CHAPTER 9

Habitat and Biological Communities: Tryon Creek Watershed

This chapter characterizes habitat and biological communities in the Tryon Creek Watershed. It includes:

- Reach Descriptions
- Habitat Characterization by Reach
- Habitat Characterization Summary
- Biological Communities by Reach (Target Species)
- Biological Communities Summary
- Critical Issues

REACH DESCRIPTIONS

Reaches are used to divide streams into segments with common hydrologic, land use, or habitat features. Reach breaks may also occur where structures such as culverts create breaks in stream connectivity and function. The following reach delineations reflect current data and habitat features.

For this report, Tryon Creek reaches were chosen to reflect land use, gradient or stream condition (tributaries), significant culverts and barriers, and significant habitat features. The reach breaks generally coincide with the reach designations the Oregon Department of Fish and Wildlife (ODFW) used during its 2001 ODFW aquatic inventory project. Some of the reach breaks used for this report have been altered to accommodate headwater characterizations. In addition, subreaches were assigned to provide detailed habitat descriptions. Approximate stream miles (from the Willamette River confluence) are described, but stream centerline (thalweg) distance has not been surveyed.

Tryon Creek Mainstem Reaches

Tryon 1: Confluence

MOUTH OF TRYON CREEK (WILLAMETTE RIVER) TO THE WEST SIDE OF SW STATE STREET (RIVER MILE [RM] 0.0 – TO 0.24; APPROXIMATELY 1,286 FEET)

This reach includes a hydraulic jump and culvert (State Street culvert, approximately 200 feet long) at the upstream end. Although the culvert is long, it is considered partially passable to adult salmonids during certain times of the year (e.g., high flows). Stream gradient is 2.3 percent. Critical habitat features include the confluence of Tryon Creek and the Willamette River. Land use in this area is predominantly residential; however, the Tryon Creek Water Treatment Plant is located on the south shore of this reach and directly discharges into the Willamette River.

Nettle Creek confluence
(RM 0.24 –TO 1.06; 4,330 FEET)
Although the hillside was completely logged approximately 40-60 years ago, the area is now designated as greenspace and is largely undisturbed within the confines of Tryon Creek State Natural Area. One exception is a sewer pipe that runs along the valley bottom. Several tributaries enter the lower

Tryon: Lower Canyon
STATE STREET TO CANYON NEAR THE UPPER END OF THE SUBREACH.
Land use in the drainage is split between park (along the riparian corridor) and low-density residential (in upland areas).

Tryon 3: Tryon Creek Park
(RM 1.06 TO 2.68; APPROXIMATELY 8,554- FEET)

TRYON 3A
NETTLE CREEK TO PARK CREEK CONFLUENCE (RM 1.06 TO 1.80; 3,960 FEET)
This subreach has a stream gradient of 0.6 percent. Vegetative canopy is nearly entire, with well-established second-growth forest. Four tributaries (Red Fox Creek, Palatine Hill Creek, and Park Creek) enter the subreach, and Park Creek marks the upper boundary of the subreach. Walking trails cross and parallel the creek through approximately one half of the subreach, and there are two footbridges. Tryon Creek State Natural Area bounds the drainage basin.

TRYON 3B
PARK CREEK CONFLUENCE TO THE CONFLUENCE OF TYRON CREEK AND ARNOLD CREEK (RM 1.80 TO 2.68; 4,640 -FEET)
This subreach has a stream gradient of 0.8 percent. Although the reach runs through a well-established forest stand, numerous trails run through the reach, and human and horse activity is high. The upper extent of the subreach ends at the confluence of Tryon Creek and Arnold Creek, immediately above SW Boones Ferry Road. The SW Boones Ferry Road culvert is approximately 150 feet long and is considered completely impassable to anadromous and resident fish. Tryon Creek State Natural Area generally bounds the drainage basin; some low-density residential areas exist in the uplands.

Tryon 4: Upper Tryon Creek
(RM 2.68 TO 4.02; 7,076 FEET)
This reach comprises six subreaches, based on distinct hydrologic, habitat, and land use regimes. The SW Boones Ferry Road culvert (located at the bottom extent of this subreach) is considered to be a barrier to fish passage.

TRYON 4A
UPPER TRYON PARK (RM 2.62 TO 3.28; APPROXIMATELY 3,485 FEET)
This reach segment is 1,590 feet long and has a stream gradient of 2.3 percent. JUST ABOVE, IT SAYS IT IS 3,485 FEET LONG. It includes SW Maplecrest Drive (100 feet long), which bounds the upper extent of the reach. Mature second0growth forests dominate the landscape. Some low-density residential use is found in the uplands.

TRYON 4B
SW MAPLECREST DRIVE TO MARSHALL CASCADE (RM 3.28 TO 3.48; APPROXIMATELY 1,056 FEET)
This reach is generally similar to Tryon 4A, except that land use is dominated by low-density residential development (with landscaped vegetation in the riparian zone and along southwest-facing slopes). Marshall Cascade (a run of rock pools and steps) bounds the upper end of this subreach.

TRYON 4C
MARSHALL CASCADE TO SW 18TH PLACE CULVERT (RM 3.48 TO 3.55; 3,696 FEET)
Four to five tributaries enter Tryon Creek in this subreach, including Burlingame Creek. The SW 18th Place culvert (approximately 70 feet long) is located at the upper end of the subreach, immediately above Marshall Cascade.

TRYON 4D
SW 18TH PLACE TO SW LANCASTER DRIVE (RM 3.55 TO 3.98; 2,270 FEET)
Quail Creek defines the upper end of this short, 850-foot subreach. The hydrology is predominantly perennial flow, but sections become perennial-surface flow (i.e., dispersed and shallow flow) in bedrock areas. Land use is a mixture of park and low-density residential.

QUAIL CREEK TO SW LANCASTER ROAD (RM 3.92 TO 4.11; 1,050 FEET)
This subreach ends at the upstream end of the SW Lancaster Road culvert, which is approximately 80 feet long. Land use is exclusively residential, with significant landscaping and only a partial tree canopy. Stream gradient is approximately 3.7 percent, with two short reaches of much steeper gradient.

TRYON 4E
SW LANCASTER DRIVE TO SW 26TH AVENUE/TAYLORS FERRY ROAD (FALLING CREEK)
(RM 3.98 TO 4.03; 265 FEET)
This subreach is very short (260-280 feet) and moderately steep (2 percent). Land use is residential, and the riparian canopy is limited. Falling Creek defines the upper extent of the subreach.

Tryon 5: Headwaters
(RM 4.03 –to > 4.85; approximately/over 3,690 feet)
The headwater section of Tryon Creek is enclosed in residential development, commercial development, and transportation uses, and is divided into five subreaches based on culvert locations.

TRYON 5A
SW TAYLORS FERRY RD. TO INTERSTATE 5/SW BARBUR CULVERT (RM 4.16 TO 4.32; 845 FEET)
This reach extends from Falling Creek to the bottom of I-5/SW Barbur Boulevard. The downstream reach is dominated by a series of five closely spaced streets and driveway culverts (near the intersection of SW 26th Ave and Taylors Ferry Road). Four closely spaced culverts (approximately 320 feet total length) bound the upper extent of the subreach. Stream gradient is moderate (2.0 percent). Residential development and landscaped lawns dominate the land use in the area and characterize the riparian and floodplain land base.

TRYON 5B
I-5/SW BARBUR BOULEVARD TO END OF OPEN REACH BELOW SW DOLPH COURT (RM 4.32 TO 4.46;740 FEET)
This reach begins with the long approximately 580 feet) I-5/Barbur Boulevard culvert. Commercial development and arterial roads dominate the landscape and land –use. As a result, stormwater runoff (from impervious surfaces) is significant throughout the subreach. The upper 150-160 feet of the subreach is an open channel, and the subreach ends just below an industrial parking lot near Dolph Court.

TRYON 5C
SW DOLPH COURT TO BOTTOM OF CULVERTS BELOW SW 30TH AVENUE (RM 4.46 TO 4.56; 530 FEET)
This short reach terminates at an apartment complex (and culverted stream segment) just below SW 30th Avenue. Wetland habitat exists immediately above SW Dolph Court.

TRYON 5D
SW 30TH AVENUE TO END OF SW CARSON STREET (RM 4.56 TO 4.85; 1,530 FEET)
This subreach is the uppermost segment on Tryon Creek. The SW 30th Avenue culvert is approximately 160 feet long and defines the downstream extent of the subreach. A series of three closely spaced culverts (approximately 260 feet in total length) bound the upper extent of the subreach. Stream corridor characteristics from above SW 30th Avenue to SW Carson Street are highly variable. Storm runoff is a dominant component of hydrology in these subreaches, and land use is primarily moderate-density residential.

TRYON 5E
HEADWATERS COMPLEX – INCLUDES ALL SMALL UPPER TRIBUTARIES ABOVE RM 4.85
The headwater complex is a series of intermittent stream segments, all flowing into mainstem Tryon Creek. Although stream flow is seasonally intermittent, peak flows probably impact water quality and hydrologic processes in downstream creek reaches.

Tryon Creek Tributary Reaches

Tributaries are presented in ascending geographic order in the subbasin. They include lower canyon tributaries (Nettle, Palatine Hill, Red Fox, Park and Fourth Avenue Creeks); Arnold Creek; upper tributaries (Burlingame and Quail Creeks), and Falling Creek. Arnold Creek and Falling Creek are believed to significantly impact habitat and hydrologic functions in the Tryon Creek subbasin, and are characterized in more detail than lower canyon tributaries and upper tributaries.

The estimated relative drainage size compared to the Arnold Creek catchment is shown in braces {}.

Lower Canyon Tributaries

Nettle Creek, Palatine Hill Drainage, Red Fox Creek, Park Creek, and Fourth Avenue Creek

Thorough habitat surveys have not been conducted in these lower Tryon Creek tributaries; detailed habitat descriptions are therefore not available. However, lower tributary segments flow

into and are bound by Tryon Creek State Natural Area and are considered to have an intact forest canopy, high riparian integrity, and variable hydrology. The upper reaches of all these creeks are in low-density residential development.

NETTLE CREEK

Nettle Creek enters Tryon Creek at RM 1.15 (Tryon 2/Tryon 3A reach break). The mainstem reach is approximately 1.7 miles long {basin size - 0.7}. It is about 75 percent residential land use, and lies within Lake Oswego and Multnomah County.

PALATINE HILL DRAINAGE

Palatine Hill drainage is approximately 0.5 mile long {basin size - 0.2}. It is 40-50 percent residential land –use, and is largely contained in Multnomah County

RED FOX CREEK

Red Fox Creek is approximately 0.7 miles long {basin size - 0.1}. It is 50 percent residential land use and lies primarily within the City of Lake Oswego

PARK CREEK

Park Creek enters Tryon Creek at RM 2.82 (Tryon 2/Tryon 3A reach break) and is approximately 1.0 mile long {basin size - 0.3}. It is 50-60 percent residential land use and lies within Multnomah County and the City of Portland.

FOURTH AVENUE CREEK

Fourth Avenue Creek is approximately 0.7 mile long {basin size - 0.2}. About 40 percent of the subbasin is located within Lewis & Clark College, with the remainder within Tryon Creek State Natural Area and low-density residential land use (within the City of Portland).

Arnold Creek Reach

MOUTH OF ARNOLD CREEK TO ABOVE SW 43RD AVENUE (RM 0.0 TO 1.84; APPROXIMATELY 9,700 FEET)

Approximately 80 percent of Arnold Creek is encompassed by residential land use within the City of Portland. Arnold Creek is divided into seven subreaches, based on culvert locations and past surveys; however, detailed habitat and biological communities characterizations have been done for only subreaches Arnold 1A and Arnold 1B. Low flows within Arnold Creek and a cascade reach just below SW 16th Place (Arnold 1B) probably isolate fish populations. At least eight tributaries enter Arnold Creek; these are not included in this characterization.

ARNOLD 1A

MOUTH OF ARNOLD CREEK TO SW ARNOLD ROAD (RM 0.0 - 0.13; APPROXIMATELY 680 FEET)

This reach begins at the confluence of Tryon Creek and Arnold Creek. The reach is heavily wooded, with a dense canopy (except along SW Arnold Street, which runs parallel to the creek). Some of the subreach lies with Tryon Creek State Natural Area. Stream gradient is less than 1 percent. The SW Arnold Street culvert (approximately 50 feet long) forms the upper end of the subreach.

ARNOLD 1B

SW ARNOLD ROAD TO ABOVE SW 16TH PLACE (CASCADE REACH) (RM 0.13 - 0.41; 1,480 FEET)
Stream gradient averages 6 percent and is broken into a gentle portion and a series of three steep cascade sections in the upper portion of the subreach. This stream segment is believed to be impassable to fish migrations, and the ODFW habitat surveys ended here. SW Arnold Street continues to parallel the stream at a distance of 50-75 feet to the north. The SW 16th Place culvert bounds the upper extent of the subreach.

ARNOLD 1C

SW 16TH PLACE TO SW LANCASTER ROAD (MIDDLE ARNOLD) (RM 0.41 - 0.78; 1,950 FEET)
Stream gradient is 1.8 percent. The predominant land use in the subreach is residential, with several driveway culverts crossing the stream channel. SW Arnold Street continues to parallel the subreach along the north slope. The SW Lancaster Road culvert (approximately 110 feet long) marks the upper extent of the subreach.

ARNOLD 1D

SW LANCASTER ROAD TO SW 31ST AVENUE (RM 0.78 ABOUT 1.15; 1,950 FEET)
Stream gradient is approximately 3 percent; this subreach is otherwise similar to Arnold 1C. The SW 31st Avenue culvert bounds the upper extent of the subreach.

ARNOLD 1E

SW 31ST AVENUE TO SW 35TH AVENUE (ARNOLD HEADWATERS) (RM 1.15 - 1.42; 1,430 FEET)
Stream gradient is 6.3 percent. The long SW 35th Avenue culvert (approximately 100 feet) defines the upper end of this subreach.

ARNOLD 1F

ARNOLD HEADWATERS (RM 1.42 - ABOUT 1.84)
This headwaters reach is predominantly in public land ownership. It is over 2,500 feet long, with a gradient of approximately 8 percent.

Upper Tributaries

The upper tributaries include Burlingame Creek and Quail Creek. Detailed habitat descriptions (and other instream and riparian data) are not available for these two reaches. A brief description of basin size and dominant land-use by reach is provided below.

BURLINGAME CREEK

Burlingham Creek flows into Tryon Creek near RM 3.89 (Tryon 4D). The creek is approximately one mile long {basin size - 0.3. About 90 percent of the drainage is in residential land use within Portland

QUAIL CREEK

Quail Creek flows into Tryon Creek near RM 3.92 (near the upper extent of Tryon 4D). The creek is approximately 0.5 mile long {basin size - 0.1}. More than 90 percent of the drainage is in residential land use within Portland.

Falling Creek Reach

Falling Creek is approximately one mile long {basin size -0.5}. The Falling Creek drainage is

bound by urban development, roads, and parklands. Limited data are available to characterize instream channel condition and riparian and floodplain characteristics. Culverts divide Falling Creek into three subreaches: Falling 1A, Falling 1B, and Falling 1C. The SW 35th Avenue culvert is believed to define the upper limit of fish habitat in Falling Creek, but this assumption has not been confirmed.

FALLING 1A

MOUTH OF FALLING CREEK TO SW 26TH AVENUE (LOWER FALLING) (APPROXIMATELY 30 FEET)

This subreach begins at the confluence of Falling Creek and Tryon Creek (RM 4.16: Tryon 4E). Stream gradient is approximately 2.5 percent. Land use is predominantly multiple-family residential, with a large number of apartments close to the stream corridor. SW Taylors Ferry Road and SW 35th Drive parallel the stream at distances between 100 and 300 feet. The SW 35th Avenue culvert defines the upper extent of the subreach; the culvert is approximately 150 feet long and has a gradient of 6.5 percent.

FALLING 1B

SW 26TH AVENUE TO SW 35TH AVENUE (APPROXIMATELY 3,500 FEET)

FALLING 1C

SW 35TH AVENUE TO SW HUBER STREET (APPROXIMATELY 1,500 FEET)

Stream gradient is 2.2 to 2.5 percent. Land use is primarily residential, although the lower half of the subreach has few structures. The subreach ends immediately above the SW Huber Street culvert, which is approximately 60 feet long.

FALLING 1D

SW HUBER STREET TO JACKSON MIDDLE SCHOOL (UPPER FALLING) (APPROXIMATELY 200 FEET)

FALLING 1E

JACKSON MIDDLE SCHOOL (1,800 FEET)

The majority of this creek segment is buried (piped) under Jackson Middle School playfields. The lower portion of the reach lies within a residential neighborhood.

HABITAT CHARACTERIZATION BY REACH

Mainstem Tryon Creek

Tryon 1: Confluence

FLOODPLAIN CONDITION

The mouth of Tryon Creek is part of the Willamette River floodplain; portions of it are seasonally inundated. Multiple terraces currently constrain the mouth of Tryon Creek; however, the creek runs through a broader outwash, with a valley width index (VWI) of 20.0. Stream gradient is moderately steep, averaging 2.3 percent.

Although creek depth, channel flow, and floodplain inundation are influenced by perennial channel flows and Willamette River flows, floodplain interactions between Tryon Creek and its floodplain are impaired. Bank slopes are relatively severe; the channel is incised; and urban

development (residential, industrial, and public utility) abuts both the north and south sides of the creek. However, the floodprone width is approximately 1.5 times greater than the active channel width, indicating that flood flows occasionally top the banks and interact with the floodplain.

RIPARIAN CONDITION

For the reasons stated above, riparian condition in lower Tryon Creek is "quite poor" (ODFW 2000). Buffers are narrow, and backyards and a sewage treatment facility are predominant land uses and features in the riparian area.

Canopy cover is approximately 50 percent within the immediate 010 meters, then drastically diminishes to 23 percent at 10-20 meters and 0 percent at 20-30 meters. Grasses and forbs are common, and overstory canopy is mostly provided by second-growth deciduous trees (15-30 – centimeters [cm] dbh). Small conifers are coming up through the understory, and cedar and arbor vita hedges are common along the landscaped portions of the creek bank. Vegetative cover is generally greater along the north bank and floodplain terrace (Map 7 – Tryon Creek Vegetative Cover Maps by subwatershed, Map Atlas). Hardwoods are only moderately mature and do not currently contribute significant pieces of large woody debris into Tryon Creek. As these trees mature and die off, they will provide source wood material into the creek (and the lower Willamette River).

State Street (Highway 43) and a railroad crossing severely disconnect Tryon 1 from Tryon 2A and impede migration of riparian-dwelling organisms.

STREAM CONNECTIVITY

Connectivity with the Willamette River is good up to State Street. A culvert that runs under this roadway, along with a railroad bridge, significantly reduce but do not entirely block stream connectivity with the upstream reaches of Tryon Creek. The culvert is 200-feet long, with a formidable jump and slope. Anadramous salmonids might navigate through the culvert during higher annual flow periods (winter – spring). Even then, however, passage is probably limited to periods when flows provide adequate water depth (for jump height into the culvert and passage through the baffles), yet do not pose a velocity barrier. It is unlikely that fall-run coho salmon pass above the culvert, except during very opportune periods. Flows during this period are too low in most years to allow adequate access into and through the culvert. Late-run winter steelhead may pass in late winter and spring. Resident trout probably cannot move upstream through the culvert; however, they may pass downstream during spring freshets or other high-flow periods.

REFUGIA

Undercut banks, which constitute 38 percent of bank form, probably provide most instream refugia. Additional cover may be found in deep pools, among the few pieces (and clusters) of wood and under overhanging vegetation. The beaver pond, located near the confluence of the Willamette River, may provide important high-water refugia and fringe/shoreline habitat.

No off-channel habitats or secondary channels were identified during ODFW 2000 surveys, and no tributaries flow into this lower portion of Tryon Creek.

