Summary

This report is a follow-up to the *Nimishillen Creek Macroinvertebrate Survey* conducted by the Northeast Ohio Four County Regional Planning and Development Organization (NEFCO) in the fall of 2000 (NEFCO, 2000). The original study was conducted to obtain baseline data and characterize Nimishillen Creek's water quality in the Canton area. In addition to the goals of the 2000 report, this follow-up study will also identify areas that have shown significant changes (macroinvertebrates scores, pollution, riparian habitat, etc.) over the past two years.

NEFCO staff sampled the same selected sites as the 2000 Survey within the Nimishillen Creek watershed at approximately the same time of year (late summer and early fall) using the methodology from the Scenic Rivers Stream Quality Monitoring Program. The Ohio Department of Natural Resources (ODNR) developed this methodology as a screening tool for environmental education to examine the macroinvertebrate community and to score stream segments accordingly.

Macroinvertebrate monitoring was conducted at sixteen sampling stations, with three samples per station. The sampling stations are located throughout the watershed, but primarily at the confluence of the three main tributaries near downtown Canton. A copy of the Stream Quality Assessment Form for each of the three samples taken at each monitoring station (forty-eight samples in total) is included in the report. In general, the 2002 results of the macroinvertebrate monitoring were slightly lower than in 2000. However, the data still implies that the waters of the Nimishillen Creek watershed, in the vicinity of the City of Canton, are of relatively fair quality, but are most likely still not meeting the designated standards.

It should be noted that all the sampling sites were chosen for their ideal habitat conditions; i.e. exposed rocks, riffles, and low sediment. Existing biological communities adjust their composition (diversity and number) to the quality of the water that flows over and around them. Poor water quality promotes poor communities of macroinvertebrates even in ideal habitat conditions. Excellent water quality encourages a diverse biological community of macroinvertebrates in an ideal habitat. By holding habitat as a constant (as much as possible) insight can be gained into chronic water conditions from the watershed. Sampling of additional parameter (chemical and bacterial) within the watershed may provide more comprehensive baseline data that would better evaluate water quality conditions within the Nimishillen Creek watershed.

Ohio EPA's standardized method for sampling macroinvertebrates is the Invertebrate Community Index (ICI). It is a more effective method of determining the water quality of a stream than ODNR's Scenic Rivers Stream Quality Monitoring Program. However, two reports written by the Ohio EPA (Dilley, 1991; Yoder and Davis, 1996) indicate that ODNR's technique in determining the health of a stream is reliable in certain circumstances. Both reports have found that the results from ODNR's Stream Quality Monitoring Program have correlated somewhat with Ohio EPA's ICI when the water quality was excellent, fair or poor. It is also suggested that when a sample reveals excellent water quality (using ODNR's technique), that sample is most likely meeting

Ohio EPA's Warmwater Habitat use designation (based on macroinvertebrate monitoring only).

Introduction

The purpose of this report is to continue the study of Nimishillen Creek's water quality by characterizing and monitoring the status of the macroinvertebrate communities in the stream. This report funded by the City of Canton is a followup to the 2000 *Nimishillen Creek Macroinvertebrate Study* and indicates the City of Canton's commitment to regular water quality monitoring of Nimishillen Creek and its tributaries (NEFCO, 2000).

Macroinvertebrates are organisms (such as insects, worms, clams) that "lack a backbone and are visible to the naked eye" (ODNR, 1993). The condition of the stream's macroinvertebrate community can provide the baseline data needed to measure water quality progress, as well as identify areas for possible stream remediation. ODNR's Scenic Rivers Stream Quality Monitoring Program is a screening tool that helps to identify these areas. Over time, long term macroinvertebrate monitoring can help identify trends (improving or degrading) of the Creek's overall health.

The examination of benthic macroinvertebrates has several advantages: their size makes them easy to identify, their limited mobility restricts them to specific environments or areas, and their life cycles span months or even years and, therefore, makes them indicators of past as well as present stream conditions. For example, if pollutants impact a stream, a considerable period of time may be required for the macroinvertebrate community to fully recover. Therefore, macroinvertebrate surveys can provide information regarding the long-term quality of a stream.

The benthic macroinvertebrate community is commonly used as an indicator to determine the environmental quality of a stream. Analysis of the community structure, especially species composition, diversity of taxa, number of taxa, a stream's physical characteristics, and surrounding land use, provides a more accurate representation of the condition of the aquatic ecosystem when determining water quality. However, according to the Ohio EPA, when determining the water quality of a stream, two or three groups of organisms (i.e. aquatic insects, fish, plants) should be examined in order to get more accurate results. Macroinvertebrate monitoring looks at one group of organisms, providing only part of the story about the health of a stream (Yoder and Davis, 1996).

