Tryon Creek Environmental Baseline Conditions and Limiting Factors Analysis For Anadromous Salmonids

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INTRODUCTION

This report is part of an on-going watershed assessment and action planning process for Tryon Creek, a small stream system in northwestern Oregon. Tryon Creek enters the lower Willamette River near the City of Lake Oswego. Tryon watershed includes land in Lake Oswego and the City of Portland. The watershed has experienced rapid housing and other urban development during the past twenty years, particularly in the last five years.

Tryon Creek is one of the few remaining streams in the Portland metropolitan area that supports a run of anadromous steelhead trout (*Oncorhynchus mykiss*). The steelhead are part of the Lower Columbia River Steelhead Trout Evolutionarily Significant Unit (ESU), and they are listed as a threatened species under the Endangered Species Act (ESA). There is growing concern that development-related changes in the condition of the watershed, and especially degradation of the fish habitat, will lead to the loss of the steelhead trout and other important natural values of the creek system.

Within the past several years a number of studies have been conducted within the Tryon Creek watershed that provide information useful for assessing the present status of the watershed and fish habitat within the creek. These studies include a report on fish assemblages and distribution for the Tryon Creek watershed which was prepared by the City of Portland Endangered Species Act Program (CoP ESA Report 2001); an Oregon Department of Fish and Wildlife analysis of creek conditions (ODFW Habitat Assessment 2000); a riparian wetland "Properly Functioning Condition" assessment prepared by the National Riparian Service Team (NRST--PFC Report 2001), and several educational field study projects conducted by students at Lewis and Clark College (Ault 1994) and Portland State University (PSU macroinvertebrate sampling 2000-01).

Reports on a macroinvertebrate assessment for the watershed (Klatte 2001), a preliminary hydrologic evaluation of the upper watershed (PWA 1999), and a preliminary hydrogeologic assessment of the Tryon Creek basin (NRMG 2001) also provide insights into existing conditions.

In this study, we used available information in conjunction with our own survey data to develop both a watershed level and a reach-specific assessment of existing fish habitat conditions in Tryon Creek. In the reach-specific assessment, emphasis was placed on identifying limiting factors for anadromous salmonids such as steelhead trout and sea-run cutthroat trout (*Oncorhynchus clarki clarki*).

BASIN OVERVIEW

The Tryon Creek Watershed is approximately 4,200 acres, and is divided between the City of Portland (about 75 %), the City of Lake Oswego (about 10 %), and unincorporated rural residential land in Clackamas and Multnomah Counties. The watershed is entirely within the Metro urban growth boundary. It is bounded to the east by the Palatine Hills, to the north and west by Portland's west hills, and to the southwest by Mt. Sylvania.

The Tryon Creek watershed is decidedly urban although the most significant feature of the watershed is Tryon Creek State Park, a 640-acre Oregon State Park shared by the cities of Portland and Lake Oswego. Tryon Creek is approximately seven stream miles long, originating in Mt. Sylvania (970 feet msl) and flows southeasterly into the Willamette River (10 feet msl). Tryon Creek is one of the major remaining free flowing tributaries that drains Portland's West Hills. The Creek's major tributaries include: Arnold Creek, Falling Creek, Park Creek, and Nettle Creek (Figure 2).

Fish species known to occur in Tryon Creek include coho salmon (*Onchorhynchus kisutch*), steelhead trout, cutthroat trout, and sculpins (*Cottus spp*.). Tryon Creek is one of the few remaining streams in the Portland metropolitan area that still supports a small run of steelhead trout.

Methods

To provide a watershed level assessment of existing fish habitat in the Tryon Creek watershed, we used the National Marine Fisheries Services (NMFS) Matrix approach for evaluating baseline conditions for anadromous salmonid habitat (NMFS 1996). This approach evaluates a list of environmental pathways and indicators that are known to be important in determining the suitability of freshwater habitat to anadromous salmonids. For each indicator a determination is made as to whether it is "properly functioning", "at risk", or "not properly functioning". The NMFS' "Matrix of Pathways and Indicators" (Appendix A) provides criteria for making these determinations at the watershed scale. For example, water temperature (an indicator of water quality) is considered to be properly functioning if it is within the range 50-57^0 F, at risk if in is in the range 57-60^0 F during spawning or 57-64^0 F during rearing, and not properly functioning if it is >60^0 F during spawning or >64^0 F during rearing. Similar criteria are available for each of the indicators shown in the checklist of pathways and indicators (Table 1).

