Appendix 6

Invertebrate Survey

Prepared by:

Rushing Rivers Institute

January 2010

This appendix defines the invertebrate species that use the habitat in the Wekepeke Brook. Invertebrates were sampled within the designated river to assess the status of their communities.

Macroinvertebrate Survey

A kick net macroinvertebrate survey was conducted on August 20, 2008 and over the period between September 16, 2008 and September 18, 2008. A total of 77 grids were sampled during these four survey days. Samples were distributed evenly throughout the eight representative sites. We conducted this survey in accordance to the standardized traveling kick method endorsed by the New York State Department of Environmental Conservation (NYS DEC; Bode *et al.*, 1991) using D-nets of mesh size 0.5–0.6 mm. For each sample, we positioned a net in the habitat unit and disturbed the middle third of a 1-m grid of riverbed by hand, causing the dislodged invertebrates to flow into the net. After each grid, the contents of the net were emptied into a pan glass jar, after allowing the contents to settle, excess water was removed and a 70% ethyl alcohol solution was added to the remaining contents for preservation.

Macroinvertebrates

In the laboratory, each macroinvertebrate sample was rinsed with tap water and then emptied into an enamel pan. All organisms in the sub-sample were identified to the order level and number of families. Species of the orders Ephemeroptera, Trichoptera, and Plecoptera were identified at the family level. All samples were processed and placed back in the original bottle containing 70% ethyl alcohol.

Once all sub-samples were identified, the following metrics were used to describe and evaluate the macroinvertebrate communities in the river. The values from each sub-sample were averaged to calculate a score for each site in each of the metrics:

***Family Richness*.** The total number of different families found in the sample.

EPT Value. The total number of families in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), that is found in a sample. Mayflies, stoneflies, and caddisflies are generally considered clean-water organisms, so their presence tends to be correlated with good water quality. For this report, we determined the number of families in each of these orders, the percent of the total sample comprised of these orders, and the percent of the total sample comprised of members of the Trichoptera order alone.

EPT Family Richness is rated as:

> 7 = non-impaired

4 - 7 = slightly impaired

1 - 3 = moderately impaired

0 = severely impaired

Biotic Index. The Hilsenhoff Biotic Index is calculated by multiplying the number of individuals of each family by the assigned tolerance value of that family and calculating the average

tolerance for each sub-sample. Tolerance values come from NYS DEC assignments (Bode et al. 1991). Values range from 0 (intolerant) to 10 (tolerant).

Family Biotic Index is rated as:

0 - 4.5 = non-impaired

4.51 - 6.5 = slightly impaired

6.51 - 8.5 = moderately impaired

8.51 - 10 = severely impaired

Species Diversity. The Shannon-Wiener diversity index (H') combines taxa richness and community balance according to the following equation:

$$H' = -\sum_{i=1}^{S}(p_i \ln p_i)$$

Where p = the individual proportion of each taxon (Magurran 1988).

