The Macroinvertebrate Communities of the Great Swamp Watershed

Part II: Summer, 2013: Results

A Report to the
Ten Towns Great Swamp Management Committee

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Macroinvertebrate Communities of the Great Swamp, 2013 Results

Executive Summary

In late May, 2013, sampling of macroinvertebrate (MIV) communities was performed at 17 sites spread among the 5 streams that drain the Great Swamp. Preceding precipitation pattern included generally lower than usual precipitation but higher amounts in December and May.

Between 9 - 4 on May 18, 2013, we used field meters to monitor temperature, dissolved oxygen (DO), pH, total dissolved substances (TDS), and turbidity at all 17 sites. We also completed an EPA "high gradient" habitat assessment form (Barbour et al., 1999) at each site. Overall, temperatures and turbidity were lower, but TDS, dissolved oxygen, and pH were a little higher than in the two preceding years. The earlier sampling date dictated lower temperatures that, in turn, explain higher levels of dissolved oxygen. The drier winter-spring period (see discussion above) apparently left Total Dissolved Solids less diluted than in the past. BB1, all the Loantaka Brook sites, and GB4 all exceeded the NJ DEP water quality standard for TDS in surface waters (with GB5 coming close to it for the second time in 3 years). pH values were somewhat, but not alarmingly, higher pretty much across the board. They were much higher (ca 8.50) than usual at both Black Brook sites, and also high (ca 8.30) at GB2 however. High levels of turbidity were noted at two Great Brook sites: GB3 (below Silver Lake) and GB5 (below Footes Pond). These are both very productive impoundments, so downstream detrital outwash would be expected.

A total of 3612 individuals were examined in 2013, representing 90 distinctive MIV types. Simuliidae (blackfly) larvae were much fewer, Hydropsychidae caddisfly larvae were also lower, but gammarid amphipods were abundant – 776 compared to 527 individuals in 2012 (397 in 2011, 383 in 2010).

B-IBI-measured community quality matched or exceeded 2012 results at 13 of our 17 sites, falling below 2012 results at just 4 sites. Scores were markedly higher at nearly all sites along Loantaka and Great Brooks, and also improved at Passaic River sites, PR1 and PR3, and at BB1. They fell at upper and lower sites on Primrose Brook and marginally at our reference site, IG1, and at the Chatham Sewage Treatment site, BB2.

PB2's score improved from low values in the two previous years. But PB3 and PB1 both declined – driven by reduced species of Trichoptera (caddisflies) and Plecoptera (stoneflies). In the case of PB3, the total number of taxa observed fell by one quarter (from 39 to 29) in 2013. All three “high quality” insect groups (mayflies, stoneflies, & caddisflies) have declined in sampling abundance there since 2010. No negative alterations have been noted in the immediate surroundings of these high-quality stream sites either in the environmental data monitored or in field observations.

That the newly relocated PR2 site is inferior to the old one (destroyed by Hurricane Irene in 2011) is demonstrated by the poor B-IBI and habitat scores derived from its sampling in both years. Its low scores recently are primarily responsible for the apparent decline for the Passaic River scores since both PR1 and PR3 scored above their averages in 2013.

Great and Loantaka Brooks both show dramatic improvement in B-IBI scores compared to 2012 results. In part these changes represent a recovery from particularly poor scores in 2012. At all sites except LB2 and GB2, the total number of TAXA observed is much higher in 2013. The number of species of chironomid was doubled at GB2, GB3, GB4, tripled at LB2 and LB4, and quadrupled at LB1 and GB5. Total chironomids for 2013 is 32, compared with 21 in 2012. At least some of this may be due to better identifications provided in 2013 by Normandeau Associates. At several sites, dominance by hydropsychid caddisflies and simulid blackflies) is much lower in 2013, resulting in 3-6 point increases in B-IBI scores.

Study-long B-IBI scores were plotted for each site to distinguish 2000-2007 data from 2008-2013 data. Results fall into two basic similarity-groups. In both groups, scores trended upward during the 2000-2007 period, matching a comparable upward trend in regional precipitation. Scores at Group I sites (Black Brook, Loantaka Brook and Passaic River sites), continued to increase during the 2000-2007 period. Group II sites (Great Brook, Primrose Brook) had declining scores during the 2008-2013 period - better matching the trend in regional precipitation. Until a better explanation for downward trends in B-IBI scores is uncovered, we need to pay close attention to Group I sites in Great and Primrose Brooks in particular, to determine whether these B-IBI trends are associated with changes in regional climate factors, with sample timing, and/or with other more local environmental factor(s) over which we might have some responsibility, but also some control.

See Appendix 13-2 for Stream Summaries and suggestions for further action.

The 2013 Great Swamp Watershed Study

In late May, 2013, sampling of macroinvertebrate (MIV) communities was performed at 17 sites spread among the 5 streams that drain the Great Swamp Watershed. See Pollock (2000 and updates described in the Introduction in Pollock, 2012) for a complete description of the sampling sites and the methodology that was used during this survey (techniques based on the EPA Rapid Bioassessment Protocols (Barbour et al., 1999)). As part of a logistical transition in these studies, this year I was responsible for field collections, sample sorting, and data analysis, but specimen identifications were made by George Christian (Normandeau Associates, Kennett Square, Pennsylvania).

Habitats & Environmental Monitoring

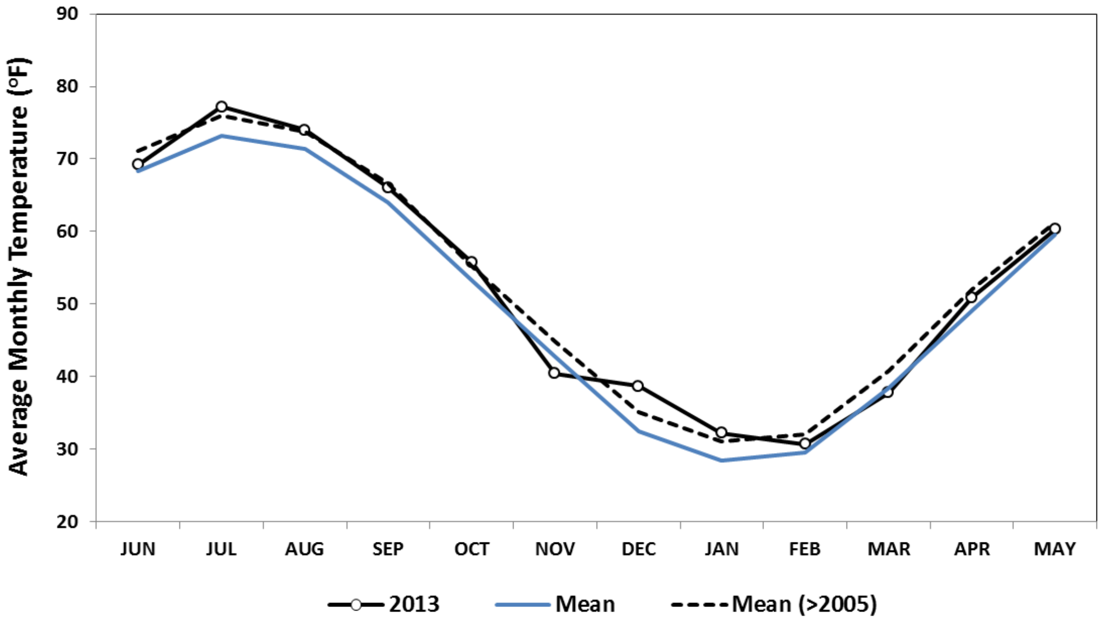
Environmental Observations

Habitat Conditions:

In Figure 13-1a & b, we use climate data (http://climate.rutgers.edu/stateclim_v1/data.html) for northern New Jersey (to review temperature and precipitation patterns both historically and more recently during the 12 month period preceding our May collection time. The overall mean monthly values (1895-2013) form a baseline against which values of monthly temperature and precipitation since 2005 and from 2013 are compared. Note in Figure 13-1a that monthly average temperatures during the years since 2005 have been a bit higher than the overall averages since 1895. Averages for 2013 illustrate the sort of variability expected in individual-year data relative to smoother averaged values. Results for 2013 followed post-2005 averages, falling slightly below them in the spring. In Figure 13-1b, we see greater variability found in monthly precipitation totals. Mean values from 1895-2013 are nearly equal in every month of the year, while mean values from 2006-2013 are somewhat elevated. The pattern for 2013 is just the opposite – lower precipitation through the year but slightly higher amounts in September, October, December and May.