Many waterways suffer from some degree of degradation ranging from mild nutrient enrichment from wastewater treatment plants, failing septic systems and agricultural activities, to the dumping of toxic chemicals by manufacturers. Effective evaluation is necessary if water quality problems are to be identified and mitigated. A number of methods to assess stream quality may include the evaluation of the physical, chemical and biological characteristics of a stream. Although physical and chemical conditions are easy to measure, the use of these parameters as the sole criteria for water quality evaluation has limitations. Chemical measurements represent the condition of the stream only at the time of measurement. Contaminants, which may have affected the aquatic community, may be missed at a particular sample time as the contaminants are swept downstream. However, the biological communities within the aquatic system provide a more comprehensive picture of the actual, long-term conditions. One community commonly used to determine the water quality of a stream are the benthic macroinvertebrates.

Methodology

Assessment of the water quality of Nimishillen Creek involved re-sampling and re-monitoring the biological and physical parameters of the sixteen sampling sites selected in the original survey (NEFCO, 2000). The biological evaluation consisted of a survey of the benthic macroinvertebrate community. Evaluation of the physical characteristics of the sites included measurements of the stream's dimensions, habitat, riparian corridor, land uses, and possible adverse impacts.

During October of 2002, a survey of the benthic macroinvertebrates community was conducted by using the Ohio Department of Natural Resources' (ODNR) Scenic Rivers Stream Quality Monitoring Program (kick seining technique) (ODNR, 1993). Figure 1 indicates the locations of the sampling stations and Table 1 lists the sampling date, location, river mile, and latitude/longitude of each site. For further details on the procedure for macroinvertebrate sampling, please refer to the *NEFCO Citizen Stream Monitoring Program Final Report* (NEFCO, 1994).

Several physical parameters were measured at each of the sampling stations. These parameters included stream width, depth, temperature, water condition, bed composition, habitat, stream shading, stream bank vegetation, stream channel alterations, in-stream alterations, the riparian corridor, possible point and nonpoint sources, and surrounding land use. Refer to the Stream Quality Assessment and Stream Inventory - Watershed Assessment Forms found in Appendix A. Also, photos of each station were also taken and compiled into a photo album found in Appendix B.

The width and depth of the streams were measured using a Keson 300 Feet tape measure (Model OTR-18M-300). The stream width was measured at the widest point of the sampling area. The depth was measured at the actual sampling area. The temperature was measured using alcohol centigrade thermometers. Evaluation of the substrate was accomplished by visual inspection each sampling location and classifying the substrate according to percent bedrock, boulder, gravel, sand, and silt.

Sites were chosen based on adequate riffle activity, riparian cover, accessibility and good in-stream habitat (boulders, cobbles, and gravel that provide a home for macroinvertebrates). The riffle areas represent the best habitat for macroinvertebrates and should produce the maximum number of species and individuals. However, it should be noted that riffle areas alone do not represent the entire biological community within a stream. Pool and margin areas are also micro-habitats that should be sampled in order to obtain the best picture of distribution and presence of taxa.

A sample point in the riffle was selected based upon a variety of factors including stream bed compositions and water depths. Ideally, the sample site should contain stones ranging from gravel size to greater than 10 inches, with water depth between two inches to one foot and a moderate stream velocity. The seine was placed into the riffle, and an area the width of the outstretched seine and the length three feet upstream was disturbed. Initially, boulders and cobbles were moved and rubbed gently by hand to dislodge any organisms such as crayfish, snails, clams, and benthic macroinvertebrates. The remaining stream bed material was kicked vigorously side-to-side and toward the seine to dislodge any remaining organisms. The purpose was to trap as many macroinvertebrates in the net as possible. The seine was then carefully removed from the riffle to avoid losing any organisms and carried over to the stream bank and placed over a table. Leaves, rocks and debris were carefully examined for organisms and removed from the seine. The macroinvertebrates were sorted by type and placed into a divided plastic tray filled with water and were counted and grouped into three categories: Taxa 1 (pollution-intolerant organisms), Taxa 2 (organisms that can live in both polluted or clean water), and Taxa 3 (pollution-tolerant organisms) (Appendix A).

Once all the macroinvertebrates were counted and grouped, the number of different types of organisms per taxa group were tallied. This number was then multiplied by an index value to get a total for each taxa group. Assigning index values was a way to weight each aquatic insect to emphasize the importance of the intolerant macroinvertebrates. The index value for group one taxa is 3 (heavily weighted for most pollutant intolerant macroinvertebrates); the index value for group two taxa is 2 (moderately weighted for organisms who can live in both polluted or clean waters); and the index value for group three taxa is 1 (the lowest weight for the most pollutant tolerant organisms). The total from each of the three taxa categories was then combined to get the cumulative index value (CIV). Cumulative index values less than 11 were given a poor rating; a fair rating was assigned if the CIV was between 11 and 16; CIVs between 17 and 22 were given a good rating; and an excellent rating was assigned if the CIV was 22 or higher. This procedure was repeated two more times (three total samples) in a different riffle area at the same stream segment. Therefore, there were three cumulative index values (A, B, and C) for each sampling site.

