STREAM BIOASSESSMENT OF THE BLACK ROCK CREEK, ORANGE COUNTY, NY

Conducted: June 1 – 3, 2005

Black Rock Creek, Orange County, NY

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Contents

SUMMARY

During June 1 – 3, 2005, Hudson Basin River Watch performed a biological stream assessment on the Black Rock Creek, in Orange County, NY, as part of a Hudson Basin River Watch stream monitoring training workshop. Individual biological assessment indices indicated a water quality range from moderately to non-impacted however, due to time constraints the tier 2 biological analyses was not completed. This likely indicated poorer water quality than actually exists.

BACKGROUND

Black Rock Creek originates from Black Rock mountain in Orange County. The creek travels through forested areas as well as along a busy 4 lane divided highway runoff from the highway has the potential to adversely affect its water quality. Even though the preferred time for kick sampling, in assessing water quality within the NYS DEC four-tiered assessment system, is July — September (Novak and Bode, 1992) the individual metrics indicate an altered benthic macroinvertebrate community. This stream was previously assessed in 2004 by HBRW for Orange County Water Authority and the biological assessment profile indicated slightly impacted water quality.

RESULTS

[Explanation of the methods used to collect and evaluate the data obtained in this study can be found in the section on Rationale of Data Collected and Methods pages 4-7. Physical, chemical, and biological data are included in this report.

The Hudson Basin River Watch Rapid Biological Assessment Quality Assurance Quality Control (QAQC) was developed and written following the EPA guidelines for volunteer stream monitoring programs and outlines in detail the study's organization, objectives, volunteer training requirements, methods of data collection, documentation, analysis, and quality control. The QAQC is available from the author.]

Site Location:

Behind Black Rock Forest old office building. Coordinates: 41^{o} 25' 23" N—74^{o} 1' 43" W.

Physical and Chemical Assessment

Physical site assessment, chemical analysis, and collection of macroinvertebrates were performed once on June 1 and 2, 2005.

Stream banks are covered with larger vegetation (bushes and trees). The current velocity was 0.38 meters per second, stream depth of 0.2 meters, and stream width of 4.5 meters. The pH was 7.27, alkalinity was 34.5 mg/l, turbidity was 0 FAU, conductivity was 178 µS/cm, nitrate-nitrogen (NO_3-N) was 0.37 mg/l, phosphate (P) was 0.04 mg/l, dissolved oxygen was 8.7 mg/l, water temperature was 15.3 degree Celsius, and the dissolved oxygen percent saturation was 88.4 percent (see attached).

Biological Data

All five criteria were met for Bethnic Macroinvertebrate Screening Criteria for Non-Impacted Streams. Tier 2 benthic macroinvertebrate taxa richness, EPT taxa richness, percent model affinity, and biotic index, (based on doubling the 50 identified taxa) indicated non, slightly, moderately, and non impacted water quality respectively.

Impression, Conclusions, Suggestions

Physical habitat appeared excellent, the chemical data fell within healthy limits and the screening criteria for benthic macroinvertebrates indicate non-impacted water quality. Unfortunately, due to time constraints of the workshop, proper tier 2 biological analyses were not completed which may have influenced each of the four metric scores lowering overall water quality. The presence and relative abundance of the Plecopterans Pteronarcyidae and Leuctridae, both intolerant to pollutants, are indicators of good water quality.

RATIONALE OF DATA COLLECTED AND METHODS

Physical

The *physical survey* is essential to a stream study because aquatic fauna often have specific habitat requirements independent of water composition, and alterations in these conditions affect the overall quality of a water body (Giller and Malmqvist, 1998). Additionally, the physical characteristics of a stream affect stream flow, volume of water within the channel, water temperature, and absorbed radiant energy from the sun.

Testing sites are evaluated for: stream size and gradient; surrounding land use; presence/absence of upstream dams; algal or weed growth; presence/absence of oily film, grease globules, or unusual odor or color; riffle size; substrate size; presence/absence of shelter for fish; flow pattern; channel alteration; stream bank cover and stability; disruption of the riparian bank cover; width of the riparian vegetation zone; and the presence of litter. Habitat condition was scored as excellent, good, fair, or poor. (See physical survey/habitat assessment data sheets for scoring parameters). Site photos were taken of the upstream area, downstream area, and banks of each testing site, and are included in the attached physical survey/habitat assessment sheets.

W*ater temperature* directly affects both the nature of aquatic fauna and species diversity; temperature tolerance is organism specific, and the reproductive cycle (including timing of insect emergence and annual productivity) will vary within different temperature ranges. Temperature can also affect organisms indirectly as a consequence of oxygen saturation levels. As water temperature rises, the metabolism of aquatic organisms increases, with an attendant increase in their oxygen requirements. At higher water temperatures, however, the oxygen carrying capacity of water decreases because of a diminished affinity of the water for oxygen.

Optimal water temperature ranges and lethal limits of water temperature vary among different organisms. The ratio of Plecoptera to Ephemeroptera (individuals and numbers of species) has been found to drop as the annual range of temperature increases (Hynes, 1970). The optimal temperature range for Brook trout is 11-16 ^{0} Celsius with an upper lethal limit of 24^0 Celsius (Hynes, 1970). NYS DEC does not have a water quality standard for water temperature.

