How does proximity to human development affect water quality characteristics in streams?

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ABSTRACT

Human development can impact freshwater ecosystems in a number of ways. This investigation sought to evaluate these impacts through a macroinvertebrate-based analysis of various points in a local stream. Specifically, I evaluated whether there was a discernible difference between sites along Birch Mountain Brook—characteristic of suburban development and different in water quality metrics at points with different proximities to human development to draw conclusions about the overall health of the stream. To do so, samples of macroinvertebrates were collected from four riffle sites in the stream and analyzed to the family level. In addition, pH, phosphorous, and dissolved oxygen levels were measured at each site. Examination of macroinvertebrate results showed that while the stream was overall healthy, there were some interesting disparities between sites. Sites further away from human development and more upstream exhibited the most diversity, a greater presence of pollution-indicator orders, and fewer indicators of organic pollution. These results imply that there may be an inverse relationship between stream ecosystem quality and proximity to human development, an implication that is particularly relevant as suburban developments continue to expand and impact ecosystems like that of this stream.

INTRODUCTION

Between 1985 and 2010, Connecticut gained an astounding 149 million square acres of developed land—land that is characterized by the presence of roads, rooftops, and parking lots. About 19% of Connecticut is now developed land.3 Such a dramatic increase can translate to significant impacts on surrounding freshwater ecosystems, such as loading sediments, altering stream environments, and damaging local stream ecosystems. While many new homes are being constructed, these new developments may be accompanied by increased pollution and environmental stressors and toxins. I aimed to determine whether there were discernible differences in the percentage of pollution-indicator orders and pollution-tolerant orders among the sites as well as the number of families belonging to these orders

MATERIALS AND METHODS

Area of Study

This investigation was conducted in various sections of Birch Mountain Brook, a stream that flows adjacent to Birch Mountain Road, through Case Pond, and under Spring Street in Manchester, CT (see Fig. 1).

Data Collection

For each site, dissolved oxygen, phosphate, and pH levels were tested according to the test manufacturers’ directions.

Macroinvertebrate samples were collected during October and November 2015, the standard season for data collection of this type. A series of steps were followed to collect each set of sample organisms.

1. Select a riffle habitat and choose different stops to collect macroinvertebrates.
2. For each site, dissolve oxygen, phosphate, and pH levels were tested according to the test manufacturers’ directions.
3. Pick out organisms and place in a vessel of alcohol for preservation. Work through the sample until 100 bugs have been found and preserved. This produces one macroinvertebrate sample for one site.

RESULTS

Water Chemistry

Most sites showed similar pH and dissolved oxygen levels (see Fig. 2).

% of total individuals belonging to EPT orders

Overall family diversity—Site 1, the furthest upstream site, had by far the greatest number of families (18) compared to the downstream sites (Fig. 3).

EPT index—This index measures water quality by calculating the number of different families belonging to the three most pollution-sensitivity orders of macroinvertebrates—Ephemeroptera, Plecoptera, and Trichoptera. (Fig. 6)—in a given sample. The metric does not take into account the number of individuals in these families. Site 1 had the highest EPT index (9), while Site 3 and Site 4 were tied for the lowest EPT index with a score of only 3 (Fig. 3).

RESULTS CONT.

Feeding groups—Each macroinvertebrate family can be grouped into five main feeding groups—collector-gatherers, scrapers, collector filterers, shredders, and predators. Based on the properties of each feeding group, one can draw conclusions about things like the availability of resources such as food for the macroinvertebrates and the different roles each plays in ecosystem function at points with different proximities to human development.

CONCLUSIONS

Overall, these results suggest that Birch Mountain Brook is a relatively healthy stream, based on its high oxygen content (Fig. 2) and the presence of indicators like scrapers and shredders, EPT order members (Fig. 4), and other organisms like a young brook trout found in Site 3 (a species that requires high oxygen levels and generally good water quality). However, there were some marked differences between sites in many of the water quality metrics used. Downstream sites generally showed more indicators of mild pollution and lower water quality according to the water quality metrics used, with a few exceptions in the case of Site 3. While these results do not point directly to human impact, they may suggest that human developments like roads, houses, and tunnels—all of which are found in increasing concentration the further downstream one goes—can have an impact on the stream ecosystem. This point is particularly salient in an era when suburban developments in Manchester and other towns like it are continuing to expand, producing vast quantities of pollutants through sediments, stormwater runoff, fertilizers, and other chemicals that are an inevitable result of modern lifestyles. More investigation would be required to make a more direct link between these lifestyles and pollution in these ecosystems, so as to inform conservation efforts in the future.

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REFERENCES