Project Plan

1. Project Title: How does urbanization affect stream ecosystem health?
a. Group Members:

Alex

BIOL570L Students

2. Topic Background Statement:

Aquatic ecosystems and human populations are closely intertwined. These systems, particularly rivers, streams, and creeks provide humans with a wide range of ecosystem services. Namely, humans get drinking water, food, raw materials, energy, transportation, and many other valuable resources (Grizzetti et al. 2016). However, as humans develop population centers near aquatic environments and deplete resources, it can greatly alter the physical, chemical, and biological properties of the ecosystem. Physical alterations are common in many systems. For example, humans will create dams and reroute the natural flow of streams for flood-mitigation, water storage, and energy. However, the creation of such physical structures can decrease the biodiversity of the system across multiple functional groups (Wu et al. 2019). Additionally, human pollution and subsequent eutrophication can greatly alter the chemical composition of stream habitat, reducing oxygen or suitable conditions for a wide range of organisms.

The complex and compounding impacts of human stressors on stream ecosystems is dubbed the "urban stream syndrome" (Walsh et al. 2005). This syndrome can be diagnosed by a wide shift of ecosystem properties that has been consistently observed across multiple locations. However, the exact impacts of urban stream systems can be variable, particularly with respect to nutrient uptake, algal biomass, and secondary production. However, a consistent marker of urban stream syndrome is a decrease in sensitive macroinvertebrates and an increase in tolerant ones. Macroinvertebrates (arthropods, gastropods, etc), are common residents of stream ecosystems and can be present in a diverse array of organisms. The high biodiversity of macroinvertebrates is attributable to the range of suitable habitat from streams, such as variable flows, high-plant input, rugged structures, etc. However, as streams are subject to urbanization, the range of ideal conditions for these macroinvertebrates shrinks. As a consequence, there are only a few "tolerant" species which can survive in the urbanized stream. As the more sensitive taxa are depleted, there is ample opportunity for the tolerant ones to thrive.

3. Main Question(s):

In Columbia, can we identify urban stream syndrome by measuring macroinvertebrate abundance?

4. Hypothesis(es):

In accordance with urban stream syndrome, a more urbanized stream will have a depleted habitat due to less rugged structure, more pollution, and decreased suitable habitat for macroinvertebrates. Due to this depletion of habitat quality, only tolerant species will thrive, and more sensitive ones will be pushed out. If we sample an urbanized and a less-disturbed stream, we will observe a notable difference in abundance of tolerant (increased) and sensitive (decreased) macroinvertebrates.

5. Proposed Methodology:

We will sample two locations in the Gills creek watershed. The urbanized location is downstream of many residential areas and situated in a commercial zone with major habitat alternations. The less-urbanized stream is upstream and drains a largely undeveloped region. Thus, the habitat alternations are only from minor road infrastructure, yet it is within the same watershed.

At each sampling location, macroinvertebrate surveys will be conducted. Macroinvertebrates will be identified into major taxonomic groups and classified as sensitive, moderately sensitive, and tolerant taxa. To survey the area, a systematic, time-based approach will be implemented to ensure equal sampling effort at each location. Thus, a single sampling event will be a 5-minute survey using multiple instruments (seine net, dip-net, and visual observers) to identify macroinvertebrates. This will be repeated at least six times at each location. To ensure that we don't resample organisms, survey efforts will be in 1-2m stretches of stream in non-overlapping sections.

Prior to the surveys, a stream health assessment guide will be completed. This will provide valuable context for the difference in the disturbance-level between the two sites.

a. List of Needed Equipment:

Seine nets, dip-nets, stopwatches, transect tape, waders, bug-spray, clipboards, ID-guides, stream assessment forms.

b. List of Collected Variables:

Abundance of different taxa groups (numerical, response variable)

Stream location (categorical: urbanized/pristine, predictor variable)

c. Proposed Analysis Method:

The abundance of taxa can be compared between the two sites using a t-test. The t-test will be run for each category of taxa (sensitive/moderate/tolerant).

Additionally, another analysis could be to compare the biodiversity between the two sites using a Shannon-Weiner index.

We are planning to collect 6 samples at each site, giving a sample size of 6 per site with a total size of 12.

6. Group Member Responsibilities:
    a. Siene-netters: These people will sample the water using a kick-seine net. This is where we will need the most people. These people will collect, count and identify aquatic macroinvertebrates living in the substrate.
    b. Dip-netters: Dip-netters will work the banks of the creek to collect larger macroinvertebrates.
    c. Visual-counters: Visual-counters will observe flying insects and bank-side organisms over the sampling region. They will classify them as: Odonata (dragonflies & damselflies), Lepidoptera (Butterflies & moths), and Hymenoptera (bees, wasps, ants).
    d. Data-Recorder: The data record will be responsible for coordinating the groups, collecting information, and assisting all groups with taxa identification.

7. References:

Grizzetti B. Lanzanova D. Liquete C. Reynaud A. & Cardoso A.C. 2016. Assessing water ecosystem services for water resource management. *Environmental Science & Policy* 61: 194-203.

Walsh CJ. Roy AH. Feminella JW. Cottingham PD. et al. 2005. The urban stream syndrome: current knowledge and the search for a cure. *J. N. Am. Benthol. Soc.* 24(3): 706-723.

Wu H. Chen J. Xu J. Zeng G. et al. 2019. Effects of dam construction on biodiversity: A review. *Journal of Cleaner Production* 221: 480-489.