

**Restoring Fish Passage in Tryon Creek (OR): Lampreys**  
**(NFWF 2006-0175-004)**  
***Final Programmatic Report***

T.A. Whitesel, G.S. Silver, C.W. Luzier, and J.M. Hudson

*U.S. Fish and Wildlife Service – Columbia River Fisheries Program Office*  
*1211 SE Cardinal Ct – Ste 100*  
*Vancouver, WA 98606*

**Introduction**

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 most portion of Tryon Creek flows 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.

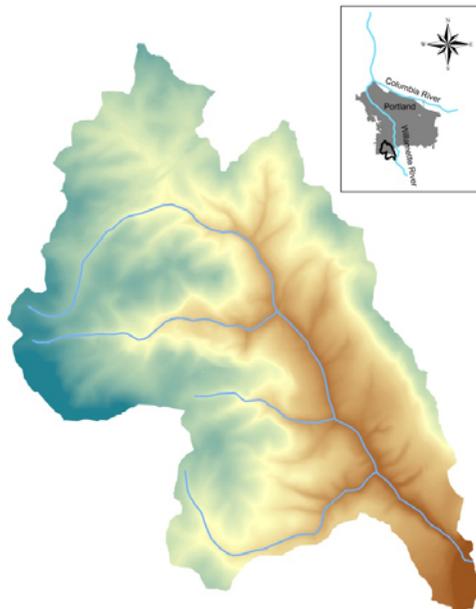


Figure 1. Tryon Creek watershed.

Tryon Creek is one of the largest, relatively protected, urban watersheds in Oregon. A number of native species can currently be found in this stream including *Oncorhynchus mykiss* (resident and anadromous) and coastal cutthroat trout (*O. clarki*) (Tinus et al. 2003) as well as coho salmon (*O. kisutch*, Hudson et al. 2007) and Chinook salmon (*O. tshawytscha*). Historically, it is thought that Pacific lamprey (*Entosphenus tridentatus*) and western brook lamprey (*Lampetra richardsoni*) as well as other salmon species also utilized this stream. However, the culvert under Highway 43 and the adjacent railroad is potentially inhibiting, if not preventing, passage of lampreys and salmonids.

The Highway 43 culvert was constructed in the late 1920s. It is approximately 122 m long with a drop of nearly 6.7 m from top to bottom, resulting in an average grade of 4.6% (Figure 2). There are a series of alternating baffles that provide some structure within the culvert, but do not provide adequate holding water for fish attempting to migrate upstream. The culvert is perched at the lower end approximately 20 cm above stream level at base flow. This design likely blocks lamprey migration and hinders salmonid movements upstream through the culvert (Henderson Land Services 2007, Rhodes 2002).

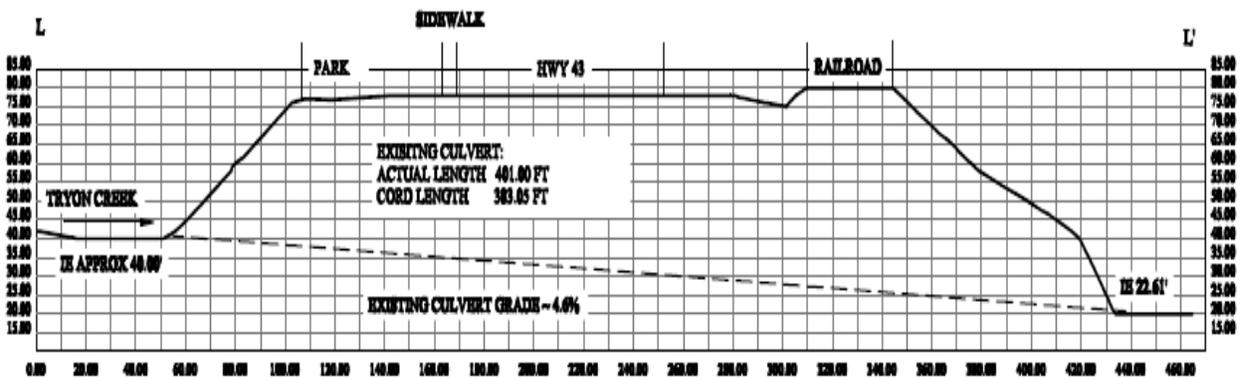


Figure 2. Longitudinal profile of Tryon Creek culvert (Henderson Land Services 2007).