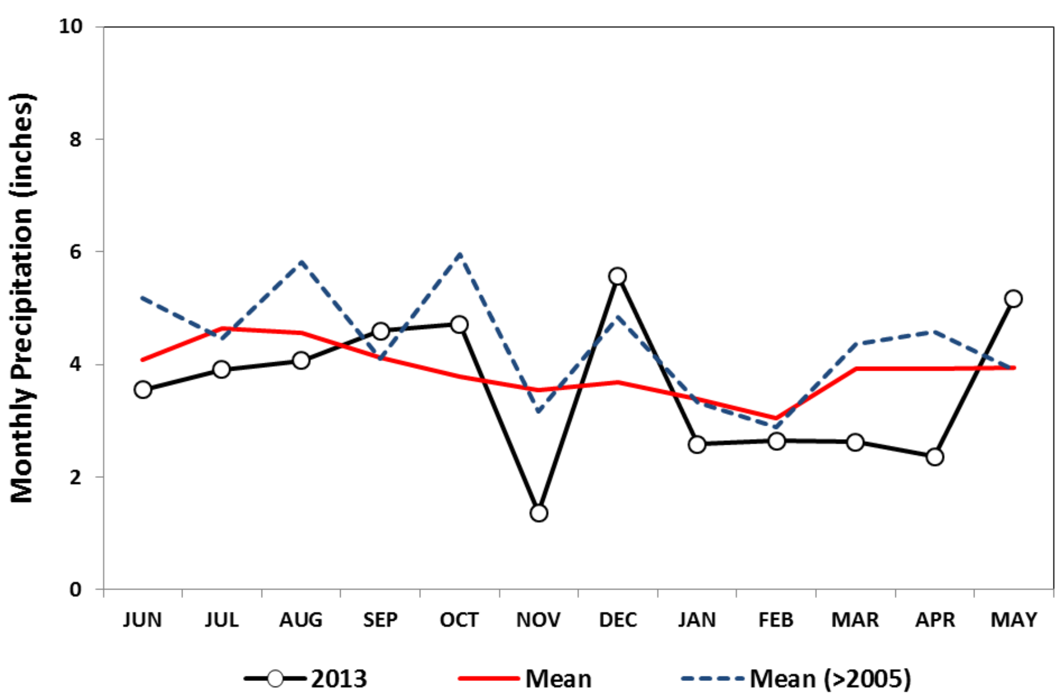
Last year, GSWA reviewers suggested graphing results of this study so as to compare data from the first part of the program to those from the later portion. Follow-up revealed this to be an informative approach for both environmental and biotic data. Biotic trends treated in this fashion will be discussed below. Figure 13-2 shows regional climate information separated into

Figure 13-1a   Northern New Jersey
Average Monthly Temperature (°F) preceding sampling date



Source: http://climate.rutgers.edu/stateclim_v1/data/north_njhisttemp.html

Figure 13-1b. Northern New Jersey
Monthly Precipitation (inches) - preceding sample date

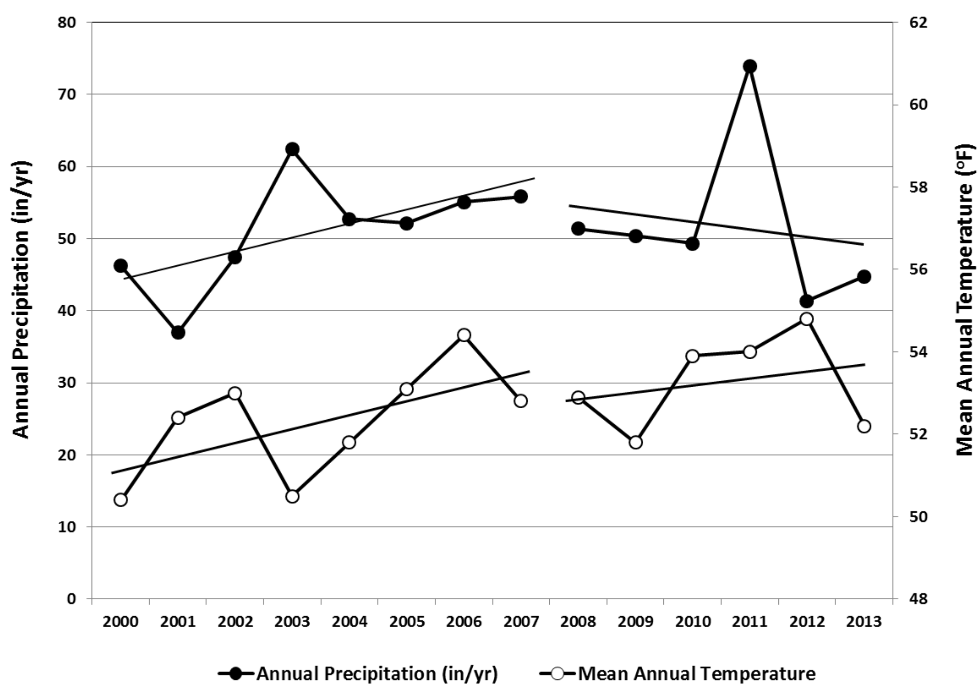


Source: http://climate.rutgers.edu/stateclim_v1/data/north_njhistprecip.html

2000-2007 vs 2008-2013. This cut-off date was chosen as the point when annual sampling dates were moved into late May as opposed to early June. Both mean annual temperature and total annual precipitation in northern New Jersey increased during the 2000-2007 period. But annual precipitation declined in the post-2007 period (with the notable exception of Hurricane Irene's influence in fall, 2011). The mean temperature has steadily increased throughout the study period. The possible impact of these shifts on MIV communities will be discussed below.

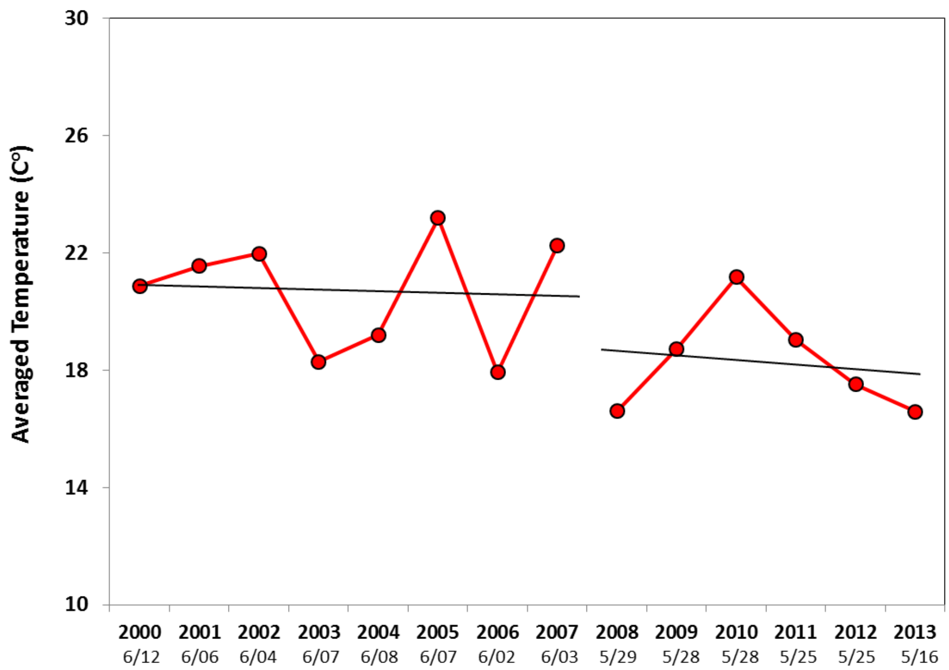
While this shift in climate variables is clear, the post-2007 period differs from the pre-2007 period in another important way. My move from New Jersey to New Hampshire just following the 2005 sampling period resulted in adjustment in subsequent sampling dates – especially from 2008 onward. For efficiency, sampling dates for each year were combined with oral reporting dates for the previous year's survey. To avoid late-May, Memorial Day complications in the reporting dates, the associated collections occurred progressively earlier in May over the years. The mid-point date of each sampling period is noted below each year in Figure 13-3, which also illustrates the impact of these date adjustments on the important

Figure 13-2 Northern New Jersey Annual Climate Values



environmental variable, temperature averaged from observations made at each stream during sampling. Naturally, earlier sampling dates resulted colder temperatures during the 2008-2013 period. This has unfortunately introduced more complexity by inserting additional variation to an already important variable in the study. More discussion of this point will follow below.

Figure 13-3 Great Swamp Watershed Streams Averaged Temperatures



Hurricane Sandy impacted the area in fall, 2012 with modest rain but with strong but patchy winds. Its major effect was to flatten isolated clusters of trees while leaving surrounding ones unscathed. While we have no specific examples of damage to or near our sites, such loss of canopy and root structure can lead to elevated ground temperatures and excessive erosion.

Between 9 am and 4 pm on May 16, 2013, we used field meters to measure temperature, dissolved oxygen (DO), pH, total dissolved substances (TDS), and turbidity at all 17 sites. We also completed an EPA "high gradient" habitat assessment form (Barbour et al., 1999) at each site. Refer to Table 13-1 for site-specific values for these variables. Note that the 2013 sampling date (dictated by the scheduling of my annual trip to New Jersey for the oral reporting results of these studies) is a week earlier in the year than has been typical since 2006 (and 3 weeks earlier than comparable surveys in earlier years). In any case, Table 13-2 shows three-year comparisons for key variables. Overall in 2013, temperatures and turbidity were lower, but TDS, dissolved oxygen, and pH were a little higher than in the two preceding years. The earlier sampling date dictated lower temperatures that, in turn, explain higher levels of dissolved oxygen. The drier winter-spring period (see discussion above) apparently left Total Dissolved Solids less diluted than in the past.

