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Water Quality Trends in the Genesee River

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Long-term water quality trend monitoring

Programs aimed at achieving and maintaining good water quality in our rivers and streams have often overlooked the vital component of trend monitoring. Without this component, we would have no measure of the success or failure of improvement measures, or knowledge of areas that still need improvement. Biological monitoring is especially valuable, providing "ground-truth" to determine if the chemical measurements of the water add up to an inhabitable environment for aquatic plants and animals. In many states, biological monitoring of water quality began in the early 1970's, following the passage of the Clean Water Act in 1972. New York State's stream biomonitoring program began in 1972, and today has one of the longest-term biological data sets in the country. Biological assessment is now a common method of measuring water quality across the country, and is the primary measure of water quality in New York State streams.

The most commonly monitored portion of the aquatic biota is the macroinvertebrate community. Macroinvertebrates are larger-than-microscopic invertebrate animals that inhabit aquatic habitats, including insects, worms, clams, snails, and crustaceans. They are widely used today as indicators of water quality. Macroinvertebrate community data are well suited to the monitoring of temporal trends in water quality. The final assessment of water quality is based on a suite of measurements (metrics) which are combined to give a water quality rating in one of four impact categories, ranging from non-impacted (very good) to severely impacted (very poor). One of the metrics, EPT richness, especially captures the essence of measuring the variety of sensitive organisms at a given site. EPT stands for Ephemeroptera, Plecoptera, and Trichoptera, the names of some of the most sensitive orders of aquatic insects: mayflies, stoneflies, and caddisflies (Figure 1).

Figure 1
The EPT clean-water indicator organisms: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).

For monitoring large non-wadeable rivers in New York State, the specific method of biological sampling used by the Stream Biomonitoring Unit has remained unchanged since its inception in 1972. Multiplate samplers (multiplates), a type of artificial substrate sampling device, are used in flowing waters too deep for net sampling. Artificial substrates obtain a macroinvertebrate sample by providing a substrate for macroinvertebrate colonization for a fixed exposure period (5 weeks), after which the sampler is retrieved and the attached organisms are harvested. The use of artificial substrate samplers allows the comparison of results from different locations and times by providing uniformity of substrate type, depth, and exposure period. The sampler design is 3 hardboard plates, each 6 inches square, separated by spacers, and mounted on a turnbuckle (Figure 2). Samplers are usually suspended from navigation buoys or floats, at a depth of one meter.

Figure 2
Multiplate Sampler

In the lower Genesee River, using the multiplate sampling method in an identical way in 2004 as in 1974 provides a comparison of data that is invaluable in trend monitoring. The continuity of methods, combined with similarity in sampling sites and data analysis, as well as continuity of personnel, adds up to a powerful tool for the detection of long-term trends.

Water quality trends in the upper Genesee River

Figure 3
Kick Sampling

Our most upstream Genesee River sampling site in New York State is located in Shongo, 1.5 miles north of the Pennsylvania border. Water quality is assessed as non-impacted at this site, based on sampling in 1999 and 2004. The macroinvertebrate community is one typical of a high-quality stream, diverse and well-balanced, with many mayflies, stoneflies, and caddisflies. Moving downstream, sites in Wellsville and Scio have been assessed as slightly impacted in recent samplings. Nonpoint source nutrient enrichment is the primary cause of impact. In this reach, sensitive mayflies and stoneflies become less numerous, and more tolerant filter-feeding caddisflies become more numerous, feeding on suspended plankton. Continuing downstream, most sites in Caneadea and Cuylerville have been found to be non-impacted. Some of the largest of the clean-water macroinvertebrates, the formidable hellgrammites, are often found under stream rocks at these sites. Further downstream at Avon, water quality has been assessed as slightly impacted in all years sampled since 1974, likely from siltation and nonpoint source nutrient enrichment. The upper Genesee River has wadeable riffles, and the kick sampling method is used (Figure 3); downstream of Avon, multiplates are deployed by boat.

Water quality near the Erie Canal junction in Rochester

The Genesee River entering Rochester upstream of the junction with the Erie Canal has exhibited substantial fluctuations in water quality from 1974 to 2004. Water quality in this reach was assessed as poor (moderately impacted) in 1974. Macroinvertebrate communities on multiplates were dominated by sewage-tolerant midges such as *Glyptotendipes lobiferus* and *Dicrotendipes nervosus*, and the sewage-tolerant worm *Dero nivea*. In a series of three multiplate samples over the summer, only one mayfly and one caddisfly were found. The situation was likely the result of the discharge from the Gates-Chili-Ogden Wastewater Treatment Facility (WWTF).

