

**U.S. Fish and Wildlife Service  
Columbia River Fish and Wildlife Conservation Office**

# **Tryon Creek Restoration Monitoring Project**

*City of Portland FY 2018 Progress Report*



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**February 20, 2019**

***On the cover:*** *Measuring, weighing and tagging fish below the Highway 43 culvert (l to r Emily Rosebrook, Brook Silver) photo by Brendan White 2018.*

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*Abstract*

Tryon Creek is a relatively undisturbed urban watershed located in southwest Portland, Oregon. The habitat is well suited for native fish; however, the lower portion of the stream is bisected by a culvert that runs under Oregon State Highway 43. A collaborative project to improve habitat and passage conditions for anadromous fish retrofitted the culvert with a new baffle system, elevated the pool below the culvert, and enhanced floodplain habitat. The U.S. Fish and Wildlife Service is working with the City of Portland to assess the restoration response of multiple species historically present, or believed to be present, in Tryon Creek. Goals are to evaluate fish 1) community, 2) relative abundance, and 3) residence time in the confluence habitat, 4) estimate the population abundance of trout species above the Highway 43 culvert and 5) investigate larval lamprey occupancy. Between 2012 and 2018, the fish community below the Highway 43 culvert included 7,545 individual fish among 22 species. Native fish were the most abundant comprising 64% (n = 14) of the species captured and 99% (n = 7,479) of the individuals captured. The majority of juvenile anadromous salmonids (Chinook Salmon, Coho Salmon, and *O. mykiss*) captured below the Highway 43 culvert were of wild origin from elsewhere in the Willamette River Basin (2,715/2,780), all other juvenile anadromous salmonids were hatchery reared. At the mouth of Tryon Creek, juvenile Chinook Salmon, juvenile Coho Salmon, and juvenile *O. mykiss* were present throughout the year and the numbers captured peaked in the winter and spring months. Juvenile anadromous salmonids were detected emigrating a median 16 days after their initial capture. Salmonids exhibiting both resident and anadromous behaviors (Coastal Cutthroat Trout and their *O. mykiss* hybrids) were detected emigrating a median 182 days after tagging. Since 2005, multiple species of lamprey (primarily larval Pacific Lamprey) have been found using Tryon Creek below the Highway 43 culvert but not above.

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# Tryon Creek Restoration Monitoring

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## Introduction

Tryon Creek is one of the largest (approximately 16.8 km<sup>2</sup>), relatively protected, urban watersheds in Oregon (Callison et al. 2002). Native salmonid species currently found in this stream include Coastal Cutthroat Trout (*Oncorhynchus clarki*), *O. mykiss* (resident Rainbow Trout and anadromous Steelhead Trout), Coastal Cutthroat Trout x *O. mykiss* hybrids (hybrid trout) (Tinus et al. 2003), Coho Salmon (*O. kisutch*), and Chinook Salmon (*O. tshawytscha*) (Hudson et al. 2008). Historically, Pacific Lamprey (*Entosphenus tridentatus*) and Western Brook Lamprey (*Lampetra richardsoni*) may have utilized this stream. However, a culvert that currently runs under Oregon State Highway 43 and the adjacent railroad potentially inhibits, if not prevents, passage of lamprey and salmonids.

A collaborative project was implemented by the Oregon Department of Transportation (ODOT), Oregon Department of Fish and Wildlife (ODFW), Oregon State Parks, National Marine Fisheries Service, Cities of Portland and Lake Oswego, Friends of Tryon Creek, Tryon Creek Watershed Council, National Fish and Wildlife Foundation, and the U.S. Fish and Wildlife Service (USFWS) to improve passage conditions for multiple species historically present, or believed to be present, in Tryon Creek. The initial phase of the project (conducted by ODOT in August 2008) retrofitted the existing culvert with a new baffle system to improve fish passage. The effort also provided habitat restoration to the stream, which included raising the level of the pool below the culvert to create a swim-in, rather than jump-in, situation thought to be more beneficial to lamprey and salmonid passage (Silver et al. 2014). In 2010, the City of Portland completed phase two of the Tryon Creek Confluence Habitat Enhancement Project, which improved floodplain connectivity, removed invasive plant species, and installed root wads and boulders. The project included stream enhancement of approximately 300 m of Tryon Creek from its confluence with the Willamette River to the culvert below Oregon State Highway 43. The third phase, if implemented, will provide a long-term solution to replace the existing culvert.

The USFWS assessment and monitoring program is focused on investigating the effectiveness of restoration actions in three stages: 1) prior to the initial phase of culvert improvement; 2) post-assessment and monitoring of the first two phases and prior to the third phase of the culvert replacement; and 3) post-assessment of the completed culvert replacement project. The focus of the assessment and monitoring project was originally directed at Pacific and Western Brook Lamprey in Tryon Creek and was expanded to include salmonids. In 2012, the USFWS and City of Portland Bureau of Environmental Services collaborated to further the program to include all fish species in the confluence habitat. The partnership continues with the following objectives:

1. Assess fish abundance, community, and residence time of fish in the Tryon Creek confluence

## Tryon Creek Restoration Monitoring

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- a. Estimate presence/absence and relative abundance of fish species present below the Highway 43 culvert
    - i. Conduct monthly sampling (seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert for City of Portland fiscal years 2013, 2015, 2017, and 2019.
    - ii. Conduct weekly sampling (seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert in the springs of 2013, 2015, 2017, and 2019.
  - b. Describe fish community throughout the year
  - c. Document salmonid residence time
    - i. Maintain a Passive Integrated Transponder (PIT) array at the mouth of Tryon Creek
2. Estimate relative abundance of salmonid species above the Highway 43 culvert
    - a. Conduct a two-pass abundance estimate of salmonid species between the Highway 43 culvert and Maplecrest Drive culvert in fall 2015 and 2019; conduct a single pass in fall 2013 and 2017
  3. Conduct electrofishing surveys to detect larval lamprey distribution above and below the Highway 43 culvert

Information collected from this assessment will aid the City of Portland in determining if the project is meeting its goals, evaluating if the site is achieving desired function over time, and improving the design of future projects.

### ***Relationship to the U.S. Fish & Wildlife, Fish & Aquatic Conservation Program's Strategic Plan***

Implementation of this project demonstrates application of the Pacific Region's 2016-2020 Strategic Plan. The following National goals (NG) and objectives (O) have been addressed by this project:

- NG1 Conserve Aquatic Species
  - O1.2 Identify population objectives and restoration criteria for declining species
  - O1.4 Evaluate effectiveness of our conservation actions and adapt as necessary
- NG2 Conserve, Restore, and Enhance Aquatic Habitats
  - O2.3 Work with federal, tribal, state and other partners to implement additional actions to achieve landscape-scale habitat conservation objectives
- NG5 Enhance Recreational Fishing and Other Public Uses of Aquatic
  - O5.3 Increase recreational fishing and other public uses and enjoyment of aquatic resources

## Tryon Creek Restoration Monitoring

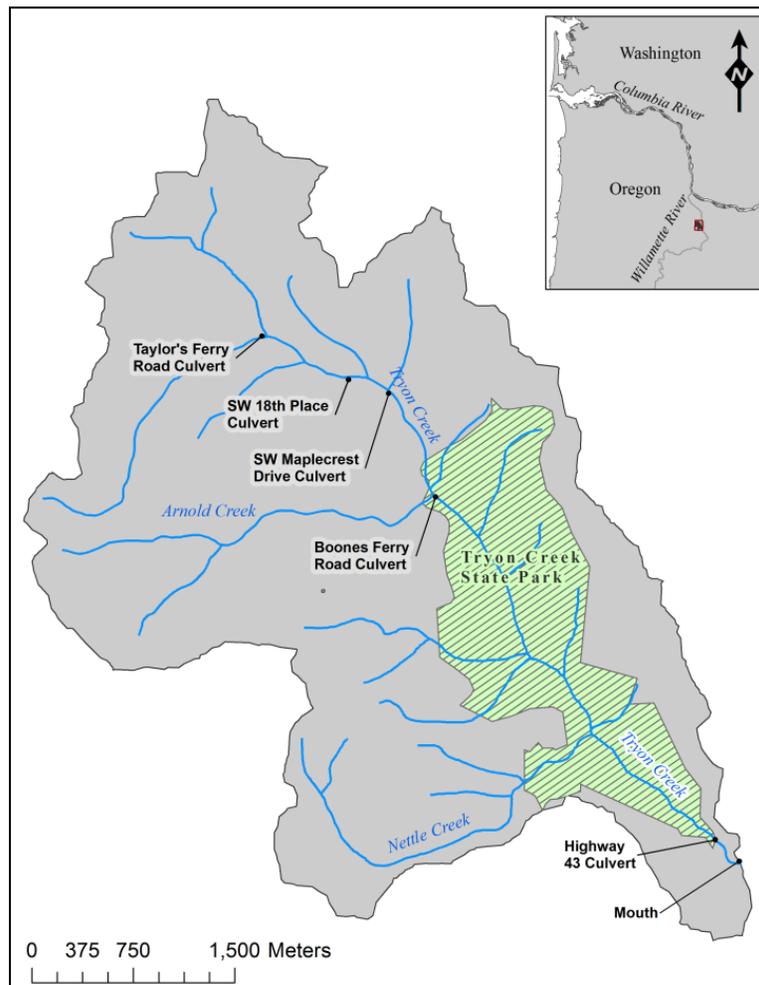
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- NG6 Increase Staffing Levels, Technical Capabilities, and Natural and Physical Assets to Fully Meet Our Mission
  - O6.3 Enhance scientific capacity and technological tools necessary for conservation and management
  
- NG7 Educate and Engage the Public and our Partners to Advance our Conservation Mission
  - O7.1 Use communication tools to engage and educate the public in the Service's conservation mission
  - O7.2 Conduct hands-on community-based recreation and education programs to engage the public in outdoor recreational activities and the Service's conservation mission
  - O7.3 In partnership with other federal agencies, states, tribes, and the private sector, develop and implement a comprehensive and unified national public outreach and education strategy

# Tryon Creek Restoration Monitoring

## Study Area

Tryon Creek is a 7.8 km, second order tributary to the Willamette River located in southwest Portland, OR (Figure 1). Its watershed covers 16.8 km<sup>2</sup> in Multnomah and Clackamas counties and its headwaters are located within suburban neighborhoods. The mainstem flows approximately 4 km through privately owned land including culverts at Taylor's Ferry Road, SW 18th Place, SW Maplecrest Drive, and a perched pipe culvert at Boones Ferry Road before entering Tryon Creek State Natural Area. Tryon Creek State Natural Area is a 2.59 km<sup>2</sup> area of public land through which the stream flows another 3.5 km. A baffled box culvert bisects the lower portion of Tryon creek at Oregon State Highway 43 and a railroad near the mouth of Tryon Creek. The lowest portion of Tryon Creek flows 0.3 km through public land owned by the City of Lake Oswego and the City of Portland (confluence area) before entering the Willamette River at river kilometer 32.



**Figure 1. Tryon Creek watershed and major culverts.**

## Tryon Creek Restoration Monitoring

The Highway 43 culvert was constructed in the late 1920s. It is approximately 122 m (401 ft.) long with a drop of nearly 6.7 m (22 ft.) from top to bottom, resulting in an average grade of 4.6% (Figure 2). Baffles located within the Highway 43 culvert provide structure, holding water for fish attempting to migrate upstream (Figure 3).

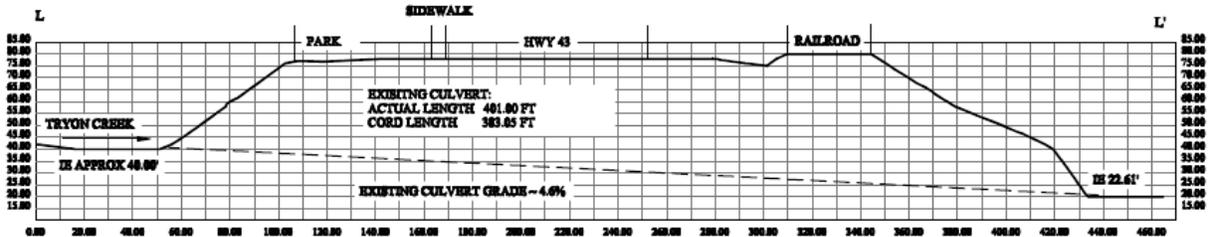


Figure 2. Longitudinal profile of Tryon Creek culvert under Oregon State Highway 43 (Henderson Land Services 2007).