High TDS values continue at all stations along Loantaka Brook – highest toward its source, lower downstream – a pattern suggesting an upper-subwatershed, point-source enrichment. This year, values were the highest seen in the past several years (see Table 13-2). While TDS readings were lower than usual at BB2 (below the Chatham Township Sewage Treatment Plant), they were doubled from 2012 at BB1 (along Southern Boulevard). Perhaps the earlier sampling period and/or less precipitation-dilution of road salt residue may explain this and the higher values also seen at Great Brook sites (especially so at GB4). The New Jersey DEP water quality standard for surface waters sets a TDS limit of 500 mg/L for FW2-category waters (including all those in the watershed). BB1, all the Loantaka Brook sites, and GB4 all exceeded this limit (with GB5 coming close to it for the second time in 3 years).

pH values were somewhat, but not alarmingly, higher pretty much across the board. They were much higher (ca 8.50) than usual at both Black Brook sites, and also high (ca 8.30) at GB2 however. Values this high are often associated with excessive plant productivity upstream. Golf course ponds upstream from BB1, the STP upstream from BB2, and, perhaps, fertilizing and/or horse waste upstream from and adjacent to GB2 may help explain these values. We should keep an eye on the pH at these sites in subsequent years.

High levels of turbidity were noted at two Great Brook sites: GB3 (below Silver Lake) and GB5 (below Footes Pond). These are both very productive impoundments, so downstream detrital outwash would be expected. Still, values were not exceptional at LB2 and PR1, both below much more productive impoundments (Kitchell Pond and Osbourn Pond respectively). Possibly something more local stirred up excess turbidity at the Great Brook sites shortly before monitoring?

As in the past, highest temperatures were associated with GB5 and PR1 - sites just below dammed impoundments that lack sunlight-blocking canopy cover. Loantaka Brook site 4, followed by BB2 (below the STP) and Irene-destroyed PR2 (downstream from I-287) scored worst in habitat quality, while uppermost Primrose and Passaic River sites, PB3, PR3 and IG1 were highest.

Macroinvertebrate Survey

Data in Appendix 13-1 show that a total of 3612 individuals (3777 in 2012) were examined in 2013, representing 90 distinctive MIV types (124 in 2012). Fluctuating numbers among the groups that often dominate macroinvertebrate communities continued in 2013. Simuliidae (blackfly) larvae were much fewer – 156 compared to 629 individuals in 2012 (268 in 2011, 632 in 2010); Hydropsychidae caddisfly larvae were also lower – 318 compared to 650 individuals in 2012(339 in 2011, 817 in 2010); and but gammarid amphipods were abundant – 776 compared to 527 individuals in 2012 (397 in 2011, 383 in 2010). However, we find no consistent patterns nor correlations among these organisms. Underlying factors stimulating these population patterns remain a mystery.

A site's Benthic Index of Biological Integrity score (B-IBI) can be considered a proxy for its "community quality". Using B-IBI values, the macroinvertebrate communities at sites can be described as "good", "fair", "poor", or "very poor". As a result of the scoring method used to calculate B-IBI values (see Pollock, 2003a), an annual change of just two points up or down can be considered to be minimal. An initial way to focus on "noteworthy" changes is to identify sites that show a change of four or more points in a year. Using this criterion, B-IBI-measured community quality exceeded 2012 results at 8 of our 17 sites, falling below 2012 results at just 2 sites (see Figure 13-4). Scores were markedly higher at nearly all sites along Loantaka and Great Brooks, and also improved at Passaic River sites and at BB1. They fell at upper and lower sites on Primrose Brook and marginally at our reference site, IG1, and at the Chatham Sewage Treatment site, BB2. Specific causes of change in B-IBI scores between 2012 and 2013 can be explored in Table 13-3.

We can put the community changes seen in 2013 into broader perspective by viewing them, in Fig. 13-5, relative to 2000-2013 mean values, plus or minus 1 standard deviation. Using this criterion, only PB3 was significantly low this time, while BB1, all the Loantaka and Great Brook sites, and both PR1 & PR3 sites fared much better than average.

Figure 13-4. Great Swamp Streams
B-IBI Summer, 2013 vs Summer, 2012

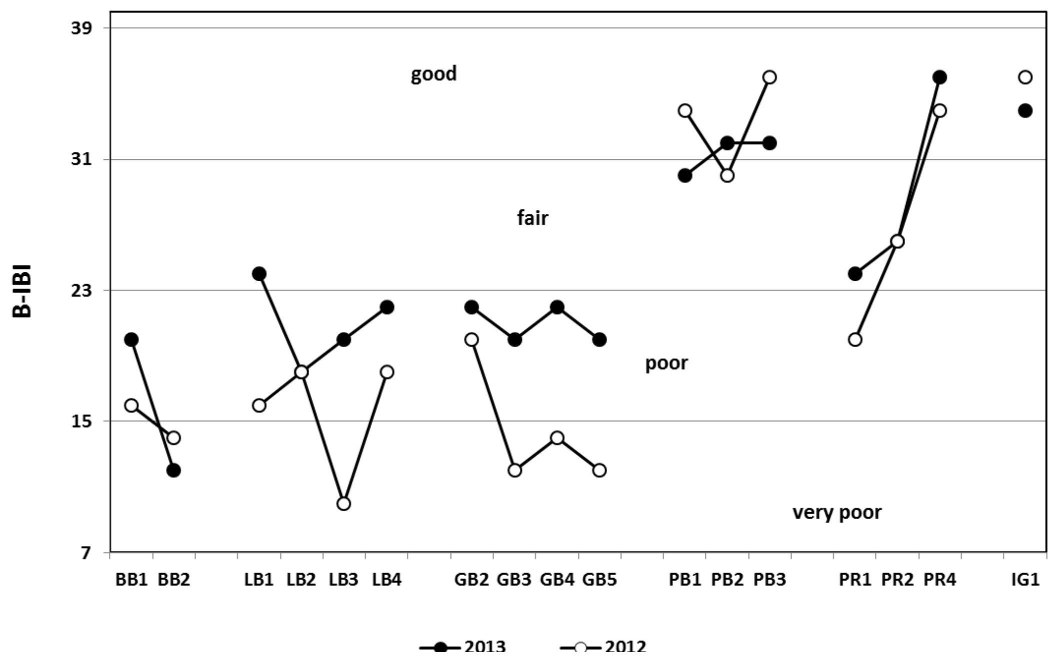
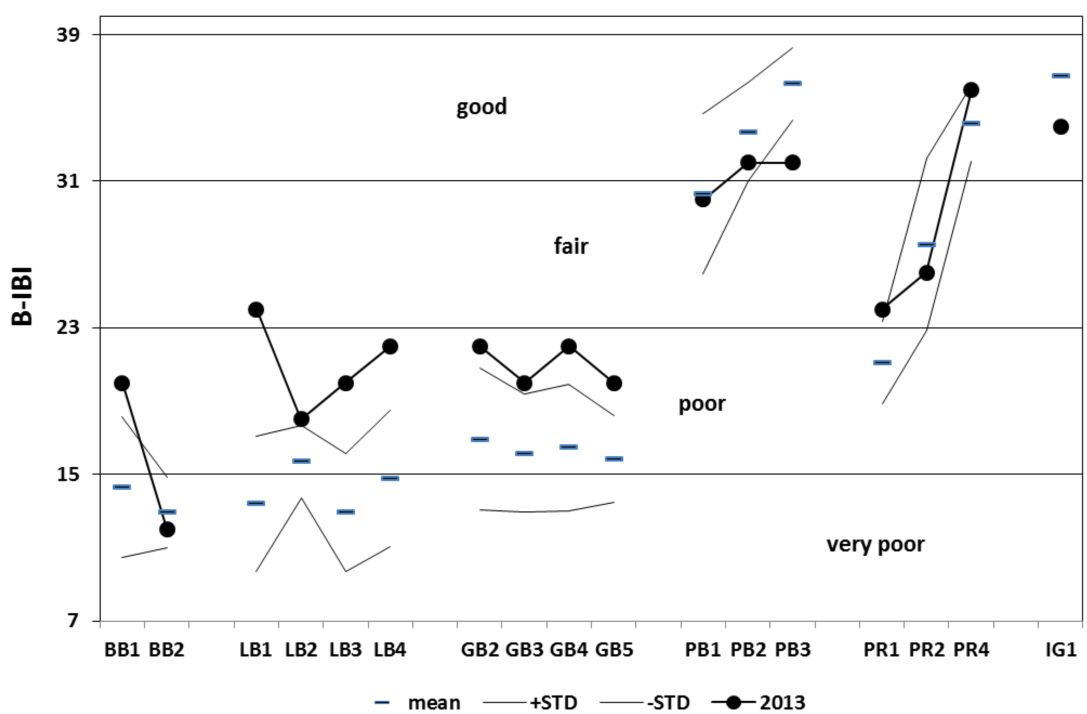


Figure 13-5. Great Swamp Streams
Summer 2013, Mean +/- STD (2000-2013)



Combining these strategies for identifying sites for particular attention in 2013, we include concern about PB1 and PB3 along with that stream's general decline. On the other side, improvements in Loantaka Brook and Great Brook B-IBI scores deserve comment.