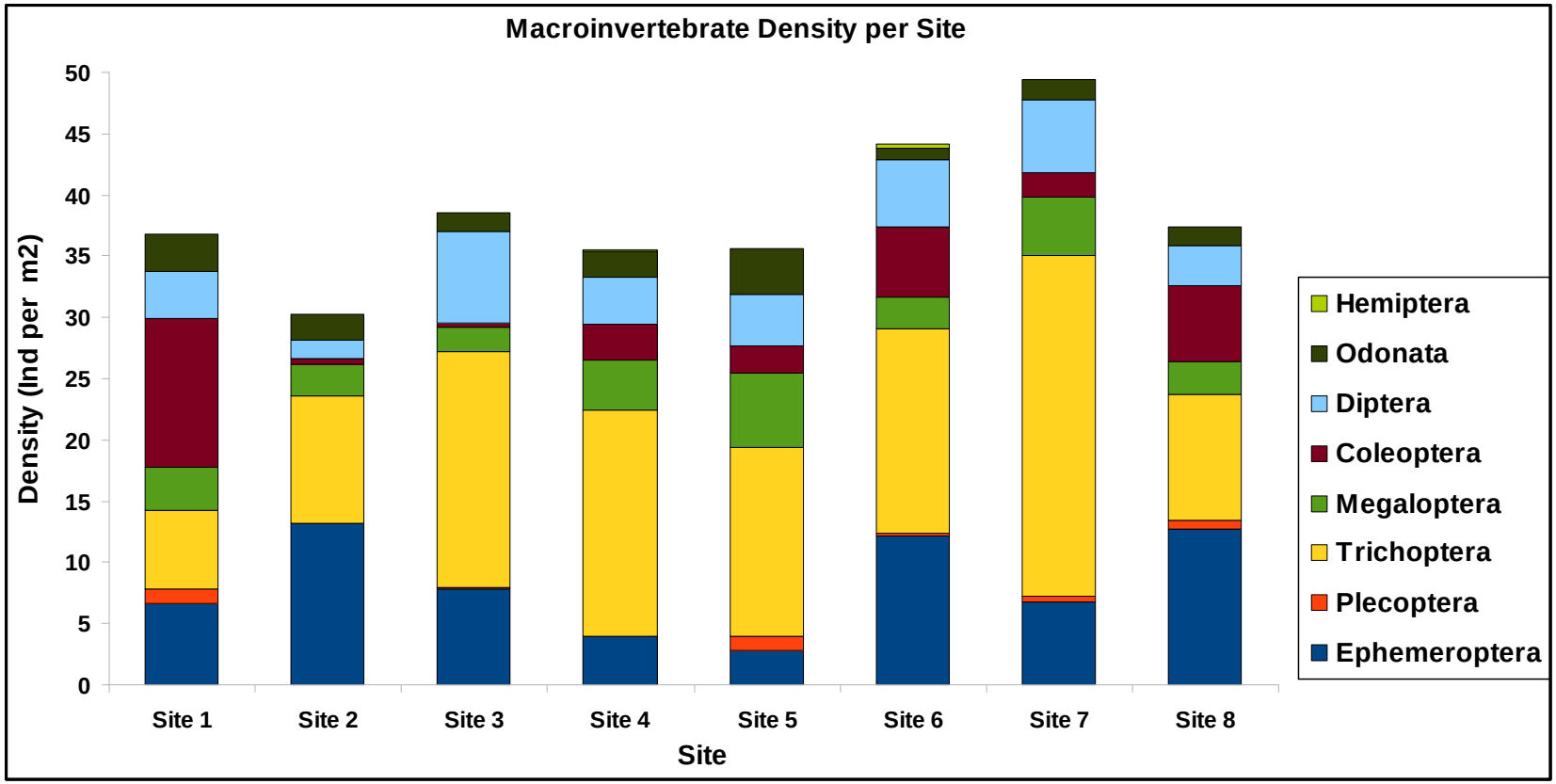
The Shannon-Wiener index is not a true evenness measure; however, it does take into account the distribution of organisms in a sample. The lower the index value is, the greater the degradation at the site.

Percent Model Affinity. This value is a measurement of similarity between the measured and model compositions of macroinvertebrate communities at a given site, based on the percent abundance of seven invertebrates groups from the northeast (Novak and Bode 1992). The model community is 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% others.

Table 1: Macroinvertebrate Diversity Index Values

Site	Subtotal Insects	# Grids	Density per m²	Family Richness	EPT Value	% EPT	T Value	% T	Hilsenhoff	Species Diversity	% Model Affinity	Level of Impact
1	479	13	36.90	13	9	39	4	17	4.14	5.87	61.72	slight
2	243	8	30.38	9	5	78	2	34	3.52	3.86	66.61	non
3	237	6	39.50	12	7	69	5	49	3.87	4.14	60.21	slight
4	249	7	35.57	11	7	63	5	52	4.07	4.35	50.14	slight
5	285	8	35.63	13	9	54	5	43	3.8	5.16	49.13	moderate
6	309	7	44.14	16	8	66	5	38	3.39	4.81	63.70	non
7	692	14	49.43	17	13	71	8	56	3.98	3.9	50.78	slight
8	451	12	37.58	14	10	63	4	27	3.81	4.95	74.76	non

Figure 1: Graph of Macroinvertebrate Density by HMU mapping site.