Results

A summary of the selected physical characteristic for each sampling site is contained in Table 2. For more information regarding the physical parameters, refer to Appendix A which contains the *Stream Quality Assessment and Stream Inventory - Watershed Assessment Form* for each monitoring site.

Stream temperatures taken during the monitoring period of October ranged from 48.2^{o}F to 66.2^{o}F. The temperatures for each sampling site can be found in the Stream Assessment forms in Appendix A.

The results (mean CIVs) of the macroinvetebrate surveys at each of the selected stations all fell within the fair and good water quality range. Table 3 presents the mean

CIVs and corresponding stream segment conditions (poor, fair, good, excellent) for each site surveyed. Stations 2, 4, 5, 7, 8, 9, 10, 12, 13, and 15 all received scores indicating fair water quality, with sample sites 5 and 11 scoring the lowest with mean CIVs of 11. Stations with good water quality scores were 1, 3, 6, 11, 14, and 16. Station 14 had the highest mean CIV (22) of all the sites sampled. Refer to Table 2 and Figure 2 for the location and water quality results for each site.

Appendix C illustrates the type and abundance of macroinvertebrates recorded at each of the sixteen stations.

The mean CIV for the entire Nimishillen Creek watershed was 15 indicating the overall water quality for the Creek and its tributaries was fair.

West Branch Results

Four sites (3, 5, 13 and 14) on the West Branch of the Nimishillen Creek were surveyed for macroinvertebrates. Site 14 had the highest cumulative index value (CIV) score of 22 (good). The first two scores were excellent with the third rating a good. All samples contained a variety of taxa from each of the three groups. Caddisfly larvae (group one taxa), aquatic worms (group three taxa), and planaria (group three taxa) were the most abundant organisms. Site 3 had the second highest rating among the West Branch sites with a mean CIV rating of 17 (good), with consistent scores of 16, 19, 17, respectively. This site also had multiple organisms from each of the three taxa with caddisfly larvae, beetle larvae (group two taxa), aquatic worms, and planaria being the most abundant macroinvertebrates in each of the three samples. The three samples taken at Site 13 also varied considerably with CIV scores of 8, 18, and 15, averaging out to a score of 14 (fair). The dominant taxa collected in each sampling were caddisfly larvae, beetle larvae, and aquatic worms. The lowest CIV scores on the West Branch of the Nimishillen Creek was at sample station 5. The site had a mean CIV score of 11, tied for the worst among all locations sampled in the entire Nimishillen Creek watershed, and had the greatest variability of all West Branch sites with scores of 8, 12, and 16, respectively. This site lacked both variety and abundance of macroinvertebrates. Caddisfly larvae, crane fly larvae (group two taxa), and aquatic worms were found in the greatest number.

Middle Branch Results

There was one site (station 1) sampled on the Middle Branch of Nimishillen Creek. Station 1 had a good mean CIV of 18. However, sample A's CIV score of 22 (excellent) was well above samples B (16) and C (15) scores (both fair). Sample A had a greater variety of organisms than the latter two samples, including mayfly larvae (group one taxa), sowbugs (group two taxa), and blackfly larvae (group three taxa) which increased its CIV score. However, each of the samples had an abundance of planaria (group three taxa), pouch snails (group three taxa), with only beetle larvae (group two taxa) and small numbers of organisms from the other (more pollutant intolerant) taxa groups.

Table 3
Mean Cumulative Index Values (CIVs) and stream segment conditions based on macroinvertebrate surveys at selected sites

Station Number	Sample Date	Stream	Cumulative Index Values*			Mean	
			A	B	C	CIV	Segment Condition**
1	10/1/02	Middle Branch Nimishillen Creek (Reifsnyder Park@ 31st St. and S.R. 62)	22	16	15	18	Good
2	10/9/02	East Branch Nimishillen Creek (Cook Park @ Mahony Rd.)	11	13	14	13	Fair
3	10/4/02	West Branch Nimishillen Creek (Monument Park@ 12th St.)	16	19	17	17	Good
4	10/24/02	Nimishillen Creek Mainstem (Cherry Rd. and Sherrick Dr.)	12	14	14	13	Fair
5	10/23/02	West Branch Nimishillen Creek (Cleveland and Market)	8	12	16	11	Fair
6	10/16/02	Hurford Run (Harrison Ave.)	19	20	14	18	Good
7	10/23/02	Hurford Run (Boliver and 1-77)	16	14	16	15	Fair
8	10/10/02	Sherrick Run (Allen Rd. @Taylor Beverage Co.)	14	13	15	14	Fair
9	10/11/02	Sherrick Run (Cherry Rd./ Central Ave.)	10	12	14	12	Fair
10	10/11/02	Sherrick Run (Moore Rd., just south of Sherrick Dr.)	9	11	13	11	Fair
11	10/9/02	East Branch Nimishillen Creek (Broadway Rd. south of Mahoning Rd.)	12	24	14	17	Good
12	10/10/02	Nimishillen Creek Mainstem (Baum Rd., west of Central Ave, North Industry)	16	11	14	14	Fair
13	10/10/02	West Branch Nimishillen Creek (Navarre Rd.)	9	18	15	14	Fair
14	10/1/02	West Branch Nimishillen Creek (Everhard Rd., east of Whipple Ave.)	22	20	23	22	Good
15	10/9/02	East Branch Nimishillen Creek (Georgetown and Trump Ave.)	10	15	13	13	Fair
16	10/7/02	Tributary to Hurford Run (Shepler Church Rd., just west of I-77)	18	19	19	19	Good

* Stream Quality Assessment (Source: ODNR, Stream Quality Monitoring Manual)
**Excellent: >22, Good: 17-22, Fair: 11-16, Poor < 11.