Some of the criteria in the NMFS' matrix are based on quantitative measurements and some are based on professional judgment, especially when applying the criteria to a urban watershed. We used available information as well as observations made during habitat surveys of the Creek conducted in October and November, 2001 to make the determinations for each indicator. James Turner (NMFS Fisheries Biologist) and Bernard Klatte (Consulting Fisheries Biologist) conducted the October 17 survey. During this survey, the criteria in the Matrix of Pathways and Indicators were discussed and evaluated relative to their application in urban watersheds. On November 30, 2001 Bernard Klatte returned to Tryon Creek to evaluate selected environmental indicators in the creek under higher flow conditions.

A reach-specific limiting factors analysis also was conducted to identify key problem areas for salmonid fish species that historically have used the watershed. This analysis was conducted using the Washington Conservation Commission (WCC) criteria established in "Salmonid Habitat Condition Rating Standards for Identifying Limiting Factors". The WCC criteria are very similar to the NMFS' watershed criteria and employ a similar matrix approach. However, the WCC criteria or more appropriate for evaluating limiting factors in specific reaches of a stream rather than the entire watershed. The WCC matrix lists each potential limiting factor and provides a rating of "good", "fair", or "poor" based on a quantifiable range for each parameter (Appendix B). The study area for this survey is based on the reach map established by ODFW, 2000, Habitat Inventory Survey (see preceding report this publication, by ODFW).

Limiting Factors Analysis

In conducting the Limiting Factors Analysis, information was gathered from local, state and federal agencies and other sources including the gray literature (files and unpublished data). Many of the contacts providing information identified additional sources for review. Documents were evaluated for relevance to the Limiting Factor Analysis in Tryon Creek and are summarized in an annotated bibliography (Appendix C). The annotated bibliography lists the author, year, title, location and a brief description of the contents. We also used site-specific survey data gathered during the October 17 and November 30 surveys discussed above. The site-specific data included measurements of channel width, pool depth, riffle/pool frequencies, substrate condition, and bank condition in each of four reaches of mainstem Tryon Creek.

Study Reaches

The four study reaches (Figure 3) in Tryon Creek were initially established by ODFW (ODFW 2001) as part of their Aquatic Inventory Project for Oregon streams. We used the same reaches during our survey of the creek. The following is a general description of the boundaries of each reach:

Reach 1: Begins at the confluence of Tryon Creek with the Willamette River and ends at the west side of the State Route 43 stream crossing (culvert) (392 meters).

Reach 2: Begins at the west side of State Route 43 stream crossing and ends at the confluence of Nettle Creek with Tryon Creek in the Tryon Creek State Park (junction of Iron Mt. Bridge trail with Red Fox Bridge trail) (1,309 meters).

Reach 3: Begins at the confluence of Nettle Creek with Tryon Creek and ends at the confluence of Arnold Creek with Tyron Creek, just upstream from SW Boones Ferry Road stream crossing (culvert) (2,621 meters).

Reach 4: Begins at the confluence of Arnold Creek with Tryon Creek and ends at the confluence of Falling Creek with Tryon Creek just upstream with SW Lancaster Road (2,157 meters).

RESULTS

Watershed Evaluation

Results from the watershed-level evaluation (NMFS Matrix and Checklist) indicate that the Tryon Creek watershed is no longer properly functioning with respect to nearly all of the environmental parameters important to salmonid fish species (Table 2).

Water quality is degraded throughout the majority of the basin. Water temperatures during the summer often are greater than 64^0 F and Tryon Creek has been added to the 303(d) list of streams not in compliance with federal water temperature guidelines. Fine sediments blanket the lower ends of several of the tributary streams and comprises from 27 to 44 percent of the substrate in mainstem Tryon Creek riffle habitat.

No information was available to us on the occurrence of toxic chemicals or nutrients in Tryon Creek. However, it is possible that storm water runoff from paved areas in the upper watershed could be contributing oils and grease and possibly trace metals to the creek. Also drainage from lawns and gardens in the upper watershed could be contributing pesticides and plant nutrients.

