U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office

Tryon Creek Restoration Monitoring

FY 2014 Progress Report

Brook P. Silver, J. Michael Hudson, and Timothy A. Whitesel

U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office
Vancouver, WA 98683

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On the cover: *Seining fish below the Highway 43 culvert pool 2014, photo by Marc Peters.*

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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 to assess the restoration response of multiple species historically present, or believed to be present, in Tryon Creek. Goals in 2014 were to evaluate fish community, relative abundance, and temporal use in the confluence habitat. Fish occupancy and abundance was assessed through electrofishing and seining. To determine temporal use of fish in the confluence habitat, Passive Integrated Transponder (PIT) antennas were installed to detect PIT tagged fish entering or exiting the Willamette River.

The fish community below the Highway 43 culvert included 11 species, numbering 618 individuals. Native fish were the most abundant comprising 81.8% (n = 9) of the species captured and 97.7% (n = 604) of the individuals captured. The majority of tagged coastal cutthroat trout were not detected leaving the system, suggesting the resident form may be dominant. Nearly all juvenile anadromous salmonids (Chinook, coho, and *O. mykiss*) captured below the Highway 43 culvert were wild (98.5%, 191/194) originating from elsewhere in the basin. Coho and Chinook salmon were detected leaving Tryon Creek 0 - 73 (median = 0) days after tagging, indicating habitat in Tryon Creek below the Highway 43 culvert acts as rearing habitat for out-migrating juvenile salmon in the Willamette River basin.

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Introduction

Tryon Creek (approximately 1,680 hectares) is one of the largest, relatively protected, urban watersheds in Oregon (BES 1997). A number of native fish species can be currently found in this stream including coastal cutthroat trout (*Oncorhynchus clarki*) (cutthroat), *O. mykiss* (resident and anadromous) (steelhead), cutthroat/steelhead hybrids (hybrids) (e.g., Tinus et al. 2003), coho (*O. kisutch*), and Chinook salmon (*O. tshawytscha*) (Chinook) (e.g., Hudson et al. 2009). Historically, it is thought Pacific lamprey (*Entosphenus tridentatus*) and western brook lamprey (*Lampetra richardsoni*) as well as other salmonids utilized this stream. However, a culvert that runs under Oregon State Highway 43 and the adjacent railroad is potentially inhibiting, if not preventing, 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 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 Highway 43 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 3 km of Tryon Creek from its confluence with the Willamette River to the Highway 43 culvert. In 2012, the U. S. Fish and Wildlife Service began a partnership with the City of Portland's Bureau of Environmental Services to assess fish abundance, community, and temporal use of the Tryon Creek confluence with the following objectives:

1. Estimate relative abundance of fish species present.
    a. Conduct monthly sampling (seine/electrofish) from the Tryon Creek confluence to the Highway 43 culvert (7/2014-2015, 7/2016-2017, and 7/2018-2019).
    b. Conduct weekly sampling (seine/electrofish) from the Tryon Creek confluence to the Highway 43 culvert in the spring/summers of 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 two-pass abundance estimates of salmonid species above the Highway 43 culvert in fall 2015 and 2019, plus a single pass in fall 2017.
2. Describe fish community throughout the year

3. Document temporal use of this habitat by the fish species present during the spring/summer.

    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 Fisheries Program Strategic Plan

Implementation of this project demonstrates application of the Pacific Region's 2009-2013 Fisheries Program 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

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.

Study Area

Tryon Creek is a 7.81 km, second order tributary to the Willamette River located in southwest Portland, OR (Figure 1). Its watershed covers 17.9 km^2 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 Taylors 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^2 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 before entering the Willamette River at river kilometer (rkm) 32.

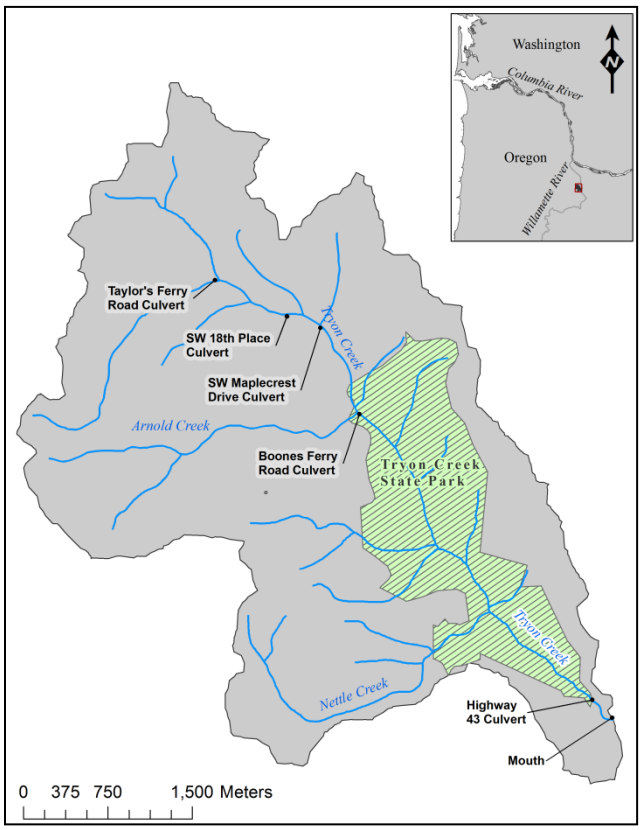

Figure 1. Tryon Creek Watershed

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).