CHANNEL CONDITION AND HABITAT STRUCTURE

The confluence segment of Tryon Creek is highly eroded (69 percent actively eroding banks) and channelized, with bank slope of 25 percent (ODFW 2000).

Predominant habitat types include pools (55 percent) and riffles (20 percent) (ODFW 2001). Riffle quality is marginal to poor, with gravels and sands constituting 21 percent and 18 percent, respectively, of substrate. Fines and organics constitute 21 percent of these riffles and may significantly affect riffle quality, particularly for epifaunal and macroinvertebrate production. Cobbles constitute 27 percent of riffle substrate, and boulders constitute only 8 percent of substrate; some substratum is therefore available for epifaunal cover.

Streambed substrate in pool habitat is well mixed with cobbles, gravels, and fines (ODFW 2000). Pool quality is optimal, with 55 percent total pool area. Average residual pool depth throughout the reach is 0.64 meter, approximately 27 percent deeper than the prevailing stream depth. Although most pools are not significantly deeper than the average channel depth, four pools greater than 1.0 meter were noted within the reach and probably provide important cover and refuge throughout the year.

Complex pools with wood are rare, and boulders constitute only 9 percent of pool substrate; protective cover is therefore most probably provided in the deepest areas of the pools. Sediment deposition in pools is moderately high (31 percent), signifying erosive flows in the upper watershed and sediment fallout in this lower depositional area. Sediment concentrations greater than 25 percent of substrate coverage signify unstable conditions during storm flows. Lateral scour pools are the predominant pool type; however, one beaver pond/dam complex was noted near the confluence.

Wood count and volume are low. Wood density is 5.06-m3/100 meters; wood count is 4.55 pieces per 100 meters; and key pieces are 0) (ODFW 2001

Two culverts/pipes (one concrete and one metal) enter Tryon Creek approximately 180 meters and 190 –meters, respectively, from the confluence with the Willamette River. Their source (stormwater or sewer) and flow contribution to Tryon Creek is not known.

HYDROLOGY

Tryon Creek is a perennial, spring-fed creek. No tributaries or springs are known to enter this reach of Tryon Creek. Winter flows may be influenced by runoff from the State Street corridor. Low summer flows range from 3-10 – cubic feet per second (cfs).

EVALUATION OF TRYON 1: CONFLUENCE

- Floodplain connectivity and riparian condition could probably be improved by planting native shrubs and trees in the riparian corridor and broader floodplain area. Key benefits that additional plant cover would probably provide include stabilizing creek banks and channel, providing additional canopy cover, providing instream woody structure (small wood clusters and allochthonous inputs for macroinvertebrates and fish), and attenuating creek flows.

- Lower Tryon Creek is part of the larger Willamette River floodplain and should be protected from future development or redevelopment to the maximum extent possible. In addition to providing habitat to local populations, this short reach provides critical refuge to upper Willamette Basin fish populations year-round.

- Channel condition and habitat structure could be improved by enhancing channel complexity and instream structure. Adding large wood and boulders instream would increase channel roughness and help pool and riffle forming processes. Lower Tryon Creek currently does not exhibit complex habitat types. Riffle area is low. Lateral scour pools predominate and are not significantly deeper than the prevailing channel depth; they probably do not provide significant depth refugia or protective cover.

- An evaluation of the two pipes that enter Tryon Creek is needed to determine the source (stormwater or sanitary), flow contribution, and water quality.

- Fish access into upper reaches of Tryon Creek could be improved by retrofitting or replacing the State Street culvert. This culvert is impassable nearly year-round and under most hydrologic conditions. Adult winter steelhead may be able to navigate through the culvert during very opportune periods, but other species (such as coho and coastal cutthroat) probably do not pass through the barrier.

Tryon 2: Lower Canyon

FLOODPLAIN CONDITION

The floodplain in this reach is narrow and constrained by steep valley walls. The average VWI is 4.3, and stream gradient is low at 1.3 percent (ODFW, 2001). Within the floodplain, the channel is constrained by alternating terraces. The lower canyon reach lies entirely within Tryon Creek State Natural Area and interacts with its floodplain much more than a typical urban creek (ODFW 2000). Broader floodplain areas were noted in ODFW's 2000 stream survey. Most were associated with beaver dams and ponds, which are prevalent throughout the reach.

RIPARIAN CONDITION

Riparian condition varies from good to excellent. The corridor is wide (over 200 feet) and continuous, without breaks in longitudinal connectivity. Trails running through Tryon Creek State Natural Area do not appear to impact habitat condition and structure in Tryon Creek. However, an exposed sewer pipe (supported by concrete pillars) runs parallel to the creek for approximately 325 meters. Depending on its condition, this sewer pipe may significantly impact riparian condition and water quality.

Large deciduous trees (30-50 cm dbh) are the dominant tree class.. Grasses and forbs are common. Trees probably provide important coarse organic material into the creek. Generally, canopy cover is good and continuous within the immediate 30 meter riparian zone: 56 percent in zone 1 (0-10 meters from the stream bank); 80 percent in zone 2 (10-20 meters from the stream bank); and 66 percent in zone 3 (20-30 meters from the stream bank). Vegetative cover is greater

along the northerly hillslopes, particularly adjacent to the creek (Map 7 – Tryon Creek Vegetative Cover Maps by subwatershed, Map Atlas). A mid-reach landslide was noted during the ODFW 2000 stream surveys. The slide was characterized as "stable," with no evidence of recent activity.

STREAM CONNECTIVITY

Stream connectivity is excellent. There are no culverts or other manmade structures that impair stream connectivity. However, five beaver dams are present in the mid-to-upper portion of the reach and may temporarily or seasonally impede fish movement. In addition, several steps over bedrock may impede fish movement during very low flows. These steps range from 0.4 to 0.8 meter in height. The State Street culvert at the downstream extent of the reach impedes fish movement to and from Tryon 1 during all (or certain parts of) the year.

REFUGIA

Undercut banks (38 percent of bank form) and wood provide primary instream refugia. Additional overwintering habitat is found in the five beaver ponds. These ponds probably provide important slack water during high storm flows.

Off-channel refugia may be found in Nettle Creek and in secondary channels (a total stream length of 36 meters). Although off-channel refugia is low, it is more than that found in most other reaches of the Tryon Creek Basin.

CHANNEL CONDITION AND HABITAT STRUCTURE

Tryon Creek is moderately unstable in this reach, with 36 percent actively eroding banks. Bank slope is also high (53 percent), indicating that erosive flows have cut and incised the main channel. Channel condition and structure vary as springs and seeps, beaver dams, and broader floodplain areas interact with the creek.

The predominant habitat forms are scour pools (51 percent), dammed pools (25 percent), and riffles (17 percent). Although the riffle area is small, 40 percent of the riffle habitat is considered optimal for fish bearing because it has more than 35 percent gravel composition. The remaining riffle habitat is considered marginal, with 15-35 percent gravel composition. More than half (65 percent) of the riffle habitat contains 12-25 percent fines and organics in the substrate (marginal fish habitat), and only 15 percent contains less than 12 percent fines (desirable). Relative to other areas in Tryon Creek, riffles in this subreach are in good condition. Only Tryon 3A and Tryon 3B exhibit more favorable riffle habitat.

Pool area is high (76 percent), the highest of any other reach surveyed in the Tryon Creek Basin. Twenty-five percent of this pool area is found in five beaver ponds and a backwater pool. Beaver ponds have characteristically high proportions of silt (45 percent) and sand (28 percent), and are probably functioning as depositional zones during erosive flows. Beaver dam heights varies from 0.3 to 0.6 –meter, and may temporarily or seasonally prevent resident fish from moving upstream (and possibly downstream).

Lateral scour pools are the predominant pool type, constituting 51 percent of the pool habitat. Riffle substrate is 17 percent gravels, 25 percent sands, and 31 percent fines. The moderately

high proportion of fines indicates that lateral scour pools, like the five beaver ponds, are depositional zones during erosive flows.

Nine complex pools with wood were observed during the 2000 surveys. Boulders constitute only 2 percent of the stream bottom substrate and therefore do not provide substantive cover. However, the pools average 0.59 meter deep, approximately 25 percent deeper than the prevailing channel depth, and six pools are greater than 1.0 –meter deep. These pools probably provide important depth refugia.

Wood count through this reach is high at 42 pieces per 100 –meters of stream length, but wood densities are low (1.40-m3/100 meters). The existing tree canopy comprises smaller trees (less than 30 cm dbh), with some large trees (50-90 cm dbh), indicating that potential large wood recruitment exists.

HYDROLOGY

This reach of Tryon Creek experiences perennial channel flow. Springs and seeps were observed during 2000 ODFW surveys and are believed to augment summer and winter base flows throughout the year. Late summer (September – October) stream flows are expected to range from 3 to 7 cfs. Nettle Creek flows into mainstem Tryon near the upstream extent of the subreach. Its contribution to mainstem flow has not been quantified.

EVALUATION OF TRYON 2: LOWER CANYON

- The lower canyon reach running through Tryon Creek State Natural Area contains critical fish-bearing habitat. This area should be protected, and recreational use should be minimized in the riparian corridor and instream. Pool area and quality are optimal, and riffle habitat is good. The riparian corridor and adjacent floodplain interact with the creek. Large wood recruitment is plausible, and springs and seeps augment summer and winter base flows. The combination of these instream and terrestrial characteristics creates a favorable environ for aquatic organisms.

- Beaver activity should be encouraged and retained. Beaver ponds provide important flood storage and high-flow winter refugia to fish. In addition, they are sources of large wood clusters that provide cover to fish in both the pond and downstream creek.

- Sediments overlying stream-bottom substrates may limit fish productivity. Only 15 percent of the riffle habitat has less than 12 percent fines, which is considered desirable for salmonids. More than half (65 percent) of the riffle habitat has 12-25 percent fines and organics (marginal fish habitat). Amassed sediments may cover spawning grounds, and sediments may limit epifaunal production and subsequent macroinvertebrate production. Actions to minimize sediment load into Tryon Creek should be considered.

- Increasing the amount and density of large wood would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows), and aid channel-forming processes (habitat formation of pools and riffles) and meanders.

- The sewer pipe running along the lower quarter of the reach should be evaluated for leaks and breaks. Sewage leaking from the pipe may significantly impact riparian condition and water quality.

- Fish access into this reach of Tryon Creek could be improved by retrofitting or replacing the State Street culvert. This culvert is impassable nearly year-round and under most hydrologic conditions. Adult winter steelhead may navigate through the culvert during very opportune periods, but other species (such as coho and coastal cutthroat) probably do not pass above the barrier.

Tryon 3A: Lower Park

FLOODPLAIN CONDITION

The valley is predominantly U-shaped, with a narrow floodplain/floodway (although some wider terraces are present). The average VWI is 7.8, and stream gradient is very low (0.6 percent), suggesting that floodplain functions were historically significant in this portion of Tryon Creek. The channel is currently constrained by multiple terraces. It meanders through the valley bottom and probably interacts with adjacent riparian and floodplain habitats during some times of the year. However, channel scouring and incision probably minimize potential floodplain interactions. The floodprone width is not significantly greater than the active channel width (1.3 times greater), indicating that flood flows do not regularly extend beyond the active channel width and floodplain interactions are limited.

Floodplain expanses increase at tributary junctions, most notably at Palatine Hill drainage, Red Fox Creek, and Park Creek. The entire reach lies within Tryon Creek State Natural Area and is zoned as greenspace.

RIPARIAN CONDITION

Riparian condition is considered very good (ODFW 2000), with riparian widths greater than 250 feet and no perceived breaks in riparian connectivity. Foot trails, bridges, and a sewer line interact with the riparian corridor. A manhole was noted in the active channel (ODFW 2000).

The dominant tree class includes medium-sized (second-growth) deciduous trees (ranging from 15-30 cm dbh). Grasses and forbs are common in the understory, and climbing clematis forms part of the overstory canopy. Canopy coverage is high, ranging from 75-87 percent within the immediate 30 –meters of the stream channel. High terraces and hillslopes form the riparian and floodplain area. The northern hillslopes provide greater vegetative cover than the southern hillslopes.

Two earthen flows were noted during the 2000 ODFW stream surveys. Both slides/flows were considered inactive, but not stabilized, indicating that the slide probably occurred during winter 1999 or during recent high flows.

STREAM CONNECTIVITY

Stream connectivity is good throughout the subreach in both upstream and downstream directions. Two foot bridges (Red Fox and Iron Mountain) pass over the creek, and a sewer line parallels the creek. Neither the bridges nor the sewer line is believed to disrupt stream connectivity. Two beaver ponds were noted during the ODFW 2000 stream surveys. The dams average 0.25 meter and 0.35 –meter, respectively, and may temporarily impede fish movement during low flows.

REFUGIA

Primary in-channel refugia are probably found near seeps and springs, undercut banks (30 percent of bank form), and near wood clusters. The two beaver ponds probably provide important overwinter habitat and refugia during higher storm flows.

Off-channel refugia exist in Red Fox Creek and Park Creek. The extent of their use by mainstem fish populations is not known.

The wider valley bottom may also provide opportunities for floodplain-related refugia during peak flow events.

CHANNEL CONDITIONS AND HABITAT STRUCTURE

This portion of Tryon Creek exhibits unstable banks, with 66 percent actively eroding banks. However, bank slope is relatively low (6 percent), indicating that the channel (although t erosive, with exposed soils) is interacting with its floodplain to attenuate storm flows.

The dominant habitat types are scour pools (57 percent) and riffles (29 percent). Substrate is a mixture of cobbles, gravels, sand, and fines. Riffle area is moderately low, but riffle quality is relatively good; 75 percent of riffle habitat has 35 percent or more gravel substrate. Although the percent gravel composition is optimal, however, 55 of these riffles have 12-25 percent fines in the substrate (marginal conditions), and only 21 percent have less than 12 percent fines (desirable conditions). Relative to other subreaches in Tryon Creek, this subreach is in good condition, with the second-highest proportion of optimal riffle habitat basinwide.

Pool quality is very good throughout the subreach , relative to desirable fish habitat and relative to other subreaches within Tryon Creek. Pool area constitutes 65 percent of stream habitat. More than half the pools (53 percent) have depths greater than 0.5 meter, and the remainder has depths between 0.2 and 0.5 meter. In addition to deep pools, pools contain wood, yielding 13.5 complex pools per 100 –meters of stream length. This is the most of all the reaches surveyed, and more than five times the amount considered desirable for fish-bearing streams.

Wood counts are relatively high throughout the subreach, with 54 pieces per 100 –meters of stream length. Of all the subreaches surveyed in Tryon Creek, this reach contains the most wood per stream length, and is the only reach that contains key pieces of wood. In addition, ODFW noted two significant debris jams that were not associated with beaver activity. As noted above under Riparian Condition, tree cover is intact and will probably provide long-term sources of woody debris.

Two beaver ponds constitute 424 –square meters of wetted area. Both ponds have associated beaver dams that average 0.25 meter and 0.35 meter in height, respectively, and are located approximately 250 meters downstream of the confluence with Park Creek.

HYDROLOGY

This portion of Tryon Creek remains perennial year-round, with low summer flows ranging from 3-7 cfs. Two key tributaries (Red Fox Creek and Park Creek) augment annual flows.

Springs seeps and hyporheic areas have not been mapped, but are thought to be significant throughout the subreach (personal communications, Gerrit Rosenthal). These habitats (and associated flows) are critical for maintaining flows, temperatures, and water quality during low-flow seasons. Several foot trails have impacted the seepage areas; however, efforts are being made to either elevate the park trails or locate them away from the creek to protect these fringe habitat areas.

EVALUATION OF TRYON 3A: LOWER PARK

- The lower reach in Tryon Creek State Natural Area contains critical fish-bearing habitat, riparian habitat, and floodplain habitat. This area should be protected, and recreational use should be minimized in the riparian corridor and instream. Specifically, pool quality (pool area, pool depths, and number of complex pools), large wood counts, and instream structure are favorable for fish productivity. Compared to other reaches in Tryon Creek, riffle habitat is good quality: 75 percent of the riffles have optimal gravel composition, and 21 percent have less than 12 percent fines (desirable condition). This reach has the best wood structure of all the reaches in the subbasin.

- Although riffle quality is relatively good in this reach, actions to minimize sediment load into Tryon Creek should be considered. Amassed sediments may cover spawning grounds, and sediments may limit epifaunal production and subsequent macroinvertebrate production.

- Increasing the amount and density of large wood would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows), and aid channel-forming processes (habitat formation of pools and riffles) and meanders.

- Floodplain connectivity with the stream channel should be enhanced. The channel appears to meander through the valley floor; however, it does not significantly interact with the floodplain. Improved connectivity with the floodplain and riparian corridor would allow the creek to adjust to differing flows, attenuate flood flows, and minimize flow-related bank erosion. Other indirect benefits of enhancing floodplain interactions include retaining woody debris and other instream structure, and stabilizing habitat-forming processes (riffle/pool formations).

- Beaver activity should be encouraged and retained. Beaver ponds provide important flood storage and high-flow winter refugia to fish. They are also sources of large wood clusters that provide cover to fish in both the pond and downstream creek.

- Connectivity to Red Fox Creek and Park Creek should be retained. Both tributaries probably provide important off-channel refugia to resident fish, and their flows augment Tryon Creek base flow year-round.

Tryon 3B: Middle Park

FLOODPLAIN CONDITION

Floodplain conditions in the middle park reach are similar to floodplain conditions in the lower park (Tryon 3A). The valley is a bit broader (with an average VWI of 10.6), generally U-shaped, and constrained by multiple terraces. Stream gradient remains low (0.5 percent). Floodprone width is greater than the active channel width, indicating that flood flows top the bank and run into the adjacent floodplain. This portion of Tryon Creek continues to be protected within the confines of Tryon Creek State Natural Area.

This reach of Tryon Creek interacts with the floodplain similarly as downstream reaches, except that the stream gradient is lower, VWI is broader, and entrenchment ratio is generally larger (i.e., flood flows span into the floodplain proportionally more than the adjacent downstream reach). The potential to reestablish or enhance floodplain interactions throughout this reach may therefore be easier (or more attainable) than in other mainstem reaches. Because Tryon Creek is relatively bound by steep valley walls, intact floodplain interactions probably played a critical role in maintaining properly functioning watershed conditions. For example, intact aquatic land interactions probably allowed the creek to adjust to higher storm flows (by meandering from hillslope to hillslope) and probably maintained summer base flows via springs, seeps, and hyporheic flows.

RIPARIAN CONDITION

Riparian condition in the middle park reach is similar to that in the lower park reach, except that more wetlands were observed in Tryon 3B during the 2000 habitat surveys. In addition, three foot trails run along and cross the creek and probably disrupt riparian functions more than in the adjacent downstream reach. The three footbridges include Obies, Beaver, and High Bridge. Other human constructs include a buried sewer line, a stormwater (or sewer) pipe entry, and a pump station (and associated screened water diversion) (ODFW 2000).

Canopy cover varies from 5 percent to greater than 95 percent, averaging 75-87 percent throughout the reach (PHS 1997; ODFW 2001). The overstory canopy is dominated by mature second-growth deciduous trees (big leaf maple, vine maple, and red alder) and conifers (Douglas fir), ranging from 15 to 30 cm dbh. High terraces and hillslopes form the riparian and floodplain area.

An inactive earthen flow was noted approximately 100 meters upstream of Beaver footbridge.

STREAM CONNECTIVITY

Stream connectivity throughout the reach is relatively good. Three artificial structures cross Tryon Creek, ranging rom 0.20 to 0.35 meter high. Some or all of these barriers may impede fish movement, particularly during low summer flows. In addition, the SW Boones Ferry Road culvert bounds the upper end of this reach. The culvert is long (approximately 150 feet) and steep (2.0 percent slope), and jump height into the culvert outlet is at the maximum end of that considered navigable by fish (12 inches). A trash rack that hangs over a concrete platform is present at the culvert inlet. This structure is considered completely impassable to anadromous and resident fish moving upstream.