The sewage treatment plant was upgraded in 1977. During the 1980's this site showed greatly improved water quality following the upgrade, and was assessed as good (slightly impacted). The number of EPT illustrated this change, increasing from an average of 1 per sample to 6 per sample (Figure 4). The first stonefly was found at this site in 1990. During the 1990's, water quality worsened at the site, and by 1999, the EPT numbers returned to 1974 levels, and water quality was assessed as severely impacted. Without knowing specifics of the Gates-Chili-Ogden WWTF, we assume that it likely followed the course of many aging WWTFs, facing issues of exceeding capacity and aging equipment. In late 1999, the Gates-Chili-Ogden WWTF was decommissioned and a sewage pumping station was constructed on the site. This station routes the sewage north to the Frank E. Van Lare WWTF, where it is treated and discharged into Lake Ontario.

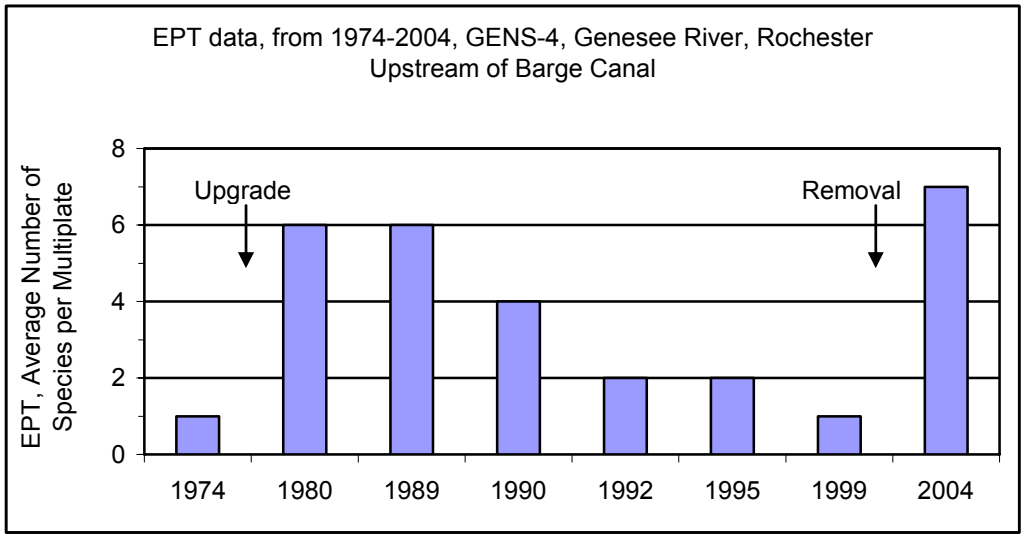

Figure 4
EPT richness in the Genesee River upstream of the Barge Canal, 1974-2004.
Arrows indicate the upgrade and removal of Gate-Chili-Ogden WWTP.

Sampling in 2004 at the site upstream of the canal documented a substantial reversal in water quality trends following the 1999 removal of the sewage discharge. Water quality was assessed as non-impacted, and EPT numbers were up to 7, higher than at any time since 1974. The macroinvertebrate community on plates collected in July and August was dominated by clean-water mayflies.

The confluence of the Genesee River and the Erie Canal presents an interesting hydrological situation. During the winter months, the canal guard gates on both sides of the intersection are closed, the canal is drained on either side, and the river flows through the intersection unaffected. During the navigation season, the gates are open, and the river is augmented by a significant eastward flow of canal water. Our investigation of the mixing patterns at the confluence was from a water quality standpoint, rather than a hydrological standpoint, but revealed patterns that can alter the dynamics of the system. During one sampling, we measured conductivity upstream and downstream in the canal and the river. River water upstream of the intersection had a reading of 1000 μmhos/cm, canal water upstream had a reading of 400 μmhos/cm, and both river and canal water downstream of the confluence had readings of 650 μmhos/cm. All measurements were taken at a depth of one meter. This measurement supports the idea that near-homogeneous mixing of the river and the canal occurs, at least at the flow conditions present during our sampling.

During 1974-1975, we sampled macroinvertebrate communities from four sites around the confluence of the river and the canal to measure the mixing biologically. Results of this sampling also supported the idea of homogeneous mixing, with the downstream river community being very similar to the downstream canal community. At that time, the upstream river water quality was poor and the upstream canal water quality was good, so the canal exerted a positive influence on river water quality. During the 2004 sampling, the canal exerted a slightly poorer influence, because water quality at the upstream river site had improved substantially. The downstream river site was assessed as slightly impacted in 2004.

