

U.S. Fish and Wildlife Service

Tryon Creek Restoration Monitoring

2013 Progress Report



**Brook P. Silver, J. Michael Hudson, Gregory S. Silver, Jeffrey Jolley, and
Timothy A. Whitesel**

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

On the cover: Sampling fish below the Highway 43 culvert 2012, photo by Marc Peters.

The correct citation for this report is:

Silver, B.P., J.M. Hudson, G.S. Silver, J. Jolley, and T.A. Whitesel. 2014. Tryon Creek Restoration Monitoring, 2013 Progress Report. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, WA.

Tryon Creek Restoration Monitoring 2013 Progress Report

Study funded by

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

City of Portland
Bureau of Environmental Services

and authored by

Brook P. Silver
J. Michael Hudson
Gregory S. Silver
Jeffrey Jolley
Timothy A. Whitesel

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

Final
May 2014

Disclaimers

Any findings and conclusions presented in this report are those of the authors and may not necessarily represent the views of the U.S. Fish and Wildlife Service.

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the federal government.

Tryon Creek Restoration Monitoring 2013 PROGRESS REPORT

Brook P. Silver, J. Michael Hudson, Gregory S. Silver, Jeffrey Jolley, and Timothy A. Whitesel

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

Abstract – Tryon Creek and its headwaters are located in southwest Portland, Oregon. The lower portion of the stream is bisected by a culvert that runs under Oregon State Highway 43 near the mouth. A collaborative project to improve passage conditions for anadromous fish is occurring in two phases. The initial phase retrofitted the existing stream and culvert with an elevated pool and new baffle system to improve fish passage. The second phase proposes to provide a long-term solution by replacing the existing culvert. 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. Occupancy and distribution of larval Pacific and western brook lamprey was determined through electrofishing and spawning ground surveys. Salmonid occupancy and abundance was assessed through electrofishing and seining. In addition, salmonid movement through the Highway 43 culvert and at the confluence with the Willamette River was evaluated using passive integrated transponder (PIT) arrays.

A larval Pacific lamprey outplanting effort occurred in May 2013 using larvae collected from the Clackamas River basin. Larval Pacific lampreys (N = 1,046) were tagged with Visible Implant Elastomers (VIE) and released in Tryon Creek at four locations below Boones Ferry Road. Occupancy of larval Pacific lamprey was assessed through an electrofishing survey. Ten VIE tagged larvae were recaptured during the survey, four were collected below the Highway 43 culvert, six were collected above the Highway 43 culvert near the site of outplanting. Spawning ground surveys were conducted following outplanting to monitor for adult Pacific lamprey entering and spawning in Tryon Creek. There was no evidence of Pacific lamprey spawning.

Resident trout and juvenile salmonids were captured above and below the Highway 43 culvert. The estimated abundance of trout >100 mm from a single pass above the Highway 43 culvert was 747 individuals (95% CI = 671 – 873). The fish community below the Highway 43 culvert included fourteen species, numbering 1,943 individuals. Native fish were the most abundant comprising 71.4% (n = 10) of the species captured and 98.6% (n = 1,916) of the individuals captured. The majority of juvenile anadromous salmonids (Chinook, coho, and steelhead) captured below the Highway 43 culvert were of wild origin (96.8%, 481/497).

Passage of salmonids upstream through the Highway 43 culvert and the Boones Ferry Road culvert has been documented by PIT tag detections. The majority of tagged coastal cutthroat trout have not been detected leaving the system, suggesting the resident form may be dominant. Coho and Chinook salmon were detected leaving after residing in Tryon Creek for 10 – 86 days after tagging, indicating habitat in Tryon Creek below the Highway 43 culvert acts as rearing habitat for out-migrating juvenile salmonids originating elsewhere in the Willamette basin.

Page intentionally left blank

Table of Contents

List of Tables	iv
List of Figures.....	v
Introduction.....	1
Relationship to the Fisheries Program Strategic Plan	2
Study Area	4
Methods.....	5
Lamprey	5
Outplanting	5
Larval Occupancy.....	5
Adult Monitoring.....	5
Salmon, Steelhead and Coastal Cutthroat Trout	6
Abundance	6
Fish Passage	8
Movement.....	8
Confluence Monitoring	8
Results.....	9
Lamprey	9
Outplanting	9
Occupancy	9
Adult Monitoring.....	9
Salmon, Steelhead and Coastal Cutthroat Trout	10
Abundance	10
Fish Passage	10
Movement.....	10
Confluence Monitoring	11
Findings.....	18
Acknowledgements.....	20
Literature Cited	21

List of Tables

Table 1. Total number of salmonids captured above the Highway 43 culvert in the fall 2013 single pass abundance estimate.....	10
Table 2. Two salmonids tagged between the Highway 43 culvert and the Boones Ferry Road culvert and recaptured above the Boones Ferry Road culvert indicate upstream passage.	11
Table 3. Species captured below the Highway 43 culvert each month (7/3/2012-3/7/2013), and each week (3/22/2013-6/14/2013).....	12
Table 4. Number of PIT tagged salmonids at the Tryon Creek Confluence and frequency of capture (July 2012 - June 2013).....	15
Table 5. Detections of salmonids tagged in Tryon Creek detected outside the basin.	16
Table 6. Mean number of days between tagging date and last detection (presumed outmigration).....	17

List of Figures

Figure 1. Tryon Creek Watershed.....	4
Figure 2. Longitudinal profile of Tryon Creek culvert (Henderson Land Services 2007).	5
Figure 3. Lamprey survey sites in Tryon Creek between the Highway 43 culvert and Boones Ferry Road.....	6
Figure 4. The Tryon Creek study area. Sixteen reaches between the Highway 43 culvert and the Boones Ferry Road crossing, three reaches in Upper Tryon Creek above Boones Ferry Road to Taylors Ferry Road, and one reach in Arnold Creek above Boones Ferry Road.....	7
Figure 5. Release and detection locations outside of the Tryon Creek watershed	16
Figure 6. Abundance estimates for all trout above Highway 43 culvert in Tryon Creek. Bars represent 95% confidence intervals.....	19

Introduction

Tryon Creek (approximately 1,680 hectares) is one of the largest, relatively protected, urban watersheds in Oregon. A number of native fish species can be currently found in this stream including *Oncorhynchus mykiss* (resident and anadromous), coastal cutthroat trout (*O. clarki*) (CCT) (e.g., Tinus et al. 2003), as well as coho (*O. kisutch*) and Chinook salmon (*O. tshawytscha*) (CHN) (e.g., Hudson et al. 2009). Historically, it is thought that Pacific lamprey (*Entosphenus tridentatus*) and western brook lamprey (*Lampetra richardsoni*) as well as other salmonids utilized this stream. However, a culvert under Highway 43 and the adjacent railroad is potentially inhibiting, if not preventing, passage of lampreys and salmonids.

