthroat trout, Pacific lamprey, and other aquatic organisms | A. Remove/modify Balm Grove Dam | Middle Gales Creek | MG2 | 3 | 1 | 2 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 25 | H | The dam is a barrier to adult lamprey and all juvenile salmonids; blocks juvenile access to temperature refugia. Addressing barrier opens up 21.93 miles of upstream habitat. Rapid response to opening access. |
| | | B. Remove a culvert in Beaver Creek Watershed | Beaver Creek | B_TB1 | 3 | 1 | 1 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 3 | 1 | 2 | 20 | M | The culvert is a barrier to juvenile coho and cutthroat. Addressing barrier opens up 5.32 miles of upstream habitat. Rapid response to opening access. |
| Goal 2: Restore aquatic and floodplain habitat to benefit fish and wildlife populations | Improve riparian conditions through planting native vegetation and removing invasive species | A. Improve riparian conditions in Little Beaver Creek Watershed | Little Beaver Creek | LB1 | 2 | 2 | 1 | 3 | 3 | 3 | 1 | 2 | 3 | 0 | 0 | 2 | 2 | 24 | H | Greater than 75% plantable area is present. Restores riparian processes (e.g., nutrient inputs and large wood delivery) and improves water temperatures through increased stream shade. Urgent priority because of presence of knotweed. |
| | Improve stream channel complexity through placement of large wood and other actions | B. Improve stream complexity in Upper Gales Creek by placing wood in channels related to harvest operations | Clear Creek Upper Gales Creek | Multiple | 1 | 3 | 1 | 0 | 1 | 0 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 17 | M | Large wood placement in streams associated with timber harvest operations. Opportunistic action that improves stream complexity in an important areas for steelhead and coho rearing. Medium-term fix while riparian areas mature into conditions that will provide long-term large wood delivery and restore other watershed processes. |

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# 10. Action Plan Implementation

## Other Factors to Consider for Prioritizing Projects

This Action Plan is intended to be a planning tool and a living document to be updated regularly and made relevant each year by including specific prioritized actions in annual work plans.

This Action Plan contains recommended goals and priorities for implementation on the Gales Creek Sub-Basin scale. The Action Plan goals can also be prioritized at the watershed scale (e.g., aquatic habitat restoration in Upper Gales Creek). In either case there is no wrong project to choose for implementation as all of them will contribute to improvement of the watershed. For instance, a list of the top 18 barriers to fish passage is included in the Action Plan (Table 11) and prioritized based on their biological, physical, and geographic locations. Balm Grove dam is the top-priority barrier to remove as it is low in the watershed and its removal will provide access to many miles of upstream tributaries. However, it may not be possible to move forward quickly with this project for a number of reasons. If advance planning is done on multiple barriers at once and an opportunity to replace priority barrier number 18 appears, there is no reason to wait. There are other factors besides biological and geographic location to consider regarding project implementation. Social and economic factors must also be considered.

Any project takes a lot of advance work and planning before on-the-ground implementation. For example, some watershed councils have found that by developing a list of projects that are nearly ready to implement it is possible to bundle projects in one larger funding request. A database of landowners interested in projects can be developed and maintained. Once funding is acquired, the Council can provide financial, technical, and organizational assistance to participating landowners when possible.

Socio-economic considerations are linked: a restoration project cannot move forward without landowner permission and an understanding of cost and feasibility. The following socio-economic criteria are proposed for discussion as the Council evaluates the relative merits of proposed projects:

- Landowner cooperation
- Ability to act as a demonstration or outreach project
- Cost
- Feasibility

These factors should not be applied in a strict number ranking but as a set of items to be considered. The Council may choose to do a higher cost project because it is a higher biological priority. Or it may choose to do a lower-priority project because the landowner is ready to move forward and willing to provide a large amount of in-kind services to make the project happen. Another strategic reason to pursue a lower-priority project is the case of an enthusiastic landowner who will showcase the project and help catalyze interest from neighbors in also engaging in restoration.

