The Effects of Human Influences on Pollution Run-off into Streams

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Abstract

- Human influences are a leading cause of pollution within our surrounding streams. Biodiversity is another factor reducing our water quality.
- Stream assessments were done along 7 sites near the Chehalis River Basin. Water samples were collected for 16sRNA sequencing, and the riparian zones were characterized for potential pollution levels and plant diversity.
- Microbiome analysis showed distinct differences going further downstream into residential areas.

Introduction

Pollution from human influences is a growing problem in the Chehalis River and tributaries causing deleterious effects on stream health. Pollution runoffs happen when rainfall or snow melt pick up and carry human-made or natural pollutants, depositing them into streams, lakes, and rivers. A study in North Carolina evaluated streams by looking at sources/locations of runoffs into streams in conjunction with pathogens present each site. The source of these pathogens can be difficult to pin-point when streams aren't properly monitored (1). With a better understanding of microbial populations within streams you can correlate the role the surrounding environment is playing on overall stream health.

Stream water has been facing a decline in quality from the leading cause of pollution from agriculture and manufacturer run-offs (2). A study in China showed the severity that growing populations, increased industrial sites, and urbanization have on stream health resulting in significant levels of water pollution. Areas of urbanization have higher forms of toxic run off from manufacturing buildings. The locations of this run off changes the severity of pollution impacting the ecosystem (2). Another study done in Eastern England showed the effects that motorway runoff had on macroinvertebrate diversity, demonstrating the streams may pose a greater pollution threats in the future (3). These studies are important in a world that is facing increasing industrialization, and suffering ecological consequences. Although there have been many studies related to runoff pollution affecting streams, there are no in-depth studies done on the taxonomy and functionality of microbes in urban water ecosystems, so it is important for this to be further investigated.

For this project, overall stream health is measured through water quality and riparian composition. Pollution influences the abundance and diversity of aquatic life, including at a microbial level, and the environment of the stream. The microbes present are a strong indicator of the health of the ecosystem (3). Microbiome analysis can provide insight into what is happening within the stream, and the effects of human impact. This project presents the second year of an ongoing study, through which the abundance and diversity of organisms are periodically analyzed to assay stream-health within regions of varying levels of human impact. From this information, future studies can identify patterns indicating priority need for stream restoration.

