Water Quality Analysis of the Eagle Creek Watershed

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Summary:

Very few studies have analyzed water quality recently (within the past 10 years) within the Eagle Creek watershed, and these studies have been very narrow in duration (two months at the most) and/or the number of sampling sites utilized was very limited (typically one or two). Therefore, I decided to undertake a broader investigation (please refer to the "Testing methods and references" section at the end of this report for a description). Over the course of one year (September 26, 2019 to October 1, 2020), I acquired selected, weekly water quality data at six selected sites within the Eagle Creek watershed and at one location within the Clackamas River, upstream of where Eagle Creek flows into the Clackamas River at Bonnie Lure State Park (seven sites, total). Please refer to Map 1 for locations of these sampling sites. Sites were chosen to understand how the selected water quality parameters vary between the two largest tributaries of the North Fork Eagle Creek (Suter and Bear Creeks), within the North Fork Eagle Creek itself, within Eagle Creek and finally within the Clackamas River, upstream of where Eagle Creek flows into it. An entire year of sampling was performed within Suter Creek, the North Fork Eagle Creek, and at two locations within Eagle Creek: at the National Fish Hatchery (only water temperatures were acquired at this site) and at Eagle Fern Park. About four months of data collection (during the late spring and summer) were taken within Eagle Creek at Bonnie Lure State Park, Bear Creek and the Clackamas River at Paradise Park.

Findings:

- 1. Water temperatures (Graphs #1 and #2):
 - a. Temperature differences between sampling sites from June through September (Graph #2): Within the Eagle Creek watershed, water temperatures generally increased as one proceeds farther downstream:
 - i. Within Eagle Creek from the Eagle Creek National Fish Hatchery (at Eagle Creek river mile 13) to its confluence with the Clackamas River at Bonnie Lure, the temperature at the hatchery is consistently between 2 4°C colder than downstream at Bonnie Lure. This makes sense as the surrounding terrain changes from a forested canopy to more open forest, then mixed grassland, agriculture and some residential, allowing more solar heat gain.
 - ii. The temperature difference between the North Fork Eagle Creek (flows into Eagle Creek at Eagle Creek river mile 6.5) and Eagle Creek down at Bonnie Lure reveals that the North Fork Eagle Creek is also similarly colder.
 - iii. There is little temperature difference between Eagle Creek at Eagle Fern Park (at Eagle Creek river mile 6.6) and the North Fork Eagle Creek's confluence at Eagle Fern Park, they are reasonably similar about +/-1°C. (One is not always colder than the other, and the difference is rather minor.)
 - iv. The temperature difference between the Clackamas River at Paradise Park and Eagle Creek at Bonnie Lure (where Eagle Creek flows into the Clackamas) varies about +/-2°C. (One is not always colder than the other.) Therefore, at times, due to Eagle Creek's increased water temperature near its confluence, it could be considered a sporadic heat input for the Clackamas River.

