BUREAU OF ENVIRONMENTAL SERVICES • CITY OF PORTLAND

Portland Area Watershed Monitoring and Assessment Program

Executive Summary—Findings from the First Two Years

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Nick Fish, Commissioner
Michael Jordan, Director

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EXECUTIVE SUMMARY

Portland Area Watershed Monitoring and Assessment Program

Findings from the First Two Years

PAWMAP gathers and analyzes data from these Portland-area watersheds:

- Columbia Slough
- Fanno Creek
- Johnson Creek
- Tryon Creek
- Tualatin Streams
- Willamette Streams (west-side tributaries to the Willamette River)

Many different types of streams and rivers flow in and through Portland. The city is located at the joining of two of the West's largest rivers—the snowmelt-driven Columbia and the rain-fed Willamette.

Local streams include the low gradient, tidally-influenced Columbia Slough, moderate gradient Johnson Creek, and small, higher gradient streams draining the West Hills. For a 150-square mile area, Portland's watersheds are as diverse an assemblage of flowing waters as can be found.

This report summarizes the results from the first two years (2010-11 and 2011-12) of a monitoring program designed to guide the City of Portland in managing these diverse watersheds. The Portland Area Watershed Monitoring and Assessment Program (PAWMAP) measures water quality, habitat, and biological conditions in Portland's watersheds to assess their health and identify key threats. PAWMAP supports the implementation of the Portland Watershed Management Plan by supplying key data to guide actions and evaluate the success of those actions. For more about the monitoring program design and background, see **www.portlandoregon.gov/bes/PAWMAP**.

At the end of the first two years of monitoring, the program has sampled 64 of the 128 stations that will be sampled every four years. The results from the second year were largely consistent with the findings from the first year. The full PAWMAP 2-Year Report is available upon request. A more robust report of findings and recommended management actions will be available when data from the full four-year monitoring cycle is analyzed, and in future reports when upland land use and other data are considered.

What We Measure

PHYSICAL HABITAT

- Stream substrate
- Large wood
- Bank condition
- Riparian vegetation and shading
- Human disturbance
- Gradient, habitat type, depth, etc.

WATER QUALITY

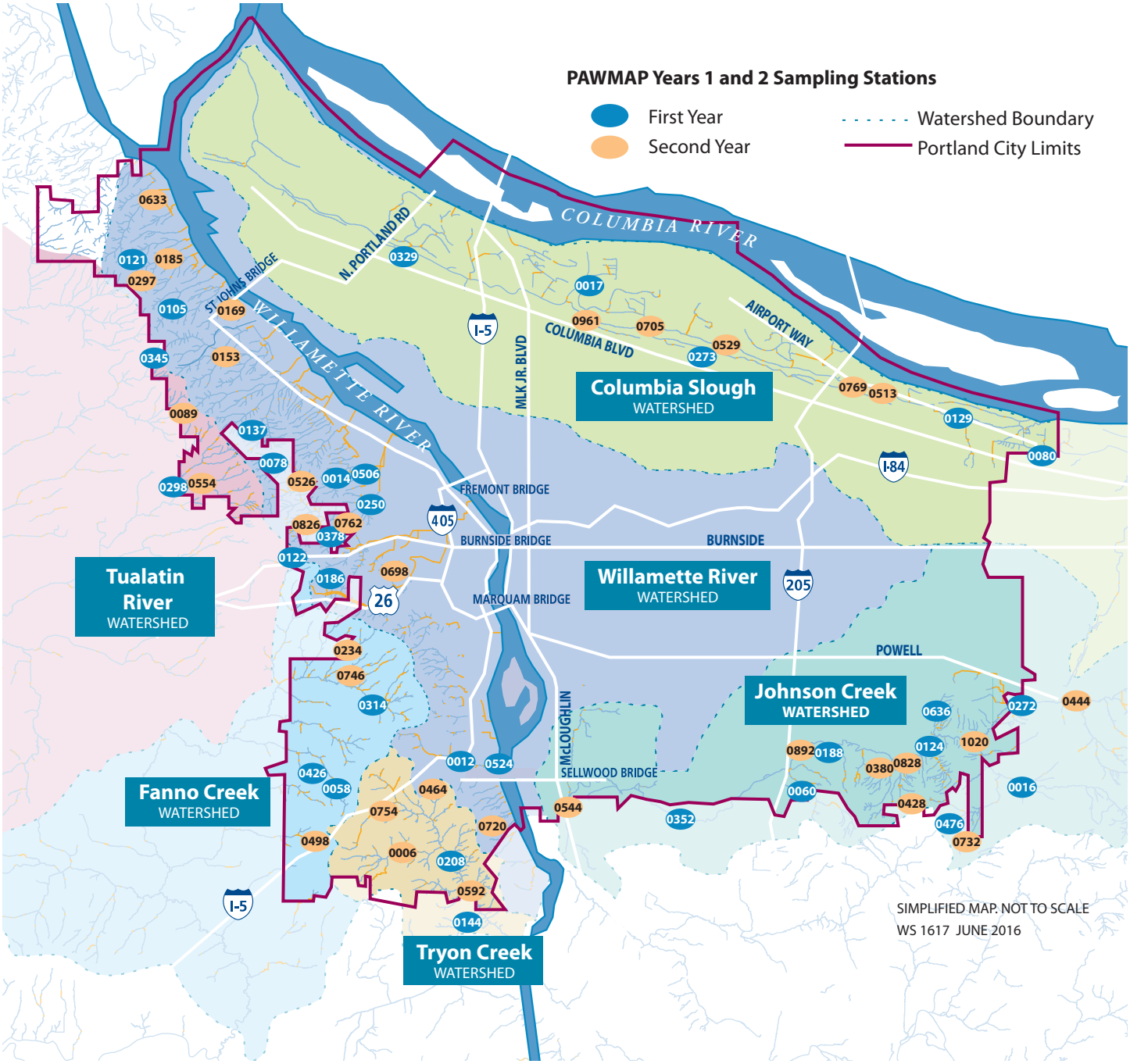
- Temperature
- Total suspended solids
- Dissolved oxygen
- *E. coli*
- Nutrients (e.g., phosphorus)
- Metals (e.g., copper)
- Other conventional water quality indicators (hardness, pH, etc.)