Figure 3. Modified baffles were installed in the Highway 43 culvert to improve fish passage (2008).

# Tryon Creek Restoration Monitoring

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## Methods

### *Below the Highway 43 Culvert - Confluence Sampling*

#### *Fish Collection*

Sampling in the confluence area occurred monthly July to March, and weekly April to June for the City of Portland's 2012 - 2013, 2014 - 2015, and 2016 - 2017 fiscal years. Monthly sampling occurred from July to December in 2019. Backpack electrofishing was conducted as described by Silver et al. 2016 from the mouth of Tryon Creek to the downstream edge of the Highway 43 culvert pool (Figure 4). The pool below the Highway 43 culvert was sampled with a seine in two passes as described by Silver et al. 2016.

At the completion of each sampling method, we anesthetized all captured fish in a bath containing 60 mg/l MS-222 and 60 mg/l sodium bicarbonate until we observed complete loss of equilibrium (3-4 minutes). Each fish was identified, checked for any external markings, measured (fork length), weighed (grams), and scanned for a PIT tag. We tagged all non-injured salmonids over 70 mm fork length if a PIT tag was not detected. We released all fish back into their capture reach after full recovery within an aerated bucket. Genetic samples collected from salmonids are archived at the USFWS Columbia River Fish and Wildlife Conservation Office.

#### *Relative Abundance*

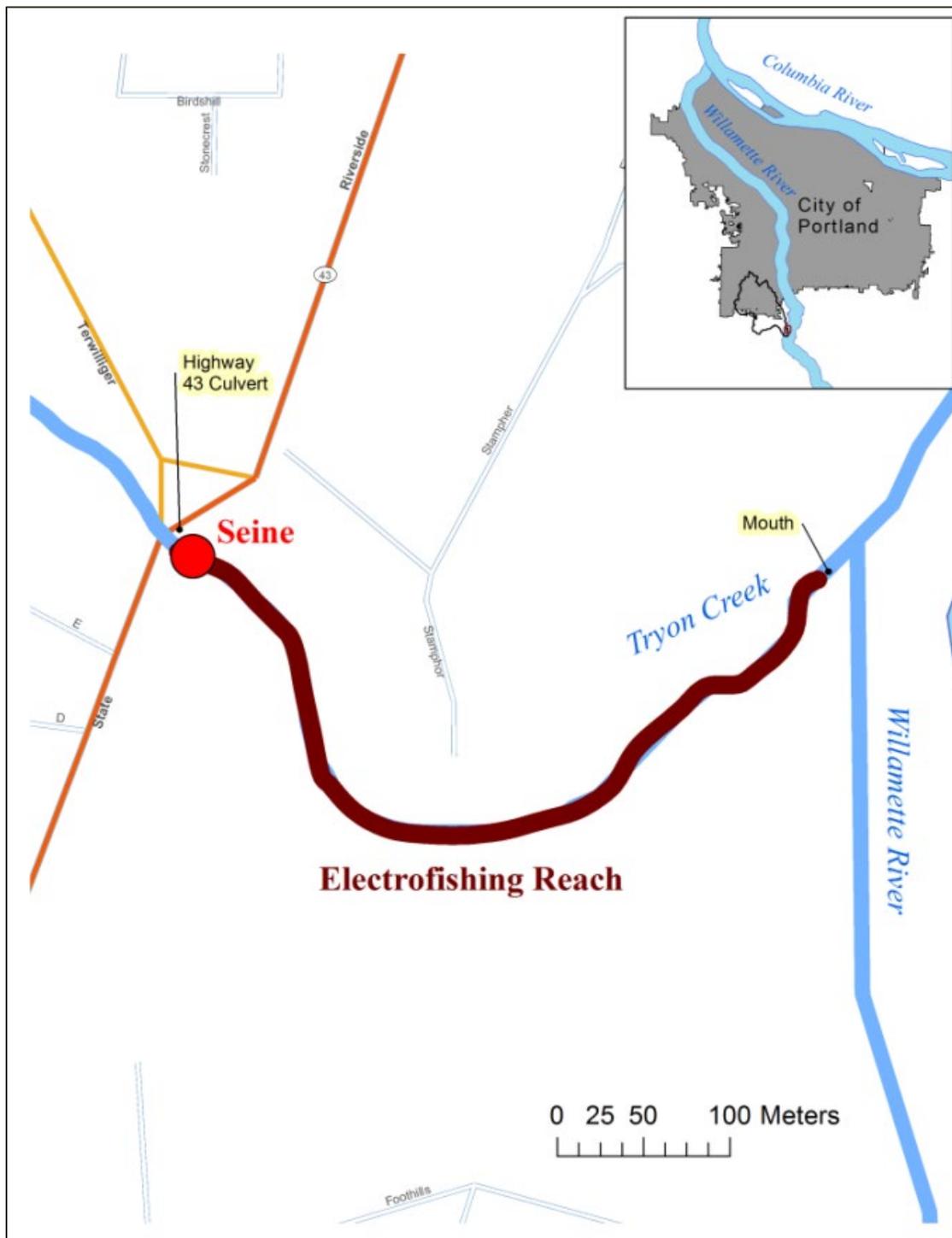
We used catch per unit effort (CPUE) to determine fish abundance trends in the confluence habitat. It is an index of relative abundance, which is often related to absolute abundance (Hubert and Fabrizio 2007; Pope et al. 2010). Theoretically, CPUE will increase with an increase in population size or abundance ( $N$ ), assuming catch ( $C$ ), effort ( $E$ ), and catchability ( $q$ ) remain relatively constant.

$$CPUE = \frac{C}{E} = Nq$$

If catchability varies (i.e. by season, number of crewmembers, temperature, time of day, flow, etc.) it could influence the abundance estimate.

Catch per unit effort was calculated differently for electrofishing and seining. For electrofishing, we recorded total sample time (in seconds) at the end of each survey. We then divided the total number of fish collected during the electrofishing survey by the number of seconds the survey lasted. For each seine, we divided the total number of fish collected by sampled pool volume in  $m^3$  (pool width x pool length x seine max depth). Seine CPUE was averaged each sample event.

# Tryon Creek Restoration Monitoring



**Figure 4. Tryon Creek confluence area monitoring reach**

## *Community*

We used the ratio of native to introduced fish, species richness (Simpson Diversity Index), and relative abundance versus frequency of occurrence (ecological classification) to describe fish community.

# Tryon Creek Restoration Monitoring

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## Native to Introduced Fish Ratio

All fish captured were categorized as “native” or “introduced” according to the Willamette Basin Atlas (Hulse et al. 2002). We calculated the proportion of native species to introduced species for both richness (number of species present) and abundance (number of fish present).

## Species Richness

The Simpson (1-D) Diversity Index is an index of species richness, or number of species within a sample area as well as the relative abundance of each species.

$$D = 1 - \left( \frac{\sum n(n-1)}{N(N-1)} \right)$$

Where  $n$  is the number of individuals from one particular species and  $N$  is the total number of individuals found. The index approaches 1.0 when numbers of individuals collected are evenly distributed among the number of species present (evenness of abundance). Biodiversity analysis was calculated each confluence sample event.

## Ecological Classification

All species encountered in the confluence were ecologically classified according to relative abundance and percent frequency of occurrence (González-Acosta 1998; González-Acosta et al. 2005). This method of classification is based on Olmstead-Tukey’s test (Sokal and Rohlf 1969) and allows an ecological and quantitative classification of the species in each area (González-Acosta et al. 2005). The analysis results in the division of species present into four ecological categories (dominant, common, occasional, and rare) represented by quadrants of a scatter plot that is divided by two axes identifying the mean frequency of occurrence and mean relative abundance for a specific area.

## *Residence Time*

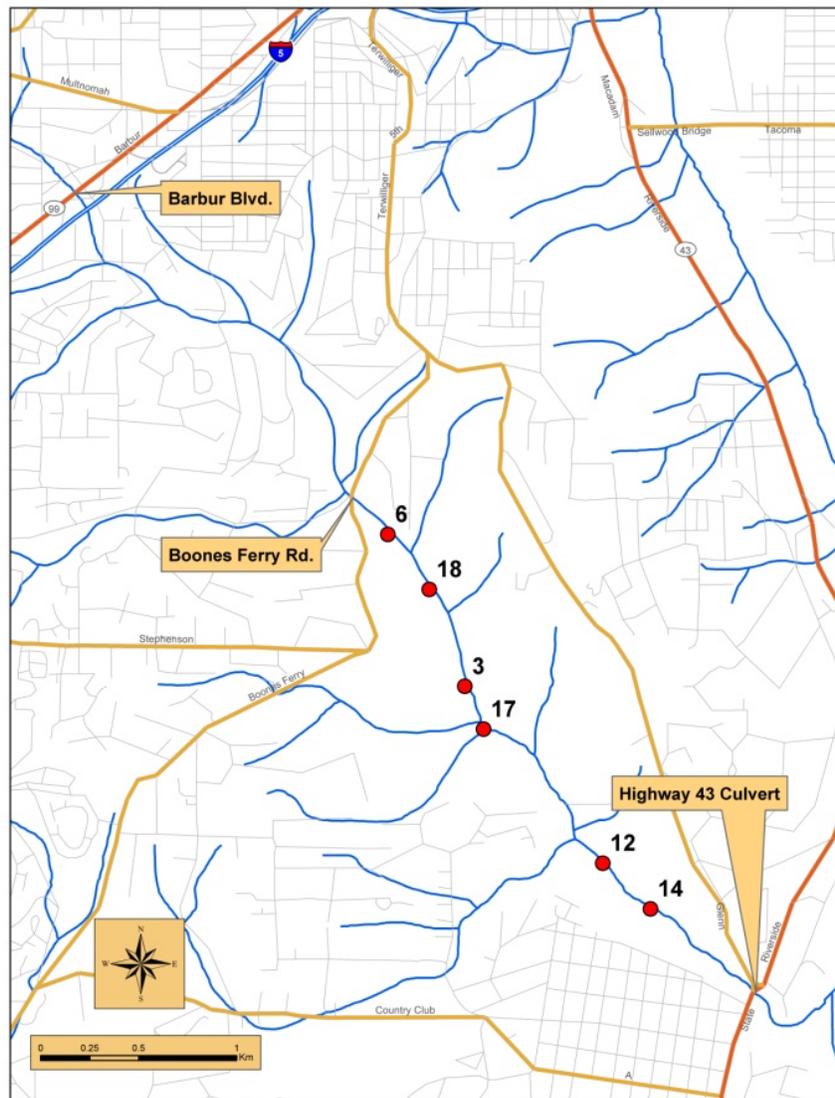
We installed PIT tag antennas at the mouth of Tryon Creek in November 2011 (TCM). Efficiency was calculated in 2014 as described in Silver et al. (2015). PIT-tagged fish moving over or through these antennas had the opportunity to be detected and identified. The PIT tag code and time of detection was logged on a Biomark Multiplexing Transceiver (FS 1001M) from which data was downloaded on a monthly basis and uploaded to the Columbia Basin PIT Tag Information System (PTAGIS) online database. We queried PTAGIS to identify fish detected in Tryon Creek that were tagged and released by other agencies between 2012 and 2019. For all fish tagged in Tryon Creek, we used PTAGIS to query for detections at all interrogation sites in the Columbia River Basin.