REFUGIA

Instream refugia are associated with a larger number (eight to 12) of small springs and seeps. Groundwater inflow varies from little or none to strong throughout isolated areas of the reach. These inflow areas may provide critical ecological functions during the summer by providing thermal refugia and maintaining summer flows.

Instream refugia associated with habitat structure are limited. Undercut banks may provide some cover. Very little woody debris or other instream structure or cover exists within the reach, and only a few large woody debris complexes have been noted.

Two tributaries enter Tryon Creek in this reach and probably provide winter and summer habitat (off-channel refugia). The tributaries are not named and are believed to be intermittent.

CHANNEL CONDITION AND HABITAT STRUCTURE

Channel banks are actively eroding (66 percent) and are unstable. ODFW noted channelized streambanks throughout the entire reach. However, bank slope is low (6 percent), indicating that although creek banks are probably exposed and erosive, the channel has not yet become incised or channelized. Unlike Tryon 3A, the channel is relatively straight and does not currently exhibit sinuosity.

Habitat consists of pools (55-60 percent) and riffles (26-28 percent). Stream-bottom substrates comprise a mixture of cobbles and gravels and are considered optimal for spawning and rearing. Riffle area is moderately low, and riffle quality is poor. Riffles are significantly covered in fine sediment and organic material; approximately 74 percent of them have greater than 25 percent fine organic matter overlying riffle substrate. These high sediment loads undoubtedly limit the potential habitat value in this reach. Riffle habitat found in the upper reach of Tryon 3B (the upper 400 meters) is in excellent quality; 100 percent of the riffle habitat has greater than 35 percent gravels, and the substrate is not embedded or covered with fines. (Less than 72 percent of the riffle habitat has less than 12 percent fines). Large sand is relatively absent, but gravel bars and sediment deposits are common.

Pool area is moderately high (57 percent), and pool quality is generally good, based on depth. Of those pools present, 72 to 81 percent are greater than 0.5 meter deep, with the highest proportion of deep pools found in the upper portion of the subreach. The remaining pools are greater than 0.2 –meter, but less than 0.5 meter, deep. Pool complexity varies within the subreach, with 7.6 complex pools in the lower two-thirds of the stream reach (more than three times the number

considered desirable for fish habitat). No complex pools were found in the upper third of the subreach.

Wood counts per stream length are considered fair throughout the subreach (34 pieces); however, wood volume is low and key pieces are rare. Current conditions (second-growth forest of mixed conifer and deciduous species) indicate that long-term large wood recruitment is feasible; however, channel morphology (straight) and condition (channelized stream bank) may prevent large wood from being retained.

A culvert (stormwater or sewer pipe) enters Tryon Creek approximately 120 meters downstream of SW Boones Ferry Road. A screened diversion/pump system was also noted at this location.

HYDROLOGY

The middle park reach experiences perennial channel flow, with low summer flows ranging from 3-7 cfs. Numerous seeps and springs exist throughout the reach; they probably provide critical groundwater flow during low-flow periods, and base flows year-round. Two intermittent tributaries enter Tryon Creek in this reach; their hydrologic contribution is not known.

A pump station exists approximately 120 meters downstream from SW Boones Ferry Road. The volume, rate, and timing of withdrawal are unknown.

EVALUATION OF TRYON 3B: MIDDLE PARK

- The middle park reach contains a high proportion of pool habitat, and deep pools. These areas probably provide critical refuge to salmonids during low-flow and high-flow seasons. This area should be protected, and recreational use in the immediate riparian corridor and instream should be minimized. Substrate composition in riffle habitats in the upper 400 meters of this reach is of excellent quality; 100 percent of the riffle habitat has greater than 35 percent gravels, and the substrate is not embedded or covered with fines. (Less than 72 percent of the riffle habitat has less than 12 percent fines.)In the lower portion of the reach, substrate composition in riffle habitats is considered very good; in 81-100 percent of the riffles, gravels constitute 35 percent or more of the habitat. However, the great spawning and rearing potential in this segment is severely impaired by the high proportion of fines present on the stream bottom; approximately 74 percent of the riffle habitats have greater than 25 percent fines covering the substrate. Amassed sediments may cover spawning grounds, and sediments may limit epifaunal production and subsequent macroinvertebrate production. Actions to minimize sediment load into Tryon Creek should be considered.

- Increasing the amount and density of large wood would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows). and aid channel-forming processes (habitat formation of pools and riffles) and meanders.

- Floodplain connectivity with the stream channel should be enhanced. Improved connectivity with the floodplain and riparian corridor would allow the creek to adjust to differing flows,

attenuate flood flows, and minimize flow-related bank erosion. Other indirect benefits of enhancing floodplain interactions include retaining woody debris, stabilizing stream banks, retaining instream structure, and stabilizing habitat-forming processes such as riffle/pool formations.

- Replacing or retrofitting the SW Boones Ferry Rd. culvert would provide year-round access to upper mainstem Tryon Creek (to SW Maplecrest Drive) and Arnold Creek. Habitat quantify and quality in Tryon Creek and Arnold Creek should be thoroughly evaluated to establish plausible expectations (in terms of fish productivity) if upper Tryon Creek were accessible. Specifically, if the habitat is of low quality in these reaches, providing access still may not increase fish productivity within the Tryon Creek Basin.

- The water withdrawal (pump station) approximately 120 meters downstream of SW Boones Ferry Road should be investigated. This should include quantification of water withdrawal characteristics (volume, rate, and timing) and an evaluation of the screens.

- Tributary flow contributions of the two intermittent creeks should be evaluated to determine annual flow characteristics, hydrologic connectivity with Tryon Creek, and use by resident fish.

Tryon 4A: Upper Park

FLOODPLAIN CONDITION

This segment of Tryon Creek lies within the upper portion of Tryon Creek State Natural Area. The channel is relatively confined by terraces and hillslopes (VWI of 5), and stream gradient is moderately steep (2.3 percent), indicating that floodplain functions are spatially constrained and temporally short.

RIPARIAN CONDITION

Riparian condition (and wildlife value) is good to excellent (BES 1997; ODFW 2001). Riparian corridors are intact, wide (over 250 feet), and not fragmented. Forest canopy is dominated by large deciduous trees (30-50 cm dbh), grasses, and forbs. Maples and cedars predominate. Tree canopy cover is moderate, increasing from 33 to 51 percent from the stream bank out to the edge of the riparian corridor (0-30 meters). Few areas with less than 25 percent vegetative cover exist. High and low terraces and hillslopes characterize riparian land forms.

STREAM CONNECTIVITY

The SW Boones Ferry Road culvert isolates this segment of Tryon Creek from downstream habitats and fish populations. The culvert is long (approximately 150 feet), steep (2.0 percent slope), and jump height to the culvert outlet is at the maximum end extent of that considered navigable by fish (12 inches). The upper end of the reach is bound by the SW Maplecrest Drive culvert, which is long (80 feet), steep (over 2.0 percent slope), and perched (12 inches). The culvert is considered impassable to resident fish.

Within this portion of Tryon Creek, stream connectivity is fragmented by numerous steps. During the ODFW 2000 surveys, steps were characterized as concrete weirs, concrete steps, step logs, and step cascades. These structures vary in height, ranging from a 0.15-meter drop to 0.8-meter drop. These natural and manmade instream barriers probably impact resident fish movement, specifically during low flow periods.

REFUGIA

Instream refugia are limited throughout the reach; few or no backwater pools and side channels are present, and undercut banks are few. Large wood probably provides the best instream structure. Springs and seeps (noted on the south bank) probably provide important hyporheic flows during the summer. Tributaries and intermittent creeks probably provide important off-channel refugia during winter and cool stream temperatures in the summer.

Arnold Creek provides important off-channel tributary habitat.

CHANNEL CONDITION AND HABITAT STRUCTURE

Channel conditions are generally fair to good throughout the subreach, but are considered sub-optimal in the lower segment, immediately above the SW Boones Ferry Road culvert. Surveys conducted in 1997 showed excessive sediment immediately upstream of SW Boones Ferry Road (BES 1997). Banks are unstable (58 percent actively eroding) and are channelized throughout the upper 150 meters.

Channel complexity and diversity is generally low. Habitat is characterized as riffle/step forms in the lower reach; rapids at mid-reach; and pool/step forms in the upper reach. Steps formed by concrete, logs, and cobbles are common throughout this reach. Pool area is comparatively lower than in downstream reaches. This upper park reach has only 34 percent pool area (moderate), and only 35 percent of the pool habitat is greater than 0.5 meter deep (considered desirable for fish-bearing streams). Remaining pools range from 0.2 to 0.5 meter deep, and are considered moderate fish habitat. This subreach marks the upstream extent where complex pools are present; it has 2.1 complex pools per 100 meters stream length.

Wood density is low (3.82-m3/100 meters); it is considered undesirable for fish habitat, but is relatively good compared to other subreaches within Tryon Creek. This subreach marks the upstream extent of where wood counts are greater than 10 pieces per 100 –meters of stream length (marginal habitat condition); habitat quality associated with wood counts and densities is considered undesirable upstream of this subreach.

Stream-bottom substrates are mixed, comprising fines, gravels, and coarse cobbles. Riffle habitat is generally considered desirable; 71 percent has more than 35 percent gravel composition. However, riffle quality is impaired by amassed sediments and fines overlying the riffle habitat; 81 percent of the riffle area has between 12 and 25 percent fines, and 15 percent has more than 25 percent fines. These amassed sediments probably impair habitat quality and fish productivity.

Bedrock is common mid-reach, where stream channelization was also noted (ODFW 2001). This reach lies immediately downstream of a culvert outlet approximately 25 meters downstream of SW Maplecrest Drive.

HYDROLOGY

Low-flow hydrologic condition has not been analyzed; however, low flows (September – October) are believed to be less than 3.0 cfs. Arnold Creek joins Tryon Creek at the downstream end of the reach (just above the SW Boones Ferry Road culvert) and contributes approximately one-third of the channel flow to mainstem Tryon Creek. A stormwater and/or sewer pipe enters Tryon Creek near the upper end of the reach. Its flow contribution in terms of volume, rate, and timing is not known. Springs and hyporheic areas have not been well documented.

EVALUATION OF TRYON 4A: UPPER PARK

- This subreach marks the upstream extent of where wood counts are greater than 10 pieces per 100 –meters of stream length, and pool quality is marginal. Instream structure associated with large woody debris and depth refugia are severely lacking upstream of Tryon Creek State Natural Area. Increasing the amount and density of large wood would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows), and aid channel-forming processes (habitat formation of pools and riffles) and meanders.

- This subreach marks the upstream extent of where desirable pool conditions are present. Although riffle habitats have adequate gravel composition, they are largely covered in fine sediments, severely limiting the potential of these habitats to support salmonid rearing. Actions to minimize sediment load into Tryon Creek should be considered.

- Floodplain connectivity within the stream channel should be enhanced. Improved connectivity with the floodplain and riparian corridor would allow the creek to adjust to differing flows, attenuate flood flows, and minimize flow-related bank erosion. Other indirect benefits of enhancing floodplain interactions include retaining woody debris, stabilizing stream banks, retaining instream structure, and stabilizing habitat-forming processes such as riffle/pool formations.

- Replacing or the retrofitting SW Boones Ferry Road culvert would provide year-round access to this reach and Arnold Creek. Habitat quantify and quality in this portion of Tryon Creek and Arnold Creek should be thoroughly evaluated to establish plausible expectations (in terms of fish productivity) if this portion of Tryon Creek were accessible. Specifically, if the habitat is of low quality in these reaches, providing access still may not increase fish productivity within the Tryon Creek Basin.

- Replacing or retrofitting SW Maplecrest Drive would provide year-round access to an additional segment of Tryon Creek (Tryon 4B). Habitat quantify and quality in this portion of Tryon Creek should be thoroughly evaluated to establish plausible expectations (in terms of fish productivity) if this portion of Tryon Creek were accessible. Specifically, if the habitat is of low quality in these reaches, providing access still may not increase fish productivity within the Tryon Creek Basin.

- The stormwater and/or sewer pipe outlet approximately 25 meters downstream of SW Maplecrest Drive should be investigated to determine its water source, flow contribution (volume, rate, and timing) and water quality. ODFW notes that Tryon Creek is channelized where the culvert enters the creek and immediately downstream (13+ meters) of the outlet.

- Connectivity to Arnold Creek should be retained, and tributary flow should be evaluated. Arnold Creek provides important base flows to Tryon Creek and probably provides important off-channel refugia to resident fish.

Tryon 4B: SW Maplecrest Drive to Marshall Cascade

FLOODPLAIN CONDITION

The floodplain (and valley bottom) is broad (VWI = 10.5), and the channel gradient is moderately steep (3.1 percent). There is therefore great potential for aquatic/land interactions between Tryon Creek and its floodplain, especially during higher flows. However, residential development impacts the floodplain, particularly along the northeast side of the creek, which consequently receives the highest solar input. Vegetation is partially landscaped, and areas of open pasture and cleared land exist. Part of this subreach is within Marshall State Park.

RIPARIAN CONDITION

Riparian integrity is fair to poor (ODFW 2000). Tree canopy cover is relatively low (0-20 percent) near the stream bank (0-20 meters). Common tree species include maple and alder. Shrubs and grasses provide the greatest amount of shade (or cover) throughout the entire riparian area. The understory is sparse because of footpaths and other recreational uses. Hiking trails transect steep banks (and cliffs) and are often on top of the stream bank in Maplecrest Park. Hyporheic conditions have not been documented.

The SW Maplecrest Drive culvert and residential landscaping fragment the riparian corridor. The southwest side of the stream corridor maintains higher canopy cover within Marshall State Park. However, much of the riparian area has been cleared of mature trees. Lawns, pastures, and other human use are common, and wetland habitat is rare.

STREAM CONNECTIVITY

The SW Maplecrest Drive culvert (which bounds the downstream reach break) is considered completely impassable because of its length, slope, and outlet drop. Stream connectivity to the upstream reach is impaired at Marshall Cascades, a natural fish barrier.

Marshall Cascades is long (60 –meters, or approximately 200 feet) and impairs fish passage during most periods of the year. Some opportunities for passage may exist during high storm flows, when creek depth is high enough to allow movement beyond the cascade, boulder, and bedrock rapid reach. This cascade reach probably marked the end of anadromy for winter steelhead. It is (and was) undoubtedly a barrier to resident populations during most of the year.

REFUGIA

Instream refugia are limited within the reach because of the absence of large wood or rocks, bank erosion, fragmented riparian areas, and an absence of channel diversity. The primary refugia are found in deep pools and among small wood clusters.

Two tributaries enter Tryon Creek near river mile 3.3 and probably provide some off-channel refugia. These tributaries have fish passage barriers approximately 0.2 mile from their confluence with Tryon Creek, but probably provide important winter refugia to Tryon Creek populations during high flows.

CHANNEL CONDITION AND HABITAT STRUCTURE

Fish habitat is considered sub-optimal (BES 1997). Stream banks are partially eroded (58 percent), but some areas are stable. ODFW 2000 survey notes show that Tryon Creek is channelized throughout most of the reach. Stream bank development, manmade bank structures, and the SW Maplecrest Drive culvert significantly impact natural habitat-forming processes. In addition, the absence of large boulders and large wood (wood density = 0.39-m3/100 meters and wood count = 3 pieces/100 meters), coupled with lack of streamside and instream vegetation, reduces the amount and quality of instream structure and fish habitat.

Stream-bottom substrate composition is fair, with a mix of substrate types. ODFW data indicate that gravel composition in riffles is desirable; for all surveyed riffles, gravels constituted greater than 35 percent of the stream-bottom substrate. Similar to downstream reaches (Tryon 4A and most of Tryon 3B), however, sediments and fines impair riffle habitat quality. Fines constitute between 12 and 25 percent of the substrates in all riffle habitat, yielding marginal riffle quality. Rapids formed by boulders are common.

Pool area is extremely low (7-9 percent), and no complex pools with wood are present. Approximately one-half of the pools are greater than 0.51 meter deep, providing some depth refugia.

A culverted pipe enters Tryon Creek approximately 25 meters upstream of SW Maplecrest Drive.

HYDROLOGY

The hydrologic regime is characteristic of perennial channel flow, although some areas may experience perennial surface flows during low-flow periods (September – October) and along steeper stream reaches. Two tributaries flow into this portion of Tryon Creek, neither of which has been named. Both have impassable barriers approximately 0.2 mile from their confluence with Tryon Creek. They both probably provide important base flow to Tryon Creek, particularly during low summer flows, and may attenuate flood flows in the winter. Both tributaries are mapped as intermittent. A culvert pipe (stormwater and/or sanitary) enters Tryon Creek just upstream of SW Maplecrest Drive; its flow contribution (volume, rate, and timing) is not known.

EVALUATION OF TRYON 4B

- Riparian widths and riparian continuity are significantly reduced within private (residential) parcels of land. Instream structure is lacking within the stream reach. Floodplain connectivity, riparian condition, and habitat structure and condition could probably be improved by planting native shrubs and trees in the riparian corridor and broader floodplain area. Key benefits that additional plant cover would probably provide include stabilizing creek banks and channel, providing additional canopy cover, providing instream woody structure (small wood clusters and allochthonous inputs for macroinvertebrates and fish), and attenuating creek flows.

- The absence of large wood and boulders limits habitat structure and compromises the area's benefit as potential fish habitat. Lack of pool area and complex pools limits potential salmonid rearing. Increasing the amount and density of large wood would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows), and aid channel-forming processes (habitat formation of pools and riffles) and meanders.

- Excellent riffle substrate exists; however, amassed sediments probably impair potential habitat quality. One hundred percent of the riffle habitats are considered marginal, with more than 12 percent fines covering stream bottom substrates). Actions to minimize sediment load into Tryon Creek should be considered.

- Replacing or retrofitting SW Maplecrest Drive would provide year-round access to an additional segment of Tryon Creek (Tryon 4B). Habitat quantity and quality in this portion of Tryon Creek should be thoroughly evaluated to establish plausible expectations (in terms of fish productivity) if this portion of Tryon Creek were accessible. Specifically, if the habitat is of low quality in these reaches, providing access still may not increase fish productivity within the Tryon Creek Basin.

- Marshall Cascades is a natural cascades that probably impairs fish passage during most periods of the year. Some opportunities for passage may exist during winter flows, when creek depth is high enough to allow movement beyond the cascade, boulder, and bedrock rapid reach. In addition to impeding resident fish movement, the cascade was probably the end of anadromy for most salmonid populations.

- The stormwater and/or sewer pipe outlet approximately 25 meters upstream of SW Maplecrest Drive should be evaluated to determine its water source, flow contribution (volume, rate, and timing), and water

- Tributary flow contributions of the two intermittent creeks should be evaluated in terms of annual flow characteristics, hydrologic connectivity with Tryon Creek, and use by resident fish.

Tryon 4C: Marshall Cascade (upstream to 18th Pl.)

FLOODPLAIN CONDITION

Stream gradient is moderately steep (2.7 percent). The floodplain and floodway are narrower than Tryon 4A and Tryon 4B, with a VWI of 8.0. The floodplain is generally considered disconnected from the stream channel.

RIPARIAN CONDITION

Riparian condition varies throughout the stream reach, ranging from low to high in alternating segments (BES 1997)). The riparian corridor is formed by high and low terraces and hillslopes. The vegetated corridor is generally greater than 100 feet in width and is minimally fragmented. SW 18th Place bounds the upper end of the reach. Tree canopy is intact and continuous, and is characterized by mixed conifer/deciduous second-growth forest. Common tree species include big leaf maple and Douglas fir.