Several physical barriers to fish migration were identified in the watershed and will be discussed below relative to limiting factors for salmonids. Habitat elements (i.e., substrate, large woody material, pool frequency, pool quality, off-channel habitat, and refugia) were all found to be “not properly functioning”. Tributaries and mainstem habitat in the upper reaches of the watershed tended to be in the worst shape with respect to habitat elements.

These are the areas where most of the development has occurred in the watershed. Large woody material is generally in low abundance throughout the watershed although recruitment potential in Tryon Creek State Park is

fair to good. Deep pool habitat (i.e, >1 m deep) is generally lacking throughout mainstem Tryon Creek and its tributaries. A few deep pools are present in Tryon Creek State Park.

Channel condition was evaluated with respect to width/depth ratio, streambank condition and floodplain connectivity. According to the NMFS' matrix criteria, width/depth ratios <10 are recommended for properly functioning forested, small salmonid streams. The width/depth ratio for mainstem Tryon Creek ranged from 11.1 to 16.2 with most of the values falling within the "at risk" category (i.e., 10 to 12). Streambank conditions were variable. Banks in the upper reaches of the watershed are often highly modified due to housing developments and high densities of paved streets. Within Tryon Creek Park, there are localized areas of bank erosion due to overuse by park visitors and failing cross drains.

Floodplain connectivity is very poor in the upper reaches of the watershed where much of the stormwater runoff is channeled through ditches or conveyed by storm drains. Many of the tributary stream channels in the upper reaches of the drainage basin show downcutting and a general loss of channel complexity. The section of Tryon Creek that passes through Tryon Creek Park is better connected with its flood plain but still shows degradation due to down cutting. The lower end of the creek (between the mouth and State Route 43) has been confined due to filling and bank stabilization. Head cutting is occurring within this reach.

Flow/Hydrology has been substantially modified due to runoff from impervious surfaces in the upper watershed and a complex network of storm drains and ditches that convey runoff water within the basin. Peak flows and an increased frequency of high flow events represent pronounced changes in hydrology relative to an undisturbed watershed of similar size, geology and geography. In addition, there has been a significant increase in the drainage network density due to roads in the upper portions of the watershed and the previously-mentioned complex network of storm drains and ditches.

General watershed conditions were evaluated with respect to road density and location, disturbance history and riparian reserves. Road density is >3 miles of road per square mile of watershed, which is the criterion for a not properly functioning condition. Although much of the lower mainstem of Tryon Creek lies within relatively protected State Park lands, the majority of the upper watershed has undergone extensive disturbance due to development of residential and commercial property and extensive street development.

The rate of development has increased substantially within the last 10 to 15 years, which has intensified problems in the small headwater tributaries that feed Tryon Creek. Disturbance history was given a "not properly functioning" rating due to the relatively large percentage of the watershed that has been disturbed. Riparian reserves in the Tryon Creek basin are fragmented and poorly connected in the majority of the upper watershed. Riparian reserves in Tryon Creek Park are in better condition and provide shade and limited refuge habitat for sensitive species such as steelhead and cutthroat trout. Overall, riparian reserves were given a "not properly functioning" rating.

Table 1. Results of properly functioning condition analysis for the Tryon Creek watershed.

PATHWAYS Indicators	**SOURCE**	**ENVIRONMENTAL BASELINE**		
		Properly Functioning	At Risk	Not Properly Functioning
▪ Temperature	303(d) ODEQ 1996			
▪ Sediment	27% - 46% fines, ODFW 2001			
▪ Chemical		Unknown	Unknown	Unknown
▪ Physical Barriers	ODFW 2001			
▪ Substrate	ODFW 2001			
▪ Large woody	16.1- 49.0/mi, ODFW 2001			
▪ Pool Frequency	12.9 - 17.9/mi, ODFW 2001			
▪ Pool Quality	1.1- 6.3/mi, ODFW 2001			
▪ Off-Channel	0.24 - 4.9/mi, ODFW 2001			
▪ Refugia	0, ODFW 2001			
▪ Width/Depth	11.1 - 16.2, ODFW 2001			
▪ Streambank	31% - 58%, ODFW 2001			
▪ Floodplain	ODFW 2001			
▪ Peak/Base Flows	BES 1997			
▪ Drainage Network	BES 1997			
▪ Road Density &	> 3, BES 1997			
▪ Disturbance	>15% , BES 1997			
▪ Riparian Reserves	<70%, ODFW 2001			