PB2's score improved from low values in the two previous years. But PB3 and PB1 both declined – driven by reduced species of Trichoptera (caddisflies) and Plecoptera (stoneflies). In the case of PB3, the total number of taxa observed fell by one quarter (from 39 to 29) in 2013. One novel and possibly important variable this year's data gathering is the change in the individual performing identifications. Differences in expertise (admittedly higher in the case of George Christian (Normandeau Associates) in 2013 compared to my own efforts in previous years), can result in identification adjustments that almost certainly influenced differences in B-IBI scores this year. Such differences may include the tendency to be a "lumper" (i.e., one who groups more than one difficult-to-distinguish species together as a unit) resulting in fewer identified "types" or a "splitter" (i.e., one who separates taxa into distinct types) resulting in more. But we should note that scores at PB3 in particular have been lower for the past 3 years. All three "high quality" insect groups (mayflies, stoneflies, & caddisflies) have declined in sampling abundance there since 2010. No negative alterations have been noted in the immediate surroundings of these high-quality stream sites either in the environmental data monitored or in field observations.

The Passaic River sites showed a similar downward trend since 2006. As noted last year, Hurricane Irene completely washed out the original PR2 spot, and in 2012 and 2013 we have occupied the only available alternative location for our sampling some 50 yards downstream from the original site. That this new PR2 is inferior to the old one is obvious to our inspection and is demonstrated by the poor B-IBI and habitat (see Table 13-1) scores derived from its sampling in both years. As part of a transition phase of this study, current plans call for eliminating this site altogether. Its low scores recently are primarily responsible for the apparent decline for the Passaic River scores since both PR1 and PR3 scored above their averages in 2013.

Secondly, Figure 13.2 shows a break at 2008 in the annual precipitation trend similar to that seen in B-IBI scores at Primrose Brook and Passaic River sites. We have previously cited increasing precipitation levels as a trend generally correlated with improving B-IBI scores over the years. While "correlation" does not necessarily mean "causation", one might speculate that biological communities at higher quality streams might be more sensitive to alterations in precipitation trends than are those at lower quality streams (the latter still improving in B-IBI score, see Fig. 13-5). For example, less precipitation produces slower flow that leads to somewhat higher temperatures and associated reduction in dissolved oxygen. Demanding MIVs such as Plecoptera or Ephemeroptera are especially sensitive to temperature and oxygen stress. More on this topic will follow.

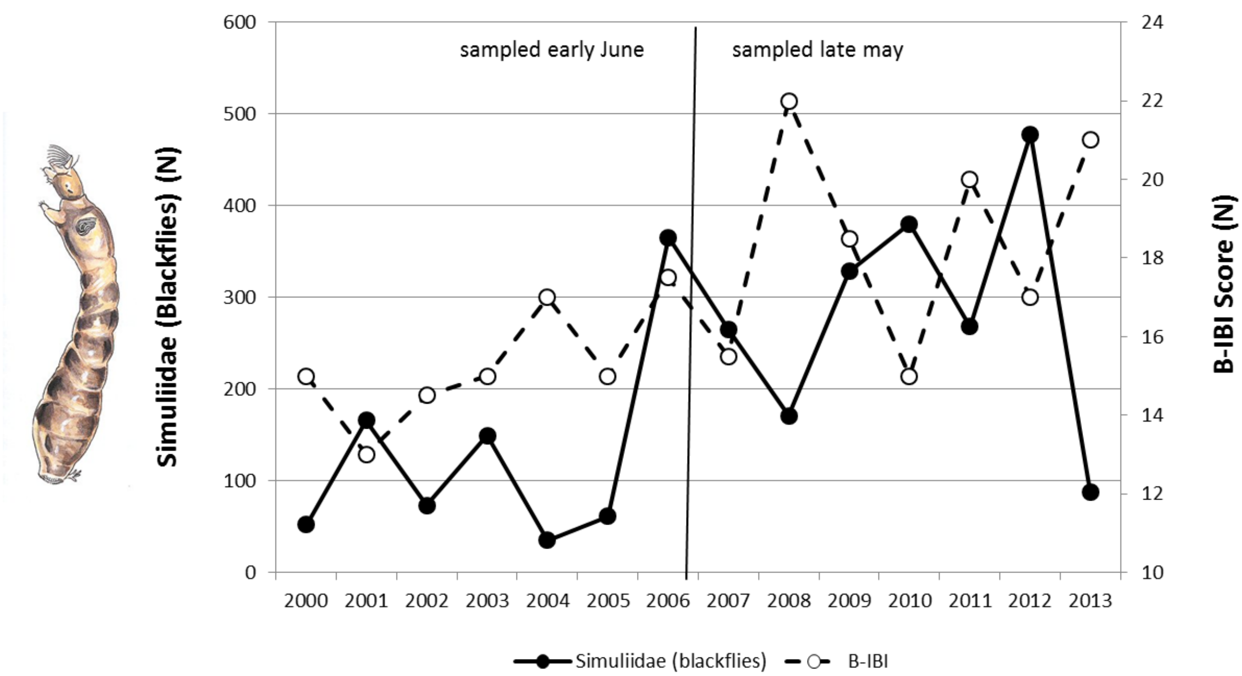
So possibly difference in taxonomic skills, earlier sampling dates, annual precipitation levels, changes in the forests of the Jockey Hollow Historic Park or in the small impoundment immediately above PB3, or other factors entirely must be responsible for declining scores especially at Primrose Brook. It will be important to play close attention to the condition of Primrose Brook to pursue these hypotheses and to keep on top of this situation.

Great and Loantaka Brooks both show dramatic improvement in B-IBI scores compared to 2012 results. A review of Figures 13-4 shows that in part these changes at several sites represent a recovery from particularly poor scores in 2012 at those locations. But Figure 13-5 also reveals that the 2013 scores lie more than 1 standard deviation above the mean at all LB and GB sites. By exploring differences in B-IBI components between 2012 and 2013 results in Table 13-3, we find that at all sites except LB2 and GB2, the total number of TAXA observed is much higher in 2013 (doubled at LB1, LB4, and GB3). A closer look shows that the number of species of chironomid Diptera (non-biting midge larvae) recorded was ca. doubled at GB2, GB3, GB4, tripled at LB2 and LB4, and quadrupled at LB1 and GB5. The total chironomid species listed for 2013 is 32, compared with 21 listed in 2012. Again, with different identifiers in the two years, some (most? all?) of these increases may be the result of better scrutiny in 2013, or they may at least in part represent real increases in chironomid diversity at these sites.

At LB3, LB4, GB3, GB4, and GB5, dominance by the two most abundant species (in most cases, hydropsychid caddisflies and simulid blackflies) is much lower in 2013. These changes alone resulted in a 3-6 point increase in B-IBI scores. In the past, we have noted a reciprocal pattern between B-IBI scores and Simuliidae (blackfly) larval abundance since our 2008 shift to earlier sampling dates. That pattern continues at Great Brook in 2013 (see Figure 13-6). We have also noted in the past that a reciprocal, predator-prey pattern of abundance appeared to exist between blackfly larvae and one of their predators, the chironomid larva, *Cardiocladius*. That relationship was not evident in the 2013 data. While Cardiocladius may still be a factor in the population dynamics of blackfly larvae, it is clearly not the only contributor. Results for Loantaka and Great Brooks in 2013 are encouraging. They appear to continue overall improvement in those streams over the course of the study.

GB5 also shows declining community quality in the 2006-2013 period. It lies immediately downstream from Footes Pond on James Street in Morristown. This pond and its associated dam experienced major renovation during 2006. Despite resultant improved attractiveness of the area, the impoundment remains very productive, and GB5 is flooded with its by-products, including high temperatures, low DO, lots of organic silt and excessive algal growth. Also upstream of Footes Pond, Great Brook passes through a golf course and also drains areas associate with heavily traveled I-287 and US Rte. 202.