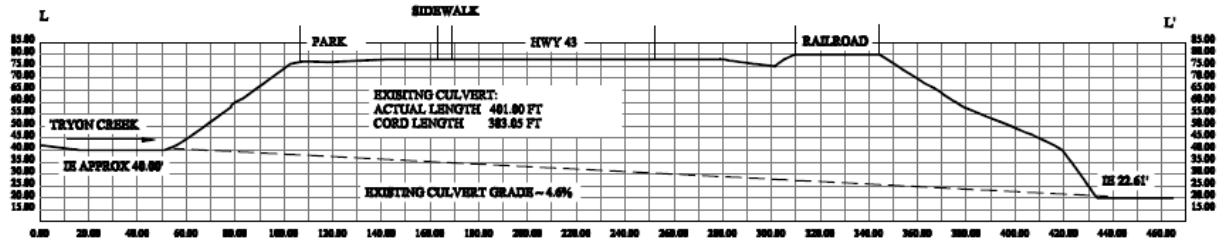

Figure 2. Longitudinal profile of Tryon Creek culvert (Henderson Land Services 2007).

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

Methods

Sampling and Collection

Sampling for the City of Portland fiscal year 2015 occurred monthly July 2014 to December 2014 (monthly sampling will continue until April 2015 and weekly sampling will occur from mid- April to mid-June 2015). Backpack electrofishing occurred in a single pass from the mouth of Tryon Creek to the downstream edge of the Highway 43 culvert pool (Figure 4). Electrofishing was conducted using a Smith-Root model LR-24 shocker in a manner to reduce potential harm to the sampled population. Specifically, any area considered holding habitat for fish species (plunge pools, overhanging banks, eddies, large woody debris, and pocket pools within riffles) were sampled in a "stalk and shock" approach. The LR-24 shocker used pulsed direct current set at a frequency of 25 Hz, 13 - 25% duty cycle, and voltage 300 - 375 V. All settings were subject to modification depending on conditions (i.e. water depth, conductivity, flow). Flow was measured by the USGS Discharge Gauge #14211315 approximately 1.5 km upstream (USGS 2015).

The pool below the Highway 43 culvert was then sampled with a seine in two passes. An unbagged 15.2 m long 1.8 m deep, 0.6 cm mesh seine net with float and lead lines was utilized for sampling the Highway 43 culvert pool. Two consecutive hauls were pulled by holding one end of the net at the side of the pool, towing the other end around the perimeter of the pool, and pulling the draglines to shore simultaneously. Fish were then netted out of the seine and placed in an aerated bucket.

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). Fish were then identified, checked for external markings, measured (fork length), weighed, scanned for PIT tags, and tagged if one was not found. After full recovery within an aerated bucket, all fish were released within the reach from which they were captured. Genetic samples were collected from all salmon and steelhead and archived at the USFWS Columbia River Fisheries Program Office.

Occupancy of larval Pacific and western brook lampreys in Tryon Creek was assessed through an annual electrofishing survey conducted on 8/6/2014. 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. Above the Highway 43 culvert, six 50 m-long, randomly selected, spatially-balanced reaches were sampled (Figure 5).