A collaborative project has been implemented by Oregon Department of Transportation, 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 fish migrating into Tryon Creek. An improvement project for the Highway 43 culvert is proposed to occur in two phases. The initial phase (conducted 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. The second phase, if implemented, will provide a long-term solution to replace the existing culvert. Solutions currently being considered include a larger culvert or bridge (Henderson Land Services 2007).

The USFWS assessment and monitoring program has focused on monitoring the effectiveness of restoration actions to improve fish passage through the Highway 43 culvert. This program is being conducted in three phases: 1) pre-assessment and monitoring prior to the initial phase of culvert improvement; 2) post-assessment and monitoring subsequent to the initial phase and pre-assessment and monitoring prior to the second phase of culvert replacement; 3) post-assessment and monitoring subsequent to the completed culvert replacement project. The focus of the assessment and monitoring project was originally directed at Pacific and western brook lampreys in Tryon Creek and now includes salmonids, specifically *O. mykiss*, and coastal cutthroat trout. The study will assess the restoration response of multiple species historically present, or believed to be present, in Tryon Creek. The objectives are broken into three species groups as follows:

Lamprey

1. Outplant larval Pacific lampreys to provide pheromone attractants for adult Pacific lamprey.
2. Determine whether larval lamprey occupy Tryon Creek.
3. Determine whether adult Pacific lampreys successfully pass through the culvert.
4. Determine whether adult Pacific lamprey spawn above the culvert.

Salmon and Steelhead (anadromous *O. mykiss*)

1. Determine whether juveniles and adults enter the culvert.
2. Determine whether juveniles and adults pass through the culvert.
3. Determine the upstream passage efficiency of juveniles and adults through the culvert.
4. Determine if salmon and steelhead occupy Tryon Creek above the culvert.

Coastal cutthroat trout and resident *O. mykiss*

1. Determine whether juvenile and adult trout species enter the culvert.
2. Determine whether trout species successfully pass through the culvert at any life stage.
3. Determine the upstream passage efficiency of resident trout species through the culvert.
4. Estimate the relative population abundance of trout species above the culvert.

In July 2012, additional work between the City of Portland and U.S. Fish & Wildlife Service began to assess species community, abundance, and temporal use of fish in the confluence habitat below the Highway 43 culvert with the following objectives:

1. Determine fish species community throughout the year.
2. Estimate abundance of fish species present each month of the year.
3. Document temporal use of this area by the fish species present during the spring/summer.

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 located in southwest Portland and its headwaters are located within those neighborhoods (Figure 1). It flows approximately 5 km through this privately owned land before entering Tryon Creek State Natural Area, a 259 hectare area of public land, through which the stream flows another 5 km. The lower portion of Tryon Creek flows 0.3 km through public land owned by the City of Lake Oswego and the City of Portland. This portion of the stream is bisected by a culvert that runs under Oregon Highway 43 and a railroad near the mouth of Tryon Creek. Tryon Creek enters the Willamette River at river kilometer (rkm) 32.

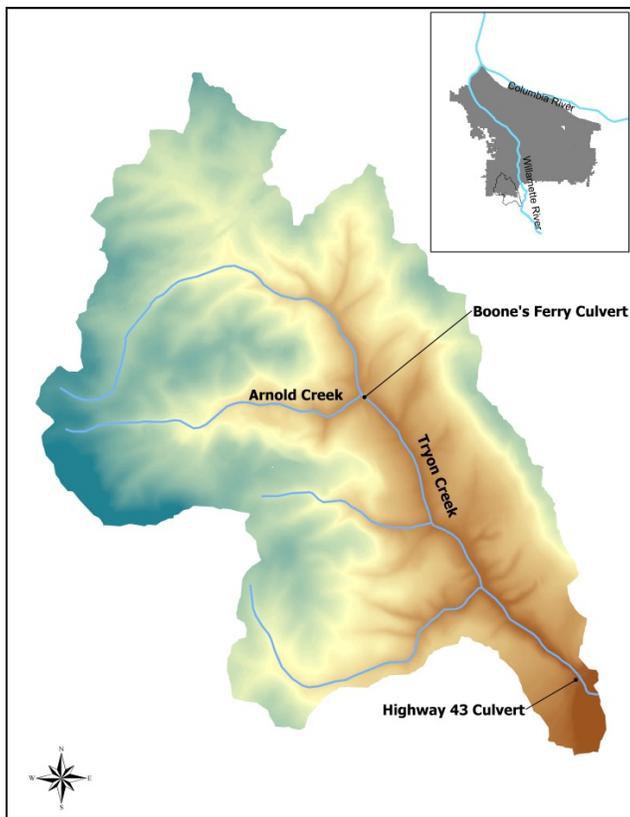


Figure 1. Tryon Creek Watershed

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). There are a series of baffles that provide some structure within the culvert, holding water for fish attempting to migrate upstream through the culvert.

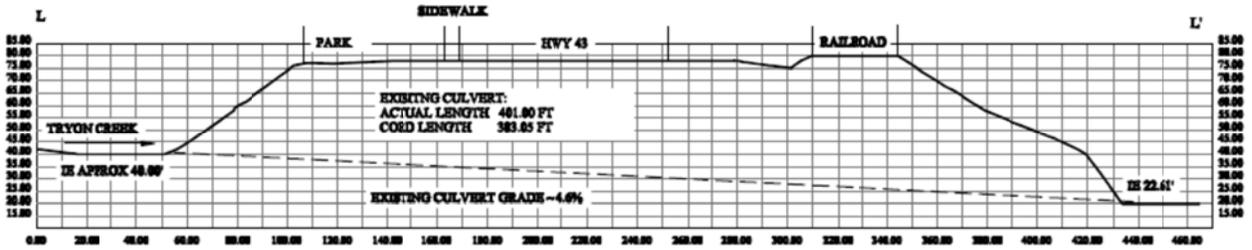


Figure 2. Longitudinal profile of Tryon Creek culvert (Henderson Land Services 2007).

Methods

Lamprey

Outplanting

Larval Pacific lampreys were collected from tributaries of the Clackamas River (Clackamas County, Oregon) using an AbP-2 backpack electrofisher. Collections occurred over four days between 5/7 and 5/13/2013. Collection locations included Clear Creek near the mouth at the Clackamas River, two locations in N.F. Eagle Creek, and Eagle Creek at Eagle Fern Park. Larvae were transported to Tryon Creek in buckets containing aerated river water. Larvae were anesthetized, measured for total length (TL) in mm, and tagged with Visible Implant Elastomer tags (VIE; Northwest Marine Technology, Shaw Island, WA). Upon resuming active swimming behavior, larvae were released at four locations in Tryon Creek approximately 100 to 200 m below Boones Ferry Road. Collection and release sites were georeferenced using a Trimble hand-held GPS unit.