A collaborative project has been implemented by Oregon Department of Transportation (ODOT), Oregon Department of Fish and Wildlife (ODFW), Oregon State Parks (OSP), National Marine Fisheries Service (NMFS), Cities of Portland (COP) and Lake Oswego (COLO), Friends of Tryon Creek (FTC), Tryon Creek Watershed Council (TCWC), National

Fish and Wildlife Foundation (NFWF) and U.S. Fish and Wildlife Service (USFWS) to improve passage conditions for anadromous fish migrating into Tryon Creek. A replacement project for the Highway 43 culvert is scheduled to occur in two phases. Phase one of the culvert restoration (conducted in August, 2008) was designed to a) raise the level of the pool below the culvert so that fish can swim in to the culvert (rather than have to jump in to the culvert) and b) modify the baffle structure in the culvert to improve passage conditions within the culvert itself. Pending the results from phase one, the second phase may provide and implement a long-term solution to the existing culvert. Alternatives to the existing culvert currently being considered include replacement with a larger culvert or a bridge (Henderson Land Services 2007).

This USFWS-led monitoring and evaluation program is focused on assessing the success of the Highway 43 culvert replacement project. This monitoring program is being conducted in three stages: 1) pre-assessment and monitoring prior to the initial phase of culvert improvement; 2) assessment and monitoring subsequent to the culvert improvement and prior to the second phase of culvert replacement; 3) post-assessment and monitoring subsequent to the completed culvert replacement project. The NFWF-funded work described in this report is focused on Pacific and western brook lampreys in Tryon Creek associated with monitoring stages one and two described above. The study was designed to assess the restoration response of lampreys believed to be historically present in Tryon Creek. The objectives were to 1) determine whether larval lamprey are present in Tryon Creek; 2) determine the distribution of larval lamprey in Tryon Creek; 3) determine whether adult lamprey move upstream through the culvert; 4) determine the upstream passage efficiency of adult lamprey through the culvert; and 5) meet with FTC personnel as well as Tryon Creek watershed community members regarding the ecological importance of native lamprey species and methods to sample lamprey and their habitats.

## **Methods**

### Larval presence and distribution

Presence (or absence) of larval (ammocoetes) Pacific and western brook lampreys in Tryon Creek was determined through electrofishing surveys using an ABP-2 backpack electrofisher. In 2005, 2006 and 2007, the entire mainstem of Tryon Creek was sampled, from the mouth upstream to Barbur Boulevard (Figure 3). In 2009, a generalized random tessellation stratified (GRTS), survey design was applied to Tryon Creek (McKenzie et al. 2005) resulting in

six randomly selected, spatially-balanced 50-m survey reaches between Highway 43 and Boones Ferry Rd. (at an overall density averaging one reach every 0.5 km) (Figure 3). In addition, the entire lower reach from the mouth of Tryon Creek to the Highway 43 culvert was again sampled in 2009. This design, along with information on the probability of detecting ammocoetes using a backpack electrofisher in wadeable streams (unpublished data), were used to assign a probability that lampreys were present in Tryon Creek. All ammocoetes captured were identified to species (using visual characteristics), measured for total length (TL), and released back to Tryon Creek.

