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EEB Research Project
5-7-04

Effects of Stream Alteration on Benthic Macroinvertebrates in Seven Mile Creek and Shanaska Creek

Introduction:

A stream ecosystem is quite intricate. Effects on stream alteration, including clearing riparian zones, substituting agricultural crops for native flora, impounding streams, and the channelization of streams for navigation/irrigation/drainage reasons, have major repercussions on the biodiversity of the stream, including its benthic macroinvertebrates (Hynes 1970, Hilsenhoff 1977, Kerans and Karr 1994, Barton 1996, Gergel et al. 1999). Biotic indices of benthic macroinvertebrates can be used as "indicator species" to determine the quality of a stream (Hilsenhoff 1977, Kerans and Karr 1994, Wallace et al. 1996, Pacific Streamkeepers Association 2000).

Benthic macroinvertebrates are spineless animals that live part of their lives in the bottom of a body of water, and are visible to the naked eye (Hynes 1970). They are particularly good indicators of localized conditions due to their limited migration patterns. Many combined factors regulate the distribution, variety, and number of benthic macroinvertebrates including: current speed for food availability, colder temperatures, substratum, dissolved substances (oxygen), liability to drought and floods, and competition between species (Hynes 1970).

For my study, I looked at Seven Mile Creek and Shanaska Creek, both located south of Saint Peter. Near its mouth to the Minnesota River in Seven Mile Creek Park, the Minnesota DNR has managed brown trout (*Salmo trutta*) in Seven Mile Creek since 1986. This section in the park is considered a "marginal trout stream" due to its improved habitat and presence of coldwater springs (Kuehner 2001). The stream's headwaters (Highway 99 crossing), which are located several miles upstream, have been impacted by agriculture.

An outlet of Lake Washington, Shanaska Creek travels through the town of Kasota before empting into the Minnesota River. At its headwaters, Shanaska Creek flows unaltered from Lake Washington before crossing Highway 19 south of the intersection of Highway 102 where it has been rechannelized. This altered channel, known as Ditch No. 67, then flows back into the natural Shanaska Creek channel north of Highway 102.

I compared levels of benthic macroinvertebrates at each site to determine if they do "indicate" the quality of a stream. I hypothesized that the unimpacted sections will have a wider range and number of benthic macroinvertebrates than the impacted sections.

Methods:

Study Sites

I compared the headwaters and park area of Seven Mile Creek (Figs. 1b, 2b) as well as above and below Ditch No. 67 in Shanaska Creek (Figs. 1c, 2c). For a control (Barton 1996), I used a quality, unaltered stream in the Upper Peninsula of Michigan (Figs. 1a, 2a). Qualitative Habitat Evaluation Index (QHEI) field sheets were done at each stream site in order to quantify a rating with a 0 for lowest quality and a 100 for highest quality. The index tested for a variety of conditions including: substrate, instream cover, channel morphology, riparian zone, bank erosion, and pool/glide and riffle/run quality. I also recorded the water temperature, stream velocity, and rate of flow at each site (Ohio Environmental Protection Agency 2001).

Macroinvertebrate Sampling

I collected and measured benthic macroinvertebrates (experimental unit) using a Surber sampler. At each site I randomly drew a transect horizontal to the stream channel, and took a sample at ¼, ½, and ¾ the width of the stream along the transect. Placing the Surber sampler on the stream bottom so that the net was swept downstream, I cleared the area within the frame (1 ft^2), allowing the current to sweep any organisms into the net (Brower et al. 1998). For each site, I emptied each sample into a shallow white pan filled with some water, and combined all samples in a labeled plastic bucket. In the laboratory, I identified and counted each benthic macroinvertebrate (Appendix 1b) using a 5x hand lens and dichotomous keys (Needham and Needham 1962, Hilsenhoff 1975). I classified the macroinvertebrates to genus (*Heptagenia*, *Leptophlebia*, and *Pteronarcidae*) to family (Leptoceridae, Limnepheilidae, Athericidae, Chironmidae, Tipulidae, and Physidae), to order (Hemiptera, Coleoptera, Amphipoda, and Hydracarina), and to class (Turbellaria, Olgiochaeta, and Hirudinea).

Biotic Indices

I measured each site's overall population size and diversity using several common metrics. Benthic macroinvertebrates are broken into three categories, based on their ability to withstand stress (pollution, degradation of habitat). Category 1 macroinvertebrates are stress intolerant, and can only live in high water quality conditions. Category 2 macroinvertebrates are somewhat tolerant of stress. Category 3 macroinvertebrates are stress tolerant, and can handle adverse water quality conditions (Pacific Streamkeepers Association 2000).