East Branch Results

The East Branch (and tributaries) of the Nimishillen Creek had 3 sample stations: 2, 11 and 15. Station 11 had a mean CIV of 17 (good). This site had two fair scores with samples A and C, while sample B scored in the excellent range. The most abundant macroinvertebrates were caddisfly larvae (group one taxa) in all samples. The presence of water penny larvae (group one taxa), mayfly nymphs (group one taxa) and dragonfly nymphs (group two taxa) in sample B was the reason for its higher rating. Both stations 2 and 15 had fair cumulative CIV values of 13. All three samples from site 2 had a larger number of organisms from pollution-tolerant taxa (group three taxa) than the other two taxa combined. However, the most abundant organism was the caddisfly larvae, a group one taxa. All three surveys at station 15 resulted in fair scores with caddisfly larvae, sowbugs (group two taxa), beetle larvae (group two taxa), and crane fly larvae (group two taxa) the most voluminous organisms collected.

Hurford Run Results

Macroinvertebrate sampling sites 6, 7 and 16 were in Hurford Run and its tributaries. Site 16 scored the highest with a cumulative CIV value of 19 (good). Caddisfly larvae (group one taxa), water penny larvae (group one taxa), riffle beetle adults (group one taxa), crane fly larvae (group two taxa), beetle larvae (group two taxa), and midge larvae (group three taxa) were collected during each sampling event. Sample station 6 also had a good mean CIV score (18). Caddisfly larvae was the most abundant macroinvertebrate at this site. Site 7 had a fair CIV of 15. For all three samples at this site, the only pollution intolerant organism found was caddisfly larvae. Other macroinvertebrates like crane fly larvae, beetle larvae, clams (group two taxa), midge larvae, and pouch snails (group three taxa) were also present for all three samples, but in small quantities.

Sherrick Run Results

Sherrick Run had three sample sites, 8, 9 and 10, and all had fair cumulative index values of 14, 12, and 11, respectively. At station 8, caddisfly larvae (group one taxa) was the most numerous macroinvertebrate collected in all three samples. However, all other organisms collected, except one riffle beetle adult, were group two or group three taxa. Site 9 macroinvertebrate sampling was also dominated by caddisfly larvae with very few other organisms collected. The worst sampling site along Sherrick Run was Station 10. The site had the lowest cumulative CIV score of all the sites sampled in the Nimishillen Creek watershed. Caddisfly larvae and crane fly larvae (group two taxa) were the macroinvertebrates found in largest quantities. All other taxa found at site 10 were in low quantity.

Nimishillen Creek Mainstem Results

Two sites were sampled along Nimishillen Creek's mainstem, stations 4 and 12. Of the two sites, station 12 had the higher mean CIV score of 14 (fair). Caddisfly larvae (group one taxa) was the predominant organism collected in each of the three samples.

Clams (group two taxa) and aquatic worms (group three taxa) were the only other macroinvertebrates captured during all three sampling attempts. Like site 12, station 4 also had a fair CIV score of 13. The most abundant organism in all three samples was caddisfly larvae, with beetle larvae (group two taxa), aquatic worms (group three taxa), midge larvae (group three taxa) and pouch snails (group three taxa) also collected in each of the three samples.

Discussion

Physical Characteristics

An ideal stream sampling site has a good riparian habitat consisting of a variety of vegetation (trees, plants, shrubs, etc.), good in-stream habitat, and a good riffle area. Many of the sixteen sites sampled did have these characteristics (Table 2), yet failed to score well in the macroinvertebrate monitoring. For example, sampling site 9 appeared to have the ideal habitat, however, it only received a fair mean CIV of 12. A site that scored a high CIV (station 1) is located in an urban park that has virtually no riparian habitat at all; has numerous storm water outlet pipes resulting in sedimentation; the riffle activity is adequate, and the in-stream habitat is average. With this in mind, it may be suggested that riparian habitat, riffle activity and in-stream habitat are not limiting factors on the macroinvertebrate communities. It seems that other factors are affecting the water quality and macroinvertebrate communities of these streams, such as the industrial and urban land uses that surround these streams.

Stream Temperature

The stream temperatures measured at each sampling station were lower than the criteria established for the Ohio River basin. The stream temperatures that were recorded during that time period ranged from 48.2°F to 66.2°F (Appendix A).