Site 1 – Invertebrate Metric and Water Quality Data Results

Invertebrates at Section 1 were at a Density of 36.9 insects/m², an average value in comparison to the other sites. Family Richness was also comparatively average with a value of 13. The presence of a greater than 7 EPT Family Richness generally indicates non-impaired conditions. However, the 62% affinity to the reference model, suggests that other unnatural circumstances are affecting the overall species assemblage. Nearly 33% of the insects were of the order Coleoptera, a high level in comparison to the ideal 10% of a model stream composition. Species diversity was calculated to be 5.87, which is the highest of all sections. While the biotic index score of 4.14 is within the range of "non-impaired" waters, it is the highest value of all eight sites.

Site 1 had the highest pH of all the sites. As Coleoptera can be quite tolerant of low dissolved oxygen and high pH levels, this may partly explain their predominance. High N/P ratios promote the presence of stress-tolerant species; in this case, the ratio is 41.24. Often, levels >20 are indicative of limited productivity and of an environment more stressful to biota. The high level of Ammonia at this site is indicative of productivity.

Site 2 – Invertebrate Metric and Water Quality Data Results

Site 2 had the lowest Density of 30.38 insects/m² and the lowest species diversity value of 3.86. Family Richness was lowest at this site with an EPT richness value of 5 making this site slightly impaired. When Family Richness and overall Density are combined into a Percent Model, the affinity score of 67% defines this site as non-impacted. Inverse to Site 1, this site had a smaller Density of less tolerant species. The Hilsenhoff Tolerance was at a low of 3.86, making this the least impaired site.

This site is located on Lynde Brook. A 1.213 mg/L Ammonia level suggests that there may be inputs from the Basin upstream. Phosphorus levels (0.025) are the lowest of all 8 sites. However, a high Nitrate level leads to a N/P ratio of 48.06. Notably, Site 2 has the greatest Density of fish/m². The low Density of aquatic insects may be caused by the abundance of feeding fish.

Site 3 – Invertebrate Metric and Water Quality Data Results is strong, with an EPT richness >7 and a tolerance value of 3.87, this part of the channel is within the limits of non-impaired waters. The majority of aquatic insects were made up of the tolerant EPT families yet a 60% affinity to the Percent Model puts this site into the bracket of slightly impacted.

Water Quality Data for sites 3 and 4 were combined, due to their spatial proximity. As both of these sites are directly downstream from both the Heywood Reservoir and the Lynde Basin, the combination of Water Quality data from Sites 1 and 2 serve as the data for both Sites 3 and 4. Site 3 can be most directly associated with this combined data. Data collected at the Heywood Spillway and the Lynde Basin shared high N/P ratios. Inputs from both Basins are most likely the cause of heightened enrichment.

Site 4 – Invertebrate Metric and Water Quality Data Results

The Density value was found to be 35.57 insects/m². Overall Family and EPT richness values as well, as a Hilsenhoff tolerance value of 4.07, were indicative of non-impaired waters. The

Species Diversity was 4.35. The 50% affinity to the Percent Model, on the other hand, indicates a slight and nearly moderate level of impact to the macroinvertebrate species.

The Water Quality data for this section, as discussed above, may clarify the causes for the impacts on species composition. Water quality data was taken for Spring Brook, which intersects with Wekepeke Brook just downstream of Site 4. From this point on, water quality measurements tend to show lower N/P ratios, higher Phosphorus levels and pH levels stabilized over the course of the last five sites.

Site 5 – Invertebrate Metric and Water Quality Data Results

Macroinvertebrates were at a Density of 35.63 insects/m^2. Species were rather diverse here at a value of 5.16, while Family Richness and EPT Richness were of non-impaired values. The Megaloptera have an unusual 17.2% make-up at this site. These species are known for their ability to find homes in unusual environments. There is a 49% Affinity to the Reference Model, a sign of moderate impact. This suggests that, while inflow from the Spring Basin positively affects certain environmental attributes, significant negative effects to insects are caused by upstream inputs.

