BIOLOGICAL STREAM SURVEY

ROCKLAND COUNTY, NEW YORK
LOTIC SCENE INVESTIGATION (LSI)
2007 STREAM BIOMONITORING WATER QUALITY PROJECT

PREPARED FOR
HUDSON BASIN RIVER WATCH
EAST GREENWICH, NEW YORK

BY
WATERSHED ASSESSMENT ASSOCIATES, LLC
SCHENECTADY, NEW YORK

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East Greenwich NY 12865

By

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Project Overview

The purpose of this study was to sample 20 stream sites within Rockland County (Figure 1) for benthic (bottom dwelling) invertebrates (2006 and 2007) to determine both water quality and the source of impact affecting a site, if any, based on the invertebrate community structure.

During 2007 data collection, under the direct guidance of a professional aquatic biologist, an undergraduate student applied training in rapid watershed assessment technique and analysis to complete side-by-side data collection at 4 stations. A separate analytic report was compiled by the student.

The data and analysis obtained from this project may be used by county planning and development agencies for planning purposes (e.g., increase the riparian buffer in areas where the streams were classified as slightly to moderately impacted). In addition, the results of the surveyed stations located within Municipal Separate Storm Sewer Systems (MS4) communities may be used by the MS4 community to meet several requirements set forth in the US EPA MS4 regulations.

Background

Rockland County encompasses approximately 210 miles of streams and rivers and more than 600 lakes and ponds, comprising a drainage area of about 114,000 acres. It is the smallest New York County outside of New York City. According to the Rockland County Planning Department, the most recent (2003/2004) percentages of land use within the county are: 32% residential, 5% commercial/office/industrial, 8% institutional/utilities, 0.2% agricultural, 38% parks/open space, 8% transportation, 9% vacant/not yet classified. A detailed definition for each category is available from the Rockland County Planning Department.

Threats to water quality of the streams and rivers in Rockland County include wastewater and runoff from public sewage treatment facilities, human impact from increasing land use and urbanization, runoff from urban and residential areas, industrial discharges, and water withdrawal (both surface and ground) for its public water supply.

The Rockland County Soil and Water Conservation District (RC SWCD) endeavors to develop responsible soil and water conservation programs in order to protect and conserve soil and water resources, as well as to educate the community on the importance of conservation measures. To that end, the RC SWCD has retained Hudson Basin River Watch (HBRW), through its Lotic Scene Investigation (LSI) program, to provide water quality data and educational services to municipalities and agencies that will guide relevant water supply planning, watershed protection, stormwater management, economic development, and aquatic habitat protection, and fulfill

Municipal Separate Storm Sewer Systems (MS4) mandated requirements.

The HBRW program was developed with the intent of providing state agencies, counties, municipalities, and organizations with water quality reports that mirror a state Department of Environmental Conservation's stream biomonitoring methodology, while providing educational research opportunities to students. The course instructor, a professional aquatic biologist, generates a survey report analyzing the side-by-side samples collected by him/her and the students. Side-by-side analysis validates student data, ensuring that the LSI assessment report is valuable for water quality and watershed planning and protection. Dependent upon station selection, assessment results provide either baseline information against which future changes in water quality may be compared to or to monitor trends.

Biological assessments are a widely used cost effective method for assessing water quality. Biological communities may assist identification of stressors to a water body, detect impaired waters, determine restoration priorities, help set protection and restoration goals, aid restoration progress tracking, and support water discharge permit enforcement.

Methods and Rational

The methods, rational, and data analysis used for this study adhered to procedures outlined in the Hudson Basin River Watch Hudson River Estuary Watershed Assessment and Outreach Water Quality Biomonitoring Project Quality Assurance Project Plan (Gruber 2006) and the Quality Assurance Work Plan for Biological Stream Monitoring in New York State (Bode et al. 2002). Both documents are available upon request from Hudson Basin River Watch (HBRW). A brief explanation of methods and rationale of data collected follow. A glossary of selected terms is provided in Appendix I.

Biological

In this study, biological refers to benthic macroinvertebrate larvae community in stream habitats. Because benthic macroinvertebrates are constantly exposed to the effects of various stressors, these communities reflect not only current conditions, but also the cumulative impact of stressors over time. Ascertaining the benthic macroinvertebrate community structure at a station can determine the level of water quality and the most likely stressors affecting the station.

Biological samples were collected at each station using an 800-900 micron mesh kick net (9 by 18 inch). Samples were collected by disturbing the substrate by foot upstream of the net and continuing over a five-meter transect for five minutes as described in the Quality Assurance Work Plan for Biological Stream Monitoring in New York State (Bode et al. 2002). Samples were separately preserved in 95% ethyl alcohol and were then sub-sampled in the lab by randomly selecting 15 cc of detritus from the sample and examining it under a dissecting microscope. Invertebrates larger than 1.5 mm were removed until 100 organisms were obtained for each sample. Macroinvertebrates were identified to genus taxonomic level to determine the water quality category for each station. Identification to the required taxonomic level was conducted for each subsample to determine the Impact Source Determination (ISD) described by Riva-Murray et al. (2002).

The metrics used to determine water quality were those recommended by the

NYS DEC Stream Biomonitoring Unit with one exception, taxa were identified to genera level only instead of a combination of genera and species level identification. In our laboratory trials we have found that identification to genera level accurately categorizes water quality in the NYS DEC four tiered method of assessment (Nolan, unpublished data). The expected variability of a single macroinvertebrate sample and sampling results are stated in Smith and Bode (2004).

Four community metrics were utilized for genera level: Richness (Plafkin et al. 1989), Ephemeroptera-Plecoptera-Trichoptera (EPT) richness (Lenat 1987), Hilsenhoff's Biotic Index (Hilsenhoff 1987), and Percent Model Affinity (PMA) (Novak and Bode 1992). Taxa richness is the total number of taxa represented in a sample; higher taxa richness is associated with clean water (Bode et al. 1996). EPT richness represents the total number of mayfly, stonefly, and caddisfly taxa within a sample; these groups are considered primarily cool, clean water organisms, although caddisfly taxa may occupy a wide range of habitats and temperature regimes (Bode et al. 1996, Peckarsky et al. 1990). The Hilsenhoff Biotic Index assesses organic pollution based on the associated macroinvertebrate tolerance to organic pollution (Hilsenhoff 1988, Bode et al. 1996). Percent Model Affinity evaluates the observed benthic community structure to an expected community structure of seven major groups (Oligochaeta, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Chironomidae, and Other) (Bode et al. 2002). Communities similar to the expected community are considered to be minimally disturbed, where as communities that are less similar are considered severely impacted (Novak and Bode 1992).

The score for each of the above mentioned metrics were combined to calculate each station's Biological Assessment Profile (BAP) by converting each metric score to a common scale of 0 – 10. The BAP score categorizes the overall water quality assessment into one of four categories: non-, slightly, moderately, or severely impacted (Bode et al. 2002). The NYS 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 have higher tolerance to pollutants and are not as sensitive to ecological changes. See Appendix II for complete definitions of each category.

Impact Source Determination (ISD) was calculated for each station. ISD compares test station communities to model communities empirically derived from macroinvertebrate data; the greater the similarity of a test station community to a model community, the more likely a particular impact source is affecting the test community. Data is most conclusive if a test community exhibits at least 50% similarity to a model community (Bode et al., 2002). Riva-Murray et al. (2002) found that ISD correlated well with impairment sources inferred from chemical, physical, and watershed characteristics, and biomonitoring results.

Appendix III contains the macroinvertebrate taxa list and ISD results for each station.

Physical

Benthic macroinvertebrate community structure varies dependent on physical habitat. Multi-metrics used to determine water quality and impact source are based on divergence from the expected community and have been calibrated for a specific habitat.

In general, stations are to be a "wadeable riffle" habitat with physical attributes that are consistent with the habitat comparability criteria outlined in Bode et al. (1990). Therefore, each station was evaluated for percent canopy cover, current speed, and percent of rock, rubble, gravel, sand, and silt, and the embeddedness of the substrate. The depth and width of the stream were also measured and site photos were taken of the upstream and downstream areas to be included with the physical and chemical data.

An optimal macroinvertebrate collection site has a velocity between 0.45 and 0.75 meter/second. Velocity was taken using a Global Water Flow probe (range: 0.3-15 FPS, accuracy: 0.1 FPS) following the manufacturer calibration guidelines.

Water 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 concentration 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 ° Celsius with an upper lethal limit of 240 ° Celsius (Hynes, 1970). The NYS DEC does not have a water quality standard for water temperature.

Temperature was recorded using a Hydrolab Quanta probe (accuracy ± 0.2° C) following the manufacturer calibration guidelines.

Chemical

Dissolved oxygen (DO) level is a function of water turbulence, diffusion, and plant respiration. A significant drop in DO concentration can occur over a 24-hour period, particularly if a water body 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. However, under these conditions at night once photosynthesis ceases, the biological oxygen demand (respiration and decomposition) may cause DO to drop to lethal levels when DO is 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 a Hydrolab Quanta Probe (range: 0 to 50 mg/L, accuracy: ±0.2 mg/L) following the manufacturer calibration guidelines.

It is also important to consider percent oxygen saturation, since dissolved oxygen levels vary inversely with water temperature. Percent saturation is the ratio of dissolved oxygen present in the water at a specific temperature to the 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. It can rise to super-saturated level secondary to photosynthetic activity of abundant algae growth.

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 inability of these organisms to migrate away from the changing conditions, a drop in saturation can be lethal.

Specific conductance or 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. Conductivity increases when inorganic ions are dissolved in water. Organic ions, such as phenols, oil, alcohol and sugar, can decrease conductivity (EPA, 1987). Warmer water is also more conductive and, therefore, conductivity is reported for a standardized water temperature of 25°C. Measurements are reported in micro Siemens per centimeter (µS/cm) following the manufacturer calibration guidelines.

In the United States, freshwater stream conductivity readings vary greatly (50-1,500µS/cm). Conductivity of a particular stream remains relatively constant, 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.

A Hydrolab Quanta probe was used to measure conductivity (range of 0 – 100 mS with a resolution of 4 digits) following the manufacturer calibration guidelines.

The pH is a measure of a stream's acidity. A desirable pH for salmonid is 6.5-8.5. A Hydrolab Quanta probe was used to obtain pH (range: 2 to 12 units, accuracy: ± 0.2 units) following the manufacturer calibration guidelines.

For physical and chemical data see Appendix III.

Results and Discussion

An examination of all possible relationships between land use and water quality is beyond the scope of this project, but some general relationships may be derived from the data.

Biotic assessment profile scores classified water quality for the 20 stream sites from non-impacted to moderately impacted in both 2006 and 2007 (Table 1). In 2007, of the 20 stream stations assessed, 6 stations were non-impacted, 10 were slightly impacted and 4 were moderately impacted. Water quality classifications for seven sites changed from 2006 to 2007 (Table 2). For definitions of impact categories see Appendix II.

Three sites (TIOR 01, CDRP 01, and MNGO 08) water quality classification improved from slightly impacted to non-impacted and one site (SPAR 07) classification improved from moderately impacted to slightly impacted (Table 2). TIOR 01 had the most significant BAP score change, 7.11 (2006) to 8.87 (2007) and CDRP 01 changed from 7.24 (2006) to 8.61 (2007). TIOR 01 and CDRP 01 are in Cedar Pond Brook located in the northeastern part of Rockland County where the upstream drainage is primarily forested. The other two Cedar Pond Brook sites were classified as non-impacted in both 2006 and 2007 (Figure 2 and Table 2). MNGO 08 had the least dramatic BAP score shift, 7.46 (2006) to 7.61(2007), the minor change was enough to place the site in the non-impacted classification. MNGO 08 is the most upstream site on Minisceongo Creek where the surrounding land use is largely residential and crop land. The remaining Minisceongo Creek sites were classified as slightly impacted in both 2006

and 2007(Figure 3 and Table 2). SPAR 07 BAP score improved from 4.73 to 5.46 (Figure 4 and Table 2). SPAR 07 is in the Sparkill (southwestern Rockland County) located within area dominated by industrial land use, although the upstream drainage is predominantly forested. Field data sheets indicate SPAR 07 site condition improved from poor (2006) to good (2007).

Three sites degraded from 2006 to 2007: HACK 24 in the Hackensack River water classification shifted from non-impacted (7.83) to slightly impacted (6.01), PASC 04 in the Pascack Brook changed from slightly impacted (5.68) to moderately impacted (4.85), and NAUR 03 located in the Nauraushaun Brook changed from slightly impacted (5.30) to moderately impacted (4.97). The change in species richness and HBI metric scores had the greatest impact on HACK 24 BAP score from 2006 to 2007 (Table 2 and Figure 5). The majority of land use surrounding HACK 24 and the Hackensack River is a mix of forested and developed land. In 2006, the PASC 04 BAP score was close to the boundary between slightly impacted and moderately impacted and the decline in species richness adjusted the 2007 BAP score into the high range of the moderately impacted category (Table 2 and Figure 6). PASC 04 is located on the Pascack Brook; the land use surrounding the majority of the Pascack Brook and both study sites is dominated by residential and urban/built-up land uses. The lower Pascack Brook site, PASC 02, BAP score declined due to a change in the PMA metric, however the water quality classification remained slightly impacted (Table 2 and Figure 5). The 2006 BAP score for NAUR 03 was at the very bottom range for classification as slightly impacted (Figure 5). The EPT and PMA metric scores fell from 2006 to 2007 reducing the 2007 BAP score enough to drop NAUR 03 just into the moderately impacted classification (Table 2 and Figure 5). Land use upstream of NAUR 03 is dominated by residential, commercial, industrial, and urban/built-up with pockets of forested area buffering the Nauraushaun Brook.