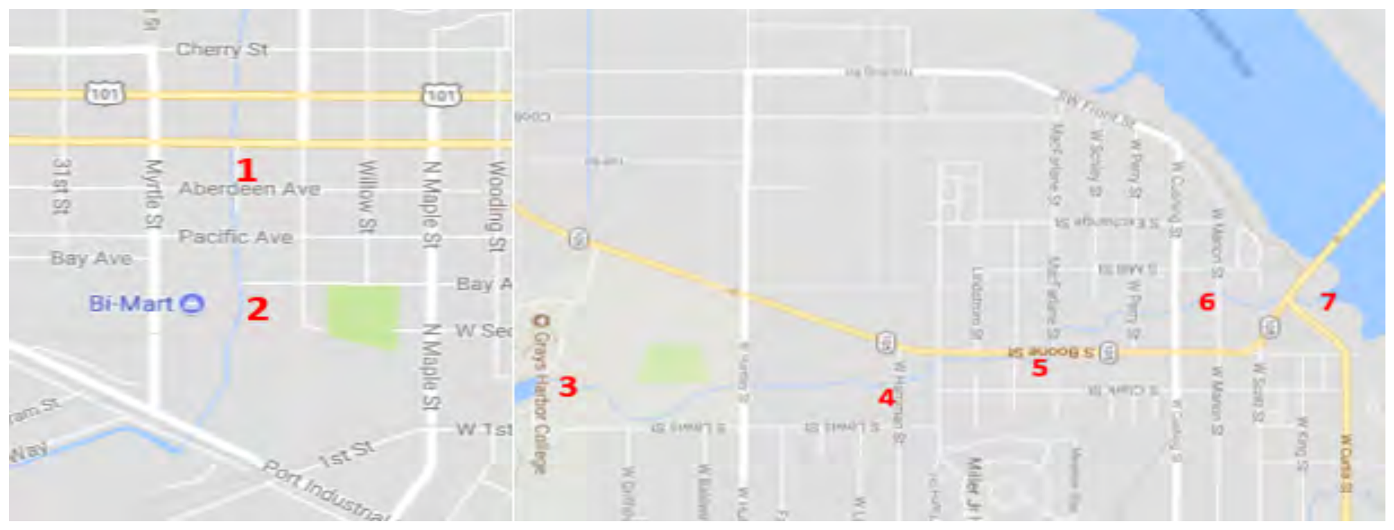


Figure 1

Site 1: Fry creek- 90% man-made covering, roadway on all asides of the stream creating higher amounts of run-off, has deeper culverts that allows for holding flood water.

Site 2: Fry creek-75% man-made covering, significant amounts of blackberry plants, significant amounts of garbage, wider stream, mucky water, further from culvert.

Site 3: Alder creek- most natural setting, no man-made covering, shade availability from trees (native species), rocks in bed of the stream, diverse species of insects, plants, and birds, monitored regularly by the college, no potential run-offs.

Site 4: Alder creek-20% man-made covering, roadway on both sides of the stream, low roadway direct run-offs into stream, has surrounding trees and plant life, side walk for pedestrians resulting with high amounts of littering, leveled sidewalk on the side of the stream.

Site 5: Alder creek75% man-made covering, runs parallel with the main road, housing and companies surround the stream, overgrowth of water grass within the stream and inside culvert, along street has little shade availability, small amount of plant diversity, surrounding area is mowed regularly, lower road elevation, high amounts of potential run-off, vertical or sloped sidewalks on the side of stream.

Site 6: Alder creek-residential area, popular apartment complex and houses on all sides of stream, free range domestic animals within the area, deeper culverts for flood purposes, sloped sidewalks, higher road elevation, high amounts of potential run-off, popular street.

Site 7: Alder creek-located right before the flood gates, surrounding roadway along stream, high transient population, higher amounts of roadway run-off.

Methods

Two samples were collected from 5 sites along Alder creek and 2 from Fry creek(Figure 1). The samples were taken roughly 6-8 inches below surface level and were collected in falcon tubes. Half of the samples collected were sent to Omega Bio-service for 16sRNA sequencing for microbiome analyses (Figure 5). The other half were plated on both MacConkey and Mannitol plates and compared to previous data (Figure 4).
The site of each sample was observed from a 10 feet radius around the collection. The location of each site was characterized for potential pollution runoffs and environmental factors (Figure 1). Identification was done on the surrounding plants, insects, fungi, and amphibians within the radius through the app called "inaturalist" (Figure 2). Stream monitoring was also taken into consideration outside of our involvement. The water was tested for dissolved oxygen levels, pH, and the temperature using a lab quest to determine water quality (see figure 3).