BIOLOGICAL COMMUNITIES

- Fish
- Birds
- Macroinvertebrates (e.g., aquatic insects)

Sampling Sites

In the first sampling season (July 2010 – June 2011) BES Field Operations staff monitored 20 sites along perennial streams and 12 sites along intermittent streams. An additional 20 perennial and 12 intermittent sites were monitored in the second sampling season (July 2011-June 2012).



Key citywide findings include:

- Issues with stream substrate (inadequate gravel or excessive fine sediment at riffle sites, which impairs habitat value) do not appear widespread, although the report identifies a few riffle sites where high percentages of fine sediments might warrant further investigation of possible sediment sources.
- In contrast, inadequate volumes of large wood is a widespread problem across Portland watersheds, with most sites having less than half the volume of wood considered "undesirable" and one-third the level considered "desirable" in the Oregon Plan for Salmon & Watersheds. The data suggest that this is due to a long legacy of removing wood from streams and the relatively young age of riparian forests in Portland, and that adding wood to streams will be necessary to restore stream functions until existing riparian forests mature and provide wood naturally.

Inadequate volumes of large wood is a widespread problem across Portland's watersheds.

- High stream temperature and *E. coli* levels were the two water quality issues observed most consistently across Portland watersheds. Stream temperatures were highest in the Columbia Slough and Johnson Creek. The Columbia Slough historically had higher stream temperatures than other Portland streams because of its configuration (low gradient, slow flows and wide channels). Human alterations that converted this massive floodplain wetland to a channelized, pumped drainage system with limited riparian vegetation have clearly altered fundamental components of the hydrology and habitat, and further exacerbated problems with stream temperatures. High temperatures in Johnson Creek are a priority concern because of the importance of this watershed in providing local spawning and rearing habitat for salmon. Approximately 15% of the *E. coli* samples across the city exceeded the water quality criterion, with concentrations being highest during storms and in the summer and lowest in the winter. *E. coli* tended to be highest in Tryon and Johnson creeks and lowest by far in the Willamette Streams.
- Metals infrequently exceeded state water quality criteria. Total copper was the only metal to exceed criteria over the first two years, yet even for this metal values above the criterion were uncommon: only 10 of the 272 copper samples were above the criterion over the first two years, and these all occurred during storms.

However, metals are valuable water quality indicators not only because they have direct toxic effects (which are assessed by comparison to the criteria), but also because they may be indicators of areas where human activities introduce toxic pollutants into streams. An Urban Metal Index was developed to assess areas where inputs of human pollutants are most likely to impact streams and where source evaluation and control measures might be considered. The index confirmed that highways that drain to small streams produce high pollutant concentrations in streams compared to other sites across the city, and would be possible priorities for stormwater evaluation and treatment.

- Tryon Creek and the Willamette Streams had the healthiest macroinvertebrate communities (aquatic insects) across city streams. The highest Observed/Expected ratio (an index of macroinvertebrate community health) detected from the PAWMAP data was in Balch Creek. This was the only site in the first two years of monitoring that was above Oregon Department of Environmental Quality (DEQ) criterion for a "most impacted" macroinvertebrate community in Western Oregon. The Columbia Slough had the lowest metrics of all the watersheds for macroinvertebrates, but most metrics used to evaluate the health of macroinvertebrate communities are developed for pool-riffle stream systems, and are not as effective in low gradient, slow flowing systems like the Columbia Slough.
- Portland streams still provide valuable habitat for native fish species. Nine of the ten most commonly encountered fish species were native, and two of the five most commonly encountered species were salmonids (cutthroat trout and steelhead/rainbow trout). However, scores using a regional Index of Biotic Integrity (IBI) in Portland streams were poor due to the low abundance and diversity of native species at any given site. Comparison of IBI scores to stream accessibility and culvert locations indicated that culverts have an extreme effect on the health of fish communities. Over the first two years, more than 45% of the sites above impassable culverts had an IBI score of zero because zero fish were present. In contrast, none of the sites above partially or fully accessible reaches ever had zero fish.

Cutthroat trout are one of five most commonly encountered species in Portland watersheds.

- Riparian bird communities were also dominated by native species: only one of the 25 most commonly encountered species was non-native (European starling). At-risk and special status species were found in all watersheds. Bird Integrity Index (BII) scores were highest in the Willamette Streams and lowest in the Columbia Slough and Fanno Creek. The BII scores were strongly correlated with the amount of tree canopy in the buffer zone around the sampling site.

The Columbia Slough at Whitaker Slough (site 0273) is an example of a "boatable" survey site, where deep water does not allow field staff to traverse the stream safely on foot and sampling must be done from a boat.

WATERSHED: COLUMBIA SLOUGH

This Columbia Slough site (0129) is an example of a typical slough site. The slough is a naturally low-gradient, slow-flowing system which is very different from the other streams in Portland.

The Columbia Slough begins at Fairview Lake and meanders west for 19 miles to Kelley Point Park where it empties into the Willamette River. Historically, the Columbia Slough waterway was a low-gradient collection of wetlands, lakes and streams that formed the Columbia and Willamette River floodplains. The slough is Portland's most altered watershed and waterway. Over the years, the area was heavily altered to accommodate industry, transportation and agriculture. Beginning in 1918, levees were built to provide flood protection. Wetlands and side channels were drained and filled to allow for development. The waterway was channelized, and dozens of streams were filled or diverted to underground pipes.

Field staff measuring a common carp, a non-native fish species common in the Columbia Slough. Non-native fish are abundant in the Columbia Slough. While most Portland streams typically have less than 1% non-native fish comprising their fish communities, the Columbia Slough has well over 20% non-native fish in its fish communities.

