The Impact of Land Cover on Habitat Assessment and Nitrogen Levels in Vermont's Lake Champlain Basin

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Introduction

- Nitrogen is a naturally occurring nutrient that is essential to aquatic ecosystems. Dissolved nitrogen is in the form of nitrate and nitrite (Connolly, 2015). Natural sources of aquatic nitrogen include plant materials (detritus) or naturally eroding soils (Klapproth & Johnson, 2009). Most dissolved nitrogen is the result of human activities including lawn and crop fertilizers and sewage.
- Habitat assessment is a way to assess the quality of an ecosystem around a particular stream. These assessments are broken down into many individual assessments including determining flow, looking at riparian vegetation around the stream, canopy cover, bank stability, etc. These assessment is of high importance as land cover has a huge effect on the physical and chemical characteristics of a stream (Astudillo, 2015).
- I hypothesized that there would be a relationship between habitat assessment score and the amount of nitrogen in individual streams. Additionally, I hypothesized that there would be a relationship between land use and habitat assessment score. Based on a study by Astudillo (2015), that indicated land cover has a huge effect on physical and chemical characteristics of a stream, I predicted:
  - If a stream has a better habitat assessment score, nitrogen levels would be lower in that stream
  - If a large percentage of a watershed is agricultural, that habitat score will be low
  - If a large percentage of a watershed is urban, the habitat score will be low
  - If the watershed is mostly forested, the habitat score will be high

Methods

Nitrogen Data

- Nitrate and nitrite are passed through a column of granulated copper cadmium to reduce all nitrate to nitrite.
- Nitrite is then turned into a highly colored dye and levels can be measured colorimetrically.
- Steps can also be carried out to obtain values for nitrate and nitrite separately.

ISCOs

- Water samples are collected using an automated water sampler, an ISCO. ISCOs are programmed by the USGS, and a pulse telling the ISCO to collect a sample occurs when the height of the stream is elevated or the water is flowing at a certain speed, usually after a storm with significant rainfall.
- In addition, baseline grab samples are taken at each ISCO site throughout the sampling season.

GIS

- All land use data was collected from the EPSCoR online database.

Habitat Assessment

- A way to evaluate stream characteristics like the existence of riffles and pools in a stream, riparian buffer zones, etc.
- Individual categories at each stream are scored from 1-20 and these scores are added together resulting in an overall habitat assessment score.

Results

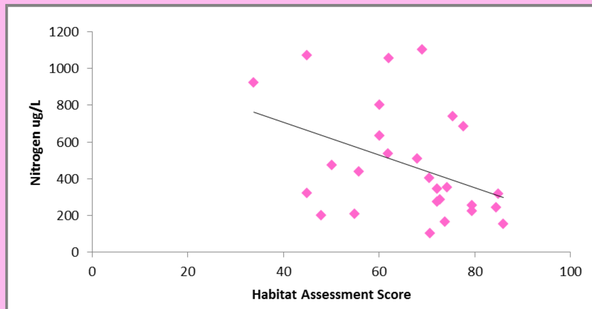

Figure 1. The relationship between habitat assessment score and nitrogen levels (ug/L) in streams within the Lake Champlain basin. The relationship between nitrogen and the habitat assessment score was significant (p=0.037), (R^2 = 0.1619).

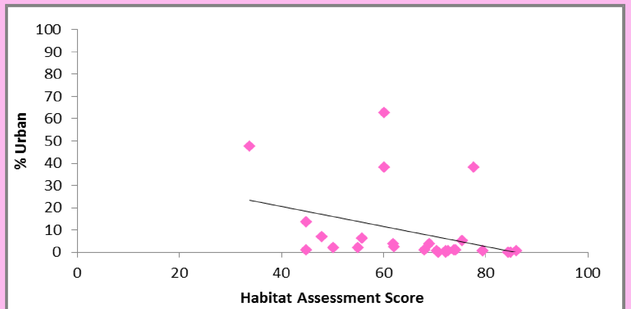

Figure 3. The relationship between habitat assessment score and the percentage of the watershed classified as urban. The relationship was negatively correlated but not significant (p=0.06, R^2 = 0.1333).