Temperature was recorded by grab samples with a glass thermometer.

Turbidity, or the cloudiness of water, is caused by multiple factors such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, and other microscopic organisms. Because the ability of trout to sight feed is restricted at turbidity levels above 50 Nephelometric Turbidity Units (NTU), salmonid displacement will occur above this level. A turbidity of less than 10 NTU is recommended for trout propagation (Watersheds, 1994).

The Hach 890 colorimeter was used in this study, which measures turbidity in Formazin Attenuation Units (FAU) (The equivalency ratio is 1FAU/1NTU).

NYS DEC does not have a numeric standard for turbidity.

Percent cobble embeddedness, the degree to which gravel-sized and larger particles are surrounded by sand-sized and smaller particles, is an indicator of a stream's ability to support trout survival and propagation. If deposition of sediment occurs in spawning areas, it can be detrimental to trout reproduction. Trout eggs require a well-oxygenated environment; the eggs are laid in permeable gravel beds with many open spaces to allow continuous bathing of the eggs with cool, oxygenated water. Sediment deposition destroys this environment by clogging these open spaces, leading to oxygen deprivation and buildup of metabolic waste. When cobble embeddedness reaches 50-60%, a stream loses its salmonid fry. Furthermore, although habitat quality is still considered fair for trout survival (though not propagation) at 50-75% embeddedness, changes in the bethnic macroinvertebrate fauna population, on which trout feed; begin to occur (Harvey, 1989).

Velocity was calculated at the time of macroinvertebrate collection because an optimal macroinvertebrate collection site has a velocity between 0.45 and 0.75 meter/second. Velocity was determined by averaging the time it takes a float to travel a marked distance midstream and near each bank, and dividing the distance of the course by the average time.

Chemical

Dissolved Oxygen (DO) level is a function of water turbulence, diffusion, and plant respiration. The EPA recommends that dissolved oxygen levels remain above 11 mg/l during embryonic and larval stages of salmonid production and above 8 mg/l during other life stages (EPA, 1987). The NYS DEC standard for dissolved oxygen for this class C(T) and C(TS) stream is 6 mg/L and 7 mg/L respectively.

A significant drop in DO concentration can occur over a 24-hour period, particularly if a waterbody contains a large amount of plant growth. Oxygen is released into the water as a result of plant photosynthesis during daylight; dense plant growth within a stream can therefore elevate the DO level significantly. At night photosynthesis ceases and DO may drop to levels maintained by diffusion and turbulence. A pre-dawn DO level will, in this case, reflect the lowest DO concentration in a 24 hour period and thus provide important data on the overall health of the system.

DO was measured using the modified Winkler titration with microburet method.

It is also important to consider *percent oxygen saturation*, since dissolved oxygen levels vary inversely with water temperature. Percent saturation is the maximum level of dissolved oxygen that would be present in the water at a specific temperature in the absence of other influences, and is determined by calculating the ratio of measured dissolved oxygen to maximum dissolved oxygen for a given temperature. (The calculation is also standardized to altitude or barometric pressure.) Percent oxygen saturation falls when something other than temperature, such as dissolved solids or bacterial decomposition, affects oxygen levels.

A healthy stream contains near 100 percent oxygen saturation at any given temperature (Hynes, 1970). Trout are particularly sensitive to even a slight drop in oxygen saturation and will migrate away from streams when oxygen saturation falls. Similarly, certain macroinvertebrates are sensitive to varying saturation levels and because the ability of these organisms to migrate away from the changing conditions is limited a drop in saturation can be lethal. NYS DEC has not adopted percent oxygen saturation as a water quality standard. The assessment was included in this study because of our belief that it is vital to the complete evaluation of the health of a stream.

Conductivity is a measure of the ability of an electrical current to pass through a stream; it is dependent on both the concentration of dissolved electrolytes within the water and water temperature. When inorganic ions are dissolved in water, conductivity increases. Organic ions, such as phenols, oil, alcohol and sugar, can decrease conductivity (EPA, 1997). Warmer water is also more conductive and, therefore, conductivity is reported for a standardized water temperature of 25 degrees Celsius. Measurements are reported in microsiemens per centimeter (μS/cm).

In the United States, freshwater stream conductivity readings vary greatly from 50-1,500μS/cm. The conductivity of most streams remains relatively constant, however, unless an extraneous source of contamination is present. A failing septic system would raise conductivity because of its chloride, phosphate, and nitrate content, while an oil spill would lower conductivity.

Conductivity between 150 and 500μS/cm is considered a good mixed-fisheries range (EPA, 1997). A Corning conductivity meter was used to measure conductivity. NYS DEC does not have a standard for conductivity.

The *pH* and *alkalinity* are measures of a stream's acidity and its buffering capacity, or ability to neutralize acidic influences and resist changes in pH. A desirable pH for salmonid is 6.5-8.5. An alkalinity of greater than 20 ppm helps to protect a stream from pH altering influences (such as acid rain). An Oakton pHtestr meter and the Lamotte alkalinity test kit direct reading titrator method were used to obtain pH and alkalinity, respectively. The NYS DEC standard for pH is 6.5-8.5. No standard has been established for alkalinity.

