

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

# **Tryon Creek Restoration Monitoring Project**

*City of Portland FY 2016 Progress Report*



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**U.S. Fish and Wildlife Service  
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**March 21, 2017**

***On the cover:*** Coastal Cutthroat Trout captured below the Highway 43 culvert, photo by Brook Silver 2015.

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Tryon Creek Restoration Monitoring Project  
City of Portland FY 2016 Progress Report  
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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) conduct an occupancy survey for larval lamprey 5) and estimate the population abundance of trout species above the Highway 43 culvert. Between 2012 and 2016, the fish community below the Highway 43 culvert included 21 species of 5,667 individual fish. Native fish were the most abundant comprising 62% (n = 13) of the species captured and 99.1% (n = 5,616) 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 (2,220/2,265), all other juvenile anadromous salmonids were hatchery reared. Presence of juvenile Chinook Salmon at the mouth of Tryon Creek peaked in fall months and juvenile Coho Salmon peaked in spring months. Juvenile anadromous salmonids were detected emigrating a median 13.5 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 252.5 days after tagging.

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Basin. The Tryon Creek Mouth antenna (TCM) detected Chinook Salmon, Coho Salmon, and *O. mykiss* released upstream in tributaries to the Willamette River. .... 20

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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 lampreys 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 assess the restoration response of 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 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. In 2012, the U. S. Fish and Wildlife Service continued its partnership with the City of Portland's Bureau of Environmental Services to assess fish abundance, community, and residence time of fish in the Tryon Creek confluence with the following objectives:

1. Estimate relative abundance of fish species present.
  - a. 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.
  - b. Conduct weekly sampling (seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert in the springs of 2013, 2015, 2017, and 2019.
  - c. Conduct an annual survey in July to electrofish above and below the Highway 43 culvert to detect larval lamprey distribution.
  - d. Conduct a two-pass abundance estimate of salmonid species above the Highway 43 culvert in fall 2015 and a single pass in fall 2013 and 2017.

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2. Describe fish community throughout the year
3. Document residence time of this habitat by the fish species present during the spring.
  - a. Maintain a Passive Integrated Transponder (PIT) array at the mouth of Tryon Creek.

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 2009-2013 Strategic Plan. The following National goals (NG) and Regional objectives (RO) have been addressed by this project:

- NG1 Open, interactive communication between the Fisheries Program and its partners.
  - RO1.1 Develop and maintain relationships with partners throughout the Pacific Region.
  - RO1.3 Improve data collection and management and internal and external reporting to reduce redundancy and improve access and usefulness for ourselves and our partners.
  
- NG2 America's streams, lakes, estuaries, and wetlands are functional ecosystems that support self-sustaining communities of fish and other aquatic resources.
  - RO2.1 Facilitate management of aquatic habitats on national and regional scales by working with Tribes, States, partners and other stakeholders.
  - RO2.2 Develop and expand the use of its expertise to help avoid, minimize or mitigate impacts of habitat alteration on aquatic species and monitor and evaluate completed projects.
  - RO2.4 Expand opportunities to connect people with nature, engage citizen scientists and volunteers, and temporarily employ youth in the aquatic habitat conservation and monitoring programs and activities we lead or support.
  
- NG3 Self-sustaining populations of native fish and other aquatic resources that maintain species diversity, provide recreational opportunities for the American public, and meet the needs of tribal communities.
  - RO3.1 Collaborate with Ecological Services (ES) Program, National Oceanographic and Atmospheric Administration Fisheries (NOAA Fisheries) and others, to recover fish and other aquatic resource populations protected under the ESA.
  - RO3.2 Maintain healthy, diverse, self-sustaining populations of fish and other aquatic resources

## Tryon Creek Restoration Monitoring

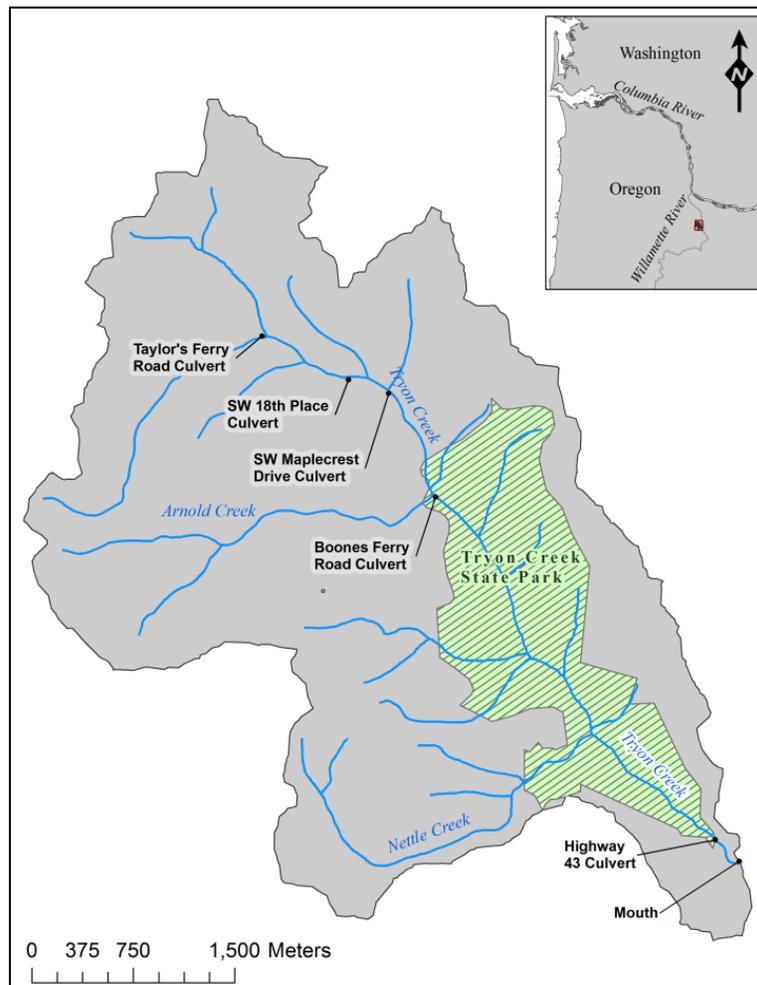
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- RO3.3 Support the research and fish culture needed to prevent listing or to recover native species listed or proposed for listing under ESA.
- NG9 Science developed and used by Service employees for aquatic resource restoration and management is state-of-the-art, scientifically sound and legally defensible, and technological advances in fisheries science developed by Service employees are available to partners.
- RO9.2 Use state-of-the-art, scientifically sound, legally defensible scientific and technological tools in formulating and executing fishery-related plans and policies.

# 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).

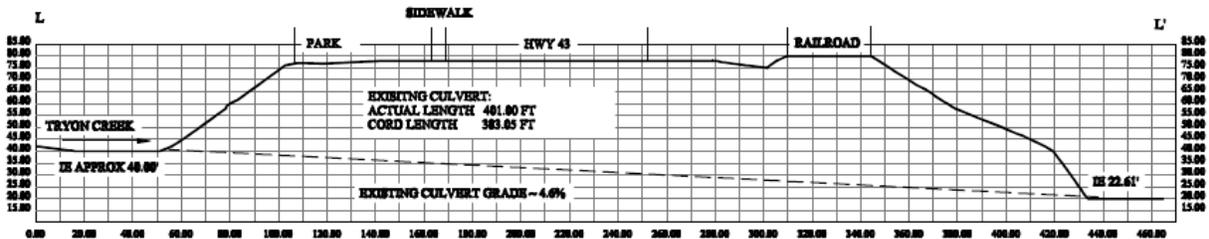


Figure 2. Longitudinal profile of Tryon Creek culvert under Oregon State Highway 43 (Henderson Land Services 2007).