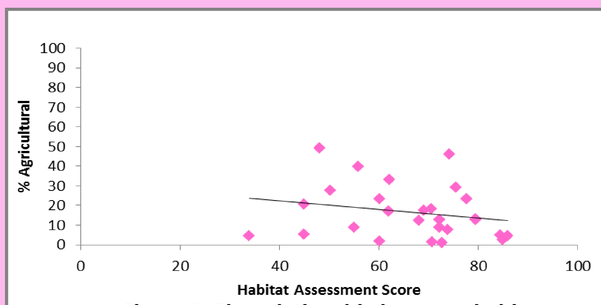

Figure 2. The relationship between habitat assessment score and the percentage of the watershed classified as agricultural. The relationship was negatively correlated but not significant (p=0.26, R^2 = 0.0498).

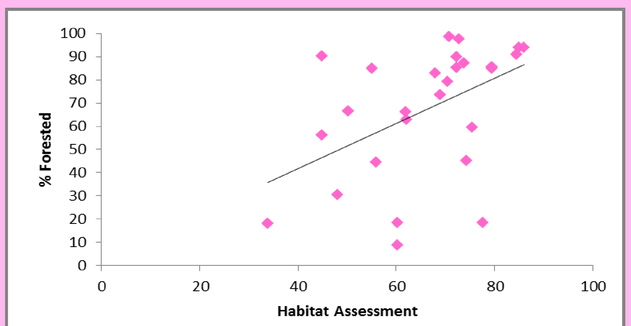

Figure 4. The relationship between habitat assessment score and the percentage of the watershed classified as forested. The relationship was positively correlated and significant (p=0.01, R^2 = 0.2254).

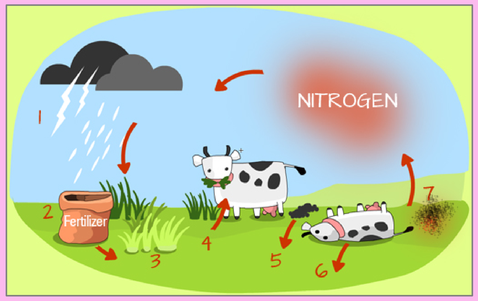

Figure 5. A cartoon diagram of the nitrogen cycle. Nitrogen makes up 78% of the atmosphere, the nutrient is also found in plants, fertilizer, as well as animal waste and decay.

Discussion

- Nitrogen is a naturally occurring nutrient in the air, soil, and water. Nitrogen occurs naturally in forested sampling sites, the specific source of the nutrient at these sites is decaying detritus. However, some nitrogen is added to the environment through human activities. In agricultural settings, this can be in the form of manure application and crop fertilizers. In urban settings, this can be in the form of lawn fertilizing, coal and oil burning plants, as well as the presence of sewage.
- Habitat assessment refers to the process in which we visit sites and score different aspects of the stream surroundings including riparian buffer zones, stream bank stability, stream flow, etc. Scores for individual categories are added together to get an overall score, a higher habitat assessment score is indicative of a healthier stream surrounding.
- Initially, I predicted that habitat assessment score would be negatively or positively affected by the land use in the watershed of a stream.
- Figure 1 shows a significant relationship between habitat assessment score and levels of nitrogen. As the habitat score increases, the amount of nitrogen decreases, supporting my initial predictions. However, the correlation was not as strong as I had anticipated (R2= 0.1619).
- Figures 2, 3, and 4 detail relationships between habitat assessment score and agricultural, urban, and forested watersheds, respectively. Each relationship was correlated, Figure 4 indicated the only significant relationship between habitat assessment score and percent forested catchment. This relationship was positively correlated, as the percent catchment of the watershed that was forested increased, the habitat assessment score also increased.
- While results supported my hypothesis, the figures did not indicate a relationship that was as strong as I had thought.
  - Streams in Vermont do not have a large urban percent catchment, and this could result in a difference from my hypothesis. There are no oil or coal burning plants adding nitrogen to streams (Figure 2).
  - Additionally, landscape plays a huge role in runoff and where storm water enters the stream. Habitat assessment does not account for this. The areas in which runoff enters the stream could be upstream or downstream of the sampling site (Figure 1).
- "The valley rules the stream," (Astudillo, 2015) indicates that land cover has a *huge* impact on chemical stream characteristics. Generally crop land has a strong influence on nitrogen loadings in river water (Bu, et. al., 2016).
- Habitat assessment subjectivity could have an impact on data.
- Additionally, even good riparian zones aren't enough to bring nitrogen concentrations down to recommended water quality guidelines (Connolly, 2015). A major way to reduce nitrogen levels? Reduce fertilizer application.

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