Water Quality data from the Spring Basin Spillway are applicable to this site. The Ammonia level was much lower at this site than any upstream. The N/P ratio was at 19.19. A turbidity of 13.10 NTU coupled with a decreased DO level, 7.97 mg/L, suggests some sedimentation. Overall, water quality data for the Spring Basin indicates a healthy environment for aquatic insects.

At this point, the Brook is receiving inputs from Spring Brook. The following data applies to both Sites 5 and 6, due to their spatial proximity. At this section, there is a N/P ratio of 16.58. Phosphorus levels are at 0.072 mg/L and Dissolved Oxygen is 105.60%. Turbidity at the Basin measured 13.10 and decreases to 12.43 by the time the water has reached Site 5. This is the highest Turbidity value among the eight sites and may be significant to the heightened number of Megaloptera at Site 5.

Site 6 – Invertebrate Metric and Water Quality Data Results

In Site 6, the overall species Density was among the highest at 44.14 insects/m^2. Species Diversity had a value of 4.81. Species resembling the Reference Model with a 64% affinity can be classified as non-impacted. Family Richness, EPT Richness, and the Hilsenhoff indices all point to an unimpaired site.

As noted above, High Turbidity and Phosphorus levels stand out among the Water Quality Data. Overall, normal N/P ratio and pH values present at this site are representative of the remaining sites downstream.

Site 7 – Invertebrate Metric and Water Quality Data Results

At a Density of 49.43 insects/m^2, this site shows the highest Density with the most species being of the Trichoptera and Ephemeroptera Orders. About 71% of species were of the EPT taxa, with a low species diversity of 3.9. Hilsenhoff and Richness values indicate non-impaired waters. The 50.78 Affinity to the Percent Model demonstrates a slight impact to aquatic insects.

A healthy N/P ratio of 16.81 can be found at Site 6. While the Phosphorus levels were relatively high at 0.070 mg/L, a high percentage of dissolved oxygen suggests that these nutrients have not overly enriched the stream segment. It is possible that the incongruence of the species assemblage will be affected by a separate factor such as variations in flow or riparian buffer.

Site 8 – Invertebrate Metric and Water Quality Data Results

Species Density was at 37.58 insects/m^2. Family Richness, EPT Richness of 10, and a Hilsenhoff tolerance value of 3.81 all indicate a non-impaired site. While populations were not dense, they were diverse at a value of 4.95. Ephemeroptera made up 34% of the population and Trichoptera made up 27%. Approximately 17% of the species were of the Order Coleoptera. Overall, the species make-up was closest to the Model at a non -impacted affinity value of 75%.

A healthy N/P ratio of 14.03 can be found at this site. This is partly due to a higher level of Phosphorus. All other Water Quality data are average in comparison to the other sites and promote a healthy biotic environment.

Summary of Invertebrate Metric and Water Quality

Site 1 had the greatest insect species diversity, suggesting a habitat enriched by resources that, while increasing biota Density, may also move assemblage towards the dominance of more tolerant species. A precipitation of nutrient enrichment may create detrimental affects to invertebrate species if not maintained. Site 2 seems to continue this trend of enriched habitat. Site 3 is just downstream of the confluence of Lynde and Wekepeke Brook and had similar characteristics as Sites 1 and 2, appearing to be an average of these two sites. High nutrient values and large amounts of pollution-tolerant species are signs of an imbalanced habitat. It is therefore suggested that downstream of these two sites the existing communities are already experiencing challenges. Gathering a timeline of water quality data may aid in defining the severity of issues affecting the biota and finding a management solution.

Heightened levels of Ammonia, Nitrogen and Phosphorus are important factors to consider in any future operations on the Wekepeke Brook. A fluctuation in insect assembly has been found to occur downstream from the Reservoir and Lynde Basin. Effects can be seen from Sites 1-5. The Spring Basin appears to be cleaner, displaying little negative affect to downstream sites. These basins must also be considered as potential recipients of shifting ecology as a result of anthropogenic operations.