- b. Given the distribution of water temperatures within the entire Eagle Creek watershed, at least 87% of the Eagle Creek watershed possesses year-round adequate water temperatures for salmonid and trout species (Eagle Creek upstream of Eagle Fern Park and the North Fork Eagle Creek and each of their tributaries), with the limited exceptions noted immediately below.
- c. During the October 15th through May 15th timeframe, of the creeks surveyed (Eagle Creek at the hatchery and at Eagle Fern Park, the North Fork Eagle Creek and Suter Creek) consistently remained below the 13°C (55.4°F) threshold for salmonid spawning use. Given the similarities between Bear Creek and Suter Creek, we can infer similar results would be achieved within Bear Creek as well.
- d. During the September 1st through June 15th timeframe, five of the sampling sites within the watershed (Eagle Creek at the hatchery, Eagle Fern Park, the North Fork Eagle Creek, Suter Creek and the partial survey within Bear Creek) consistently remained below the 16°C (60.8°F) threshold for core cold water habitat use. By examining Graph #1, Eagle Creek at Bonnie Lure may have exceeded this criterion for a couple of weeks, but data could not be recorded to verify this due to the wildfire evacuation restrictions noted.
- e. The North Fork Eagle Creek, its two tributaries (Bear and Suter creeks) and upper Eagle Creek at the hatchery consistently remained below 18°C (64.4°F) during the summer months, with Suter Creek consistently being the coolest, most likely due to its dense tree canopy. Bear and Suter creeks are very similar in water temperatures over time, again, most likely due to similar flows, maximum/minimum elevations and tree canopy cover.
- f. All sites consistently remained below 20°C (68°F) during the summer months, with the exception of Eagle Creek at Bonnie Lure State Park (exceeded four times) and the Clackamas River site (exceeded one time).
- g. During the fall and winter months, Eagle Creek at the hatchery and at Eagle Fern Park were typically the coldest followed by the North Fork Eagle Creek and then Suter Creek. This is most likely due to the presence of snow and colder atmospheric temperatures at the upper elevations of both Eagle and North Fork Eagle creeks.
- h. Water temperatures at all sites consistently respond in similar manner to changes in atmospheric temperature.
- 2. Dissolved oxygen (Graphs #3 and #4):
 - a. Levels consistently remained above 8 mg/L (the accepted minimum standard for cold water aquatic life) for all sites during the entire year, which indicates that sufficient dissolved oxygen is present for the rearing freshwater life stage.
 - b. All sites remained above 9 mg/L dissolved oxygen with the exception of the following sites where values between 8 and 9 mg/L were recorded: Eagle Creek at Bonnie Lure (9 times), Eagle Creek at Eagle Fern Park (one time), Bear Creek (3 times) and Suter Creek (2 times), and all of these were recorded during the summer months.
 - c. Oregon DEQ standards require a dissolved oxygen level of 11 mg/L from September 1st through June 15th. This standard is not met at any of the Eagle Creek watershed sampling sites during the month of September (nor at the Clackamas River site) or from about the middle of May through June 15th. However, as discussed below, this should not seriously affect salmonids spawning in the Eagle Creek watershed due to their actual migration arrival timing (with the exception of some early-arriving spring Chinook). Measurements within Eagle Creek at Eagle Fern Park and North Fork Eagle Creek from October through April (when the vast majority of salmonids migrate into this watershed) reveal that dissolved oxygen values were consistently above 11 mg/L. (We can infer that levels are similarly as high farther upstream at the Eagle Creek National Fish Hatchery.)

- d. From June through September, the Clackamas River site typically had the highest dissolved oxygen content, followed by the North Fork Eagle Creek and then Eagle Creek at Eagle Fern Park.
- e. From Graph #4, it can be seen that the dissolved oxygen within Eagle Creek is usually greater from June through September at Eagle Fern Park compared to that at Bonnie Lure State Park. This could be due to either the water being warmer farther downstream or increased use of the dissolved oxygen by chemical or biological factors (or a combination of both) farther downstream of Eagle Fern Park.
- 3. pH (Graph #5):
 - a. During the entire year, the variability of pH within the Eagle Creek watershed is fairly clustered (ranging between a pH of about 7 to about 7.8, with an average of about 7.4) and fluctuated consistently between the subwatersheds sampled.
 - b. Interestingly, the pH of Eagle Creek at Eagle Fern Park from July through September drifted higher than the rest of the Eagle Creek watershed measurements, to as high as 8.1, but then settled back down closer to the other readings. This may be due to increased algal metabolic activity during this period. The readings at Bonnie Lure State Park remained within the range of the others, this indicates that the higher pH of the water recorded at Eagle Fern Park was reduced from Eagle Fern Park to Bonnie Lure.
 - c. The pH of the Clackamas River upstream of Bonnie Lure State Park at the Paradise Park site ranged between about 8 and 8.6 during the summer months, with an average of about 8.2.
- 4. The specific conductivity (Graph #6) at all sites is considered to be good, with all readings well below the generally accepted "good" upper threshold of 93 μS/cm.
- 5. Visual observations of aquatic habitat and forested canopy cover within the Eagle Creek watershed indicate that the characteristics of the North Fork Eagle Creek and upper Eagle Creek (upstream of Eagle Fern Park) are more closely related than those of lower Eagle Creek, which is predominantly forest transitioning to agricultural.

Questions that arise:

1. Why does the Clackamas River at Paradise Park possess a consistently higher pH compared to the Eagle Creek watershed (at least during the time frame measured)? Is this related to increased algal metabolic activity, or is it of geologic origin?