Larval Occupancy

Occupancy of larval Pacific and western brook lampreys in Tryon Creek was assessed through an annual electrofishing survey conducted on 7/3/2013 (Figure 3). 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 3). In addition, weekly sampling at the Tryon Creek confluence below the Highway 43 culvert took place 5/16 - 6/19/2013 (as part of ongoing salmonid monitoring activities).

Adult Monitoring

To monitor whether adult Pacific lamprey entered and spawned in Tryon Creek, two approaches were used. A single PIT antenna was installed to detect tagged adult lamprey (N = 2,065) moving into Tryon Creek from previous tag and release efforts at Willamette Falls (rkm 43) by the Confederated Tribes of the Warm Springs Reservation (PTAGIS 2014a). The antenna operated from 5/16/2013 – 7/10/2013; data was logged on an Oregon RFID half duplex PIT tag reader and downloaded weekly. Foot surveys were conducted on five occasions (5/16, 6/6, 6/14, 6/27, and 7/2/2013) following larval outplanting. The presence and number of nests (redds), live adults and dead adults was documented through surveys conducted moving upstream, beginning at the mouth of Tryon Creek and ending at the Boones Ferry Road culvert.

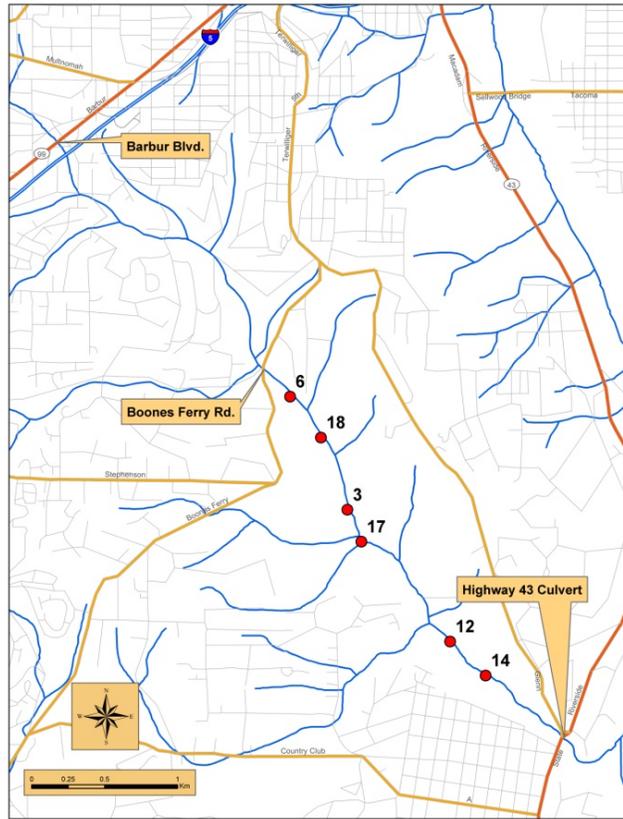


Figure 3. Lamprey survey sites in Tryon Creek between the Highway 43 culvert and Boones Ferry Road.

Salmon, Steelhead and Coastal Cutthroat Trout

Abundance

The population abundance of trout species in Tryon Creek above the Highway 43 culvert was estimated using a single pass conducted 9/9/2013 - 9/13/2013. The estimate included the lower portion of Arnold Creek between the Boones Ferry Road and the culvert at SW Arnold St (Figure 4). The sample method consisted of backpack electrofishing as described in Silver et al. 2013. The electrofisher used pulsed direct current set at a frequency of 26 Hz, 18% duty cycle, and voltage 350 V. All settings were subject to modification depending on conditions (i.e. water depth, conductivity, flow).

At the completion of each sampling reach, all captured fish were anesthetized, identified, checked for external markings, measured (fork length), weighed, and scanned for passive integrated transponder (PIT) tags. After full recovery within an aerated bucket, all fish were released at the top of the reach from which they were captured.

Single-pass data was analyzed using the population estimate for single catches method (Seber and Le Cren 1967):

$$\hat{N} = \frac{C}{\hat{p}}$$

Where \hat{N} is the estimated abundance, C is the number of captured individuals from the single-pass, and \hat{p} is the estimated capture probability. Capture probability was estimated to be 0.30, an average of capture probability generated from the 2008 and 2011 mark-recapture estimates in Tryon Creek (Cook et al. 2009, Silver et al. 2013). Confidence intervals (95%) around the single-pass estimate were generated using the methodology of Seber and Le Cren (1967).