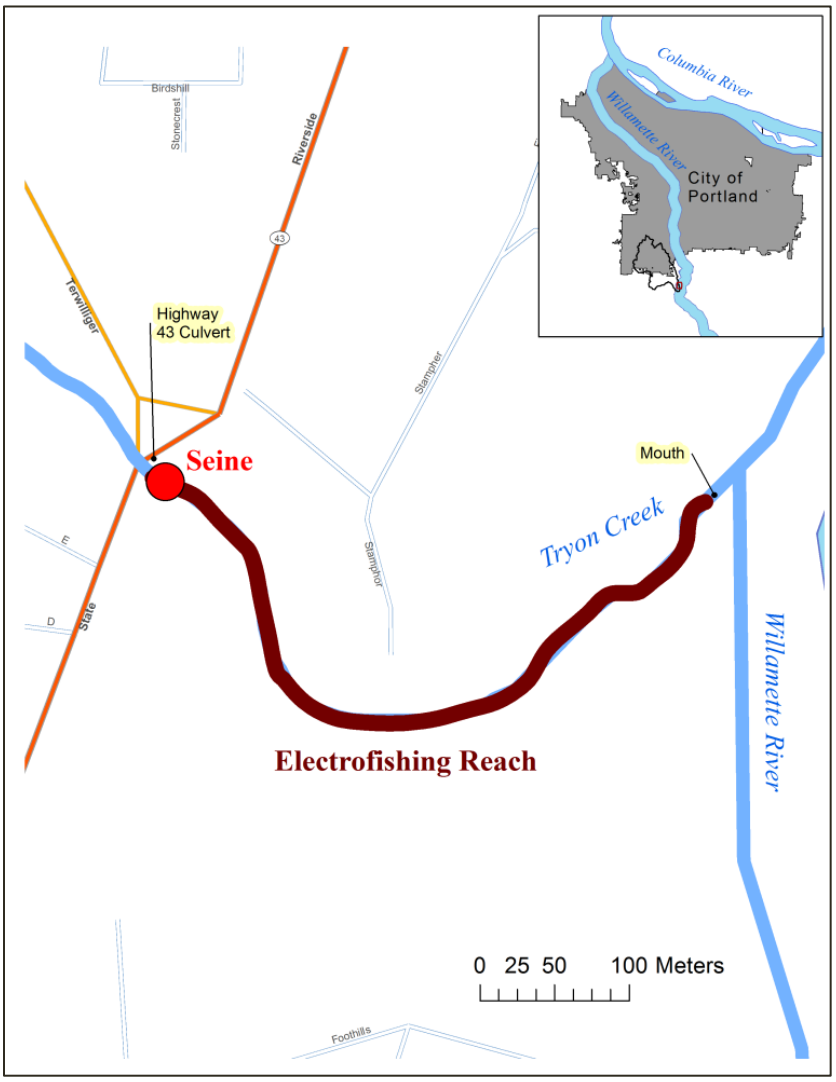

Figure 4. Confluence monitoring reach

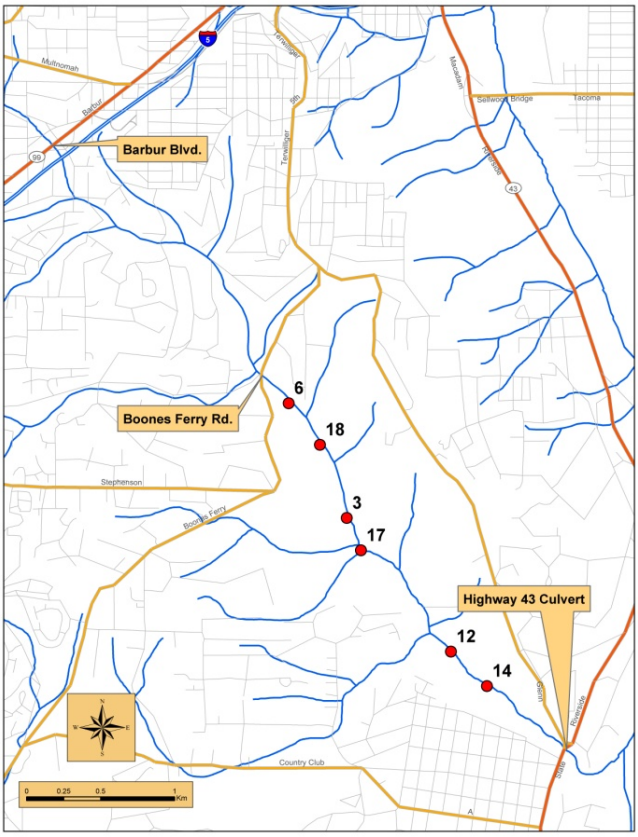

Figure 5. Lamprey survey sites in Tryon Creek between the Highway 43 culvert and Boones Ferry Road.

Abundance

Below the Highway 43 Culvert

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 (Pope et al. 2010; Hubert and Fabrizio 2007). Theoretically, CPUE will increase with an increase in population size where C= catch, E= effort, q = catchability, and N = abundance.

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

It is important to note catchability is variable and can influence the abundance estimate (i.e. season, number of crewmembers, temperature, time of day, etc.).

CPUE varied according to gear type. After each electrofishing survey was completed, the total time (in seconds) of sampling was recorded. The total survey time was converted from seconds to hours. The total number of fish collected during the electrofishing survey was divided by the number of hours the survey lasted. After seining, the total number of fish collected was divided by the pool volume in m^3 (pool width x pool length x seine max depth). The CPUE was averaged by the number of hauls pulled. CPUE was calculated for each sample event.

Above the Highway 43 Culvert

The population of trout species in Tryon Creek above the Highway 43 culvert was not estimated in 2014. The estimate will be conducted in fall 2015 as described in Silver et al. (2014).

Community

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

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) in 2014.

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 conducted on data collected during each sample event in 2014.

Ecological Classification

All species encountered within the confluence habitat 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. Ecological classification was conducted on data collected during 2014.

Temporal Use

Two PIT tag antennas were installed at the mouth of Tryon Creek in February 2014 (TCM). Efficiency was calculated for the upstream antenna (A1) by calculating the proportion of tags detected at both antennas and the number of tags detected at the downstream antenna (A2) only (E_{a1}=# fish detected at A1 and A2/# fish detected at A2). To calculate the efficiency of both antennas, it was assumed that A2 harbored the same efficiency as A1; both antennas were built with the same specs and operated under the same conditions ($1-(1-E_{a1})^2$). 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. For fish tagged in Tryon Creek, PTAGIS was used to query detections at all interrogation sites in the Columbia River Basin. Detection histories for PIT tagged fish were examined to determine whether they moved upstream or downstream in 2014.