At each site, I compared total numbers of individuals and taxas for categories 1-3, using this data to measure abundance and density, predominate taxa, water quality indexes (including pollution tolerance, EPT index, EPT to total ratio, and Chironomidae index), and diversity assessment. This data was interpreted into an overall site assessment rating with a 1 for poor and a 4 for good (Pacific Streamkeepers Association 2000).

Results:

Cooks Run (control stream) had the highest QHEI scores with a 95 and 99 at its respective sites. Seven Mile Creek had QHEI scores of 41 at its headwaters and 76 at Seven Mile Creek Park. Shanaska Creek had QHEI scores of 62 above Ditch No. 67 and 27 below Ditch No. 67 (Appendix 1a).

Cooks Run (control stream) had overall site assessment scores of 3 and 3.5 at its respective sites (Appendix 1c). Cooks Run had the greatest majority of Category 1 macroinvertebrates (Fig. 3), as well as the highest number of EPT (Category 1) macroinvertebrates of the three streams (Fig. 4). Seven Mile Creek had an overall site assessment score of 1 at its headwaters and a 2.25 at Seven Mile Creek Park (Appendix 1c). The park area had a larger percentage of Category 1 and 2 macroinvertebrates (Fig. 3), as well as a lower Chironomidae (Category 3) index (Fig. 5) than the stream's headwaters. The distribution of macroinvertebrates was significantly different between the headwaters and park area ($X^2 = 18.5$, $P < 0.001$). Shanaska Creek had an overall site assessment score of 1.75 above Ditch No. 67 and a 1.5 below Ditch No. 67 (Appendix 1c). The site below the ditch had more Category 3 macroinvertebrates (Fig. 3), as well as more Chironomidae (Fig. 5) than the site above the ditch. The distribution of macroinvertebrates was significantly different above and below the ditch ($X^2 = 12.7$, $P = 0.0018$).

Discussion:

The Minnesota River and its tributaries (including Seven Mile Creek and Shanaska Creek) have been influenced by stream alterations. Much of the Minnesota watershed is directly impacted by agriculture (Kuehner 2001). The substitution of agricultural crops for natural flora can lead to soil erosion and embeddedness, resulting in degraded stream habitat (Hynes 1970, Barton 1996). This is seen in the lower QHEI score for the headwaters of Seven Mile Creek. The channelization of streams for navigation/irrigation/drainage reasons also has a negative effect on stream habitat (Hynes 1970), as seen in the lower QHEI score for the site below Ditch No. 67 in Shanaska Creek.

Distributions of macroinvertebrates, including numbers and stress tolerance, are affected by the quality of a stream. High numbers of Category 1 macroinvertebrates and low numbers of Category 3 macroinvertebrates in Cooks Run indicate a high quality stream with few alterations (Hilsenhoff 1977, Pacific Streamkeepers Association 2000). The opposite trend in Seven Mile Creek and Shanaska Creek indicate a lower quality streams with heavy impact (Hilsenhoff 1977, Pacific Streamkeepers Association 2000).

The effects of stream alteration can be seen within a stream as well. Shanaska Creek had a higher number of Category 1 macroinvertebrates and lower number of Category 3 macroinvertebrates at the natural site (above Ditch No. 67), with an overall site assessment of 1.75. As the stream was altered by channelization, its quality suffered. Category 3 macroinvertebrates saw a rise in numbers while Category 1 macroinvertebrates saw a decline. The overall site assessment score also dropped to a 1.5.

Seven Mile Creek also had differences between sites due to stream alteration. Several organizations, including the Minnesota Department of Natural Resources, have done trout stream improvement projects on the stream in Seven Mile Creek Park. Due to an influx of spring water in the park area and stream habitat improvements, the stream is suitable for brown trout (*Salmo trutta*). The stream's quality in the park area was indicated by its moderate numbers of Category 1 and 2 macroinvertebrates, and an overall site assessment score of 2.25. The headwaters, which have been altered, had a lower overall site assessment score with a 1. Compared to the park area, lower numbers of Category 1 and higher number of Category 3 macroinvertebrates were found in the headwaters. The difference in macroinvertebrates between the park and headwaters in Seven Mile Creek is less than that of Shanaska Creek above and below Ditch No. 67. The impact of agriculture on Seven Mile Creek has been lessened due to work done by several organizations, including the Brown Nicollet Cottonwood Water Quality Board. Improvements, including runoff control and stream monitoring, have improved Seven Mile Creek. These methods are shown to be successful, and should be implemented in impacted streams to improve their quality.

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