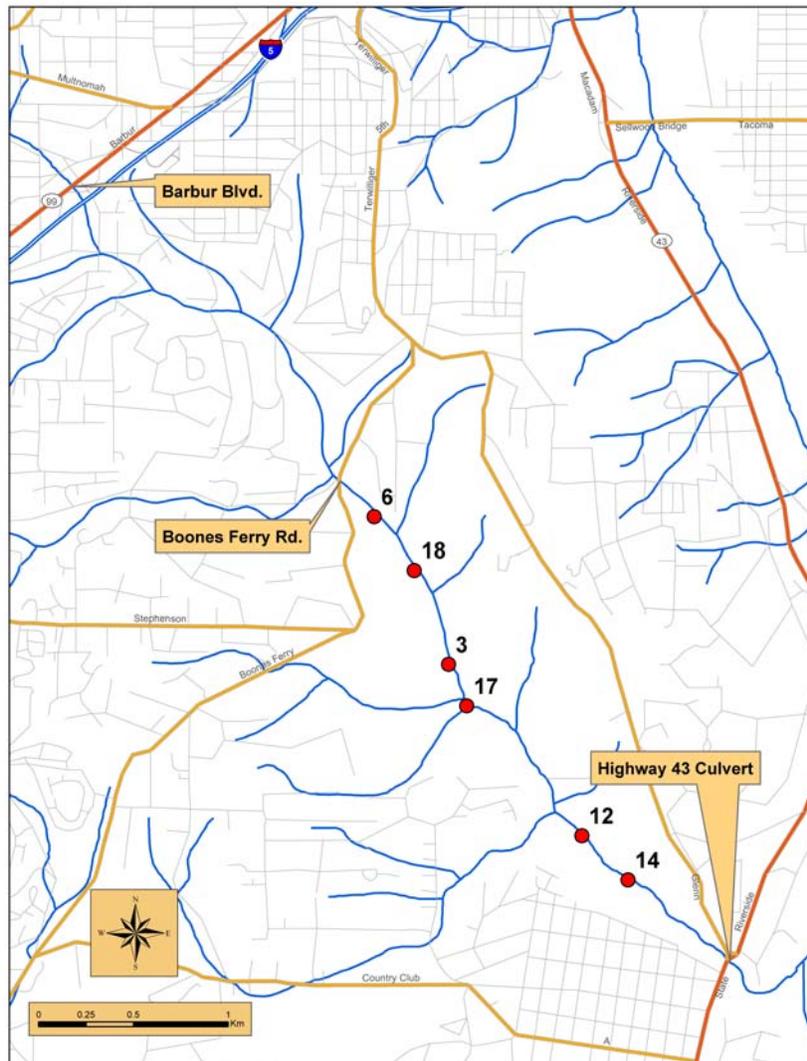


Figure 3. The Tryon Creek study area (mouth to Barbur Boulevard) with six sample reaches between the Highway 43 culvert and Boones Ferry Road.

### Adult presence and distribution

Presence of adult Pacific and western brook lampreys was determined by visual surveys conducted on foot in Tryon Creek from the mouth upstream to Boones Ferry Rd. Surveys were conducted during the spring, summer and fall (2008, 2009) when adults would be expected to be present or spawning. Live adult lamprey, adult lamprey carcasses and lamprey nests were enumerated.

### Adult movement and passage efficiency

Presence of adult Pacific lampreys was determined by capture in pot traps deployed downstream of the culvert (summer-fall 2007 and 2008) and the operation of a weir (fall 2006-fall 2007). A pot trap consists of a 92 cm x 20 cm PVC pipe with a funnel on the downstream-facing end, an internal funnel positioned to divide the trap into two chambers and a perforated one inch thick round of wood on the upstream-facing end (see Luzier and Silver 2005, Luzier et al. 2006). Adult Pacific lampreys captured were measured (TL), weighed (g), and implanted with a passive integrated transponder (PIT) tag. All adult lampreys were released alive back to Tryon Creek below the culvert.

### Coordination and collaboration

Annual meetings (2007-2009) for information exchange between collaborators associated with the Tryon Creek project were facilitated each year.

## **Results**

### Larval presence and distribution

Larval lampreys were captured below the Highway 43 culvert in 2005, 2006 and 2007 but not in 2009 (Table 1). Larvae ranged from 14-145 mm TL. Both Pacific and western brook lampreys were captured below the culvert. No larval lampreys were detected or captured above the culvert in any year (before or after phase one culvert modification). In 2009, a probabilistic survey was conducted between the Highway 43 culvert and Boones Ferry Road. Based on information from other, similar tributaries in the area, we assumed that the site-specific probability of detecting lamprey by electrofishing in Tryon Creek was no less than 0.50. Given this detection probability, along with no lamprey being detected in six reaches, we estimated the probability that Tryon Creek was occupied with larval lamprey to be  $< 0.02$ .

Table 1. Lampreys captured between the Highway 43 culvert and the mouth of Tryon Creek. The entire reach was sampled once during the summer of each year. PCL = Pacific lamprey, WBL = western brook lamprey, TL = total length.

Year	Species	Number	Size range (TL, mm)
2005	PCL	1	113
	WBL	0	-
	Unknown	6	14-45
2006	PCL	25	93-132
	WBL	0	-
	Unknown	0	-
2007	PCL	0	-
	WBL	1	145
	Unknown	0	-
2009	PCL	0	-
	WBL	0	-
	Unknown	0	-

#### Adult presence and distribution

No adult lampreys (live or dead) or lamprey nests were detected before or after phase one culvert modification.

#### Adult movement and passage efficiency

No adult lampreys were captured below the culvert and none were observed attempting to pass or move above the culvert. Passage efficiency could not be estimated.

#### Coordination and collaboration

Personnel from the USFWS organized and facilitated annual meetings for information exchange and educational purposes. Attendees included personnel from the Friends of Tryon Creek, the Tryon Creek Watershed Council, Oregon Department of Fish and Wildlife, City of Portland, City of Lake Oswego, Oregon State Parks, Oregon Department of Transportation, and the National Marine Fisheries Service. In addition to presentations at the annual meetings,

USFWS personnel also made presentations to the Tryon Creek Watershed Council as well as the City of Portland.