Fig 13-7 Great Brook, 2000-2013
Simuliidae vs B-IBI Score



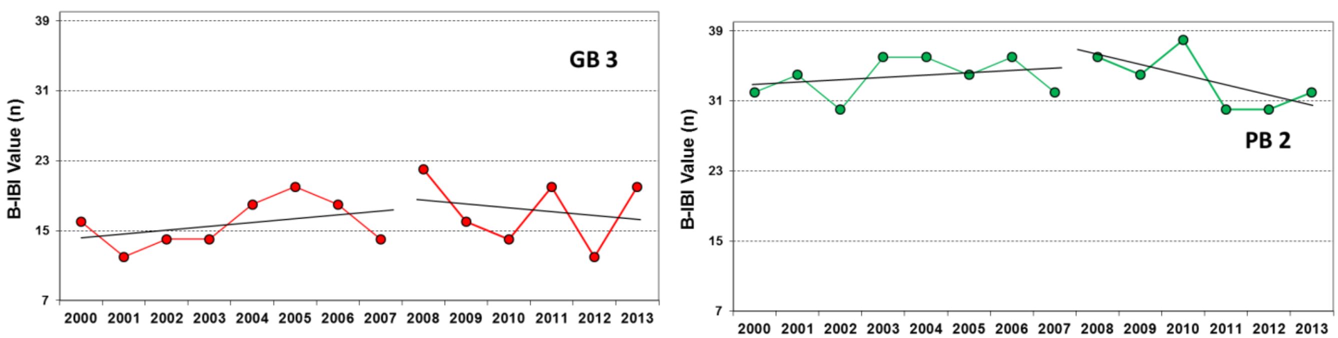
Finally, beyond the analysis of this year's changes in community quality scores, we can discern larger scale patterns by viewing the distribution of B-IBI scores over the full study period. Figures displaying these data for each stream site appear in the 2013 Stream Summary section in Appendix 13-2. Unlike previous years, this time, we have applied the same strategy described above regarding regional climate trends. By plotting these study-long histories for each site so as to distinguish 2000-2007 data from 2008-2013 data, we find that the overall upward trend in B-IBI scores over the entire study period, which we have noted in the past, misses an important counter trend at two of our five streams. At nearly all Great Swamp sites, scores trended upward during the 2000-2007 period. (Exceptions: BB2, LB2, and GB2 showed very little change). These patterns are illustrated by examples in Figure 13-7. Data from 14 comparable stream sites in the nearby Rockaway River watershed also match this upward trend during the same period. Attempting to identify underlying causes of such widespread change is difficult because of the inherent complexity of these systems – organisms bring a diversity of tolerance/preference responses to confront an array of potentially important environmental factors that they face simultaneously. In addition, our available environmental data is extremely limited.

However, this virtually universal response by MIV communities in the area hints that some beneficial regional factor may have been at work during this period. Increasing levels of annual precipitation in northern New Jersey represents one matching regional factor during the same time frame (see Figure 13-2). This hypothesis is strengthened by the fact that this period of increasing precipitation followed a drought-prone drier spell during the late-1990s, as illustrated in Figure 13-8. Although we have no direct, supporting evidence to say so, increased precipitation may have improved conditions for macroinvertebrates, at least to a point, by avoiding extreme low-flow/drying/stagnant periods; by rinsing in more allochothonous (i.e., non-stream-produced) organic matter to serve as a MIV food supply; by rinsing out fine, pore-space-clogging sediments and silt; by diluting contaminants (e.g., excessive road salt in Loantaka Brook); and perhaps by improving survival/reproduction of terrestrial life history stages. None of the other variables that we routinely monitor show a matching improvement over this time period.

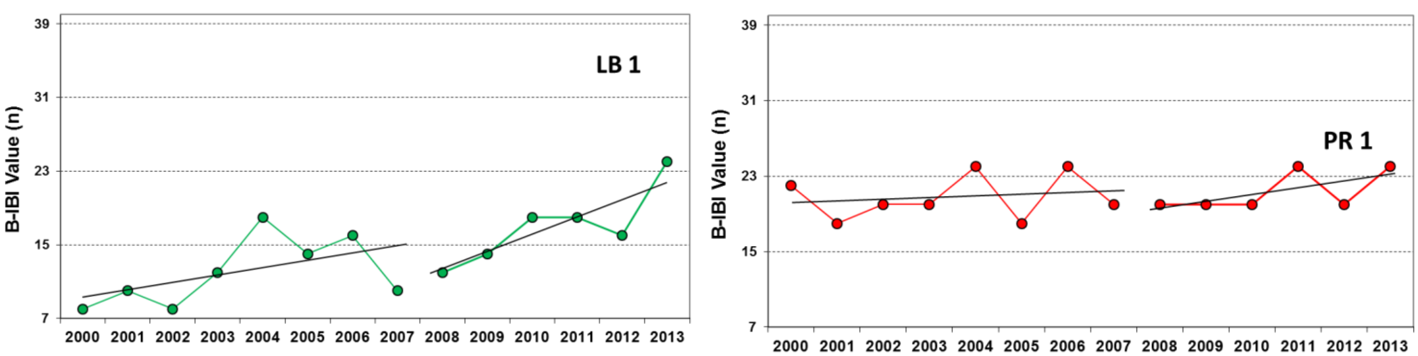
Trends in B-IBI scores during the 2008-2013 period were not identical at all stream sites. They fell into two broad patterns, both in the Great Swamp watershed and also in the Rockaway River watershed. In some cases we will refer to as Group I sites (Great Brook, Primrose Brook in this watershed), B-IBI scores experienced gentle to more pronounced decline. Scores at other – Group II – locations (Black Brook, Loantaka Brook, Passaic River) continued in modest to more significant increase over the same period. That Passaic River sites should exhibit a community response similar to that seen in our most-stressed streams requires a closer look. PR1, located downstream of the eutrophic Osborne Pond impoundment, has had low habitat scores and suffers from high temperatures (see Table 13-1). It truly belongs with these other "poorer habitat" sites (also note its relative position in Figure 13-4). The curve for PR2

Figure 13-7 Similarity-Groups formed from study-long trends in B-IBI score. (Examples are highlighted – see Appendix 13-2 for the full series of stream site figures)

Group I: Great Brook sites (GB2, GB3, GB4, GB5), Primrose Brook sites (PB1, PB2, PB3)

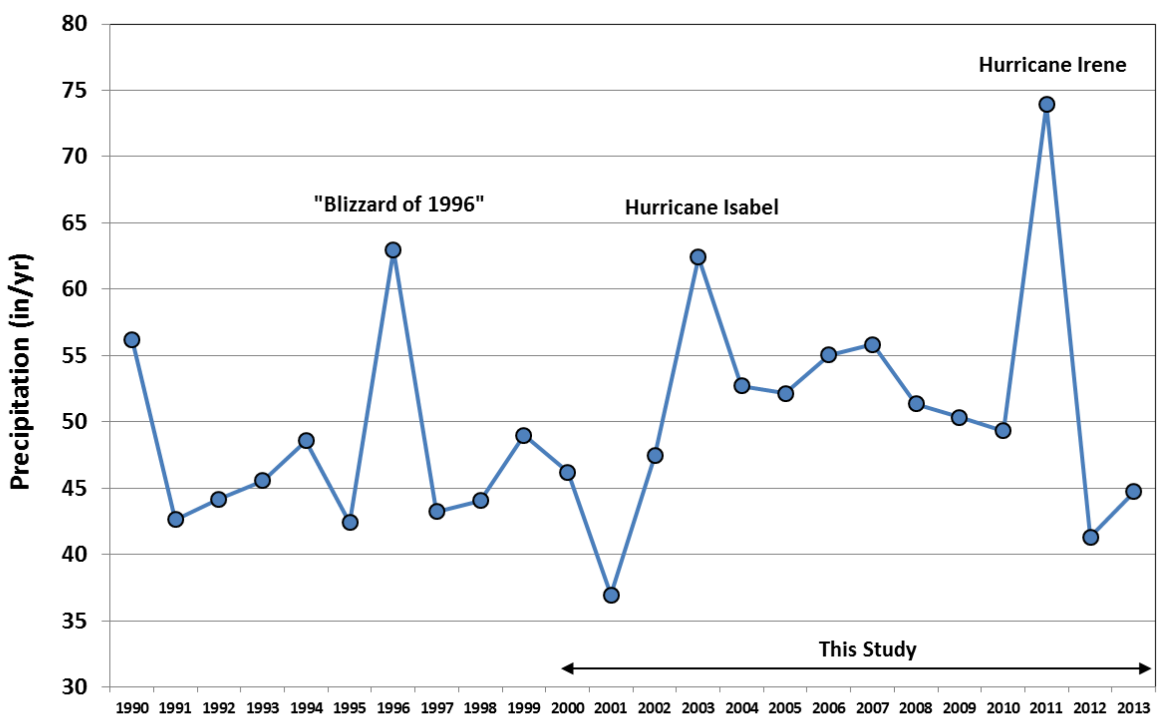


Group II: Black Brook sites (BB1, BB2), Loantaka Brook sites (LB1, LB2, LB3, LB4), Passaic River sites (PR1, PR2, PR3)



shows a declining not an increasing trend in the 2008-2013. However, this trend is largely a consequence of its downstream relocation following post Irene devastation of the original site, as described previously. This poor quality of the substitute site has driven its habitat score to very low levels in 2012 and 2013 (see Table 13-2). If these last two (not really from the "true" PR2) data points were omitted for the moment, a nearly flat B-IBI trend for the post 2007 period would result, making a more convincing fit for Group II inclusion. That the pattern at PR3 belongs in this group is clear, but it seems odd for it to do so. This site has consistantly earned the next-to-highest habitat scores in the watershed, yet its community quality trend matches stream sites of the worst quality. In fact, scores here have actually varied very little over the course of this study and remained basically unchanged in 2008-2013. In this way, it resembles IG1, our reference site, which also has maintained nearly constant B-IBI scores overall.