BAP scores and water quality classifications for the stations in the Stony Brook and Mahwah River did not change dramatically (Figure 7 and Table 2). The Ramapo River station BAP score declined slightly, but remained within the slightly impacted water quality category (Figure 7 and Table 2).

Although water quality determinations shifted for seven sites, the differences between 2006-2007 BAP scores were not great and most likely the changes may be attributed to natural community variation. In most instances, a shift of less one point was enough to move the site into a different impact category. Analysis of historical macroinvertebrate data, physical and chemical variables, and land use change coupled with continued monitoring will elucidate the factors driving the biological community shifts, help identify which streams are most threaten by urbanization, and provide opportunities to assess conservation efforts.

More than half of the 20 sites impact source determination (ISD) shifted between 2006 and 2007 (Table 3 and Figure 8). Four sites ISD results were less than 50% in all categories, therefore limited observations may be made from these determinations (Table 3). Hackensack River site HACK 24, ISD shifted from natural to impoundment/nutrient category this coincides with the site's change in water quality classification, non-impacted to slightly impacted. Pascack Brook site PASC 04 experienced a decline in water quality (slightly impacted to moderately impacted) and the ISD category changed from nutrients/toxins/organic/complex to toxins (Table 3). NAUR 03 ISD remained

complex, however in 2007 the siltation category exhibited the highest percent similarity replacing the nutrient category in 2006 (Table 3). Overall, ISD categorizations reasonably reflect the upstream land use characteristics affecting the 20 sites and indicate the most likely sources that impact biological communities.

Similar to the 2002 NY DEC statewide assessment, which found that 52% of the impacted stations were affected by non-point source nutrient enrichment (Bode et al., 2004), the most likely impairment in this present survey, determined by ISD, is non-point source nutrient enrichment, affecting approximately 50% of stations in 2006-2007. The remaining impacted stations are influenced by toxic or complex municipal/industrial discharge or sewage effluent/organic inputs. Seventy percent of Rockland County 2006-2007 stream assessments were classified as slightly impacted; this is approximately 30% more than the streams assessed in 2002 by NY DEC (Figure 9). The percentage of Rockland County (2006-2007) moderately impacted streams was similar to 2002 statewide stream assessments. The percentage of non-impacted streams in Rockland County (20%) in 2006-2007 deviates by 25% from the streams categorized in 2002 (Figure 2); compared to the 2002 statewide bioasssessments and based on the 2006-2007 assessments, Rockland County streams are more degraded (Figure 9).

The differences between physical and chemical data collected in 2006 and 2007 were not significant. The most remarkable difference between 2006 and 2007data was that 15 of the 20 sites experienced higher specific conductance readings in 2007. This is most likely the result of lower flow velocities during 2007 sampling; US Geological Survey monthly statistics for three gaging stations on the Hackensack River and Mahwah River showed lower discharge (ft^3/sec) values during June-August 2007 than in 2006. Flow velocity affects conductivity readings in lotic systems; under low flow conditions the concentration of dissolved ions is higher and may better reflect the impact of the surrounding land use.

The 2006-2007 survey results showed a correlation between increasing mean specific conductance and declining water quality, based on resident benthic macroinvertebrates mean BAP scores (Figure 10). Degraded EPT richness may indicate a corresponding loss of sensitive fishes (Miltner and Rankin, 1998; Kilgour and Barton, 1999), and this may occur in waters assessed as slightly impacted. Land use and the percent of impervious surface area have clearly been shown to affect water quality, and specific conductance can be used as an indicator of land use contaminants. Changes in conductivity begin to occur when impervious surface area in a catchment area reaches greater than ten percent. This type of calculation is beyond the scope of our current study, however, Figure 11 illustrates higher conductivity values were associated with developed land use based on our study sites (GIS data obtained from the USGS, NY Land Cover Data Set).

A large portion of Rockland County is developed and most of the 20 sites sampled are located within a developed land area. The BAP scores indicate stream biological communities to be non-impacted to moderately impacted; the majority of sites (65% in 2006 and 50% in 2007) are considered to have good water quality (Table 1). This means that macroinvertebrate community may be slightly degraded (i.e., fewer species of mayflies and stoneflies) and the reproductive capacity of fish communities may be impaired. The pace, configuration, and types of land use change and urbanization may have varying degrees of impact on stream communities. Continued monitoring and

application of best management practices (i.e., siltation fencing, riparian corridors, and monitoring) during development activities may deter further degradation of biological stream community structure and ecosystem function.

NYS DEC SBU has conducted numerous water quality assessments within Rockland County, providing valuable historical documentation of the county's water quality for monitoring longitudinal water quality trends. Several stations assessed during this survey were previously assessed by NYS DEC; when feasible, the data from NYS DEC assessments were incorporated into this survey to provide trend analysis. To better understand the long term direction of biological change in Rockland County streams it may be a worthwhile for Rockland County Soil and Water District to investigate historical water quality trends utilizing all available macroinvertebrate data.

Description of Remaining Sections of this Report

An overview map of Rockland County containing all sites assessed in 2007, with corresponding steam name, station number, and water quality category, precedes narrative descriptions for each major watershed basin in Rockland County.

Following this, the physical and chemical data page and macroinvertebrate community data page for each individual station sampled within the particular watershed is provided, which includes: site location, number, sampling date, physical and chemical data obtained, taxa identified, multi metric scores, biological assessment profile score, and ISD scores.

Stream Narratives

The biological assessment profile is comprised of four contributory indices that are determined from sub-samples of macroinvertebrates collected from each station.

Cedar Pond Brook
Station TIOR 01 is located just above the CR 106/210 Bridge. Based on the benthic macroinvertebrate sub-sample, water quality in 2007 was non-impacted and source determination is slightly impacted and impact source determination is most similar to a natural, non-impacted community structure. This station was previously assessed by NYS DEC in 2002 as non-impacted.

Station CDRP 03 is located just above the West Main Street Bridge. This tributary of Cedar Pond Book enters approximately 0.9 miles downstream from station TIOR 01. Water quality, based on the benthic macroinvertebrate community, is non-impacted. ISD indicates a community structure most similar to a natural, non-impacted community structure.

Station CDRP 02 is located just above Reservoir Road Bridge and approximately 2.4 miles below the upper most station, TIOR 01. Based on the benthic macroinvertebrate sub-sample, water quality is non-impacted and impact source determination is most similar to a natural, nutrient impacted community structure.

Station CDRP 01 is located approximately 1.1 miles below Station CDRP 02 and just above Lowland Hill Road Bridge. Based on the benthic macroinvertebrate sub-sample, water quality is non-impacted. ISD is most similar to a natural community structure with non-point source nutrients and complex inputs.

Minisceongo Creek
Station MNGO 08 is located approximately 5.6 miles above the confluence with the Hudson River just above Storrs Rd. Bridge. By benthic macroinvertebrate community structure, water quality is non-impacted. ISD indicated a community structure most similar to one affected by non-point source nutrient inputs.

Located approximately 2.2 miles below station MNGO 08, just off Church Street, station MNGO 04 is slightly impacted, based on the benthic macroinvertebrate community structure. The most likely cause of water quality impairment, by ISD, is non-point source nutrients, complex municipal and industrial inputs.

Station MNGO 03 is located approximately 1.2 miles below station MNGO 04. Based on the benthic macroinvertebrate community structure, water quality is slightly impacted. ISD indicates a community structure affected by multiple stressors, including industrial, toxins, and complex inputs. The ISD for impoundment is spurious, as no impound exists.

Station MNGO 02 is located approximately 0.9 miles below station MNGO 03, and water quality is slightly impacted by macroinvertebrate community structure. ISD indicates a

community structure most affected by non-point source nutrients.

Ramapo and Mahwah River and Stony Brook
Located just above Seven Lakes Road Bridge, station STOB 01 water quality is non-impacted and most similar to a natural community by macroinvertebrate community structure and ISD. The NYS DEC also assessed water quality here as non-impacted in 2002.

Station MAWA 01, located approximately 100 meters above Montebello Road Bridge, was slightly impacted, but the benthic macroinvertebrate community structure was close to the moderately impacted category. ISD indicated a community structure affected by industrial, impoundment, and non-point source nutrient enrichment. NYS DEC assessed this station as slightly impacted in 2001.

Located just above the Fourth Street Bridge, station RAMA 07 was slightly impacted based on the benthic macroinvertebrate community structure. ISD indicated a community structure most similar to one affected by non-point source nutrient additions, impoundment and industrial inputs. NYS DEC assessed this station in 1991, 1993, 1997, 1998, 2002, and 2003. Compared to those years, the water quality shows improvement, based on the benthic macroinvertebrate community structure.

Pascack and Muddy Brook
PASC 04 is located approximately 5.4 miles above the NY/NJ border, just off Memorial Park Drive. Water quality, based on the benthic macroinvertebrate community structure, is moderately impacted and the ISD indicates a community structure most affected by toxins.

Station PASC 02 is located approximately 1.4 miles below station PASC 04. Water quality, based on the benthic macroinvertebrate community structure is slightly impacted and ISD indicates a community structure most similar to a community affected by toxic, siltation, and industrial inputs.

MUDD 02 is located just below the West Washington Avenue Bridge. Water quality is moderately impacted, falling just outside the slightly impacted category by macroinvertebrate community structure. ISD indicated a community structure most similar to one affected by toxic inputs.

Hackensack River
Station HACK 24 is located approximately 13 miles above the NY/NJ border and just above the Old Route 304 Bridge. Water quality, based on the benthic macroinvertebrate community structure, is slightly impacted. ISD indicated a community affected by an impoundment and non-point source nutrient inputs.

Located just above Sittle Torr Road Bridge, station DMRK 01 was slightly impacted. ISD indicated a community most likely affected by organic, non-point source nutrients, complex inputs, and impoundment effects. While the station is located below a small

wetland, the dominant surrounding land use is residential and the immediate adjacent land use is a commercial nursery.

Located just below the Western Highway bridge, station HACK 01 is moderately impacted based on the benthic macroinvertebrate community structure. ISD indicated a community affected by industrial inputs. In 2006, HACK 01A was sampled due to flow conditions at HACK 01. HACK 01A was located below Lake de Forest, which likely has a major influence on the community structure at this station. Therefore, as outlined in the QAWP (Bode et al., 2002), the BAP was adjusted up one category to reflect genuine water quality and was categorized as slightly impacted. In 2007, BAP scores were not adjusted.

Station NAUR 03 is located just below the Town Line Road Bridge and the water quality is moderately impacted. ISD indicates a community most similar to one affected by siltation, organic, industrial, toxic, and non-point source nutrients. In 2002, the NYS DEC assessed the stream well below this station as moderately impacted.

Sparkill

Station SPAR 07 is located approximately 4.3 miles above the confluence with the Hudson River, just below the Route 340 Bridge. Based on the benthic macroinvertebrate community structure, water quality is slightly impacted. ISD indicates the community is most likely affected by industrial inputs.

Located approximately 4 miles downstream from station SPAR 07 and just below the New Street Bridge, station SPAR 06 is slightly impacted. ISD indicates a benthic macroinvertebrate community structure most similar to one affected by organic and industrial inputs. The NYS DEC assessed this station in 2003 and determined the water quality was moderately impacted.

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Table 1. Percentage (and number) of stream sites water quality classifications for 20 Rockland County stream sites sampled in 2006 and 2007, based on aquatic macroinvertebrate biotic assessment profile (BAP) scores. See Appendix II for detailed descriptions.

Year	Non-impacted	Slightly impacted	Moderately impacted
2006	20% (4)	65% (13)	15% (3)
2007	30% (6)	50% (10)	20% (4)

Table 2. Biotic assessment profile scores, metric scores, and water quality classifications for 20 stream sites sampled in 2006 and 2007. Spp Richness = species richness, HBI= Hilsenhoff Biotic Index, EPT = Ephemeroptera-Plecoptera-Trichoptera richness, PMA= Percent Model Affiinity.** HACK 01A was sampled in 2006 due to flow conditions at HACK 01; sites are not directly comparable.