## **Discussion**

The presence of both larval Pacific and western brook lampreys below the Highway 43 culvert indicates that lampreys do occupy and rear in Tryon Creek. In addition, the presence of young-of-the-year (age 0), ammocoetes (i.e., 14 mm TL) suggests that lamprey spawning occurs in Tryon Creek below the Highway 43 culvert. It is possible that the age 0 lampreys could have been produced in a neighboring tributary, traveled into the Willamette River and ultimately entered into Tryon Creek. However, larval lampreys are thought to be poor swimmers and are not likely to migrate upstream (Hardisty and Potter 1971). Therefore, the presence of age 0 larval lampreys in Tryon Creek provides indirect evidence of lamprey spawning below the Highway 43 culvert.

Lamprey do not appear to occupy Tryon Creek above the Highway 43 culvert. This was evident by the lack of ammocoete detections in any year of sampling. In particular, the analysis from the probabilistic design used in 2009 suggested that there is < 2% probability that lamprey are above the culvert. Phase one of the restoration activities a) raised the level of the pool below the culvert so that fish can swim in to the culvert (rather than have to jump or climb in to the culvert) and b) modified the baffle structure in the culvert in an attempt to improve passage conditions. Why lamprey are not currently found above the culvert is unclear. It is possible that the original structure (2006) may have been a passage barrier to lamprey, that the existing culvert structure (after the 2008 modification) may be a passage barrier to lamprey, that lamprey have not had enough time to take advantage of potentially improved passage conditions at the culvert, or that lamprey are not trying to enter Tryon Creek and pass above the culvert.

Conditions in Tryon Creek prior to phase one of the restoration appeared to be such that they would have inhibited or prevented lamprey from passing upstream of the Highway 43 culvert. The culvert was perched and the baffling was angular and did not create pools for fish to be able to easily hold position. For lamprey to move into upper Tryon Creek under these circumstances, they would have had to climb into the culvert over a 90° angle and negotiate approximately 125 m of relatively laminar flow and baffles that presented numerous and exclusively 90° angles (City of Portland, personal communication). These conditions would not

be considered conducive to the upstream passage of adult lamprey (Moser et al., 2002). Thus, it is reasonable to conclude that from the mid 1900's through 2008, it was difficult or impossible for lamprey to move upstream through the culvert and is, at least in part, one reason that lamprey do not occupy Tryon Creek above the culvert.

Conditions in Tryon Creek after phase one of the Highway 43 culvert restoration (since fall 2008) no longer appear to present an obvious barrier to lamprey passing upstream. The culvert is no longer perched and the baffling is rounded and organized in a manner that creates some pool habitat in the culvert. Under these conditions, lampreys can swim into the culvert (at least during certain flow conditions) as well as have access to pools for holding and rounded surfaces which are relatively conducive to their movement. Relative to the upstream passage of lampreys, these conditions are, at worst, improved from previous conditions and may be adequate for lamprey passage. However, to date, no adult lampreys or ammocoetes have been observed above the culvert or attempting to pass through the culvert. Since we have no evidence that lamprey have passed upstream through the culvert, we cannot rule out the possibility that the culvert remains an upstream passage barrier.

It is possible that lamprey could currently pass upstream through the modified culvert but have not attempted to do so yet. Although we have been monitoring the system since 2005 and have not detected any lamprey above the culvert, phase one of the restoration work was not completed until the end of summer, 2008. Adult lamprey would typically be in the vicinity of and expected to enter Tryon Creek between April and September (Mesa et al. 2009). Thus, in 2008, relatively few (if any) adults would have been likely to move into Tryon Creek prior to phase one of the restoration being complete. Subsequent sampling the following summer (2009) did not detect any ammocoete production, suggesting that adult lamprey did not move upstream in Tryon Creek in 2008. However, it is unclear whether they could not pass the modified culvert or whether the adult migration had concluded before the modification was complete.

It is possible that lamprey are not entering Tryon Creek and attempting to pass the culvert. However, many tributaries adjacent to Tryon Creek support Pacific lamprey spawning (i.e. Johnson Creek, Tinus et al. 2002). In addition, relatively large numbers of adult Pacific lamprey (which have not been shown to home to their natal stream; see Keefer et al. 2009) migrate past the mouth of Tryon Creek to Willamette Falls (Mesa et al. 2009) and are in close proximity to Tryon Creek. Furthermore, relative to tributaries such as Johnson Creek, Tryon

Creek contains some of the most natural habitat conditions within the city of Portland (see Tinus et al. 2002). Thus, if lamprey can pass upstream through the culvert, there is no obvious reason to suspect they would not colonize upper Tryon Creek.