In most fresh water streams, *nitrates and phosphates* are in short supply and are therefore the nutrients that limit plant growth. Because of this, even small excess amounts of these substances can significantly impact a stream. Typically, natural levels of nitrate nitrogen (NO_3 –N) are <1.0 mg/l. Phosphorus (P) levels of >0.05 mg/l indicate that impact is likely; at levels of >0.1 mg/l impact is certain. Increased levels of these nutrients often indicate that sewage, animal manure, fertilizer, and other types of contamination from commercial sites, residential homes, or farms are entering the system.

These nutrients affect aquatic organisms indirectly when elevated levels increase plant proliferation and, ultimately, decaying plant material in the stream. Bacteria that decompose this material require oxygen, depleting the dissolved oxygen. Excessive plant growth also physically changes the substrate on which macroinvertebrates live, altering the diversity of macroinvertebrate community on which trout feed.

It has been documented that nitrate levels are highest just before dawn due to plant inactivity (Stevenson et al., 1996). Plant uptake of nitrates during daylight due to plant metabolism can lower the levels in the water column; at night when plant activity ceases nitrate levels increase. Pre-dawn nitrate levels will therefore indicate maximum nitrate present in a 24-hour period.

Nitrates (NO_3 –N) and Phosphorus (P) were measured using the Hach DR 890 colorimeter by chromotropic acid method and ascorbic acid reduction method, respectively. NYS DEC does not have a numeric standard for nitrates or phosphates.

Biological

Macroinvertebrates are collected by kick net and the specimens are preserved. Pollution-sensitive *macroinvertebrates*, a food source for trout, require similar chemical parameters as trout. The relative numbers of different macroinvertebrate groups indicate the overall health of an ecosystem. Perhaps more importantly, macroinvertebrate data demonstrate the effects of problems that may not be detected by chemical testing.

The NYS DEC Stream Biomonitoring Unit has utilized stream biological monitoring and water quality analysis since 1972 but the biological profiles and water quality assessments are not a part of the state's standards. They serve as a "decision threshold" to determine the need for further studies.

The Environmental Protection Agency recommends that states and tribes with biomonitoring experience adopt biological criteria into water quality standards to provide a quantitative assessment of a waterway's designated and supportive use. Currently only five states have done so; NY is not one of these states. Biological assessment was included in this study because of our belief that it is vital to the complete evaluation of the health of a stream.

The four family indices, or metrics, that are recommended by the NYS DEC Biomonitoring Unit to provide a biological profile and overall stream water quality assessment are as follows:

1. Family Richness: The total number of families found in the sample.
2. EPT richness: The number of families in the three most pollution sensitive orders – Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)- that are present.
3. Biotic index: The product of the quantity of a particular macroinvertebrate found and its assigned biotic value (pollution tolerance value).
4. Percent model affinity, PMA: A comparison of the number of identified macroinvertebrates to a New York model "non-impacted" community, based on percent abundance in seven major groups.

A Biological Assessment Profile, as outlined by the DEC, is obtained from the four metrics by converting each metrics score to a 0-10 water quality scale and calculating their mean. The mean score identifies the water quality impact as: non-, slightly, moderately, or severely impacted. [For definitions of each category, see appendix VI]. The DEC surmises the ability of each of the above water qualities to support fish and their propagation, but a particular family or species of fish is not identified. This is significant because trout are sensitive to small amounts of pollutants and slight ecological changes, whereas bass or carp, having a higher tolerance to pollutants and ecological changes, are not.

It is prudent to remember that an index is a means to convey information about the status of a water body, but should not be used exclusive of its component metrics and data (EPA, 1999).

The HBRW Rapid Biological Assessment includes the above indices and:

1. Organism Density Per Sample: An estimate of the total number of individuals in the sample.
2. EPT/EPT + Chironomidae: A measure of the ratio of the intolerant EPT orders to the generally tolerant Diptera family Chironomidae.
3. Percent Contribution of Dominant Family: The percentage of the sample made up of the most abundant family.

4. Percent Composition of Major Groups: The percent of the sample comprised of selected major groups. [For complete definitions of indices see appendix VII]

Bacteriological

Coliforms are a group of bacteria that include fecal coliforms and other non-fecal bacteria that are widespread in the environment. They are found in the feces of both warm- and cold- blooded animals; they commonly live alongside numerous other pathogenic organisms present in fecal material, and serve as an indicator that these organisms might also be present in the water. Fecal material can pose a health risk, cause cloudy water with an unpleasant odor, and decrease dissolved oxygen as bacteria decompose the material.

Fecal coliforms are a subset of total coliforms; they are more specific to feces but not necessarily fecal in origin. They can originate from textile, pulp, and paper mill wastes (Behar, 1997). *E. Coli* is a fecal coliform specific to fecal material from humans and other warm-blooded animals. It is an indicator of health risk from water contact. (See appendix V for NYS DEC standards)

The Micrology Laboratories Coliscan Membrane method was used to determine total coliforms and E. coli.

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