Data summary—Columbia Slough

HABITAT

WOOD

Like most Portland watersheds, large wood is very scarce and well below desired levels in the Columbia Slough, in part because of limited riparian vegetation and the need to maintain flood control capacity. Only one of the ten stations sampled in the first two years even had half the level considered undesirable for Western Oregon streams.

SUBSTRATE

Columbia Slough substrates are naturally fine grained due to its low gradient, slow flows and floodplain deposits.

RIPARIAN CONDITIONS

The levee system precludes the presence of riparian vegetation along many parts of the slough, and this is reflected in percentages of riparian canopy far below the other watersheds. There were three sites in Middle and Upper Slough (sites 0080, 0705 and 0961) with somewhat higher proportions of large riparian canopy (>20%) when compared to other slough sites.

WATER QUALITY

TEMPERATURE[1]

The Columbia Slough had some of the highest temperatures of Portland streams. Sites on the mainstem – particularly the lower mainstem – had the hottest temperatures in the watershed, whereas sites in areas with high groundwater inputs such as Whitaker Slough were considerably cooler.

EUTROPHICATION

The Columbia Slough is one of the few watersheds in which signs of eutrophication – excessive nutrients that lead to overproduction of algae and low dissolved oxygen – are present. The slough is naturally susceptible due to low gradient, slow flows and long residence times, but human alterations including removal of wetlands that process nutrients, segmentation by culverts, and discharges that increase nutrient loads have made the problem worse.

TOTAL SUSPENDED SOLIDS

The slough had the second highest average concentration of suspended solids of all the Portland watersheds for seasonal samples over the first two years, but the lowest average storm concentrations because of the slough's lower stream gradients and less flashy flows.

E. coli

The slough had the second lowest overall geometric mean *E. coli* concentration (59 MPN), and the second lowest percentage of samples above the acute (14%), and the chronic (26%) criteria in city streams over the first two years.

METALS

The slough had moderate levels in comparison to other city watersheds for zinc, and lead, and low values for copper and mercury. The slough was the only watershed that did not have at least one exceedance of the copper criterion during storm flows over the first two years.

PORTLAND WATER QUALITY INDEX

The Columbia Slough had a moderate Portland Water Quality Index (PWQI) score of 44 over the first two years in comparison to city watershed scores that ranged from a low of 24 to a high of 52. This appears to be driven by the highest (=best) score for mercury and a comparatively good score for dissolved copper.

BIOLOGICAL

AQUATIC INSECTS

The Columbia Slough had the lowest aquatic macroinvertebrate community scores of all the city streams. However, most metrics used to evaluate the health of macroinvertebrate communities are developed for pool-riffle stream systems. They are not as effective in addressing low gradient systems like the slough. Poor aquatic macroinvertebrate communities in the slough are likely a result of two factors: macroinvertebrate metrics are not designed for slough systems, and watershed conditions are also poor.

FISH

Non-native fish species are a significant component of fish communities in the slough (~ 20% of captured fish over the first two years) whereas they are a minor component in other Portland watersheds. While the most abundant species was the native three-spined stickleback, five of the ten most abundant species were non-native.

RIPARIAN BIRDS

Riparian bird communities typically had low integrity in the slough compared to other city watersheds. The Columbia Slough had the highest number of non-native birds, lowest number of special status birds and the lowest riparian bird integrity scores overall for the first two years of monitoring. However, the slough was one of only two watersheds in which willow flycatchers – an At Risk species – were present. The highest slough Bird Integrity Index score was from the Big Four Corners Natural Area (0080).

1 Note: Because of the time required to secure access to sample stream reaches through private property, temperature probes were often not installed until mid- late-summer. This will be an issue in sampling the four rotating panels for the first time, but since access permissions have now been acquired, will not be an issue for the second and subsequent rounds of sampling each panel.

Fanno Creek sampling location #0314 is adjacent to the Beaverton-Hillsdale Highway. Culverts are common along urban streams and have major impacts on stream health. They can limit the ability of fish to move between different habitats seasonally, impact water quality, and alter natural stream flows.

WATERSHED: FANNO CREEK

Fanno Creek is one of a series of streams that drain the west slope of the Tualatin Mountains to the Tualatin River, then flow to the Willamette River above Willamette Falls. As part of the Tualatin River Basin, Fanno Creek drains about 20,500 acres. Of that land area, 4,528 acres are within the City of Portland. Land use in the Fanno Creek Watershed is dominated by residential, industrial and commercial activities.

Riparian vegetation at sampling location #0234

Water quality is sampled quarterly on the Fanno mainstem to capture seasonal changes, and once during storm flows at each site. Stormwater can be a major threat to the health of urban watersheds, and sampling during storm flows helps to understand how stormwater affects stream health.

Data summary—Fanno Creek

HABITAT

WOOD

Like most Portland watersheds, the volume of large wood is very low and well below desired levels in Fanno Creek, in part because of limited riparian vegetation. A station in Woods Creek had the highest wood volume in Fanno Creek, and was the only station in the watershed that had even half the level of wood considered desirable for Western Oregon streams.

SUBSTRATE

Of the six sites sampled in the first two years, one was a naturally fine-grained site with low gradient and few riffles. A riffle site in Woods Creek (0058) met both the fines and gravel benchmarks, though it was close to exceeding the fines benchmark. Another site in Woods Creek (0426) met benchmarks for gravel but had excessive levels of fines well above the benchmark, while a tributary to Fanno mainstem had adequate amounts of gravel that met the benchmark but levels of fines that were too high. A riffle site in South Ash had low levels of fines that met the benchmark but inadequate amounts of gravel.

RIPARIAN CONDITIONS

The six sites sampled in Fanno Creek over the first two years clustered towards the middle of the range of large riparian canopy cover among citywide sites, with neither notably high nor low values. However, Fanno Creek had the lowest median percent cover compared to other west side streams.