Conclusions & Recommendations:

1. In terms of water quality, the Eagle Creek watershed generally meets accepted water quality standards for fish for the parameters measured. (Sporadic warm water temperatures occur near Eagle Creek's confluence with the Clackamas River at Bonnie Lure State Park during the summer months, but fish can find colder water elsewhere within the watershed upstream or have simply adapted to these temporary conditions. Often during the summer months, I did see fish of various ages at or near all sample sites, so their presence indicates that they are surviving within their environment.) The Eagle Creek watershed is extensive: about 66% of it is accessible to anadromous fish, the remaining 34% is upstream of the Eagle Creek National Fish Hatchery (at Eagle Creek river mile 13). Upstream migration beyond the hatchery is prevented for two reasons: 1) an electric weir at the hatchery, and 2) the Upper Falls, a 16 foot tall, natural falls with a manmade concrete top weir, existing about ¼ mile farther upstream of the hatchery, that is a barrier to migration. (Prior to the late 1940's, the 17 foot tall, single-drop Middle Falls, just upstream of the Delph Creek confluence with Eagle Creek (at river mile 9), was clearly the historic barrier to migrating fish, but a primitive ladder was built at this time for fish to surmount

it, later superseded in 1957 by the ladder seen today.) Therefore, the watershed provides ample places for fish to spawn, rear and find the coldest, cleanest water required. It also possesses ample sources of cold water from the larger tributaries. (Suter and Bear creeks, the largest tributaries of the North Fork Eagle Creek, for example, consistently remain below 18°C year-round.) Therefore, in terms of these parameters, water quality should not be considered as a limiting factor for fish in the Eagle Creek watershed, except perhaps near its confluence with the Clackamas River, and then, only sporadically during the summer months or at the tail ends of the actual Eagle Creek salmonid migration season (September through May) when either water temperature and/or dissolved oxygen levels do not meet specified criteria.

- 2. Additional water quality studies should be performed in the future to further this work. This should particularly be done during a hotter than normal summer season, when water temperatures could exceed what was measured in 2020, and compare the results achieved to other watersheds within the entire Clackamas River basin to more precisely define cold and clean watersheds within the basin. Studies should also include Delph Creek, which was not a part of this study. Studies should include most of the multiple sites used in this study to understand how parameters vary over stream length.
- 3. Ion-specific (e.g. nitrate/nitrite and ammonium) studies should be performed, at least within Eagle Creek at Bonnie Lure State Park, to capture any effects from the more developed, lower segment downstream of Eagle Fern Park. The last comprehensive water quality study I found that included two sampling sites within Eagle Creek, a 2003 USGS report of data collected in 1998, "Water Quality and Algal Conditions in the Clackamas River Basin, Oregon, and their Relations to Land and Water Management," should be updated. (No ion-specific findings of concern were detected within Eagle Creek's upper sampling site, but a high level of nitrate and a modest level of ammonium were detected down near Bonnie Lure, but a lot can change in 22 years.)
- 4. Pesticide sampling is conducted by the Clackamas Pesticide Stewardship Partnership (PSP). They published their latest biennial report covering sampling between 2015 and 2017. As part of the PSP program, water quality is monitored for pesticide residues beginning in March and continuing through June and again in September and continuing through mid-October. During the period July 1, 2015 through June 30, 2017 water quality samples were collected from six locations within the Clackamas River basin. Results of this study included sampling within Eagle Creek at Eagle Fern Park. <u>No</u> detections of pesticides were found within Eagle Creek. Future studies should also include a sampling site within Eagle Creek at Bonnie Lure State Park to determine if any pesticides are released into Eagle Creek downstream of Eagle Fern Park, where agriculture and residential development is more prevalent.
- 5. To assess informative aspects of biological health, the Lower Clackamas River Macroinvertebrate Assessment study commissioned by the Clackamas River Water Providers should be expanded to include a site within Eagle Creek, preferably in the Eagle Fern Park area.

A Brief Natural History of the Eagle Creek Watershed:

Eagle Creek is the least developed, and largest, in terms of flow rate, of the four principal tributaries (Eagle, Clear, Deep and Rock creeks) that discharge into the lower Clackamas River (the portion of the Clackamas River downstream of River Mill Dam). In terms of drainage area, the North Fork Eagle Creek (27.9 square miles) represents about 31% of the entire Eagle Creek watershed (89.3 square miles). When comparing 2 year peak flood flows, Eagle Creek flows at 3,930 cubic feet per second (cfs); the North Fork Eagle Creek, Eagle Creek's largest tributary flows at 1,160 cfs; followed by the South Fork Eagle Creek (confluence is at Eagle Creek river mile 16) at 517 cfs; and Delph Creek (confluence is at Eagle Creek's 50% duration flow is 192 cfs. As a basis for comparison to

streams in the upper Clackamas basin, Eagle Creek's 2 year peak flood flow rate is about twice that of the Roaring River and the Oak Grove Fork of the Clackamas River, and about half of the Collawash River.