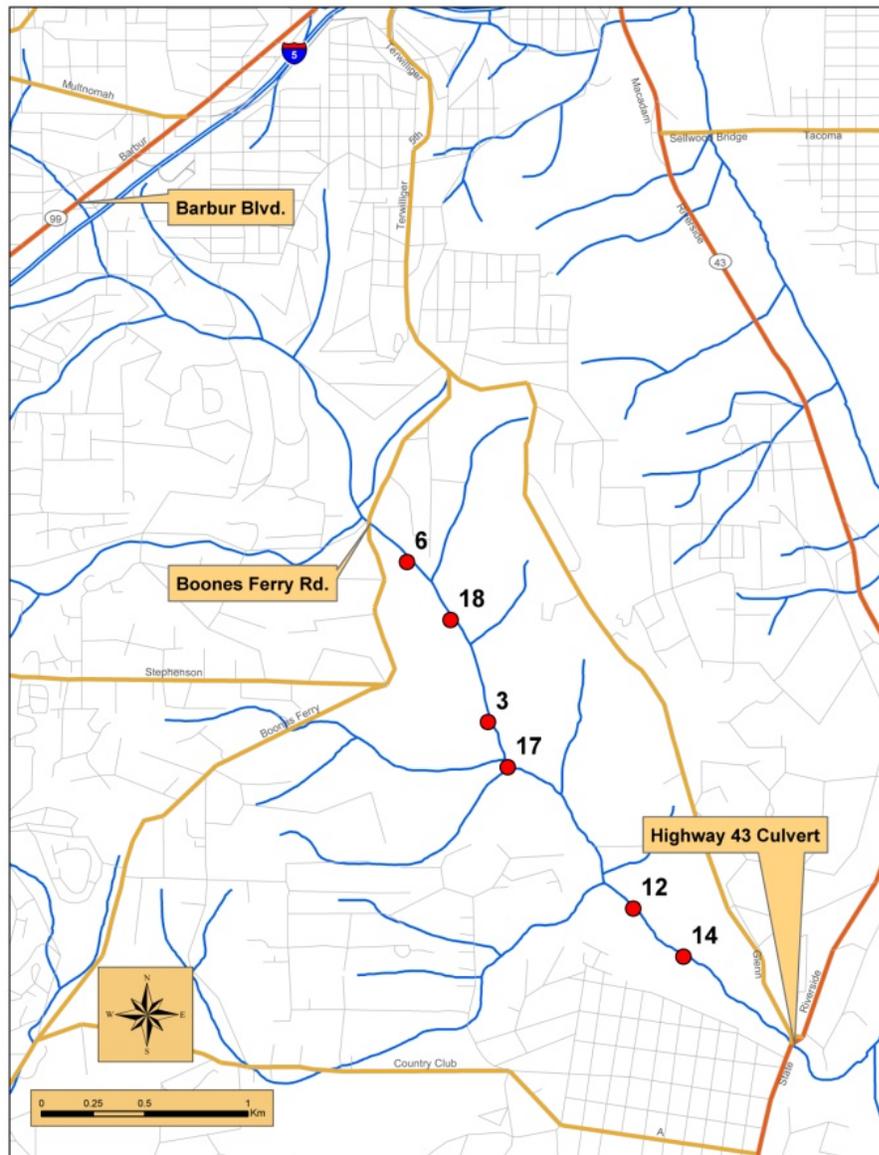
Figure 3. Modified baffles were installed in the Highway 43 culvert to improve fish passage (2008).

# Tryon Creek Restoration Monitoring

## Methods

### *Lamprey Occupancy*

Occupancy of larval Pacific and Western Brook Lampreys in Tryon Creek was assessed with an annual electrofishing survey taking place each July 2012 - 2016. Detailed methods are described in Silver et al. (2013). In brief, the entire reach from the mouth of Tryon Creek to the Highway 43 culvert was sampled. Between the Highway 43 culvert and Boones Ferry Road, six 50 m-long, randomly selected, spatially-balanced reaches were sampled (Figure 4).



**Figure 4. Lamprey survey sites in Tryon Creek between the Highway 43 culvert and Boones Ferry Road.**

# Tryon Creek Restoration Monitoring

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## *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. 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 5). 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, all captured fish were anesthetized in a bath containing 60 mg/l MS-222 and 60 mg/l sodium bicarbonate until complete loss of equilibrium was observed (3-4 minutes). Each fish was identified, checked for any external markings, measured (fork length), weighed (grams), and scanned for a PIT tag. If a PIT tag was not found, all non-injured salmonids over 70 mm fork length were tagged. After full recovery within an aerated bucket, all fish were released within the reach from which they were captured. Genetic samples collected from salmonids were archived at the USFWS Columbia River Fish and Wildlife Conservation Office.

### *Relative Abundance*

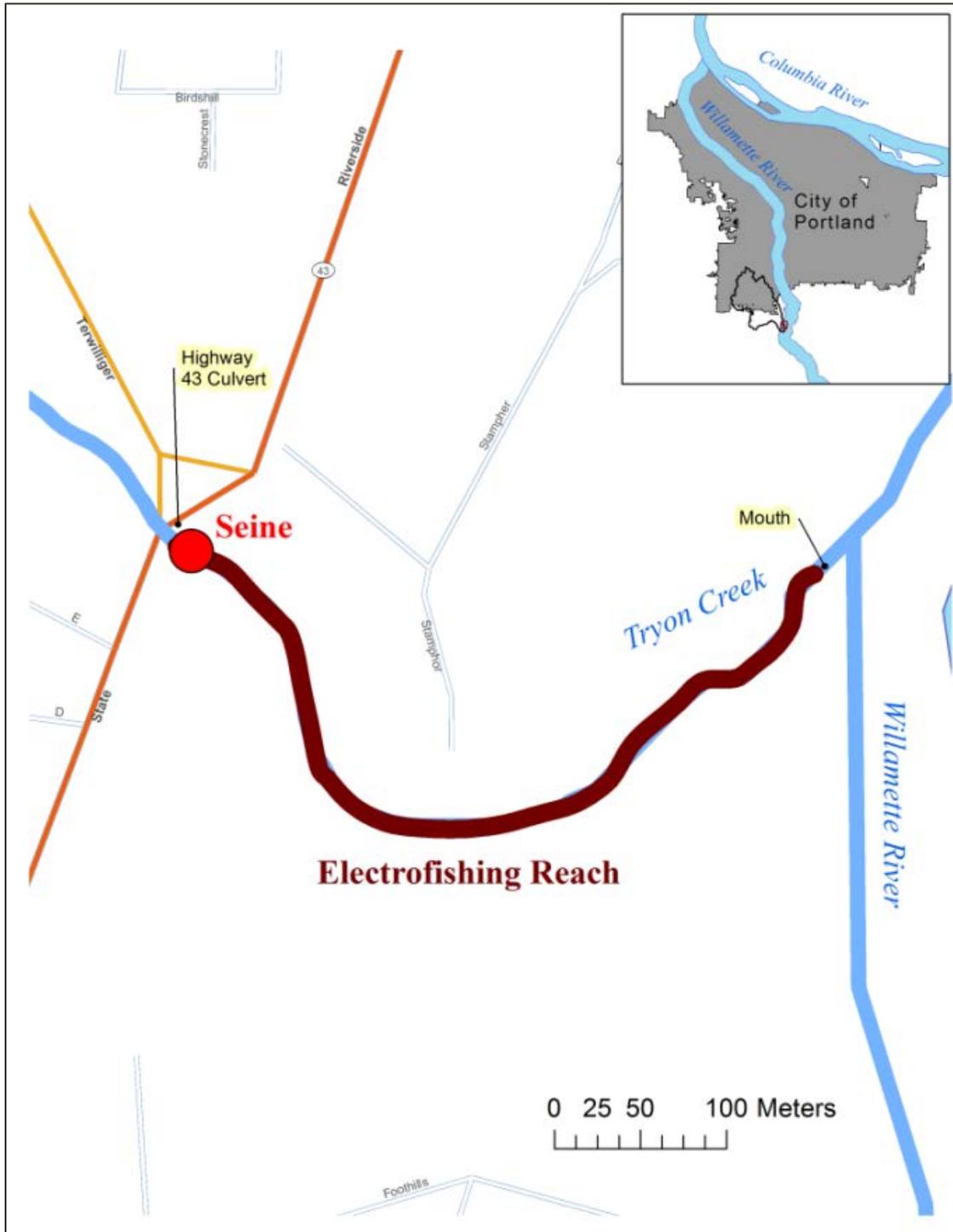
Catch per unit effort (CPUE) was used to determine trends in fish abundance of the confluence habitat. It is an index of relative abundance, which is often related to absolute abundance (Hubert and Fabrizio 2007; Pope et al. 2010). Theoretically, CPUE will increase with an increase in population size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

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

It is important to note if catchability varies (i.e. by season, number of crewmembers, temperature, time of day, flow, etc.) because it could influence the abundance estimate.