Sampling results did indicate stream temperatures are affected by various land and water uses in and around the City of Canton. This effect is readily observable during the fall and winter when cooler stream temperatures noticeably increase as a result of various urban sources including industrial or utility plant cooling water discharges, runoff from impervious surfaces, discharges from wastewater treatment plants, and/or solar warming from inadequate riparian cover.

NEFCO's sampling results provided two separate indications of thermal warming from urbanized areas. This was accomplished by comparing water temperatures taken on the same day from urban sites with point source dischargers and/or lacking riparian habitat, and from sites with few or no known point sources and/or good riparian cover. Sites 12, located downstream of the City of Canton's Water Pollution Control Center, and site 13, located in the City of Canton, were respectively 8.1°F and 13.2°F warmer than station 8 located in Sherrick Run, a tributary with high to moderate riparian quality and no industrial dischargers (NEFCO, Nov. 2000). Site 2, located near the mouth of the East Branch and directly downstream of Republic Engineered Steel, Inc. was 6.3°F and 5.4°F warmer than sites 11 and 15, respectively. Sites 11 and 15 are located in a less industrialized area upstream of station 2.

Increased stream temperature enhances oxygen retention in the water and facilitates the stream assimilative capacity. Variation of stream temperature could affect feeding, reproduction and the metabolism of aquatic animals. Temperature preferences among species vary, but all species can tolerate slow, seasonal changes better than rapid changes. Factors that could lower stream temperature are underground water sources, snow melt and shade (Campbell and Wildberger, 1992).

Benthic Macroinvertebrate Monitoring

Even though this type of stream assessment takes into consideration all of the factors which can pose threats to aquatic life, such as stream modification, climatic change and land use within the riparian buffer zone, one should understand that even sampling of the macroinvertebrate community has its limitations. For example, it cannot specifically identify any pollutant that is impacting the macroinvertebrate community, and the presence of any particular species may only indicate that the minimum requirements for its existence have been met. In addition, its absence or presence may be due to factors other than water quality problems. These may include the natural change of dynamics of the macroinvertebrate community (seasonal cycles), unsuitable natural conditions, substrate composition, and the lack of introduction into a stream.

The monitoring results suggest that ten sampling sites had fair water quality and the remaining six sites had good water quality (Table 3). NEFCO staff took the mean of all scores from the sixteen sites, giving the streams in the watershed an overall evaluation of fair water quality. Most of the sampling stations had a good riparian cover and riffle activity; however, the Nimishillen Creek watershed is heavily urban and industrial, which may explain the majority of low cumulative index values. This evaluation may be attributed to the predominance of storm water runoff (from major industries in the area), urban runoff and sedimentation within the watershed.

When looking at the macroinvertebrate monitoring results for each stream (starting from upstream locations and moving downstream) the following was observed:

West Branch
The West Branch of the Nimishillen Creek began with a good CIV at site 14, remained good at the next site downstream (site 3), and then dropped to fair CIVs at the last two sites downstream (sites 13 and 5). The two sites located closer to the confluence (13 and 5) are in a more industrial area which would account for the low CIVs.

Middle Branch
Since only one site was surveyed on the Middle Branch there isn't enough data to make any observations, except that the results reveal good macroinvertebrate communities.

East Branch

Results from station 11 on the upstream portion of the East Branch imply a good macroinvertebrate community. The other upstream site on the East Branch, station 15, and the site near the effluence revealed a fair mean CIVs. The lower score for site 2 is understandable since it is located downstream from Republic Steel. However, the reason for the lower CIV rating for station 15 is not known for certain, but might be the result of the reduction in riparian cover upstream and adjacent to the sampling locations .

<u>Hurford Run</u>

The monitoring stations on Hurford Run revealed a pattern similar to the East Branch sites, in that the sites further upstream (6 and 16) suggested good macroinvertebrate communities, whereas site 7, further downstream, revealed fair macroinvertebrate communities. The drop in CIVs from the upstream sites to the downstream sites may be attributed to the fact that two major industrial dischargers and a number of storm sewers drain the property of a major steel mill and refinery upstream from site 7 (Ohio EPA-NEDO, pers. comm. with Dave Stroud).

<u>Sherrick Run</u>

The three monitoring stations on Sherrick Run (8, 9 and 10) implied fair macroinvertebrate communities all sites. The CIVs recorded on this stream seem consistently low and may be attributed to sedimentation, storm water runoff and industrial runoff. In addition, iron oxide deposits heavily coated sites 9 and 10, and was still visible at site 8. Also at site 10, a black, oil-like substance coated the stream's substrate. The origin(s) of these deposits was not determined, although any future investigation into the origin(s) should include a large auto scrap yard less than a quarter mile from station 10.

<u>Mainstem</u>

Sites 4 and 12 on the Nimishillen Creek Mainstem both revealed fair macroinvertebrate communities. Both sites are located in urban areas, yet primarily downstream from the industrial activities occurring in the City of Canton area. Site 12 is also downstream of the City of Canton's Water Pollution Control Center's outlet.