Results

Abundance

The confluence habitat was sampled on seven occasions between 7/2/2014 and 12/31/2014. The habitat showed seasonal variation of water temperature and flow. In the summer it was warm (17.5 °C) and flowing slowly (0.5 cfs), in the winter it was cold (0.5 °C) with higher flows (4.5 cfs) (Table 1). Electrofishing was cancelled on 8/27/2014 because the water temperature was too high (17.5°C). A beaver dam was constructed between 7/2/2014 8/6/2014 and was washed out during a fall storm before 10/8/2014 (Figure 6). This beaver dam did not prohibit fish passage, as untagged migratory fish were present in the pool upstream.

Electrofishing effort ranged from 427 seconds to 952 seconds, seine effort was the same for all events (pool volume = 225 m^3, two hauls). Mean electrofishing CPUE (± SE) was 349.95 ± 83.64 and was greater in the summer and early fall months (Table 1). Mean seine CPUE (± SE) was 0.08 ± 0.01. Native salmonids captured include cutthroat, hybrids, steelhead, coho, Chinook, and trout fry (*O. sp.* < 100 mm) (TF). Additional native species consisted of peamouth (*Mylochelius caurinus*) (peamouth), speckled dace (*Rhinichthys osculus*) (speckled dace), and sculpin (*Cottus spp.*) (sculpin). Two introduced species were captured, largemouth bass (*Micropterus salmoides*) (largemouth bass), and smallmouth bass (*Micropterus dolomieu*) (smallmouth bass) (Figure 7). Genetic samples collected from Chinook, coho, and steelhead were archived at the CRFPO (n = 127).

During the larval lamprey occupancy survey conducted on 8/6/2014, one Pacific lamprey larva was collected below the Highway 43 culvert, and one larval Pacific lamprey was caught in reach 18 above the Highway 43 culvert (Figure 5). Reach 18 is near a release site that was part of a 2013 larval Pacific lamprey outplanting effort (Silver et al. 2014). Neither lamprey was visibly tagged with a visual implant elastomer as part of the outplanting project.

Table 1. Sample conditions and catch per unit effort (CPUE) in the Tryon Creek confluence habitat.

Sample Date	Temp (C°)	Flow (cfs)	Sample Method	Seine Effort (Pool Volume m^3, hauls)	Efish Effort (sec)	Effort (hours)	Fish Captured (N)	Efish CPUE	Seine CPUE
7/2	17.0	1.7	Efish	-	796	0.22	118	536.36	-
			Seine	225, 2	-	-	29	-	0.06
8/6	16.6	0.7	Efish	-	427	0.12	54	450.00	-
			Seine	225, 2	-	-	43	-	0.09
8/27	17.5	0.5	Seine	225, 2	-	-	40	-	0.08
10/8	13.9	0.7	Efish	-	800	0.22	119	540.91	-
			Seine	225, 2	-	-	18	-	0.04
11/5	13.3	7.5	Efish	-	952	0.26	65	250.00	-
			Seine	225, 2	-	-	23	-	0.05
12/3	4.4	4.7	Efish	-	724	0.20	48	240.00	-
			Seine	225, 2	-	-	68	-	0.15
12/31	1.7	4.5	Efish	-	597	0.17	14	82.40	-
			Seine	225, 2	-	-	41	-	0.09

Photo Marc Peters 8/6/2014

Figure 6. Beaver dam built in the Tryon Creek confluence habitat. Presence of untagged migratory fish upstream and PIT detections downstream indicate it did not prohibit fish passage.

The proportion recaptured fish varied by species (Figure 7). Recaptures of PIT tagged fish occurred on all but the first sample event. Of the 37 PIT tagged fish recaptured, 35% (13/37) were recaptured two or more times. Migratory fish were recaptured at a lower rate. Of the 100 tagged Chinook, six were recaptured; of the 90 coho tagged, 11 were recaptured. Resident fish such as cutthroat and hybrids were recaptured at a greater rate (42.5 and 100.0, respectively) (Table 2).