Figure 13-8 Northern New Jersey Annual Precipitation (in)



These divergent patterns in community quality during the later 2000s appear to be operating on a stream-wide, but not a region-wide basis. This argues against the effectiveness of a regional influence, such as annual precipitation levels, as an explanation at least during this time frame. In Figure 13-2, we have seen that regional precipitation modestly declined during 2008-2013. Group I (declining) patterns are a better correlational match than are Group II patterns for the rising and then declining trend in regional precipitation seen during this period. But why should communities in these two streams be more "precipitation-sensitive" than those in the Group II streams? In fact, decreased rainfall should provide less than usual dilution of the always high and potentially stressful TDS levels in Loantaka Brook, and yet community quality there increases as precipitation levels fall. Still thinking of regional vs stream-specific influences for the moment, the Group II pattern is a better match for the steady rise in average regional temperature over the study period (also in Figure 13-2). But why would the increased stress of warmer air temperatures be beneficial to already stressed Black and Loantaka Brook organisms.

Of course, climate issues are just one of many important variables that may come into play here. We recall that coincident with the declining post-2007 precipitation pattern was an irregularly progressive shift in sampling date from early June in 2000-2005 to nearly a full month earlier by 2013. As discussed above, earlier sampling dates result in lower temperatures and, in turn, must influence the distribution, behavior, abundance and life-cycle timing of macroinvertebrates – but in ways largely unknown to us. If earlier dates catch a larger portion of aquatic stages of seasonally emerging populations of dominant species, e.g., blackfly larvae, those species will occupy more of the 200 individual sample-total, leaving less sample-space for less abundant types. Twenty-five more blackfly or hydropsychid caddisfly individuals occupy the sample-space that could be taken up by 5 other species each with 5 individuals. This could influence the total TAXA as well as the EPT (or other) species count and negatively affect B-IBI scores. Failure to maintain a more constant sampling period has added an unfortunate complication as we try to interpret longer term data. Sampling dates in May invite this blackfly variability, especially visible in post-2007 numbers at Great Brook sites (Figure 13-6). I suggest that annual sampling in the future be set for the last few days of May or the first few of June.

Among Great Swamp watershed sites, IG1 shows an exceptional B-IBI pattern over time. Scores have been high and remarkably consistent throughout the study period, reflecting the appropriateness of this locality as our "reference (ie., minimally stressed) site". The pattern does include a 2-point step-down during the post-2005 period.

At the present time, we are unable to attach a convincing explanation regarding the underlying influence(s) that have produced these distinctive and contrasting trends in MIV community quality in both the Great Swamp and Rockaway River watersheds. Just to add another component to the confusion, the stress-level associated with Group I (declining in 2008-2013) vs Group II (increasing in 2008-2013) communities in the Rockaway River watershed is exactly the reverse of that associated with Great Swamp sites. Our higher stress sites show the Group II (increasing) pattern, while their most-stressed sites are in Group I, declining in B-IBI score. The bottom line is that until a better explanation for their downward trends in B-IBI scores is uncovered, we need to pay close attention to Group I sites in Great and Primrose Brooks in particular, to determine whether these B-IBI trends are associated with changes in regional climate factors, with sample timing, and/or with other more local environmental factor(s) over which we might have some responsibility, but also some control.

An attribute of scientific investigations is that frequently they generate more questions than they answer. That certainly can be said for this project! It will be fascinating to see if these contrasting patterns persist over time. Equally interesting will be trying to identify the stream-wide driving influences over community quality patterns that produce such opposite trends in adjacent streams: Great Brook: Loantaka Brook Primrose Brook: Passaic River. Why should the best endowed sites in the Rockaway River watershed produce ommunity patterns that are most similar to those in Loantaka and Black Brooks, while sites in urban/suburban localities produce ones like we see in Primrose Brook? The story continues!

See Appendix 13-2 for Stream Summaries and suggestions for further action.

2013 Great Swamp Watershed Study:

Recommendations

1. With 22 years of unbroken annual data on Great Swamp Watershed streams, continuing to monitor these sampling sites carries significant regional value.
2. Establishing a narrow sampling-date window, within the last few days of May and the first few days of June, is highly recommended to control variability introduced by the larger date window used during the past 8 years.
3. A series of stream-site specific recommendations have been made below in the Stream Summaries section of this report (Appendix 13-2).
4. We have highlighted issues to be alert to in 2014 sampling. They include:

   -- High TDS levels, new at BB1, and perennially high levels at GB4 & 5 and throughout and above LB5. Also pH was high at BB1, BB2, and GB2.

   -- Continue to keep an eye on the declining B-IBI scores at PB1 and 3, and at other Group I sites, to determine whether these trends are linked to changes in regional climate factors, with sample timing, and/or with other more local environmental factor(s) over which we might have some responsibility, but also some control.

Works Cited

Barbour, M.T., J.Gerritsen, B.D.Snyder, and J.B.Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. (EPA 841-B-99-002). U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Pollock, L.W. 2000. The Macroinvertebrate Communities of the Great Swamp Watershed. A Report to the Ten Towns Great Swamp Management Committee. General Introduction and Methods: 2000 and Subsequent. 12 pages, 1 table, 1 figure

Pollock, L. W. 2011. The Macroinvertebrate Communities of the Great Swamp Watershed, 2010: Results. A Report to the Ten Towns Great Swamp Management Committee. 13 pages, 4 tables, 5 figures, 2 appendices

Pollock, L. W. 2013. The Macroinvertebrate Communities of the Great Swamp Watershed, 2012: Results. A Report to the Ten Towns Great Swamp Management Committee. 23 pages including 12 figures, 3 tables, 2 appendices

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Table 13-1. Great Swamp Watershed, May 16,2013. Habitat Assessment

* Average, 2000-2008 ** Determined once

	B-IBI	width*	X depth*	X velocity*	discharge*	Gradient**	order**	%riffle	temp	TDS	DO	pH	Turbidity	
BB1	20	8.4	0.45	0.18	0.294	0.000	1	30	15.0	631	7.49	8.48	1.06	BB1
BB2	12	13.2	0.51	0.43	1.927	0.000	1	0	15.1	343.7	6.81	8.53	4.52	BB2
LB1	24	19.7	0.54	0.62	6.258	0.002	3	20	14.8	569	6.94	7.90	5.97	LB1
LB2	18	14.1	0.47	0.79	4.438	0.002	2	10	17.4	708	9.24	7.83	4.29	LB2
LB3	20	9.5	0.43	1.17	3.318	0.000	2	2	17.7	752	7.83	7.08	1.59	LB3
LB4	22	6.3	0.27	0.25	0.306	0.000	1	2	15.7	1013	8.89	7.83	5.47	LB4
GB2	22	27.1	0.31	0.90	6.613	0.002	2	15	14.1	293.8	8.39	8.29	5.05	GB2
GB3	20	27.0	0.71	0.90	13.311	0.002	2	30	14.7	308	8.59	7.96	6.45	GB3
GB4	22	10.1	0.45	0.58	2.102	0.000	1	5	16.7	568	7.48	7.57	2.67	GB4
GB5	20	9.0	0.61	0.46	2.475	0.003	1	30	21.9	487	8.61	7.76	11.60	GB5
PB1	30	19.5	0.41	0.87	6.715	0.002	2	60	17.0	171.4	9.48	7.67	1.88	PB1
PB2	32	18.4	0.39	1.00	7.203	0.006	2	60	17.4	176.1	9.05	7.61	2.06	PB2
PB3	32	10.8	0.54	0.77	4.260	0.013	2	40	17.1	97.8	9.75	7.76	1.84	PB3
PR1	24	22.4	0.57	1.12	12.001	0.000	3	50	18.8	199.7	10.1	7.51	2.96	PR1
PR2	26	21.2	0.61	1.33	14.047	0.006	3	10	17.1	187.9	10	7.62	2.67	PR2
PR3	36	23.0	0.54	1.70	18.742	0.006	3	75	17.1	148.8	10.02	7.41	1.09	PR3
IG1	34	15.3	0.42	1.06	6.205	0.017	2	35	16.9	156.7	9.86	7.49	1.05	IG1
Mean	24.35	16.17	0.48	0.83	6.48	0.004	1.94	27.88	16.73	400.70	8.74	7.78	3.66	
Max	36	27.11	0.71	1.70	18.74	0.017	3	75	21.9	1013	10.1	8.53	11.6	
Min	12	6.33	0.27	0.18	0.29	0.000	1	0	14.1	97.8	6.81	7.08	1.05	