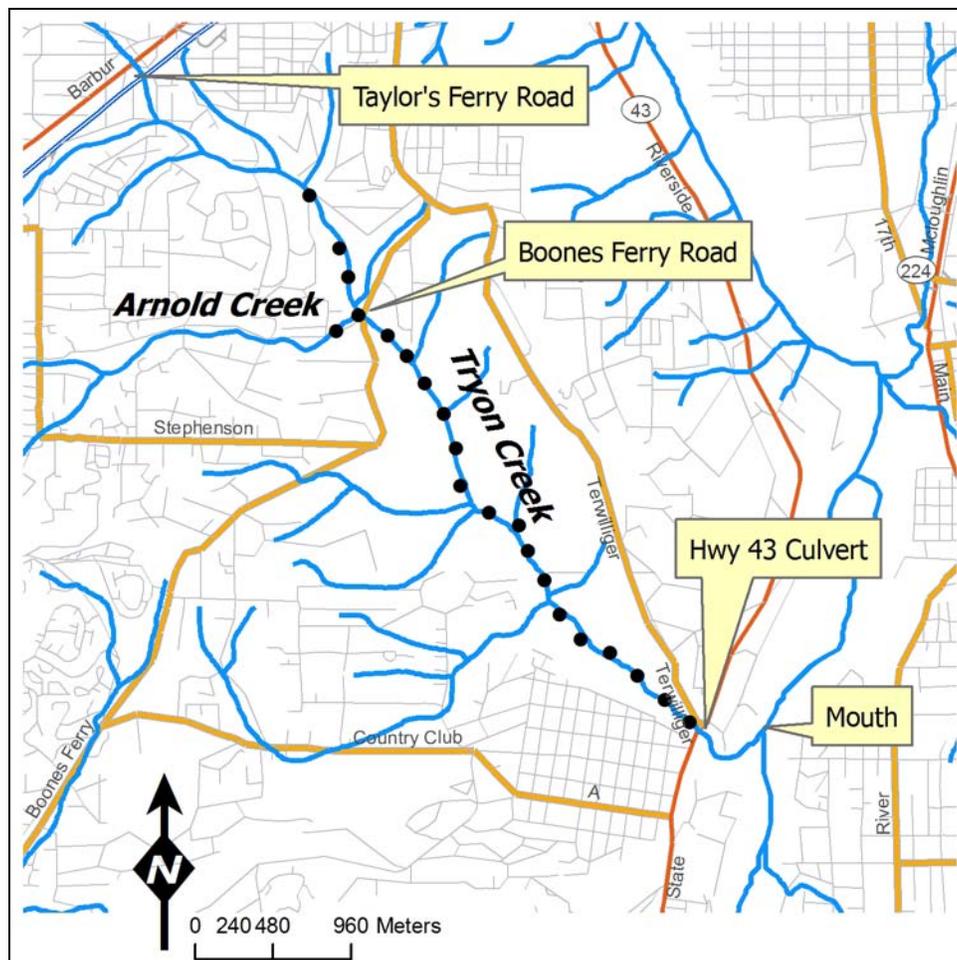


Figure 4. The Tryon Creek study area. Sixteen reaches between the Highway 43 culvert and the Boones Ferry Road crossing, three reaches in Upper Tryon Creek above Boones Ferry Road to Taylors Ferry Road, and one reach in Arnold Creek above Boones Ferry Road.

Fish Passage

Movement

- **Highway 43 Culvert**

Upstream passage through the Highway 43 culvert was assessed using a combination of known tagging locations and movement determined by PIT tag antenna detections. One PIT tag antenna was maintained at the upstream opening of the Highway 43 culvert (TCU). All PIT tagged fish moving over or through this antenna had the opportunity to be detected and were 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 until 11/25/2013 when power was inadvertently turned off to the site.

A test of antenna detection efficiency was conducted on this antenna using twenty PIT tags embedded in corks (Silver et al. 2009). The average antenna efficiency was determined to be 96%. There is no indication that detection efficiency has declined since this time.

- **Boones Ferry Road Culvert**

Passage upstream through the Boones Ferry Road culvert was assessed using mark-recapture sampling from all years (2007-2013). Fish PIT tagged at any location below the Boones Ferry Road culvert were queried for recapture at any location above the Boones Ferry Road culvert in any year.

Confluence Monitoring

To assess community and temporal use of fish in the confluence of Tryon Creek and the Willamette River, electrofishing occurred in a single pass from the mouth of Tryon Creek to the downstream edge of the Highway 43 culvert pool. The Highway 43 culvert pool was then sampled with a seine in two passes. Sampling for the City of Portland fiscal year 2013 occurred monthly July 2012 to March 2013 and weekly from mid-March to mid-June. Backpack 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 24 - 25 Hz, 12 - 14% duty cycle, and voltage 350 V. All settings were subject to modification depending on conditions (i.e. water depth, conductivity, flow). Immediately below the Highway 43 culvert, a deep, non-wadeable pool exists where electrofishing is not an efficient sampling method. Therefore, 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. Fish were identified and tagged as previously described. Genetic samples were also collected from all salmon and steelhead and transferred to the City of Portland.

One PIT tag antenna was installed at the mouth of Tryon Creek in November 2011 (TCM). PIT tagged fish moving over or through this antenna had the opportunity to be detected and were 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. Due to ongoing

noise issues from the power source, no reliable estimate of antenna detection efficiency could be conducted.

The Columbia Basin PIT Tag Information System (PTAGIS 2014b) online database was queried to identify fish detected in Tryon Creek that were tagged and released by other agencies. For fish outmigrating from Tryon Creek, PTAGIS was queried for all 2013 detections of PIT tagged fish from Tryon Creek at all interrogation sites in the Columbia Basin. Detection histories for PIT tagged fish were examined to determine whether they moved upstream or downstream.

Results

Lamprey

Outplanting

A total of 1,046 larval Pacific lampreys were tagged and released into Tryon Creek. Of these, ten larvae were subsequently recaptured during occupancy electrofishing sampling in July 2013 (as described below).

Occupancy

All lamprey outplanted into Tryon Creek were VIE tagged. Below the Highway 43 culvert, four larvae were collected during the electrofishing survey conducted on 7/3/13. One additional larval lamprey was detected during weekly salmonid confluence monitoring sampling, but eluded capture. Above the Highway 43 culvert, zero larval lamprey were caught in reaches 14, 12, 17, and 3 (Figure 3). In reach 18, one larva was collected, and in reach 6, five larvae were collected, all of which had VIE tags.

Adult Monitoring

No adult Pacific lamprey (live or dead) were captured, detected, or observed either above or below the Highway 43 culvert, and no nests were detected in any reach of Tryon Creek.

Salmon, Steelhead and Coastal Cutthroat Trout

Abundance

The fall single-pass survey above Highway 43 resulted in capture of 224 trout (CCT, *O. mykiss*, and Hybrids [CCT/*O. mykiss*] [HYB] combined) >100 mm (Table 1).

Table 1. Total number of salmonids captured above the Highway 43 culvert in the fall 2013 single pass abundance estimate

	Tagged	Not Tagged	Total
CCT (>100 mm)	143	17	160
HYB (>100 mm)	58	4	62
<i>O. mykiss</i> (>100 mm)	2	0	2
Total	203	21	224

A probability of capture of 0.30 for all trout species above the culvert was estimated from an average of those determined from the 2008 and 2011 multiple pass mark-recapture abundance estimates (Cook et al. 2009, Silver et al. 2013). Given this, the estimated abundance of trout >100 mm, between the Highway 43 culvert and S.W. 18th Place, was estimate at 747 individuals (95% CI = 671 – 873) in 2013.

Fish Passage

Movement

- **Highway 43 Culvert**
During the time of operation in 2013, TCU recorded 2,783 detections from 23 unique tags. Of these unique detections, 21 fish (6 CCT, 14 HYB, and 1 CHN) were originally tagged and released downstream of the Highway 43 culvert (2012-2013) indicating some rate of culvert passage. Two detected tags (1 CCT and 1 HYB) were fish released from upstream locations (2009-2011).
- **Boones Ferry Road Culvert**
To date, 1,006 salmonids have been captured and tagged above the Highway 43 culvert and below the Boones Ferry Road culvert. Eighty-nine salmonids have been recaptured above the Boones Ferry Road culvert. Of the salmonids recaptured above the Boones Ferry Road culvert, two (1 HYB and 1 CCT) were tagged downstream (above the Highway 43 culvert and below the Boones Ferry Road culvert) indicating upstream passage through the culvert (Table 2).