WATER QUALITY

TEMPERATURE[1]

Temperatures at the Fanno mainstem site (0314) were among the highest observed across the city at any station over the first two years. Temperatures at Woods Creek (0058), South Ash Creek (0498) and two tributaries to Fanno Mainstem (0234 and 0746) were much cooler and only exceeded the summer 18°C standard for very short periods of a few days in August.

EUTROPHICATION

While signs of eutrophication in Fanno Creek are less than in the Columbia Slough (chlorophyll a was never detected in Fanno), nutrients and eutrophication are still a concern in this watershed because 1) it drains to the Tualatin River, where eutrophication is a problem being addressed through regulatory limits, and 2) it was one of the few watersheds where ammonia was detected regularly.

TOTAL SUSPENDED SOLIDS

Fanno Creek had the lowest seasonal mean and second lowest storm mean for total suspended solids in city watersheds over the first two years of sampling.

E. coli

Fanno Creek had a moderate geometric mean *E. coli* concentration (81 MPN) compared to other city watersheds, with 18% of samples above the acute and 46% above the chronic criteria.

METALS

In comparison to other city watersheds the median value for Fanno Creek was high for copper, lead and zinc, and low for mercury in the first two years of sampling.

PORTLAND WATER QUALITY INDEX

Fanno Creek had a Portland Water Quality Index score of 37, which was the second lowest of city watershed scores that ranged from a low of 24 to a high of 52. Fanno had comparatively poor scores for dissolved copper and *E. coli* within the index, but its index score was raised by the fact that it had the second best score for mercury.

BIOLOGICAL

AQUATIC INSECTS

Five stations were sampled for aquatic macroinvertebrates in the first two years. Results from Woods Creek and a station on a tributary to Fanno mainstem (0234) were moderate when compared to other streams across the city, while the results from Fanno mainstem, South Ash and another tributary to Fanno mainstem (0746) were very poor in comparison to other city stream stations. The macroinvertebrate community score at the Fanno mainstem site was the third lowest score of the 40 sites sampled citywide over the first two years.

FISH

Fish communities were poor at the stations sampled for fish in Fanno Creek in the first two years. Out of 11 surveys at six sites, eight surveys did not capture any fish. Only a single mosquitofish – a non-native species – was captured in summer in three surveys at a Fanno mainstem site. The most encouraging results were obtained at site 0746 (a tributary to Fanno mainstem) where three cutthroat were captured in August and a single cutthroat was captured in May.

RIPARIAN BIRDS

All the bird species observed at the six stations sampled in the first two years were native. However, Fanno Creek had the lowest mean number of Special Status Species of all the city watersheds, and the second lowest average Bird Integrity Index scores of all the city watersheds.

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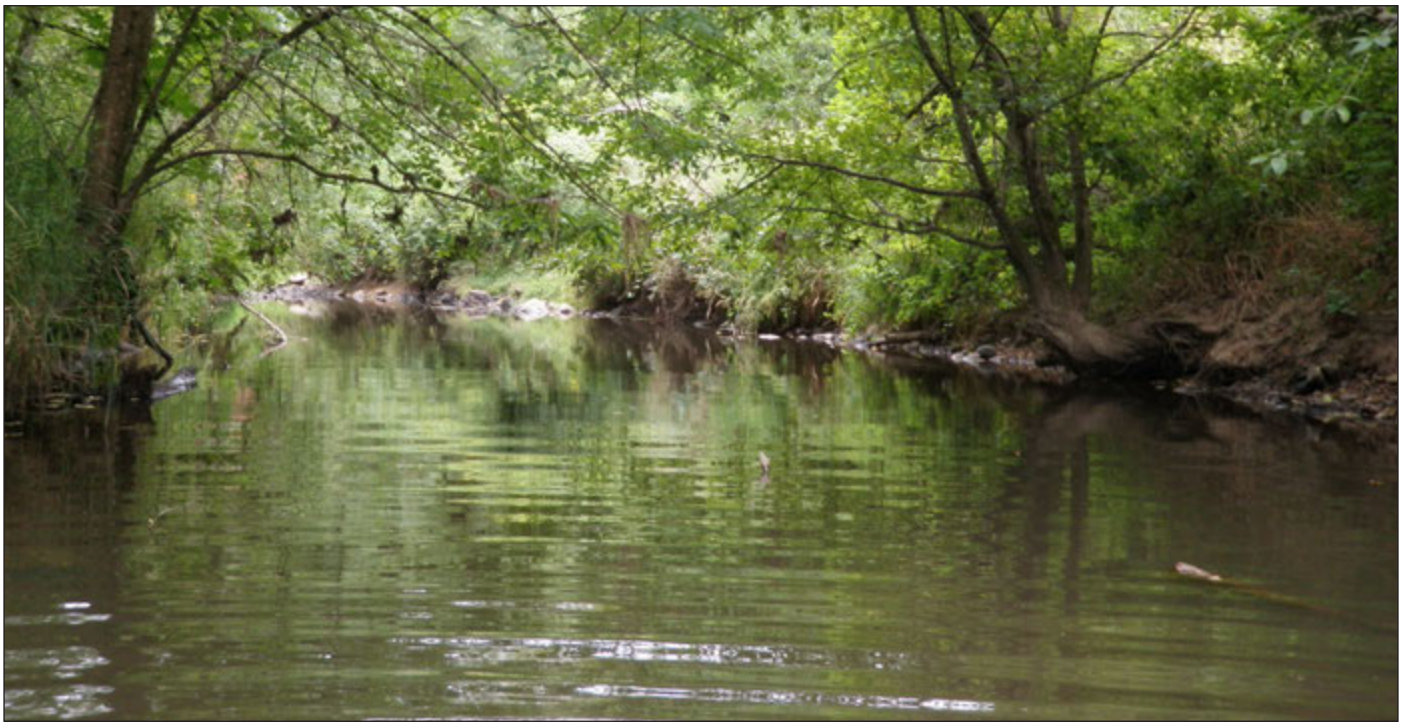

Sampling site #0124 is in middle Johnson Creek and shows trees in the riparian area along the banks. The riparian vegetation shades streams and moderates stream temperatures, controls erosion, and provides a source of organic matter and insects that support aquatic food chains.