CPUE was calculated differently for electrofishing and seining. For electrofishing, total sample time (in seconds) was recorded at the end of each survey. The seconds of sample time were converted to hours and the total number of fish collected during the electrofishing survey was divided by the number of hours the survey lasted. For each seine, the total number of fish collected was divided by 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 5. Tryon Creek confluence area monitoring reach**

## *Community*

The ratio of native to introduced fish, species richness (Simpson Diversity Index), and relative abundance versus frequency of occurrence (ecological classification) were used 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). The proportion of native species to introduced species was calculated 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*

PIT tag antennas were installed 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. PTAGIS was queried to identify fish detected in Tryon Creek that were tagged and released by other agencies between 2012 and 2016. For fish tagged in Tryon Creek, PTAGIS was used to query for detections at all interrogation sites in the Columbia River Basin.

# Tryon Creek Restoration Monitoring

## Results

### *Lamprey Occupancy*

Between 2009 and 2012, two larval Pacific Lamprey were caught below the Highway 43 culvert and zero were caught above the Highway 43 culvert (Table 1). In 2013, 1,046 larval Pacific lampreys were tagged and released into Tryon Creek above the Highway 43 culvert. That same year, all five lampreys collected above Highway 43 culvert had visible VIE tags. Lampreys 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.

**Table 1. Number of larval Pacific Lamprey collected above and below the Highway 43 culvert 2009-2016.**

Sample Year	Below the Highway 43 Culvert	Above the Highway 43 Culvert
2009	0	0
2010	0	0
2011	2	0
2012	0	0
2013	5	5
2014	1	1
2015	11	2
2016	1	0

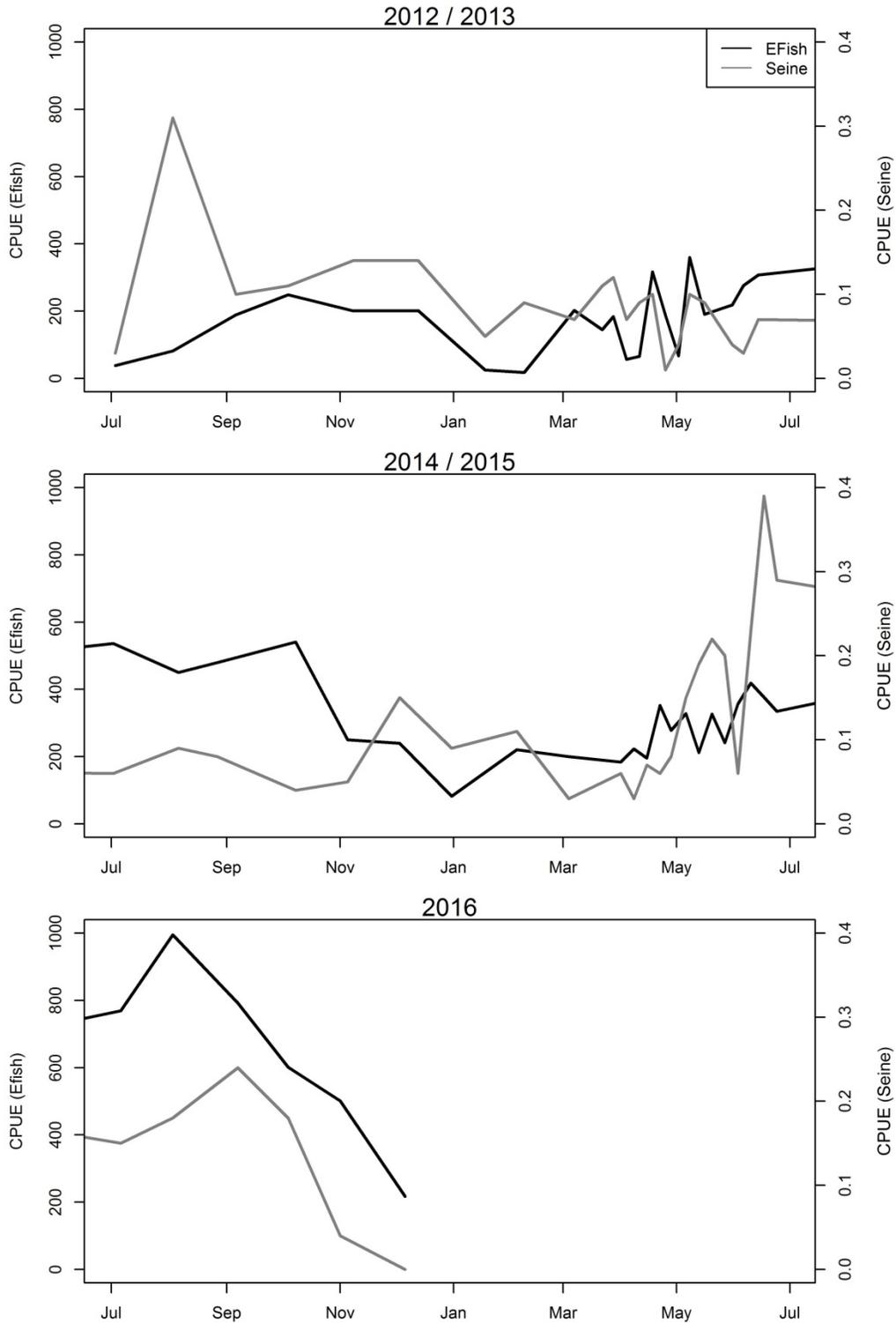
### *Below the Highway 43 Culvert - Confluence Sampling*

#### *Relative Abundance*

We sampled the confluence habitat on 49 occasions from 7/3/2012 to 12/6/2016. The habitat showed seasonal variation of water temperature and flow. In the spring and summer (March - August) it was warm (mean = 12.9 °C) and flowing slowly (mean = 3.05 cfs); in the fall and winter (September - February) it was cold (mean 10.4 °C) with higher flows (mean = 5.6 cfs) (Appendix A). Beaver dams constructed in the summers of 2014 and 2016 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 427 seconds to 1,547 seconds, seine effort was the same for all events (pool volume = 225 m<sup>3</sup>, two hauls) (Appendix A). Mean electrofishing CPUE ( $\pm$  SE) was 285.60  $\pm$  29.66 and mean seine CPUE ( $\pm$  SE) was 0.11  $\pm$  0.01 (Figure 6).