# Tryon Creek Restoration Monitoring

## *Lamprey Occupancy*

We assessed occupancy of larval Pacific and Western Brook Lamprey in Tryon Creek with an annual electrofishing survey. Detailed methods are described in Silver et al. (2013). In brief, we sampled the entire reach from the mouth of Tryon Creek to the Highway 43 culvert each year (except 2008) 2005 - 2017. Between the Highway 43 culvert and Boones Ferry Road, six 50 m-long, randomly selected, spatially-balanced reaches were sampled each July 2009 - 2016 (Figure 6).



**Figure 6. Lamprey survey sites in Tryon Creek between the Highway 43 culvert and Boones Ferry Road (2009-2016).**

# Tryon Creek Restoration Monitoring

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## Results

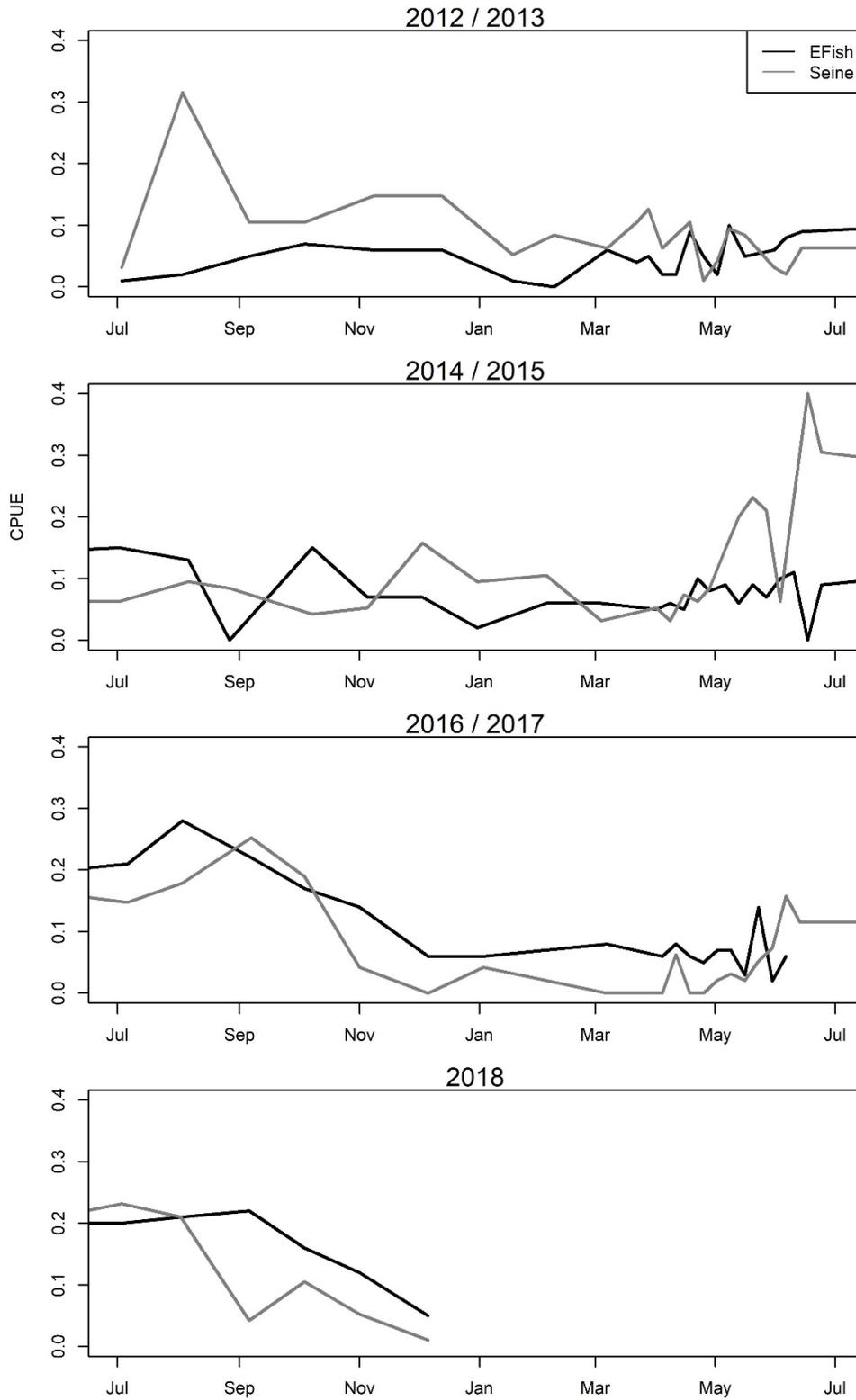
### *Below the Highway 43 Culvert - Confluence Sampling*

#### *Relative Abundance*

We sampled the confluence habitat on 68 occasions from 7/3/2012 to 12/6/2018/2017. The habitat showed seasonal variation of water temperature and flow. In the spring and summer (March - August) it was warm (mean = 12.7 °C) and flowing slowly (mean = 4.19 cfs); in the fall and winter (September - February) it was cold (mean 8.4 °C) with higher flows (mean = 5.5 cfs) (USGS 2018; Appendix A). Beaver dams constructed in the summers of 2014, 2016, and 2018 washed away during October storm events. These beaver dams did not appear to prohibit fish passage, as untagged migratory fish were present upstream in the pool below the Highway 43 culvert.

Electrofishing effort ranged from 369 seconds to 1,547 seconds, seine effort was the same (pool volume = 225 m<sup>3</sup>, two hauls) for all events except 4/4/2017 where only one seine haul was completed (Appendix A). Mean electrofishing CPUE ( $\pm$  SE) was  $0.08 \pm 0.007$  and mean seine CPUE ( $\pm$  SE) was  $0.10 \pm 0.01$  (Figure 7).

# Tryon Creek Restoration Monitoring

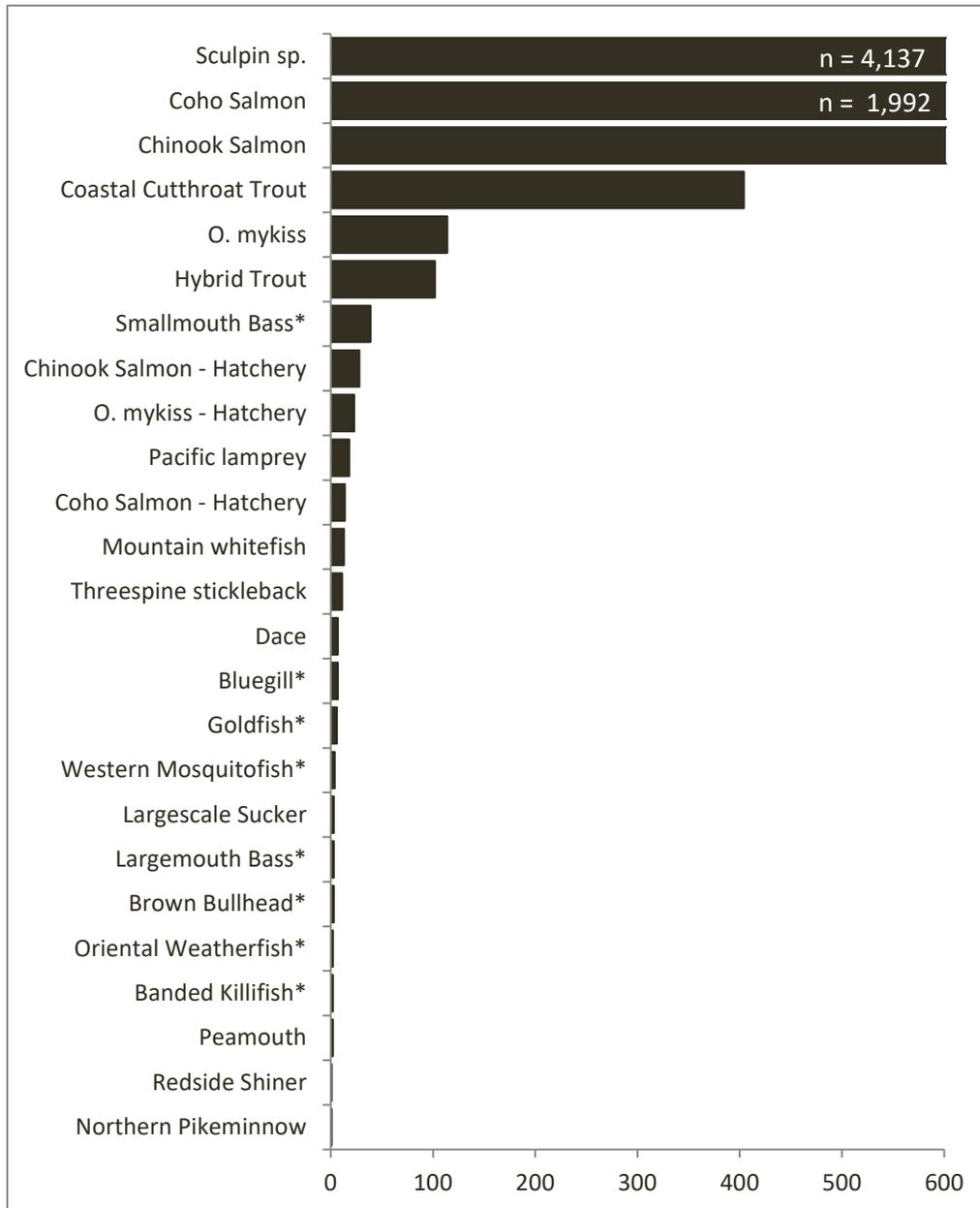


**Figure 7. Catch per unit effort (CPUE) for all sample events in the Tryon Creek confluence habitat 2012 - 2018.**

## Tryon Creek Restoration Monitoring

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Sculpin (*Cottus spp.*) are the most abundant family followed by salmonids: Coho Salmon, Chinook Salmon, Coastal Cutthroat Trout, hybrid trout, and *O. mykiss* (Figure 8). Genetic samples collected from salmonids were either archived at the CRFWCO or sent to Abernathy Fish Technology Center for analysis (n = 988) (Table 1).



**Figure 8. Total fish captured in the Tryon Creek Confluence habitat 2012 - 2018.**  
**\*Introduced species**

## Tryon Creek Restoration Monitoring

**Table 1. Genetic Samples collected below the Highway 43 culvert 2013 – 2018**

Species	2013	2014	2015	2016	2017	2018
Coastal Cutthroat Trout	5	1	6	--	1	--
Chinook Salmon	56	54	31	21	33	26
Chinook Salmon-Hatchery	4	1	--	--	2	--
Coho Salmon	103	68	334	65	40	76
Coho Salmon - Hatchery	2	1	--	--	--	--
Hybrid Trout	12	--	--	--	--	--
Pacific Lamprey	--	1	10	2	--	--
<i>O. mykiss</i>	14	1	4	--	10	--
Trout Fry	4	--	--	--	--	--