Table 2. Two salmonids tagged between the Highway 43 culvert and the Boones Ferry Road culvert and recaptured above the Boones Ferry Road culvert indicate upstream passage.

Species	PIT ID #	Capture Date	Capture Reach	Below/Above Boones Ferry	Length (mm)	Weight (g)
CCT	3D9.1C2C6C2921	3/20/2008	TC14	Below	127	20.3
		10/7/2008	TC14	Below	164	45.5
		9/14/2011	UTC04	Above	236	125.2
HYB	3D9.1C2C687ADF	10/7/2008	TC16	Below	138	27.6
		9/17/2009	UTC01	Above	193	85.5

Confluence Monitoring

Sampling below the Highway 43 culvert resulted in the capture of both native and nonnative fish and wild and hatchery salmonids (Table 3). The fish community below the Highway 43 culvert included fourteen species, numbering 1,943 individuals. Native fish were the most abundant comprising 71.4% (10/14) of the species captured and 98.6% (1,916/1,943) of the individuals captured. Native salmonids captured below the Highway 43 culvert included CCT, HYB, *O. mykiss*, Coho, CHN, trout fry (*O. sp.* < 100 mm) (TF), and mountain whitefish (*Prosopium williamsoni*) (WHF). Additional native species consisted of longnose dace (*Rhinichthys cataractae*) (LND), sculpin (*Cottus spp.*) (SCP), three spine stickleback (*Gasterosteus aculeatus*) (SKB), and sucker (*Catostomus sp.*) (SUK). Nonnative species captured were bluegill (*Lepomis macrochirus*) (BG), brown bullhead (*Ameiurus nebulosus*) (BBH), largemouth bass (*Micropterus salmoides*) (LMB), and smallmouth bass (*Micropterus dolomieu*) (SMB).

Hatchery produced salmonids are marked with an adipose fin clip to facilitate distinction from naturally produced (wild) salmonids. The majority of juvenile anadromous salmonids (Chinook, coho, and steelhead) captured below the Highway 43 culvert were of wild (naturally produced) origin (96.8%, 481/497). Wild CHN and coho immigrated into the pool below the Highway 43 culvert in summer and late fall (August –December 2012) (Table 3). Whereas the majority of CHN emigrated in February coinciding with observations of hatchery origin CHN, coho emigrated at the end of May along with observations of hatchery origin coho.

Recaptures of PIT tagged salmonids (N = 391) occurred throughout the sample year (July 2012 - June 2013) (Table 4). Of the 105 CHN tagged, 20 (19%) were recaptured. Of the 191 coho tagged, 71 were recaptured (37%). Multiple recaptures of all species occurred with 85 of 131 being recaptured two or more times (65%) (Table 4).

Table 3. Species captured below the Highway 43 culvert each month (7/3/2012-3/7/2013), and each week (3/22/2013-6/14/2013).

Sample Date	Sample Method	BBH*	BG*	CCT	CCT-Recap	CHN	CHN-Recap	CHN-HAT	CHN-HAT-Recap	COHO	COHO-Recap	COHO-HAT	COHO-HAT-Recap	HYB	HYB-Recap	LMB*	LND	SCP	SKB	SMB*	STH	STH-Recap	STH-HAT	SUK	TF	TF-Recap	WHF	
7/3/2012	E-Fish				1	1				2				2							2							
7/3/2012	Seine 1				1					4				1	1													
7/3/2012	Seine 2				2					4				1														
8/3/2012	E-Fish	1			1	1	3			3								14			3				1		1	
8/3/2012	Seine 1				5		22			18				3				85	1		1						3	
8/3/2012	Seine 2																											
9/6/2012	E-Fish				2		6			1						1		44	2						2			
9/6/2012	Seine 1				4	2	7	4		14	4							2			2						3	
9/6/2012	Seine 2				1					1																	1	
10/4/2012	E-Fish						11	1		1				2			3	54		10				1			1	
10/4/2012	Seine 1				6	6	2			13	4				3			11			1						1	
10/4/2012	Seine 2																	1									1	
11/8/2012	E-Fish						2			2						1		27		13								
11/8/2012	Seine 1				1	5		3		32	1			1				2			1							
11/8/2012	Seine 2					5	1			11								1										
12/13/2012	E-Fish				1	2	1			1								45			1				3			
12/13/2012	Seine 1					6				7	1			1							1							
12/13/2012	Seine 2				1	6		1	1	31				1				1			4	1	1		1			
1/18/2013	E-Fish					2	1			3				1	1						2							
1/18/2013	Seine 1				2	5			1	13	2			1														
1/18/2013	Seine 2																											
2/8/2013	E-Fish				1	1				2												1						
2/8/2013	Seine 1				1	2	5	1	1	20	7			2								1						
2/8/2013	Seine 2																											
3/7/2013	E-Fish				1	7	1			1				1				55			1							
3/7/2013	Seine 1						2		1		10																	

Sample Date	Sample Method	BBH*	BG*	CCT	CCT-Recap	CHN	CHN-Recap	CHN-HAT	CHN-HAT-Recap	COHO	COHO-Recap	COHO-HAT	COHO-HAT-Recap	HYB	HYB-Recap	LMB*	LND	SCP	SKB	SMB*	STH	STH-Recap	STH-HAT	SUK	TF	TF-Recap	WHF
3/7/2013	Seine 2			1		1	1	1		6	7			1													
3/22/2013	E-Fish				1	3	1	1		1	1							42				1					
3/22/2013	Seine 1			1			1		2	10	30			2								2					
3/22/2013	Seine 2																										
3/28/2013	E-Fish			1		5		1		1				1				48	1		1	2					
3/28/2013	Seine 1						2		3		43			1								3	3				
3/28/2013	Seine 2									1																	
4/4/2013	E-Fish			1		3	3			1	2			1	3											3	
4/4/2013	Seine 1									1	6																
4/4/2013	Seine 2						1		1	1	19			1													
4/11/2013	E-Fish			1	1					11	1			2						2		1	1				
4/11/2013	Seine 1								2	1	31			2	2							2					
4/11/2013	Seine 2																										
4/18/2013	E-Fish					5	1			3	1							76	1			3					
4/18/2013	Seine 1			1			4		1		35			2								1	1				
4/18/2013	Seine 2													1													
4/25/2013	E-Fish				1		1			5								51	1		2	1					
4/25/2013	Seine 1				1	2	1																				
4/25/2013	Seine 2						1																				
5/2/2013	E-Fish		1		1	3	2			5	1			1			1		2			3					
5/2/2013	Seine 1					4	1			3	2																
5/2/2013	Seine 2									1	5	2															
5/8/2013	E-Fish					4	1							1				62				1	1				
5/8/2013	Seine 1			1	1		6			8	18		1	1	4							3					
5/8/2013	Seine 2																										
5/16/2013	E-Fish									9	1							46				1					
5/16/2013	Seine 1					5	1			9	13		1	2	3			1									