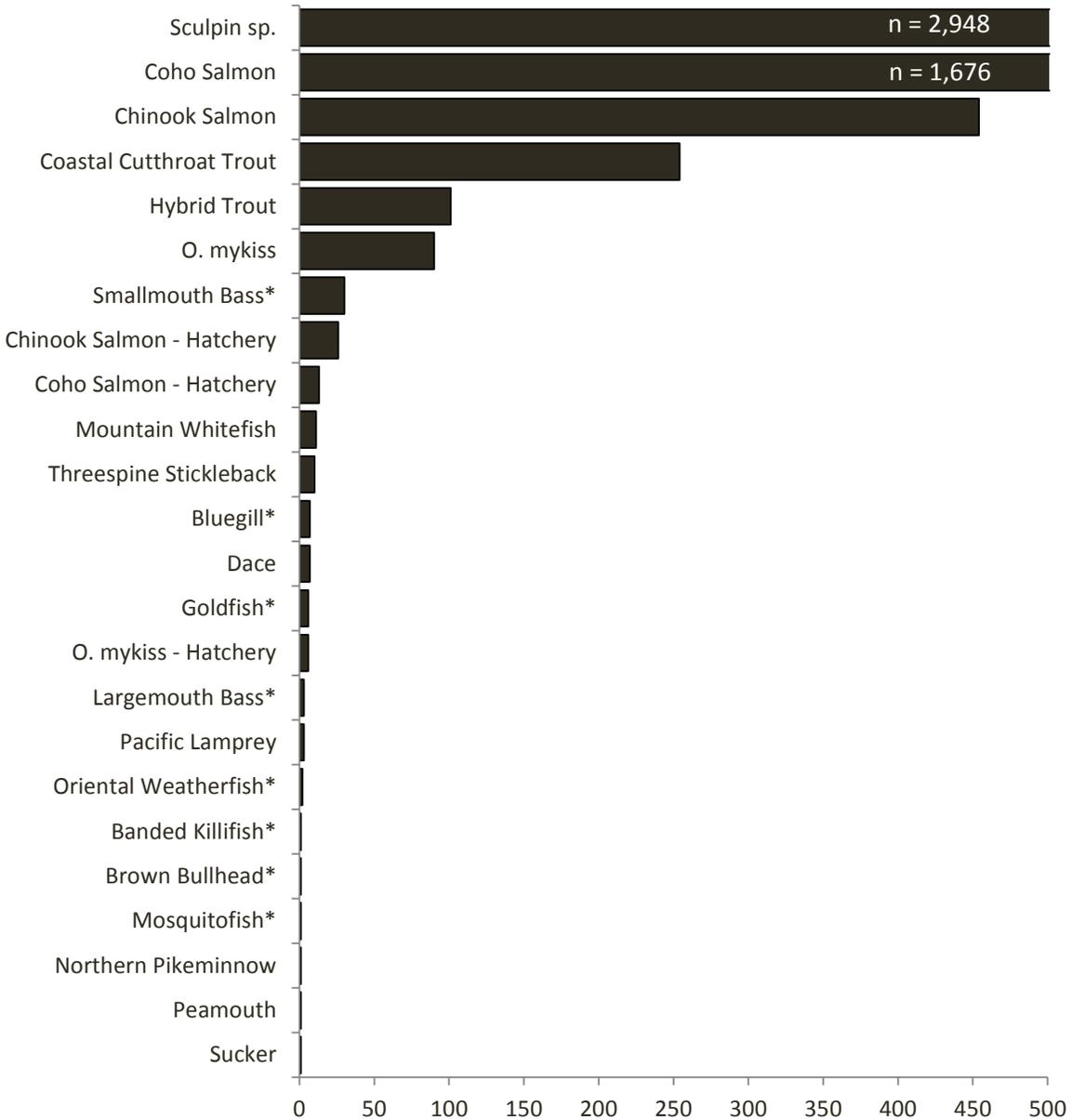
# Tryon Creek Restoration Monitoring



**Figure 6. Catch per unit Effort (CPUE) for all sample events in the Tryon Creek confluence habitat 2012 - 2016.**

## Tryon Creek Restoration Monitoring

Sculpin (*Cottus spp.*) are the most abundant family followed by salmonids: Coho Salmon, Chinook Salmon, Coastal Cutthroat Trout, hybrid trout, and *O. mykiss* (Figure 7). Genetic samples collected from salmonids were archived at the CRFWCO (n = 787) (Table 2).



**Figure 7. Total fish captured in the Tryon Creek Confluence Habitat 2012 - 2016.**  
**\*Introduced species**

## Tryon Creek Restoration Monitoring

**Table 2. Genetic Samples collected below the Highway 43 culvert 2013 - 2016**

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

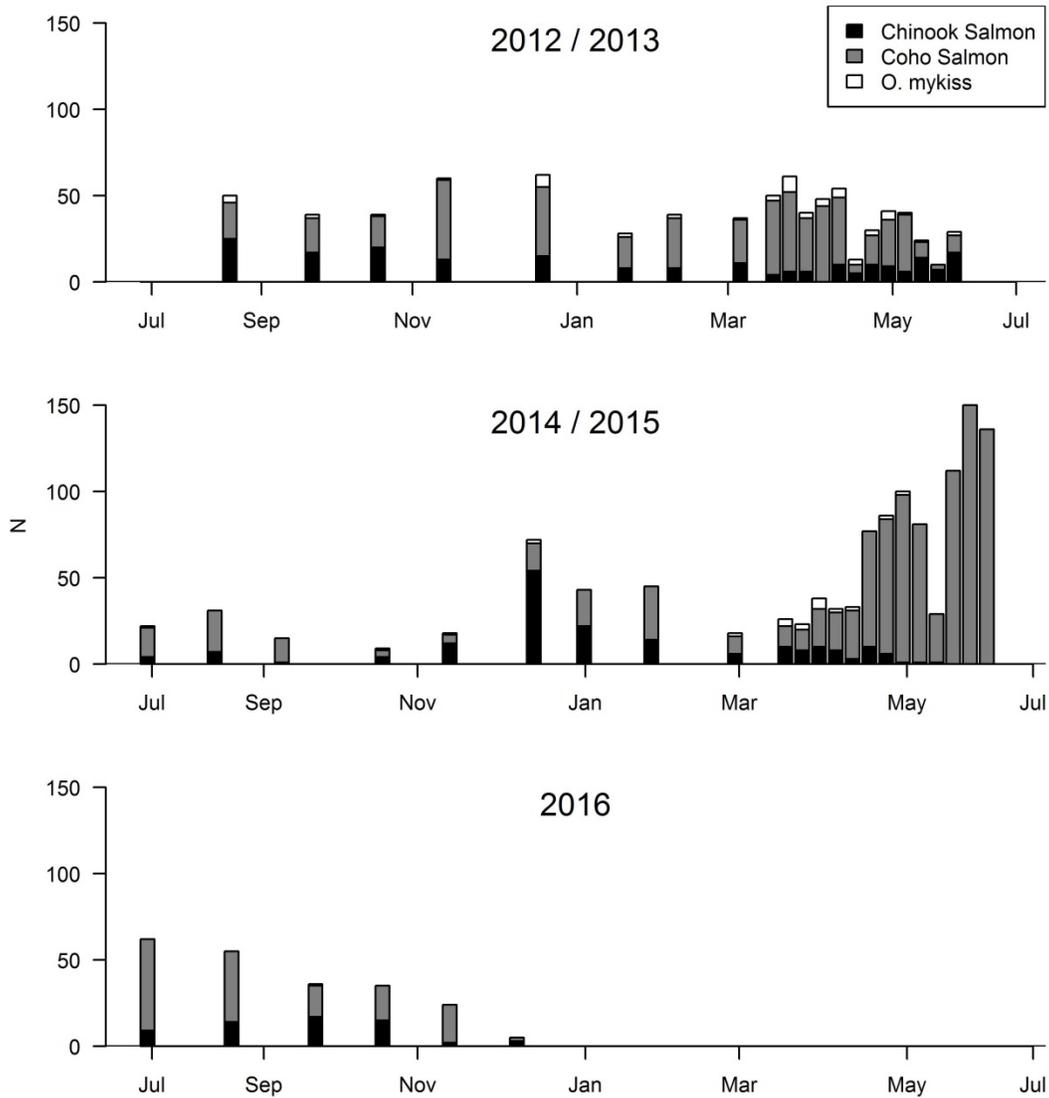
We recaptured 33% (387/1182) of PIT-tagged fish at least once. The recapture rate of juvenile migratory fish, Chinook Salmon and Coho Salmon, was 0.20 and 0.34 respectively, and the recapture rate of *O. mykiss* was 0.31. The recapture rate of resident fish, such as Coastal Cutthroat and hybrid trout, was 0.55 and 0.73, respectively. We did not recapture trout fry or Mountain Whitefish (Table 3).