WATERSHED: JOHNSON CREEK

In the 1930s, the Work Progress Administration (WPA), deepened, straightened, and armored the creek by installing large basalt rock lining along its banks and streambed. The WPA work eliminated aquatic habitat such as riffles, pools, and large wood and impaired the stream's ability to migrate and recruit gravels and large wood. It also disconnected the stream from its floodplain which previously absorbed, stored, and conveyed floodwater.

Johnson Creek originates in the hills east of Portland and flows westward approximately 25 miles to its confluence with the Willamette River. The stream receives water from several major tributaries, including Crystal Springs Creek, Kelley Creek, Mitchell Creek, Butler Creek, Hogan Creek, Sunshine Creek and Badger Creek. Land use in the 34,310-acre watershed ranges from heavily developed urban and industrial areas to rural farm and nursery lands.

Crews sample at location #0352 in the lower mainstem of Johnson Creek.

During summer most Portland streams exceed temperature standards. Fish communities often cannot be sampled during these low flow periods if species listed under the Endangered Species Act (e.g., salmon) are present, because high temperatures and stress from sampling may be harmful to these sensitive species.

Data summary—Johnson Creek

HABITAT

WOOD

One site in Johnson Creek – near a restoration site in Kelley Creek – was just at the benchmark level for wood. Three stations in Kelley Creek and Middle Johnson were below this level but above the undesirable level. The remaining 12 sites were well below the undesirable level.

SUBSTRATE

Of the 16 sites sampled in Johnson Creek over the first two years, 12 had less than 50% riffle habitat and were not compared to substrate benchmarks. One site in Middle Johnson (0828) met benchmarks for both gravels and fines. One site in Veterans met the gravel benchmark but just exceeded the fine benchmark. Two sites in Lower Johnson (0352 and 0544) had very low levels of fine substrates but inadequate amounts of gravel.

RIPARIAN CONDITIONS

Riparian canopy varied widely in the Johnson Creek stations sampled in the first two years, and the overall average for the watershed was towards the low end for city watershed averages. More vegetated reaches (> 50% riparian cover) included reaches in Veterans Creek, Mitchell Creek and a tributary to Middle Johnson.

WATER QUALITY

TEMPERATURE[1]

Temperatures in Johnson Creek were high in comparison to other city streams except the Columbia Slough, and a particular concern given the importance of this stream for local salmon spawning and rearing. Temperatures were highest on the mainstem stations in Middle and Lower Johnson. Stations in tributaries – Kelley and Veterans creeks – were typically lower and only exceeded summer rearing standards for a few days.

EUTROPHICATION

The first two years of data suggest that eutrophication is not a major issue in Johnson Creek.

TOTAL SUSPENDED SOLIDS

Johnson Creek had low seasonal and moderate storm TSS values in comparison to other city watersheds, although high values were occasionally observed over the first two years. One station in Middle Johnson (0428) had the sixth highest seasonal mean citywide, and was considerably higher than other Johnson Creek sites.

E. coli

Johnson Creek had a geometric mean *E. coli* value of 116 MPN, behind Tualatin and Tryon, with 16% of samples above the acute and 53% above the chronic criteria.

METALS

In comparison to other watersheds, median levels for Johnson Creek were low for copper, lead and zinc and moderate for mercury over the first two years.

PORTLAND WATER QUALITY INDEX

Johnson Creek had a Portland Water Quality Index score of 42 over the first two years, which was moderate in comparison to other city watershed scores that ranged from a low of 24 to a high of 52. Johnson Creek had a good index score for dissolved copper, but was moderate in comparison to other city watersheds for all other variables included in the index.

BIOLOGICAL

AQUATIC INSECTS

Stations in Johnson Creek tended to be in the middle of aquatic macroinvertebrate community scores across the city. The best of the 11 stations sampled in the first two years were in Veterans Creek (0060) and Middle Johnson (0444), while the worst score in the watershed was in Middle Johnson (0124).

FISH

Johnson Creek had the least degraded fish communities of all city watersheds. Johnson Creek had seven of the ten best Index of Biotic Integrity scores across city streams. The vast majority of fish (>99%) were native. Johnson Creek also had the most salmonids. The most commonly encountered salmonids were rainbow/steelhead – 28 were captured over five sites on eight different dates. Kelley Creek (at a restoration site) had the most rainbow/steelhead, and was one of three sites where Chinook and coho were captured over the first two years. A site on Middle Johnson (0828) was notable for having three of the four Chinook captured in Johnson. However, two different sites in Veterans Creek had no fish in spite of good habitat, likely due to an impassable culvert at its mouth.

RIPARIAN BIRDS

Bird Integrity Index scores varied widely in Johnson Creek, from the poorest score across the entire city over the first two years at a site in Lower Johnson, to relatively good scores at Powell Butte and Mitchell Creek. In addition, about half the species observed at the Kelley Creek station were non-native, whereas non-natives were in low numbers at other Johnson Creek sites.

1 Because of the time required to secure access to sample stream reaches through private property, temperature probes were often not installed until mid- late-summer. This will be an issue in sampling the four rotating panels for the first time, but since access permissions have been acquired, will not be an issue for the second and subsequent rounds of sampling each panel.

Tryon Creek sampling location #0208, at the restoration project near 4th Ave. The creek had eroded its banks and exposed a sewer pipe. The restoration project protected and stabilized the sewer pipe, and enhanced aquatic habitat by redirecting the creek away from the pipe, adding large wood, creating pool and riffle habitats, and revegetating riparian and floodplain areas.