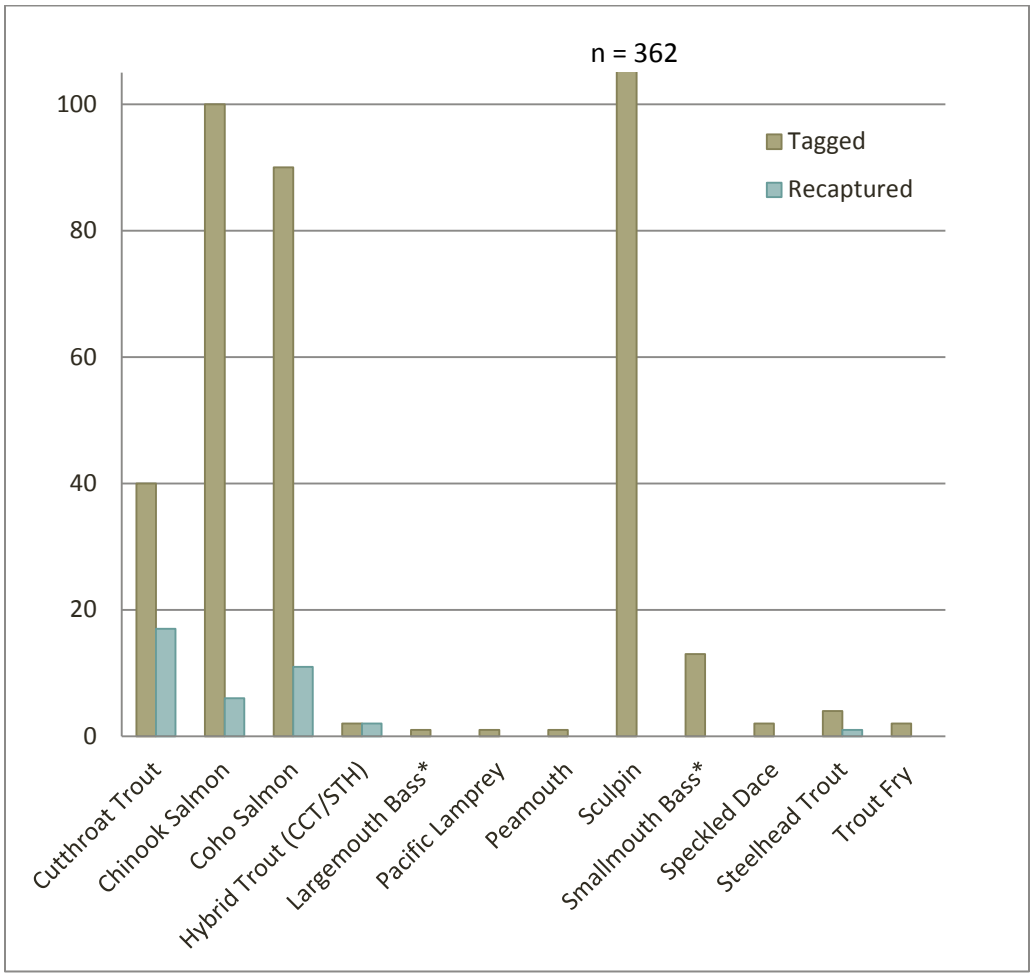

Figure 7. Fish captured in the Tryon Creek Confluence Habitat 7/2/2014 – 12/31/2014. *Indicates introduced species

Table 2. Number of 2014 PIT tagged salmonids and proportion of recaptures indicating resident or migratory behaviors.

Species	# PIT Tagged	# Recaptured	Recapture Rate (Tagged/Recaptured)	Size Class	Life History Behavior
Cutthroat	41	17	41.5	Adult/Juvenile	Resident/Migrant
Chinook	93	6	6.5	Juvenile	Migrant
COHO	83	11	13.3	Juvenile	Migrant
Hybrids	2	2	100.0	Adult/Juvenile	Resident
Steelhead	4	1	25.0	Adult/Juvenile	Migrant/Resident

Hatchery produced salmonids are marked with an adipose fin clip to facilitate distinction from naturally produced (wild) salmonids. The majority (98.5%, 191/194) of juvenile anadromous salmonids (Chinook, coho, and steelhead) captured below the Highway 43 culvert were of wild (naturally produced) origin and immigrated into the pool below the Highway 43 culvert from summer to early winter (August –December) (Appendix A).

Community

Native to Introduced Fish Ratio

Sampling below the Highway 43 culvert resulted in the capture of native and introduced fish, and wild and hatchery reared salmonids. The fish community below the Highway 43 culvert included eleven species numbering 618 unique individuals (Table 3, Appendix A). Native fish were the most abundant comprising 81.8% (9/11) of the species captured and 97.7% (604/618) of the individuals captured.

Table 3. Species captured in the Tryon Creek Confluence Habitat 2012-2014 (grey shading indicates species not captured in 2014, but captured in prior years))

Family	Genus species	Common Name	Species Acronym	Origin (Native/ Introduced) (Hulse 2002)
Catostomidae	*Catostomus sp.*	Sucker	SUK	N
Centrarchidae	*Lepomis macrochirus*	Bluegill	BG	I
Centrarchidae	*Micropterus dolomieui*	Smallmouth bass	SMB	I
Centrarchidae	*Micropterus salmoides*	Largemouth bass	LMB	I
Cottidae	*Cottus sp.*	Sculpin	SCP	N
Cyprinidae	*Mylocheilus caurinus*	Peamouth	PEA	N
Cyprinidae	*Rhinichthys cataractae*	Longnose dace	LND	N
Cyprinidae	*Rhinichthys osculus*	Speckled dace	SPD	N
Gasterosteidae	*Gasterosteus aculeatus*	Three spine stickleback	SKB	N
Ictaluridae	*Ameiurus nebulosus*	Brown bullhead	BBH	I
Petromyzontidae	*Lampetra tridentata*	Pacific lamprey	PCL	N
Salmonidae	*Oncorhynchus clarki*	Cutthroat trout	CCT	N
Salmonidae	*Oncorhynchus clarki/mykiss*	Cutthroat/Rainbow trout hybrid	HYB	-
Salmonidae	*Oncorhynchus kisutch*	Chinook salmon	CHN	N
Salmonidae	*Oncorhynchus mykiss*	Steelhead/Rainbow trout	STH	N
Salmonidae	*Oncorhynchus tshawytscha*	Coho salmon	COHO	N
Salmonidae	*Prosopium williamsoni*	Mountain whitefish	WHF	N

Species Richness

The Simpson Diversity Index was calculated for each sample event. The mean Simpson (1-D) Diversity Index (± SE) was 0.590 ± 0.04 and ranged from 0.446 to 0.691 (Table 4). The index remained relatively constant and showed a diverse species community that was not entirely equitable.