Sample Date	Sample Method	BBH*	BG*	CCT	CCT-Recap	CHN	CHN-Recap	CHN-HAT	CHN-HAT-Recap	COHO	COHO-Recap	COHO-HAT	COHO-HAT-Recap	HYB	HYB-Recap	LMB*	LND	SCP	SKB	SMB*	STH	STH-Recap	STH-HAT	SUK	TF	TF-Recap	WHF
5/16/2013	Seine 2				1						1		1					1									
5/31/2013	E-Fish					11	1			6								75				1					
5/31/2013	Seine 1			1	2	1				2				3	3												
5/31/2013	Seine 2					1				1				1	1												
6/6/2013	E-Fish			1		5	1			1		1		1				78							6	1	
6/6/2013	Seine 1				1							1		4				1									
6/6/2013	Seine 2				1	1				1	1	1		1													
6/14/2013	E-Fish				2	3				4				1				80			1		2				
6/14/2013	Seine 1				2	11	1			3	3		3	5								1					
6/14/2013	Seine 2					2																					
Total		1	1	30	28	169	49	8	13	278	251	5	6	23	50	2	4	903	10	23	34	27	3	1	13	1	10

Species Key:

Brown bullhead (*Ameiurus nebulosus*) (BBH)*
 Bluegill (*Lepomis macrochirus*) (BG)*
 Coastal cutthroat trout (*Oncorhynchus clarki*) (CCT)
 Chinook salmon (*Oncorhynchus tshawytscha*) (CHN)
 Coho (*Oncorhynchus kisutch*) (Coho)
 Hybrid (*Oncorhynchus clarki/O. mykiss*) (HYB)
 Largemouth bass (*Micropterus salmoides*) (LMB)*
 Longnose dace (*Rhinichthys cataractae*) (LND)
 Sculpin (*Cottus spp.*) (SCP)
 Three spine stickleback (*Gasterosteus aculeatus*) (SKB)
 Smallmouth bass (*Micropterus dolomieu*) (SMB)*
 Steelhead/Rainbow Trout *Oncorhynchus mykiss* (resident and anadromous), (*Oncorhynchus mykiss*) STH
 Sucker (*Catostomus sp.*) (SUK)
 Trout fry (*Oncorhynchus sp.* < 100 mm) (TF)
 Mountain whitefish (*Prosopium williamsoni*) (WHF)

-HAT Hatchery Produced Fish
-Recap Recaptured Fish (Previously PIT Tagged)

*Nonnative species

Table 4. Number of PIT tagged salmonids at the Tryon Creek Confluence and frequency of capture (July 2012 - June 2013).

Species	Total Fish Tagged	# Fish Not Recaptured	# Fish Recaptured													
			1x	2x	3x	4x	5x	6x	7x	8x	9x	10x	11x			
CCT	28	15	7	3	1		1		1							
CHN	97	81	8	4	3	1										
CHN-HAT	8	4	1		1	1	1									
COHO	186	120	15	12	2	18	10	3	4	2						
COHO-HAT	5	0	3	2												
HYB	24	9	7	2	1	1	2						1		1	
STH	31	19	5	3	1	2	1									
STH-HAT	3	3														
TF	4	4														
WHF	5	5														

To document fish movement, TCM recorded 44 detections from 14 unique fish during the time of operation in 2013. Of these unique detections, 13 (2 CCT, 2 HYB, 1 STH-Hatchery origin, 2 *O. mykiss*, 3 coho, and 3 CHN) were tagged and released downstream of the Highway 43 culvert (2012-2013). A query of the PTAGIS database showed one CHN sampled by ODFW beach seine was tagged and released on 6/13/2013 at Irish Bend County Park (WILLR3) (Willamette rkm 230), detected 6/30/2013 at Sullivan Dam at Willamette Falls (SUJ) (Willamette rkm 43), and detected 7/1/2013 at TCM (Willamette rkm 32) (Figure 5).

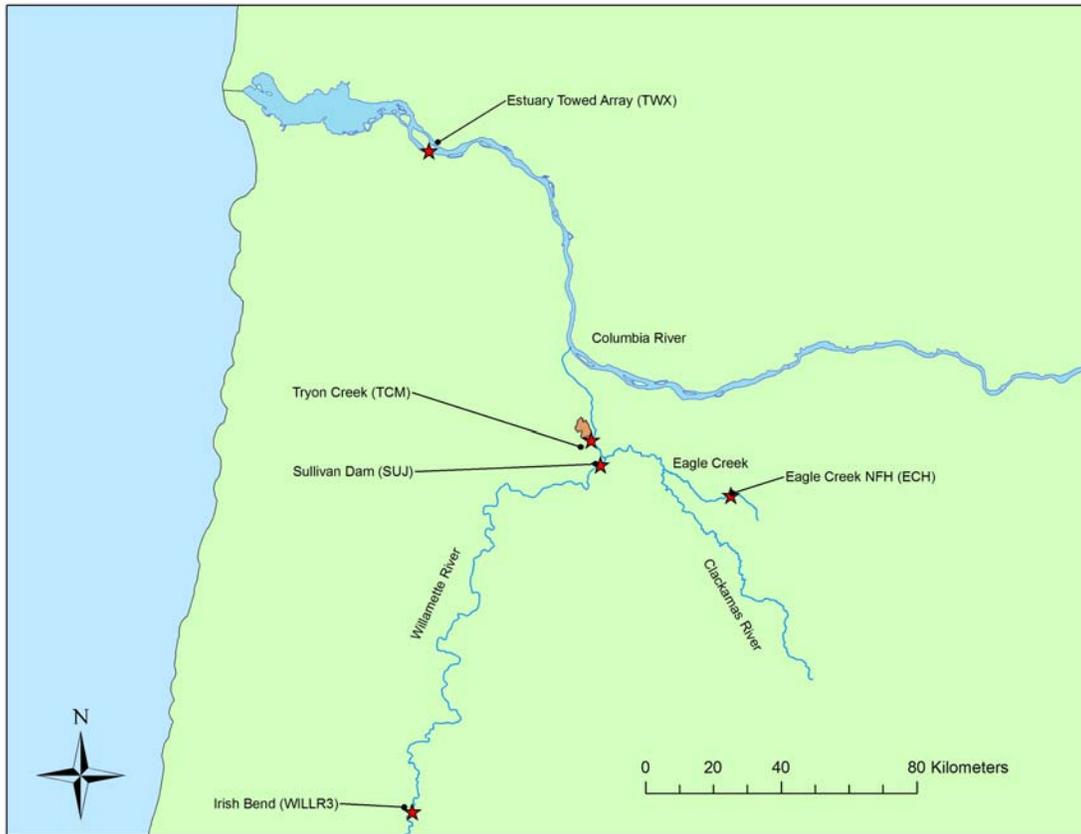


Figure 5. Release and detection locations outside of the Tryon Creek watershed

Three fish tagged below the Highway 43 culvert were detected by antennas located outside the watershed (PTAGIS 2014b). One coho was detected upstream at the Eagle Creek National Fish Hatchery Fish Ladder (ECH) at Eagle Creek rkm 20. Two coho and one STH were detected outmigrating by an Estuary Towed Array (TWX) in the Lower Columbia River at rkm 75 (Table 5, Figure 5).