Stream	Station	Species Richness		HBI		EPT		PMA		BAP		Water quality	
		2006	*2007*	*2006*	*2007*	*2006*	*2007*	*2006*	*2007*	*2006*	*2007*	*2006*	*2007*
Cedar Pond Brook	TIOR 01	8.50	9.0	7.91	9.06	5.91	10.0	6.13	7.42	7.11	8.87	Slight	Non
	CDRP 03	9.50	8.50	7.68	8.26	8.00	7.27	6.94	7.88	8.03	7.98	Non	Non
	CDRP 02	10.0	7.27	8.31	9.05	9.00	9.00	7.10	6.29	8.60	7.90	Non	Non
	CDRP 01	8.00	8.50	7.84	8.33	6.82	10.0	6.29	7.60	7.24	8.61	Slight	Non
Minisceongo Creek	MNGO 08	8.50	5.91	7.86	9.53	6.36	6.82	7.10	8.17	7.46	7.61	Slight	Non
	MNGO 04	8.00	5.45	6.29	7.28	4.17	4.17	6.77	5.16	6.31	5.51	Slight	Slight
	MNGO 03	5.91	10.0	7.04	6.54	4.72	5.91	4.60	6.13	5.57	7.14	Slight	Slight
	MNGO 02	2.95	5.91	6.64	7.56	4.72	5.91	6.94	6.94	5.31	6.58	Slight	Slight
Hackensack River	HACK 24	10.0	7.27	8.39	5.54	6.82	5.91	6.13	5.32	7.83	6.01	Non	Slight
	HACK 01A	4.77	**	6.09	**	1.25	**	3.63	**	5.90	**	Mod	**
	HACK 01	**	5.91	**	5.11	**	1.25	**	3.79	**	4.02	**	Mod
Hackensack Creek	DMRK 01	8.50	10.0	7.70	6.56	4.72	5.45	5.65	5.32	6.64	6.83	Slight	Slight
Stoney Brook	STOB 01	8.00	9.00	8.29	9.19	9.00	9.50	8.37	6.94	8.41	8.66	Non	Non
Ramapo River	RAMA 07	6.82	4.32	7.08	7.73	6.82	6.36	8.46	5.65	7.29	6.01	Slight	Slight
Mahwah River	MAWA 01	5.45	6.36	6.81	6.38	4.72	4.72	3.63	2.82	5.15	5.07	Slight	Slight
Pascack Brook	PASC 04	6.36	3.41	5.06	5.06	3.61	4.17	7.69	6.77	5.68	4.85	Slight	Mod
	PASC 02	6.36	6.36	5.99	6.43	4.17	3.61	9.04	5.81	6.39	5.55	Slight	Slight
Nauraushaun Brook	NAUR 03	3.41	3.41	6.48	6.68	3.61	4.17	7.69	5.65	5.30	4.97	Slight	Mod
Sparkill	SPAR 07	3.86	5.45	6.84	6.79	3.61	3.61	4.60	5.97	4.73	5.46	Mod	Slight
	SPAR 06	4.77	5.91	6.50	6.70	3.61	5.45	5.48	5.48	5.09	5.89	Slight	Slight
Muddy Creek	MUDD 02	3.86	6.36	6.29	5.76	3.61	3.61	6.13	3.95	4.97	4.92	Mod	Mod

Table 3. Impact source determination (ISD) classifications, BAP scores, and water quality classifications for 20 stream sites sampled in 2006 and 2007. See Appendix II for definitions of water quality classifications and ISD methodology. *Indicates the ISD similarity results were less than 50% for all categories therefore fewer conclusions may be inferred.** HACK 01A was sampled in 2006 due to flow conditions at HACK 01; sites are not directly comparable.

Stream	Station	BAP		Water quality		Impact source determination	
		2006	*2007*	*2006*	*2007*	*2006*	*2007*
Cedar Pond Brook	TIOR 01	7.11	8.87	Slight	Non	Natural	Natural
	CDRP 03	8.03	7.98	Non	Non	Nutrients/Complex	Natural
	CDRP 02	8.60	7.90	Non	Non	Natural	Natural/Nutrient
	CDRP 01	7.24	8.61	Slight	Non	Natural/Nutrients	Natural/Nutrient/Complex*
Minisceongo Creek	MNGO 08	7.46	7.61	Slight	Non	Nutrients	Natural*
	MNGO 04	6.31	5.51	Slight	Slight	Complex	Nutrient/Impoundment
	MNGO 03	5.57	7.14	Slight	Slight	Nutrients/Organic/Complex	Industrial/Toxins/Complex
	MNGO 02	5.31	6.58	Slight	Slight	Nutrients/Organic/Complex	Nutrient
Hackensack River	HACK 24	7.83	6.01	Non	Slight	Natural	Impoundment/Nutrient
	HACK 01A	5.90	**	Mod	**	Nutrients/Toxic/Complex	**
	HACK 01	**	4.02	**	Mod	**	Industrial
Hackensack Creek	DMRK 01	6.64	6.83	Slight	Slight	Nutrients/Complex	Organic/Natural/Complex*
Stoney Brook	STOB 01	8.41	8.66	Non	Non	Natural	Natural
Ramapo River	RAMA 07	7.29	6.01	Slight	Slight	Natural/Nutrients	Nutrient/Impoundment/Industrial
Mahwah River	MAWA 01	5.15	5.07	Slight	Slight	Nutrients	Industrial/Impoundment/Nutrient*
Pascack Brook	PASC 04	5.68	4.85	Slight	Mod	Nutrients/Toxic/Organic/Complex	Toxins
	PASC 02	6.39	5.55	Slight	Slight	Natural/Nutrients/Toxic	Toxins/Siltation/Industrial
Nauraushaun Brook	NAUR 03	5.30	4.97	Slight	Mod	Nutrients/Complex	Siltation/Organic/Complex
Sparkill	SPAR 07	4.73	5.46	Mod	Slight	Complex	Industrial
	SPAR 06	5.09	5.89	Slight	Slight	Toxic/Organic	Organic/Industrial
Muddy Creek	MUDD 02	4.97	4.92	Mod	Mod	Toxic	Impoundment/Toxins

Figure 1. Biotic assessment score (BAP) water quality classifications for the 20 stream stations sampled in Rockland County, NY in relation to land use.

Figure 2. Biotic assessment (BAP) scores and water quality classifications for Cedar Pond Brook stations collected in 2006 and 2007.

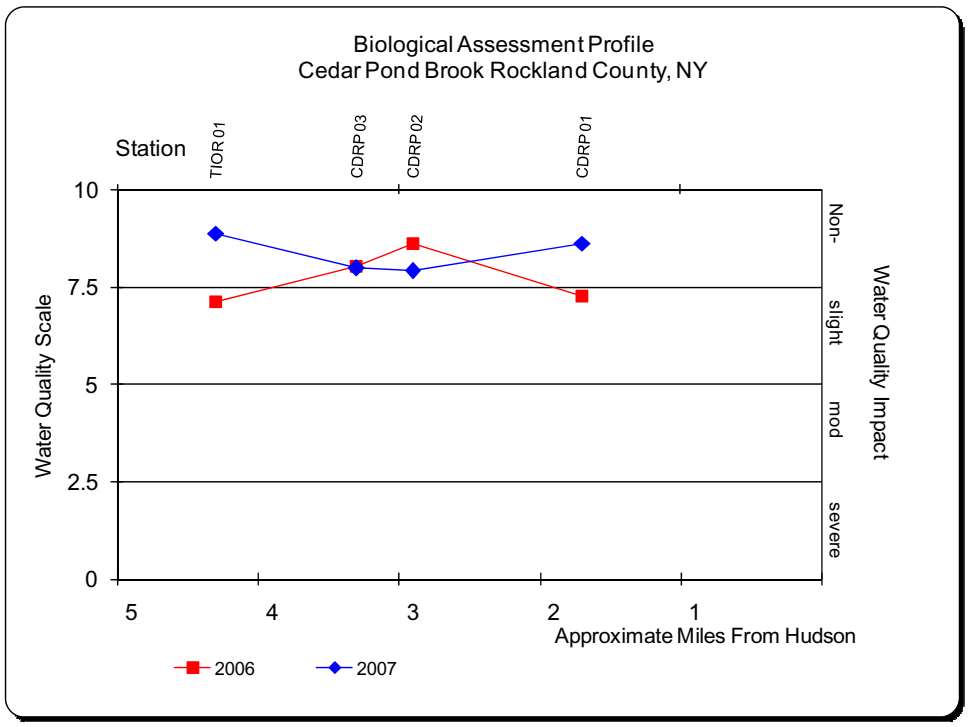


Figure 3. Biotic assessment (BAP) scores and water quality classifications for Minisceongo Creek stations collected in 2006 and 2007.

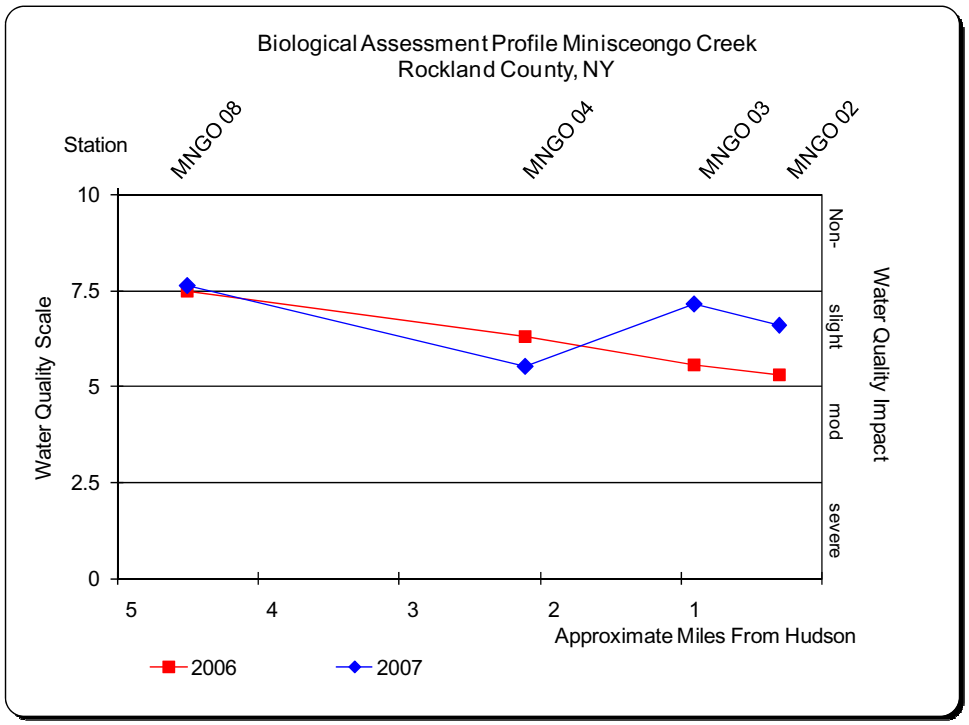


Figure 4. Biotic assessment (BAP) scores and water quality classifications for Sparkill stations collected in 2006 and 2007.

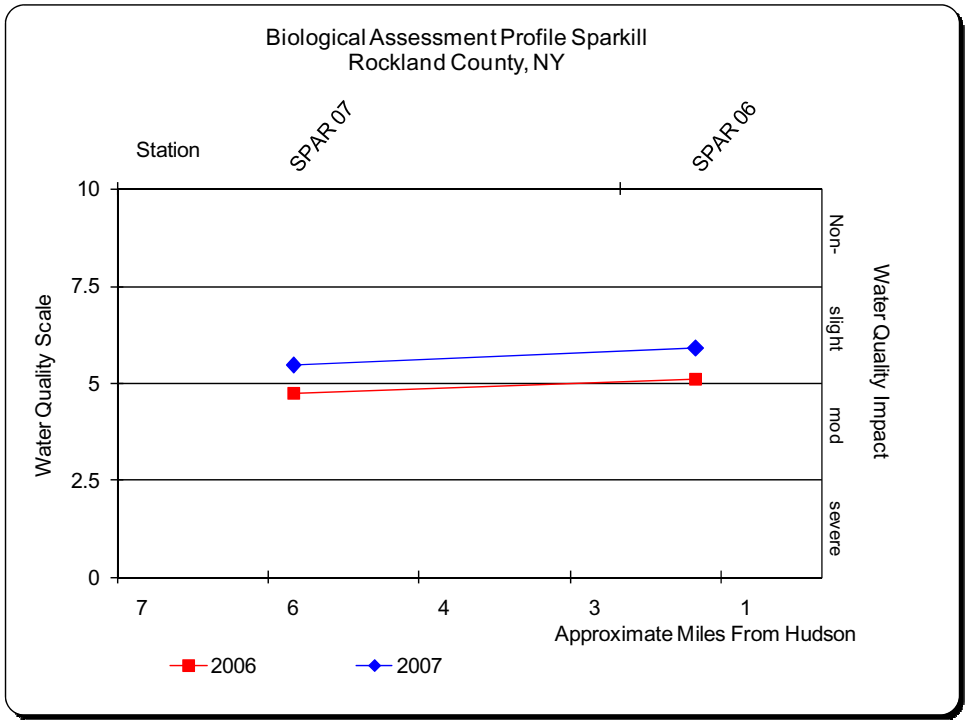


Figure 5. Biotic assessment (BAP) scores and water quality classifications for Hackensack River stations collected in 2006 and 2007.