Table 4. Simpson (1-D) Diversity Index for each sample event

Sample Event	Season	Simpson (1-D) Diversity Index
7/2/2014	Summer	0.446
8/6/2014	Summer	0.689
8/27/2014	Summer	0.691
10/8/2014	Fall	0.466
11/5/2014	Fall	0.526
12/3/2014	Fall	0.663
12/31/2014	Winter	0.651

Ecological Classification

Ecological classification indicates sculpin, coho, Chinook and cutthroat were classified as dominant species because they were captured frequently and abundantly. Common species such as steelhead and hybrids were captured less frequent and in smaller numbers; species classified as rare (smallmouth bass, speckled dace, peamouth, largemouth bass, and Pacific lamprey) were captured infrequently and in small numbers.

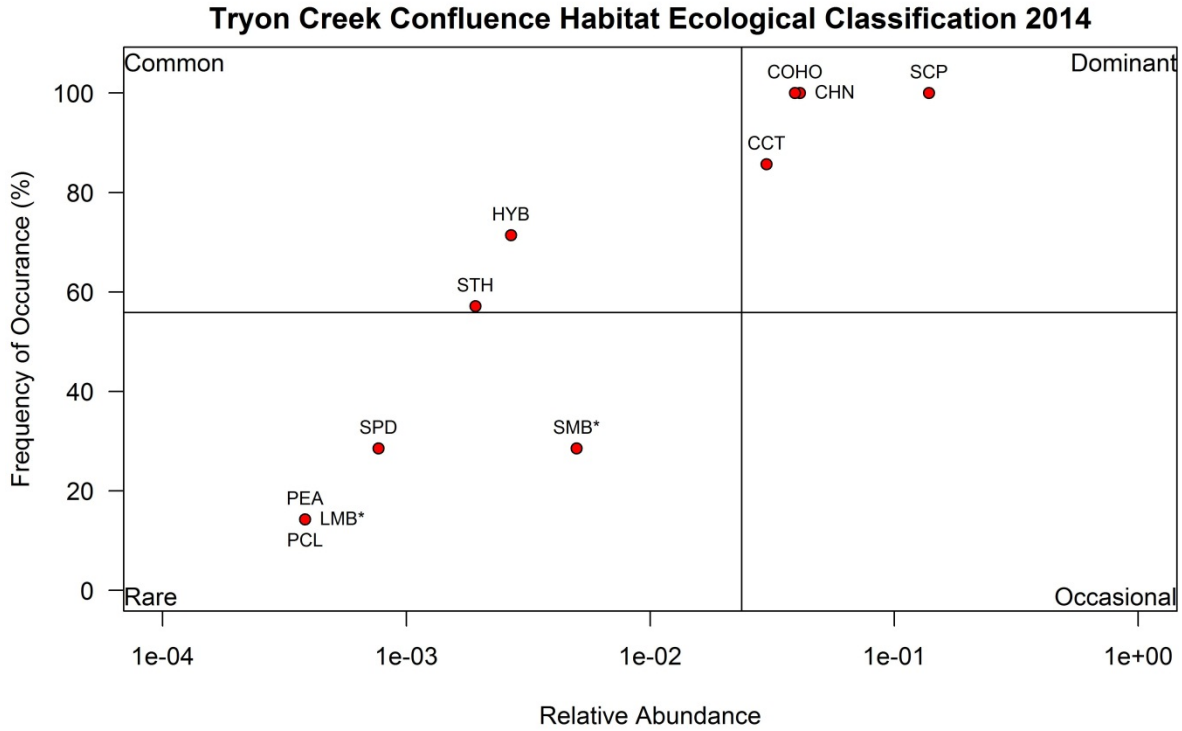

Figure 8. Ecological Classification of species captured in 2014.
*** Indicates introduced species**

Temporal Use

In 2014, the TCM antenna site had an average efficiency of 80.6% and recorded 7,111 detections of 110 unique fish (Table 5). Of these unique detections, 65% (72/110) were juvenile migratory salmonids (Chinook and coho). The majority (83/110) of the fish detected at the TCM antenna site were tagged and released in Tryon Creek below the Highway 43 culvert between 2010 and 2014. Nineteen fish (11 cutthroat, 4 hybrids, and 4 steelhead) were tagged and released above the Highway 43 culvert in 2013. The majority of unique detections occurred in December when coho and Chinook tagged upstream of the antenna emigrated out of the confluence habitat. Resident fish such as cutthroat, steelhead, and hybrids were detected throughout the year (Figure 9).