**Table 3. Number of PIT-Tagged and recaptured salmonids below the Highway 43 Culvert 2012 - 2016**

Species	# PIT Tagged	# Recaptured	Recapture Rate (Recaptured/Tagged)	Size Class	Life History
Chinook Salmon	264	52	0.20	Juvenile	Migrant
Coastal Cutthroat Trout	89	49	0.55	Adult/Juvenile	Resident/Migrant
Coho Salmon	732	247	0.34	Juvenile	Migrant
Hybrid Trout	30	22	0.73	Adult/Juvenile	Resident
Mountain Whitefish	6	0	0	Juvenile	Migrant
<i>O. mykiss</i>	55	17	0.31	Adult/Juvenile	Migrant/Resident
Trout Fry < 100 mm	6	0	0	Juvenile	Resident/Migrant

Hatchery produced salmonids are marked with an adipose fin clip to facilitate distinction from naturally produced (wild) salmonids. The majority of juvenile anadromous salmonids (*O. tshawytscha*, *kisutch* and *mykiss*) captured below the Highway 43 culvert were of wild (naturally produced) origin (2,220/2,265). Presence of juvenile Chinook Salmon at the mouth of Tryon Creek peaked in fall months and juvenile Coho Salmon peaked in spring months (Figure 9).

# Tryon Creek Restoration Monitoring



**Figure 8. Number of wild migratory salmonids sampled below Highway 43 culvert 2012 - 2016**

# 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 21 species numbering 5,667 total fish between 2012 and 2016 (this includes unmarked, marked, and recaptured fish) (Table 4, Appendix B). Native fish comprised 62% (13/21) of the species captured and 99.1% (5,616/5,667) of the individuals captured. In 2016, four additional species were captured: Banded Killifish (*Fundulus diaphanus*), Mosquitofish (*Gambusia affinis*), Northern Pikeminnow (*Ptychocheilus oregonensis*), and Oriental Weatherfish.

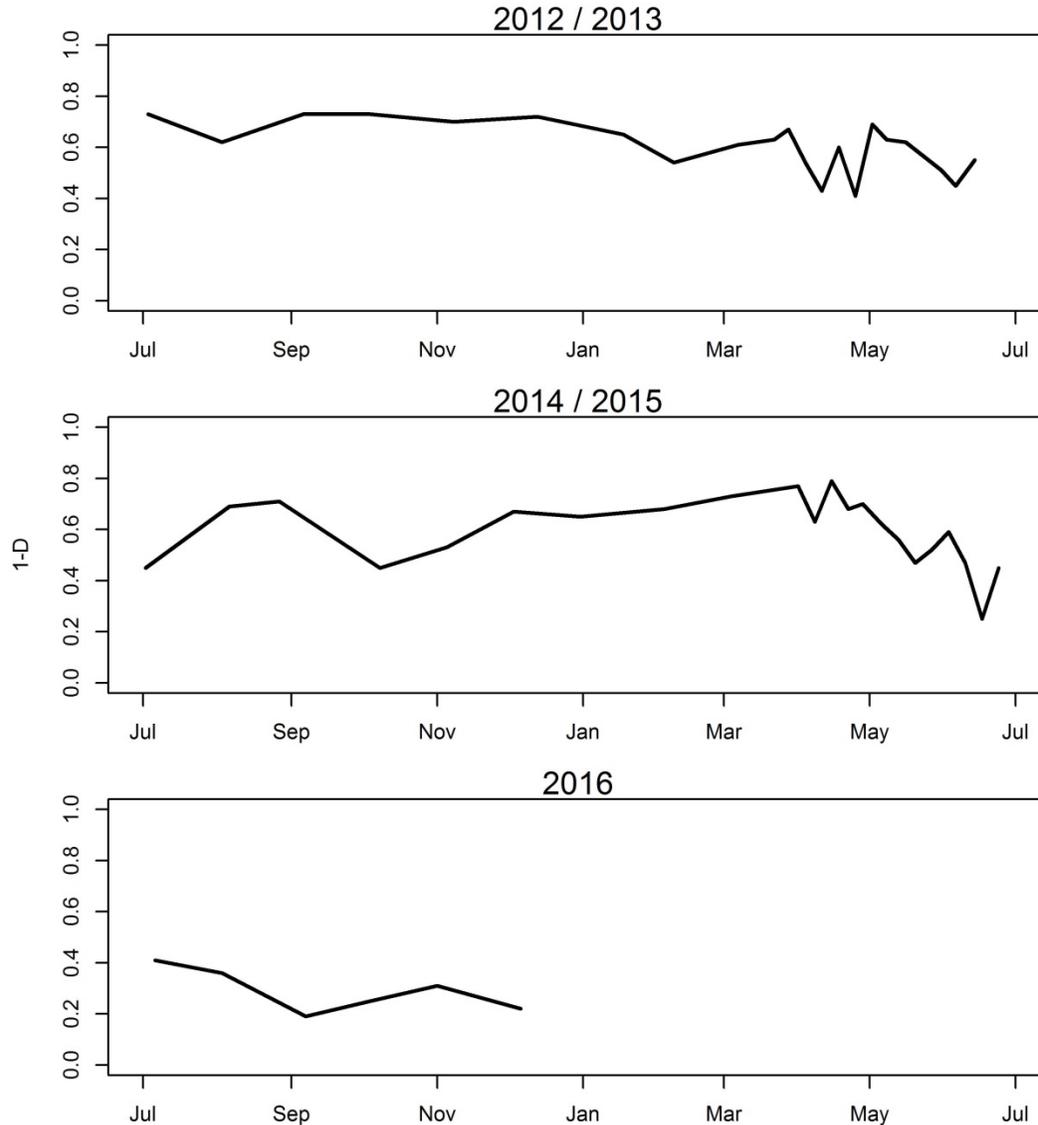
**Table 4. All species captured in the Tryon Creek Confluence Habitat 2012 - 2016. N = Native, I = Introduced**

Family	Genus species	Common Name	Species Abbreviation	Origin (Native/Introduced) (Hulse 2002)
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
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  $0.56 \pm 0.02$  and ranged from 0.19 to 0.78 (Figure 9, Appendix C).

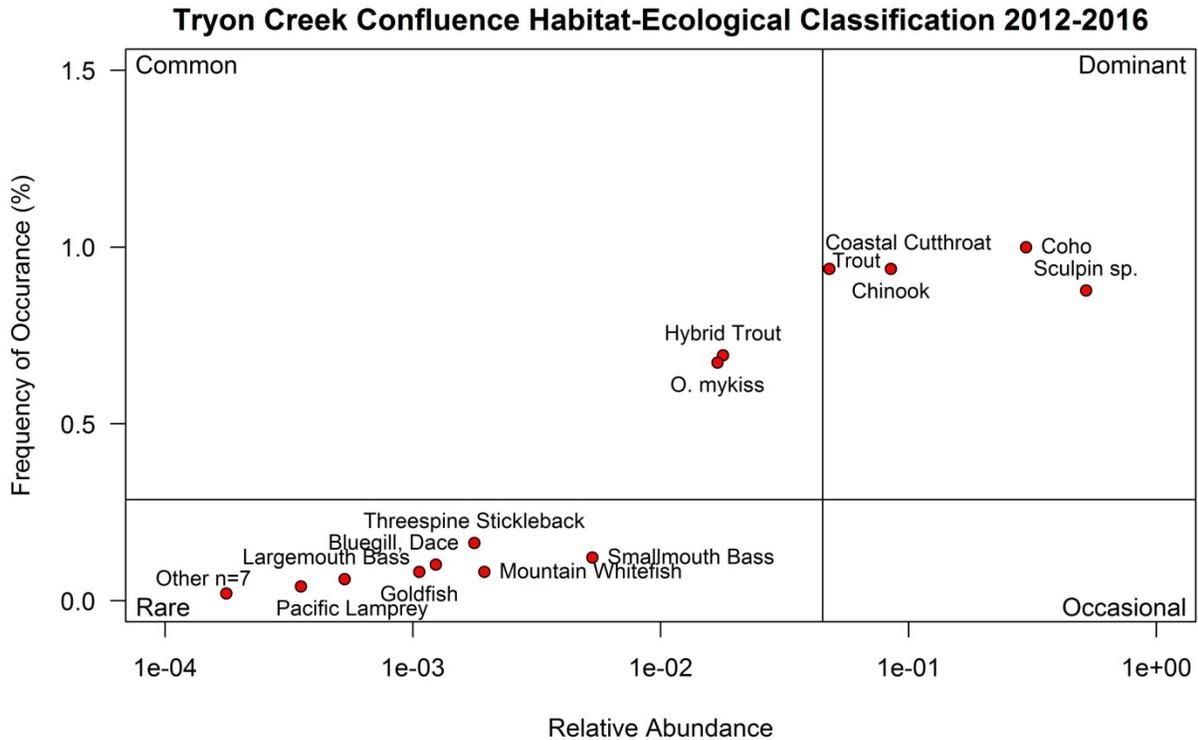


**Figure 9. Simpson Diversity Index (1-D) below Highway 43 culvert 2012-2016**

## 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 10). Common species, *O. mykiss* and hybrid trout, are captured less frequently and in smaller numbers; all other species are classified rare because they are captured infrequently and in small numbers.

