Classification of Primary Headwater Streams Using the Headwater Habitat Evaluation Index Rocky River Watershed Summer, 2002

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Table of Contents

Executive Summary……..Page 1

Introduction……..Page 2

Methods……Page 4

Equipment……Page 4

Classifications……..Page 5

Results……..Page 6

Conclusions……..Page 12

Bibliography…….Page 14

Appendix A……..Page 15

Appendix B……..Page 18

Appendix C…….….Page 20

Appendix D……..Page 22

Executive Summary

From May 29, 2002 to July 15, 2002, nineteen primary headwater streams in North Royalton were sampled using a recently developed Ohio Environmental Protection Agency (Ohio EPA) index. These tributaries of the Rocky River were classified using the Headwater Habitat Evaluation Index (HHEI). This method could only be performed on streams with a watershed of less than or equal to 1 square mile and with a maximum pool depth of 40 centimeters. This method involves the collection of three measurements at each stream site. The composition of the substrate, the deepest pool and the bankfull width were used to classify headwater streams. Streams were classified as one of three classes. Class one streams have ephemeral flow, class two contains warm water adapted communities and class three contains cool-cold water adapted communities. Class three streams flow continually throughout the year and provide the best habitat for aquatic species of fish, amphibians and macro invertebrates. Class three provides very little suitable habitats for aquatic species. Five Percent of the streams sampled were classified as Class I. Twenty-six percent of the streams sampled were found to be Class II. Sixty-nine percent were classified as Class III.

This research is part of an Ohio EPA study of headwater streams in Ohio. Headwater streams are defined as the very small swales, creeks and streams that are the origin of most streams. The problem is that these small streams are treated merely as conveyances for storm waters. They are diverted, ditched, moved and even buried in pipes leading to a reduction or elimination of any suitable aquatic life habitat. This destruction of water quality in the headwaters will eventually flow downstream to the larger rivers and streams affecting their water quality as well. These small streams are the source of larger rivers but many people do not realize their importance. The efforts to classify these types of streams will help to protect them in the future.

This study was conducted by Nicholas Blau, Student Intern, Kent State University, under the direction of Jill Lis, R.S., Program Manager, Cuyahoga County Board of Health.

Introduction

Headwater streams are the very small swales, creeks, and streams that are the origin of most rivers. These small streams join together to form larger streams and rivers that flow directly into large streams and lakes. The Ohio EPA defines a headwater stream as one with a watershed less than or equal to 20 square miles. These streams comprise about 78% of the streams flowing in Ohio. There are many streams however, with watersheds less than just one square mile. These small streams are known as Primary Headwater streams. Primary headwater streams directly influence the water quality of the larger rivers and lakes downstream. Poor water quality in the headwaters will most likely lead to poor water quality in the larger streams and rivers. Conversely, excellent water quality in upstream headwaters leads to excellent water quality in the larger bodies of water. In the past headwater streams have not been acknowledged for their contribution to overall water quality. They have been treated as water conveyances and have been ditched, channelized, moved, and even buried in pipes. Until recently, it was not realized that by their sheer numbers alone they play a very important role in the maintenance of the biological integrity of the waters of the State.

Water quality problems were heightened in Ohio in the late 1960's to the early 1970's with publicized events such as the burning of the Cuyahoga River. Since then, there have been great efforts to reduce pollution in Ohio's larger waterways. These efforts have lead to substantial progress in restoring the larger rivers of Ohio to acceptable levels of water quality and aquatic life. The majority of the improvement is due to the reduction, or in some cases the elimination, of point source pollution sources. These are direct pollution discharges that are easily located and dealt with accordingly. Smaller headwater streams however, have not seen the same improvement that the larger streams have. The primary reason is that a large portion of the impacts of small streams is due to nonpoint source pollution, which cannot be easily traced to a single source such as agricultural runoff, sedimentation, and nutrient enrichment. These types of pollution sources must be dealt with in order to continue the trend of improving water quality in Ohio.

Pollution impacts to small headwater streams may not be easily noticed, but over time their cumulative effects can be quite substantial. The improvement of Ohio's water quality through the reduction of point source pollution may further help to mask pollutions negative effects on headwater streams and larger rivers. Also, loss of primary headwaters is a slow cumulative process. Loss of one small stream may not be immediately evident, but over time the effects be seen. The small headwaters are also more susceptible to the effects of nonpoint sources of pollution. This may be due to the fact that headwaters form the primary boundary between land and water. They receive the inputs of water, sediment, energy, and chemicals, which are then transported downstream. Because of their small size, the concentrations of pollutants may be very high in these headwater streams.