STREAM CONNECTIVITY

Marshall Cascades characterizes this entire reach and impedes fish movement throughout. Marshall Cascades is long (60 –meters, or approximately 200 feet) and impairs fish passage during most periods of the year. Some opportunities for passage may exist during high storm flows, when creek depth is high enough to allow movement beyond the cascade, boulder, and bedrock rapid reach. This cascade reach probably marked the end of anadromy for winter steelhead. It is (and was) undoubtedly a barrier to resident populations during most of the year.

SW 18th Place also impairs stream connectivity to upstream reaches. This barrier bounds the upstream extent of the reach and is considered completely impassable, based on length (70 feet) and slope (velocity barrier).

REFUGIA

Pools probably provide the best instream refugia. An intermittent tributary probably provides some off-channel refugia, particularly during high flows.

CHANNEL CONDITION AND HABITAT STRUCTURE

Channel conditions are fair to good, but are considered sub-optimal for fish rearing throughout much of the reach (BES 1997). Primary habitat includes rapids, cascades, and steps formed by both bedrock and boulders. Pocket pools within these fast water habitats are present, but do not provide substantive pool area or depth.

The following observations were made during one field visit (100 feet below SW 18th Place) in May 2003 (personal communication, Chad Smith and Cindy Studebaker):

- Storm flows have eroded the stream banks and downcut the stream channel to bedrock substrate in the upper portion of the reach.

- Water currently fills greater than 25 percent of the creek channel, and channel substrates are mostly exposed in non-pool habitats.

- The only area where the creek appears to be confined is at SW 18th Place. The remaining portion of the reach is relatively unconstrained, although downcut to bedrock hardpan.

- Stream banks are relatively stable and show little evidence (approximately 5 percent) of erosion or bank failure.

Scour pools and rapids dominate the lower subreach; cascades, rapids, and bedrock pools dominate the upper reach (approximately 100 feet below SW 18th Place.). A field visit on May 22, 2003, showed approximately 70 percent sediment deposition overlying bedrock substrate just below SW 18th Place (personal communication, Chad Smith and Cindy Studebaker).

Large wood count (six pieces per 100 meters of stream length) and density (3.5-m3 per 100 meters of stream length) are low (undesirable).

HYDROLOGY

Low seasonal flows have not been documented; however, a combination of geology, low-flow hydrology (perennial surface flow), and channel morphology (series of pocket pools and cascades) indicates that this subreach is probably the upstream extent of historical anadromy. Resident fish probably persisted (and may still) above this reach. Flow in this stream segment has been characterized as sheet, laminar flow (ODFW 2001).

EVALUATION OF Tryon 4C: MARSHALL CASCADE

- Marshall Cascades is a natural cascade that probably impairs fish passage during most periods of the year. Some opportunities for passage may exist during winter flows, when creek depth is high enough to allow movement beyond the cascade, boulder, and bedrock rapid reach. In addition to impeding resident fish movement, the cascade was probably the end of anadromy for most salmonid populations.

- Replacing or retrofitting the SW 18th Place culvert may not provide additional access to Tryon Creek. This culvert lies immediately above Marshall Cascade, which is considered a natural barrier to resident fish. Fish populations that persist above the cascade reach have probably been isolated from downstream populations for many years. Some fish may have historically passed above Marshall Cascades in the past, but it was probably during very discrete periods.

- Based on habitat form, it is unlikely that fish reside in this reach for prolonged periods of time. The reach is steep, provides very little cover, lacks substantive pool area, and lacks typical rearing habitat (riffle type habitat) that is characteristic of fish-bearing streams. In addition, absence of instream refugia, preponderance of bedrock substratum, and lack of substantive pool habitat may predispose rearing fish to "blow-outs" during peak flows. Increasing the amount and density of large wood would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows), and aid channel-forming processes (habitat formation of pools and riffles) and meanders.

Tryon 4D: SW 18th Place to Quail Creek

FLOODPLAIN CONDITION

Floodplain condition is similar to downstream reaches, except that homes are a more prominent land use and feature in the floodplain.

RIPARIAN CONDITION

Riparian integrity is considered fair to poor, and wildlife habitat value is considered low (BES 1997). Riparian areas are fragmented by homes, landscaped yards, and a relatively narrow riparian corridor (less than 100 feet in width). Common tree species include cedar, alder, hemlock, and maple. Tree canopy coverage varies from 10 to 100 percent within the riparian area. In areas with sparse overstory canopy, grasses and forbs dominate. Residential development entirely surrounds the riparian corridor (and surrounding floodplain) in the upper portion of the reach. Much of the subreach has been channelized, or the banks have been modified to protect residences.

A bridge (driveway) crosses Tryon Creek approximately 150 meters downstream from SW Lancaster Drive. This driveway spans the creek; although it does not impair stream connectivity, it undoubtedly impacts riparian connectivity.

STREAM CONNECTIVITY

The culvert that runs under SW 18th Place completely blocks stream connectivity to downstream reaches. The culvert is relatively long (70 feet) and steep (over 2.0 percent) and is considered a velocity barrier. SW Lancaster Road completely blocks fish movement into upstream reaches. The culvert running under SW Lancaster Street is also steep (> 2.0 percent) and moderately long (50 feet).

Connectivity within the upper 200 meters is poor, with numerous steps formed by bedrock, boulders, and artificial structures (e.g., dams, weirs). These steps range from 0.1 1.6 meters in height.

REFUGIA

The confluence of Tryon Creek and Quail Creek and the confluence of Tryon Creek and Burlingham Creek provide moderate habitat value (BES 1997) and, presumably, off-channel refugia. Boulders are prevalent from the mid- to upper reach and may provide high-water refugia in cascades and rapids.

CHANNEL CONDITION AND HABITAT STRUCTURE

A 1993 study found marginal fish habitat in this reach of Tryon Creek. The reach is bound by culverts on the upstream and downstream extent and is significantly fragmented in the upper portion. In addition, stream banks are landscaped and lined with rock walls (BES 1997). Private homes are abundant and are very close to (and encroach into) the immediate riparian corridor.

Rapids, cascades, and steps formed by bedrock and boulders are common in the lower 140 meters, then transition to sequences of shallow pools for approximately 300 meters. Rapids and steps dominate the upper 370 meters. Channels are scoured in isolated areas, but scouring is not prevalent throughout the entire reach (ODFW 2000). Gravels are common in the lower reach; boulders are common from mid-reach through the upper reach; and bedrock is common

throughout. Woody debris is severely lacking throughout the reach; abundance and volume are low, and no key pieces were noted (ODFW 2000).

HYDROLOGY

Annual flow regimes are not well known throughout the subreach, especially during low-flow periods. However, it is assumed that the stream segment experiences low-flow conditions in late summer and fall (roughly mid-August through mid-October). It is likely that this subreach is dominated at times by surface (shallow) flow that limits habitat quantity and quality. Constructed pools and ponds may provide limited habitat for resident fish. Quail Creek and Burlingham Creek both enter Tryon Creek in this reach. Their flow contribution is not known. Numerous spring and seeps were noted within the lower and middle reach during ODFW 2000 surveys.

EVALUATION OF TRYON 4D:

- Rapids and cascades dominate instream habitat in the lower and upper reach. Pools found mid-reach might provide some rearing habitat. Instream structure is noticeably lacking. Resident fish may use this reach for temporary rearing or for transport, but probably do not rear year-round. Lack of riffle and substantive pool habitat, along with a preponderance of cascades, rapids, and shallow pools, probably limit year-round rearing. This area may provide important transitory habitat.

- Stream banks are heavily impacted by residential development and associated landscaping and rock embankments. Riparian widths and riparian continuity are significantly reduced within private (residential) parcels of land. Floodplain connectivity, riparian condition, and habitat structure and condition could probably be improved by planting native shrubs and trees in the riparian corridor and broader floodplain area. Runoff of chemicals and other contaminants from residential areas and streets (e.g., sediments, pesticides, oils, metals, fecal wastes) may be a significant contaminant source.

- Addition plant cover would probably provide key benefits, including stabilizing creek banks and channel, providing additional canopy cover, providing instream woody structure (small wood clusters and allochthonous inputs for macroinvertebrates and fish), and attenuating creek flows. Increasing the amount and density of large wood into Tryon Creek would undoubtedly improve instream refugia, add channel roughness (to armor during erosive flows), and aid channel- forming processes (habitat formation of pools and riffles).

- Because Tryon 4D does not provide substantive fish-bearing habitat, removing or retrofitting the SW 18th Place culvert and Lancaster Road culvert may not substantially improve resident fish productivity. Fish could access Quail Creek and Burlingham Creek; fish presence/absence and productivity in these two tributaries are not currently known. Habitat quality and quantity in upstream reaches should be evaluated before considering removal (or retrofit) of the Lancaster Road culvert.

- Connectivity to Quail Creek and Burlingham Creek should be retained. The flow contributions from these tributaries should be evaluated in terms of hydrologic connectivity and annual flow characteristics. Both tributaries probably provide critical flows during low-flow periods and are important for peak flow attenuation. Tributary flow may also impact downstream water quality (temperature, sediments, and toxics).

Tryon 4E: Falling Creek

Conditions on this short subreach are similar to Tryon 4D; however, stream banks are heavily landscaped and homes abut the creek bank. Falling Creek enters Tryon Creek at the upper end of the subreach. The confluence of these two systems may provide critical refugia for residing fish and other aquatic species. The upper extent of this reach (Tryon 4E/Tryon 5) is bound by Taylors Ferry Road, which is considered passable.

The following observations were made just below SW Taylors Ferry Road in May 2003 (personal communications, Chad Smith and Cindy Studebaker):

- The effective riparian corridor is very narrow and does not extend above the terraced bank. Landscaped yards probably provide important vegetative cover and canopy; however, natural vegetative structure is lacking, and lawns create unnatural riparian habitat.

- Vegetative canopy cover generally ranges from 25–50 percent, with some areas greater than 75 percent. The more vegetated areas generally abut the creek bank.

- The creek is relatively channelized. SW Taylors Ferry Road effectively constrains a segment of the reach, and lawns and homes constrain the creek by forming high terraces. Although the creek is not straight, there is very little opportunity for it to top its bank during high flows.

- Although landscaped yards abut both sides of Tryon Creek and vegetation is present on the stream bank and instream, coarse particulate organic matter in the creek is low (less than 20 percent).

- Creek banks are moderately unstable, with significant areas actively eroding and void of stream bank vegetation. Patches of bare soil are common.

- The predominant substrate is cobbles (60 percent) and gravels (20 percent), with greater than 85 percent sediment and silt deposition on top of larger substratum.

- Riffles and pools are common, and stream gradient is low.

- Pools are of relatively good quality. The substrate is considered optimal, with mixtures of gravels and firm sands, and pools are deep compared to the prevailing creek depth.

Tryon 5: Headwaters

Floodplain condition, riparian condition, instream habitat, and hydrology are not well documented in this reach. The following evaluation is based on aerial photographs, anecdotal information, past reviews, and personal communications:

- Flooding occurs when culverts at I-5/ SW Barbur Boulevard, SW Dolph Court, SW 30th Avenue, and Spring Garden are backed up.
- Riparian areas are highly fragmented. Vegetative cover ranges from 25–50 percent downstream of SW Barbur Boulevard, then diminishes to less than 25 percent from SW Barbur Boulevard upstream through the headwater reaches.

- Riparian quality is believed to be best between SW Carson Street and SW Dolph Court. Wetlands are suspected to be present near both roadways.

- Culverts, embankments, and bank modifications are prevalent (and are dominant features) throughout the stream reach. Bank modifications are primarily in place to prevent erosion from streamside residential properties. The impact to fish passage and stream connectivity varies, depending on the culvert.

- Wetlands probably provide the most potential habitat for fish and birds, crustaceans, amphibians, and small mammals. Two tributaries flowing into Tryon Creek provide important off-channel refugia. Both tributaries have impassable roadways approximately 0.1 mile upstream; off-channel refugia is therefore probably limited, although present.

- Stream channel conditions are considered marginal to very poor (BES 1997). Channel substrates are mixtures of gravels, fines, and lesser amounts of cobbles. BES data show that sediment accumulates just above the Dolph Court culvert because the culvert blocks up and does not properly convey stormwater. Study results also show that the stream channel is incised and marginal-fish bearing habitat. The National Riparian Services Team assessed Spring Garden Creek on October 31, 2001 (WMSWCD 2003b). Based on the channel configuration (drainage ditch), preponderance of storm drains that enter the creek, and number of roadways and driveways that cross the creek, the team determined that the creek was no longer functioning as a stream. They further concluded that the filling of the floodplain and the expansive urban development in this headwater reach is characteristic of other headwater reaches of Tryon Creek.

- Based on the subbasin size and slope, this area is probably an important hydrologic component of the Tryon Creek drainage. Two mapped tributaries flow into Tryon Creek at approximately river mile 4.5 and river mile 4.6, respectively. These tributaries probably augment summer base flows and may provide important hydrologic inputs.

- The headwaters of Tryon Creek are not believed to support salmonids, but may provide critical habitat for other riparian-dwelling and stream-dwelling organisms.

Tributaries to Tryon Creek

Arnold Creek

At least eight intermittent creeks flow into Arnold Creek; one enters in Tryon 1B, and all others enter Arnold Creek above Arnold 1B. These tributaries are not evaluated individually, but probably provide important intermittent flows and potential off-channel refugia to Arnold Creek.

Arnold 1A (Lower Arnold) and Arnold 1B (Cascade Reach)

FLOODPLAIN

The floodway/floodplain is relatively narrow along lower Arnold Creek (VWI is 5.0 for Arnold 1A and 11.5 for Arnold 1B), and flood events are of very limited duration. Stream gradients are moderate in both Arnold 1A (3.1 percent) and Arnold 1B (3.6 percent). Floodplain interactions are not believed to be extensive within this tributary reach, except at the confluence with Tryon Creek.

RIPARIAN INTEGRITY

Riparian and wildlife values are considered high (BES 1997). Riparian widths are greater than 100 feet along much of the stream corridor. SW Arnold Street parallels the tributary channel and is generally within 100 feet of the creek.

STREAM CONNECTIVITY

Stream connectivity in Arnold Creek is impaired at the Arnold Creek culvert (at 0.1 –river mile). This culvert is considered impassable year-round because of slope (3 percent) and perch height (36 inches). The culvert isolates the lower third of the tributary reach from upstream habitat. However, the confluence of Arnold Creek is well connected with Tryon Creek (just upstream of the SW Boones Ferry Rd culvert), and probably provides refuge and additional habitat to rearing fish.

REFUGIA

Refugia within Arnold Creek are non-existent. No off-channel areas and tributaries are present. The confluence of Arnold Creek and Tryon Creek probably provides potential refugia at high flows, but not low flows.

CHANNEL CONDITIONS AND HABITAT STRUCTURE

Channel condition is fair, and fish habitat is considered sub-optimal; stream habitat surveys show numerous areas with incised channels (BES 1997). Cascades are present at the upper end of Arnold 1B at the SW 16th Place culvert.

Lower Arnold Creek lacks channel complexity because of channel undercutting and low wood. For Arnold 1A, wood count is six pieces/100 meters, and wood volume is 2.9 m3/100 meters. For Arnold 1B, wood count is seven pieces/100 meters, and wood volume is 3.3 m3/100 meters. However, some boulders are present and may provide critical cover and refuge during high

flows. Although the existing stream condition does not have adequate amounts and complexities of large wood, the potential for future recruitment is believed to be fair.

Most riffles have good gravel composition; 100 percent of riffles comprise 35 percent or more gravels). The reach is dominated by good riffle/pool sequences. However, all riffle habitats are embedded with fines at concentrations of 12-25 percent of substrate composition. This probably impairs habitat quality.

In Arnold 1A, pool area (52 percent) is considered desirable for fish habitat. Pool depth is largely moderate, with 82 percent of the pools having depths of less than 0.5 meter. This subreach is the only stream segment in Arnold Creek with pool depths greater than 0.5 meter (18 percent of the pools). No complex pools are present in the subreach. Arnold 1B has very low pool area (16 percent), marginal pool condition (100 percent of the pools are less than 0.5 meter deep), and no complex pools.

HYDROLOGY

Data to assess low-flow and peak-flow conditions in Arnold Creek are lacking. It is assumed that peak flows are greater than historical conditions as a result of urban development. This catchment is probably critical for maintaining suitable hydrology and water quality in lower portions of Tryon Creek. Low flows have not been documented; based on the catchment area, however, Arnold Creek probably supplies 1-2 cfs of flow during low-flow periods, and year-round channel flows are believed to contribute approximately one-third of the channel flow to Tryon Creek. One tributary enters Arnold Creek from the south. This creek has not been evaluated, but presumably provides important intermittent flows to Arnold Creek and lower Tryon Creek.

EVALUATION OF ARNOLD 1A AND ARNOLD 1B

- Arnold Creek is the largest tributary to Tryon Creek, and is important for habitat continuity and water quantity and quality. Low summer flows and peak-flow erosion (and channel incising) significantly impact instream habitat conditions and riparian and floodplain interactions in lower Arnold Creek.

- Other key problems and issues in lower Arnold Creek include: 1) The impassible SW 16th Place culvert and a series of waterfalls (both located at the upper end of Arnold 1B) compromise stream connectivity, and 2) Lack of pool area, shallow pools, and absence of complex pools is believed to limit the amount and quality of fish-bearing habitat. Riffle habitats are embedded with fine sediments (and organics) and are considered marginal fish habitat at best, with between 12 and 25 percent fines covering stream-bottom substrates.

Arnold 1C (Middle Arnold) and Arnold 1D (Lancaster)

Limited data are available to effectively characterize this reach. Briefly, the floodplain is narrow (VWI is 3.0 for Arnold 1C and 8.3 for Arnold 1D); however, several flats are interspersed with steeper hillside gradients. Stream gradient is low: 1 percent for Arnold 1C and 1.5 percent for Arnold 1D. The riparian corridor is quite fragmented as a result of residential landscaping and the presence of SW Arnold Street, which in many areas is less than 50 feet from the stream along the northern side.. Wetland and hyporheic areas have not been identified. Stream connectivity is marginal, with several driveway culverts. These culverts are not considered significant blockages; however, several areas of steep gradients near river mile 5.0 may impede resident fish passage.

Refugia, channel conditions, and instream structure have not been well documented in these subreaches. ODFW surveys show that wood counts and wood densities are undesirable for fish habitat. For Arnold 1C, wood count is 1 piece/100 meters, and wood volume is 0.12 m3/100 meters. For Arnold 1D, wood count is 6 pieces/100 meters, and wood volume is 1.6 m3/100meters). Arnold 1C has the fewest number of wood pieces and the lowest wood densities in all of Arnold Creek and Tryon Creek combined.

Pool area is considered desirable: 47 percent in Arnold 1C and 41 percent in Arnold 1D. Pool depths are of marginal quality; all pools in both subreaches are less than 0.5 meter deep. No complex pools have been noted in Arnold 1C or Arnold 1D. Arnold 1C has excellent gravel composition in riffle substrates. However, fine sediments constitute more than 25 percent of the substrate in 87 percent of the riffles surveyed. The fine sediments are probably severely impairing the potential habitat quality and water quality. Arnold Creek flows year-round, but with notably shallow flow over rocky sections in some stream reaches.

Four tributaries enter Arnold Creek throughout these two reaches. These tributaries have not been evaluated, but presumably provide intermittent flows to Arnold Creek and lower Tryon Creek.

Arnold 1E (Upper Arnold) and Arnold 1F (Headwaters)

Data are generally insufficient to characterize these two subreaches. Riparian canopy is mixed because of residential development, but largely intact throughout both reaches. Wood counts and wood densities are low (wood count is 11 pieces/100 meters, and wood volume is 3.81 m3/100 meters) relative to optimal fish habitat, but are the highest for all other reaches surveyed in Arnold Creek. Pool area in Arnold 1E is very low, with pools constituting only 4 percent of the stream habitat. These pools are relatively shallow (less than 0.5 meter) and are not considered complex in terms of instream structure and associated large woody debris. Of all reaches surveyed in Arnold Creek, this subreach exhibits the least-desirable pool habitat conditions.