## Action Phasing and Implementation

The Action Plan is a living document that will be updated as new information becomes available and project opportunities and new partnerships arise. The Action Plan provides a framework for Council planning and implementation. The Council will develop annual work plans based on the Action Plan, landowner and partner organization interest in pursuing projects, and other new information and opportunities.

## Monitoring and Evaluation

The RBA and other sources provide baseline information on habitats and fish populations. The Council should pursue coordinated monitoring to evaluate restoration actions and track progress across the Gales Creek Sub-Basin. Measures should be selected by first developing hypotheses, then determining what information is needed to test the hypotheses. The monitoring approach should include strategic locations for data collection and the frequency of data collection, dependent upon the measure of interest.

Examples of measures that will be useful for evaluation of Gales Creek restoration activities include:

**Hydrology:** long-term flow measures at key tributaries (e.g., Clear, Iler, Beaver) and along the mainstem at strategic locations (e.g., below Balm Grove Dam).

**Geomorphology:** cross-section surveys within restored sections of stream to evaluate stream channel response over time.

**Water Quality:** stream temperatures at flow gages (continuous, during summer months), and pollutant sampling at strategic times.

**Riparian Habitat:** track changes in extent or quality of riparian areas, with a repeat sampling interval of 5 years.

**Stream Habitat:** macroinvertebrate sampling to understand water quality and habitat (every 2-3 years), and RBA surveys to assess fish response to restoration actions (pre- and post-project, and every 2-3 years after baseline established).

Additionally, the Gales Creek Sub-Basin Information Gap Analysis (Cascade2014) identified a number of measures that are not being collected or are not being collected at intervals that provide the resolution necessary for determining the effectiveness of restoration activities (Table 12). Addressing these gaps would build understanding of watershed characteristics for the entire sub-basin, and would provide more clarity on the issues limiting fish populations for specific stream reaches and tributaries, all of which would aid restoration action planning.

**Table 12. Gales Creek Sub-Basin information data gaps and recommendations (Cascade 2014).**

| Data Description | Data Gap | Recommendation (Short-Term for Action Planning) | Recommendation (Long-Term) |
|---|---|---|---|
| Stream flow | There is one flow gauge on the mainstem of Gales Creek, at RM 2.36, but there is limited flow data for the tributaries | Identify trends for Gales Creek and tributaries from existing data sources | Establish and implement a tributary flow monitoring strategy to assess status and trends |
| Stream temperature | Limited temperature data for tributaries | Monitor key cool water tributaries identified in the RBA | Establish and implement a tributary temperature monitoring strategy to assess status and trends |
| Tributary stream habitat data | Limited information on tributary stream habitat | Survey selected tributary stream reaches based on the RBA assessment of "hot spots" and other parameters | Implement a tributary stream habitat inventory program, including pre- and post-project inventories |
| Macroinvertebrate surveys | Missing key tributaries | Continue to monitor current locations | Explore augmenting current Gales Creek sites with tributary locations |
| Mussel surveys | Limited survey locations | None | Explore adding locations that overlap the macroinvertebrate monitoring sites |
| Fish passage barriers | All of the data have not been synthesized to provide comprehensive mapping and prioritization of fish passage barriers | Compile all fish passage barrier information into a comprehensive database | Track and document fish passage barrier improvement implementation |
| Implemented restoration projects | No comprehensive database that includes all partner restoration projects (e.g., SWCD, timber company projects) | Compile a database that includes all restoration projects within Gales Creek Sub-Basin | Track and document restoration project implementation |

| Data Description | Data Gap | Recommendation (Short-Term for Action Planning) | Recommendation (Long-Term) |
|---|---|---|---|
| Sediment sources/ inputs | No information on sediment sources | Evaluate whether sediments are a key limiting factor and therefore require a sediment source assessment | Track projects (e.g., road drainage improvements) that reduce sediment inputs |

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