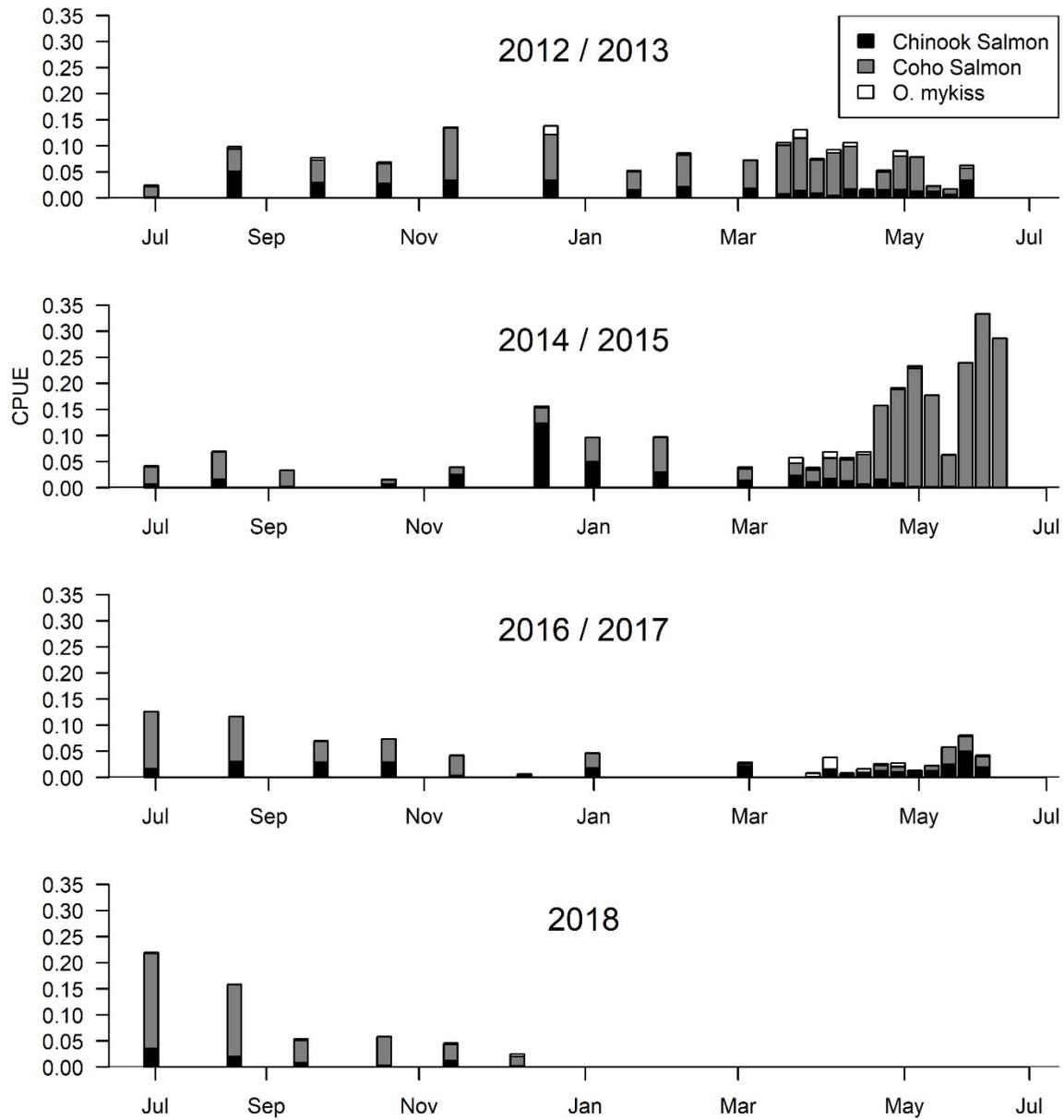
We recaptured 34% (505/1,466) of PIT-tagged fish at least once. The recapture rate of juvenile migratory fish, Chinook Salmon and Coho Salmon, was 0.21 and 0.36 respectively, and the recapture rate of *O. mykiss* was 0.27. The recapture rate of resident fish, such as Coastal Cutthroat and hybrid trout, was 0.54 and 0.73, respectively. We did not recapture trout fry or Mountain Whitefish (Table 2).

**Table 2. Number of PIT-Tagged and recaptured salmonids below the Highway 43 culvert 2012 - 2018**

Species	# PIT Tagged	# Recap	Recapture Rate (Recaptured/Tagged)	Size Class	Life History
Coastal Cutthroat Trout	143	77	0.54	Adult/Juvenile	Resident/Migrant
Chinook Salmon	317	66	0.21	Juvenile	Migrant
Coho Salmon	870	317	0.36	Juvenile	Migrant
Hybrid Trout	30	22	0.73	Adult/Juvenile	Resident
Mountain Whitefish	6	0	0	Juvenile	Migrant
<i>O. mykiss</i>	85	23	0.27	Adult/Juvenile	Migrant/Resident
Trout Fry < 100 mm	15	0	0	Juvenile	Resident/Migrant

Hatchery-produced salmonids are marked with an adipose fin clip to facilitate distinction from naturally-produced salmonids. The majority (97.7%) of juvenile anadromous salmonids (*O. tshawytscha*, *kisutch* and *mykiss*) captured below the Highway 43 culvert were of natural origin (2,715/2,780). At the mouth of Tryon Creek, juvenile Chinook Salmon, juvenile Coho Salmon, and juvenile *O. mykiss* were present throughout the year with CPUE peaking in the winter and spring months (Figure 9).

# Tryon Creek Restoration Monitoring



**Figure 9. Total catch per unit effort (CPUE) of wild migratory salmonids sampled below Highway 43 culvert 2012 -2018**

# Tryon Creek Restoration Monitoring

## Community

### Native to Introduced Fish Ratio

Sampling efforts below the Highway 43 culvert resulted in the capture of native and introduced fish. The fish community below the Highway 43 culvert included 22 species numbering 7,545 total fish between 2012 and 2018 (this includes unmarked, marked, and recaptured fish) (Table 3, Appendix B). Native fish comprised 64% (14/22) of the species captured and 99% (7,479/7,545) of the individuals captured.

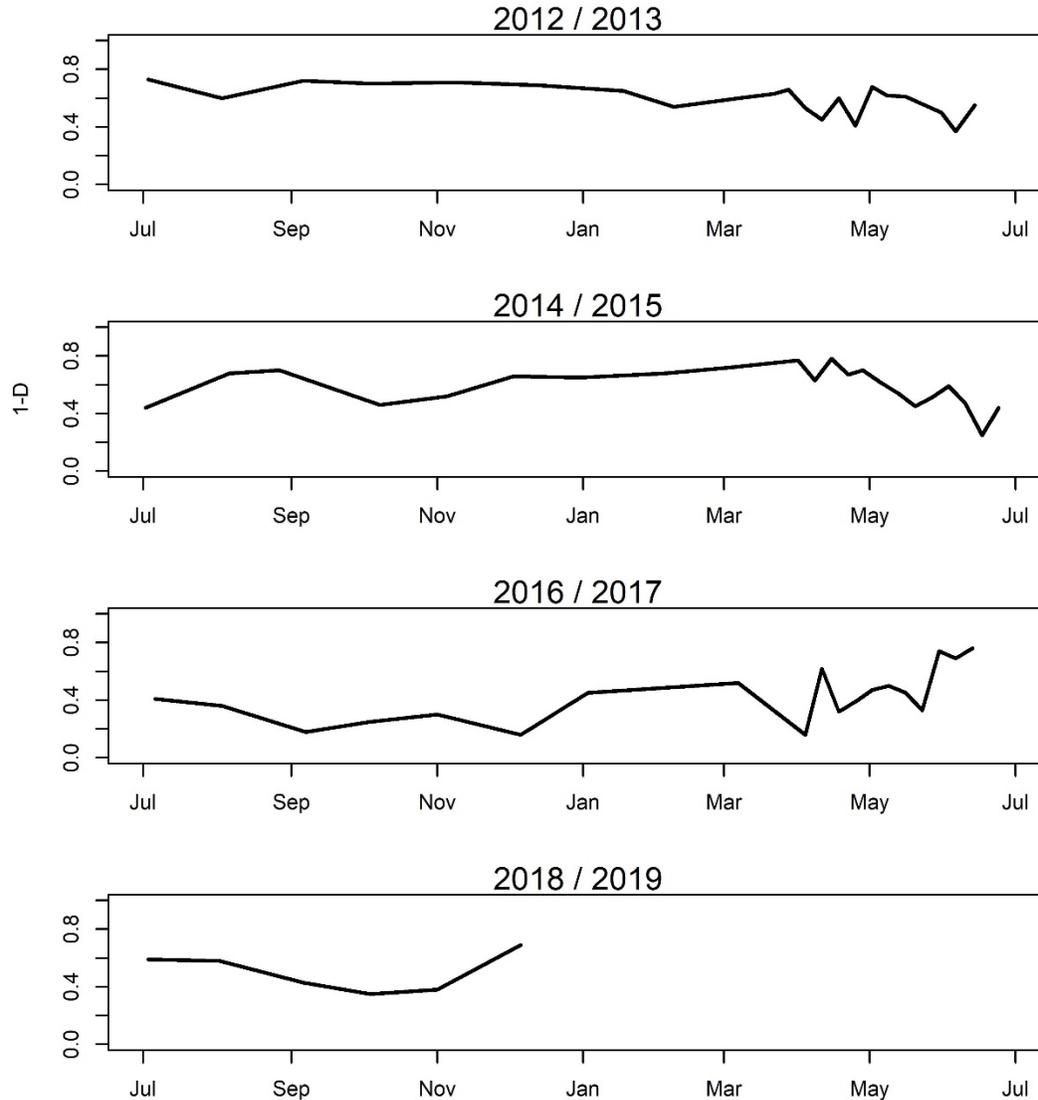
**Table 3. All species captured in the Tryon Creek Confluence Habitat 2012 - 2018. N = Native, I = Introduced**

<b>Family</b>	<b>Genus species</b>	<b>Common Name</b>	<b>Species Abbreviation</b>	<b>Origin (Native/ Introduced) (Hulse 2002)</b>
Catostomidae	<i>Catostomus sp.</i>	Sucker	SUK	N
Centrarchidae	<i>Lepomis macrochirus</i>	Bluegill	BG	I
	<i>Micropterus dolomieu</i>	Smallmouth Bass	SMB	I
	<i>Micropterus salmoides</i>	Largemouth Bass	LMB	I
Cobitidae	<i>Misgurnus anguillicaudatus</i>	Oriental Weatherfish	OW	I
Cottidae	<i>Cottus sp.</i>	Sculpin	SCP	N
Cyprinidae	<i>Carassius auratus</i>	Goldfish	GF	I
	<i>Mylocheilus caurinus</i>	Peamouth	PEA	N
	<i>Ptychocheilus oregonensis</i>	Northern Pikeminnow	NPM	N
	<i>Rhinichthys sp.</i>	Longnose Dace	DCE	N
	<i>Richardsonius balteatus</i>	Redside Shiner	RSN	N
Cyprinodontidae	<i>Fundulus diaphanus</i>	Banded Killifish	BKF	I
Gasterosteidae	<i>Gasterosteus aculeatus</i>	Threespine Stickleback	SKB	N
Ictaluridae	<i>Ameiurus nebulosus</i>	Brown Bullhead	BBH	I
Petromyzontidae	<i>Entosphenus tridentatus</i>	Pacific Lamprey	PCL	N
Poeciliidae	<i>Gambusia affinis</i>	Western Mosquitofish	MQF	I
Salmonidae	<i>Oncorhynchus clarki</i>	Coastal Cutthroat Trout	CCT	N
	<i>Oncorhynchus clarki/mykiss</i>	Cutthroat/ <i>O. mykiss</i> hybrid	HYB	-
	<i>Oncorhynchus kisutch</i>	Chinook Salmon	CHN	N
	<i>Oncorhynchus mykiss</i>	Steelhead/Rainbow Trout	OMY	N
	<i>Oncorhynchus tshawytscha</i>	Coho Salmon	COHO	N
	<i>Prosopium williamsoni</i>	Mountain Whitefish	WHF	N

# Tryon Creek Restoration Monitoring

## Species Richness

The Simpson Diversity Index was calculated for all fish captured each confluence sample event. The mean Simpson (1-D) Diversity Index ( $\pm$  SE) was  $0.53 \pm 0.02$  and ranged from 0.17 to 0.78 (Figure 10, Appendix C).