Table 5. All detections at the TCM antenna site in 2014. (#) Indicates fish released in the North Santiam River

Species	# Detections	Unique Detections	Tag Year				
			2010	2011	2012	2013	2014
Chinook	125	51	0	0	0	4 (1)	39 (7)
Coho	3,752	21	0	0	0	1	20
Cutthroat	3,147	23	1	0	1	11	10
Steelhead	20	7	0	0	0	5	2
Hybrids	67	8	0	0	1	6	1
Total	**7,111**	**110**	**1**	**0**	**2**	**28**	**79**

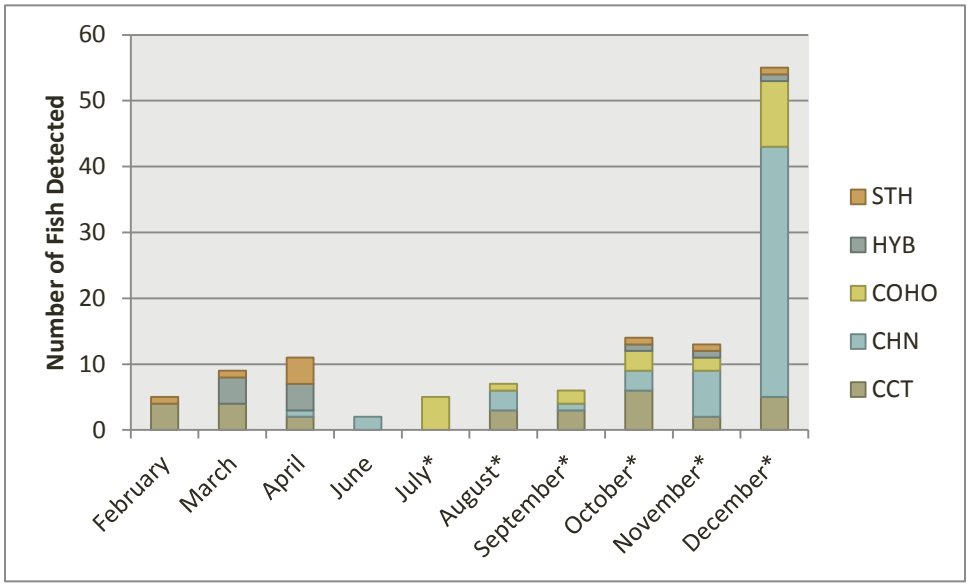

Figure 9. Number of unique detections by month and species. * Indicates a tagging event(s) occurred

The TCM antenna site detected salmonids tagged below the Highway 43 culvert in 2014 emigrating from Tryon Creek. Juvenile anadromous salmonids (39 Chinook, 20 coho) were detected emigrating from Tryon Creek 0 - 73 (median = 0) days after tagging (Table 6). Of the juvenile anadromous fish that did not immediately emigrate from Tryon Creek, 17 remained for 1- 73 days after tagging (median = 1). Salmonids exhibiting both resident and anadromous behaviors (10 cutthroat, 1 hybrid, and 2 steelhead) were detected by the TCM antenna 0 - 88 days (median = 0) after tagging (Table 6). Five of these fish did not immediately emigrate from Tryon Creek and remained for 1- 88 days after tagging (median = 40). All fish were detected moving downstream within three months of being tagged.

Table 6. Fish PIT tagged in 2014 and detected at the TCM antenna site

	# PIT Tagged	% Detected	Days after tagging and Last Detection		
			Median	Min	Max
Chinook	93	42%	0	0	73
Coho	83	24%	0	0	27
Cutthroat	41	24%	0	0	88
Steelhead	4	50%	0	0	0
Hybrids	2	50%	41	41	41
Total	**223**	**32%**			

A query of the PTAGIS database showed anadromous salmonids used the confluence habitat as part of their 2014 migration (Figure 10). One coho tagged below the Highway 43 culvert in 2013 was detected upstream at the Eagle Creek National Fish Hatchery Fish Ladder (ECH) (Eagle Creek rkm 20) on 11/23/2014 and 12/15/2014 (PTAGIS 2015). The TCM antenna site detected eight hatchery Chinook released upstream by the Marion Forks Hatchery in 2013 and 2014 (Table 7).

Figure 10. Detections of fish before/after using the Tryon Creek confluence during migration

Table 7. TCM Detections of hatchery released Chinook in 2014

PIT ID	Release Site	Release Date	First TCM Detection Date	Last TCM Detection Date
384.3B23A0D1F9	North Santiam River, Oregon	6/27/2013	6/29/2014	6/29/2014
3DD.0077621028		7/9/2014	10/29/2014	11/21/2014
3DD.0077692CF0			11/7/2014	12/4/2014
3D9.1C2DA4508A			12/10/2014	12/10/2014
3DD.00776861CA				
3DD.007768F7C0			12/11/2014	12/12/2014
3D9.1C2DA3D8DA			12/21/2014	12/21/2014
3DD.0077689865				