The primary connectivity break is the SW 35th Avenue culvert and high embankment. Both subreaches have steep gradients. Most of the land use for subreach A1E is residential. Much of the uppermost portion of subreach A1F is publicly owned.

Three tributaries enter Arnold Creek throughout these two headwater reaches. These tributaries

have not been evaluated, but presumably provide intermittent flows to Arnold Creek and lower Tryon Creek.

Falling Creek

FLOODPLAIN

Stream gradient is moderate at 4.5 percent, and the floodway is very narrow. The channel and surrounding floodplain were extensively flooded in 1996 (personal communications, Amin Wahab).

RIPARIAN INTEGRITY

The lower reach of Falling Creek has a relatively narrow riparian coverage (over 100 feet wide), is fragmented by residential developments, and is considered to provide low riparian habitat (BES 1997). The SW 35th Drive culvert and embankment significantly disrupt the riparian area. Little documentation exists about seepage and hyporheic conditions.

STREAM CONNECTIVITY

Falling Creek enters Tryon Creek in Tryon 4F. Lower Falling Creek is connected to Tryon Creek for the first 0.2 mile. SW 26th Avenue crosses the creek here and is considered seasonally passable. The culvert is long (80 feet), but has low drop height (4 inches). In addition to this roadway, SW 35th Avenue and SW Huber Street cross Falling Creek at river mile 0.9 and 1.1, respectively (Table #). SW 35th Avenue spans an extensive culverted reach (approximately 500 feet), and SW Huber Street is relatively long and steep; both are undoubtedly fish barriers. Resident fish are not believed to occupy reaches upstream of SW 35th Avenue.

Near river mile 1.5, Falling Creek is piped under Jackson Middle School playfields for approximately 1,330 feet. A trash rack spans the creek immediately before the creek drains into the underground piped network.

REFUGIA

Falling Creek does not provide significant refugia to resident fish. No tributaries converge with Falling Creek, and no other potential refugia have been identified.

CHANNEL CONDITIONS AND HABITAT STRUCTURE

Limited data exist about stream channel conditions in Falling Creek. Studies in 1993 concluded that the reach provided sub-optimal to marginal habitat conditions for fish.

Structural conditions have not been described; however, residential developments occur within 50 feet of the stream on the north side.

HYDROLOGY

Falling Creek experiences year-round flow. Summer conditions may exhibit characteristics of surface seepage and probably do not support fish. However, amphibians, reptiles, mammals, birds, and crustaceans may use the stream reach during these low-flow conditions.

EVALUATION OF FALLING CREEK

- Falling Creek is a significant headwater tributary that is impacted by extensive residential development and transportation networks (runoff, groundwater recharge). This catchment is likely to be critical for the maintenance of suitable hydrology and water quality in lower portions of Tryon Creek. Culverts on Tryon Creek and low summer flows limit direct use of Falling Creek by fish populations.

Burlingame Creek and Quail Creek

Burlingham Creek joins Tryon Creek at river mile ####. The creek may augment low summer base flows in Tryon Creek, but probably does not provide extensive off-channel refugia to residing fish. SW Broadleaf Drive crosses the creek approximately 0.1 mile upstream of the confluence (Table #); off-channel rearing is therefore limited. .

Quail Creek joins Tryon Creek at river mile ##. Much like Burlingham Creek, Quail Creek may augment seasonal flows in Tryon Creek, but probably does not provide substantive off-channel habitat because of two major roadways. Refer to Table # for details.

Habitat surveys have not been conducted for either Burlingham Creek or Quail Creek.

Iron Mountain Creek

The National Riparian Services Team visited Iron Mountain Creek in October 2001 (WMSWCD, 2003b and reported the following:

- The creek appears to have recovered from the affects of timber removal and is at an early stage of properly functioning.

- The creek experiences more normative floodplain interactions.

- Large source wood material (western red cedar) is present, and enough large wood is instream to store sediments and slow runoff.

HABITAT CHARACTERIZATION SUMMARY

Floodplain and Upland Condition

Floodplain interactions historically and currently play a critical role in maintaining watershed functions in Tryon Creek. The creek is bound by steep valley walls on the northern and southern facing hillsides. Although these hillsides constrain the creek, areas exist where the valley floor broadens, providing great opportunities for floodplain interactions. As shown in Table 9-1, these broader areas are most prominently found in the middle and upper park reaches (Tryon 3). The area in Tryon Creek State Natural Area historically functioned as a depositional reach, with deep soils and a wide historic floodplain (WMSWCD 2003b). This broader floodplain allowed the

creek to adjust to high flows (by meandering from hillside to hillside), and probably augmented summer base flows via springs, seeps, hyporheic flows, and an elevated groundwater table.

Rural development currently limits potential floodplain interactions in the upper watershed (including the headwaters). Impervious area is high, roadways cross the creek, streamside vegetation is generally landscaped, banks are hard, and the channel is incised.

Table 9-1
Floodplain Attributes in Tryon and Arnold Creeks

Basin	Reach	VWI (%) [1]	Entrenchment Ratio [2]	Stream Gradient [3] (%)
Tryon	Tryon 1	20.0	1.5	1.6
	Tryon 2	4.3	1.2	1.1
	Tryon 3A	7.8	1.3	0.8
	Tryon 3B	10.6	1.4	0.8
	Tryon 4A	5.0	1.4	3.2
	Tryon 4B	10.5	1.4	3.7
	Tryon 4C	8.0	1.4	11.1
	Tryon 4D	FILL IN?	FILL IN?	3.2
	Tryon 4E	FILL IN?	FILL IN?	0.4
Arnold	Arnold 1A	5.0	1.3	3.1
	Arnold 1B	11.5	1.3	3.8
	Arnold 1C	3.0	NA	4.5
	Arnold 1D	8.3	NA	1.1
	Arnold 1E	NA	NA	1.9
	Arnold 1F	NA	NA	3.7

[1] Valley Width Index (VWI): broad valley floor > 2.5; narrow valley floor <2.5.
[2] Entrenchment Ratio (floodprone width divided by the active channel width): Values > 1.0 signify increasing floodplain interactions.
[3] Stream Gradient (calculated from stream bed elevation / length): low < 2%; moderate 2% - 8%; steep > 8.0%.
NA = Not available
Data Source: ODFW 2000; BES 1997

Although steep valley hillsides bound Tryon Creek, the creek channel is low to moderately steep basinwide. Creeks with lower stream gradients generally interact with their riparian areas and broader floodplain areas more frequently and for longer duration than higher-gradient streams. Based on these landform characteristics, Tryon Creek would be expected to flood often and meander from hillside to hillside within the confines of the valley walls. Lower and middle portions of the basin (below Tryon 4A—SW Boones Ferry Road) are generally below 2 percent gradient, while the upper basin averages 2.3 percent, 3.1 percent, and 2.7 percent, respectively (Table 9-1). Arnold Creek is moderately steep, however. Unlike mainstem Tryon Creek, the lower portion of Arnold Creek (Arnold 1A and Arnold 1B) is steeper than the middle and upper

reaches (Arnold 1C and Arnold 1D). Falling Creek is moderately steep, with a 4.5 percent gradient.

Alluvial reaches in the lower and middle reaches (located within Tryon Creek State Natural Area) used to provide important summer and winter rearing habitat for juvenile salmon. Eradication and displacement of beavers, beaver dams, debris jams, and associated ponds and off-channel pools have undoubtedly reduced these alluvial stream interactions, yielding a less diverse floodway and associated processes:

> ...portions of the valley floor were likely inundated under beaver impoundments, which, along with silt transport mechanisms, may explain why much of the valley bottom is fairly level with deep soils composed of fine sediment. The annual recharge to shallow aquifers beneath these small floodplain areas likely contributed to summer base flows, helping to moderate stream temperatures. (PHS 1997).

Substantive floodplain interactions are now severely lacking in Tryon Creek. The creek is incised and straight. Flood flows rarely extend far into the floodway, even within the protected areas of Tryon Creek State Nature Area. Frequent flood flows are not capable of reaching the relatively flat floodplain for energy dissipation, sediment deposition, and periodic flooding of riparian vegetation (WMSWCD 2003b). Disconnection of Tryon Creek from its floodplain can be attributed to several interrelated factors and processes. Notably, the channel is downcut and has been widened, so the amount of water that formerly filled the channel and spilled onto the floodplain is now held within the deeper, wider channel. In addition, the channel length is shorter, with fewer bends and meanders, and channel complexity is lacking. The National Riparian Services Team (WMSWCD 2003b) concluded that the reduction in resistance forces (e.g., loss of large wood and woody, riparian vegetation) and increases in water velocity result in an increase of flow energy that continually erodes the stream bed and stream banks. This has been significant enough to produce rapid vertical adjustments to the channel network, effectively disconnecting the channel from its floodplain. The creek seldom accesses its floodplain and is functionally confined. The result is that more water remains in the channel, and less water infiltrates into the floodplain and aquifer during moderate storm flows. Flow overtops the creek banks only during very high, infrequent floods. Observations by ODFW state biologists in 2002 confirm this phenomenon. Floodprone widths are greater than the active channel widths, indicating that flood flows periodically top the creek banks and interact with the floodway. However, the floodprone width rarely exceeds 1.5 times the active channel width (Table 9-1) and therefore does not extend far into the floodplain, as it once did.

Similar to Tryon Creek, Arnold Creek and Falling Creek do not experience regular or prolonged floodplain interactions. Their headwaters and greater portions of their mainstem habitats are enclosed in varying severity of urban development.

Riparian Condition

Riparian condition is relatively good throughout much of the lower and middle portion of the basin (Tryon Creek State Natural Area—Tryon 2 to Tryon 4A), except for the confluence of the Willamette River and Tryon Creek. In the confluence zone, the riparian corridor is narrow, grasses and vines predominate, and tree canopy cover is relatively low. Conditions improve in

Tryon Creek State Natural Area, where riparian widths average 200 feet or more, tree canopy cover is high, and well-established second-growth forest dominates the landscape, averaging 15-30 cm dbh. The forest has converted from a mixed conifer-deciduous forest to deciduous trees and shrubs. Red alder and big leaf maple predominate in streamside areas, and large native conifers (western red cedar, Douglas fir, and grand fir) are rare. However, young western red cedar are beginning to predominate (above invasive blackberry) in some areas, notably mid-reach of Tryon 3B (just downstream of SW Boones Ferry Rd.) (personal communications, Cynthia Studebaker).

Large conifers are most prevalent in Tryon 2, downstream from Iron Mountain Bridge. The National Riparian Services Team noted that this confluence region has the most developed (and functioning) floodplain of any area of Tryon Creek (WMSWCD 2003b). They partly attributed this to larger, more mature trees. Understory species include vine maple, western wahoo, and salmonberry, with some streamside areas lined with blackberries.

The forest stand structure (size, age, and condition) within the protected areas of Tryon Creek State Natural Area does not currently provide substantive sources of wood into the creek. Past logging and tree removal have reduced the supply of large wood into the channel (WMSWCD 2003a), but the potential for long-term sources is great. An older forest encompasses the lower canyon reach (Tryon 2), while a younger forest stand encompasses the middle and upper park reaches. This undoubtedly affects the creek's ability to interact with its riparian and floodplain area.

The riparian corridor is continuous through Tryon Creek State Natural Area (Tryon 4A), except for Highway 43, SW Boones Ferry Road, and recreational trails and bridges. As residential land use becomes more common (beginning in Tryon 4B), riparian integrity declines. Corridors are fragmented (street crossings); narrow residential dwellings encroach onto the stream bank; vegetative cover diminishes; and the proportion of impervious area increases. Overall tree size is larger in the headwater reaches than in Tryon Creek State Natural Area, but the riparian corridor is narrower and tree canopy cover is lower.

Like lower and middle Tryon Creek, lower Arnold Creek exhibits high riparian integrity, with riparian widths greater than 100 feet. Riparian condition declines upstream as the creek corridor leaves protected areas of Tryon Creek State Natural Area and enters upland residential development. Falling Creek exhibits poor riparian integrity; much of the stream corridor is surrounded by residential development.

Stream Connectivity

Table 9-2 identifies key culverts (not including all driveways) in mainstem Tryon Creek, Arnold Creek, Falling Creek, Quail Creek, and several unknown tributaries in the upper Tryon Creek basin. Marshall Cascade and Arnold Cascades are the only documented natural barriers. Other natural and manmade channel forms (e.g., steps) may seasonally impede fish movement, but are not known to block fish passage year-round. The individual reach descriptions above describe these steps and breaks in connectivity.

Access to spawning and rearing habitat is a key limiting factor affecting salmonid distributions

and species diversity in Tryon Creek. As shown in Table 9-2, breaks in longitudinal stream connectivity, particularly at the State Street culvert (Reach 1), SW Boones Ferry Road culvert (Reach 3), and the SW 16th Place culvert (on Arnold Creek) severely impede resident and anadromous fish movement. Except for the two mainstem barriers, Tryon Creek is unimpeded from the mouth up to SW Maplecrest Drive (Tryon 1 to Tryon 4A: 3.1 river miles). As residential development (and street crossings) encroach onto the stream corridor, stream connectivity becomes more impaired.

The Highway 43 culvert is the roadway that most prominently impacts fish distribution and species diversity. This culvert severely limits anadromous fish from accessing spawning and rearing habitat in Tryon Creek. The culvert is a concrete box culvert that has been retrofitted with baffles to improve passage for anadromous adults; however, it remains a partial barrier, particularly for fall spawning coho salmon. During this time, flows are not high enough to allow access into the culvert (the jump height into the culvert remains too high), and passage through the long, baffled culvert is very inhospitable. Winter steelhead return to spawn in late winter to early spring when flows are higher, providing more advantageous opportunities for passage; however, passage probably remains impaired. Other fish passage barriers exist throughout the basin, but this culvert is most significant because of its closeness to the confluence and its impassability. Improving fish access into Tryon Creek by retrofitting or replacing the Highway 43 culvert could significantly increase anadromous fish productivity and species diversity throughout the watershed (WMSWDC 2003d).

Table 9-2
Roadway Culverts in the Tryon Creek Basin

Stream Name	Reach	Crossing	River Mile	Passage? [1]	Impact? [1]	Length (ft)	Drop (in)	Slope (%)	Culvert Type
Tryon Creek	Tryon 1 / Tryon 2	HWY 43	0.3	seasonally passable	perched, velocity, length	200			CCL culvert
	Tryon 3A / Tryon 4A	SW Boones Ferry Rd culvert	2.6	Impassable	length, perched, velocity	150	12	2	CMP culvert
	Tryon 4A / Tryon 4B	1222 SW Maplecrest Dr	3.2	Impassable	perched, velocity	80	12	> = 2	CMP culvert
	Tryon 4B / Tryon 4C	Marshall Cascades	3.3	Impassable	slope, low flow				cascade
	Tryon 4C / Tryon 4D	SW 18th Pl	3.4	Impassable	velocity	70		> = 2	CMP culvert
	Tryon 4D / Tryon 4E	9323 SW Lancaster St	3.9	Impassable	velocity	50		> = 2	CCL culvert
	Tryon 4E / Tryon 5A	2541 SW Taylors Ferry Rd.	4.2	Passable	length	66	< 1		CMP culvert
	Tryon 5A	9209 SW 26th Ave.	4.2	seasonally passable	perched	22	24	NA	CMP culvert
	Tryon 5A	9209 SW 26th Ave.	4.2	impassable	length	150	< 1		CMP culvert
	Tryon 5A	9115 SW 26th Ave.	4.2	seasonally passable		13	<1		CCL culvert
	Tryon 5A / Tryon 5B	8909 SW Barbur Blvd. (I-5)	4.3	impassable		550			CCL culvert
	Tryon 5B	3121 SW Spring Garden St.	4.4	impassable	velocity	45	<1		CMP culvert
	Tryon 5B	3113 SW Spring Garden St.	4.4	impassable	velocity	64	<1		CMP culvert
	Tryon 5B	3113 SW Spring Garden St.	4.4	impassable	obstructions	65	<1		CMP culvert
	Tryon 5D	3060 SW Hume St	4.6	seasonally passable	length	30	< 1		CMP culvert
	Tryon 5D / Tryon 5E	3125 SW Carson St	4.9	impassable	length, perched	190	12		CMP culvert
	Tryon 5E	SW 31st and SW Carson	4.9	Passable		4	< 1		CMP culvert
	Tryon 5E	8102 SW 31st Ave.	4.9	Impassable	Length	163	< 1		CMP culvert
Arnold Cr	Arnold 1A / Arnold 1B	1056 SW Arnold Rd	0.1	Impassable	perched, velocity	60	36	3	CCL culvert
	Arnold 1B	1350 SW Arnold Rd	0.3	seasonally passable	perched	25	18		CMP culvert
	Arnold 1B	Arnold Cascades	0.4	seasonally passable	bedrock				cascade
	Arnold 1B / Arnold 1C	11005 SW 16th Pl	0.4	Impassable	Length, perched	140	18		CMP culvert
	Arnold 1C	1824 SW Arnold St.	0.5	seasonally passable	length, drop	40	4		CMP culvert
	Arnold 1C / Arnold 1D	10921 SW Lancaster Rd.	0.8	Impassable	Length, perched	140	60		CCL culvert
	Arnold 1E / Arnold 1F	11205 SW 35th Ave	1.4	seasonally passable	length	86	< 1		CMP culvert
Tryon 4B Trib	Unknown Trib 4B1	2030 SW Taylors Ferry Rd.	0.2	Impassable	length	120	< 1		CMP culvert
	Unknown Trib 4B1	2235 SW Marigold St.	0.5	Impassable	length	133	< 1		CMP culvert

	Unknown Trib 4B2	9309 SW 18th Pl.	0.2	Impassable	length	100	NA		CMP culvert
Burlingham Cr	Burlingham 1	1803 SW Broadleaf Dr	0.1	Impassable	velocity	80	< 1	5	CCL culvert
Quail Cr	Quail 1	9640 SW Lancaster Rd	0.1	Impassable	perched, velocity	80	60	11	CCL culvert
	Quail 1	9706 SW Quail Post Rd	0.2	seasonally passable	perched	35	13	1	CMP culvert
Falling Cr	Falling 1A / Falling 1B	9310 SW 26th Ave.	0.2	seasonally passable		80	4		CMP culvert
	Falling 1B / Falling 1C	9637 SW 35th Ave.	0.9	Impassable	length, velocity	500	0	2	CCL culvert
	Falling 1C / Falling 1D	3718 SW Huber St	1.1	Impassable	velocity	60	4	2	CCL culvert
	Falling 1D / Falling 1E	10808 SW 39th Ave. (Jackson M.S)	1.5	impassable	length	1330			CMP culvert
	Falling 1E	4203 SW Pomona St.	1.7	seasonally passable	perched	60	10		CMP culvert
Tryon 5B Trib	Unknown Trib 5B1	2831 SW Dolph Ct	0.1	impassable	length	250	< 1	1	CCL culvert
Tryon 5C Trib	Unknown Trib 5C1	8473 SW 30th Ave / Spring Garden Rd	0.1	Impassable	length	150	< 1	1	CMP culvert

[1] If velocity barrier (based on slope > 2.0), then assume impassable year-round.
If perched, but not velocity, then assume seasonally passable during winter flows (November ==> March). WHAT DOES THIS SYMBOL MEAN?
If length > 100 feet, then assume impassable year-round, unless culvert is embedded with stream bottom substrate.
If drop > 6.0 inches, then presume barrier to juveniles (perched for part of the year). If drop > 12.0 –inches, then presume barrier to adults (perched for part of year)
If slope > 2.0, then presume velocity barrier.
Data Source: X:\ESA\Culverts\TryonCulverts.xls
THE TITLE OF THE TABLE SAID THE DATA SOURCE IS ODFW 2000)

Refugia

Off-channel refugia are primarily associated with perennial and intermittent tributaries. Some floodplain wetlands could be used during high flows if flood flows regularly topped the banks.