Results

Figure 2:Plant, Animal, Insect comparison

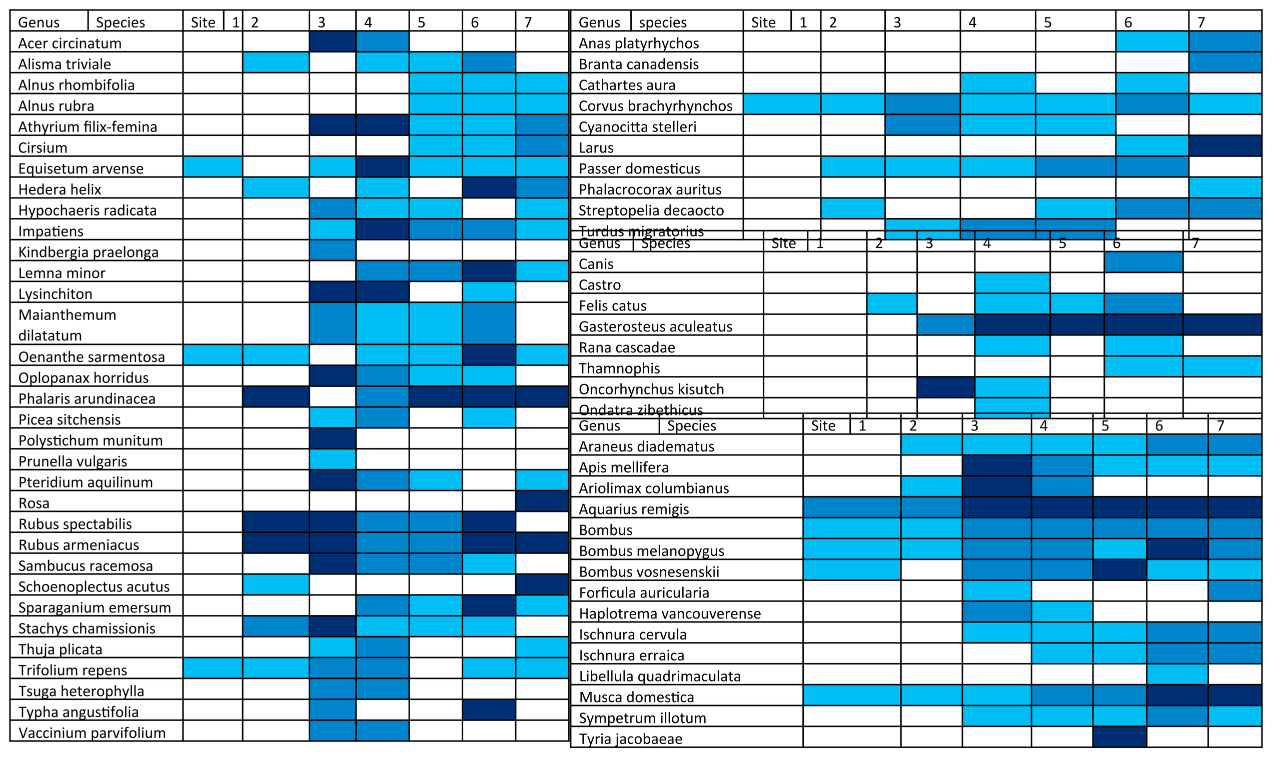
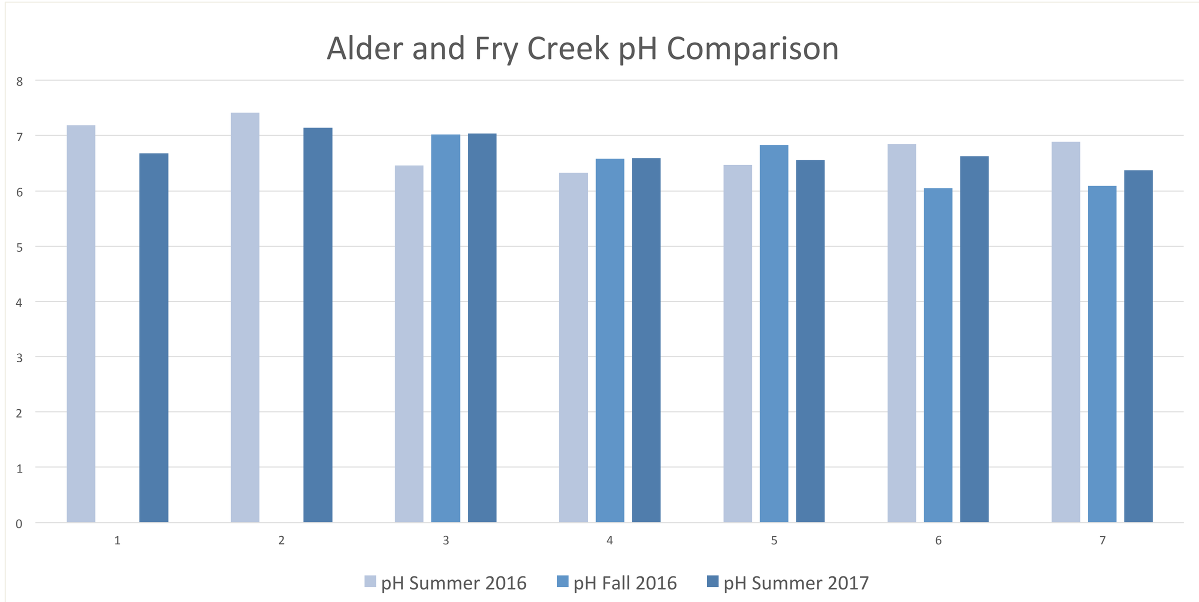