The Eagle Creek watershed's maximum elevation is 4,640 feet in the Salmon-Huckleberry Wilderness of the Mt. Hood National Forest, and the minimum, at Bonnie Lure State Park, is 198 feet, with a mean basin elevation of 1,850 feet. Regarding land use, only 10% of the Eagle Creek watershed is in cultivated crops (classes 81 & 82, NLCD 2011), principally in the lower segment; 80% is in forestland (primarily conifer, classes 41 through 52, NLCD 2011); 9% is in grasslands/shrubs (classes 71 through 74, NLCD 2011); and about 1% is developed open area (class 21, NLCD 2011). On account of extremely low development, only about 0.2% of the watershed is considered to be impervious area (concrete, asphalt, etc.).

According to the Clackamas Partnership's 2018 Strategic Restoration Action Plan, the Eagle Creek Watershed contains the greatest number of miles (45.3) of combined high intrinsic potential (HIP) habitat (meaning it has the highest potential in terms of flow and topography for the creation of high quality habitat for salmon and steelhead juveniles) of ALL watersheds within the entire Clackamas River Basin. The majority of this HIP length occurs within the North Fork Eagle Creek watershed due to its long, unobstructed length and tributaries.

Anadromous salmonids found in the Eagle Creek watershed include:

- 1. Coho salmon (*Oncorhynchus kisutch*) of the Lower Columbia River Evolutionarily Significant Unit (ESU). Coho (early (hatchery) and late (wild) runs) typically migrate upstream as adults within the Eagle Creek watershed from late September or early October through late January.
- 2. Winter steelhead (*O. mykiss*) of the Lower Columbia River Distinct Population Segment (DPS). Winter steelhead typically migrate upstream as adults within the Eagle Creek watershed from late December or early January (hatchery) through mid-May (wild). (Note: hatchery return patterns may change as responsibility for such releases transitions from the US Fish & Wildlife Service to the Oregon Department of Fish & Wildlife.)
- 3. Spring Chinook (*O. tshawytscha*) of the Upper Willamette River ESU. Spring Chinook typically migrate upstream as adults within the Eagle Creek watershed from early September through early November.

All species noted above are listed as Threatened under the Endangered Species Act.

Pacific lamprey (*Entosphenus tridentatus*) also exist within Eagle Creek and the North Fork Eagle Creek. It is believed that tule fall Chinook historically made use of Eagle Creek, but none have been observed in decades.

Fish upstream of Eagle Creek's Upper Falls have been isolated since the geologic formation of the falls. Cutthroat trout are widely distributed throughout, and are endemic to this upper basin (which represents about 34% of the Eagle Creek watershed). No fish stocking has occurred upstream of the Upper Falls, so most likely there has been no dilution of the gene pool of the original group.

Focusing now on the North Fork Eagle Creek watershed, it has a maximum elevation of 3,970 feet in the Mt. Hood National Forest, and the minimum, at Eagle Fern Park is about 510 feet, with a mean basin elevation of 1,630 feet. The watershed is about 10 miles long and three miles wide at its greatest extents. The main stem of the North Fork Eagle Creek is about 13 miles long.

Five principal tributaries feed North Fork Eagle Creek, in descending order of 2-year peak flood flow: Bear Creek (171 cfs), Suter Creek (159 cfs), Little Eagle Creek (153 cfs), Trout Creek (126 cfs) and Grabenheim Creek (90 cfs). All are medium ODF type SSBT (salmon, steelhead & bull trout) or large type F (Fish) streams. All are active coho and winter steelhead producers; Suter Creek is consistently the most productive of the three tributaries (Suter, Little Eagle and Trout) surveyed by ODFW. Bear Creek, which has been surveyed in the past by the BLM, appears similar to Suter Creek in terms of coho and winter steelhead productivity.

The North Fork Eagle Creek watershed currently supports spring Chinook (in the lower reach of the North Fork), winter steelhead and coho salmon. Sea-run and resident cutthroat are also present, but no surveys have been conducted to estimate their populations.

Regarding land use, only 4% of the North Fork Eagle Creek basin is in cultivated crops (classes 81 & 82, NLCD 2011); 82% is in forestland (primarily conifer, classes 41 through 52, NLCD 2011); 13% is grasslands/shrubs (classes 71 through 74, NLCD 2011); and about 1% is developed open area (class 21, NLCD 2011). On account of extremely low development, less than 0.1% of the basin is considered to be impervious area.

In terms of major land ownership within the North Fork Eagle Creek watershed, from the Oregon Explorer database, 24% is in public ownership (9% BLM, 7% US Forest Service, 8% Clackamas County and the Clackamas Soil & Water Conservation District). The remainder is in private ownership, with Weyerhaeuser being the largest private landowner (about 40% of the private landholdings).