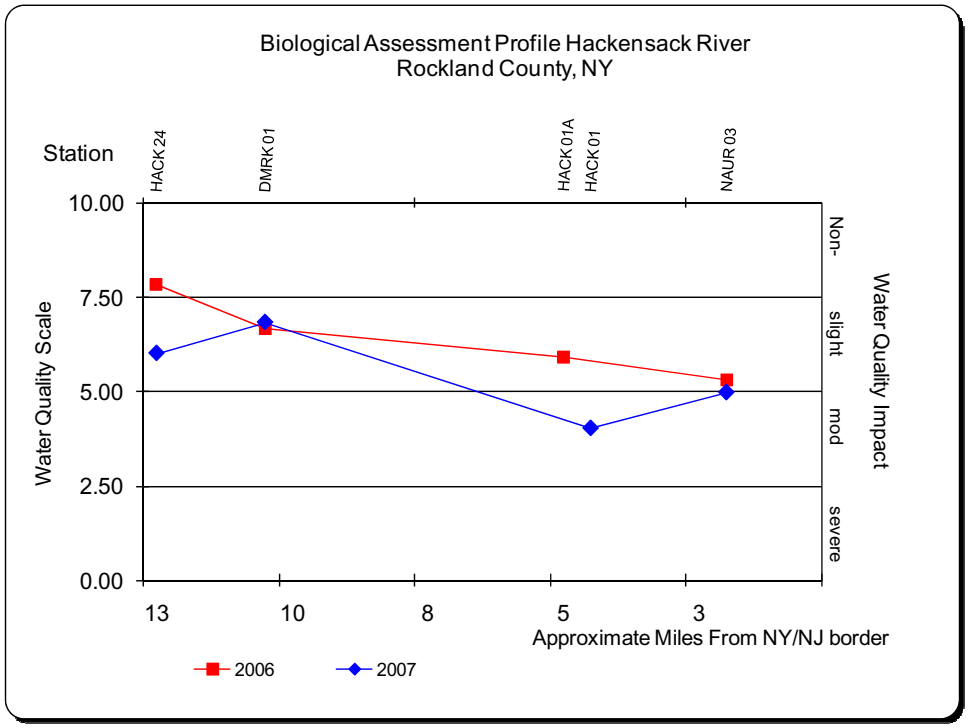


Figure 6. Biotic assessment (BAP) scores and water quality classifications for Pascack and Muddy Brook stations collected in 2006 and 2007.

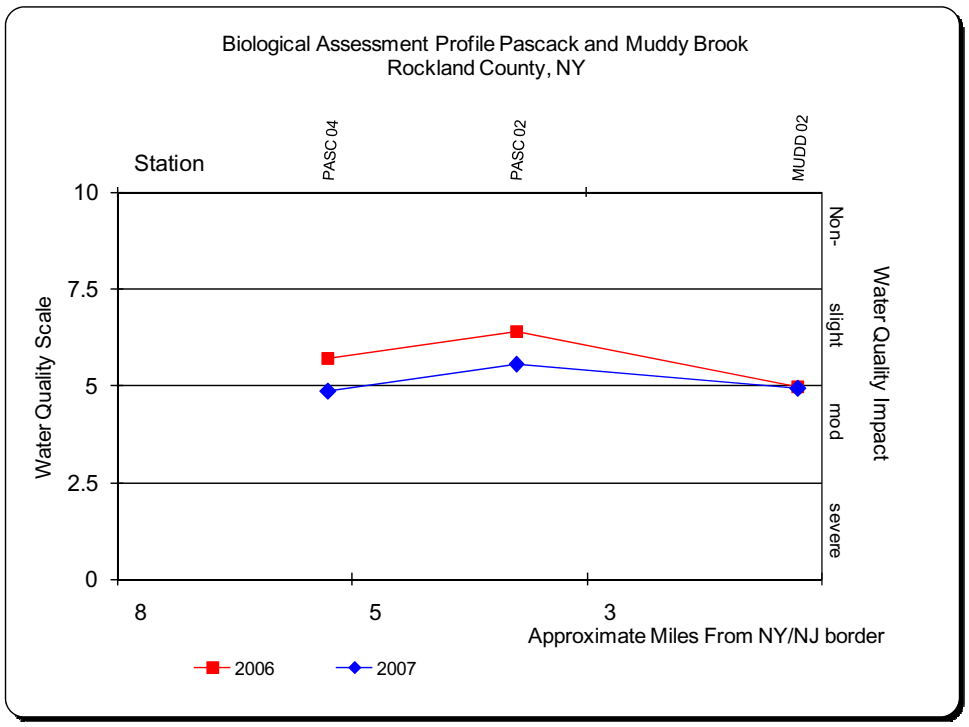


Figure 7. Biotic assessment (BAP) scores and water quality classifications for Ramapo and Mahwah River and Stony Brook stations collected in 2006 and 2007.

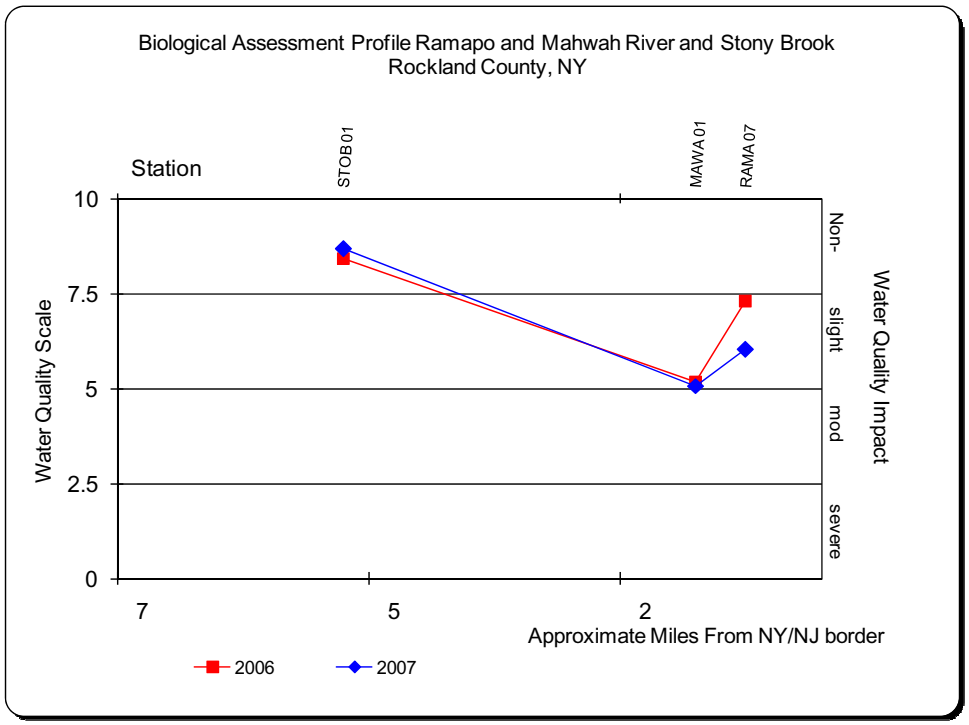


Figure 8. BAP, ISD and water quality impact categories for 20 Rockland County streams in 2007 and 2006. See Appendix II for further explanation of the biotic assessment profile (BAP) and impact category definitions.

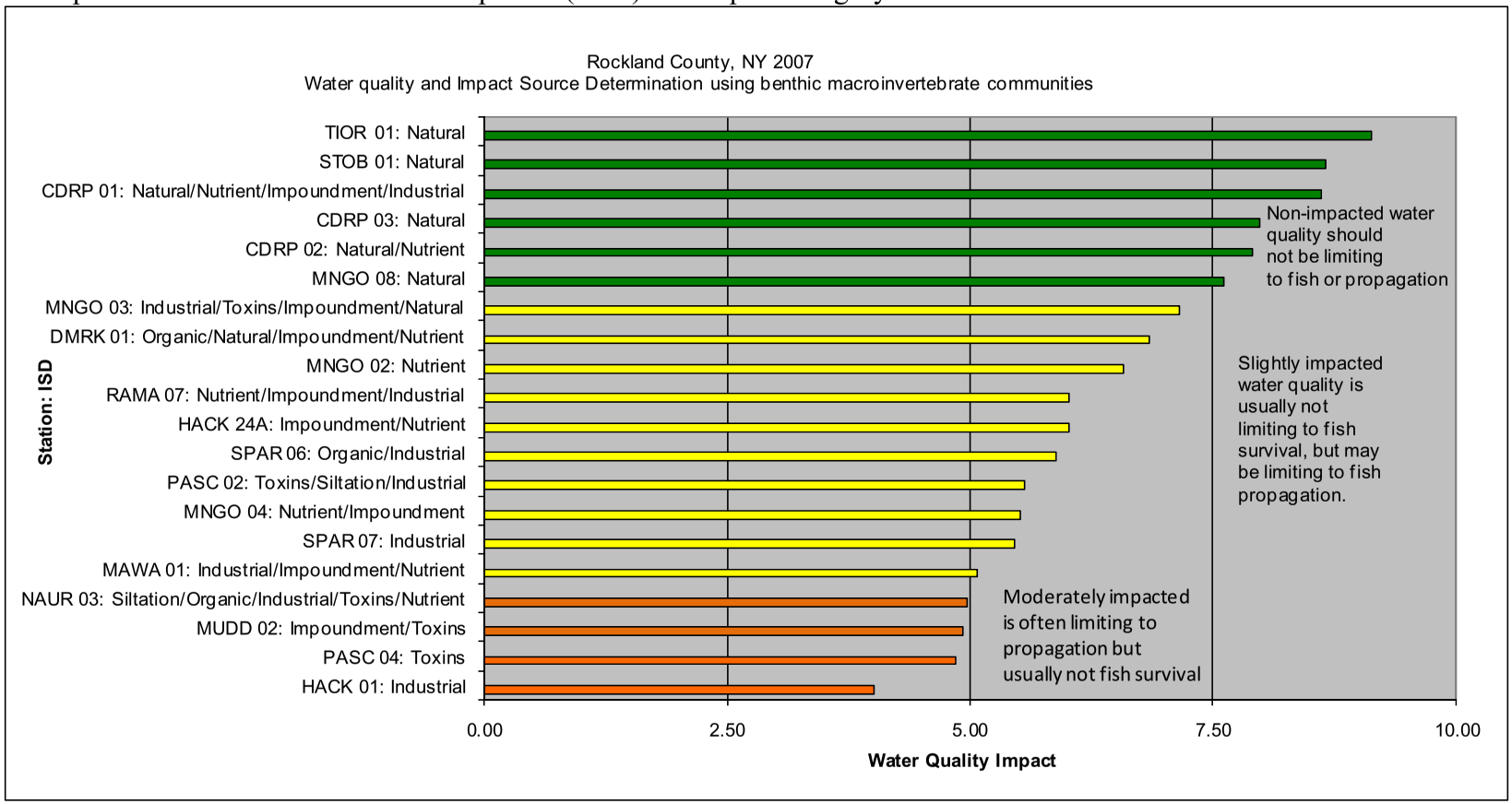


Figure 8 continued.