Reach-Specific Limiting Factors Analysis

The WCC Limiting Factors Analysis matrix utilizes many of the same indicators as the NMFS matrix. However, Technical Advisory Group members, including local citizens, state and federal agency biologists, specialists and planners, developed the WCC matrix specifically for evaluating limiting factors for anadromous salmonids (G. Wade, pers. comm. 2001).

The LFA matrix ranked each of the four reaches on the mainstem Tryon Creek similarly, with all reaches receiving an overall average of *"poor"* (Table 3). Reaches 2 and 3, which are primarily located within Tryon Creek State Park, received "*fair"* scores for several limiting factors.

All four reaches in Tryon Creek have various levels of limiting factors to fish production. The major limiting factors are addressed in the following paragraphs:

Fish Passage Barriers: Access to spawning and rearing habitat in the basin is a major limiting factor to anadromous fish production. Access to anadromous salmonid spawning and rearing habitat upstream of Reach 1 appears to be limited due to a culvert under State Route 43. The culvert is a concrete box culvert, which has been retrofitted with baffles to improve passage of adult anadromous salmonids. However, the culvert still appears to represent a partial barrier, particularly to fall-spawning coho salmon. Historically, adult coho salmon spawned throughout the mainstem of Tryon Creek. Since the culvert was installed under State Route 43, no adult coho have been observed above this culvert. Recent electrofishing surveys in Tryon Creek have found juvenile coho salmon only downstream of the culvert. Since Reach 1 lacks spawning habitat suitable for coho salmon, the juveniles observed were probably spawned elsewhere in the Willamette River system and were probably using the lower reach of Tryon Creek for rearing. Adult steelhead trout have not been documented above the State Route 43 culvert for several years (ODFW 2001).

However, steelhead runs have been low in the Willamette River basin during the past several years and numbers returning to small streams such as Tryon Creek would be expected to be small. Juvenile rainbow/steelhead trout were captured during electrofishing surveys conducted by the City of Portland in 2001 in Tryon Creek State Park (Reaches 2 and 3), which indicates that some successful steelhead spawning has probably occurred above the State Route 43 as recently as the spring of 2000. Steelhead return to spawn in the winter and spring, when flow conditions in the creek are relatively high. Higher flows through the State Route 43 culvert may allow steelhead better access than the coho salmon, which typically spawn during relatively low flow conditions in the autumn.

Access is also a problem at the culvert under S.W. Boons Ferry Road (upper end of Reach 3). This is a long (over 100 ft), sloped, culvert. Juvenile salmonids would not be able to move upstream through the culvert under any flow conditions and adult upstream migration is more than likely limited to a relatively narrow range of flow conditions.

Detailed analyses of the limiting conditions at culverts in the watershed were not one of the objectives of this study. Further studies would be necessary to specifically identify the limiting conditions for salmonid migration at each culvert.

Fine Sediment: Excessive fine sediment concentrations represent a serious limiting factor for successful spawning of salmonid fish species in Tryon Creek. We found that most of the potential spawning areas (i.e., shallow riffles and pool tailouts) contained gravel that was heavily embedded in fine sediments. Fine sediments have been shown to reduce the flow of oxygenated water to incubating embryos and thereby reduce survival of embryos. Also, excessive fine sediment deposition on salmonid redds can seal the substrate and block alevins from moving out of the gravel. Sediments appear to be entering the system from headwater tributaries as well as from localized bank erosion.

Large Woody Debris: Large woody debris was in low abundance throughout all four of the study reaches. However, Reaches 2 and 3, which lie primarily within Tryon Creek State Park, contained over twice as many pieces of large woody debris per unit length of stream than either Reach 1 or Reach 4. The number of pieces per

mile in all four reaches was well below the number recommended for a healthy anadromous salmonid stream. The low number of deep pools, lack of backwater areas and off-channel habitat in Tryon Creek can be related to the absence of large wood. Large wood (key pieces) provide cover, create pools, and provide habitat diversity and complexity for fish. Instream wood is important in reducing flood flow energy and storing sediment. The potential for large wood recruitment to the creek appeared to be substantially higher within the boundaries of Tryon Creek Park than in areas outside the Park.