There are many impacts to primary headwater streams. The leading source of impairment and the origin of habitat degradation is hydro-modification. Activities such as channelization and removal of the riparian zone can stem from agriculture and urban

development. As previously mentioned, many small streams are moved, channelized, or even buried in pipes or culverts for the sake of development. Another negative impact on headwaters is the influx of excess nutrients combined with removal of riparian vegetation. The nutrients and added sunlight cause many problems associated with increased algal growth. Changes in the water flow of surrounding areas due to impermeability can cause an increase in high/low extremes of small streams. Reduction of inputs changes the velocity, volume, and delivery patterns of headwater streams. These impacts affect the water quality of the small headwaters that is then transported downstream to larger bodies of water.

It is evident that a means of protection is needed for these primary headwater streams. The Ohio EPA is considering a new use designation for primary headwater streams. Currently many primary headwater streams are not defined or assigned beneficial uses in Ohio's water quality standards. This is probably due in part to the EPA's method of identifying and protecting streams. The Ohio EPA has developed biological criteria along with chemical and physical criteria to help designate stream habitats. These methods such as the Qualitative Habitat Evaluation index (QHEI), the Index of Biotic Integrity (IBI) and the Invertebrate Community Index (ICI) are quite useful for the designation of larger streams. However these methods do not yield conclusive results on smaller headwater streams due to their small size. Flow hydrology, and physical features such as pool depth, flow velocity, and watershed size that are used to determine designation do not translate well when streams are small. The Ohio EPA has developed a system to evaluate and classify primary headwater streams called the Headwater Habitat Evaluation Index, or HHEI. The HHEI utilizes physical habitat features that have been found to be important indicators of biological community structure. Three factors have proved to be sufficient in separating these smaller streams into separate classes. These factors are substrate composition, bankfull width, and maximum pool depth. Other factors such as sinuosity, gradient, riparian width, and composition are recorded, but not used in the HHEI class determination.

Primary headwater streams of the East Branch of the Rocky River were sampled in North Royalton over the duration of approximately 10 weeks. Streams were only sampled at least 24 hours after the last rainfall to ensure base flow conditions. Headwater Habitat Evaluation Index forms were filled out for each stream sampled (See Appendix A). Macroinvertebrate sampling was also done at a majority of the sites. The location and results of each stream included in the sample is listed below. The location of each site was marked on photocopied soil maps, United States Geological Survey (USGS) topographic maps, and road atlas maps. These maps were attached to the completed HHEI and Headwater Macroinvertebrate Field Evaluation Index (HMFEI) forms.

Methods

The HHEI could only be performed on streams with a watershed that is equal to or less than one square mile and with the deepest pools being no greater than 40 centimeters. A 200-foot section of stream channel was marked off for each sample site. A Global Positioning Unit was then used to mark the exact location of the sample site in decimal degrees. A determination of channel modification was then made. Channels were either classified as natural, recovered, recovering or no recovery. The substrate composition was analyzed next. The percentage of the two most predominant substrates was noted then the percentages of all other present substrates were recorded. The maximum pool depth of the 200-foot stream reach was then measured and recorded. The bankfull width, which is the width of the bank when full, but not the floodplain, was then measured. Each of the recorded scores were assigned a point value on the HHEI form. The scores were added up and a final HHEI score was calculated. The scores were then used in conjunction with the HHEI flow chart to make a decision on the classification of the stream (See Appendix B). Copies of the completed HHEI and the HMFEI forms are on file at the Cuyahoga County Board of Health.

Invertebrate sampling was performed at many sites. A small D-shaped net was placed downstream from the substrate as it was disturbed to dislodge and capture specimens. Large rocks were lifted by hand and examined for specimens. Fine particulate substrates were also washed into the net downstream. The contents of the net were emptied into a white enamel pan. This process was repeated at several locations along the test stream for at least one half-hour. The contents of the white pan were then examined and specimens were transferred to another pan. The specimens were classified and counted (See Appendix C). The presence and relative abundance of all taxa collected was recorded on the HMFEI form (See Appendix D). Scoring values assigned to each taxa were then used to calculate the HMFEI score. A class scale located at the bottom of the form determines the classification of the stream.