# Tryon Creek Restoration Monitoring



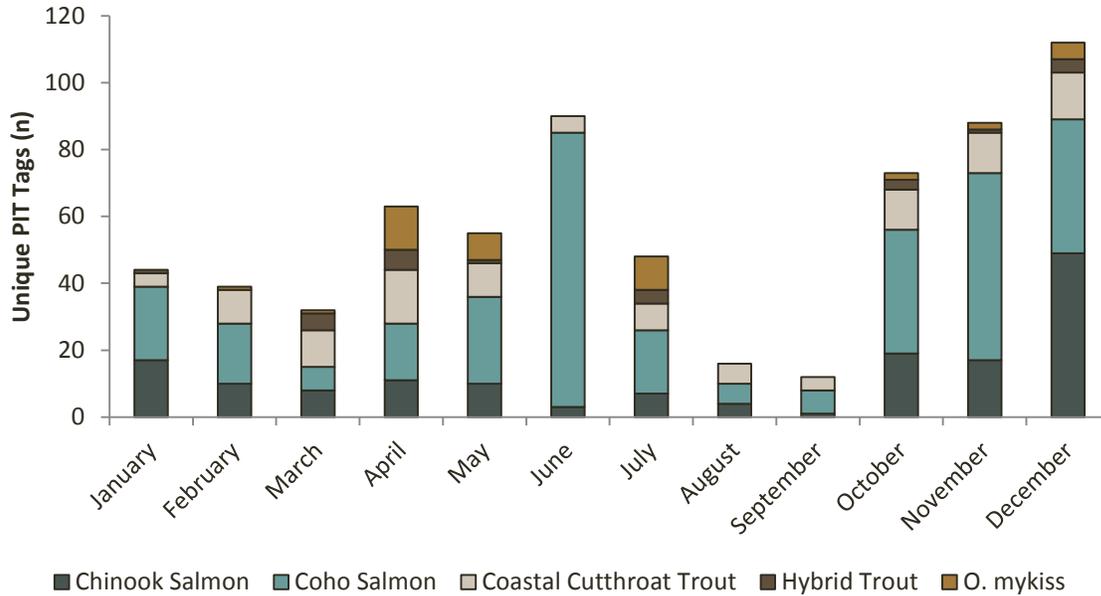
**Figure 10. Ecological Classification of species captured 2012 - 2016.**

## *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 65,957 detections of 605 unique PIT tags. Of these unique detections, 83% (505/605) were PIT tags implanted in juvenile migratory salmonids (Chinook, Coho, and *O. mykiss*). The majority (577/605) 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 11).

## Tryon Creek Restoration Monitoring



**Figure 11. Number of unique PIT tag detections by month and species 2012 - 2016**

Detections of PIT tags ( $n = 470$ ) from juvenile anadromous salmonids (Chinook, Coho, and *O. mykiss*) below the Highway 43 culvert were detected by a TCM antenna a median 13.5 days after initial tagging date. PIT tags from salmonids exhibiting both resident and anadromous behaviors (Coastal Cutthroat Trout and hybrid trout) ( $n = 62$ ) were detected by a TCM antenna a median 252.5 days after tagging. Chinook and Coho Salmon had the shortest residence times each year (Table 5).

**Table 5. Median number of days between PIT tag date and last detection date below the Highway 43 culvert**

Year	Coho Salmon	Chinook Salmon	<i>O. mykiss</i>	Coastal Cutthroat Trout	Hybrid Trout
2012	4.0	20.0	65.5	36.0	105.0
2013	15.0	28.0	1,529.0	917.0	23.0
2014	18.0	3.0	249.0	56.0	278.0
2015	12.0	20.0	25.0	258.5	100.0
2016	86.0	43.0	1,995.0	876.0	1,294.0

## Tryon Creek Restoration Monitoring

### *Movement*

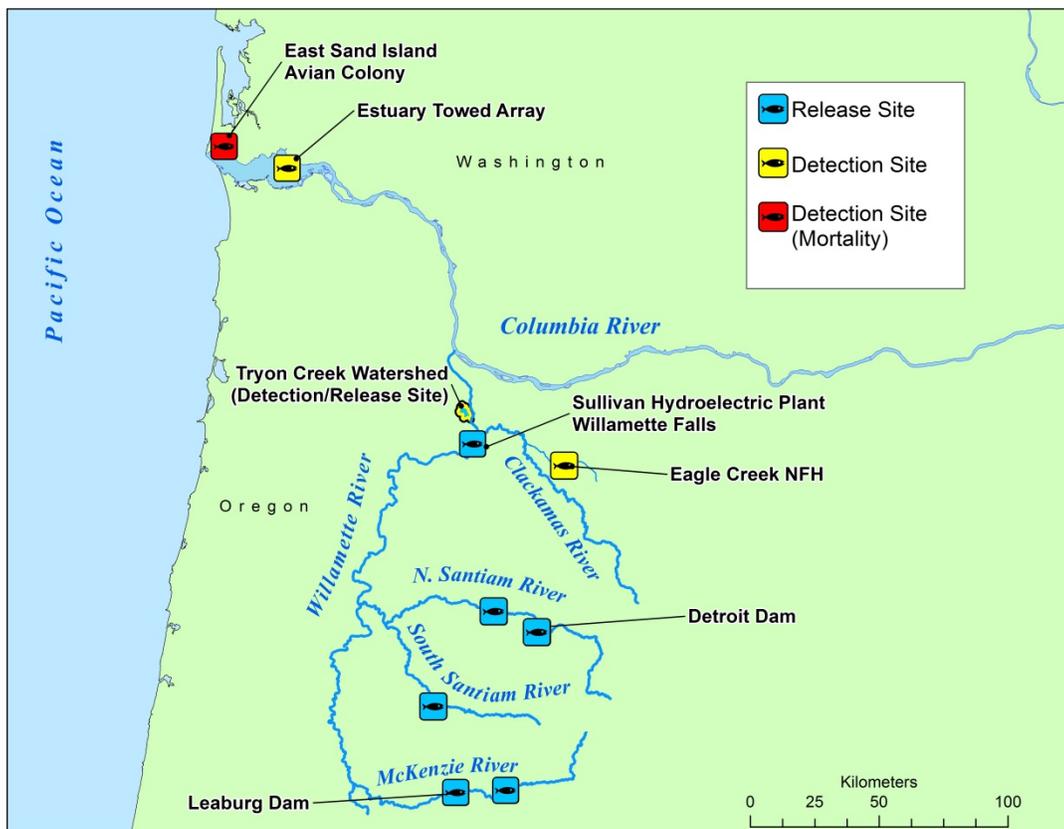
Between 2012 and 2016, the TCM antenna site detected 24 salmonids PIT tagged and released upstream in tributaries to the Willamette River. Interrogation sites in the Columbia River detected fourteen salmonids after they were PIT tagged in Tryon Creek; seven were mortalities on the East Sand Island Avian Colony (Table 6, Figure 12).