WATERSHED: TRYON CREEK

Sampling site 0144 is at Nettle Creek, a small tributary that flows from Lake Oswego into the lower mainstem of Tryon in the Tryon Creek State Natural Area.

Tryon Creek is a seven-mile long free-flowing stream that drains a roughly 4,200-acre watershed. The stream flows in a southeasterly direction from Mt. Sylvania in the Southwest Hills of Portland to the Willamette River near Lake Oswego. It is primarily a moderate gradient stream with steep slopes, which results in a high frequency of landslides and erosion. The upper watershed has suffered impacts commonly associated with urban development, including increased stream flow velocities and volumes following storm events, with subsequent stream bank erosion.

A Pacific giant salamander, found at Tryon Creek sampling location #0208, is an amphibian that is often present in Pacific Northwest streams when habitat conditions are healthy.

Data summary—Tryon Creek

HABITAT

WOOD

Two sites on Tryon Creek, both in the Tryon Creek State Natural Area, met benchmarks for large wood. One was at a restoration project below 4th Avenue. The other four stations sampled in the first two years were well below a quarter of the level considered undesirable in the Oregon Plan for Salmon & Watersheds.

SUBSTRATE

Of the six sites sampled in the first two years, two were naturally fine-grained sites with low gradient and few riffles. Two sites with riffles – in Middle Tryon and Falling Creek – met desirable benchmarks for both gravels and fines. Two riffle sites in Nettle and the State Natural Area had inadequate gravel levels below the desirable benchmark. The Nettle site had somewhat high fines, and the Natural Area site had excessive fines well above the undesirable benchmark.

RIPARIAN CONDITIONS

Tryon Creek had consistently high amounts of riparian cover compared to citywide streams, and the highest mean percent riparian cover of all the city watersheds in the first two years of sampling.

WATER QUALITY

TEMPERATURE[1]

Tryon Creek generally had cooler temperatures compared to other city streams. The two stations sampled in the first year had a small peak in temperature in late July and then reached their highest values in mid-late August. The mainstem site exceeded summer rearing standards for short times during both peaks. The station in Nettle only exceeded during the second peak for three days. Temperatures in the second year appeared cooler and although there were a number of incomplete records, no exceedances of the temperature standard were observed in the second year in Tryon.

EUTROPHICATION

The first two years of data suggest that eutrophication is not a major issue in Tryon Creek.

TOTAL SUSPENDED SOLIDS

Tryon Creek had moderate seasonal and storm values for suspended solids in comparison to other watersheds. Tryon did have one site with the fourth highest seasonal mean TSS (Middle Tryon 0464) over the first two years.

E. coli

Tryon Creek had the second highest geometric mean concentration of *E. coli* (124 MPN) of Portland watersheds, and the second highest proportion of samples above the acute (23%) and chronic (50%) criteria in the first two years.

METALS

In comparison to other watersheds, median levels for Tryon Creek were moderate for copper, lead and mercury and high for zinc over the first two years of sampling.

PORTLAND WATER QUALITY INDEX

Tryon Creek had the highest (=best) Portland Water Quality Index score of 52 in the city streams sampled over the first two years. Tryon had moderate to good scores for most of the variables contained in the index.

BIOLOGICAL

AQUATIC INSECTS

Tryon Creek had the highest mean macroinvertebrate community scores at the four sites sampled for macroinvertebrates the first two years. The station in Falling Creek had a noticeably lower macroinvertebrate community score (0.43) than three sites in the well-forested State Park and Nettle Creek stations (which ranged from 0.60 – 0.74).

FISH

Tryon Creek had less degraded fish communities at the three sites sampled within the State Natural Area over the first two years compared to other citywide streams, but no fish in the Falling Creek site. No non-native fish were captured at any of the four sites. Reticulate sculpin dominated fish communities (90% of individuals captured). Only a single coho and two rainbow/steelhead trout were captured, but 41 cutthroat trout were captured at three sites over the nine surveys.

RIPARIAN BIRDS

The Bird Integrity Index scores varied widely at the six sites sampled over the first two years, with poorer scores at Middle Tryon, Falling and Arnold and better scores at Nettle Creek and the two state park sites. The only non-native bird species detected in Tryon Creek was the European starling, which comprised only two of the 144 birds detected over the first two years.

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Identifying and measuring fish at Cedar Mill Creek, which flows westward from the West Hills and eventually to the Tualatin River. The number, size and condition of each fish species is recorded to provide information on the health of fish communities in Portland streams. Fish are a barometer of the overall ecological health of a stream.

WATERSHED: TUALATIN RIVER

Over the crest of the West Hills (also known as the Tualatin Mountains) is a long range of streams that drain to the Tualatin River, then flow to the Willamette River above Willamette Falls. Some of these streams, such as Bronson and Cedar Mill creeks, start within the City of Portland's boundaries. This is also referred to as the Skyline West watershed area. Land use around these streams ranges widely from well-forested natural areas to residential and transportation uses. Fanno Creek also drains to the Tualatin River, but is characterized and monitored separately since such a large portion of its watershed is within Portland.

The Cedar Mill Creek site shows wood and boulders piling up at a culvert. Culverts often limit the passage of large wood and fish and wildlife and degrade stream flow and water quality, which adversely affects stream health.

Data summary—Tualatin River

HABITAT

WOOD

The five stations sampled in the Tualatin Streams in the first two years were all less than half the level considered undesirable for Western Oregon streams.

SUBSTRATE

In the first two years, three of the five sites sampled had >50% riffle habitat and could be compared to substrate benchmarks. Although Bronson and Golf creeks both met the benchmark for gravel, they greatly exceeded the undesirable level for fines. A site in Cedar Mill Creek (0554) met benchmarks for both gravels and fines.