Equipment

Materials needed for HHEI calculation:

- 60 meter measuring tape
- Meter stick
- 10 meter string
- Line level
- Pencil
- HHEI form

Materials needed for HMFEI calculation:

- Hip waders
- Fine mesh kick net
- White bottomed sorting pans
- Fine tip forceps
- Macroinvertebrate classification guide
- HMFEI form

Classifications

Primary headwater streams can fall into one of three classes. A Class III stream supports a cool water biologic community. Theses streams tend to contain species of organisms that have adapted to a year round presence of cool water. Class III streams are the highest quality primary headwater streams. Flow in these streams is derived mostly from groundwater. Class III streams should be protected for many reasons. Their ability to process nutrients, dissipate energy, process sediment, maintain stream energy dynamics, maintain downstream beneficial uses and their aquatic communities are only some benefits of Class III streams.

A Class II stream supports perennial or intermittent warm water biologic communities. They tend to contain species of organisms that are adapted to the warm water conditions found in these streams. These watercourses do not have demanding habitat requirements and are more easily reproduced or mitigated. Class II streams should be protected for their aquatic communities and their ability to process nutrients, dissipate energy, process sediment, maintain energy dynamics, and protect downstream uses.

A Class I stream is one with an ephemeral, or seasonal, flow. This class of primary headwater habitat streams supports a warm water biologic community but is often dry for long periods of time with no aquatic life present. Class I streams do not have demanding habitat requirements and are the most easily reproduced. They may also be mitigated through non-stream replacement such as retention/detention basins. Class I streams should be protected for their ability to process nutrients, dissipate energy, process sediment, maintain energy dynamics, and protect downstream uses.

Results

Date: 5-29-02
Location: Broadview Rd. and Edgerton Rd.
Latitude: 41.29333
Longitude: 81.68556
Drainage Area: 0.25mi^2
Downstream: East Branch Rocky River – ¼ mi.
HHEI Score: 68
HMFEI Score: 8
Classification: Modified Class II
Description: Recovering channel stream located in a residential area. Moderate to no Riparian zone, flat to moderate gradient. Several small outfalls along 200-foot section. Canopy 85% open, water Temperature 18.3°C.

Date: 6-4-02
Location: Barnsley Way in Macintosh Farms Subdivision
Latitude: 41.28446
Longitude: 81.69535
Drainage Area: 1mi^2
Downstream: East Branch Rocky River – 1mi
HHEI Score: 79
HMFEI Score: 21
Classification: Class III
Description: Natural channel located in recently developed subdivision. Wide to moderate riparian zone, moderate gradient. Golf Course located upstream, cart path runs along stream section. Canopy 30% open, water temperature 17.2°C

Date: 5-30-02
Location: York Rd and Valley Parkway
Latitude: 41.30361
Longitude: 81.75750
Drainage Area: 0.25mi^2
Downstream: East Branch Rocky River – 1mi
HHEI Score: 71
HMFEI Score: 21
Classification: Class III
Description: Natural channel located in the Metroparks. Wide riparian zone, flat to moderate gradient. Canopy 10% open, water temperature 16.7°C

Date: 6-5-02
Location: Edgerton Rd. and Valley Parkway
Latitude: 41.30302
Longitude: 81.77190
Drainage Area: 1mi^2
Downstream: East Branch Rocky River – 0.25mi
HHEI Score: 82
HMFEI Score: 12
Classification: HHEI Class III – HMFEI Class II
Description: Natural channel located in the Metroparks. Wide riparian zone, flat to moderate gradient. Stream flows into a culvert under valley parkway, an outfall is located 2 meters upstream from the culvert. Canopy 20% open, water temperature 14.4°C.

Date: 6-5-02
Location: York Rd. Picnic Area – west of entrance
Latitude: 41.17085
Longitude: 81.76065
Drainage Area: 1mi^2
Downstream: East Branch Rocky River – 0.5mi
HHEI Score: 69
HMFEI Score: 17
Classification: Class II
Description: Natural channel located in the Metroparks. Wide riparian zone, flat to moderate gradient. Small bog lies on right bank, two small tributaries enter the stream 30 meters downstream from the bog. Canopy 5% open, water temperature 18.9°C.