	B-IBI	cover	embed	regim	sedim	flow	chann	riffle	bank	veget	ripar	total	HabValue2	
BB1	20	3	3	11	1	15	5	2	11	11	16	78	28	BB1
BB2	12	12	4	10	2	13	5	9	4	5	3	67	24	BB2
LB1	24	9	3	13	9	15	8	4	6	7	7	81	29	LB1
LB2	18	14	5	16	4	14	7	13	5	5	11	94	32	LB2
LB3	20	2	3	13	3	13	14	16	5	6	15	90	33	LB3
LB4	22	8	1	9	1	13	3	10	5	4	5	59	21	LB4
GB2	22	7	4	14	2	13	8	13	6	6	5	78	31	GB2
GB3	20	17	14	19	15	15	11	15	14	12	4	136	70	GB3
GB4	22	9	9	10	7	10	8	7	6	11	6	83	40	GB4
GB5	20	12	11	10	3	11	6	14	8	11	12	98	47	GB5
PB1	30	13	6	15	15	13	15	18	11	9	9	124	59	PB1
PB2	32	15	9	17	12	13	18	20	8	7	15	134	56	PB2
PB3	32	20	19	18	19	13	14	20	9	9	14	155	76	PB3
PR1	24	9	7	15	8	15	10	17	7	11	20	119	50	PR1
PR2	26	14	6	5	5	13	6	2	6	5	20	82	24	PR2
PR3	36	17	18	19	20	15	13	20	10	10	12	154	78	PR3
IG1	34	18	17	19	18	16	12	16	17	15	10	158	83	IG1
Mean	24.35	11.71	8.18	13.71	8.47	13.53	9.59	12.71	8.12	8.47	10.82	105.29	45.94	
Max	36	20	19	19	20	16	18	20	17	15	20	158	83	
Min	12	2	1	5	1	10	3	2	4	4	3	59	21	

Table 13-2. Great Swamp Watershed, Summary of Environmental Data 2011-2013 | **stressful conditions*** |

	B-IBI			Temperature			TDS			DO			
	2011	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	
BB1	**16**	16	20	**21.2**	**19.0**	15.0	381.7	300.7	**631**	**5.43**	**5.24**	7.49	**BB1**
BB2	**16**	14	**12**	16.8	17.2	15.1	**592**	**555**	343.7	8.8	8.16	6.81	**BB2**
LB1	18	16	24	19.2	17.5	14.8	**517**	**438.5**	**569**	7.73	6.99	6.94	**LB1**
LB2	**16**	18	18	20.0	**18.5**	17.4	**680**	**578**	**708**	7.67	6.37	9.24	**LB2**
LB3	20	10	20	17.5	18.1	17.7	**756**	**701**	**752**	7.4	6.68	7.83	**LB3**
LB4	20	18	22	18.0	16.7	15.7	**906**	**737**	**1013**	8.13	6.5	8.89	**LB4**
GB2	22	20	22	18.4	17.4	14.1	246.1	239.5	293.8	8.43	7.4	8.39	**GB2**
GB3	20	**12**	20	19.0	17.7	14.7	254.8	245.3	308	8.6	7.85	8.59	**GB3**
GB4	22	14	22	19.7	17.5	16.7	304	419.1	**568**	6.94	6.56	7.48	**GB4**
GB5	**16**	**12**	20	**21.0**	**18.9**	**21.9**	498	381	487	7.96	5.48	8.61	**GB5**
PB1	34	34	30	18.0	17.3	17.0	148.7	157.4	171.4	9.31	8.69	9.48	**PB1**
PB2	30	30	32	18.0	17.2	17.4	145.5	157.1	176.1	9.35	8.79	9.05	**PB2**
PB3	36	36	32	17.0	16.0	17.1	90	92.2	97.8	9.88	9.21	9.75	**PB3**
PR1	24	20	24	**21.0**	**18.5**	**18.8**	170.6	146	199.7	9.6	8.39	10.1	**PR1**
PR2	32	26	26	**20.5**	17.1	17.1	157	153.5	187.9	8.98	8.62	10	**PR2**
PR3	36	34	36	18.9	17.0	17.1	144.4	118.7	148.8	9.15	8.97	10.02	**PR3**
IG1	36	36	34	18.3	15.5	16.9	157.9	148.9	156.7	9.23	9.16	9.86	**IG1**
mean	24.35	21.53	24.35	18.97	17.48	16.73	361.75	327.58	400.70	8.39	7.59	8.74	**mean**
max	36	36	36	21.2	19	21.9	906	737	1013	9.88	9.21	10.1	**max**
min	16	10	12	16.8	15.5	14.1	90	92.2	97.8	5.43	5.24	6.81	**min**

	pH			Turbidity			Habitat			Habitat Value			
	2011	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	**2011**	**2012**	**2013**	
BB1	7.04	7.35	**8.48**	**9.99**	6.93	1.06	61	75	78	27	33	28	**BB1**
BB2	6.87	7.57	**8.53**	4.42	0.81	4.52	71	76	**67**	22	22	**24**	**BB2**
LB1	7.22	7.57	7.90	4.87	4.44	5.97	66	**62**	81	19	**16**	29	**LB1**
LB2	7.31	7.50	7.83	3.21	3.72	4.29	78	98	94	24	36	32	**LB2**
LB3	7.30	7.21	7.08	1.19	1.54	1.59	**49**	**66**	90	**7**	**17**	33	**LB3**
LB4	7.44	7.42	7.83	5.01	4.54	5.47	**40**	**60**	**59**	**15**	22	**21**	**LB4**
GB2	7.32	7.19	8.29	5.79	**8.98**	5.05	74	80	78	34	39	31	**GB2**
GB3	7.40	7.43	7.96	**8.13**	**13.00**	**6.45**	119	135	136	58	68	70	**GB3**
GB4	7.57	7.50	7.57	4.24	4.14	2.67	**55**	76	83	20	31	40	**GB4**
GB5	7.58	7.55	7.76	4.64	5.10	**11.60**	91	96	98	38	42	47	**GB5**
PB1	7.35	7.62	7.67	1.76	2.95	1.88	129	116	124	68	25	59	**PB1**
PB2	7.42	7.54	7.61	1.92	5.56	2.06	137	136	134	63	56	56	**PB2**
PB3	7.84	7.63	7.76	2.09	2.23	1.84	159	161	155	75	73	76	**PB3**
PR1	7.58	7.42	7.51	3.79	5.93	2.96	105	121	119	46	57	50	**PR1**
PR2	7.38	7.34	7.62	**8.14**	3.17	2.67	108	77	82	40	24	**24**	**PR2**
PR3	7.50	7.53	7.41	1.85	2.27	1.09	150	157	154	77	81	78	**PR3**
IG1	7.51	7.50	7.49	1.68	1.12	1.05	154	153	158	79	85	83	**IG1**
mean	7.39	7.46	7.78	4.28	4.50	3.66	96.82	102.65	105.29	41.88	42.76	45.94	**mean**
max	7.84	7.63	8.53	9.99	13	11.6	159	161	158	79	85	83	**max**
min	6.87	7.19	7.08	1.19	0.81	1.05	40	60	59	7	16	21	**min**

Table 13-3. Comparison between B-IBI components, 2012 and 2013

declined
improved

	BB1		BB2		LB1		LB2		LB3		LB4	
Data	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
DOM	0.81	0.52	0.65	0.87	0.59	0.46	0.71	0.61	0.81	0.29	0.68	0.39
TAXA	12	22	18	11	14	27	16	15	13	19	12	24
PPred	0.05	0.09	0.00	0.01	0.00	0.05	0.01	0.01	0.00	0.02	0.25	0.02
IndIntol	0	3	3	2	0	3	2	3	0	3	1	3
#Eph	0	0	0	0	0	1	0	0	0	1	0	0
#Trich	2	2	0	0	2	3	3	3	1	2	1	2
#Plec	0	0	0	0	0	0	0	0	0	0	0	0
IndTol	4	6	6	3	3	2	3	2	5	4	4	4
B-IBI Scores	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
DOM	1	**3**	3	*1*	3	**5**	3	3	1	**5**	3	**5**
TAXA	3	**5**	3	*1*	3	**5**	3	3	3	3	3	**5**
PPred	3	3	1	1	1	**3**	1	1	1	1	5	*1*
IndIntol	1	**3**	3	3	1	**3**	3	3	1	**3**	1	**3**
#Eph	1	1	1	1	1	1	1	1	1	1	1	1
#Trich	3	3	1	1	3	3	3	3	1	**3**	1	**3**
#Plec	1	1	1	1	1	1	1	1	1	1	1	1
IndTol	3	*1*	1	**3**	3	3	3	3	1	**3**	3	3
B-IBI Total	**16**	**20**	**14**	**12**	**16**	**24**	**18**	**18**	**10**	**20**	**18**	**22**