The macroinvertebrate sampling was useful in helping to determine the environmental quality of the streams in the Nimishillen Creek Watershed. However, determining the water quality of a stream entails more extensive sampling (i.e. Ohio EPA's biological assessments), that would include looking at more components within the community such as fish or vegetation.

<u>CIV vs. Land Use</u>

The relationship between the monitoring sites and drainage basins was characterized by examining the correlation of the 2002 mean CIV scores and the sum of the ranked scores from the Land Use Characterization Table completed by NEFCO in the *Nimishillen Creek Comprehensive Watershed Management Plan - Phase II* (NEFCO, Nov. 2000). In the Phase II study, watershed stakeholder evaluated and ranked the top

25 land uses that they believed cause the most water quality impairments within the Nimishillen Creek watershed.

The rankings were divided into four subwatersheds: Subwatershed 1 which includes the mainstem, Hurford Run, and Sherrick Run; Subwatershed 2 which is the West Branch; the Middle Branch is Subwatershed 3; and Subwatershed 4 is the East Branch. These subwatershed scores were then weighted based on Ohio Comparative Risk Project (OCRP) rankings developed by the Ohio Environmental Protection Agency (Ohio EPA, 1997). OCRP is basically a ranking of the 45 potential threats to human health, ecosystems, and quality of life throughout Ohio. Appendix D has the pollution potential ranking scores for each subwatershed. The cumulative total of these scores for each subwatershed will be referred to as the Subwatershed Composite Ranking Score. In general, the higher the Composite Ranking Score, the greater the risk to the Creek's water quality from potential pollution source.

Figure 3 presents the graph of this data illustrating for each subwatershed the mean and range of CIV score, the Composite Rating Score, and the regression (or trend) line. There is a moderate negative correlation (r = -0.65) between the mean CIV scores and the Subwatershed Composite Rating Scores. This seems to suggest that the industrial pollution sources and urban land uses are associated with reduced biological communities and decreased water quality. Improved biological communities in the upstream and headwater may be associated with a less presence of problematic land uses and pollution sources. The data presents an interesting picture, and it may well be stating an obvious event. Nevertheless the documentation of a relationship between biological communities and land use is important.

<u>Sampling Method</u>

There are a variety of quantitative indices used in assessing biological data. The Invertebrate Community Index (ICI) is one index in particular that was developed by the Ohio EPA as a standardized sampling method for macroinvertebrates. This method is more effective at determining the health of a stream than ODNR's Scenic Rivers Stream Quality Monitoring Program, in that the ICI identifies macroinvertebrate organisms as far down as the genus and species level, whereas, the Stream Quality Monitoring Program only identifies to the order/family level (Pers. Comm. with Steve Tuckerman, Ohio EPA - NEDO, Division of Surface Water). However, reports written by the Ohio EPA suggest that although the Scenic Rivers Stream Quality Monitoring Program is used as a gross screening tool, its results do correlate to Ohio EPA's ICI in some cases. The ODNR method agreed with the Ohio EPA ICI in 82 percent of the comparisons where Warmwater Habitat (WWH) ICI met the ecoregion biocriteria and in 73 percent of the comparison where the ICI indicates non-attainment of WWH (Ohio EPA, 1996).

One report, A *Comparison of the Results of a Volunteer Stream Quality Monitoring Program and the Ohio EPA's Biological Indices*, compares ODNR's Stream Quality Monitoring Program and Ohio EPA's ICI, Stating that, "ODNR's CIV ratings do tend to reflect the attainment ("excellent" CIVs) or non-attainment ("fair" and "poor" CIVs) of aquatic life uses, as designated by the Ohio EPA, for both the IBI and the ICI. Hence, the assessments may be useful in screening sites at a basic level" (Dilley, 1991, p.10). Therefore, ODNR's Stream Quality Monitoring Program could be used to imply excellent water quality, and fair to poor water quality, but is unreliable when determining "in between" or good water quality. The report also suggests that ODNR's technique provides reliable enough results to suggest the probability of a stream meeting the Warmwater Habitat use designation (based on macroinvertebrate sampling only). Warmwater Habitat use designation is a beneficial use category (for the protection of aquatic life) according to Ohio's water quality standards, in which a stream possesses "typical assemblages of fish and invertebrates, similar to least impact reference conditions" (Ohio Administrative Code (OAC) 3745-1-07 Draft, 1998).

Another report, *The Ohio EPA Bioassessment Comparability Project: A Preliminary Analysis*, suggests that the Scenic Rivers Stream Quality Monitoring Program, "would be most useful to the Ohio EPA when the CIV rating is either exceptional or fair/poor and only for WWH designated streams draining less than 200 $mi.^2$" (Yoder and Davis, 1996).

Both reports support the fact that although ODNR's Scenic Rivers Stream Quality Monitoring Program is a gross screening tool, it can imply the water quality of a stream in some circumstances. When the results reveal excellent, fair or poor water quality conditions, the Ohio EPA considers ODNR's technique reliable. The Ohio EPA also supports the fact that when a sample reveals excellent water quality (using ODNR's technique), that sample is considered meeting the Warmwater Habitat use designation.