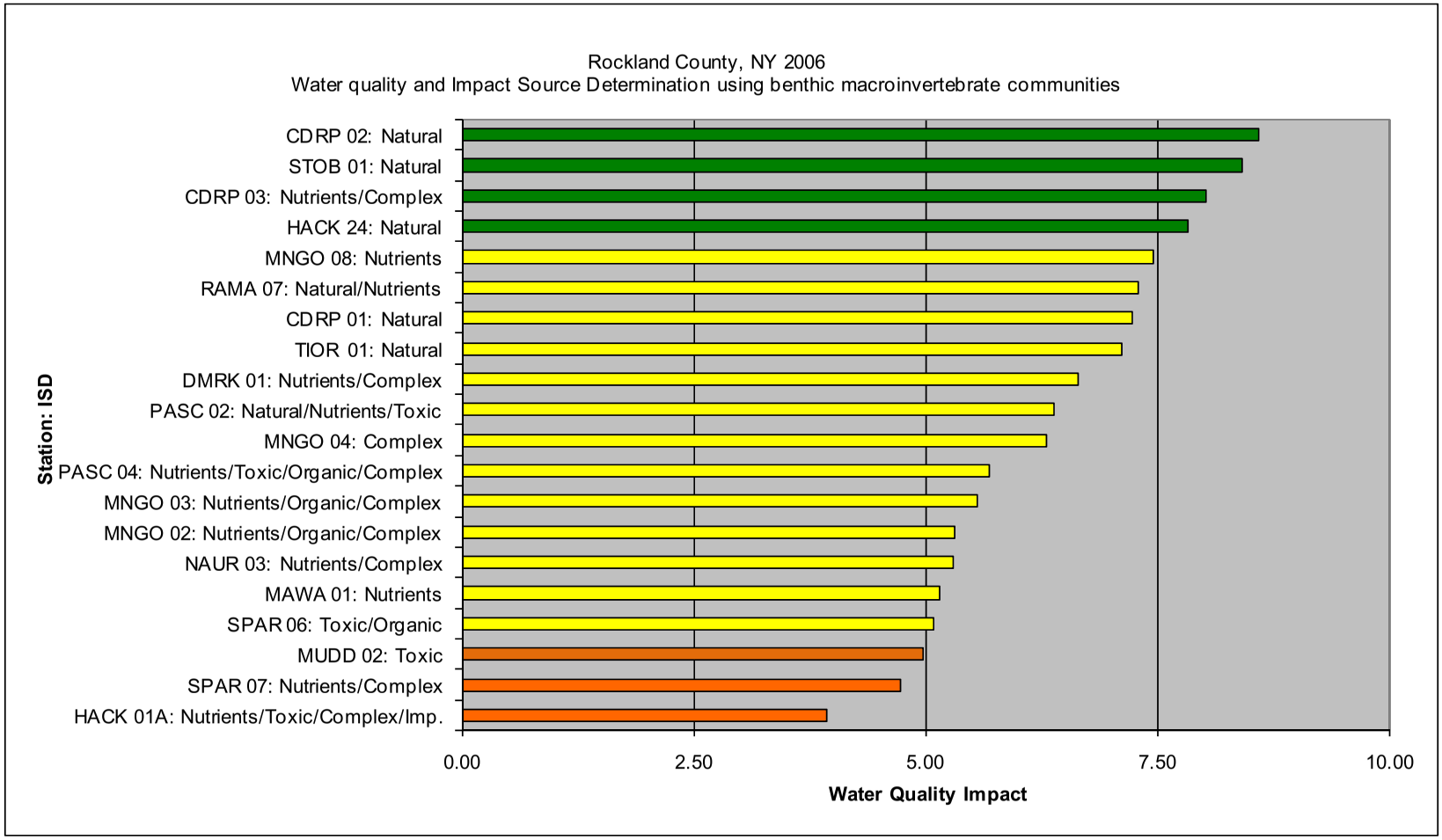
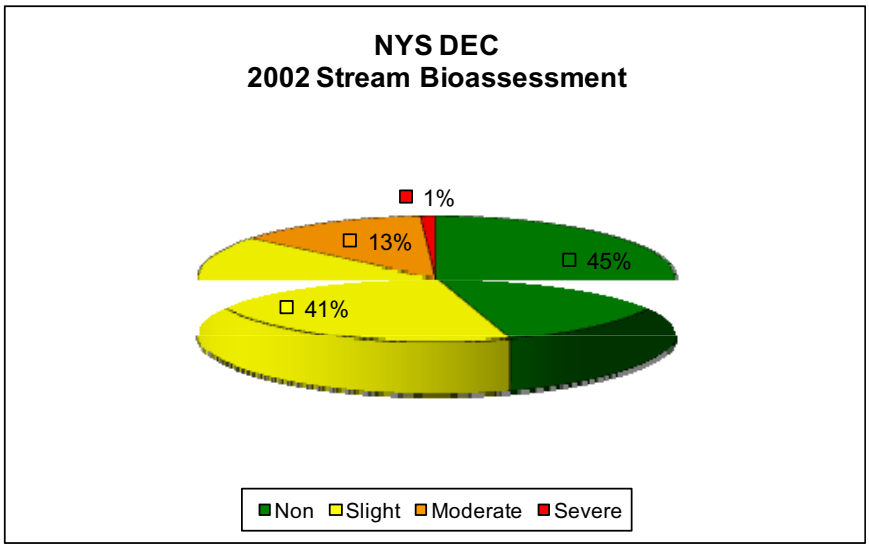


Figure 9. Water quality categories of all NY State sites surveyed by NYS DEC in 2002 and the 20 Rockland County sites surveyed by HBRW in 2006-2007.



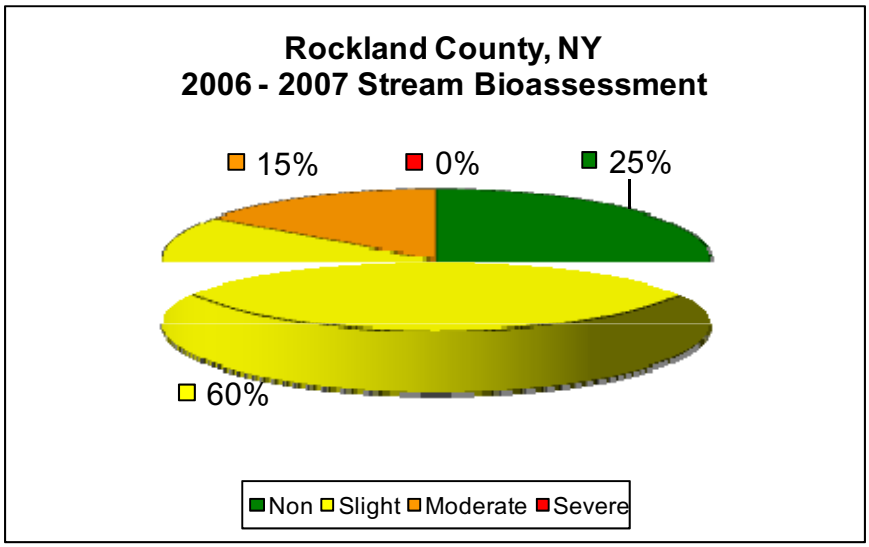


Figure 10. Graph depicts the inverse relationship between mean specific conductance (SC) and mean BAP scores for Minisceongo Creek surveyed in Rockland County in 2006-2007.

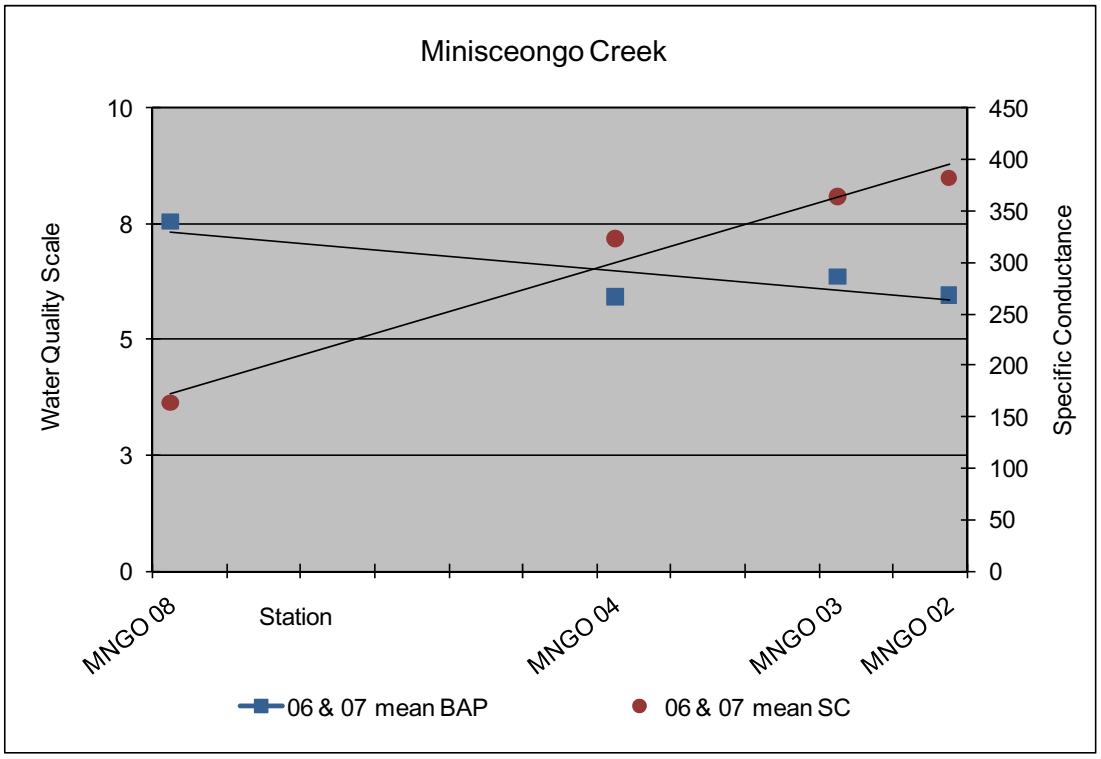
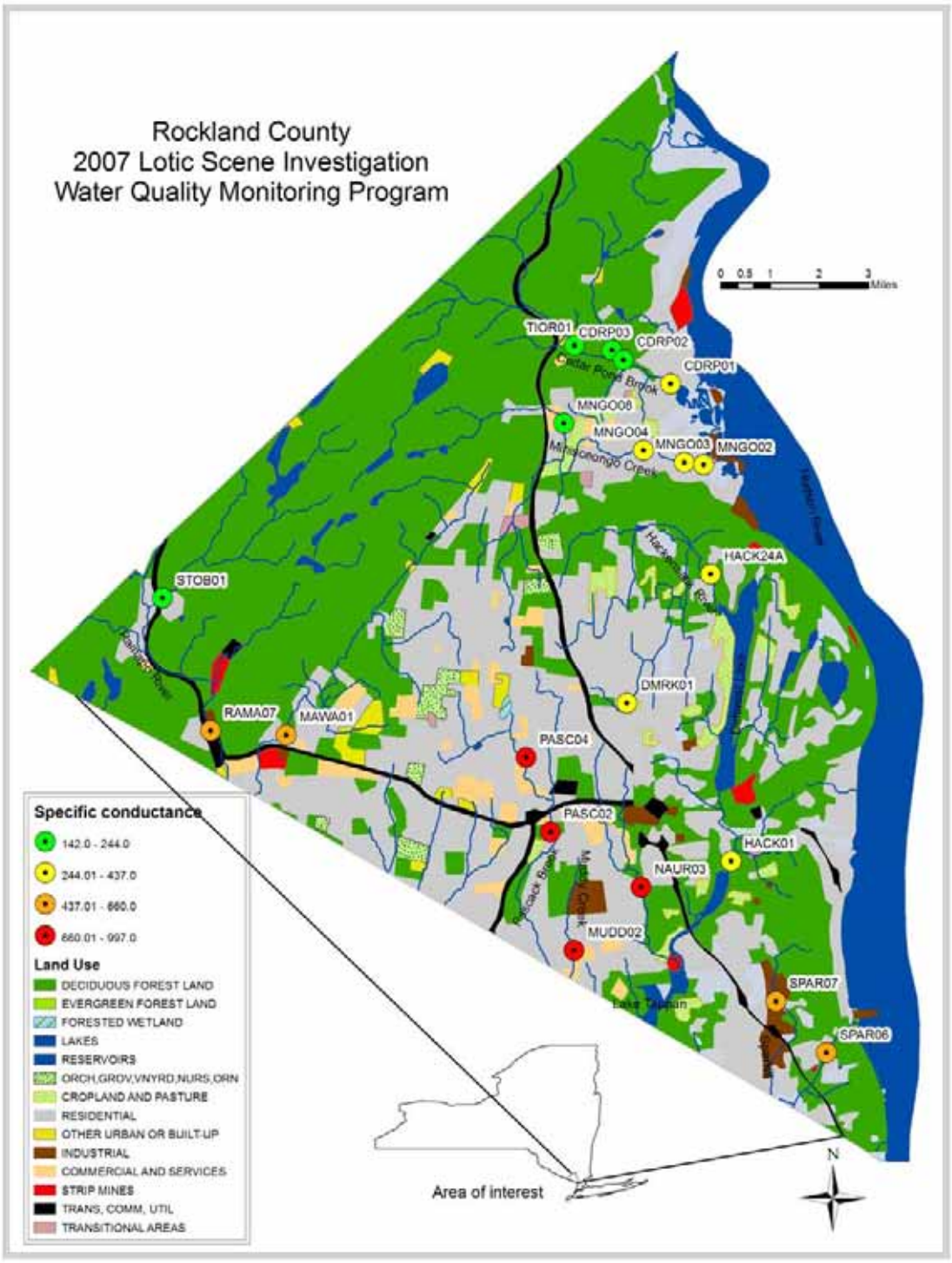


Figure 11. Distribution of specific conductance values in relation to land use for the 20 study sites sampled in Rockland County, NY.



Appendix I: Glossary

Anthropogenic: caused by man

Assessment: a diagnosis or evaluation of water quality

Benthic: located on the bottom of a body of water or in the bottom sediments or pertaining to bottom-dwelling organisms

Benthos: organisms occurring on or in the bottom substrate of a waterbody

Biomonitoring: the use of biological indicators to measure water quality

Diel cycle: referring to the 24 hr day

Impact: a change in the physical, chemical, or biological condition of a waterbody

Impairment: a detrimental effect caused by an impact

Index: a number, metric, or parameter derived from sample data used as a measure of water quality

Intolerant: unable to survive poor water quality

Macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

Non point source: diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet)

Periphyton: are algae that grow on a variety of submerged substrates, such as rocks, plants or debris, in lakes or streams

Point source: a stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack

Rapid bioassessment: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short turn-around-time; usually involves kick sampling and laboratory subsampling of the sample

Station: a sampling site on a waterbody

Stenotherms: organisms having a very narrow thermal tolerance and preferring cooler temperatures

Survey: a set of sampling conducted in succession along a stretch of stream

Tolerant: able to survive poor water quality

Appendix II: Water quality impact categories and ISD definitions

Biological Assessment Profile: Conversion of Index Values to Common 10-Scale.