Water quality in the lower Genesee River in Rochester

The lower Genesee River has exhibited substantial improvement in water quality from 1974 to 2004. We have sampled a site opposite the Genesee Docks in Rochester (also known as Turning Point Park), approximately two miles from the mouth at Lake Ontario, at approximately 5-year intervals since 1974. An overview of the 1974-2004 period shows fluctuations in the multi-metric profile (Figure 5), with an overall improvement trend. Water quality was severely impacted in 1974, reflecting both municipal and industrial wastes. As point sources have been remediated, water quality has improved. Mayflies and caddisflies were first collected on multiplates in 1980, and their numbers and species have gradually increased since then. Water quality was assessed as slightly impacted in 1992, 1995 and 1999. In 2004, water quality at this site was assessed as non-impacted, which may reflect the removal of Gates-Chili-Ogden effluent in 1999. The 2004 assessment also is probably inflated by high flows, as 2004 was a wet summer, and any point sources to the river would be diluted.

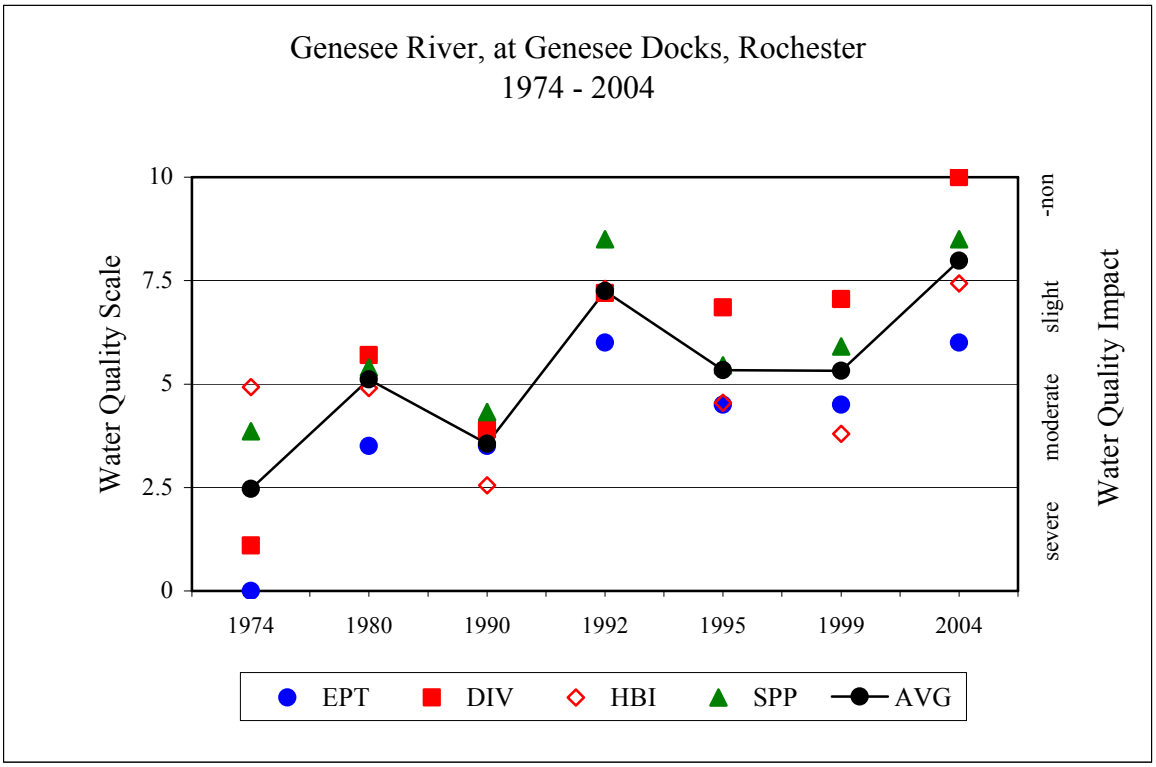

Figure 5
Biological Assessment Profile of index values, Genesee River, at Genesee Docks, Rochester, 1974 - 2004. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing EPT richness, Species Diversity (DIV), Hilsenhoff Biotic Index (HBI) and species richness (SPP).

General trends and the future of water quality in New York State streams

The problem of aging wastewater treatment facilities in the area around Rochester is an example of one of the trends in water quality in New York State and around the nation. This has resulted in increased number of documented declines in water quality in New York State for the period of 1992-2002 as reported in "30 year trends in water quality of rivers and streams in New York State" (Bode et al., 2004). It will be a challenge for the next decade to devote funds to maintain aging infrastructure to prevent reversals in the gains in water quality in the 1970's and 1980's.

The removal of the sewage effluent inputs to the Genesee River has had a demonstrably positive effect on water quality in the river. The assessment of any impacts of the diverted effluent to Lake Ontario is beyond the scope of this study.

About the Authors: Robert Bode and Margaret Novak are both entomologists. Mr. Bode is head of the Stream Biomonitoring Unit and Ms. Novak is chief of the Statewide Waters Monitoring Section, both in the NYSDEC's Division of Water. The Stream Biomonitoring Unit, established in 1972, is one of the longest-running biological monitoring programs in the country, and conducts monitoring and assessment of rivers and stream across New York State.