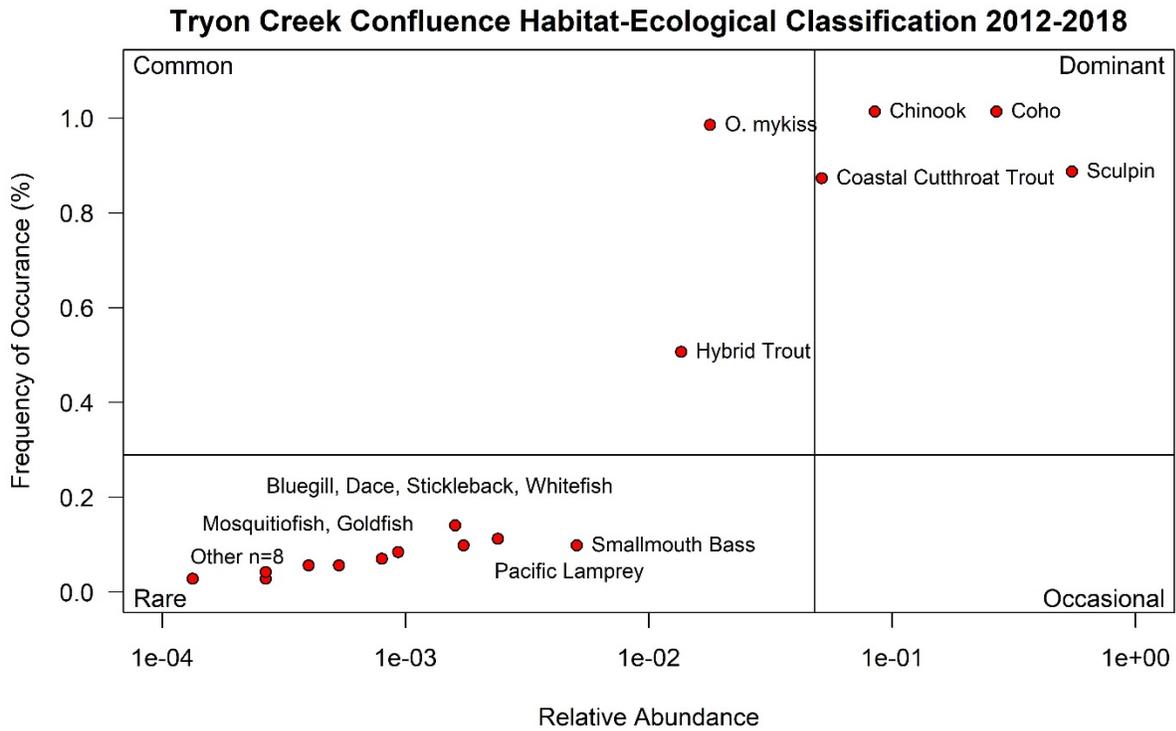


**Figure 10. Simpson Diversity Index (1-D) below Highway 43 culvert 2012-2018**

## Ecological Classification

Ecological classification indicates Coho Salmon, Chinook Salmon, Coastal Cutthroat Trout and species of sculpin are dominant species because their capture is relatively frequent and they are relatively abundant when captured (Figure 11). We captured common species, *O. mykiss* and hybrid trout, less frequently and in smaller numbers; all other species classified rare because we captured them infrequently and in small numbers. The ecological classification of each species remained the same each year.

# Tryon Creek Restoration Monitoring



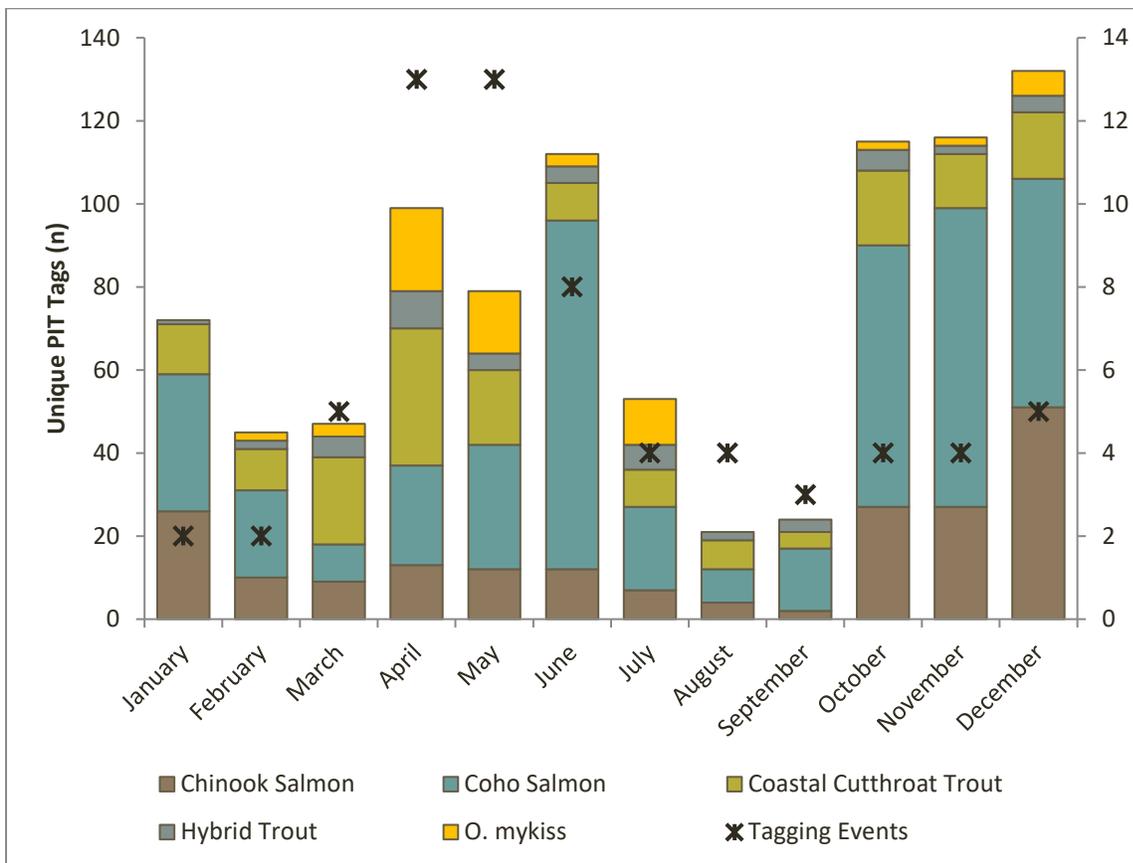
**Figure 11. Ecological Classification of species captured 2012 - 2018.**

# Tryon Creek Restoration Monitoring

## Residence Time

We installed the Tryon Creek Mouth (TCM) antenna site in November 2011, which monitored for PIT tags until July 2013. In February 2014, we reinstalled antennas and they were operational until a high water event (>600 cfs) washed out all but one antenna in December 2015. We installed replacements for two antennas in February 2016. A high flow event (>200 cfs) in October 2016 severed the cable for one antenna and was repaired that same month.

The site had 78,729 detections of 764 unique PIT tags. Of these unique detections, 81% (619/764) were PIT tags implanted in juvenile migratory salmonids (Chinook, Coho, and *O. mykiss*). The majority (735/764, 96.2%) of all PIT tags detected were from fish tagged in Tryon Creek below the Highway 43 culvert. The peak of unique detections per month occurred in June for Coho Salmon and December for Chinook Salmon (Figure 12).



**Figure 12. Number of unique PIT tag detections by month and species 2012 – 2018. Asterisks indicate total tagging events each month for all years.**

## Tryon Creek Restoration Monitoring

Detections of PIT tags (n = 619) from juvenile anadromous salmonids (Chinook, Coho, and *O. mykiss*) below the Highway 43 culvert were detected by a TCM antenna a median 16 days after initial tagging date. PIT tags from salmonids exhibiting both resident and anadromous behaviors (i.e., Coastal Cutthroat Trout and hybrid trout) (n = 145) were detected by a TCM antenna a median 182 days after tagging. Overall, juvenile anadromous salmonids had the shortest residence times (Table 4).

**Table 4. Median number of days between first PIT tag date and last detection date below the Highway 43 culvert 2012 – 2018**

<b>Year</b>	<b>Coastal Cutthroat Trout</b>	<b>Chinook Salmon</b>	<b>Coho Salmon</b>	<b>Hybrid Trout</b>	<b><i>O. mykiss</i></b>
2012	611.5	9.0	5.5	358.0	117.0
2013	197.0	510.0	554.5	212.5	227.5
2014	260.0	9.5	18.5	115.0	174.0
2015	54.0	15.0	11.0	27.0	16.0
2016	--	44.5	15.0	323.0	--
2017	162.0	10.0	26.0	--	11.0
2018	117.0	29.0	117.0	--	28.5
<b>Mean</b>	<b>233.6</b>	<b>89.6</b>	<b>106.8</b>	<b>207.1</b>	<b>95.7</b>

### *Movement*

Between 2012 and 2018, the TCM antenna site detected 30 salmonids PIT-tagged and released upstream in tributaries to the Willamette River, none of these fish were detected again after exiting Tryon Creek. Interrogation sites in the Columbia River detected seventeen salmonids after they were PIT-tagged in Tryon Creek; five were detected in the Lower Columbia River, two were detected at Eagle Creek National Fish Hatchery and nine were mortalities on the East Sand Island Avian Colony (Table 5, Figure 13). One adult Chinook was detected upstream in the Clackamas River three years after being tagged as an out-migrating juvenile in Tryon Creek.

## Tryon Creek Restoration Monitoring

**Table 5. Salmonid movement before or after detection in the Tryon Creek confluence. Gray shading indicates fish tagged in Tryon Creek, no shading indicates fish tagged outside of Tryon Creek. No fish were detected at more than one observation site.**

Release Year	Observation Year	Species Name	Release Site Name	Observation Site Name	Number of Fish
2012	2013	Coho	Tryon Creek	Eagle Creek NFH	1
	2014	Steelhead	Tryon Creek	East Sand Island	1 (Mortality)
	2012	Chinook-Hatchery	Middle Fork Willamette	Tryon Creek	4
2013	2013	Coho	Tryon Creek	Estuary Towed Array	2
	2013	Hybrid Trout	Tryon Creek	East Sand Island	1 (Mortality)
	2013	Steelhead	Tryon Creek	Estuary Towed Array	1
	2013	Chinook	Willamette River	Tryon Creek	1
	2014	Chinook-Hatchery	North Santiam River	Tryon Creek	1
	2014	Coho	Tryon Creek	Eagle Creek NFH	1
	2014	Steelhead	Tryon Creek	East Sand Island	1 (Mortality)
2014	2014	Chinook-Hatchery	North Santiam River	Tryon Creek	8
	2015	Chinook-Hatchery	North Santiam River	Tryon Creek	3
2015	2015	Chinook	Tryon Creek	East Sand Island	1 (Mortality)
	2015	Coho	Tryon Creek	East Sand Island	2 (Mortality)
	2015	Cutthroat Trout	Tryon Creek	Estuary Towed Array	1
	2015	Steelhead-Hatchery	South Santiam River	Tryon Creek	2
	2015	Steelhead-Hatchery	Tryon Creek	East Sand Island	1 (Mortality)
	2015	Steelhead	Tryon Creek	Estuary Towed Array	1
	2016	Chinook	McKenzie River	Tryon Creek	1
	2016	Chinook-Hatchery	North Santiam River	Tryon Creek	2
	2017	Coho	Tryon Creek	East Sand Island	1 (Mortality)
	2018	Chinook	Tryon Creek	Clackamas River Mill Dam adult ladder	1
2016	2016	Chinook-Hatchery	Detroit Dam Forebay	Tryon Creek	1
	2016	Chinook	Leaburg Dam Bypass	Tryon Creek	1
	2016	Chinook-Hatchery	North Santiam River	Tryon Creek	1
	2016	Coho	Sullivan Dam Bypass	Tryon Creek	3
	2016	Steelhead	Sullivan Dam Bypass	Tryon Creek	1
	2017	Chinook-Hatchery	North Santiam River	Tryon Creek	1
2017	2018	Coastal Cutthroat	Tryon Creek	East Sand Island	1 (Mortality)

## Tryon Creek Restoration Monitoring



**Figure 13. Detections of PIT-tagged salmonids before or after detection in Tryon Creek 2012 - 2018. Chinook Salmon, Coho Salmon, *O. mykiss*, Cutthroat Trout, and hybrid trout tagged in Tryon Creek were detected outside of the Tryon Creek Watershed in the Lower Columbia River Basin. The Tryon Creek Mouth antenna (TCM) detected Chinook Salmon, Coho Salmon, and *O. mykiss* released upstream in tributaries to the Willamette River.**

### ***Above the Highway 43 Culvert - Abundance Estimate***

The most recent single-pass abundance survey occurred in 2017 (Silver et al. 2018). The estimated abundance of trout (Coastal Cutthroat Trout and *O. mykiss* hybrids) > 100 mm above the Highway 43 culvert and below the Boones Ferry Road culvert was 424 (95% CI [351, 520]) individuals, the estimated density was 0.026 (95% CI [0.021, 0.032]) individuals/ m<sup>2</sup> (Table 6, Figure 14). The estimated abundance of trout above the Boones Ferry Road culvert and below the SW Maplecrest Drive culvert was 113 (95% CI [87, 157]) individuals, the estimated density was 0.023 (95% CI [0.018, 0.032]) individuals/ m<sup>2</sup> (Table 7, Figure 14). Mean density of trout below Boones Ferry Road is 0.031 individuals/m<sup>2</sup>, the 2017 estimate was 16% less than the mean. Mean abundance of trout above Boones Ferry Road is 0.022 individuals/m<sup>2</sup>, the 2017 estimate was 5% greater than the mean. Capture probabilities were not significantly different above and below the Boones Ferry road. A length/frequency histogram of trout in Tryon Creek shows a range of sizes from 100 mm to 292 mm for all abundance estimates conducted 2008 – 2017 (Figure 15).