The Biological Assessment Profile of index values, developed by Phil O'Brien, Division of Water NYS DEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined previously are converted to a common 0-10 scale using the formulae in the NYS DEC Quality Assurance document (Bode *et al*., 2002).

Water Quality Impact Categories

Non-impacted: Indices reflect very good water quality. The macroinvertebrate community is diverse, usually greater than 13 families in riffle habitats. Mayflies, stoneflies, and caddisflies are well represented; EPT family richness is greater than 7. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

Slightly impacted: Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Family richness usually is 10 -13. Mayflies and stoneflies may be restricted, with EPT values of 3-7. The biotic index value is 4.51-5.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

Moderately impacted: Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Family richness usually is 7-9. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; EPT richness is 1-2. The biotic index value is 5.51-7.00. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

Severely impacted: Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant Families. Family richness is less than 7. Mayflies, stoneflies, and caddisflies are rare or absent; EPT richness is 0. The biotic index value is greater than 7.01-10. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

NYS DEC Methods for Impact Source Determination

Definition: Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. Impact Source Determination uses community types or models to ascertain the primary factor influencing the fauna.

Development of methods: The method found to be most useful in differentiating impacts in New York State streams was the use of community types, based on composition by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: agricultural nonpoint, toxic-stressed, sewage (domestic municipal), sewage/toxic, siltation, impoundment, and natural. Each group initially contained 20 sites. Cluster analysis was then performed within each group, using percent similarity at the family or genus level. Within each group four clusters were identified, each cluster usually composed of 4-5 sites with high biological similarity. From each cluster a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. The method was tested by calculating percent similarity to all the models, and determining which model was the most similar to the test site. New models are developed when similar communities are recognized from several streams.

Use of ISD methods: Impact Source Determination is based on similarity to existing models of community types. The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural", lacking an impact. In the graphic representation of ISD, only the highest similarity of each source type is identified, and similarities that are within 5% of the highest. Similarities less that 50% are considered less conclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

Limitations: These methods were developed for data derived from 100-organism subsamples of traveling kick samples from riffles of New York State streams. Application of the methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

Appendix III: Field and Biological Data Summaries

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Cedar Pond Brook** Watershed: **Hudson** ID: **TIOR**

Location: **Just above CR 106/210 bridge** Station: **01**

Municipality: **Stoney Point** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **8:16 AM**

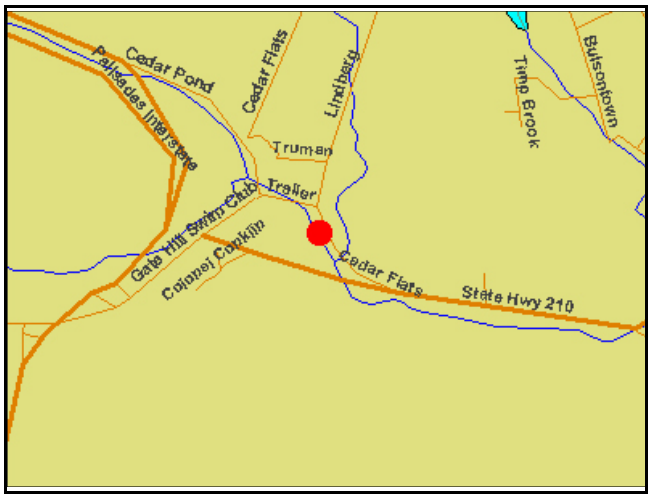
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**5**
Depth (meters)	**0.18**
Current (cm/sec)	**60**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**30**
Rubble (6.35 - 25.4 cm)	**20**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**15**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**16.5**
Specific conductance (umhos)	**171**
DO (mg/l)	**8.32**
DO % saturation	**84.6**
Baro pressure (mm)	**759**
pH	**7.48**
Salinity (PSS)	**0.08**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.238233

Longitude: -74.022150

Degree Minutes

N
W E
S

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

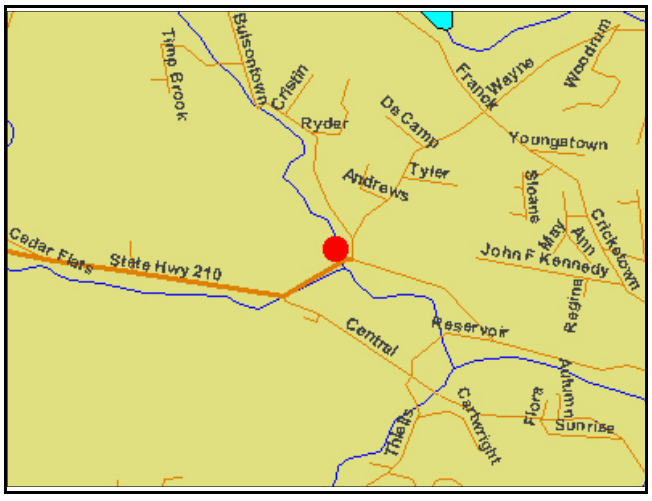
Stream name: **Cedar Pond Brook** Watershed: **Hudson** ID: **CDRP**
Location: **Just above W. Main St. bridge** Station: **03**
Municipality: **Stoney Point** **Rockland Co., NY**
Date sampled: **Saturday, June 30, 2007**
Arrival time at station: **9:11 AM**
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**3.8**
Depth (meters)	**0.2**
Current (cm/sec)	**60**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**30**
Rubble (6.35 - 25.4 cm)	**25**
Gravel (0.2 - 6.35 cm)	**25**
Sand (0.06 - 2.0 cm)	**15**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**18.18**
Specific conductance (umhos)	**244**
DO (mg/l)	**9.18**
DO % saturation	**98.7**
Baro pressure (mm)	**759**
pH	**8.02**
Salinity (PSS)	**0.12**
Biological Attributes	
Canopy (%)	**80**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	
Megaloptera	**Y**
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.236833
Longitude: -74.007433
Degree Minutes

N
W E
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Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Cedar Pond Brook** Watershed: **Hudson** ID: **CDRP**

Location: **Just above Reservoir Rd. bridge** Station: **02**

Municipality: **Stoney Point** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **9:42 AM**

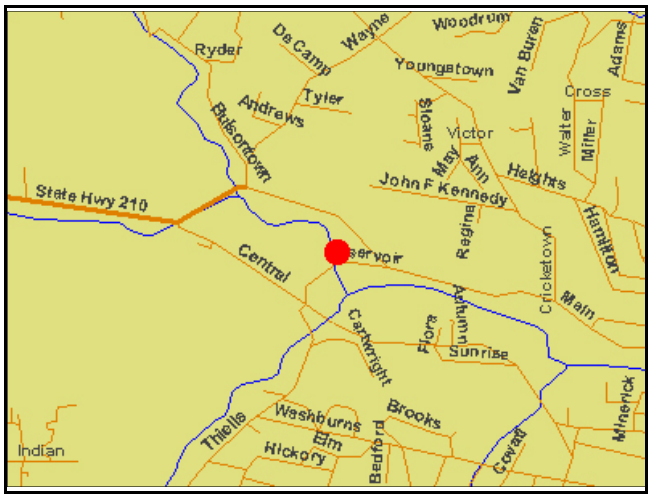
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**9**
Depth (meters)	**16**
Current (cm/sec)	**47**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**15**
Rubble (6.35 - 25.4 cm)	**55**
Gravel (0.2 - 6.35 cm)	**15**
Sand (0.06 - 2.0 cm)	**10**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**17.51**
Specific conductance (umhos)	**215**
DO (mg/l)	**8.08**
DO % saturation	**83.8**
Baro pressure (mm)	**762**
pH	**7.67**
Salinity (PSS)	**0.1**
Biological Attributes	
Canopy (%)	**70**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	
Simuliidae	
Decapoda	**Y**
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.233916

Longitude: -74.003000

Degree Minutes

N
W E
S

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Cedar Pond Brook** Watershed: **Hudson** ID: **CDRP**

Location: **Just above Lowland Hill Rd. bridge** Station: **01**

Municipality: **Stoney Point** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **10:25 AM**

Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**6**
Depth (meters)	**15**
Current (cm/sec)	**52**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**10**
Rubble (6.35 - 25.4 cm)	**45**
Gravel (0.2 - 6.35 cm)	**25**
Sand (0.06 - 2.0 cm)	**15**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**30**
Chemical Measurements	
Temperature (C)	**18.34**
Specific conductance (umhos)	**330**
DO (mg/l)	**9.87**
DO % saturation	**104.5**
Baro pressure (mm)	**765**
pH	**8.01**
Salinity (PSS)	**0.16**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Flow

Flow

Scale: 1 mile

Latitude: 41.226800

Longitude: -73.98465

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

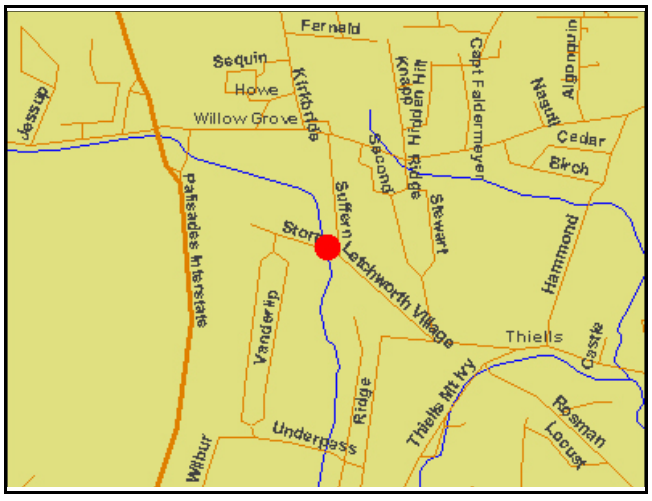
Stream name: **Minisceongo Creek** Watershed: **Hudson** ID: **MNGO**
Location: **Just above Storrs Rd. bridge** Station: **08**
Municipality: **Haverstraw** **Rockland Co., NY**
Date sampled: **Saturday, June 30, 2007**
Arrival time at station: **11:07 AM**
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**5.6**
Depth (meters)	**12**
Current (cm/sec)	**22**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**5**
Rubble (6.35 - 25.4 cm)	**35**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**20**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**35**
Chemical Measurements	
Temperature (C)	**18.08**
Specific conductance (umhos)	**200**
DO (mg/l)	**8.29**
DO % saturation	**87**
Baro pressure (mm)	**757**
pH	**7.65**
Salinity (PSS)	**0.1**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	**Y**
Megaloptera	**Y**
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.215333
Longitude: -74.026383
Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Minisceongo Creek** Watershed: **Hudson** ID: **MNGO**
Location: **Just off Church St.** Station: **04**
Municipality: **Haverstraw** **Rockland Co., NY**
Date sampled: **Saturday, June 30, 2007**
Arrival time at station: **11:58 AM**
Field personnel: **J. Kelly Nolan**

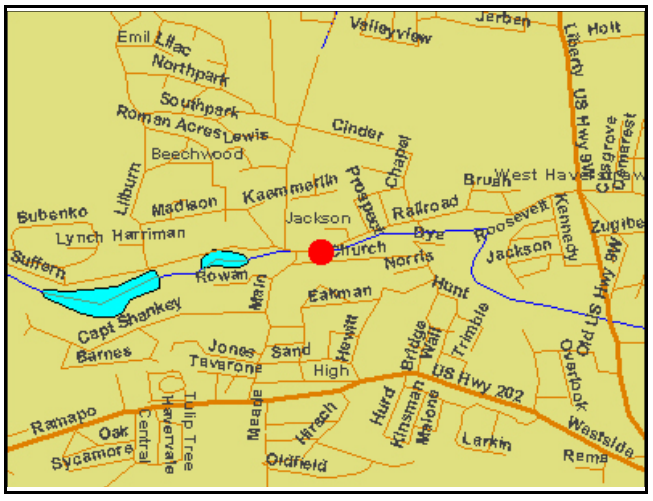
Physical Characteristics	
Width (meters)	**12**
Depth (meters)	**25**
Current (cm/sec)	**41**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**20**
Rubble (6.35 - 25.4 cm)	**15**
Gravel (0.2 - 6.35 cm)	**25**
Sand (0.06 - 2.0 cm)	**20**
Silt (0.004 - 0.06 cm)	**20**
Embeddedness (%)	**35**
Chemical Measurements	
Temperature (C)	**21.08**
Specific conductance (umhos)	**360**
DO (mg/l)	**7.73**
DO % saturation	**83.4**
Baro pressure (mm)	**759**
pH	**7.88**
Salinity (PSS)	**0.17**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	Isopoda
Field faunal condition	**Very good**