Date: 6-10-02
Location: Valley Parkway and Bennett Rd.
Latitude: 41.30300
Longitude: 81.74413
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – 1mi
HHEI Score: 70
HMFEI Score: 20
Classification: Class III
Description: Natural channel located in the Metroparks. Wide riparian zone, moderate gradient. Stream flows into culvert under Valley Parkway. Canopy 35% open.

Date: 6-11-02
Location: 16887 Ridge Road
Latitude: 41.29413
Longitude: 81.74390
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – ¾ mi.
HHEI Score: 79
HMFEI Score: 26
Classification: Class III
Description: Natural channel located along residence on Ridge Rd. Moderate to wide riparian zone, moderate to severe gradient. Canopy 15% open, water temperature 20°C.

Date: 6-12-02
Location: 500 meters south of 16887 Ridge Road
Latitude: 41.29361
Longitude: 81.74405
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – ¾ mi.
HHEI Score: 78
HMFEI Score: 25
Classification: Class III
Description: Natural channel located in forested area along Ridge Rd. Wide riparian zone, moderate to severe gradient. Canopy 20% open, water temperature 20.5°C.

Date: 6-13-02
Location: Valley Parkway and Edgerton Road
Latitude: 41.30503
Longitude: 81.77918
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – 0.25mi
HHEI Score: 44
HMFEI Score: N/A
Classification: Class I
Description: Natural channel located 0.5mi West of Edgerton Rd. Wide riparian zone, flat to moderate gradient. Bog located on right side, no flowing water in channel-ephemeral flow. Canopy 10% open, water temperature 18.9°C.

Date: 6-17-02
Location: West 130th Street
Latitude: 41.30785
Longitude: 81.78473
Drainage Area: 1mi^2
Downstream: East Branch Rocky River – 5 meters
HHEI Score: 68
HMFEI Score: 28
Classification: HHEI- Modified Class II – HMFEI- Class III
Description: Recovered stream located south of Valley Parkway on West 130th St. Wide riparian zone, moderate gradient. Netting on banks is evidence of a re-seed, appears to have recovered. Flows directly into the East Branch of the Rocky River approximately 5 meters downstream. Canopy 90% open, water temperature 18.9°C.

Date: 6-18-02
Location: Donmar Road
Latitude: 41.28830
Longitude: 81.76701
Drainage Area: 1mi^2
Downstream: East Branch Rocky River – 0.5mi
HHEI Score: 72
HMFEI Score: 22
Classification: Class III
Description: Natural channel located in a residential area. Moderate to wide riparian zone, flat to moderate gradient. Dumping area for soil located on right side of stream. Canopy 75% open, water temperature 16.6°C.

Date: 6-19-02
Location: York Road. and Delsy Road
Latitude: 41.34075
Longitude: 81.75303
Drainage Area: 1mi^2
Downstream: East Branch Rocky River – 1mi
HHEI Score: 89
HMFEI Score: 21
Classification: Class III
Description: Natural channel located in a residential area. Moderate riparian zone, moderate gradient. Flows out of a culvert running under York Road. Canopy 5% open, water temperature 14.4°C.

Date: 6-19-02
Location: 11509 York Road
Latitude: 41.32726
Longitude: 81.75698
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – 2mi
HHEI Score: 77
HMFEI Score: 26
Classification: Class III
Description: Natural channel located just North of Wallings Road. Moderate to wide riparian zone, moderate to severe gradient. Flows between two residences. Canopy 10% open, water temperature 16.6°C.

Date: 6-20-02
Location: Ponderosa Drive and Harley Hills Drive
Latitude: 41.32165
Longitude: 81.75233
Drainage Area: 0.25mi^2
Downstream: East Branch Rocky River – 2.5mi
HHEI Score: 78
HMFEI Score: 22
Classification: Class III
Description: Natural channel located in the Harley Hills Subdivision. Wide riparian zone, moderate to severe gradient. Very wide flood plain, some large falls formed from woody debris and leaf pack. Canopy 5% open, water temperature 18.8°C.

Date: 7-1-02
Location: Valley Parkway – along turnpike
Latitude: 41.30345
Longitude: 81.74335
Drainage Area: 0.25mi^2
Downstream: East Branch Rocky River – 0.5mi
HHEI Score: 75
HMFEI Score: 20
Classification: Class III
Description: Natural channel that flows along the Ohio turnpike. Wide riparian zone, moderate to severe gradient. Canopy 25% open, water temperature 21.7°C.