## Tryon Creek Restoration Monitoring

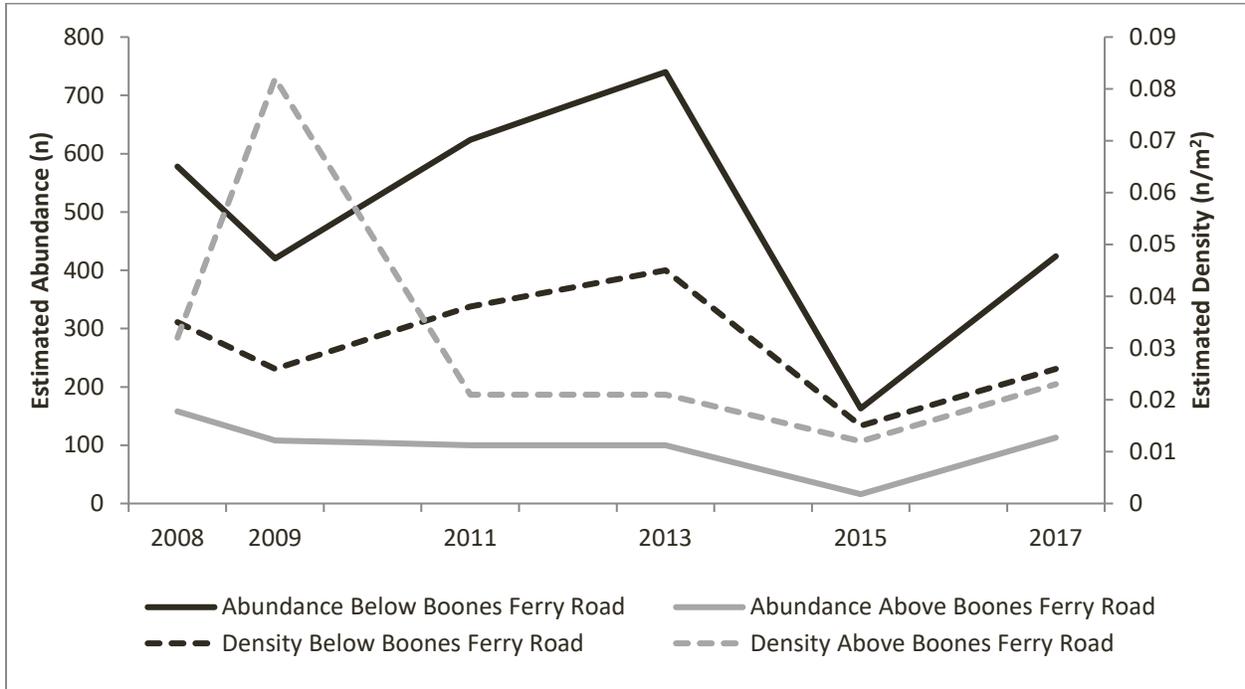
**Table 6. Abundance and density estimates for trout (Coastal Cutthroat Trout and Hybrids) above the Highway 43 culvert and below the Boones Ferry Road culvert. Area = the estimated area sampled by backpack electrofishing,  $1p_i$  = capture probability in the first pass,  $p_i$  was only calculated in years when two pass surveys were conducted.**

Year	Area (m <sup>2</sup> )	$1p_i$	Abundance	Density (Fish/m <sup>2</sup> )
2008	16,314	0.28 (0.22 – 0.36)	578 (458 – 754)	0.035 (0.028 – 0.046)
2009	16,314		420 (347 – 515)	0.026 (0.021 – 0.032)
2011	16,314	0.21 (0.15 – 0.28)	624 (465 – 880)	0.038 (0.028 – 0.054)
2013	16,314		740 (612 – 907)	0.045 (0.038 – 0.056)
2015	10,981	0.23 (0.13 – 0.34)	163 (108 – 275)	0.015 (0.010 – 0.025)
2017	16,314		424 (351 – 520)	0.026 (0.021 – 0.032)

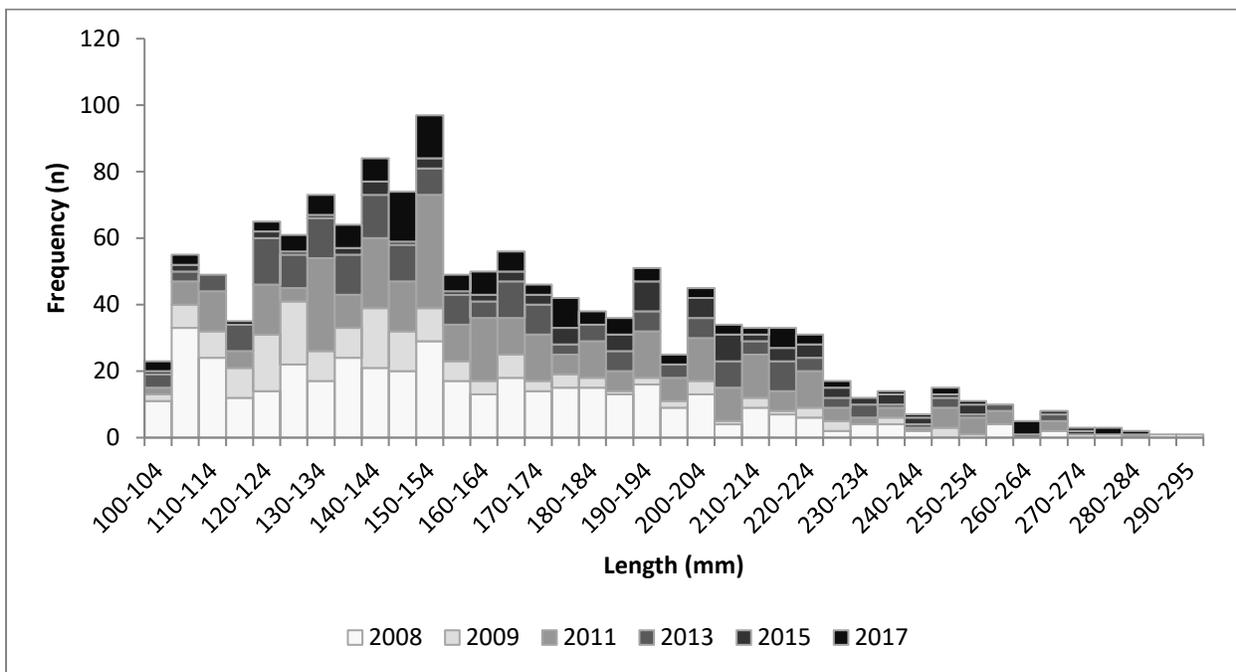
**Table 7. Abundance and density estimates for trout (Coastal Cutthroat Trout and Hybrids) above the Boones Ferry Road culvert and below the SW Maplecrest Drive culvert. Area = the estimated area sampled by backpack electrofishing,  $1p_i$  = capture probability in the first pass,  $p_i$  was only calculated in years when two pass surveys were conducted.**

Year	Area (m <sup>2</sup> )	$1p_i$	Abundance	Density (Fish/m <sup>2</sup> )
2008	4,866	0.39 (0.28 – 0.51)	158 (121 – 221)	0.032 (0.025 – 0.045)
2009	4,866		108 (83 – 150)	0.022 (0.017 – 0.031)
2011	4,866	0.32 (0.18 – 0.49)	100 (66 – 179)	0.021 (0.014 – 0.037)
2013	4,866		100 (77 – 139)	0.021 (0.016 – 0.029)
2015	1,312	0.45 (0.18 – 0.74)	16 (10 – 38)	0.012 (0.007 – 0.029)
2017	4,866		113 (87 – 157)	0.023 (0.018 – 0.032)

# Tryon Creek Restoration Monitoring



**Figure 14. Estimated abundance and density of trout above the Highway 43 culvert. Estimates are divided between the Highway 43 culvert to below the Boones Ferry Road culvert and above the Boones Ferry Road culvert to the SW Maplecrest Drive culvert 2008 – 2017**



**Figure 15. Length-frequency histogram of trout captured in Tryon Creek above the Highway 43 culvert and below the SW Maplecrest Drive culvert 2008 – 2017**

## Tryon Creek Restoration Monitoring

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### *Lamprey Occupancy*

Between 2005 and 2012, 29 larval Pacific Lamprey, one western brook lamprey and 6 larval lamprey of unknown species were caught below the Highway 43 culvert and zero were caught above the Highway 43 culvert (Table 8). In 2013, 1,046 larval Pacific Lamprey were tagged and released into Tryon Creek above the Highway 43 culvert. That same year, all six lamprey collected above Highway 43 culvert had visible VIE tags. Lamprey collected above the Highway 43 culvert in 2014 and 2015 did not have visible VIE tags, however, based on the size and location of the larvae as well as the challenges adults would encounter to migrate upstream through the Highway 43 culvert, it is most likely that they were larvae from the 2013 outplanting. During the 2016 larval lamprey occupancy survey, one larval Pacific Lamprey and two Oriental Weatherfish (*Misgurnus anguillicaudatus*), were caught below the Highway 43 culvert and zero lamprey were captured above the Highway 43 culvert. In 2017, one larval Pacific Lamprey was caught below the Highway 43 culvert; occupancy sampling above the culvert did not occur. No lamprey sampling occurred in 2018. Overall, larval Pacific Lamprey have been detected 8 out of the 12 years of sampling below the Highway 43 culvert.

**Table 8. Number of larval Pacific Lamprey collected above and below the Highway 43 culvert 2005-2017.**

Sample Year	Below the Highway 43 Culvert	Above the Highway 43 Culvert
2005	1 (+ 6 unidentified larvae)	N/A
2006	26	N/A
2007	0 (+1 Western Brook Lamprey)	N/A
2009	0	0
2010	0	0
2011	2	0
2012	0	0
2013	4	6
2014	1	1
2015	10	2
2016	1	0
2017	1	N/A

# Tryon Creek Restoration Monitoring

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## Findings

The Tryon Creek confluence continues to support native fish, predominantly salmonids during their juvenile life history stages and all life history stages of Coastal Cutthroat Trout. Native fish species were the most abundant, resident fish were present throughout the year, and out-of-basin juvenile salmonids were captured or detected below the Highway 43 culvert. Next year, 2019, we will conclude our sampling of migratory and residential fish use of Tryon Creek before future culvert replacement takes place.

Below the Highway 43 culvert, we have identified 14 native species and 8 introduced species in Tryon Creek to date (2012 - 2018); the Willamette Basin contains 31 native species and 29 introduced species (Hulse et al. 2002). Our ecological classification in the confluence habitat indicated all native species are dominant or common, which suggests conditions are suitable for native species below the Highway 43 culvert. Currently, all fish species above the Highway 43 culvert are native. Planned improvements to passage conditions under the Highway 43 culvert may permit the possible movement of introduced species upstream into the Tryon watershed. It will be valuable to sample above the Highway 43 culvert to document potential changes in species distribution after passage improvements are completed.