Figure 3: Water Quality



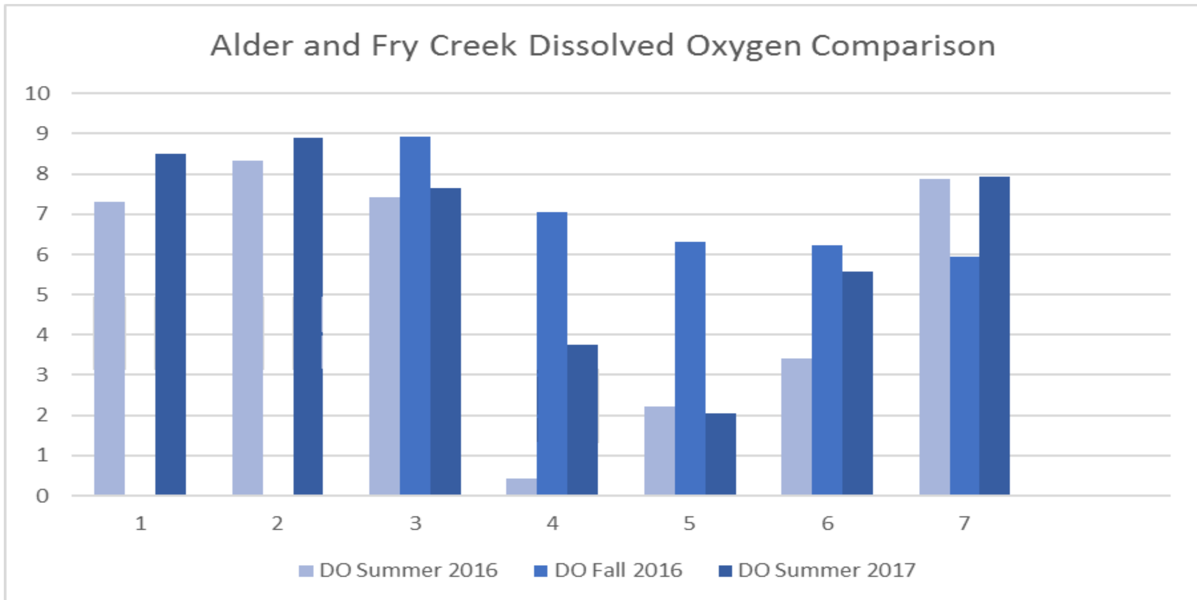
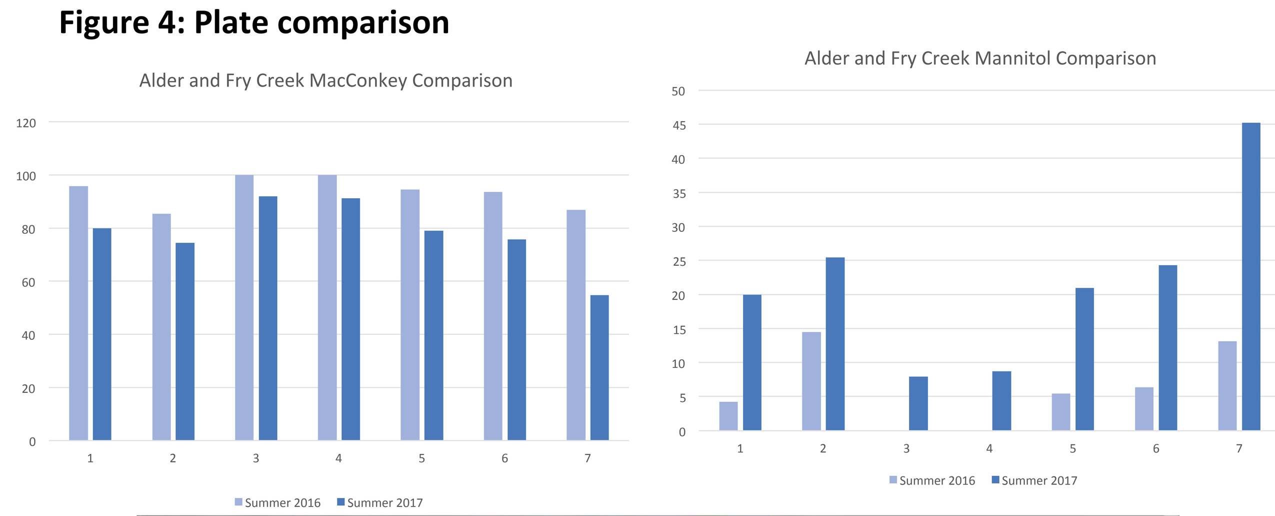