Findings

- The habitat and biological conditions created by the Tryon Creek Confluence Enhancement Project are suitable for native resident and migratory fish. Although introduced species of fish are found in the confluence area, they are infrequent and not abundant.
- The greater electrofishing CPUE in the summer and early fall months could be due to the low flow rate during that time. Catchability varies under different flow conditions; as flow increased in the winter months, clarity was reduced, thus lowering the catch rate. Fish captured by seine were in greater abundance in the late fall and early winter months when juvenile migratory fish were moving downstream and taking refuge in the pool below the Highway 43 culvert.
- Species diversity showed a diverse community that was composed of both abundant and scarce species for all sample events.
- Species richness (the number of species) reflects the overall biodiversity of the aquatic ecosystem. The Willamette Basin contains about 31 native fish and 29 introduced species (Hulse 2002). In the confluence habitat, eleven species were captured numbering 618 unique individuals. Native fish were both the most abundant species captured (n = 9) and individuals captured (n = 604).
    - A total of 13 native species and four introduced species have been captured in the confluence habitat to date (2012 - 2014).
- Relative to the confluence habitat, the ecological classification of species captured ranged from "rare" to "dominant." Dominant species such as sculpin, coho, Chinook, and cutthroat were captured frequently and abundantly. Species such as steelhead and hybrids were captured less frequently and in smaller numbers and were classified as "common." Species classified as "rare" (smallmouth bass, speckled dace, peamouth, largemouth bass, and Pacific lamprey) were captured infrequently in small numbers.
    - Native species captured from previous sampling (2012-2013) include longnose dace (*Rhinichthys cataractae*), three spine stickleback (*Gasterosteus aculeatus*), sucker (*Catostomus sp.*), and mountain whitefish (*Prosopium williamsoni*). All of these species were relatively rare in the confluence habitat.
    - Introduced species captured from previous sampling (2012-2013) include brown bullhead (*Ameiurus nebulosus*) and bluegill (*Lepomis macrochirus*). Both were relatively rare in the confluence habitat.
    - Relative to the Willamette River, all species in the confluence habitat are classified as "common," except coho, which are classified "rare" (Hulse et al. 2002).
- The majority of the fish detected at the TCM antenna site were tagged and released in Tryon Creek below the Highway 43 culvert between 2010 and 2014.
    - Resident fish such as cutthroat, steelhead, and hybrids were recaptured at a higher rate and detected throughout the year at the TCM antenna site. This may indicate the presence of a migratory component of the population. However, the majority of tagged coastal cutthroat have not been detected leaving the system, suggesting the resident form may be dominant.
    - Migratory fish were recaptured at a lower rate than resident fish and were the majority of fish detected at the TCM antenna site. These detections occurred in

December when coho and Chinook tagged upstream of the TCM antenna site emigrated out of the confluence habitat.

- The confluence enhancement project created off channel habitat important for juvenile Chinook in winter months. Flooding in the Willamette creates strong currents and juveniles need to move into the floodplain where there is slower moving water and take refuge in the pool below the Highway 43 culvert (Schroeder et. al 2014). This off channel habitat is especially important in the lower Willamette where there has been development along the riverbanks and loss of channels due to urbanization.
    - Chinook and coho that utilize the Tryon Creek confluence as part of their migration are assumed to have originated from upstream locations (upper Willamette River basin).
    - All fish moving downstream were detected within three months of being tagged.
    - A coho was detected upstream at the Eagle Creek National Fish Hatchery and Chinook released in the North Santiam River were detected migrating downstream.
    - Fish tagged in 2014 will continue to be detected outmigrating from Tryon Creek in 2015.
- Additional years of sampling will allow a better inventory of fish species and contribute to our understanding of fish use of the habitat over time.

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Appendix A: Fish Capture

Date		Cutthroat	Cutthroat Recap	Chinook	Chinook HAT	Chinook Recap	Chinook HAT Recap	Coho	Coho HAT	Coho Recap	Hybrid	Hybrid Recap	Largemouth Bass	Pacific Lamprey	Peamouth	Sculpin	Smallmouth Bass	Speckled Dace	Steelhead	Steelhead Recap	Trout Fry
7/2	Efish	4		2				5								105			1		1
7/2	Seine	2		1				8								1					
7/2	Seine	12		1				4													
8/6	Efish	5		4												45					
8/6	Efish													2*							
8/6	Seine	4	3					7				1									
8/6	Seine	7	1	3				15		2											
8/27	Seine	1	3					2								3					
8/27	Seine	2	8					3		10		1				7					
10/8	Efish	2	1	3							2		1			95	12	1	1		
10/8	Seine															3					
10/8	Seine	1	8			1		3		1		1									
11/5	Efish		2	1												59	1	1		1	
11/5	Seine		2	10				5	1												
11/5	Seine		3	1								1									
12/3	Efish	1	3	1		1		6				1			1	32			2		
12/3	Seine		1	5			1	2													
12/3	Seine		2	48	1			7								1					
12/31	Efish			3												11					
12/31	Seine			3	1			5													
12/31	Seine			13		3		16													
Total		41	37	99	2	5	1	88	1	13	2	5	1	2	1	362	13	2	4	1	1

*1 Pacific lamprey captured above the Highway 43 culvert was not used in the confluence habitat analysis

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