We found both juvenile and adult Chinook and Coho Salmon utilizing the Tryon Creek confluence as part of their migration. Because there is no evidence of anadromous salmonids spawning upstream of the Highway 43 culvert, we can conclude juvenile Chinook and Coho Salmon originate from other locations in the Willamette River basin. In February 2017, the USGS reported the highest flows (837 cfs) in the Willamette River since our confluence sampling began in 2012 (USGS 2017). That same spring, we observed Chinook Salmon fry (age-0, < 40 mm) which may have been displaced from their natal streams by high water (Hartman et al. 1982). However, we did not capture as many juvenile Coho overwintering in the pool below the Highway 43 culvert as previous years; this could be due to abundant backwater pools throughout the inundated Willamette River floodplain. Although likely good for fish, deep water created by beaver dams in 2015 and flooding in 2017 prevented us from effectively backpack electrofishing and sampling the lower habitat where we typically capture multiple species of fish. Because we were not able to sample the habitat entirely, it is likely we underestimated the number of fish present, which could explain the lower CPUE and diversity index we observed.

The pool below the Highway 43 culvert and floodplain appears to provide refuge for juvenile migratory fish for weeks and months throughout the year. In winter, flooding of the Willamette River creates strong currents and juveniles need access to floodplains that contain slower moving water (Schroeder et al. 2014). In summer, Tryon Creek water temperatures are cooler than in the Willamette River (for example, in June 2015, mean water temperature in the Willamette River was 22°C, Tryon Creek mean water temperature was 15°C [Silver et al. 2016; USGS 2017]). During the summer months, the beaver dams between the mouth of Tryon Creek and the Highway 43 culvert create habitat suitable for juvenile salmon. Beaver dams are known to provide fish refuge by raising the water level, creating large pools where sediment is

## Tryon Creek Restoration Monitoring

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deposited, and lowering the water temperature (Bouwes et al. 2016). The relatively extensive use of the confluence habitat by salmonids and other native fish demonstrates the value of off-channel habitat in urban areas, and can help us understand habitat enhancement actions that promote recovery.

The majority of fish detected by our PIT tag antennas are the juvenile Chinook and Coho Salmon we tag and release below the Highway 43 culvert. Our PIT antennas also detected juvenile salmon tagged and released by ODFW in upstream tributaries of the Willamette River. Of the 109 *O. mykiss* and hybrid trout PIT-tagged in Tryon Creek, four (3.7%) PIT tags were found on East Sand Island, an avian colony where ocean birds nest at the mouth of the Columbia River. It is likely birds consumed these juvenile fish as they migrated toward the Pacific Ocean. Our antennas also detected resident fish such as Coastal Cutthroat Trout and hybrid trout, indicating a migratory component in both groups. However, the majority of tagged Coastal Cutthroat Trout were not detected leaving the system, suggesting the resident form may be the most common. Detections of tagged fish may continue for several years as fish mature and potentially migrate. It is important to note that shed PIT tags can move downstream during high flow events in later years. These shed tags may account for false positives when detected by our antennas and lengthens the time between PIT tag date and last detection. In 2013, we tagged few fish and had a high rate of potentially shed tags (tags that were only detected during high flow events 100 - 600 cfs more than a year later); these unusually long median residence times are anomalies and may not be accurate.

The population of trout above the Highway 43 culvert has varied between years. In 2017, the estimated density of trout below the Boones Ferry Road culvert was 16% lower than the mean, above the Boones Ferry Road culvert it was 5% higher than the mean. Although not significantly different, we saw slightly better capture probabilities above the Boones Ferry Road culvert. The lower gradient habitat creates pools for fish that are easier to catch. In higher gradient habitat below the Boones Ferry Road culvert, there are more riffles, and fish are able to escape our electrofishing field and nets. Density variations are not uncommon, Duffy and Bjorkstedt (2008) observed average population density varied seasonally with habitat type and stream location. The density of the Tryon Creek population was within the range of population densities observed in non-urban areas, but at the low end (Silver et al. 2017). The density is likely a function of environmental conditions, movement, interannual survival variability, or limits to carrying capacity (Duffy and Bjorkstedt 2008; Minto et al. 2008). Tryon Creek's relatively stable Coastal Cutthroat Trout density and full use of its habitat suggests the population is abundant enough to persist through ecological time and maintain its abundance near capacity (Connolly et al. 2008).

The USFWS has surveyed for lamprey for 12 consecutive years below the Highway 43 culvert and 8 years above. We have found that multiple species of lamprey (primarily larval Pacific Lamprey) use Tryon Creek below the Highway 43 culvert but not above. After experimentally outplanting fish above Highway 43 culvert, we proceeded to observe fish for multiple years. This suggests if adults did access and spawn above Highway 43 culvert

## Tryon Creek Restoration Monitoring

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successfully, the habitat may be able to support larval rearing. However, evidence continues to suggest that lamprey cannot pass the Highway 43 culvert or are not attracted to the upstream area. Consequently, until passage or attraction conditions change, additional monitoring for naturally-produced lamprey above the Highway 43 culvert is not warranted.

### **FY 2019 Tasks**

- Conduct monthly sampling (seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert 1/2019-4/2019
- Conduct weekly sampling(seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert 4/2019-6/2019
- Conduct a two-pass abundance estimate upstream of the Highway 43 culvert to SW Maplecrest Drive Culvert 9/2019
- Maintain a Passive Integrated Transponder (PIT) array at the mouth of Tryon Creek with daily uploads of detections to PTAGIS

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### Appendix A: Sample conditions and catch per unit effort (CPUE) for all sample events in the Tryon Creek confluence habitat (2012 - 2017)

Sample Date	Water Temp (C°)	Flow (cfs)	Sample Method	Seine Effort (pool volume m <sup>3</sup> , hauls)	EFish Effort (sec)	Fish Captured (n)	EFish CPUE	Seine CPUE
07/03/2012	14.3	2.5	Electrofishing		758	8	0.01	
07/03/2012	14.3	2.5	Seine	225, 2		14		0.03
08/03/2012	14	1.5	Electrofishing		1238	28	0.02	
08/03/2012	14	1.5	Seine	225, 2		138		0.31
09/06/2012	14.8	1	Electrofishing		1106	58	0.05	
09/06/2012	14.8	1	Seine	225, 2		45		0.10
10/04/2012		0.5	Electrofishing		1217	84	0.07	
10/04/2012		0.5	Seine	225, 2		48		0.11
11/08/2012		3	Electrofishing		806	45	0.06	
11/08/2012		3	Seine	225, 2		64		0.14
12/13/2012		15	Electrofishing		965	54	0.06	
12/13/2012		15	Seine	225, 2		65		0.14
01/18/2013		5	Electrofishing		1428	10	0.01	
01/18/2013		5	Seine	225, 2		24		0.05
02/08/2013		6	Electrofishing		1018	5	< 0.00	
02/08/2013		6	Seine	225, 2		40		0.09
03/07/2013		8.5	Electrofishing		1193	67	0.06	
03/07/2013		8.5	Seine	225, 2		31		0.07
03/22/2013		7	Electrofishing		1265	51	0.04	
03/22/2013		7	Seine	225, 2		48		0.11
03/28/2013		4	Electrofishing		1195	61	0.05	
03/28/2013		4	Seine	225, 2		56		0.12
04/04/2013		3	Electrofishing		1089	17	0.02	
04/04/2013		3	Seine	225, 2		30		0.07
04/11/2013		5	Electrofishing		1099	20	0.02	
04/11/2013		5	Seine	225, 2		40		0.09
04/18/2013		3.5	Electrofishing		1022	90	0.09	
04/18/2013		3.5	Seine	225, 2		46		0.10
04/25/2013		3	Electrofishing		1184	62	0.05	
04/25/2013		3	Seine	225, 2		5		0.01
05/02/2013		2.5	Electrofishing		1076	20	0.02	
05/02/2013		2.5	Seine	225, 2		18		0.04
05/08/2013		2	Electrofishing		701	70	0.10	
05/08/2013		2	Seine	225, 2		43		0.10
05/16/2013		2	Electrofishing		1076	57	0.05	
05/16/2013		2	Seine	225, 2		39		0.09
05/31/2013		5	Electrofishing		1547	94	0.06	
05/31/2013		5	Seine	225, 2		16		0.04
06/06/2013		2.6	Electrofishing		1241	95	0.08	
06/06/2013		2.6	Seine	225, 2		13		0.03
06/14/2013		2.5	Electrofishing		1089	93	0.09	
06/14/2013		2.5	Seine	225, 2		31		0.07
07/02/2014	17.5	1.7	Electrofishing		796	118	0.15	
07/02/2014		1.7	Seine	225, 2		29		0.06
08/06/2014	16.6	0.7	Electrofishing		427	54	0.13	
08/06/2014	16.6	0.7	Seine	225, 2		43		0.10
08/27/2014	17	0.5	Seine	225, 2		40		0.09
10/08/2014	13.9	0.9	Electrofishing		800	118	0.15	
10/08/2014		0.9	Seine	225, 2		18		0.04
11/05/2014	13.3	7.5	Electrofishing		952	65	0.07	
11/05/2014	13.3	7.5	Seine	225, 2		23		0.05
12/03/2014	4.4	4.7	Electrofishing		724	48	0.07	
12/03/2014	4.4	4.7	Seine	225, 2		68		0.15

## Tryon Creek Restoration Monitoring

Sample Date	Water Temp (C°)	Flow (cfs)	Sample Method	Seine Effort (pool volume m <sup>3</sup> , hauls)	EFish Effort (sec)	Fish Captured (n)	EFish CPUE	Seine CPUE
12/31/2014	1.7	4.5	Electrofishing		597	14	0.02	
12/31/2014	1.7	4.5	Seine	225, 2		41		0.09
02/04/2015	8.9	10	Electrofishing		681	42	0.06	
02/04/2015	8.9	10	Seine	225, 2		48		0.11
03/04/2015	4.9	3.9	Electrofishing		522	30	0.06	
03/04/2015	4.9	3.9	Seine	225, 2		14		0.03
04/01/2015	8.9	5.5	Electrofishing		691	35	0.05	
04/01/2015	8.9	5.5	Seine	225, 2		25		0.06
04/08/2015	10.4	4	Electrofishing		932	58	0.06	
04/08/2015	10.4	4	Seine	225, 2		14		0.03
04/15/2015	6.7	5.7	Electrofishing		829	45	0.05	
04/15/2015	6.7	5.7	Seine	225, 2		33		0.07
04/22/2015	9.7	3.9	Electrofishing		698	67	0.10	
04/22/2015	9.7	3.9	Seine	225, 2		27		0.06
04/28/2015	13.4	3.6	Electrofishing		665	50	0.08	
04/28/2015	13.4	3.6	Seine	225, 2		38		0.08
05/06/2015	11	3.1	Electrofishing		663	59	0.09	
05/06/2015	11	3.1	Seine	225, 2		66		0.15
05/13/2015	11.6	3.4	Electrofishing		889	53	0.06	
05/13/2015	11.6	3.4	Seine	225, 2		86		0.19
05/20/2015	13.4	2.4	Electrofishing		532	49	0.09	
05/20/2015	13.4	2.4	Seine	225, 2		99		0.22
05/27/2015	12.7	2	Electrofishing		628	41	0.07	
05/27/2015	12.7	2	Seine	225, 2		90		0.20
06/03/2015	14.4	3	Electrofishing		488	50	0.10	
06/03/2015	14.4	3	Seine	225, 2		27		0.06
06/10/2015	15.2	1.7	Electrofishing		593	67	0.11	
06/10/2015	15.2	1.7	Seine	225, 2		103		0.23
06/17/2015	14.5	1.4	Seine	225, 2		175		0.39
06/24/2015	15.8	1.1	Electrofishing		720	67	0.09	
06/24/2015	15.8	1.1	Seine	225, 2		131		0.29
07/06/2016	14.6	0.9	Electrofishing		871	186	0.21	
07/06/2016	14.9	0.9	Seine	225, 2		66		0.15
08/03/2016	14.9	0.6	Electrofishing		680	188	0.28	
08/03/2016	14.9	0.6	Seine	225, 2		79		0.18
09/07/2016	15.2	1.5	Electrofishing		1250	275	0.22	
09/07/2016	15.2	1.5	Seine	225, 2		110		0.24
10/04/2016	12.4	1.1	Electrofishing		1169	195	0.17	
10/04/2016	12.4	1.1	Seine	225, 2		82		0.18
11/01/2016	12	5	Electrofishing		1041	145	0.14	
11/01/2016	12	5	Seine	225, 2		20		0.04
12/06/2016	7.2	18	Electrofishing		947	57	0.06	
12/06/2016	7.2	18	Seine	225, 2		1		0.00
01/03/2017	1.6	6.83	Electrofishing		1148	68	0.06	
01/03/2017	1.6	6.83	Seine	225, 2		21		0.05
03/07/2017	7.3	21	Electrofishing		600	46	0.08	
04/04/2017	9	10	Electrofishing		649	42	0.06	
04/04/2017	9	10	Seine	225, 1		3		0.01
04/11/2017	8.7	7.76	Electrofishing		692	53	0.08	
04/11/2017	8.7	7.76	Seine	225, 2		28		0.06
04/18/2017	11.4	10.9	Electrofishing		495	31	0.06	
04/18/2017	11.4	10.9	Seine	225, 2		2		0.00
04/25/2017	10.8	16.1	Electrofishing		730	40	0.05	
04/25/2017	10.8	16.1	Seine	225, 2		3		0.01
05/02/2017	11.2	8.02	Electrofishing		795	57	0.07	
05/02/2017	11.2	8.02	Seine	225, 2		10		0.02
05/09/2017	12.8	6.03	Electrofishing		818	54	0.07	