Testing methods and references:

- 1. The following water quality parameters were measured weekly: water and air temperatures, barometric pressure, dissolved oxygen, specific conductance, pH, total dissolved solids, turbidity and oxidation-reduction potential. The OWEB "Water Quality Monitoring Guidebook" was utilized, where appropriate, for testing protocols.
- 2. Regarding sampling time, all measurements were taken on Thursdays, in the mid to late afternoon to attempt to capture the highest daytime water temperatures. All samples were taken within about 75 minutes from beginning of sampling to the end. The meter's probe was immersed in water for a sufficient time for all electrodes to stabilize.
 - a. The Clackamas River sampling site was along the riverfront owned by Ms. Judy Beaudoin, 28683 SE Paradise Rd, Eagle Creek.
 - b. The most downstream Eagle Creek sampling site was beneath the Dowty Road Bridge adjacent to Bonnie Lure State Park.
 - c. The remaining two Eagle Creek sampling sites were 1) downstream of the foot bridge at Eagle Fern Park, and 2) about 300 feet upstream of the confluence of the North Fork Eagle Creek at the park.
 - d. The North Fork Eagle Creek sampling site was about 200 yards upstream of the North Fork Eagle Creek confluence with Eagle Creek at Eagle Fern Park.
 - e. The water intake at the Eagle Creek National Fish Hatchery was the most upstream Eagle Creek sampling site (for water temperatures only). Temperatures are continuously monitored and the maximum values reported was provided by the US Fish & Wildlife Service.
 - f. The Bear Creek sampling site was beneath the Kitzmiller Road Bridge, just upstream of its confluence with North Fork Eagle Creek.
 - g. The Suter Creek sampling site was at the western property line of the western-most parcel of the Bugni property, about ³/₄ mile upstream of its confluence with the North Fork Eagle Creek. (Its confluence is inaccessible for weekly measurements.)
- 3. Instruments: From September 26, 2019 through October 17, 2019: YSI ProDSS handheld meter with 18M101555 digital sensor provided by the Clackamas River Basin Council was used.

Beginning on October 24, 2019 and thereafter, a Hanna HI 9829 Multimeter provided by PGE was used. Instruments were calibrated biweekly (after every other series of measurements) for chemical-related (DO, specific conductivity and pH) parameters and monthly for turbidity.

- 4. On September 10, 2020, no sampling was done at any of the sites due to mandatory wildfire evacuation requirements. On September 17, 2020, no data was collected at either the Clackamas River Paradise Park or the Eagle Creek at Bonnie Lure State Park sites due to continued wildfire exclusions.
- 5. Maximum water temperatures at the Clackamas River site were compared to those obtained from Probe #16 of Portland General Electric's continuously-monitoring water temperature array, located about 300 feet farther upstream. Very good agreement between these two locations was obtained (typically less than 0.2° C difference), which indicates that most likely other sites also had maximum, or near maximum, temperatures recorded. For the other parameters analyzed (i.e. dissolved oxygen, pH and conductivity), it is not known how far from the maximum or minimum daily values the reported values are, as varying lead/lag times often exist between these parameters and maximum water temperatures.
- 6. Natural history statistics and water quality references:
 - a. Clackamas Partnership, "Watershed Restoration for Native Fish Populations, Strategic Restoration Action Plan," July 2018.
 - b. Oregon Water Quality Pesticide Management Team, "Clackamas Pesticide Stewardship Partnership Biennial Summary 2015 -2017"
 - c. Oregon Watershed Enhancement Board, "Water Quality Monitoring Guidebook," Version 2.0
 - d. State of Oregon, Department of Environmental Quality, "Clackamas Basin: DEQ's Water Quality Status and Trends analysis for the Oregon Department of Agriculture's Biennial Review of the Agricultural Area Rules and Plans, "February 2017.
 - e. United States Department of Agriculture, Forest Service, Pacific Northwest Region, "Eagle Creek Watershed Analysis," 1995.
 - f. USGS Stream Stats, <u>http://water.usgs.gov/osw/streamstats/oregon.html</u>, accessed 10/13/2020

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Map 1: Locations of selected water parameter sampling sites within the Eagle Creek watershed and the only sampling site within the Clackamas River at Paradise Park, upstream of where Eagle Creek flows into the Clackamas River at Bonnie Lure State Park.

Note: ECNFH = Eagle Creek National Fish Hatchery.