2002 vs. 2000 Results

The comparison of the 2002 macroinvertebrate survey results to information collected for the 2000 report is useful in monitoring substantial changes in both the macroinvertebrate composition and physical characteristics at each site. However, with only two sampling events conducted, conclusions about trends in Nimishillen Creek's water quality cannot be made. Natural climatic variations i.e. rainfall and temperature from year to year can affect the composition of macroinvertebrate communities. In addition, non-chronic or one-time pollution sources (spills) can also affect a sampling event. Prolonged monitoring over several years is needed in order to understand these yearly variations and to diagnose improving or degrading water quality over time at each site.

NEFCO staff attempted to minimize variations in site conditions by sampling at the same stations at approximately the same time of year as the 2000 survey. Despite these efforts, the water temperatures in 2002 were on average 1.4^{o}F colder than in 2000. Also, 2002 had much less rainfall than 2000. According to the ODNR Division of Water, rainfall from May to October in 2002 was 2.09 inches **below** average in northeast Ohio (Cashell, 2002). In 2000, Northeast Ohio was 4.50 inches **above** normal for the same period (Cashell, 2000). This substantial difference (6.59 inches) in precipitation likely affected monitoring results, especially in areas not dominated by point source discharges i.e. the headwaters.

Mean CIV

Table 4 show the comparison of mean CIVs for the 2002 and 2000 studies. In general, there was a slight decrease, 16 to 15, in the mean CIV scores in 2002. Ten sites showed decreased scores with an overall loss of 13 CIV points from 2000. However, only two sites dropped in their classification in 2002. Station 3 went from an excellent rating to good, and site 15 went from a good to a fair score. Three sites improved their classification, with sites 8 and 10 moving from the poor to fair range and site 14 going from fair to good. The result of these rating shifts in 2002 is that all sites were classified as either good or fair, and none were poor or excellent. Although eliminating poor sites is a positive step, the loss of an excellent scoring sites is alarming, especially since sites that rate as excellent in this sampling protocol are generally in attainment with Ohio EPA water quality standards (Dilley, 1991).

Of the sites that changed their rating classification, three showed significant variations in their 2002 mean CIV scores when compared to the 2000 results. For this analysis, a site was determined to have significantly changed in its CIV if the difference from 2000 to 2002 was greater than (+/-) 7 CIV points. An increase or decrease of 7 CIV points was chosen as significant because that would mean an increase or decrease of at least three taxa at each site. Site 3 decreased nine mean CIV points and station 15 showed a seven point decline in 2002. Conversely, site 14 improved eleven mean CIV points from 2000 to 2002.

Although the significant changes in mean CIV scores should not be disregarded, the results do not necessarily suggest an overall improving (site 14) or degrading (sites 1 and 15) water quality trend. These results are based on a one-time sampling event two years apart, and unknown variables discussed above could have affected either the 2000 or the 2002 samples. Long term monitoring in the Nimishillen Creek watershed is still needed in order to determine water quality trends at all sampling locations. However, there was a significant enough mean CIV change at these three sites to warrant additional attention.

Physical Characteristics

In general, the physical characteristics at the sampling sites changed little from 2000 to 2002. The two exceptions would be sites 10 and 15. Site 10 has had over 30 tires dumped into Sherrick Run since 2000 (Appendix C, photos 46 & 48). At site 15, it was noted in the 2000 survey that the riparian vegetation upstream of the sample locations had been clear-cut exposing the soil to erosion. In 2002, dense shrubs had grown up along the banks and were providing a measure of erosion protection and stream shading, both improvements from 2000.

CIV vs. Land Use

Comparing the results from the 2002 mean CIV and land use characterization ratings (Figure 3) with the same information from 2000 (Figure 4) shows that there is still a moderate negative correlation between mean CIVs and the land use ratings in the Nimishillen Creek watershed. However, the relationship was less significant in 2002 (r= -0.65) than in 2000 (r = -0.78). This is the result of the average CIV values dropping in both subwatersheds 3 and 4 in 2002. As in 2000, subwatershed 3 maintained the highest average CIV, while subwatershed 1 remained the lowest scoring subwatershed. The 2002 findings still suggest that the industrial pollution sources and urban land uses are associated with reduced biological communities and decreased water quality.

Recommendations

This section recommends actions, that if completed, would improve the overall quality of Nimishillen Creek and its tributaries. This is not an exhaustive list of water quality improvement actions, but rather are recommendations made by NEFCO staff based on field observations while sampling the sixteen stations in 2002. For a more extensive list of watershed improvement action, refer to the *Nimishillen Creek Action Plan* (NEFCO, Nov. 2000).