Figure 4: Plate comparison



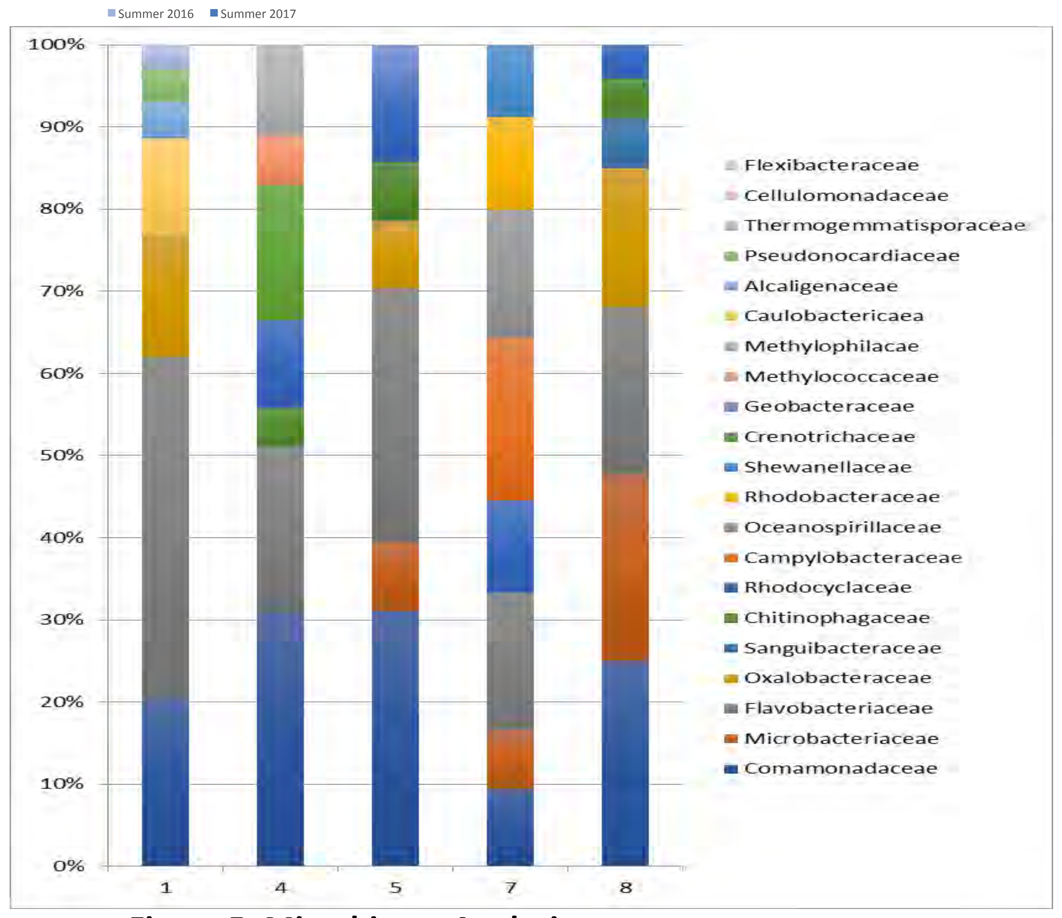


Figure 5: Microbiome Analysis

Discussion

When tributaries enter areas of urbanization and experience a change in their riparian composition, pollution can increase and affect the health of the stream. Biodiversity among neighboring species have been demonstrated to improve water quality (4). In the downstream region of Alder Creek, near the Chehalis River, plant species had less diversity and water quality was greatly affected. The residential sites were less natural, which allowed for heavier pollutants to enter the stream. The lack of diversity among species can correlate to the high levels of pollutants causing the natural mechanisms of cleansing that biodiversity helps decrease. When exposed to potential pollutions it is crucial that native species surrounds streams to help increase water quality and the streams ability to reduce the toxins (4).

Water quality testing showed areas where DO levels appeared lower are urbanized, and are believed to be altered by the run-off pollutions. The stream has a harder time dissolving oxygen when there are higher levels of toxins that are reducing the flow rate causing a blockage that is affecting the overall water quality (5). The DO, pH, and temperature of the water at each site shows that the areas with potential pollutants reduced the streams quality. The reduced levels of dissolved oxygen also suggest that the microorganisms present there are anaerobic as opposed to aerobic. Water quality of a stream can be improved when properly monitored so reducing the run-off pollution entering a stream is extremely important when restoration is in process.

Shown here, areas with higher pollution would have a lack of aerobic bacteria indicating the bacteria are likely predominantly gram positive at these sites. The Mannitol and MacConkey plates were as to be expected and were compatible with the water quality results. Sites along Alder creek in the