Notes/observations:

Water color is turbid and brownish

Flow

Flow



Scale: 1 mile

Latitude: 41.207266
Longitude: -73.995483
Degree Minutes

N
W E
S

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Minisceongo Creek** Watershed: **Hudson** ID: **MNGO**

Location: **Just above RR bridge; accessed at end of Delloro & Joseph St.** Station: **03**

Municipality: **Haverstraw** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **1:51 PM**

Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**8.6**
Depth (meters)	**18**
Current (cm/sec)	**60**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**10**
Rubble (6.35 - 25.4 cm)	**25**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**25**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**50**
Chemical Measurements	
Temperature (C)	**22.5**
Specific conductance (umhos)	**415**
DO (mg/l)	**8.51**
DO % saturation	**97**
Baro pressure (mm)	**762**
pH	**7.88**
Salinity (PSS)	**0.2**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	**Y**
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow

Scale: 1 mile

Latitude: 41.203616

Longitude: -73.979483

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Minisceongo Creek** Watershed: **Hudson** ID: **MNGO**

Location: **Aprox 100 meters below Sampsondale Rd. bridge** Station: **02**

Municipality: **Haverstraw** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **2:35 PM**

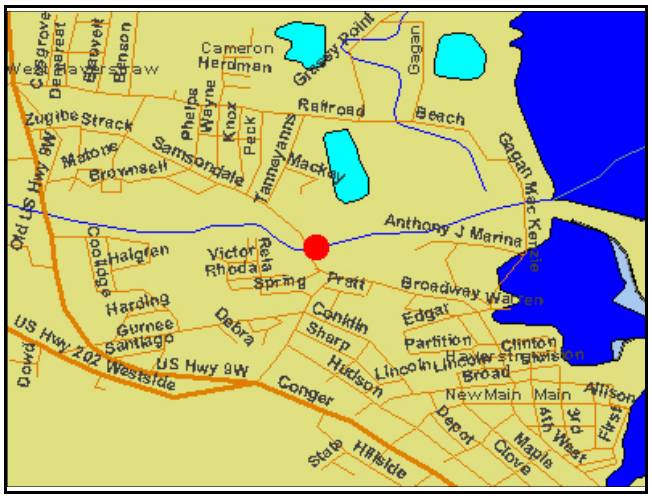
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**12**
Depth (meters)	**17**
Current (cm/sec)	**51**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**10**
Rubble (6.35 - 25.4 cm)	**45**
Gravel (0.2 - 6.35 cm)	**20**
Sand (0.06 - 2.0 cm)	**10**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**35**
Chemical Measurements	
Temperature (C)	**23.18**
Specific conductance (umhos)	**437**
DO (mg/l)	**7.81**
DO % saturation	**89.7**
Baro pressure (mm)	**765**
pH	**8.14**
Salinity (PSS)	**0.21**
Biological Attributes	
Canopy (%)	**60**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	**Y**
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.202816

Longitude: -73.971933

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Hackensack River** Watershed: **Hudson** ID: **HACK**

Location: **Just above Haverstraw Rd. bridge** Station: **24A**

Municipality: **New City** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **3:22 PM**

Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**6**
Depth (meters)	**16**
Current (cm/sec)	**52**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**10**
Rubble (6.35 - 25.4 cm)	**40**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**10**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**45**
Chemical Measurements	
Temperature (C)	**21.5**
Specific conductance (umhos)	**406**
DO (mg/l)	**7.32**
DO % saturation	**82.5**
Baro pressure (mm)	**762**
pH	**7.85**
Salinity (PSS)	**0.2**
Biological Attributes	
Canopy (%)	**75**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	**Y**
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	**Y**
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow

Scale: 1 mile

Latitude: 41.170633

Longitude: -73.96944

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Hackensack Creek** Watershed: **Hackensack** ID: **DMRK**

Location: **Just above Sittle Torr Rd. bridge** Station: **01**

Municipality: **Clarkstown** **Rockland Co., NY**

Date sampled: **Saturday, June 30, 2007**

Arrival time at station: **3:59 PM**

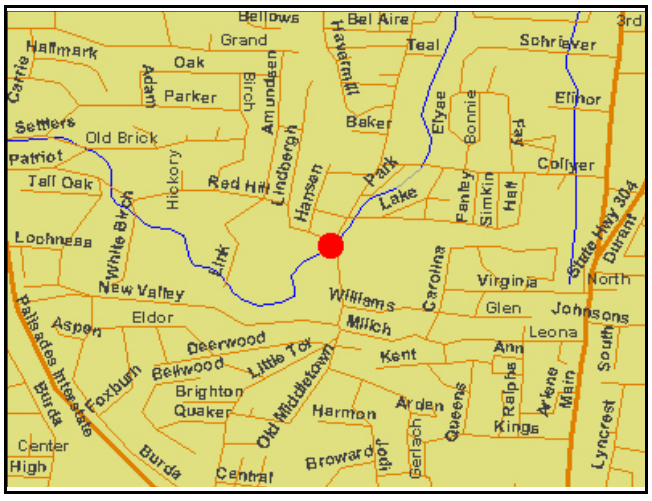
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**3.5**
Depth (meters)	**16**
Current (cm/sec)	**45**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**20**
Rubble (6.35 - 25.4 cm)	**20**
Gravel (0.2 - 6.35 cm)	**10**
Sand (0.06 - 2.0 cm)	**40**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**17.33**
Specific conductance (umhos)	**428**
DO (mg/l)	**8.34**
DO % saturation	**87.5**
Baro pressure (mm)	**756**
pH	**7.68**
Salinity (PSS)	**0.2**
Biological Attributes	
Canopy (%)	**45**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	**Y**
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow



Latitude: 41.132866

Longitude: -74.002400

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Stoney Brook** Watershed: **Ramapo** ID: **STOB**

Location: **Just above Sevens Lakes Rd. bridge** Station: **01**

Municipality: **Ramapo** **Rockland Co., NY**

Date sampled: **Wednesday, July 11, 2007**

Arrival time at station: **9:28 AM**

Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**3.5**
Depth (meters)	**0.3**
Current (cm/sec)	**45**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**25**
Rubble (6.35 - 25.4 cm)	**25**
Gravel (0.2 - 6.35 cm)	**25**
Sand (0.06 - 2.0 cm)	**20**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**21.13**
Specific conductance (umhos)	**142**
DO (mg/l)	**7.99**
DO % saturation	**90.8**
Baro pressure (mm)	**752**
pH	**7.32**
Salinity (PSS)	**0.07**
Biological Attributes	
Canopy (%)	**75**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	**Y**
Megaloptera	
Odonata	**Y**
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Pteranarcy noted in the field sample

Flow

Flow

Latitude: 41.164283

Longitude: -74.183183

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Ramapo River** Watershed: **Ramapo** ID: **RAMA**

Location: **Just above Forth St. bridge** Station: **07**

Municipality: **Ramapo** **Rockland Co., NY**

Date sampled: **Wednesday, July 11, 2007**

Arrival time at station: **10:46 AM**

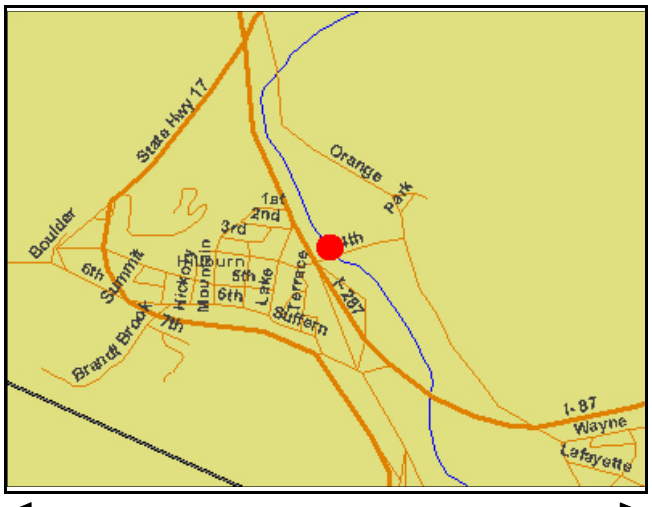
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**19**
Depth (meters)	**0.15**
Current (cm/sec)	**50**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**5**
Rubble (6.35 - 25.4 cm)	**40**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**20**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**22.52**
Specific conductance (umhos)	**571**
DO (mg/l)	**7.67**
DO % saturation	**89**
Baro pressure (mm)	**754**
pH	**7.81**
Salinity (PSS)	**0.28**
Biological Attributes	
Canopy (%)	**40**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	**Y**
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	**Y**
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Very good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.125266

Longitude: -74.164666

Degree Minutes

N
W
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Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Mahwah River** Watershed: **Ramapo** ID: **MAWA**

Location: **Aprox 100 meters above Montebello Rd. bridge** Station: **01**

Municipality: **Ramapo** **Rockland Co., NY**

Date sampled: **Wednesday, July 11, 2007**

Arrival time at station: **11:46 AM**

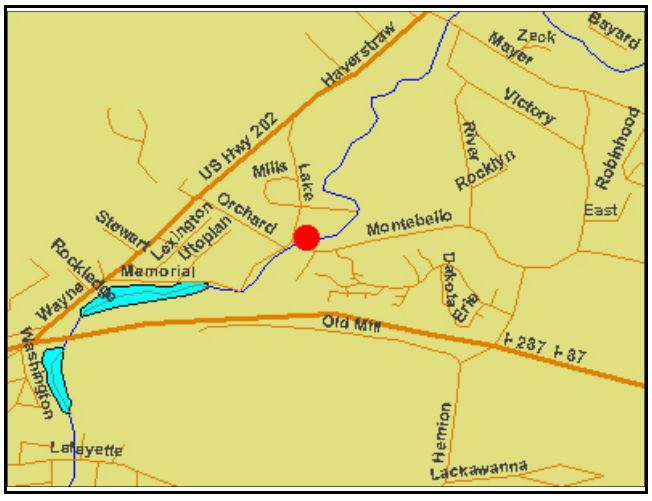
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**11**
Depth (meters)	**0.15**
Current (cm/sec)	**40**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**10**
Rubble (6.35 - 25.4 cm)	**40**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**10**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**40**
Chemical Measurements	
Temperature (C)	**25.06**
Specific conductance (umhos)	**612**
DO (mg/l)	**7.6**
DO % saturation	**93.1**
Baro pressure (mm)	**752**
pH	**8.2**
Salinity (PSS)	**0.3**
Biological Attributes	
Canopy (%)	**70**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	**Y**
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	**Y**
Gammaridae	
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.124000

Longitude: -74.135300

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Pascack Brook** Watershed: **Hackensack** ID: **PASC**

Location: **Just off Memorial Park Dr..** Station: **04**

Municipality: **Spring Valley** **Rockland Co., NY**

Date sampled: **Wednesday, July 11, 2007**

Arrival time at station: **1:14 PM**

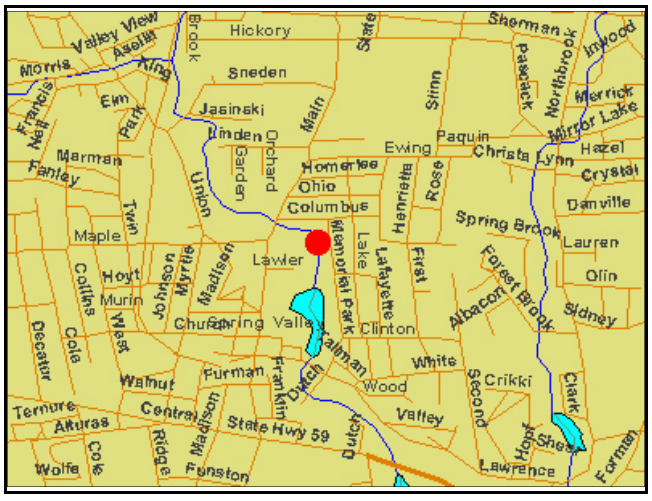
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**14**
Depth (meters)	**0.1**
Current (cm/sec)	**25**
Substrate (%)	
Rock (>25.4 cm or bedrock)	
Rubble (6.35 - 25.4 cm)	**20**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**35**
Silt (0.004 - 0.06 cm)	**15**
Embeddedness (%)	**45**
Chemical Measurements	
Temperature (C)	**25.53**
Specific conductance (umhos)	**779**
DO (mg/l)	**7.42**
DO % saturation	**88.9**
Baro pressure (mm)	**748**
pH	**7.69**
Salinity (PSS)	**0.38**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	**Y**
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.117000

Longitude: -74.041766

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Pascack Brook** Watershed: **Hackensack** ID: **PASC**