1. Increase monitoring at the sampling locations (sites 3, 14, 15) that showed significant changes to mean CIVs in 2002.

2. Continue regular macroinvertebrate and habitat monitoring for all sampling stations. Consider including chemical and bacterial sampling to better improve the characterization of water quality conditions in the Nimishillen Creek watershed. Also, consider switching to a habitat evaluation technique that quantifies the results enabling easier comparisons with other sampling sites and with future sampling events.

3. At site 10, clean up the over 30 tires that have been dumped in and along the banks of Sherrick Run since the 2000. Consider posting a “No Dumping” sign at this location.

4. Organize creek clean-ups at sites with large amounts of litter in and around the creek, especially at sites 1, 3, 4, 5, 8, 12 and 13.

5. Increase stream shading in public parks. The parks sampled at sites 1, 2, 3, and 4 were all dominated by grass adjacent to the stream with few trees or shrubs to provide shading. In general, increased shading will lower the average stream temperature. Other benefits trees and shrubs provide when planted along a stream include improved filtering of pollutants from stormwater runoff, securing and dewatering the soil, and habitat for wildlife.

6. At the sites in public parks, do not mow grass to the edge of the bank. Mowing all the way to the edge of any stream increases the likelihood of bank erosion during high flow events.

7. Add an upstream site in the Middle Branch subwatershed to the sampling protocol. Currently, the Middle Branch only has one site which limits analysis of water quality conditions in the subwatershed.

8. Continue photo documentation of the Nimishillen Creek watershed.

9. Investigate the origin(s) of the iron-oxide and oil-like coatings at the Sherrick Run sites.

Conclusion

Understanding the interrelationship of water quality, land use, aquatic habitats and their relationship with natural environments and human activities is an important element for the protection and/or enhancement of a stream's health. Over time, regular analysis of existing physical characteristics, water quality and aquatic organisms will provide base level information that will enable key stakeholders to make more effective decisions regarding both positive and/or negative impacts of hydrologic modifications.

To this end, aquatic insects and other bottom-dwelling organisms can be monitored to measure both subtle and profound effects that changes in water quality have on aquatic life. Changes in the composition of macroinvertebrate communities will reflect water quality shifts that may be caused by the addition or deletion of pollutants to the water. These pollutants may be continual, intermittent, or accidental, and they may originate from point or nonpoint sources.

The results of the macroinvertebrate sampling, based on the methodology from the Scenic River Monitoring Program, revealed fair water quality at ten sites and good water quality at six sites resulting in a cumulative index value of 15 or fair water quality. None of the sites monitored had poor or excellent water quality scores.

In comparing this study's results with the *2000 Nimishillen Creek Marcoinvertebrate Survey*, two sites lowered their water quality rankings (sites 3 and 15), while three sites improved (sites 8, 10 and 14). In addition, sites 3, 14 and 15 showed significant mean CIV changes (+/- 7 CIV points) from 2000 indicating a need for persistent monitoring. NEFCO staff also recommends continued monitoring of all sites, a clean up of heavily littered stations, and improvement in riparian habitat in park lands.

The results suggest that the riparian habitat, riffle activity, and in-stream habitat were not limiting factors in stream monitoring for macroinvertebrate community quality. When a stream possesses a good riparian habitat, good in-stream habitat, and a good riffle area it may be considered an ideal stream for macroinvertebrate sampling. However, this was not the case when NEFCO staff conducted macroinvertebrate sampling in the Nimishillen Creek. In general, the conditions in and around the stream did not seem to influence the macroinvertebrate communities. It may be suggested that other factors, such as industrial and urban land uses surrounding the sampling areas are affecting the water quality and macroinvertebrate communities in these streams.

The results for each stream also revealed a pattern in which the quality of the macroinvertebrate communities within most of the streams monitored seemed to drop from the upstream sites to the downstream sites. This observation may be attributed to higher levels of industrial activity occurring closer to the confluences of the streams. It also depends on other sources of impairment such as sedimentation, storm water runoff and urban runoff.

Two reports written by the Ohio EPA (Dilley, 1991; Yoder and Davis, 1996) suggest that ODNR's Scenic Rivers Stream Quality Monitoring Program is reliable in determining the health of a stream, in certain circumstances. Both reports have found that the results from ODNR's Stream Quality Monitoring Program have correlated with Ohio EPA's ICI when the former method implies that water quality was excellent, fair or poor. It is also suggested that when a sample reveals an excellent macroinvertebrate community (using ODNR's technique), that sample is considered by Ohio EPA as likely to be meeting the Warmwater Habitat use designation (based on macroinvertebrate monitoring only). However, determining the water quality of a stream entails more extensive sampling (i.e. Ohio EPA's biological assessments), that would include looking at more components of the biological community such as fish, or vegetation.

As previously mentioned, all the benthic macroinvertebrate sampling stations were under ideal habitat, which may or may not accurately imply the water quality conditions throughout the watershed. Sampling additional macroinvertebrate sites and conducting chemical and bacterial tests within the watershed would result in more comprehensive baseline data that would better characterize water quality conditions within the Nimishillen Creek watershed, and help explain the variations in macroinvertebrate community composition found in this study.

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