Water Temperature: Summer water temperatures exceed recommended maximum levels throughout all four reaches. This is an important limiting factor because steelhead trout, sea-run cutthroat trout, and coho salmon rear for one or more years before migrating to the ocean. Juveniles of these species, therefore, are subjected to temperature conditions during the summer that can increase stress and potentially increase susceptibility to diseases. Summer temperatures are apparently not reaching lethal levels for salmonids as indicated by the presence of a resident population of cutthroat trout. The summertime warming appears to be caused by lack of adequate riparian shading in headwater streams and low summer flow conditions throughout the watershed.

Floodplain Conditions: A large part of the Tryon Creek watershed is disconnected from its active floodplain due to streambank hardening, channelization, and channel incision. In a functioning system, the width of a floodplain acts as a buffer during flood events (storage). It dissipates stream energy allowing suspended sediments to deposit on the banks, providing access to habitat for fish during flood flows, and recharges groundwater. The disconnection in Tryon Creek can be attributed to the increase in higher flows from impervious runoff and lack of instream large woody debris (LWD) to reduce the stream energy. The increase in water in the confined channel creates an increase in stream energy and down-cutting occurs to the channel bed (incision).

In summary, Tryon Creek is suffering from a variety of problems that are limiting its suitability for production of anadromous salmonids. Protection of riparian habitat provided along the lower mainstem by Tryon Creek State Park is probably the primary reason that salmonids are still present in the system.

Table 2. Limiting Factor Analysis for four reaches of Tryon Creek .

Limiting Factor	Score			
	Reach 1	*Reach 2*	*Reach 3*	*Reach 4*
Fish Passage Barriers	Poor	No barrier	Poor	Poor
Floodplain Connectivity	Poor	Fair	Fair	Poor
Loss of Floodplain Habitat	Poor	Fair	Fair	Poor
Fine Sediment	Poor	Poor	Poor	Poor
Large Woody Debris	Poor	Poor	Poor	Poor
Pool Quality	Poor	Poor	Poor	Poor
Pool Quantity	Poor	Fair	Fair	Poor
Streambank Stability	Poor	Fair	Fair	Poor
Side Channel Habitat	Poor	Poor	Poor	Poor
Sediment Supply	Poor	Poor	Poor	Poor
Road Density	Poor	Poor	Poor	Poor
Riparian Condition	Poor	Fair	Fair	Poor
Temperature	Poor	Poor	Poor	Poor
Dissolved Oxygen	Fair	Fair	Fair	Fair
Nutrients (Carcass)	Poor	Poor	Poor	Poor
Flow	Poor	Poor	Poor	Poor
AVERAGE SCORE	Poor	Poor	Poor	Poor

DISCUSSION AND CONCLUSIONS

The present degraded condition of Tryon Creek is symptomatic of many urban streams that have excessive amounts of impervious surface in their watersheds. Research conducted in King County, Washington (metropolitan Seattle area) sheds light on how stormwater runoff from developed basins effects stream channel stability and structure (King County 1990 a, b; Booth 1991).

Before discussing the King County studies, a brief review of the natural hydrological process in a watershed will help clarify how urban and suburban development is altering the natural process. Typically, only a fraction of the total precipitation falling on a basin actually reaches the stream channel. The remainder: 1) never reaches the ground and is evaporated off the surfaces of vegetation; 2) enters the ground but is transpired by plants or evaporated from the soil; or 3) percolates deeply to the regional groundwater system, with any subsequent entry to subsurface channels significantly delayed. Of the fraction that reaches the channel, its time of arrival is controlled by whether it flows primarily through the subsurface or over the surface, how quickly it is collected into open channels, and whether it is detained in reservoirs (Booth 1991).

Disruption of a stream channel by very high flow is a natural process that occurs erratically but with characteristic time scales. During such events, the channel form itself is affected-streambanks erode, large cobbles and boulders are moved, woody debris is repositioned or flushed from the system, pools are filled, and bars are scoured. Although the form of the channel is disrupted and the quality of the aquatic habitat degraded, effects are temporary. The “disturbance” ultimately results in a reformed, rejuvenated environment that continues for many years in a state of relative stability (Booth and Baker 1998). In the Pacific Northwest and other humid environments, channel disruptions are caused by flows larger than the 5-year flood event (Carling 1998, Sidle 1988).