RIPARIAN CONDITIONS

The Tualatin Streams had a wide range in riparian canopy cover at the five sites sampled in the first two years. Sites high in riparian canopy cover tend to be along the ridge and near the Forest Park boundary, whereas sites lower in canopy cover tended to be lower on the west slope.

WATER QUALITY

TEMPERATURE[1]

The Cedar Mill Creek site (0298) just below Cedar Mill Pond was one of the warmest stations observed in city streams over the first two years. It reached seven-day average daily maximum temperatures over 24°C in late July and middle August, and exceeded the 18°C temperature standard from the start of their deployment in early July until early September. Sites at Golf Creek and higher up in Cedar Mill (0554) suggest that temperatures this high are atypical for Tualatin Streams and likely due to thermal loading from the Cedar Mill Pond.

EUTROPHICATION

While signs of eutrophication in the Tualatin Streams are less than in the Columbia Slough (chlorophyll a was only detected three times out of 34 samples), nutrients and eutrophication are still a concern in this watershed because 1) these streams drain to the Tualatin River, where eutrophication is a problem being addressed through TMDLs, and 2) it was one of the few watersheds where ammonia was detected regularly. There are also signs that eutrophication may be an issue at the site just below Cedar Mill Pond.

TOTAL SUSPENDED SOLIDS

The Tualatin Streams had the highest mean level of suspended solids for the seasonal data and the second highest mean for the storm data over the first two years. The site at Bronson (0345) was the third highest seasonal mean citywide, and considerably higher than the seasonal mean at other sites within the Tualatin watershed.

E. coli

The Tualatin Streams had the highest geometric mean *E. coli* concentration of all city watersheds sampled over the first two years (130 MPN, just above the chronic criterion), with the highest proportion of samples above the acute criterion (33%) and 48% above the chronic criterion.

METALS

The Tualatin River tributaries had high median values in all metals in comparison to other city watersheds sampled over first two years.

PORTLAND WATER QUALITY INDEX

The Tualatin Streams had the lowest Portland Water Quality Index score – 24 – which was well below all the other watershed scores which ranged from 37 – 52. The score is low because of the lowest score for mercury (which had a strong influence on PWQI scores) and the lowest scores for *E. coli*, total phosphorus and total suspended solids.

BIOLOGICAL

AQUATIC INSECTS

Three stations were sampled for aquatic macroinvertebrates in Tualatin Streams in the first two years. The station in Golf Creek was in the upper 75th percentile of stations sampled across the city, while the two stations in Cedar Mill were in the lower 40%.

FISH

The Tualatin tributaries were sampled once at Golf Creek (no fish were captured), and three times at Cedar Mill Creek. Two nonnative fish (fathead minnows) were captured in one survey, but they were well outnumbered by native reticulate sculpin and redside shiners.

RIPARIAN BIRDS

The Tualatin Streams ranged widely in Bird Integrity Index scores at the five sites sampled over the first two years. A site at Cedar Mill had very low scores, while the site at Bronson Creek had the second highest BII over the first two years. Bronson Creek also had a relatively high number of Special Status species (6).

1 Because of the time required to secure access to sample stream reaches through private property, temperature probes were often not installed until mid- late-summer. This will be an issue in sampling the four rotating panels for the first time, but since access permissions have been acquired, will not be an issue for the second and subsequent rounds of sampling each panel.

Field crew gather information at sampling site #0524. Information on instream habitat and riparian conditions helps identify the major factors threatening stream health.

WATERSHED: WILLAMETTE STREAMS

Stephens Creek sampling location #0012 shows a range of sizes in stream substrate. Substrate – the gravel, cobbles, sand and organic matter that form the stream bottom – are very important to stream health.

The Willamette Streams are a diverse set of streams that range from the highly impacted and urbanized Stephens Creek to the well-vegetated and protected streams within Forest Park. These small watersheds all drain the West Hills before discharging to the Willamette River mainstem. They are therefore grouped together into a "watershed" called the Willamette Streams, a sub-area of Portland's Willamette River Watershed. Because of their diverse land uses and characteristics, these streams typically had wide ranges in watershed metrics.

Saltzman Creek at sampling site #0137 shows mature vegetation present at many Forest Park streams.

Data summary—Willamette Streams

HABITAT

WOOD

Willamette Streams was one of only two watersheds with any sites above benchmarks for large wood in the first two years. Four of 21 sites were above benchmark levels, within the River View Natural Area and Forest Park. However, two-thirds of the sites were below half the level considered undesirable for Western Oregon streams.

SUBSTRATE

In the first two years, eight Willamette Streams stations had riffles over more than half their reaches and so could be evaluated against the substrate benchmark. The site in upper Stephens Creek below I-5 (0012) had by far the most degraded substrate of any riffle site sampled across the city. The site at the mouth of Stephens was just below the benchmark for gravels but exceeded the benchmark for fines. It is possible that some of this is due to natural conditions associated with deposition from the Willamette River. Sites in Linnton (0633) and Balch (0526) met both gravel and fine benchmarks. Sites in Balch (0762) and River View (0720) met both benchmarks but were just above the gravel benchmark. Linnton (0297) had excessive fine substrates and Tanner (0698) had inadequate gravels.

RIPARIAN CONDITIONS

The Willamette Streams varied widely in riparian canopy, but had the second highest median value for riparian canopy of city watersheds. Seven of the ten citywide stations with the highest percentages of riparian canopy were in this watershed, including sites in Forest Park, Balch Creek and Tanner Creek.

WATER QUALITY

TEMPERATURE[1]

The Willamette Streams had some of the coolest temperatures of all the city streams. All the stations measured over the first two years met the 18°C summer rearing temperature standard. In 2010, the two stations in Stephens Creek barely exceeded the fall spawning standard of 13°C. The Balch station was considerably cooler over this same time period and did not exceed the standard.

EUTROPHICATION

The first two years of data suggest that eutrophication is not a major issue in the Willamette Streams.