For lamprey to occupy Tryon Creek above the Highway 43 culvert, they would have to recolonize the area. The ability of lamprey to recolonize this area would depend on a number of variables. First, lamprey would have to be able to pass upstream through the Highway 43 culvert. Their ability to do this is still uncertain. Adult lamprey appear to be attracted to the odor of larval or juvenile lamprey (Sorensen et al., 2003). Therefore, this odor may be necessary to attract adults into Tryon Creek. Finally, adequate and appropriate habitat would be necessary to support lamprey spawning and rearing. The quantity and quality of lamprey spawning and rearing habitat within Tryon Creek has not yet been adequately assessed.

There are two phases of restoration proposed for the Tryon Creek Highway 43 culvert. Phase one has been completed, but insufficient time has passed to assess whether lamprey can and will pass the modified Highway 43 culvert. Additional monitoring over the next several years will be necessary to address this question. As part of the interagency coordination meetings associated with this project, preliminary discussions concerning management for lamprey in Tryon Creek included a number of alternatives. If lamprey do not colonize upper Tryon Creek naturally, further consideration of existing passage conditions would be warranted. As a subsequent step, consideration could be given to whether larval lamprey from adjacent tributaries should be outplanted in upper Tryon Creek to serve as an attractant for adults. If these alternatives do not result in lamprey colonizing upper Tryon Creek, a final alternative (see Moritz, 1999) could be to consider whether adult lamprey from adjacent areas should be outplanted in upper Tryon Creek. Each of these actions would also require well developed management plans and subsequent monitoring of their effectiveness.

## References

- Estrada, M. ODFW and ODOT- 2008. Fish Rescue and Salvage Report Form.  
Tryon Creek. July 15 – 23, 2008.
- Hardisty, M.W. and I.C. Potter. 1971. The behavior, ecology, and growth of larval lampreys.  
Pages 88-125 in M.W. Hardisty and I.C. Potter, editors. The biology of lampreys, volume 1.  
Academic Press, London.
- Henderson Land Services, LLC. 2007. Tryon Creek @ Hwy 43 Culvert Alternatives Analysis.  
Prepared for City of Lake Oswego, Oregon. 61 pp.
- Keefer, M.L., M.L. Moser, C.T. Boggs, W.R. Daigle and C.A. Peery. 2009. Variability in  
migration timing of adult Pacific lamprey (*Lampetra tridentata*) in the Columbia River,  
U.S.A. Environmental Biology of Fish, 85: 253-264.
- Luzier, C.L. and G.S. Silver 2005. Evaluate Habitat Use and Population Dynamics of Lampreys  
in Cedar Creek. 2004 Annual Report for BPA Project Number 2000014000.
- Luzier, C.L., Silver G.S. and T.A. Whitesel. 2006. Evaluate Habitat Use and Population  
Dynamics of Lampreys in Cedar Creek. 2005 Annual Report for BPA Project Number  
2000014000.
- Mackenzie, D.I., J.D. Nichols, N. Sutton, K. Kawanishi and L.L. Bailey. 2005. Improving  
inferences in population studies of rare species that are detected imperfectly. Ecology,  
86:1101–1113.
- Mesa, M.G., R.J. Magie and E.S. Copeland. 2009. Passage and behavior of radio-tagged adult  
Pacific lamprey (*Entosphenus tridentata*) at the Willemette Falls Project, Oregon 2005-2007:  
U.S. Geological Survey open-file report 2009-1223, 28 p.

- Moritz, C. 1999. Conservation units and translocation: strategies for conserving evolutionary processes. *Hereditas*, 130:217-228.
- Moser, M.L., P.A. Ocker, L.C. Stuehrenberg and T.C. Bjornn. 2002. Passage efficiency of adult Pacific lampreys at hydropower dams on the lower Columbia River, USA. *Transactions of the American Fisheries Society*, 131: 956-965.
- Rhodes, J.J. 2002. Overview of existing conditions, data gaps, and recommendations for the protection and restoration of aquatic resources. West Multnomah Soil and Water Conservation District, Portland, Oregon.
- Sorensen, P.W., L.A. Vrieze and J.M. Fine. 2003. A multi-component migratory pheromone in seas lamprey. *Fish Physiology and Biochemistry*, 28: 253-257.
- 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.
- West Multnomah Soil and Water Conservation District (WMSWCD). 2001. Tryon Creek Watershed Baseline Assessment 2001. Portland, Oregon.