In 2016, the TCM antenna site detected 10 salmonids originating from outside the Tryon Creek watershed. We detected four hatchery Chinook Salmon released by the Marion Forks Hatchery in the North Santiam River between 2015 and 2016, one wild Chinook Salmon released into the Leaburg Dam Bypass in 2016, and one wild Chinook Salmon released into the McKenzie River in 2015. Three wild Coho Salmon and one *O. mykiss* were released at the Sullivan Hydroelectric Plant at Willamette Falls in 2016. No fish tagged and released in Tryon Creek were detected by any other interrogation site in the Columbia River in 2106.

**Table 6. 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.**

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)
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
	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	7
	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
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

## Tryon Creek Restoration Monitoring



**Figure 12. Detections of PIT tagged salmonids before or after detection in Tryon Creek 2012 - 2016. 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.**

# Tryon Creek Restoration Monitoring

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## Findings

The Tryon Creek confluence appears to continue to support native fish, predominantly salmonids during their various life history stages. Native fish were the most abundant species captured, resident fish were present throughout the year, and out-of-basin juvenile salmonids were found in the pool below the Highway 43 culvert. Additional years of sampling will allow a comprehensive inventory of fish species and contribute to our understanding of fish use in Tryon Creek over time.

Below the Highway 43 culvert, we have identified 13 native species and 8 introduced species in Tryon Creek to date (2012-2016); the Willamette Basin contains 31 native species and 29 introduced species (Hulse et al. 2002). According to Hulse et al. (2002), all species in the confluence habitat are common in the mainstem Willamette River, except Coho Salmon, which are rare. Our ecological classification in the confluence habitat identified all dominant and common species are native, 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 necessary to sample above the Highway 43 culvert to document potential changes in species distribution after passage is improvements are completed.

Both juvenile and adult Chinook and Coho Salmon utilize 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 assume juvenile Chinook and Coho Salmon originate from other locations in the Willamette River basin. The off-channel habitat created by the confluence enhancement project may be important for these juvenile migratory fish 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 in 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]). This off-channel habitat is especially important in the lower Willamette River where there has been development along the riverbanks and loss of channels due to urbanization. The pool below the Highway 43 culvert appears to provide such refuge for weeks and months at a time.

The presence of beaver dams between the mouth of Tryon Creek and the Highway 43 culvert may create additional habitat suitable for juvenile salmon during the summer months. Beaver dams are known to provide fish refuge by raising the water level, creating large pools where sediment is deposited, and lowering the water temperature (Bouwes et al. 2016). The lower diversity indices in 2016 may have also been due to these beaver dams. The pools behind the beaver dams were too deep for backpack electrofishing, which prevented us from effectively sampling the lower habitat where we typically capture multiple species of fish.

Juvenile Chinook and Coho Salmon tagged and released below the Highway 43 culvert in the summer and fall months are the majority of fish detected by our PIT tag antennas. In 2016,

## Tryon Creek Restoration Monitoring

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Chinook and Coho salmon appeared to reside in the pool for months instead of days or weeks as previously observed. This may have been due to cooler water temperatures and beaver dams that may have provided suitable rearing habitat for a longer period. Our PIT antennas detected juvenile salmon after they were tagged by ODFW and released into tributaries of the Willamette River. Resident fish such as Coastal Cutthroat Trout and hybrid trout were detected throughout the year, which indicates there may be a migratory component in both populations. However, the majority of tagged Coastal Cutthroat Trout have not been detected leaving the system, suggesting the resident form may be the most common. It is important to note that shed PIT tags can move downstream during high flow events (>100 cfs). These shed PIT tags may account for false positive detections when detected by our antennas. Detections of fish tagged may continue for several years as fish mature and complete their migration.

### **FY 2017 Tasks**

- Maintain a Passive Integrated Transponder (PIT) array at the mouth of Tryon Creek
- Conduct monthly sampling (seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert 1/2017-3/2017
- Conduct weekly sampling (seine/electrofishing) from the Tryon Creek confluence to the Highway 43 culvert 4/2017-6/2017
- Conduct an annual survey in July to electrofish above and below the Highway 43 culvert to detect larval lamprey distribution
- Conduct a single pass abundance estimate upstream of the Highway 43 culvert to SW Maplecrest Drive Culvert

### **Acknowledgements**

Thank you to the City of Portland (for funding and field assistance), Brian Davis and the CRFWCO staff, Amelia Reed, Friends of Tryon Creek, Oregon Department of Transportation, ODFW, The City of Lake Oswego, Tryon Creek Watershed Council, Oregon State Parks, as well as the students/volunteers of Lewis and Clark College and the surrounding neighborhoods.

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## Tryon Creek Restoration Monitoring

### Appendix A: Sample conditions and catch per unit effort (CPUE) for all sample events in the Tryon Creek confluence habitat (2012 – 2016)

Sample Date	Water Temp (C°)	Flow (cfs)	Sample Method	Seine Effort (pool volume m <sup>3</sup> , hauls)	EFish Effort (sec)	Effort (hours)	Fish Captured (n)	EFish CPUE	Seine CPUE
7/3/12	14.3	2.5	E-Fish	-	758	0.21	8	37.99	-
			Seine	225, 2	-	-	14	-	0.03
8/3/12	14	1.5	E-Fish	-	1238	0.34	28	81.42	-
			Seine	225, 2	-	-	138	-	0.31
9/6/12	14.8	1.0	E-Fish	-	1106	0.31	58	188.79	-
			Seine	225, 2	-	-	45	-	0.10
10/4/12	-	0.5	E-Fish	-	1217	0.34	84	248.48	-
			Seine	225, 2	-	-	48	-	0.11
11/8/12	-	3.0	E-Fish	-	806	0.22	45	200.99	-
			Seine	225, 2	-	-	64	-	0.14
12/13/12	-	15	E-Fish	-	965	0.27	54	201.45	-
			Seine	225, 2	-	-	65	-	0.14
1/18/13	-	5.0	E-Fish	-	1428	0.40	10	25.21	-
			Seine	225, 2	-	-	24	-	0.05
2/8/13	-	6.0	E-Fish	-	1018	0.28	5	17.68	-
			Seine	225, 2	-	-	40	-	0.09
3/7/13	-	8.5	E-Fish	-	1193	0.33	67	202.18	-
			Seine	225, 2	-	-	31	-	0.07
3/22/13	-	7.0	E-Fish	-	1265	0.35	51	145.14	-
			Seine	225, 2	-	-	48	-	0.11
3/28/13	-	4.0	E-Fish	-	1195	0.33	61	183.77	-
			Seine	225, 2	-	-	56	-	0.12
4/4/13	-	3.0	E-Fish	-	1089	0.30	17	56.20	-
			Seine	225, 2	-	-	30	-	0.07
4/11/13	-	5.0	E-Fish	-	1099	0.31	20	65.51	-
			Seine	225, 2	-	-	40	-	0.09
4/18/13	-	3.5	E-Fish	-	1022	0.28	90	317.03	-
			Seine	225, 2	-	-	46	-	0.10
4/25/13	-	3.0	E-Fish	-	1184	0.33	62	188.51	-
			Seine	225, 2	-	-	5	-	0.01
5/2/13	-	2.5	E-Fish	-	1076	0.30	20	66.91	-
			Seine	225, 2	-	-	18	-	0.04
5/8/13	-	2.0	E-Fish	-	701	0.19	70	359.49	-
			Seine	225, 2	-	-	43	-	0.10
5/16/13	-	2.0	E-Fish	-	1076	0.30	57	190.71	-
			Seine	225, 2	-	-	39	-	0.09
5/31/13	-	5.0	E-Fish	-	1547	0.43	94	218.75	-
			Seine	225, 2	-	-	16	-	0.04
6/6/13	-	2.6	E-Fish	-	1241	0.34	95	275.58	-
			Seine	225, 2	-	-	13	-	0.03
6/14/13	-	2.5	E-Fish	-	1089	0.30	93	307.44	-
			Seine	225, 2	-	-	31	-	0.07
7/2/14	17.0	1.7	EFish	-	796	0.22	118	536.36	-
			Seine	225, 2	-	-	29	-	0.06
8/6/14	16.6	0.7	EFish	-	427	0.12	54	450.00	-
			Seine	225, 2	-	-	43	-	0.09
8/27/14	17.5	0.5	Seine	225, 2	-	-	40	-	0.08