TOTAL SUSPENDED SOLIDS

The Willamette Streams had moderate median levels of suspended solids in comparison to other watersheds, but some of the highest maximum values observed across all watersheds over the first two years, for both the seasonal and storm values.

E. coli

The Willamette Streams had the lowest *E. coli* concentrations compared to other city watersheds by far, with over a third of the values undetected, a median value of 10 MPN, and only 7% of the samples above the acute and 17% above the chronic criteria.

METALS

The Willamette Streams were moderate in copper, zinc and lead (although high in dissolved lead) and high in mercury in comparison to other city watersheds in the stations sampled over the first two years.

PORTLAND WATER QUALITY INDEX

The Willamette Streams had a Portland Water Quality Index score of 51, which was the second highest in comparison to city watershed scores that ranged from a low of 28 to a high of 55. The Willamette Streams had comparatively good scores in *E. coli*, dissolved oxygen and temperature, but had relatively high concentrations of mercury which drove down its index score.

BIOLOGICAL

AQUATIC INSECTS

Macroinvertebrate communities in Willamette Streams varied widely. The two highest macroinvertebrate community scores across the city were in Willamette Streams, and the station in Balch Creek was the only station sampled in the first two years that was above DEQ's benchmark for most impacted aquatic macroinvertebrate communities. The lowest score in the watershed was in Stephens Creek below I-5.

FISH

Many sites within the Willamette Streams had no fish in spite of good stream habitat because they are above impassable culverts. Balch Creek has the largest population of cutthroat trout in the city, but no other fish species have been observed in that stream. The mouth of Stephens Creek had the most diverse assemblage of fish (including coho, Chinook, steelhead and cutthroat) but also was the only site in Willamette Streams where non-native fish were captured.

RIPARIAN BIRDS

The Willamette Streams had the highest median Bird Integrity Index in comparison to other city watersheds. It also had the single highest Index score across the city over the first two years in Balch Creek. Most Willamette Streams stations had no non-native birds, and non-native species were few in number at the stations where they were observed.

1 Because of the time required to secure access to sample stream reaches through private property, temperature probes were often not installed until mid- late-summer. This will be an issue in sampling the four rotating panels for the first time, but since access permissions have been acquired, will not be an issue for the second and subsequent rounds of sampling each panel.

GLOSSARY

Bird Integrity Index: An index based off an index developed by Bryce et al. (2002) that uses bird communities as an index of riparian condition for streams in the Willamette Valley. (Bryce, S. A., R. M. Hughes, and P. R. Kaufman. 2002. Development of a bird integrity index: using bird assemblages as indicators of riparian condition. Environmental Management 30:294–310.)

Eutrophication: The process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen.[5]

Fine sediments: Sediments <0.06 mm in size, although sometimes this can include sand which is < 2 mm in size.[6]

Gradient: The degree of inclination, or the rate of ascent or descent in a river or stream. [3]

Gravels: Loose rounded fragments of rock[5], typically 2 – 64 mm in size (about the size of a ladybug to a tennis ball).

Levee: A natural or man-made earthen obstruction along the edge of a stream, lake, or river, usually built to restrain the flow of water out of a river bank and protect land from flooding. [3]

Macroinvertebrates: Macroinvertebrates are organisms that are large enough to be seen with the naked eye but do not have a back bone. Many types of macroinvertebrates live in or near the water. They are abundant in lakes, streams, ponds, marshes, and puddles.[6] The types of macroinvertebrates present in a stream are often used to assess its health.

Metals: A dense, opaque element that is usually a lustrous solid and is a good conductor of heat or electricity.[4] In high concentrations metals can be toxic to aquatic life.

Properly Functioning Condition: The sustained presence of natural habitat-forming processes that are necessary for the long-term survival of the species through the full range of environmental variation. [4]

Not Properly Functioning: The lack of the sustained presence of natural habitat-forming processes that are necessary for the long-term survival of the species through the full range of environmental variation. [4]

Portland Water Quality Index: An index comprised of eight measures that is designed to compile water quality data of importance in Portland's streams into a single value that can be tracked over time. The eight measures are temperature, dissolved oxygen, ammonia, phosphorus, total suspended solids, dissolved copper, total mercury and *E. coli*.

Riparian canopy: The canopy of the trees on the banks of a waterbody.[2]

Riparian conditions: The conditions on the banks of a waterbody.[4]

Riffles: Shallow rapids in an open stream, where the water surface is broken into waves by obstructions such as shoals or sandbars wholly or partly submerged beneath the water surface.[3]

Salmonids: Any of a family (Salmonidae) of elongate bony fishes (as a salmon or trout) that have the last three vertebrae upturned.[5] Salmonids that are present in local Portland streams and rivers include coho and Chinook salmon, and cutthroat and steelhead trout. Chum salmon are present in the Columbia River and sockeye salmon are occasionally observed in the Willamette and Columbia rivers.

Substrate: The material underlying something, such as the soil beneath plants and animals, or the gravels and sediments composing a stream bottom.[2]

Suspended sediments: Particles of organic and inorganic matter that are suspended in or are carried by water.[6]

Total suspended solids: A measure of suspended sediments in water, obtained by filtering water and weighing the amount of sediment retained on a filter.[6]

Watershed: A topographically discrete unit or stream basin that includes the headwaters, main channel, slopes leading to the channel, tributaries and mouth area.[2]

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2 Framework for Integrated Management of Watershed Health http://www.portlandoregon.gov/bes/33528

3 The Ecology Dictionary http://www.ecologydictionary.org

4 Oxford Dictionary of Environment and Conservation. http://www.oxfordreference.com/view/10.1093/acref/9780198609957.001.0001/acref-9780198609957

5 Merriam Webster http://www.merriam-webster.com/dictionary

6 Chris Prescott, Portland Bureau of Environmental Services, Personal Communication.

FOR MORE INFORMATION
Chris Prescott
503-823-7089
Chris.Prescott@portlandoregon.gov
www.portlandoregon.gov/bes/PAWMAP

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