residential areas with higher pollution levels experienced significant growth on the Mannitol plate. This shows that downstream the sites 5,6, and 7 have predominantly gram-positive. This indicates the sites closer to the Chehalis River are selecting for gram-positive bacteria in response to the pollution run-off also from being closer to salt water that selects for gram-positive. While site 3 and 4 that grew significantly on MacConkey plates showing they are predominantly gram-negative. When comparing the Alder sites to the two Fry Creek sites it is clear gram-negative bacteria are selected, consistent with an aquatic environment.

The runoff entering a stream can affect the composition of the microbial community (5). The microbial composition at each site for the Summer of 2016 showed similarities in the families present but their abundance varied among them. The sites along Alder near the start of the stream (sites 3 and 4) have bacteria that typically act as decomposers and promote an overall healthy stream. These results are as to be expected when considering potential run-offs in addition to a healthy riparian zone. Further downstream at sites 5, 6 you can find an abundance of nitrate reducing bacteria as well as higher numbers of coliforms, this resulting from microbial growth occurring from optimal environmental conditions. These areas that are mostly residential create conditions that allows the stream to select for microbes that can metabolize methane, nitrogen, sulfur, and other toxins that prevent the growth of healthy microbes thus affecting the stream quality. The Summer 2017 results will be used to indicated differences along Alder Creek and Fry Creek between the years. This information will be used as a baseline for monitoring the pollution levels in streams to find trends, and guiding restoration efforts to reduce the level of toxins and create a better ecosystem within the Chehalis River Basin.

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