Lower Tryon Creek functions as off-channel refugia to the Willamette River and is used year round by Willamette Basin salmonids.

Instream structure and cover are lacking throughout Tryon Creek Basin. Notable areas and instream refugia include:

- Beaver ponds and associated wood clusters and debris jams provide important in-channel structure and refugia in reaches running through Tryon Creek State Natural Area (Tryon 2 – Tryon 3B).

- Seeps and springs provide important hyporheic flows. These areas were noted basinwide, but appear to be most prominent in Tryon Creek State Natural Area (Tryon 2 – Tryon 4A).

- Undercut banks, large cobble and boulders, and wood provide important in-channel cover basinwide wherever they are present.

Channel Conditions and Habitat Structure

Stream Bank Condition

Stream banks are actively eroding and unstable (ODFW 2001; WMSWCD 2003a), except in Tryon 2, from Highway 43 upstream to the confluence of Nettle Creek (Table 9-3). Even within this reach, areas of excess erosion are present, most notably at the confluence of an unnamed tributary flowing in from the south hillslope (Map 7-Tryon Creek Vegetative Cover Map, Map Atlas).

Only 9 percent of the stream banks are artificially hardened (brick, laid stone, riprap, and concrete) basinwide. The remaining 91 percent of the stream banks are composed of natural materials (earth, gravel, and sand). However, landscaping practices, road crossings, and residential development have hardened natural bank forms, particularly in the upper watershed.

From its confluence up to the upper end of a narrow rock-walled canyon (lower end of Tryon 2), Tryon Creek is believed to be a natural flume that effectively transports, but does not store, stream energy, sediments, and wood (WMSWCD 2003b). The stream's bottom and banks through this segment are composed of bedrock. However, the confluence reach up to Highway 43 has been extensively constricted by fill material, most notably along the northern bank. The southern bank is composed primarily of bedrock. Channel configuration and presence of bedrock so close to the soil surface may preclude long-term establishment of deep-rooting riparian trees.

The combination of clay soil type, presence of bedrock near the soil surface, buried large wood material, and riparian tree roots are believed to be preventing further downcutting of the creek (WMSWCD 2003b). Throughout the basin, the most effective way to prevent additional stream

bank degradation will be to prevent additional increases in peak flows and sediment loads, as well as any additional losses of riparian vegetation and functions (WMSWCD 2003a).

Table 9-3
Channel Condition by Reach

Basin	Reach	% Actively Eroding [1]	Bank Slope (%) (0-10-m)
Tryon Creek	Tryon 1	69	25
	Tryon 2	36	53
	Tryon 3A	66	6
	Tryon 3B	66	6
	Tryon 4A	58	15
	Tryon 4B	58	15
	Tryon 4C	58	15
	Tryon 4D	58	15
Arnold Creek	Arnold 1A	79	21
	Arnold 1B	79	21

Note: Reaches that were not surveyed are not included.
[1] 30-60 % actively eroding = moderately unstable and signifies high erosion potential during floods (Barbour 1999).
Data Source: ODFW 2001

Large Woody Debris

The National Riparian Services Team characterizes Tryon Creek as a wood-dependent system, meaning that it developed in conjunction with a large conifer forest stand (WMSWCD 2003b). The wood provided by larger conifer tree boles historically trapped sediment and formed floodplains, retaining flood flows and promoting rich, diverse riparian vegetation. The team concluded that large wood material is the most important attribute in this stream type, and the processes associated with it are the most important to the function of the watershed.

Large woody material is lacking throughout the basin (ODFW 2001; WMSWCD 2003a, 2003b, and 2003d). As shown in Table 9-4, wood abundance is low upstream of SW Boones Ferry Road; wood volume is low throughout the basin; and key pieces are rare. The loss of accumulated large wood has resulted in channel erosion, which has further converted the stream from one that often accessed its floodplain to one that cannot. Loss of transient and buried large wood from the channel and floodplain may have had the most adverse affect on stream habitat and on riparian and floodplain connectivity.

During the 2000 ODFW stream surveys, three reaches within mainstem Tryon Creek had optimal numbers of wood pieces for fish-bearing streams (more than 20 pieces per 100 –meters of stream length): Tryon 2 (42 pieces), Tryon 3A (54 pieces), and Tryon 3B (34 pieces). All three reaches lie within Tryon Creek State Natural Area and contained enough wood to provide a marginal level of protective cover. However, wood volume was poor, with less than 20.0-m3 per

100 –meters of stream length (Tryon 2 – Tryon 4A), and few key pieces (over 60 cm diameter and over 10 meters long) were documented. Only Tryon 3A contained key pieces (0.91 piece per 100 –meters of stream length). Wood pieces indicate riparian vegetation age and species; the presence of smaller to mid-sized single pieces indicates that wood is falling into the creek, but has not yet amassed enough to provide critical habitat function in the form of debris jams or clusters.

In addition, most tributaries of Tryon Creek (excluding Iron Mountain Creek) lack enough wood to effectively store sediments and retain water. The National Riparian Services Team noted that upland and riparian vegetation is generally less than 60 years old, too young to contribute significant amounts of large woody material needed to rebuild floodplain and channel structure (WMSWCD 2003b). Buried, large wood complexes provide important overwintering habitat to salmonids. Without this protective cover, fish are often swept downstream during higher winter and spring flows.

Past logging and tree removal during urban development, prolonged or acute peak flows, and inadvertent (or planned) maintenance removal of large wood have resulted in low large wood abundance and volume throughout the basin. In addition, the combination of high flows, incised channels, and lack of in-channel complexity limits the amount of wood that is currently retained in-channel.

The lack of large wood, combined with the prevalence of higher, flashy storm flows, significantly impacts habitat formations and the maintenance of good-quality spawning and rearing fish habitat in Tryon Creek. It is probably a prominent factor limiting fish productivity.

Table 9-4
Wood Abundance, Volume and Key pieces by Reach

Basin	Reach	# Pieces per 100 – meters [1]	Volume (m3) per 100-m [2]	# Key Pieces per 100 – meters [3]
Tryon Creek	Tryon 1	4.5 (UD)	5.06 (UD)	0 (UD)
	Tryon 2	42.3 (D)	1.40 (UD)	0 (UD)
	Tryon 3A	53.6 (D)	1.74 (UD)	0.91 (M)
	Tryon 3B	34.0 (D)	0.95 (UD)	0 (UD)
	Tryon 3C	5.0 (UD)	0.94 (UD)	0 (UD)
	Tryon 4A	17.8 (M)	3.82 (UD)	0 (UD)
	Tryon 4B	2.7 (UD)	0.39 (UD)	0 (UD)
	Marshall Cascades	0.5 (UD)	0.26 (UD)	0 (UD)
	Tryon 4C	6.4 (UD)	3.47 (UD)	0 (UD)
Arnold Creek	Arnold 1A	5.5 (UD)	3.93 (UD)	0 (UD)
	Arnold 1B	6.8 (UD)	1.31 (UD)	0 (UD)
	Arnold Cas	4.6 (UD)	5.37 (UD)	0 (UD)
	Arnold 1C	1.4 (UD)	0.28 (UD)	0 (UD)

	Arnold 1D	5.5 (UD)	1.08 (UD)	0 (UD)
	Arnold 1E	11.4 (M)	0.99 (UD)	0 (UD)

Note: Wood pieces are defined as > 3 meters x 0.15 meter.
[1] # Pieces: desirable (D): > 20; marginal (M): > 10 and < 20 undesirable (UD): <10
[2] Wood Volume: desirable: > 30; marginal: > 20 and < 30; undesirable: <20.
[3] Key pieces (> 10 meters x 0.6 meter): desirable: > 3; marginal: > 1 and < 3; undesirable: <1.
Data Source: ODFW 2001

Pool Area, Depth, and Complexity

Pool area is best in the lower and middle reaches of Tryon Creek (Tryon 1 through Tryon 3B), with pool area (lateral scour pools) constituting about half of the wetted area (Table 9-5). Tryon 2 has several beaver ponds and debris jams, which constitute approximately 25 percent of the total pool area. Pool area declines upstream of SW Boones Ferry Road, transitioning from moderate to low from Tryon 4A (34 percent) to Tryon 4B (7 percent). Arnold Creek also has very little pool habitat.

The proportion of fine sediment amassed in pools ranges from 21 to 31 percent (reach average) in mainstem Tryon Creek and Arnold Creek. Sediment deposition greater than 20 percent generally signifies above-normal deposition. A disproportionate amount of amassed sediments implies that sediment recruitment, deposition, and transport are out of balance. This dynamic is descriptive of pool habitats in Tryon Creek, indicating that sediments are disproportionately filling scoured areas in pools and effectively minimizing their functional capacity.

Table 9-5
Pool Area and Substrate Composition by Reach

Basin	Reach	Total Area (m2)	Total Pool Area (m2)	% Pool Area [1]	% Gravel [3]	% Sand [3]	% Fines [2, 3]
Tryon Creek	Tryon 1	1,319	726.0	55 [4]	18	23	31
	Tryon 2	6,396	4,843.0	76 [5]	17	25	31
	Tryon 3A	11,423	7,395.0	65 [6]	25	31	27
	Tryon 3B						
	Tryon 4A	6,751	2,004.0	30	29	16	21
	Tryon 4B						
	Tryon 4C						
Arnold Creek	Arnold 1A	3,320	815.0	25	35	19	21
	Arnold 1B						

[1] % Pool Area: undesirable: <10%; marginal: >10% and <35%; desirable: >35%.
[2] 20-50% deposited fines signifies slight deposition (Barbour 1999).
[3] Substrate represents lateral scour pools - dominant pool type.
[4] 8% of 55% pool area includes a beaver pond/pool complex (25 meters x 4 meters).
[5] 25% of 76% pool area includes five beaver ponds and one backwater pool. Substrate in beaver ponds is dominated by fines (45%) and sands (28%).
[6] 8% of 65% pool area includes one backwater pool, two dammed pools, and two beaver ponds.
Data Source: ODFW 2000

The lack of deep pools, relative to the prevailing channel depth, indicates that pools are not

providing protective cover and depth refugia, compared to other channel habitats. Most deep pools are present in lower and middle Tryon Creek, within the confines of Tryon Creek State Natural Area, but are lacking upstream of SW Boones Ferry Road (Tryon 4A through Tryon 4C). Pools are considered marginal (>= 0.2 meter) or desirable (>= 0.5 meter) in most mainstem reaches. Reaches in Tryon Creek State Natural Area have more than 50 percent pool area with pools at least 0.5 meter deep, which is considered optimal for fish bearing streams. As shown in Table 9-6, however, the average channel depth is quite deep for a stream of this size, yielding relatively shallow pools compared to the average channel depth within the reach; pools are rarely more than 25 percent deeper than the average channel depth. This channel structure is characteristic of a stream that has been deepened and is channelized; it does not functionally provide adequate cover and refugia, particularly during storm flows and throughout prolonged higher flows occurring in the winter.

Most deep pools are present in Tryon 3B, with more than 70 percent of the pools being at least 0.5 meter deep. Conversely, pool area and deep pool habitat is lacking upstream of Tryon Creek State Natural Area. Tryon 4A has only 35 percent pools greater than 0.5 meter deep, and Tryon 4C has only 28 percent pool habitat deeper than 0.5 meter. Remaining pool habitat in these two reaches is marginally deep, ranging from 0.2 to 0.5 meter deep. Although not much pool area is present in Tryon 4B (7 percent of total stream area), the pool area that exists is desirable; more than 60 of the pool habitat has depths greater than 0.5 meter.

Table 9-6
Deep Pools by Reach

Basin	Reach	Deep Pools (> 1.0-m)		Avg Residual Pool Depth [1] (m)	Avg Channel Depth (m)	Relative Pool Depth (%) [2]
		# Deep Pools	# Deep Pools/1000 m			
Tryon Creek	Tryon 1	4.0	10.2	0.64	0.47	27
	Tryon 2	6.0	4.5	0.59	0.44	25
	Tryon 3A	18.0	6.7	0.62	0.47	24
	Tryon 3B					
	Tryon 4A	4.0	1.8	0.46	0.26	43
	Tryon 4B					
	Tryon 4C					
Arnold Creek	Arnold 1A	1.0	0.5	0.38	0.17	55
	Arnold 1B					

1 Residual Pool Depth: undesirable: <0.2 m; marginal: >=0.2 m and <=0.5 m; desirable: >0.5 –m.
2 Pools 75-100 % deeper than prevailing channel depth provide protective cover (NRCS 1999).
Data Source: ODFW 2000

As with deep pool habitat, complex pools (with wood complexity greater than 3.0 km) is lacking throughout the basin (Table 9-7). Some are present in lower mainstem reaches: Tryon 2 (6.8), Tryon 3A (13.5) and Tryon 3B (7.6). No complex pools were documented above Tryon 4A.

Table 9-7
Pools with Wood and Boulder Complexity

Basin	Reach	Complex Pools [1]		Substrate
		# Complex Pools	# Complex Pls/1000-m	% Boulders [2]
Tryon Creek	Tryon 1	0	0.0 (UD)	9
	Tryon 2	9	6.8 (D)	2
	Tryon 3A	16	13.5 (D)	1
	Tryon 3B	8	7.6 (D)	
	Tryon 3C	0	0.0 (UD)	
	Tryon 4A	2	2.1 (M)	1
	Tryon 4B	0	0.0	
	Marshall Cascade	0	0.0 (UD)	
	Tryon 4C	0	0.0 (UD)	
Arnold Creek	Arnold 1A	0	0.0 (UD)	2
	Arnold 1B	0	0.0 (UD)	
	Arnold Cascade	1	9.4 (D)	
	Arnold 1C	0	0.0 (UD)	
	Arnold 1D	0	0.0 (UD)	
	Arnold 1E	0	0.0 (UD)	

[1] Complex Pools: undesirable (UD): < 1.0; marginal (M) >=1.0 and <= 2.5; desirable (D) >2.5.
[2] Substrate for later scour pools is reported.
Data Source: ODFW 2000

Riffle Area, Gravels and Fines.

Riffles constitute 17 to 29 percent of the wetted habitat in mainstem Tryon Creek. Riffle area is moderately low for fish-bearing streams. Spawning and rearing grounds may be a limiting factor that affects population abundance and species diversity.

Riffle quality (substrate composition and proportion of fine sediments) is moderately good. Nearly all reaches (except for Tryon 2) have at least 50 percent riffle habitats with more than 35 percent gravel composition, which is considered optimal for fish-bearing habitat. However, the proportion of substrate and gravels covered or embedded with fine sediments and organics is marginally high throughout the basin. Fine sediments are least abundant in Tryon 2 and Tryon 3A. In Tryon 2, 15 percent of riffle habitats have less than 12 percent fines (considered desirable habitat condition for fish-bearing streams), and 65 percent have less than 25 percent fines (considered marginal habitat condition for fish-bearing streams). In Tryon 3A, 21 percent of riffle habitats have less than 12 percent fines, and 55 percent have less than 25 percent fines. The upper 400 meters of Tryon 3B has excellent gravel composition in riffle habitats, with low proportions of fines; 72 percent of the riffle habitat has less than 12 percent fines and is considered desirable. .

Table 9-8 shows riffle area and gravel composition by reach, and Table 9-9 shows riffle area and

sediment composition by reach.

Table 9-8
Riffle Area and Gravel Composition by Reach

Basin	Reach	% Riffle Area	Gravel Composition (%)		
			Undesirable <15%	Marginal >=15% & <35%	Desirable >= 35%
Tryon Creek	Tryon 1	20%	0	100	0
	Tryon 2	17%	10	58	39
	Tryon 3A	29% [1]	0	25	75
	Tryon 3B		0	19	81
	Tryon 3C		0	0	100
	Tryon 4A	17% [2]	0	29	71
	Tryon 4B		0	0	100
	Tryon 4C		0	14	86
Arnold Creek	Arnold 1A	50% [3]	0	0	100
	Arnold 1B		0	40	60
	Arnold Cascade		0	0	100
	Arnold 1C		0	0	100
	Arnold 1D		0	14	86
	Arnold 1E		0	32	68

[1] Proportion for Tryon 3
[2] Proportion for Tryon 4
[3] Proportion for Arnold 1
Data Source: ODFW 2000.

Table 9-9
Riffle Area and Fine Sediment Composition by Reach

Basin	Reach	% Riffle Area	Fine Sediment Composition (%)		
			Undesirable >25%	Marginal <=25% & >=12%	Desirable <12%
Tryon Creek	Tryon 1	20	100	0	0
	Tryon 2	17	20	65	15
	Tryon 3A	29 [1]	24	55	21

	Tryon 3B		74	26	0
	Tryon 3C		0	28	72
	Tryon 4A	17 [2]	15	81	4
	Tryon 4B		0	100	0
	Tryon 4C		21	76	4
Arnold Creek	Arnold 1A	50 [3]	0	100	0
	Arnold 1B		37	63	0
	Arnold Cascade		0	100	0
	Arnold 1C		87	13	0
	Arnold 1D		36	61	4
	Arnold 1E		16	80	4

[1] Proportion for Tryon 3
[2] Proportion for Tryon 4
[3] Proportion for Arnold 1
Data Source: ODFW 2000.

The proportion of fine sediments that cover riffles is least desirable in Tryon 1 (100 percent of riffles have more than 25 percent fines); lower Tryon 3B (74 percent of riffles have 25 percent or more fines); and Arnold 1C (87 percent of riffles have more than 25 percent fines). All remaining reaches exhibit marginal riffle quality, based on the proportion of fine sediment that covers stream-bottom substrates (12-25 percent fines). Although riffle habitat in most reaches does not have undesirable proportions of fine sediments (more than 25 percent), the majority of riffle habitat is considered sub-optimal quality, with more than 12 percent fine sediments overlying riffle gravel substrates.

Predominant sources of sediment loading into Tryon Creek are not fully understood; they are probably a combination of sediment loads in stormwater runoff and sediments injected into the creek during erosive flows. These sediments are probably in suspension, then settle and become resuspended during high, turbulent flows, yielding a constant layer of fine silt and sediment overlying stream bottom substrates. These high silt loads overlying spawning grounds may significantly impair the carrying capacity of this system.

BIOLOGICAL COMMUNITIES BY REACH (TARGET SPECIES)

Salmonids are the target species for this characterization. Other aquatic and terrestrial wildlife were not assessed. Only mainstem Tryon Creek was evaluated for fish presence. Although the tributaries are important for providing additional spawning and rearing areas, they were not assessed in this characterization.

Chinook spawn and rear in mainstem reaches of large river systems such as the Willamette River and the Clackamas River. Tryon Creek is a minor tributary to the lower Willamette River, and it is unlikely that Chinook would historically have populated this basin. However, juvenile Chinook probably used (and continue to use) the lower confluence region of Tryon Creek during

different stages of their freshwater rearing. Based on this assumption, Chinook salmon use of Tryon Creek is evaluated only for Tryon 1, the confluence reach.

Fall-run coho, winter-run steelhead, and sea-run cutthroat historically populated Tryon Creek. These species seek smaller tributary reaches of larger river systems, and all three have been historically documented throughout the Tryon Creek Basin. The characterization describes their historic presence and current potential to populate the creek for each reach.

Tryon 1 – Confluence Reach

- Based on index of biotic integrity (IBI) scores, lower Tryon Creek is considered moderately impaired (for stream integrity) in the spring and summer and is considered acceptable during the fall (ODFW 2002). These scores (or assessments) are consistent with fish data collected in 2001 and 2002.

- Field surveys showed that steelhead were present in the fall and spring, Chinook were present in the summer and fall, and coho were present in spring, summer, and fall. Species richness was highest in the fall. Cutthroat trout were also present in the lower reach throughout the three sampling seasons. Field surveys were not conducted in the winter.