## Tryon Creek Restoration Monitoring

Sample Date	Water Temp (C°)	Flow (cfs)	Sample Method	Seine Effort (pool volume m <sup>3</sup> , hauls)	EFish Effort (sec)	Fish Captured (n)	EFish CPUE	Seine CPUE
05/09/2017	12.8	6.03	Seine	225, 2		15		0.03
05/16/2017	11.3	13.6	Electrofishing		1127	35	0.03	
05/16/2017	11.3	13.6	Seine	225, 2		9		0.02
05/23/2017	14.6	5	Electrofishing		997	137	0.14	
05/23/2017	14.6	5	Seine	225, 2		23		0.05
05/30/2017	14.1	3.63	Electrofishing		661	12	0.02	
05/30/2017	14.1	3.63	Seine	225, 2		34		0.08
06/06/2017	14.2	2.84	Electrofishing		588	37	0.06	
06/06/2017	14.2	2.84	Seine	225, 2		70		0.16
06/13/2017	12.7	5.18	Seine	225, 2		53		0.12
07/03/2018	13.4	0.9	Electrofishing		781	154	0.20	
07/03/2018	13.4	0.9	Seine	225, 2		100		0.22
08/02/2018	17.5	0.62	Electrofishing		490	101	0.21	
08/02/2018	17.5	0.62	Seine	225, 2		88		0.20
09/06/2018	15	1.57	Electrofishing		369	83	0.22	
09/06/2018	15	1.57	Seine	225, 2		19		0.04
10/04/2018	12.1	1.53	Electrofishing		686	111	0.16	
10/04/2018	12.1	1.53	Seine	225, 2		44		0.10
11/01/2018	12.8	1.7	Electrofishing		1147	134	0.12	
11/01/2018	12.8	1.7	Seine	225, 2		24		0.05
12/06/2018	3.8	1.67	Electrofishing		934	46	0.05	
12/06/2018	3.8	1.67	Seine	225, 2		5		0.01

USGS Gauging station moved downstream in February 2017

## Tryon Creek Restoration Monitoring

### Appendix B: Fish Capture below Highway 43 Culvert (2012 - 2017)

Date	Banded Killifish*	Bluegill*	Brown Bullhead*	Chinook Salmon	Coastal Cutthroat Coho Salmon	Dace	Goldfish*	Hybrid Trout	Largemouth Bass*	Largescale Sucker	Mountain whitefish	Northern Pike/minnow	O. mykiss	Oriental Weatherfish*	Pacific lamprey	Peamouth	Redside Shiner	Sculpin sp	Smallmouth Bass*	Threespine stickleback	Western Mosquitofish*	
07/03/2012				1	4			5					2									
08/03/2012			1	25	7	21		3			4		4					99		1		
09/06/2012				17	9	20			1		4		2					46		2		
10/04/2012				20	6	18	3	5		1	2		1					66	10			
11/08/2012				16	1	46		1	1				1					30	13			
12/13/2012				17	2	40		2					8					46				
01/18/2013				9	2	18		3					2									
02/08/2013				10	1	29		3					2									
03/07/2013				13	2	25		2					1					55				
03/22/2013				7	1	43		3					3					42				
03/28/2013				10	1	46		2					9					48		1		
04/04/2013				7	1	31		5					3									
04/11/2013				2	2	44		6					4							2		
04/18/2013				11	1	39		3					5					76		1		
04/25/2013				5	1	5		1					3					51		1		
05/02/2013	1			10	1	19	1	1					3							2		
05/08/2013				9	1	29		7					5					62				
05/16/2013				6		35		6					1					48				
05/31/2013				14	2	9		9					1					75				
06/06/2013				7	2	6		7					0					79				
06/14/2013				17	3	13		7					4		0			80				
07/03/2013				0		0							0	4								
07/02/2014				4	18	17							1					106				
08/06/2014				7	20	24		1					0	1				45				

## Tryon Creek Restoration Monitoring

Date	Banded Killifish*	Bluegill*	Brown Bullhead*	Chinook Salmon	Coastal Cutthroat Coho Salmon	Dace	Goldfish*	Hybrid Trout	Largemouth Bass*	Largescale Sucker	Mountain whitefish	Northern Pike/minnow	O. mykiss	Oriental Weatherfish*	Pacific lamprey	Peamouth	Redside Shiner	Sculpin sp	Smallmouth Bass*	Threespine stickleback	Western Mosquitofish*
08/27/2014				1	14			1										10			
10/08/2014				4	12	4	1	3	1									98	12		
11/05/2014				12	7	6	1	1										59	1		
12/03/2014				56	7	16		1								1		33			
12/31/2014				23		21												11			
02/04/2015				14	4	31		1			1		0					38	1		
03/04/2015				7	3	10	1	1					2					20			
04/01/2015				11	6	12		1	1				5					23		1	
04/08/2015				8	7	12							4					41			
04/15/2015				10	12	22		3					7					24			
04/22/2015				8	12	22		3					2					47			
04/28/2015				3	14	28		3	1				2					37			
05/06/2015				10	12	69							0					34			
05/13/2015				6	9	87							2					35			
05/20/2015				1	9	105		1					2					30			
05/27/2015				1	8	81							0					41			
06/03/2015				1	8	28							0					40			
06/10/2015				0	6	112							0					52			
06/17/2015				0	6	150							0					19			
06/24/2015				0	6	137							0					55			
07/13/2015				0		0							0		10						
07/06/2016		3		9	1	53							0					186			
07/19/2016				0		0							0	2	1						
08/03/2016		1		14	1	41		1					0					209			
09/07/2016		1		17	1	18		1					1					346			
10/04/2016		1		15	1	20		1					0		1			238			

## Tryon Creek Restoration Monitoring

Date	Banded Killifish*	Bluegill*	Brown Bullhead*	Chinook Salmon	Coastal Cutthroat Coho Salmon	Dace	Goldfish*	Hybrid Trout	Largemouth Bass*	Largescale Sucker	Mountain whitefish	Northern Pike/minnow	O. mykiss	Oriental Weatherfish*	Pacific lamprey	Peamouth	Redside Shiner	Sculpin sp	Smallmouth Bass*	Threespine stickleback	Western Mosquitofish*
11/01/2016	1			2	22		1					1	0					135	1		1
12/06/2016				3	2								0					52			
01/03/2017				10	1	14							0					64			
03/07/2017				13		3							1					29			
04/04/2017				1		0							3					41			
04/11/2017				7	17	1							11					45			
04/18/2017				3	1	0				1			1					27			
04/25/2017				6		0							4					33			
05/02/2017				7	4	5							2					48			1
05/09/2017				5	5	6							5					47			
05/16/2017				6	4	1				1			0					32			
05/23/2017				10	14	5							0					129			2
05/30/2017	1			13	12	15							0					5			
06/06/2017				24	20	13							1					49			
06/13/2017				9	15	9		1					1					18			
07/03/2018			1	20	10	88							1					136			
08/02/2018				9	12	64					1							105			
09/06/2018			1	3	2	19					1		1					75			
10/04/2018				2	2	29												124		1	
11/01/2018				7	9	17							2					123			
12/06/2018				2	4	15							5			1	1	25			

\*Introduced species

## Tryon Creek Restoration Monitoring

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### Appendix C: Simpson (1-D) Diversity Index for each sample event (2012 - 2017)

Sample Event	Season	Simpson (1-D) Diversity Index
7/3/12	Summer	0.73
8/3/12	Summer	0.62
9/6/12	Summer	0.73
10/4/12	Fall	0.73
11/8/12	Fall	0.70
12/13/12	Fall	0.72
1/18/13	Winter	0.65
2/8/13	Winter	0.54
3/7/13	Winter	0.61
3/22/13	Spring	0.63
3/28/13	Spring	0.67
4/4/13	Spring	0.54
4/11/13	Spring	0.43
4/18/13	Spring	0.60
4/25/13	Spring	0.41
5/2/13	Spring	0.69
5/8/13	Spring	0.63
5/16/13	Spring	0.62
5/31/13	Spring	0.51
6/6/13	Spring	0.45
6/14/13	Spring	0.55
7/2/2014	Summer	0.45
8/6/2014	Summer	0.69
8/27/2014	Summer	0.71
10/8/2014	Fall	0.45
11/5/2014	Fall	0.53
12/3/2014	Fall	0.67
12/31/2014	Winter	0.65
2/4/2015	Winter	0.68
3/4/2015	Winter	0.73
4/1/2015	Spring	0.77
4/8/2015	Spring	0.63
4/15/2015	Spring	0.79
4/22/2015	Spring	0.68
4/28/2015	Spring	0.70
5/6/2015	Spring	0.62
5/13/2015	Spring	0.56
5/20/2015	Spring	0.47

## Tryon Creek Restoration Monitoring

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<b>Sample Event</b>	<b>Season</b>	<b>Simpson (1-D) Diversity Index</b>
5/27/2015	Spring	0.52
6/3/2015	Spring	0.59
6/10/2015	Spring	0.47
6/17/2015	Spring	0.25
6/24/2015	Summer	0.45
7/6/2016	Summer	0.41
8/3/2016	Summer	0.36
9/7/2016	Summer	0.19
10/4/2016	Fall	0.25
11/1/2016	Fall	0.31
12/6/2016	Fall	0.22
1/3/2017	Winter	0.45
3/7/2017	Winter	0.53
4/4/2017	Spring	0.17
4/11/2017	Spring	0.63
4/18/2017	Spring	0.33
4/25/2017	Spring	0.39
5/2/2017	Spring	0.47
5/9/2017	Spring	0.51
5/16/2017	Spring	0.45
5/23/2017	Spring	0.34
5/30/2017	Spring	0.75
6/6/2017	Spring	0.70
6/13/2017	Spring	0.76
07/03/2018	Summer	0.59
08/02/2018	Summer	0.58
09/06/2018	Summer	0.43
10/04/2018	Fall	0.35
11/01/2018	Fall	0.38
12/06/2018	Fall	0.69

**U.S. Fish and Wildlife Service  
Columbia River Fish and Wildlife Conservation Office  
1211 SE Cardinal Court, Suite 100  
Vancouver, WA 98683**



**February 2019  
[www.fws.gov/columbiariver](http://www.fws.gov/columbiariver)**