Date: 7-5-02
Location: Cady Road
Latitude: 41.28530
Longitude: 81.73567
Drainage Area: 0.25mi^2
Downstream: East Branch Rocky River – 0.5mi
HHEI Score: 62
HMFEI Score: 14
Classification: Class II
Description: Natural channel in a wooded roadside area. Stream flows down a fairly steep hillside with steep banks. Wide riparian zone, very severe gradient. Canopy 20% open, water temperature 18.8°C.

Date: 7-10-02
Location: 11046 York Road
Latitude: 41.33110
Longitude: 81.75773
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – 2mi
HHEI Score: 45
HMFEI Score: N/A
Classification: Class II
Description: Natural channel in a residential area. An open field lies along the left bank. Narrow to moderate riparian zone, flat to moderate gradient. Canopy 15% open.

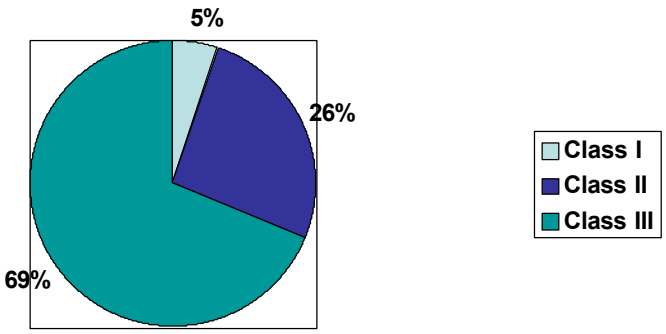
Date: 7-12-02
Location: York Road. and Cinnamon Drive
Latitude: 41.33236
Longitude: 81.75861
Drainage Area: 0.5mi^2
Downstream: East Branch Rocky River – 2mi
HHEI Score: 73
HMFEI Score: N/A
Classification: Class III
Description: Recovered channel in a residential area. Artificial substrates added to stabilize banks. Moderate riparian zone, flat to moderate gradient. Canopy 20% open.

Date: 7-15-02
Location: Chelsea and Wilton in Southhampton Woods Subdivision
Latitude: 41.33326
Longitude: 81.74203
Drainage Area: 0.25mi^2
Downstream: East Branch Rocky River – 2.5mi
HHEI Score: 75
HMFEI Score: N/A
Classification: Class III
Description: Natural channel stream in a residential area. Boulders added in small section to stabilize banks. Moderate riparian zone, moderate gradient. Canpoy 30% open, water temperature 18.9°C.

Conclusions

A total of nineteen streams were surveyed in the Rocky River watershed in North Royalton. Many other locations were examined but not surveyed for various reasons. Many sites did not qualify for HHEI analysis. Other sites were inaccessible due to overgrown vegetation or treacherous terrain. At some sites, blockages downstream, or diversions and dams upstream, disturbed the flow regime. Small tributaries were often hidden by vegetation or were located in areas where vegetation was too dense to pass.

Of the 19 streams surveyed, 13, or 69% qualified as Class III streams. Five streams, or 26% of streams sampled qualified as Class II. One stream, or 5% qualified as Class I.



The majority of streams were classified as Class III, however, this may not necessarily mean that the majority of the primary headwater streams in North Royalton fall into this class. Class III streams tend to be the largest of all headwater streams and they are more likely to be found on a map or in the field. The large percentage of class III streams may be simply due to the fact that they are easier to find. Small swales or ephemeral streams could easily be overlooked or hidden by vegetation leading to lower numbers of Class I and Class II streams. These very small streams are rarely displayed on the maps used so locating was based on trial and error. A great deal more work needs to be done to make generalizations on the overall water or habitat quality in this area.

The major problem faced during HHEI surveys involved the location of streams. Because of their small size, they are easily diverted, or buried in pipes. They are rarely displayed on maps and are easily hidden by vegetation. The rapid growth of development in North Royalton is also responsible for a great deal of primary headwater habitat destruction. Hundreds of acres of forest are being converted into housing developments, roads are being constructed, trees are being cut down, and small streams are being destroyed, diverted, buried, or blocked. The classification of these small streams will someday help to protect them from further degradation or destruction in the future.

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Appendix A

HHEI Form

Appendix B

HHEI Flow Chart

Appendix C

HMFEI Form

Appendix D

Macroinvertebrate Classification Guide