Table 5. Detections of salmonids tagged in Tryon Creek detected outside the basin.

PIT ID	Species	Tagging Fork Length	Tagging Date	Tagging Location	Detection Date	Detection Location
3D9.1C2C66B0F3	Coho	103	12/13/2012	Below Highway 43 Culvert	10/30/2013	ECH
3D9.1C2CF5F480	Coho	92	1/18/2013	Below Highway 43 Culvert	5/10/2013	TWX
3D9.1C2CF60F07	Coho	112	3/7/2013	Below Highway 43 Culvert	4/18/2013	TWX
384.1B795B1CAD	STH	126	3/28/2013	Below Highway 43 Culvert	5/7/2013	TWX

Use of the confluence by the fish species present during the spring and summer months showed juvenile anadromous salmonids (3 CHN, 3 coho) captured below the Highway 43 culvert were detected emigrating from Tryon Creek 10 – 86 days after tagging. Resident salmonids (2 CCT, 2 HYB, and 3 STH) captured below the Highway 43 culvert were detected emigrating from Tryon Creek 0 - 305 days after tagging (Table 6). All but two of these fish were detected within 4 months of being tagged. The two exceptions were a CCT detected at TCM outmigrating in May 2013 (10 months after tagging at 145 mm), and a coho upstream at ECH in October 2013 (11 months after tagging at 103 mm).

Table 6. Mean number of days between tagging date and last detection (presumed outmigration)

Species	Mean # Days	Range	# Fish	Tagging Location	Detection Location
CCT	159	13 - 305	2	Below Highway 43 Culvert	TCM
CHN	44	25 - 75	3	Below Highway 43 Culvert	TCM
CHN	18	--	1	Seined, tagged and released by ODFW (WILLR3)	TCM
COHO	37	10 - 86	3	Below Highway 43 Culvert	TCM
COHO	321*	--	1	Below Highway 43 Culvert	ECH
COHO	77	42 – 112	2	Below Highway 43 Culvert	TWX
HYB	23	0 – 46	2	Below Highway 43 Culvert	TCM
STH	85.5	54 – 117	2	Below Highway 43 Culvert	TCM
STH	40	--	1	Below Highway 43 Culvert	TWX
STH-HAT	17	--	1	Below Highway 43 Culvert	TCM

*Upstream migration

Findings

- Outplanted lamprey ammocoetes appeared to distribute between the outplanting sites and the mouth of Tryon Creek; some remained in Tryon Creek, above and below the Highway 43 culvert, for at least 2 months after outplanting.
- There was no evidence of adult lamprey in any part of Tryon Creek.
- The passage of fish from downstream locations to above the Highway 43 culvert confirms some ability of CCT, *O. mykiss*, and HYB upstream navigation through the Highway 43 culvert. There may be some maximum flow threshold in which upstream navigation through the culvert is not possible. It is possible a threshold for minimum flow exists as well.
- The passage of fish from downstream locations to above the Boones Ferry Road culvert confirms some ability of CCT and HYB upstream navigation through the Boones Ferry Road culvert. However, the rate of passage is unclear.
- The majority of observations of anadromous salmonids were below the Highway 43 culvert. One Chinook was detected at the upper end of the Highway 43 culvert after being tagged downstream.
- The only observations of nonnative fish species were below the Highway 43 culvert.
- CCT were the most frequently observed salmonid species above the Highway 43 culvert; coho were the most abundant salmonid species below the Highway 43 culvert.
- The abundance estimate of trout (> 100 mm) above the Highway 43 culvert has ranged from 748 ± 44.18 fish in 2008 (95% CI = 674-848), 713 ± 50.45 fish in 2009 (95% CI = 639-837), 891 ± 104 in 2011 (95% CI = 723-1,144), and 747 ± 51.59 in 2013 (95% CI = 671-873). Abundance estimate for 2009 was adjusted from previously reported (Silver et al. 2013) using an average of capture probability generated from the 2008 and 2011 mark-recapture estimates in Tryon Creek (Cook et al. 2009, Silver et al. 2013). Abundance estimates have not changed significantly and suggest a stable population (Figure 6).

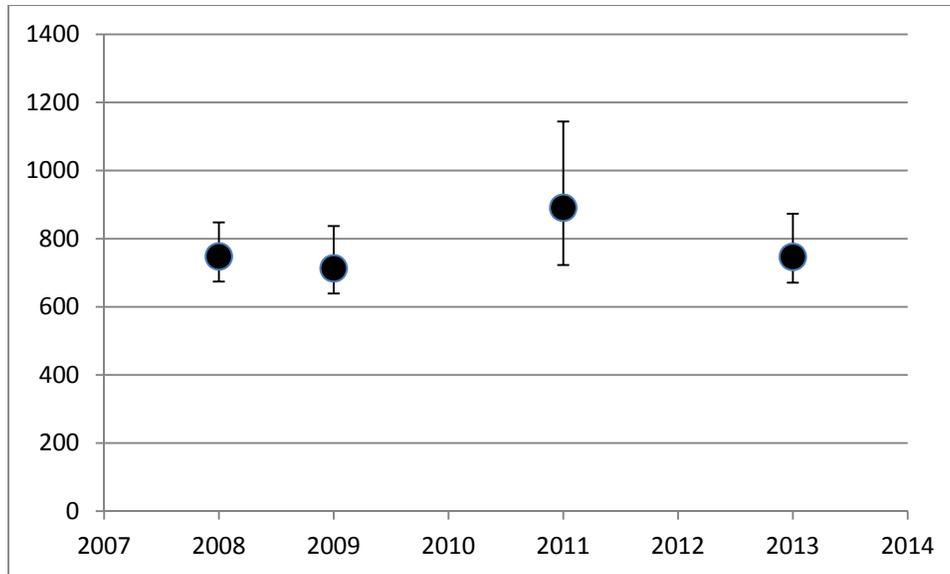


Figure 6. Abundance estimates for all trout above Highway 43 culvert in Tryon Creek. Bars represent 95% confidence intervals.