This lower confluence reach functions most prominently as off-channel habitat to the Willamette River, providing important rearing grounds and temporary refuge during high winter and spring flows. It is not believed to substantively function as salmonid spawning grounds.

Current habitat condition and quality support rearing by Chinook. Riffle habitat is marginal to poor quality, with gravels constituting only 35 percent of riffle area, and fines and organics covering greater than 35 percent of those riffles. Deep pools (greater than 0.50 meter) are present for juveniles to rear during the summer and winter. Large wood and other instream structure and complexity (boulders, undercut banks, overhanging vegetation) is lacking throughout the reach, and probably limits opportunities for prolonged rearing; juvenile Chinook rely on instream structure for cover, especially in the fall and winter months when flows are high.Juvenile Chinook temporarily occupy habitats in this lower section of Tryon Creek during downstream migrations (from the upper Willamette Basin), and/or to avoid predators and feed.

Habitat conditions in this lower confluence reach also support rearing by coho, steelhead, and cutthroat. Pools are deep, and riffles are present. Stream-bottom substrates include gravels, which are preferred by steelhead. As previously stated, riffle quality is low because heavy silt loads overlie riffle environs. However, cutthroat rear in this lower reach year-round. Data do not conclusively show whether steelhead and/or rainbow trout rear and reside here year-round, or whether they use this lower reach as temporary refuge and rearing. Based on the absence of steelhead during the summer, but their presence in the fall and spring, steelhead may use lower Tryon Creek similarly to Chinook (as refugia and temporary rearing during the downstream migrations).

Lower Tryon Creek severely lacks off-channel refugia and instream cover that sub-yearling and yearling coho and Chinook rely on. Steelhead and cutthroat also rely on these types of refugia,

particularly during high water. Lack of large wood, boulders, and undercut banks limits the quantity and quality of overwintering habitat.

In summary, lower Tryon Creek functions as off-channel, slack-water habitat to the Willamette River and undoubtedly provides important rearing and refuge habitat. Juvenile coho often move into lower mainstem river reaches as they mature to pre-smolt condition. This behavior coincides with the fall, winter, and spring seasons, which is when coho have been observed using lower Tryon Creek as well as other lower Willamette bank environs and off-channel areas (Columbia Slough and Multnomah Channel).

Tryon 2 – Lower Canyon Reach

- Biotic integrity in the lower portion of Tryon Creek is considered severely impaired in spring and summer, and moderately impaired in fall (ODFW 2002).

- Field data show that cutthroat trout were the predominant species encountered in spring, summer, and fall. Field surveys were not conducted in the winter. Steelhead were observed in the fall. Coho and Chinook were not observed in this lower canyon reach.

Adult coho return to spawn in the fall. The culvert running under the State Street Highway is considered a barrier to coho; it is steep, long, and jump height into the culvert is high. For these reasons, as well as lower stream flow during adult migrations (i.e., lower surface water elevation), it is not believed that coho can successfully pass through this culvert. The result is that coho do not currently populate Tryon Creek. However, habitat conditions could support coho if access above this barrier were provided. Winter-run steelhead return in December, January, and February, when stream flows are higher and provide more opportunities to navigate above the culvert. Although the culvert is still considered a barrier to winter steelhead, some passage does occur.

Habitat conditions in lower Tryon Creek could support steelhead, cutthroat and coho. Pools are deep (averaging 0.60 –meter), of good quality, and numerous. These habitats provide important summer rearing areas when surface waters warm, and provide important fall, winter, and spring refugia during high flows. Riffle habitat is desirable, with more than 35 percent gravel composition. Steelhead, cutthroat, and coho seek small streams (or tributaries) to reside in and prefer small to large gravels to spawn in; substrate conditions are therefore suitable for spawning. However, silt loads may significantly impede spawner success and egg-to-fry survival.

Wood counts are considered desirable throughout the reach; however, wood densities are low, and key pieces are lacking. Wood is generally classified as small to medium size; single pieces have not yet amassed to form functional wood clusters. Lack of wood-associated instream structure limits the quality of overwintering habitat and consequently the ability of salmonids to remain instream during higher flow periods. However, this lower canyon contains some of the largest and oldest riparian and forest stands in the basin, so near-term recruitment of larger wood pieces into the creek is good. Unlike Tryon 1, the lower canyon reach has some off-channel habitat, and multiple springs and seeps enter the creek. These characteristics, along with

transient beaver dams and debris jams, provide important slack-water, pooled habitat. In addition, the floodplain through this lower canyon reach is believed to be intact and well-connected to the creek, particularly near the confluence of Iron Mountain Creek (WMSWCD 2003b). This interaction probably provides additional floodplain wetlands during higher flows. These instream and temporary off-channel environs provide critical habitat to salmonid fry and juveniles, particularly during high-flow overwintering months.

In 2002, the National Riparian Service Team surveyed the watershed and concluded that the lower park is well-suited for coho and steelhead production (WMSWCD 2003b). The creek is relatively low gradient through the park reach and provides enough spawning and rearing habitat to sustain a fishery population.

Tryon 3 – Middle and Upper Park Reach

- Biotic integrity in the middle and upper park reach is considered severely impaired in spring, summer, and fall (and presumably in winter if it been sampled) (ODFW 2002).

- Cutthroat trout were observed year-round, and one steelhead was observed in the summer. Chinook and coho were not observed.

Habitat conditions in lower Tryon Creek could support steelhead, cutthroat, and coho. Pools are deep, of good quality, and numerous. This subreach contains 13.5 complex pools per 100 –meters of stream length; this is the most of all the reaches surveyed in Tryon Creek, and more than five times the number considered desirable for fish-bearing habitat. Riffle habitat is considered favorable, with desirable gravel and cobble composition. However, half of the habitats surveyed had more than 25 percent fines covering riffle areas. Only 21 percent of the riffles surveyed in the middle park (Tryon 3A) were considered desirable habitat (having less than 12 percent fine sediment accumulations). This high proportion of fines and organics significantly affects the quality of spawning grounds, the egg incubation environment, and the ability of fry to successfully emerge. Only the upper 400 –meters of this reach (immediately below SW Boones Ferry Road) exhibits good fish-bearing habitat, with good riffle habitat and low fines.

Although wood counts are considered desirable throughout the reach (and were the highest of any other subreach surveyed), wood densities are low and key pieces are lacking. Like the lower canyon reach (Tryon 2), large wood pieces and associated clustered wood masses are rare. The surrounding riparian and forest stands may provide some wood material into the creek, but the stand age is relatively young (approximately 50-70 years); short-term sources of woody material are therefore needed. The forest stand is characteristic of a deciduous-dominated forest stand, which does not represent the conditions that existed before logging occurred. With the exception of western red cedar, conifer species are noticeably lacking. Wood that falls into the creek from the surrounding forest will consist mostly of deciduous species, which have a shorter lifespan than conifers (such as Douglas fir, hemlock, and cedar) once they enter the water.

The creek running through this middle and upper park area is relatively straight and incised. Off-channel refugia are rare and are mostly associated with tributary junctions, ephemeral side

channels, and hyporheic seeps and springs. These habitat features are important to salmonids, particularly during overwintering months.

This reach does retain some of the best fish-bearing habitat in the basin, however. Pools are deep, and riffle gravels are present (although embedded with sediments in the lower two-thirds of the reach). Stream gradient remains low, and trails generally do not abut the creek channel. The potential for the creek to interact with its riparian and floodplain area is great throughout this reach if flood flows could top the bank and extend outside the creek channel. The National Riparian Service Team surveyed the watershed in 2002 and concluded that the middle and upper park reach is well suited for coho and steelhead production (WMSWCD 2003b).

Tryon 4 – Upper Tryon Creek

- Biotic integrity in upper Tryon Creek is severely impaired in spring, summer, and fall (and presumably in winter if it had been sampled).

- Cutthroat trout were observed year-round (ODFW 2002). Chinook, coho, and steelhead were not observed.

The SW Boones Ferry Road culvert (Tryon 3B/Tryon 4A), the cascade reach flowing through Marshall Park, and the SW 18th Place culvert (just upstream of Marshall Cascades) are significant fish barriers to anadromous and resident fish under most water-year conditions. However, resident populations of steelhead/rainbow and cutthroat continue to populate reaches upstream of these fish barriers. Marshall Cascades is a natural fish barrier. It probably historically marked the upstream extent of anadromous fish movement under most flow conditions. However, some winter-run salmonids may have passed this barrier when flows were particularly high, offering discrete opportunities to populate the upper basin.

Habitat conditions in this portion of Tryon Creek could support steelhead and cutthroat, but would probably not support rearing by coho. Pool abundance is relatively low (approximately 34 percent of habitat). Deep pools are few; only 35 percent of the pools have depths greater than 0.5 –meter, and none have wood or large substrate complexity. The primary rearing habitat used by coho throughout the year is not substantively available in this reach.

Riffle habitat and gravel composition are considered favorable; however, most riffle habitat (96 percent) has more than 12 percent fine sediments covering the stream bottom. The quality of spawning grounds, egg incubation environment, and ability of fry to emerge are therefore undoubtedly impaired.

Wood counts and wood densities are low, and key pieces are completely lacking. The lack of wood and large boulders instream limits the quantity and quality of overwintering habitat. Off-channel refugia are primarily found near tributary confluence regions. Backwater and side-channel habitats are nonexistent. Lack of instream refugia (deep pools and instream structure) and lack of off-channel, high-flow refugia severely limit the potential for this reach to provide key rearing habitats, particularly during the overwintering months.

Despite these conditions, cutthroat trout and steelhead/rainbow trout continue to populate Tryon Creek in this reach. This indicates that if passage were available, other, larger salmonids such as winter-run steelhead could also possibly survive. Salmonids have been reported between SW Maplecrest Drive and Marshall Cascades (Tryon 4B) during good flow years (personal communication, Maplecrest property owner, 2002).

Adequate data were not available to thoroughly assess and evaluate habitat conditions and biological community structure in the headwaters of Tryon Creek (Tryon 5), Arnold Creek, Falling Creek, and other tributary habitats.

BIOLOGICAL COMMUNITIES SUMMARY

Target Fish Species

The following population assessment is based on empirical data and is considered preliminary**.** Species population observations in Tryon Creek are based primarily on two years of data from extensive (spring, summer, and fall) and intensive (summer) stream surveys (ODFW 2002). The assessment also considered past surveys and evaluations, but those sources' conclusions about population status are often not substantiated with empirical data, sightings, or other forms of evidence and are therefore considered to be anecdotal. Viable salmonid parameters (abundance, productivity, spatial structure and diversity), as defined by NOAA-Fisheries and previously described in Chapter 7, are addressed, but are based on only two years of data. Of these four parameters,, abundance and spatial structure are evaluated. Productivity and diversity cannot be evaluated with existing data.

Coho, Chinook, steelhead, and cutthroat were observed in different parts of Tryon Creek during different seasons of the year. Of all the salmonid species observed, cutthroat trout were most abundant, with population estimates of 53 individuals in the spring, 36 in the summer, and 24 in the fall (ODFW 2002). Salmonid densities averaged 0.059 fish per square meter basinwide, and ranged from 0.047 fish per square meter in the lower canyon reach (Tryon 2) to 0.068 fish per square meter in the Willamette confluence reach (Tryon 1). Although the upper stream reach running through Tryon Creek State Natural Area (Tryon 3) and above (Tryon 4) resulted in lower biotic integrity (IBI) scores, species density per water surface area was relatively equal throughout all of the Tryon Creek Basin.

Coho historically spawned and reared throughout the Tryon Creek Basin (WMSWCD 2003d). The upstream extent of their anadromy is not known; based on the geomorphology of the channel and valley hillslopes, however, they –probably spawned at least up to the confluence of Tryon Creek and Arnold Creek (lower and middle Tryon Creek) and possibly up to the bottom of Marshall Cascades, a natural fish barrier.

Juvenile coho were present in the lower reach (Tryon 1), but were not observed in any other stream segment of the subbasin. During 2001 – 2002 field surveys, coho were observed during all three sample seasons (spring, summer, and fall periods), indicating that they use (and/or rear in) this lower confluence reach year-round. Juveniles that occupy this lower confluence area are probably progeny of coho that inhabit other Willamette Basin tributaries, primarily the Clackamas River, Johnson Creek, and the Tualatin River. Lower Tryon Creek therefore

functions as off-channel rearing and refuge habitat to other Willamette Basin coho populations. Coho were least abundant in the fall.

The State Street (Highway 43) culvert is probably the most prominent limiting factor affecting coho distribution in the Tryon Creek Basin. Flows, culvert length, and jump height into the culvert probably exclude fall-run fish from passing above this barrier. Habitat conditions in Tryon Creek remain favorable for coho spawning and rearing, however, suggesting that coho could inhabit and successfully thrive. The National Riparian Service Team surveyed the watershed in 2002 and concluded that the lower park is well suited for coho salmon production (WMSWCD 2003b). Tryon Creek has a relatively low gradient through the park reach and provides enough spawning and rearing habitat to sustain a fishery population.

Chinook were present in the lower reach (Tryon 1); they were captured in the summer and fall, but were not encountered in the spring. Tryon Creek is a minor tributary to the Willamette River, and it is unlikely that Chinook historically populated this basin. Adult Chinook generally seek upper mainstem river reaches of larger, fast-flowing rivers and streams. However, juvenile Chinook use lower Tryon Creek year–round, suggesting that juvenile Chinook from other Willamette subbasins use the confluence region of Tryon Creek as off-channel habitat to the Willamette mainstem. They seek these areas for temporary refuge and/or prolonged periods to rear and feed. They probably do not reside here year-round. This hypothesis is consistent with observations by the Independent Scientific Group (2000) of Chinook juvenile out-migration strategies that consist of movement from upriver tributary spawning sites into downstream mainstem areas, where they rear over the winter (Healey 1991).

Steelhead (winter-run) historically spawned and reared throughout the Tryon Creek Basin. The upstream extent of their anadromy is not known; based on the geomorphology of the channel and valley hillslopes, however, they likely spawned up to (and perhaps beyond) Marshall Cascades.

During 1999–2001 fish surveys, steelhead species were present in the lower and middle portions of Tryon Creek. This indicates that anadromous steelhead pass above the State Street culvert and/or that a resident steelhead population persists throughout the Tryon Creek subbasin. Steelhead were observed in the spring, summer, and fall, indicating residency year-round.

In addition to fish surveys conducted by ODFW field biologists, other surveys have documented steelhead and/or rainbow trout throughout various reaches of Tryon Creek, indicating that local populations of anadromous and resident fish continue to persist (City of Portland 1992; Pacific Habitat Services 1997; Reed and Smith 2000).. It is likely that both types of steelhead exist in Tryon Creek. In addition, juvenile steelhead from other watersheds within the Willamette River Basin are believed to rear and/or temporarily use lower Tryon Creek (up to Highway 43) during their seaward emigrations. Like coho and Chinook, juvenile steelhead use this lower confluence reach as off-channel habitat to the Willamette River; they seek refuge from high waters, avoid predators, seek food, and/or seek temporary rearing opportunities. This hypothesis is consistent with the findings of the Independent Scientific Group (2000), which found that steelhead juveniles in the Columbia Basin appear to move downstream to more productive areas as they grow and require more sustenance.

As with coho, Highway 43 significantly impedes anadromous movement of steelhead up into the lower and middle Tryon Creek subbasin. However, winter steelhead adult migrations coincide with periods of higher flow, which probably allows for better passage through the culvert. Jump height into the culvert and the culvert length probably remain key limiting factors for fish passage above this barrier. Habitat conditions in lower and middle Tryon Creek are favorable for steelhead spawning and rearing. The National Riparian Service Team surveyed the watershed in 2002 and concluded that Tryon Creek State Natural Area is well suited for steelhead production (WMSWCD 2003b). Recent surveys also suggest that spawning and rearing habitat is available, although with varying degrees of habitat quality.

Cutthroat were observed in every reach and during every sampled season in Tryon Creek. This indicates that they are present year-round and persist throughout the subbasin. Habitat conditions support cutthroat spawning and rearing; however, habitat improvements and restoration efforts would probably enhance cutthroat abundance, diversity, and distribution. Cutthroat populations that currently reside in Tryon Creek are probably remnant populations of both searun and resident populations.

Other target species that were considered include **lamprey** and **torrent sculpin**. One year of data show that lamprey do not inhabit Tryon Creek. Many people consider the Willamette River to be one of the last strongholds for lamprey in the Pacific Northwest Sculpin were encountered in Tryon 1 (the confluence reach), but not in any other reaches. Although this analysis did not consider non-native species, survey data show that non-native fish species were not encountered in any portion of Tryon Creek.

Macroinvertebrates

Macroinvertebrates are not abundant and not diverse in Tryon Creek. Data show low EPT (Ephemeroptera-Plecoptera-Trichoptera) taxa richness (four EPT taxa identified) and low EPT abundance (32 percent mean value) (PSU 2001). Klatte and Ellis noted that only three of 15 sites had macroinvertebrate assemblages indicative of fair habitat condition (West Multnomah Soil and Water Conservation District 2003c). The remaining 12 sampled sites showed poor habitat condition. Low macroinvertebrate taxa that are sensitive to habitat quality, and low EPT taxa richness, indicate that water quality and habitat conditions are impaired throughout most of the basin.

The National Riparian Service Team reported that pollutants coming from streets, storm drains, yard chemicals, and roof protection chemicals, particularly those coming from the urbanized headwater reaches, probably adversely affect macroinvertebrate populations in Tryon Creek (WMSWCD 2003b).

Riparian condition is undoubtedly a factor affecting macroinvertebrates, particularly in the upper watershed, which is more heavily impacted by urban development. It also seems likely that chronic changes in water quality (higher temperatures and nutrients, larger numbers of high-turbidity events, occasional pulse concentrations of toxic chemicals, etc.) are contributing to the observed low level of EPT diversity. Macroinvertebrates tolerant of high levels of fine sediment were common to abundant at most sampled sites in Tryon Creek (West Multnomah Soil and Water Conservation District 2003a).

It is likely that low macroinvertebrate abundance and diversity is a significant problem within the Tryon Creek subbasin. Fish abundance, distribution, and diversity will probably remain low if Tryon Creek cannot support adequate invertebrate populations that are critical food sources for fish, even if physical habitat is functionally adequate.

Summary

Steelhead, coho, and cutthroat historically populated Tryon Creek; it is unlikely that Chinook did. However, all four salmonid species probably used the lower confluence reach as off-channel habitat to the Willamette River. These species continue to use lower Tryon Creek for that purpose during various times of the year.

Only steelhead and resident cutthroat continue to populate Tryon Creek basin above Highway 43. However, coho could probably persist if passage above Highway 43 were improved. Key limiting factors that affect coho, steelhead, and cutthroat productivity and distribution throughout Tryon Creek are listed below. (These are described in detail in the Habitat Characterization sections earlier in this chapter and in the Critical Issues section below.)

- Access to spawning and rearing grounds
- Spawning habitat, including riffle area and quality and sediment composition
- Rearing habitat, including deep pools, channel complexity (large wood and stream bed substrates), and sediment composition
- Biotic integrity and food source (macroinvertebrate community composition)

CRITICAL ISSUES

This section identifies issues that will be critical to address in order to protect and restore Tryon Creek. It has three subsections:

- Protect Lands and Conserve Natural Resources
- Restore and Improve Habitat and Natural Processes
- Future Analysis—Data Gaps

Protect Lands and Conserve Natural Resources

1. **Protect and conserve undeveloped parcels of lands within the Tryon Creek Watershed.** Larger parcels of lands (greater than 0.5 acre) are critically important for conserving the hydrologic integrity of the basin. In addition to these larger-sized parcel, lands adjacent to the creek, lands with permeable soils, lands with gentle slopes, and lands with topographically low elevations should be conserved (Philip Williams and Associates 1997).

   Prevent any increase in effective impervious area to ensure that the system is not further pushed beyond its limit of resilience (West Multnomah Soil and Water Conservation

District 2003a; (WMSWCD 2003b). Increases in effective impervious area will continue to prevent the watershed from experiencing normative hydrologic processes.