Location: **Just below Blue Heron Rd. bridge** Station: **02**

Municipality: **Clarkstown** **Rockland Co., NY**

Date sampled: **Wednesday, July 11, 2007**

Arrival time at station: **2:06 PM**

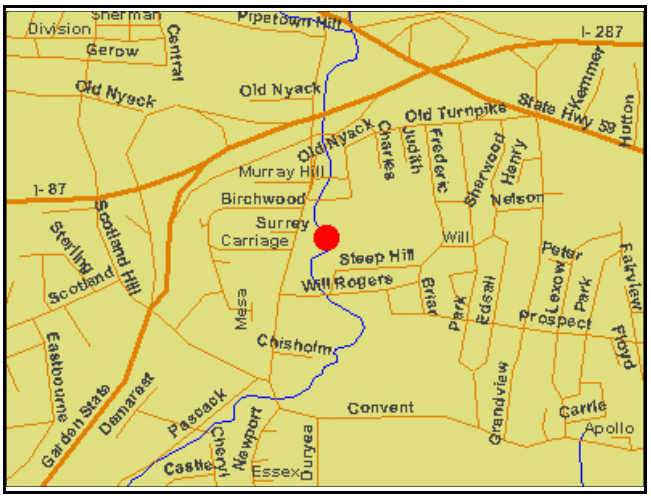
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**4**
Depth (meters)	**0.15**
Current (cm/sec)	**50**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**5**
Rubble (6.35 - 25.4 cm)	**35**
Gravel (0.2 - 6.35 cm)	**35**
Sand (0.06 - 2.0 cm)	**15**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**30**
Chemical Measurements	
Temperature (C)	**23.95**
Specific conductance (umhos)	**997**
DO (mg/l)	**5.83**
DO % saturation	**69.4**
Baro pressure (mm)	**748**
pH	**7.53**
Salinity (PSS)	**0.49**
Biological Attributes	
Canopy (%)	**35**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	**Y**
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Flow

Flow



Scale: 1 mile

Latitude: 41.094966

Longitude: -74.032516

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Nauraushaun Brook** Watershed: **Hackensack** ID: **NAUR**
Location: **Just below Town Line Rd. bridge** Station: **03**
Municipality: **Orangetown** **Rockland Co., NY**
Date sampled: **Wednesday, July 11, 2007**
Arrival time at station: **2:40 PM**
Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**4**
Depth (meters)	**0.15**
Current (cm/sec)	**45**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**10**
Rubble (6.35 - 25.4 cm)	**40**
Gravel (0.2 - 6.35 cm)	**35**
Sand (0.06 - 2.0 cm)	**10**
Silt (0.004 - 0.06 cm)	**5**
Embeddedness (%)	**25**
Chemical Measurements	
Temperature (C)	**25.46**
Specific conductance (umhos)	**798**
DO (mg/l)	**7.97**
DO % saturation	**98.2**
Baro pressure (mm)	**753**
pH	**7.96**
Salinity (PSS)	**0.39**
Biological Attributes	
Canopy (%)	**25**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	**N**
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Homeowner has denuded left strembank of vegatation fo aprox 25 yards.

Flow

Flow

Scale: 1 mile

Latitude: 41.078566
Longitude: -73.997333
Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Hackensack River** Watershed: **Hackensack** ID: **HACK**

Location: **Just below Western Highway bridge** Station: **01**

Municipality: **West Nyack** **Rockland Co., NY**

Date sampled: **Thursday, August 30, 2007**

Arrival time at station: **9:18 AM**

Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**30**
Depth (meters)	**0.2**
Current (cm/sec)	**35**
Substrate (%)	
Rock (>25.4 cm or bedrock)	
Rubble (6.35 - 25.4 cm)	**35**
Gravel (0.2 - 6.35 cm)	**35**
Sand (0.06 - 2.0 cm)	**20**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**40**
Chemical Measurements	
Temperature (C)	**21.97**
Specific conductance (umhos)	**382**
DO (mg/l)	**5.63**
DO % saturation	**63.8**
Baro pressure (mm)	**764**
pH	**7.62**
Salinity (PSS)	**0.18**
Biological Attributes	
Canopy (%)	**10**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	**Y**
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	**Y**
Gammaridae	**Y**
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	
Field faunal condition	**Poor**

Notes/observations:

Water very turbid

Flow

Flow

Scale: 1 mile

Latitude: 41.08605

Longitude: -73.96227

Degree Minutes

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Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Sparkill** Watershed: **Hudson** ID: **SPAR**

Location: **Just below Rt 340 bridge** Station: **07**

Municipality: **Orangetown** **Rockland Co., NY**

Date sampled: **Thursday, August 30, 2007**

Arrival time at station: **10:04 AM**

Field personnel: **J. Kelly Nolan**

Physical Characteristics	
Width (meters)	**3**
Depth (meters)	**0.2**
Current (cm/sec)	**45**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**15**
Rubble (6.35 - 25.4 cm)	**30**
Gravel (0.2 - 6.35 cm)	**30**
Sand (0.06 - 2.0 cm)	**15**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**40**
Chemical Measurements	
Temperature (C)	**18.62**
Specific conductance (umhos)	**660**
DO (mg/l)	**7.97**
DO % saturation	**85.5**
Baro pressure (mm)	**759**
pH	**7.5**
Salinity (PSS)	**0.32**
Biological Attributes	
Canopy (%)	**75**
Aquatic vegetation	
Algae suspended	
Algae filamentous	**Y**
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	Diptera
Field faunal condition	**Good**

Notes/observations:

Smell of phenol

Flow

Flow

Scale: 1 mile

Latitude: 41.044600

Longitude: -73.945133

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Sparkill** Watershed: **Hudson** ID: **SPAR**

Location: **Just below New St bridge** Station: **06**

Municipality: **Orangetown** **Rockland Co., NY**

Date sampled: **Thursday, August 30, 2007**

Arrival time at station: **10:36 AM**

Field personnel: **J. Kelly Nolan**

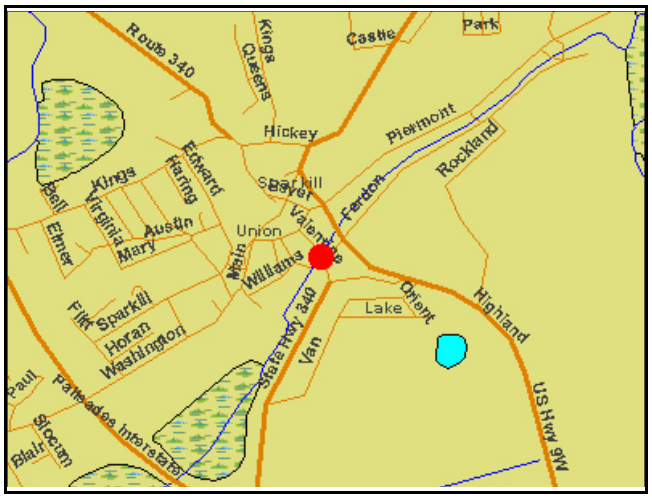
<u>Physical Characteristics</u>	
Width (meters)	**10**
Depth (meters)	**0.2**
Current (cm/sec)	**50**
Substrate (%)	
Rock (>25.4 cm or bedrock)	**20**
Rubble (6.35 - 25.4 cm)	**30**
Gravel (0.2 - 6.35 cm)	**10**
Sand (0.06 - 2.0 cm)	**30**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**45**
<u>Chemical Measurements</u>	
Temperature (C)	**19.17**
Specific conductance (umhos)	**642**
DO (mg/l)	**7.06**
DO % saturation	**76.7**
Baro pressure (mm)	**760**
pH	**7.52**
Salinity (PSS)	**0.31**
<u>Biological Attributes</u>	
Canopy (%)	**65**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	**Y**
Plecoptera	
Trichoptera	**Y**
Coleoptera	**Y**
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	**Y**
Decapoda	
Gammaridae	
Mollusca	
Oligochaeta	**Y**
Other macroinvertebrates	
Field faunal condition	**Good**

Notes/observations:

Water has a milky appearance

Flow

Flow



Scale: 1 mile

Latitude: 41.029416

Longitude: -73.925583

Degree Minutes

Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Stream name: **Muddy Creek** Watershed: **Hackensack** ID: **MUDD**

Location: **Just below Washington Ave. bridge** Station: **02**

Municipality: **Orangetown** **Rockland Co., NY**

Date sampled: **Thursday, August 30, 2007**

Arrival time at station: **11:22 AM**

Field personnel: **J. Kelly Nolan**

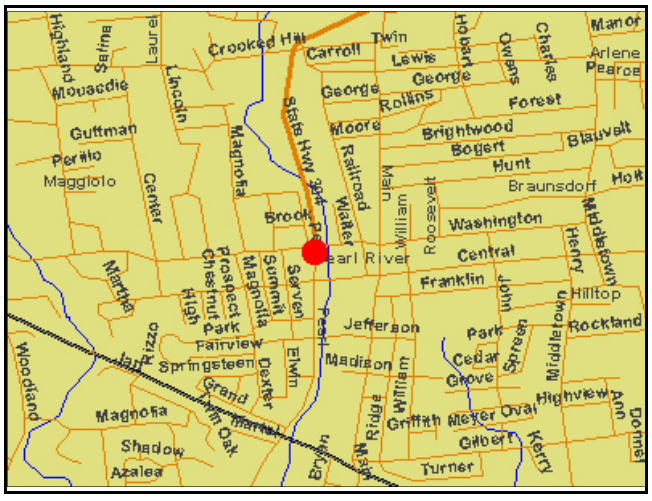
Physical Characteristics	
Width (meters)	**3**
Depth (meters)	**0.1**
Current (cm/sec)	**45**
Substrate (%)	
Rock (>25.4 cm or bedrock)	
Rubble (6.35 - 25.4 cm)	**20**
Gravel (0.2 - 6.35 cm)	**55**
Sand (0.06 - 2.0 cm)	**15**
Silt (0.004 - 0.06 cm)	**10**
Embeddedness (%)	**45**
Chemical Measurements	
Temperature (C)	**20.63**
Specific conductance (umhos)	**856**
DO (mg/l)	**7.08**
DO % saturation	**79**
Baro pressure (mm)	**760**
pH	**7.51**
Salinity (PSS)	**0.42**
Biological Attributes	
Canopy (%)	**10**
Aquatic vegetation	
Algae suspended	
Algae filamentous	
Diatoms	**Y**
Macrophytes	
Occurance of macroinvertebrates	
Ephemeroptera	
Plecoptera	
Trichoptera	**Y**
Coleoptera	
Megaloptera	
Odonata	
Chironomidae	**Y**
Simuliidae	
Decapoda	**Y**
Gammaridae	
Mollusca	
Oligochaeta	
Other macroinvertebrates	
Field faunal condition	**Poor**

Notes/observations:

Pipes ?

Flow

Flow



Scale: 1 mile

Latitude: 41.060033

Longitude: -74.023500

Degree Minutes

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W E
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Appendix IV: Water chemistry and temperature summary table

Water Chemistry and Temperature

Cedar Pond Brook Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
01	6/30/2007	8:16 AM	16.5	171	8.32	84.6	7.48	0.08
03	6/30/2007	9:11 AM	18.18	244	9.18	98.7	8.02	0.12
02	6/30/2007	9:42 AM	17.51	215	8.08	83.8	7.67	0.1
01	6/30/2007	10:25 AM	18.34	330	9.87	104.5	8.01	0.16

Hackensack Creek Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
01	6/30/2007	3:59 PM	17.33	428	8.34	87.5	7.68	0.2

Hackensack River Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
24A	6/30/2007	3:22 PM	21.5	406	7.32	82.5	7.85	0.2
01	8/30/2007	9:18 AM	21.97	382	5.63	63.8	7.62	0.18

Mahwah River Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
01	7/11/2007	11:46 AM	25.06	612	7.6	93.1	8.2	0.3

Minisceongo Creek Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
08	6/30/2007	11:07 AM	18.08	200	8.29	87	7.65	0.1
04	6/30/2007	11:58 AM	21.08	360	7.73	83.4	7.88	0.17
03	6/30/2007	1:51 PM	22.5	415	8.51	97	7.88	0.2
02	6/30/2007	2:35 PM	23.18	437	7.81	89.7	8.14	0.21

Muddy Creek Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
02	8/30/2007	11:22 AM	20.63	856	7.08	79	7.51	0.42

Nauraushaun Brook Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
03	7/11/2007	2:40 PM	25.46	798	7.97	98.2	7.96	0.39

Pascack Brook Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
04	7/11/2007	1:14 PM	25.53	779	7.42	88.9	7.69	0.38
02	7/11/2007	2:06 PM	23.95	997	5.83	69.4	7.53	0.49

Ramapo River Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
07	7/11/2007	10:46 AM	22.52	571	7.67	89	7.81	0.28

Sparkill Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
07	8/30/2007	10:04 AM	18.62	660	7.97	85.5	7.5	0.32
06	8/30/2007	10:36 AM	19.17	642	7.06	76.7	7.52	0.31

Stoney Brook Rockland Co., NY

Station	Date	Time	Temp. (C)	SC (umhos)	DO (mg/L)	DO % Sat.	pH	Sal. (PSS)
01	7/11/2007	9:28 AM	21.13	142	7.99	90.8	7.32	0.07