Salmonid populations in the Pacific Northwest have evolved under conditions of episodic disturbances. Under natural conditions, rates of disturbance and subsequent recovery varied widely, even between streams of the same watershed. Habitat elements were altered but had periods of stability that lasted from a decade to century, or more (Booth 1991).

The runoff studies conducted by King County show that hydrologic changes imposed by urban development profoundly affect the disturbance frequency in developing basins. Using a continuous hydrologic computer model (HSPF), Booth (1991) determined the occurrence between 5-year flood events in a sample basin under completely forested conditions and fully urbanized conditions (40 percent impervious surface), using the same 40-year precipitation record for both simulations. The simulation for the forested watershed resulted in seven floods at or above the predevelopment 5-year discharge, with as much as 14 years between floods. In contrast, the same precipitation in the simulated urbanized watershed had only one year without a predevelopment 5-year flood event. Since Booth’s initial modeling work, additional studies have been conducted that indicate as little as 10 percent impervious surface in some watersheds may result in development of unstable stream channels.

Booth (1991) reported that channel changes from increased flows and altered corridors have a characteristic “look” to them. Their beds are uniform, with few pools or developed riffles; channel banks are near vertical and exposed to erosion; woody debris is small and sparse; and aquatic organisms are nearly absent. These conditions often occur throughout all the streams of an urban drainage. They are maintained in this sterile condition by the high frequency of 5-year or greater flood events.

The changes in steam habitat resulting from urban development may be detrimental, long term and, to an extent, irreversible. Many urban streams in King County have already reached a point where rehabilitation is unlikely (Booth 1991). Compensation for the effects of increases in impervious surfaces in urban watershed generally involves the use of detention basins. Detention basins can reduced the rate of runoff, but they also can block migration routes for anadromous salmonids.

As documented by this study, Tryon Creek is suffering from many of the same effects described by Booth (1991) for developed King County urban streams. Impervious surfaces in the Tryon Creek watershed amount to

approximately 30 percent of the surface area, which is approaching a fully built-out condition. Even so, there are some encouraging signs with respect to the current condition of Tryon Creek. Stream banks in the lower and mid mainstem of the creek are relatively intact and benthic macroinvertebrate densities were recently found to be in the moderate range for similar size undisturbed streams (Klatte, 2001). A resident population of cutthroat trout is still present and some spawning and rearing of steelhead trout appears to be occurring.

The solutions for reducing rates of surface runoff are complex and expensive. A carefully designed management plan and widespread, long-term cooperation among landowners and local governing bodies will be required to stop further degradation of fish habitat from surface water runoff. The most important short-term steps to improve use of the area by anadromous salmonids include:

1) upgrading fish passage at problem culverts,

2) reducing fine sediment loading from headwater tributaries,

3) lowering summer water temperature through enhancement of riparian shade in the upper basin,

4) creating more deep pool habitat that can be used as winter refuge for juvenile salmonids.

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PERSONAL COMMUNICATION

J. Turner. 2001. Fisheries Biologist. National Marine Fisheries Service, Habitat Conservation District, Portland, OR.

G. Wade, 2001. Salmonid Habitat Project Coordinator, Lower Columbia Fish Recovery Board, Longview, Wash.

APPENDIX A

National Marine Fisheries Services Matrix of Pathways and Indicators

APPENDIX B

Washington Conservation Commission
Limiting Factors Analysis Matrix Criteria

APPENDIX C

Annotated Bibliography for Tryon Creek

(A complete transcript of this report will be available in the Appendix to the Baseline Assessment.)

Outer watershed**:** open land behind an apartment building at SW 26th and Dolph Court. Portland BES tree- planting project. Date of this photo was November 31, 2001. See following page for same general area in July, 2003

Same site as preceding page, in July, 2003. Creek now appears as a series of backed up, stagnant ponds which drain into a culvert under the adjacent street (SW Dolph Court). Creek later has to pass under Interstate 5.