Protect Tryon Creek State Natural Area and other natural areas by enforcing land use codes and regulations. Impacts to riparian and floodplain condition could be minimized by managing trail use and enforcing environmental zone regulations in adjacent upland properties.

2. **Retain existing vegetation** and plant native trees, shrubs, and plants in the riparian corridor, floodplains, and uplands to help stabilize stream banks, increase large woody debris recruitment, and help maintain (or reestablish) floodplain connection and aquatic/land interactions. Plant understocked areas with native conifers to reestablish a mixed conifer/deciduous forest type that is more characteristic of historical vegetation prominence and soil and land type. Conifers (or woody riparian vegetation) provide larger and more prominent (longer-living) woody material than deciduous trees.

3. **Maintain and increase large wood material instream and within the riparian and floodplain areas** while riparian vegetation grows to a size and condition (dead and dying) to be source material. Maintain wood complexity (count, volume, and size) in Tryon 3A, between Nettle Creek and Park Creek. This reach currently contains the best woody structure instream.

   Develop a decision matrix for removing large woody debris out –of –the creek if it becomes a serious threat to properties, infrastructure, etc. Document where, when, and how often woody debris is removed.

4. **Protect processes that create and maintain pool-forming habitats.** Loss of large wood has resulted in lower pool area in the upper basin, shallower pools basinwide (via sediment deposition), and more simplified pool structures.

   Protect and restore pool habitat throughout all of Tryon Creek, particularly in Tryon Creek State Natural Area (Tryon 2, Tryon 3A. and Tryon 3B). Pool area in the natural area is greater than 35 percent; deep channel area is present; and complex pools (with wood) exist. Beaver ponds and other backwater pools and debris jams are common throughout the natural area and should be retained. Lateral scour pools, as well as plunge and backwater pools, provide critical overwintering habitat and summer rearing habitat to fish. Jonathon Rhodes concluded that protecting and restoring pools in Tryon Creek requires avoiding increases in sediment delivery and peak flows; avoiding losses of large wood accumulation and recruitment; and preventing bank instability (WMSWCD 2003a).

5. **Retain stream connectivity to tributaries and other off-channel ponds and wetlands.**
   Tryon 2: Nettle Creek – No known barriers
   Tryon 3A: Red Fox Creek, Palatine Hill, and Park Creek – No known barriers
   Tryon 3B: Two unnamed tributaries – No known barriers
   Tryon 4B: One unnamed tributary – No known barriers

Restore and Improve Habitat and Natural Processes

Based on available data, analysis, and previous evaluations, the following watershed features and processes most significantly impair stream habitat and limit salmonid productivity, abundance, diversity, and distribution within Tryon Creek.

1. Improve fish access into Tryon Creek by retrofitting or replacing key culverts.

Target Reaches:

(1) Tryon 1/Tryon 2: The State Street culvert is considered seasonally passable, but only during opportune high-flow periods (particularly in fall/winter) when flows would allow navigable depth, but stream velocities would not exceed burst swimming speeds and prolonged swimming speeds. If this culvert were navigable by anadromous fish year-round, 2.6 river miles would become accessible (up to SW Boones Ferry Road). Habitat above this culvert, through Tryon Creek State Natural Area, is relatively good and has great potential to support thriving salmonid populations: large wood is present (for cover), spawning and rearing habitat is present (riffles and pools), off-channel refugia can be found in tributaries, and in-channel refugia is present in undercut banks and beaver ponds.

(2) Tryon 3B/Tryon 4A (SW Boones Ferry Road culvert): If this culvert were navigable by fish year-round, 0.6 river mile would become accessible (up to SW Maplecrest Drive) on mainstem Tryon Creek, and 0.1-river mile would become accessible on Arnold Creek. Habitat above this culvert, through Tryon Creek State Natural Area, is moderately good: pool area exists (although shallow), complex pools with wood are present, spawning and rearing habitat is present (riffles gravels), and large wood is present to provide cover. In this reach (and lower Arnold Creek), fish would probably colonize these areas, resulting in increased population productivity.

(3) Arnold 1B (two SW Arnold Street culverts): If both culverts were navigable by fish year-round, an additional 0.4 –river mile would become accessible on Arnold Creek (up to Arnold Cascade, a natural fish barrier). Habitat above these culverts is moderately good: pools are relatively deep, and spawning grounds generally provide adequate gravels with moderate levels of fines. Large wood is severely lacking, stream banks are highly eroded, and undercut banks are few; in-channel refugia may continue to be a limiting factor for fish persistence.

(4a) Tryon 4D/Tryon 4E (Lancaster Drive culvert): If this culvert were navigable by fish year-round, an additional 0.8 –river mile would become accessible on mainstem Tryon Creek. Very little is known about instream habitat potential in Tryon 4D; it is therefore difficult to evaluate potential increases in population productivity if this area were accessible to resident fish. This portion of Tryon Creek lies upstream of Marshall Cascades and would increase the migratory range of resident cutthroat and rainbow trout populations.

(4b) Tryon 4C / Tryon 4D (SW 18th Pace): If this culvert were navigable by fish year-

round, an additional 0.6 –river mile would become accessible on mainstem Tryon Creek. Very little is known about instream habitat potential in Tryon 4D; it is therefore difficult to evaluate potential increases in population productivity if this area were accessible to resident fish. This portion of Tryon Creek lies upstream of Marshall Cascades and would increase the migratory range of resident cutthroat and rainbow trout populations.

(5) Tryon 4A/Tryon 4B (SW Maplecrest Drive culvert): Removing or retrofitting this culvert would provide only an additional 0.1 river mile to resident fish, up to Marshall Cascade. This natural fish barrier is located just upstream of SW Maplecrest Drive. Although this reach undoubtedly could provide critical habitat, its impact on fish productivity is presumed to be relatively low, based on the amount of lineal habitat that would become available.

2. **Maintain and Improve channel condition and habitat by enhancing channel complexity and instream structure.** Maintain and enhance instream channel refugia, particularly beaver ponds (in Tryon Creek State Natural Area), undercut banks, wood, boulders, and deep pools. Habitat diversity, channel stability, and channel complexity (e.g., meanders, stream length) could be aided by adding large wood and boulders instream. Improving channel roughness would not only attenuate erosive flows (i.e., reduce flood flow energy), but would also aid channel-forming processes (habitat formation of pool and riffles) and add instream refugia. Indirect effects that could be realized include increasing stream length (sinuosity), capturing sediments, reclaiming (or enhancing) riparian and floodplain connectivity, and providing substrate (and detritus) for macroinvertebrate production. In addition, large wood instream aids formation of deep pools, backwater pools, and off-channel areas that provide key refugia to fish.

Based on survey data that quantified wood abundance, volume, and size, it appears that small to medium-sized wood pieces are falling into Tryon Creek. Large (key) pieces are rare, and clusters or debris jams have not yet formed to provide critical habitat function. Restoration efforts to increase large woody material instream should focus on large pieces of wood, clustered in jams and/or coincident with boulders.

Target Reaches:
(1) Tryon 1: Additional large woody debris in this entire confluence zone (up to Highway 43) would undoubtedly provide important habitat to resident fish, as well as Willamette Basin salmonids. This reach is 370 meters long and would require at least 25 cubic meters of additional wood per 100 –meters of stream length to reach optimal fish-bearing condition (OWAM DATE?). A recent study shows that small, wood-dominated streams such as Tryon Creek need close to 99 cubic meters for healthy stream function (Fox 2001).

Because Tryon 1 is a part of the lower Willamette floodplain, it does not (and theoretically should not) exhibit traditional characteristics of fish-bearing tributary habitat. This confluence reach experiences variable flows from Tryon Creek perennial flow patterns, as well as Willamette River flows. Habitat functions therefore vary often. However, additional wood in this reach could greatly enhance off-channel refugia for Willamette Basin fish. Fish surveys show that this reach is used year-round by Chinook,

coho, steelhead and cutthroat (ODFW 2001 and 2002). Additional instream structure would undoubtedly provide additional opportunities for rearing and refuge.

(2) Tryon 3B: The upper park area (from Park Creek to Arnold Creek) has low abundance, low volume, and no key pieces of large wood. This reach is approximately 1,320 meters long. At least 29.0 cubic meters of wood per 100 –meters of stream length would need to be added to reach optimal fish-bearing condition (OWAM). A recent study shows that small wood-dominated streams such as Tryon Creek need close to 99 cubic meters for healthy stream function (Fox 2001).

Tryon 3B provides some of the best habitat in Tryon Creek State Natural Area and in the basin. Pools are deep, and riffle gravels are present (although embedded with sediments in the lower two-thirds of the reach). Stream gradient is low (0.6 percent), which should aid large woody debris retention. Bank erosion is particularly high in this segment (66 percent actively eroding banks); any additional instream structure would undoubtedly help protect banks, attenuate flows, and maintain proper riffle/pool formations and seasonal shallow-water floodplain habitat.

Riparian vegetation is generally classified as second growth (15-30 cm dbh). Additional instream woody structure may provide an immediate (or short-term) remedy while surrounding vegetation grows toward long-term source material.

The combination of existing habitat potential and observed habitat impairments (bank erosion, sedimentation, and lack of large woody debris sources) make this reach an ideal priority for large woody debris placement in the Tryon Creek Basin.

(3) Tryon 4A: Additional wood could provide a great initial benefit in Tryon 4A. This reach is 580 meters long and would require at least 26 cubic meters of additional wood per 100 –meters of stream length to reach optimal fish-bearing condition (OWAM). A recent study shows that small, wood-dominated streams such as Tryon Creek need close to 99 cubic meters for healthy stream function (Fox 2001).

Tryon 4A retains marginally good habitat for resident fish. It currently (or at least in 2000) contains some large wood, although the volume is low and there are no large pieces. Bank erosion is high in this reach (58 percent actively eroding banks); any additional instream structure would undoubtedly help protect banks, attenuate flows, and ideally create more pool habitat and deeper pools. Additional wood in this reach could greatly enhance off-channel refugia for resident fish and would undoubtedly provide additional opportunities for rearing and refuge.

Although riparian vegetation is classified as large (30 cm dbh), very little wood is in the stream. This means either that wood is not falling into the creek (i.e., trees are not yet dying) and/or wood that drops into the creek is not retained and is instead quickly passing downstream. A concerted effort to place large wood pieces into this portion of Tryon Creek may provide an immediate (or short-term) remedy to instream structure while surrounding vegetation dies and becomes source material.

3. **Enhance riparian and floodplain connectivity with Tryon Creek**. Strategies to consolidate alluvial materials, grade the creek bed and minimize downcutting, improve channel configuration and increase channel length (i.e., increase sinuosity), reduce flow velocities (by increasing channel roughness), and conserve groundwater storage and hyporheic interaction should be considered.

Basinwide:

- Create small ponds, marshes, and wetlands throughout the watershed to capture and filter urban area runoff. This will help alleviate peak flows, deposit sediments, and absorb water pollutants.

- Where feasible (e.g., public properties), lay back stream banks or raise the stream channel where the channel is incised to facilitate stream bank, riparian, and floodplain interactions.

The *Comprehensive Management Plan for Tryon Creek State Park, Portland, Oregon* describes three additional methods of increasing floodplain interaction in Tryon Creek State Natural Area (PHS, 1997):

- In-channel planting: Woody plants installed into the top of unconsolidated sand and silt bars within the channel would consolidate the alluvial material and reduce flow velocities by increasing channel roughness.

- Channel flow redirection: Engineered (instream) structures (such as logs) could be used to redirect stream flow and to collect sediment. The purpose of redirecting stream flow would be to create meanders and effectively lengthen the stream channel.

- Velocity reduction techniques: Structures such as log jams, boulders, or trees planted on exposed gravel bars could reduce stream velocities within unconstrained portions of Tryon Creek. In addition, dams could be created to restore floodplain functions (similar to what may have occurred with the presence of beavers and their habitats).

Target Reaches:

(1) Tryon 1: For reasons similar to those described for improving channel condition and habitat quality (#2, above), enhancing riparian and floodplain connectivity in the lower confluence area could significantly improve habitat and fish community structure in lower Tryon Creek.

Tryon 1 is part of the lower Willamette floodplain and experiences variable flows throughout different seasons, tidal cycles, and flow management in the upper Willamette and Columbia River Basins. In addition, Tryon Creek's perennial flows prominently affect flow in this confluence region. However, lower Tryon Creek is not well connected to its riparian area or broader floodplain. Bank slopes are steep, the channel is incised, urban development abuts both sides of the creek, and dominant trees are only moderately sized (15-30 cm dbh). Increasing vegetative cover (horizontal and vertical), particularly along the northern banks, would aid flood flow response in the confluence region so

flows are attenuated and banks withstand erosive flows. Improved connectivity could provide additional refugia to salmonids (undercut banks, side channels, and off-channel pools) and enhance aquatic/land interactions (provide opportunities for additional nutrient inputs, sediment filtration, large woody debris inputs, and groundwater storage).

(2) Tryon 3A and Tryon 3B: As in Tryon 1, improved riparian and floodplain connectivity in the lower and middle park reaches could provide additional refugia to salmonids (undercut banks, side channels, off-channel pools, high-flow shallow water habitats) and enhance aquatic/land interactions (provide opportunities for additional nutrient inputs, large woody debris inputs, and groundwater storage). Stream bank erosion is a critical issue in both Tryon 3A and Tryon 3B, particularly from Park Creek upstream to SW Boones Ferry Road.

Tryon 3A and Tryon 3B provide some of the best habitat in the basin: pools are deep, and riffle gravels are present. Stream gradient is generally low (0.6 percent), and riparian vegetation is classified as second-growth deciduous (15-30 cm dbh). Improved riparian and floodplain connectivity would undoubtedly help stabilize banks, attenuate erosive flows, encourage groundwater storage, and ultimately enhance habitat function.

(3) Tryon 4A (upper 40 meters) and Tryon 4B (580 meters): These two reach segments combined comprise approximately 620 –meters of stream length. Based on topography (i.e., VWI), this portion of Tryon Creek lies within a broader valley floor; the creek probably historically meandered through the valley, interacting with its floodplain. This portion of Tryon Creek is currently not well connected to the broader floodplain, as witnessed by erosive banks, scoured channels, lack of pool habitat, and lack of large wood. Habitat is dominated by fast water cascades and rapids formed by boulders. However, stream gradient is moderately low (2.6 - 3.1 percent), and riparian condition is decent, with large hardwoods and a riparian corridor averaging 30 –meters wide.

Improving connectivity would enhance flood flow response by attenuating (or retaining) storm flows. This would affect habitats not only in this reach, but in downstream reaches as well. Other benefits could include additional refugia to resident fish (undercut banks, side channels, and off-channel pools), enhanced pool-forming processes, and enhanced aquatic/land interactions (additional nutrient inputs, large woody debris inputs, and groundwater storage). Although SW Maplecrest Drive impedes fish movement from Tryon 4A up to Tryon 4B, the potential benefits gained by enhancing riparian and floodplain connectivity in this portion of Tryon Creek would probably impact localized fish populations as well as those downstream. If flood flow intensity and velocity are reduced, stream bank erosion may be reduced, and the amount of sediments entering the waterway would also be reduced.

(4) Arnold 1B: The VWI indicates that this portion of Arnold Creek lies within a broader valley floor, indicating potential for broad floodplain interactions (greater than 10 times the active channel width). The riparian corridor is broad (30 meters) relative to this basin and is composed of large conifer and deciduous trees. However, stream banks are severely erosive, wood is lacking, and pool area is low. For reasons similar to those

stated for Tryon 4A and Tryon 4B, enhancing floodplain and riparian connectivity in this reach could provide ecological benefit within the reach, as well as in downstream reaches of Arnold Creek and Tryon Creek.

4. **Minimize sediment loads into Tryon Creek.** Based upon substrate composition, evidence of erosive stream banks, and macroinvertebrate data, it is evident that moderate to high loads of sediment are entering Tryon Creek and settling over (and embedding) stream-bottom substrates. Excessive sediment loads impact all stages of salmonid life history, including spawning, egg incubation, fry emergence, and juvenile rearing. In addition, excessive sediments impact community richness and macroinvertebrate productivity.

   Basinwide:
   - Only the upper 400 meters of Tryon 3B showed good riffle and gravel substrates that were not embedded with fine sediment material. This reach could be critical for providing key fish-spawning habitat.

   - Source control of sediment loads should be a high priority throughout the basin. Any actions to reduce fine sediment loading into the creek would undoubtedly improve aquatic habitat and should be implemented.

5. **Improve stream connectivity to tributaries and other off-channel ponds and wetlands.** Off-channel habitats provide important refugia to fish during significant storm flows and throughout prolonged wet-weather, high-channel flow periods. Access to tributaries should be maintained or barriers should be removed.

   Target Reaches:
   (1) Tryon 4A—Arnold Creek: This reach has six manmade barriers and one natural barrier. The first two (below Arnold Cascade) are at SW Arnold Road at river mile 0.1 and river mile 0.3. The first is considered completely impassable based on slope and drop height. The second is considered seasonally passable, depending on drop height.

   (2) Tryon 4B—two unnamed tributaries: One tributary has a barrier at SW Taylors Ferry Road (river mile 0.2) and is considered impassable based on length.

   (3) Tryon 4D—Quail Creek and Burlingham Creek: Quail Creek has two barriers: SW Lancaster Road at river mile 0.1 (impassable, based on drop height and slope) and SW Quail Post Road at river mile 0.2 (seasonally passable, based on drop height). Burlingham Creek has one barrier at SW Broadleaf Drive at river mile 0.1 (impassable, based on slope).

   (4) Tryon 4E—Falling Creek: Falling Creek has five barriers. The first is at SW 26th (river mile 0.2) and is considered seasonally passable based on drop height. The second is at SW 35th Avenue (river mile 0.9) and is impassable based on length and slope.

Future Analysis – Data Gaps

Macroinvertebrate Monitoring

Macroinvertebrate community composition is a good indicator of water quality and overall stream health. It could be used as a tool to assess the likelihood of habitat rehabilitation success and as an indicator of rehabilitation success.

- Consider the following key questions: Is macroinvertebrate community composition low year-round or only in particular seasons? Is low taxa richness spatially isolated or basinwide?

- Conduct additional macroinvertebrate studies to verify low EPT abundance and taxa richness in Tryon Creek State Natural Area and in other reaches of the Tryon Creek Basin.

Potential classifications are per stream reach, per habitat type—for example: spring riffle sample, summer riffle sample, pool riffle sample, and summer riffle sample.

Water Quality Monitoring

- Adapt water monitoring protocols to target stormwater-derived pollutant loading – e.g., water sample collection during wet weather and dry weather storm flows.

- Expand water quality analysis to include known urban runoff pollutants or defensible surrogates—for example, organic pollution = BOD (e.g., five-day BOD measurement, taken each month for x number of years).

Hydrologic and Hydraulic Analysis

- Further evaluate and model hydrologic process (stream power) and its impacts on riparian and floodplain connectivity to better assess and inform restoration efforts and ensure their success.

- Quantify the proportion of stream volume derived from runoff coming from large impervious surfaces (e.g., private stormwater outlets). This analysis could also inform water quality monitoring and source control.

- Evaluate the benefit of creating retarding basins and wetlands designed for hydrologic control and pollution abatement?

Sediment Loading and Source Analysis

- Further investigate point and non-point source sediment inputs (pubic and private stormwater outfalls, bank erosion, overland flow, etc.). Analysis should include quantity, timing of delivery, and frequency.

Large Wood Dynamics

- Evaluate dynamics affecting large wood retention instream, specifically considering flow regimes and effects on movement of wood.

Fish Surveys

- Expand fish surveys to include tributary reaches that probably support spawning and rearing

(Arnold and Falling Creeks).

- Evaluate overwintering use of tributaries by fish.