- Abundance estimates can be converted to a mean density across years of 139 trout/km. This density falls within the range seen for several coastal cutthroat trout populations from coastal Oregon and British Columbia (Connolly and Hall 1999; Rosenfeld et al. 2000). For example, De Groot (2004) estimated a mean summer density of 120 fish/km for coastal cutthroat trout across logged and unlogged streams.
- CCT, *O. mykiss*, and HYB were detected both leaving and entering Tryon Creek at the Highway 43 culvert. 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.
- The majority of coho and CHN were detected leaving Tryon Creek confluence area after residing in Tryon Creek for 10 – 86 days. This suggests habitat in Tryon Creek below the Highway 43 culvert may serve as rearing habitat for juvenile salmonids emigrating from elsewhere (in the Willamette basin).
- Chinook and coho salmon assumed to have originated from upstream locations (upper Willamette River basin, Eagle Creek) utilized the Tryon Creek confluence as part of their migration.
- A total of 199 genetic sample collected in the confluence area during 2012-2013 sampling were transferred to the City of Portland. These sample were collected from Chinook salmon, coho salmon, steelhead, suspected CCT/*O. mykiss* hybrids, and trout fry.

Acknowledgements

Thanks to the City of Portland (for funding, field assistance, and use of its water treatment plant for electricity), Friends of Tryon Creek, Oregon Department of Transportation, Oregon Department of Fish and Wildlife, The City of Lake Oswego, Tryon Creek Watershed Council, National Fish and Wildlife Foundation, Oregon State Parks, Portland General Electric (for the pole and power installation for the lower PIT tag antenna), as well as the students/volunteers of Lewis and Clark College and the surrounding neighborhoods.

Literature Cited

- Connolly, P. J., and J. D. Hall. 1999. Biomass of coastal cutthroat trout in unlogged and previously clear-cut basins in the central coast range of Oregon. *Transactions of the American Fisheries Society* 128:890-899.
- Cook, J. R., B. P. Silver, J. M. Hudson, G. Silver, C. Luzier, J. Johnson, and T. Whitesel. 2009. Tryon Creek Restoration Monitoring Project. FY2008 Progress Report. Columbia River Fisheries Program Office, Vancouver, Washington.
- De Groot, J. D. 2004. Densities, body condition, and movement of coastal cutthroat trout (*Oncorhynchus clarki clarki*) in logged and forested headwater streams of southwestern British Columbia. M.S. Thesis, Department of Forest Sciences, The University of British Columbia.
- Gentleman, R. and R. Ihaka. 1996. R: A Language for Data Analysis and Graphics. *Journal of Computational and Graphical Statistics*, Vol. 5, No. 3 (Sep., 1996), pp. 299-314.
- Hawkins D. K. 1997. Hybridization between coastal cutthroat trout (*Oncorhynchus clarki clarki*) and steelhead (*O. mykiss*). Doctoral dissertation. University of Washington, Seattle.
- Henderson Land Services, LLC. 2007. Tryon Creek @ Highway 43 Culvert Alternatives Analysis. Prepared fo City of Lake Oswego, Oregon. 61 pp.
- Hudson, J. M., C. Luzier, J.R. Cook, G. Silver, J. Johnson. 2009. Tryon Creek restoration monitoring project. FY- 2005-2007 Progress Report. Columbia River Fisheries Program Office, Vancouver, Washington.
- Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. *Wildlife Monographs* 62:1-135.
- Poirier J., J. Johnson, J. Jolley, G. Silver, M. Hudson, S. Lohr, and T. A. Whitesel. 2010. Presence, distribution and movement of select aquatic species in tide Creek, Merrill Creek and Deer Island Slough, Columbia County, Oregon. 2009 Progress Report
- PTAGIS. 2014a. The Columbia Basin PIT Tag Information System. www.ptagis.org. Accessed 5/13/2014 10:41:06 AM
- PTAGIS. 2014b. The Columbia Basin PIT Tag Information System. www.ptagis.org. Accessed 1/31/2014 10:02:47 AM
- Rexstad, E. and K. Burnham. 1991. User's guide for interactive program CAPTURE. Colorado State University, Colorado Cooperative Fish and Wildlife Research Unit, unpublished report, Fort Collins.

- Rosenfeld, J., M. Porter, and E. Parkinson. 2000. Habitat factors affecting the abundance and distribution of juvenile cutthroat trout (*Oncorhynchus clarki*) and coho salmon (*Oncorhynchus kisutch*). *Canadian Journal of Fisheries and Aquatic Sciences* 57:766-774
- Roussel, J. M., A. Haro, and R. A. Cunjak. 2000. Field test of a new method for tracking small fishes in shallow rivers using passive integrated transponder (PIT) technology. *Canadian Journal of Fisheries and Aquatic Sciences* 57:1326–1329.
- Seber, G. A. F. 1973. *The Estimation of Animal Abundance and Related Parameters*. Macmillan Publishing Co., New York, New York.
- Seber, G. A. F., and E. D. Le Cren. 1967. Estimating Population Parameters from Large Catches Relative to the Population. *The Journal of Animal Ecology* 36:3:631-643.
- Silver, B. P., J. R. Cook, J. M. Hudson, G. Silver, J. Poirier, J. Johnson, and T. Whitesel. 2009. Tryon Creek restoration monitoring project. FY-2009 Progress Report. Columbia River Fisheries Program Office, Vancouver, Washington.
- Silver, B.P., J.M. Hudson, S.M. Castle, J. Poirier, J. Johnson, G.S. Silver, J. Jolley, and T.A. Whitesel. 2013. Tryon Creek Restoration Monitoring, 2009 - 2012 Annual Report. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington
- Stevens, Jr., D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association* 99:262-278.
- Tinus, E. S., J. A. Koloszar, D. L. Ward. 2003. Abundance and distribution of fish in city of Portland streams. Oregon Department of Fish and Wildlife Final Report prepared for City of Portland-Bureau of Environmental Services.
- U.S. Geological Survey (USGS). 2012. National Water Information System: Web Interface. Retrieved December 17, 2012, from http://waterdata.usgs.gov/nwis/uv?cb_00065=on&cb_00060=on&format=gif_default&period=&begin_date=2012-11-17&end_date=2012-11-23&site_no=14211315
- White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. *Bird Study* 46 Supplement:120-138.
- White, G. C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, LA-8787-NERP, Los Alamos, New Mexico. (Space between references)

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



May 14