## 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)	Effort (hours)	Fish Captured (n)	EFish CPUE	Seine CPUE
10/8/14	13.9	0.7	EFish	-	800	0.22	119	540.91	-
			Seine	225, 2	-	-	18	-	0.04
11/5/14	13.3	7.5	EFish	-	952	0.26	65	250.00	-
			Seine	225, 2	-	-	23	-	0.05
12/3/14	4.4	4.7	EFish	-	724	0.20	48	240.00	-
			Seine	225, 2	-	-	68	-	0.15
12/31/14	1.7	4.5	EFish	-	597	0.17	14	82.40	-
			Seine	225, 2	-	-	41	-	0.09
2/4/15	8.9	10.0	EFish	-	681	0.19	42	221.1	-
			Seine	225, 2	-	-	48	-	0.11
3/4/15	4.9	3.9	EFish	-	522	0.15	30	200.0	-
			Seine	225, 2	-	-	14	-	0.03
4/1/15	8.9	5.5	EFish	-	691	0.19	35	184.2	-
			Seine	225, 2	-	-	25	-	0.06
4/8/15	10.4	4.0	EFish	-	932	0.26	58	223.1	-
			Seine	225, 2	-	-	14	-	0.03
4/15/15	6.7	5.7	EFish	-	829	0.23	45	195.7	-
			Seine	225, 2	-	-	33	-	0.07
4/22/15	9.7	3.9	EFish	-	698	0.19	67	352.6	-
			Seine	225, 2	-	-	27	-	0.06
4/28/15	13.4	3.6	EFish	-	665	0.18	50	277.8	-
			Seine	225, 2	-	-	38	-	0.08
5/6/15	11.0	3.1	EFish	-	663	0.18	59	327.8	-
			Seine	225, 2	-	-	66	-	0.15
5/13/15	11.6	3.4	EFish	-	889	0.25	53	212.0	-
			Seine	225, 2	-	-	86	-	0.19
5/20/15	13.4	2.4	EFish	-	532	0.15	49	326.7	-
			Seine	225, 2	-	-	99	-	0.22
5/27/15	12.7	2.0	EFish	-	628	0.17	41	241.2	-
			Seine	225, 2	-	-	90	-	0.20
6/3/15	14.4	3.0	EFish	-	488	0.14	50	357.1	-
			Seine	225, 2	-	-	27	-	0.06
6/10/15	15.2	1.7	EFish	-	593	0.16	67	418.8	-
			Seine	225, 2	-	-	103	-	0.23
6/17/15	14.5	1.4	Seine	225, 2	-	-	175	-	0.39
6/24/15	15.8	1.1	EFish	-	720	0.20	67	335.0	-
			Seine	225, 2	-	-	131	-	0.29
7/6/16	14.9	0.9	EFish	-	871	0.24	186	769	-
			Seine	225, 2	-	-	66	-	0.147
8/3/16	14.9	0.6	EFish	-	680	0.19	188	995	-
			Seine	225, 2	-	-	79	-	0.176
9/7/16	15.2	1.5	EFish	-	1,250	0.35	275	792	-
			Seine	225, 2	-	-	110	-	0.244
10/4/16	12.4	1.1	EFish	-	1,169	0.32	195	601	-
			Seine	225, 2	-	-	82	-	0.182
11/1/16	12.0	5.0	EFish	-	1,041	0.29	145	501	-
			Seine	225, 2	-	-	20	-	0.044
12/6/16	7.2	18.0	EFish	-	947	0.26	57	217	-
			Seine	225, 2	-	-	1	-	0.002

# Tryon Creek Restoration Monitoring

## Appendix B: Fish Capture below Highway 43 Culvert (2012 - 2016)

Date	Banded Killifish	Bluegill	Brown Bullhead	Chinook Salmon	Coastal Cutthroat	COHO	Crawfish	Dace	Goldfish	Hybrid Trout	Largemouth Bass	Mosquitofish	Mountain Whitefish	Northern Pike/minnow	O. mykiss	Oriental Weatherfish	Pacific Lamprey	Peamouth	Sculpin sp.	Smallmouth Bass	Sucker	Threespine Stickleback	Trout Fry
7/3/2012				1	4	10				5					2								
8/3/2012			1	25	7	21				3			4		4				95			1	1
9/6/2012				17	9	20					1		4		2				46			2	2
10/4/2012				20	6	18		3		5			2		1				56	8	1		
11/8/2012				16	1	46				1	1				1				28	9			
12/13/2012				17	2	40				2					8				46				4
1/18/2013				9	2	18				3					2								
2/8/2013				10	1	29				3					2								
3/7/2013				13	2	25				2					1				55				
3/22/2013				7	1	43				3					3				42				
3/28/2013				10	1	46				2					9				48			1	
4/4/2013				7	1	31				5					3								
4/11/2013				2	2	44				6					4							1	
4/18/2013				11	1	39				3					5				76			1	
4/25/2013				5	1	5				1					3				51			1	
5/2/2013		1		10	1	19		1		1					3							2	
5/8/2013				9	1	29				7					5				62				
5/16/2013				6		35				6					1				47				
5/31/2013				14	2	9				9					1				75				
6/6/2013				7	2	6				7									79				7
6/14/2013				17	3	13				7					4		0		80				
7/3/2013																	4						
7/2/2014				4	18	17									1				106				1
8/6/2014				7	20	24				1							1		45				

## Tryon Creek Restoration Monitoring

Date	Banded Killifish	Bluegill	Brown Bullhead	Chinook Salmon	Coastal Cutthroat	COHO	Crawfish	Dace	Goldfish	Hybrid Trout	Largemouth Bass	Mosquitofish	Mountain Whitefish	Northern Pike/minnow	O. mykiss	Oriental Weatherfish	Pacific Lamprey	Peamouth	Sculpin sp.	Smallmouth Bass	Sucker	Threespine Stickleback	Trout Fry
8/27/2014				1	14	14				1									10				
10/8/2014				4	12	4		1		3	1				1				98	10			
11/5/2014				12	7	6		1		1					1				59	1			
12/3/2014				56	7	16				1					2			1	33				
12/31/2014				23		21													11				
2/4/2015				14	4	31				1			1						38	1			
3/4/2015				7	3	10		1		1					2				20				
4/1/2015				11	6	12			1	1					5				23			1	
4/8/2015				8	7	12									4				41				
4/15/2015				10	12	22				3					7				24				
4/22/2015				8	12	22				3					2				47				
4/28/2015				3	14	28			3	1					2				37				
5/6/2015				10	12	67													34				
5/13/2015				6	9	78									2				35				
5/20/2015				1	9	97			1						2				30				
5/27/2015				1	8	80													41				
6/3/2015				1	8	28													40				
6/10/2015					6	112													52				
6/17/2015					6	150													19				
6/24/2015					6	136													55				
7/13/2015																	10						
7/6/2016		3		9	1	53	16												184				
7/19/2016							3									2	1						
8/3/2016		1		14	1	41	12			1									209				
9/7/2016		1		17	1	18	10			1					1				346				
10/4/2016		1		15	1	20	11			1							1		238				

## Tryon Creek Restoration Monitoring

Date	Banded Killifish	Bluegill	Brown Bullhead	Chinook Salmon	Coastal Cutthroat COHO	Crawfish	Dace	Goldfish	Hybrid Trout	Largemouth Bass	Mosquitofish	Mountain Whitefish	Northern Pike/minnow	O. mykiss	Oriental Weatherfish	Pacific Lamprey	Peamouth	Sculpin sp.	Smallmouth Bass	Sucker	Threespine Stickleback	Trout Fry
11/1/2016	1			2	22	3		1			1							135	1			1
12/6/2016				3	2													52				1

## Tryon Creek Restoration Monitoring

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### Appendix C: Simpson (1-D) Diversity Index for each sample event (2012 - 2016)

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

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