	GB2		GB3		GB4		GB5		PB1		PB2	
Data	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
DOM	0.53	0.71	0.85	0.59	0.70	0.39	0.83	0.45	0.41	0.26	0.28	0.23
TAXA	24	23	11	22	18	27	15	20	33	31	29	39
PPred	0.04	0.05	0.07	0.01	0.02	0.00	0.05	0.01	0.05	0.07	0.09	0.08
IndIntol	3	3	1	3	1	3	0	2	7	8	4	9
#Eph	1	1	0	0	0	1	0	1	4	5	5	4
#Trich	2	2	1	3	2	2	1	2	7	4	5	9
#Plec	1	0	0	0	0	0	0	0	5	3	4	3
IndTol	5	3	4	4	6	4	6	3	4	2	3	3
B-IBI Scores	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
DOM	3	3	1	**3**	3	**5**	1	**5**	5	5	5	5
TAXA	5	5	1	**5**	3	**5**	3	3	5	5	5	5
PPred	3	3	3	*1*	1	1	3	*1*	3	3	3	3
IndIntol	3	3	1	**3**	1	**3**	1	**3**	5	5	5	5
#Eph	1	1	1	1	1	1	1	1	3	3	3	3
#Trich	3	3	1	**3**	3	3	1	**3**	5	*3*	3	**5**
#Plec	1	1	1	1	1	1	1	1	5	*3*	3	3
IndTol	1	**3**	3	3	1	**3**	1	**3**	3	3	3	3
B-IBI Total	**20**	**22**	**12**	**20**	**14**	**22**	**12**	**20**	**34**	**30**	**30**	**32**

	PB3		PR1		PR2		PR3		IG1	
Data	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
DOM	0.25	0.34	0.71	0.58	0.43	0.50	0.23	0.37	0.31	0.50
TAXA	39	29	17	24	25	27	32	34	34	36
PPred	0.16	0.08	0.00	0.01	0.07	0.02	0.07	0.07	0.11	0.10
IndIntol	7	6	2	5	3	6	4	11	10	10
#Eph	5	3	2	4	4	3	3	7	5	4
#Trich	9	5	3	4	2	3	7	6	9	8
#Plec	8	4	0	0	2	0	6	5	7	6
IndTol	2	0	3	4	8	4	3	2	4	2
B-IBI Scores	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**

Appendix 13-1. Great Swamp, 2013

Taxon	BB1	BB2	LB1	LB2	LB3	LB4	GB2	GB3	GB4	GB5	PB1	PB2	PB3	PR1	PR2	PR3	IG1	Totals
Ann:Hirudinea:Erpobdellidae: Erpobdella	5	1		2														**8**
Ann:Oligochaeta:Enchytraidae	1				1													**2**
Ann:Oligochaeta: Naiadae	7				11	7				2					10			**37**
Ann:Oligochaeta:Lumbricidae	2	7			26	10	1		1		1	3			3	1	2	**57**
Col:Elmidae, Optioservus			1								20	14	21	6		2	7	**71**
Col:Elmidae: Stenelmis crenata gr.			27	73	2		96	8	17	8	14	2	12	17	1	1	6	**284**
Col:Elmidae: Promoresia tardella											1						1	**2**
Col:Elmidae: Ancyronyx variagatus			3								2			1		1		**7**
Col:Elmidae: Dubiraphia vittata			2															**2**
Col:Elmidae:Macronyches glabratus			9						1					1				**11**
Col:Psephenidae: Psephenus herricki											10	7	2	2	2	2	2	**27**
Cru:Amphipoda:Gammaridae: Gammarus faciatus	1	139	81	61	1	8	78	101	14	25	4	12		123	85	3	40	**776**
Cru:Dec:Cambridae: Orconectes							1		1									**2**
Cru:Isopoda: Caecidotea			22			1		5	1					1	3		1	**34**
Dip:Chironomidae:Chironomini: Dicrotendipes sp 1	2	8	1		11	3									12			**37**
Dip:Chironomidae:Chironomini: Paratendipes							1								2			**3**
Dip:Chironomidae:Orthocladini: Parametriocnemus			2		2	1	1			1		8	1			16		**32**
Dip:Chironomidae:Orthocladini: Cricotopus trifasciata gr.			2						7		2					18		**29**
Dip:Chironomidae:Orthocladini: Chaetocladius	17	1				4	1		1			2						**26**
Dip:Chironomidae:Chironomini: Stictochironomus			19	1	6	16	3		22						5			**72**
Dip:Chironomidae:Chironomini: Xenochironomus xenolabis								23										**23**
Dip:Chironomidae:Orthocladini: Cricotopus sp.			2											3				**5**
Dip:Chironomidae:Orthocladini: Orthocladius cplx.				1		47	3	3	13	5	6	6	3		6			**93**
Dip:Chironomidae:Orthocladini: Cardiocladius																3	1	**4**
Dip:Chironomidae:Orthocladini: Cricotopus bicinctus gr.			10	7	7	13			7	1			1		3			**49**
Dip:Chironomidae:Chironomini: Polypedilum flavum	108		4	8		4		10	43	50		2	9	1		5		**244**
Dip:Chironomidae:Chironomini: Dicrotendipes neomodestus						23	3											**26**
Dip:Chironomidae:Chironomini: Polypedilum spp.			3				1		1								3	**8**
Dip:Chironomidae:Chironomini: Cryptochironomus fulvus gr.						2									3			**5**
Dip:Chironomidae:Orthocladini: Orthocladius sp. 2	30	1	3				1		13				2		3		2	**55**
Dip:Chironomidae:Orthocladini: Nanocladius crassicornis								1										**1**
Dip:Chironomidae:Chironomini: Microtendipes pedellus gr.							3					1						**4**
Dip:Chironomidae:Chironomini: Parachironomus frequens										7								**7**
Dip:Chironomidae:Chironomini: Chironomus riparius		4				2	11	3		3	3				15			**41**
Dip:Chironomidae:Tanypodini: Sublettea													1					**1**
Dip:Chironomidae:Orthocladius: Tvetenia											2							**2**
Dip:Chironomidae:Chironomini: Glyptotendipes	15								1	6								**22**
Dip:Chironomidae:Tanypodini:Thienemannimyia group	20		1	1	2	1	12	1		2	6	4	11				8	**69**
Dip:Chironomidae:Orthocladini: Rheocricotopus robacki														3				**3**
Dip:Chironomidae:Tanypodini: Tanytarsus guerlus group	5				6		4		1			1			14			**31**
Dip:Chironomidae:Tanypodini: Clinotanypus															4			**4**
Dip:Chironomidae:Diamesinae: Potthastia longimanna gr.												1						**1**
Dip:Chironomidae:Diamesinae: Diamesa						2			4		6	8	6	5		2	1	**34**
Dip:Chironomidae,Tanypodini: Rheotanytarsus	30		2	1			2	1	3				1	4				**44**
Dip:Chironomidae:Tanytarsini: Micropsectra						14			1		2					5		**22**
Dip:Chironomidae:Tanypodini: Paratanytarsus			2					1							10			**13**
Dip:Empididae: Hemerodromia			1					1		1	3	1		2				**9**
Dip:Simuliidae: Simulium	5			6	5	26	3	18	50	17	15	2	1	3		4	1	**156**
Dip:Tipulidae: Antocha											1	1	1			1	3	**7**
Dip:Tipulidae: Tipula						1			1			1	1				1	**5**
Eph:Baetidae: Acentrella											6			1		39	3	**49**
Eph:Baetidae: Baetis flavistriga												14		4		10		**28**
Eph:Baetidae: Baetis			15				8		1	7	40	12	17			16	9	**125**
Eph:Ephemerellidae: Ephemerella					1						11	21	50			12	73	**168**
Eph:Ephemerellidae: Eurylophella															3			**3**
Eph:Heptageniidae:Maccaffertium modestum											3					2	1	**6**
Eph:Heptageniidae:Maccaffertium											3	7	4	22	3	3		**42**
Eph:Isonychiidae: Isonychia																1		**1**
Sisyridae: Climacia	1							4										**5**
Meg: Nigronia serricornis												4					2	**6**
Mol:Bivalvia:Sphaeriidae: Musculium	2							16	3	6			1					**28**
Mol:Bivalvia: Corbicula fluminea			3															**3**
Mol:Bivlavia:Sphaeriidae:Pisidium		1		5														**6**
Mol:Gastropoda:Pulmonata:Physidae: Physa	1	21						2		2		1		1	1			**29**
Mol:Gastropoda:Prosobranchia:Ancylidae: Ferrissia															2		3	**5**
Mol:Gastropoda:Pulmonata:Planorbidae: Gyraulus	2	1		1	2			1										**7**
Nematoda			1				2		1			2						**6**
Odo:Anisoptera:Gomphidae: Stylogomphus												1						**1**
Odo:Zygoptera:Coenagrionidae: Argia			1					1							1			**3**
Ple:Chloroperlidae: Alloperla																	1	**1**
Ple:Leuctridae: Leuctra											2	3	27			9	3	**44**
Ple:Nemouridae: Amphinemura											10	6	2			2		**20**
Ple:Perlidae: Perlesta											9	7				9	2	**27**
Ple:Perlidae: Paragnetina																1	2	**3**
Ple:Perlidae: Acroneuria abnormis																1	3	**4**
Ple:Perlotidae: Isoperla													2					**2**
Ple:Pteronarcyidae: Pteronarcys dorsata													4				2	**6**