FINAL REPORT
BENTHIC MACROINVERTEBRATE SURVEY
OLD HICKORY PROJECT
FALL 2002

FOR
US ARMY CORPS OF ENGINEERS
NASHVILLE DISTRICT

Prepared by
PENNINGTON & ASSOCIATES, INC.
570 EAST 10TH STREET
COOKEVILLE, TENNESSEE 38502-2887
931-526-6038

SUMMARY

On September 4, October 28 and November 4, 21 and 22, 2002, personnel from the Nashville District, Corps of Engineers Water Management Section (Hydrology and Hydraulics Branch, Engineering-Construction Division) collected water quality and benthic macroinvertebrate samples from nine locations (Drakes Creek Mile 1.9 and 4.9, Bledsoe Creek Mile 10.3, Barton's Creek Mile 7.1, Cedar Creek Mile 7.0, Spring Creek Mile 5.8, Round Lick Creek Mile 8.3 and Cumberland River Miles (CRM) 216.9 and 245.0) in the Old Hickory Project area.

Benthic macroinvertebrate community structure at each location and comparison of the sites were assessed using: taxa richness, EPT taxa richness, Biotic Index, % EPT individuals, Modified % EPT, % mayflies, % Chironomids and Oligochaetes, % dominant species, % clingers, Shannon Diversity Index, Jaccard's Coefficient and percent similarity. Cluster analyses were accomplished using 1-Jaccard's Coefficient and percent dissimilarity. The clusters were interpreted graphically to relate similar communities.

A minimum of 98 species of benthic macroinvertebrates was taken from the nine sites within the Old Hickory Project area. Bledsoe Creek Mile 10.3 had 46, Round Lick Creek Mile 8.3 had 41, Spring Creek Mile 5.8 had 36, Drakes Creek Mile 4.9 had 28 species, Cedar Creek Mile 7.0 had 25, Barton's Creek Mile 7.1 had 21, Cumberland River Mile 216.9 had 15, Cumberland River Mile 245.0 had 24, and Drake's Creek Mile 1.9 had 18 species. In terms of density, the embayment location at Drake's Creek Mile 1.9 had the most with ~12,338 individuals/m^2, followed by CRM 216.9 (~2,206/m^2) and CRM 245.0 (~2,125/m^2). The inflow location Round Lick Creek Mile 8.3 had a population density of ~8,907/m^2 followed by Bledsoe Creek Mile 10.3 (~7,195/m^2), Cedar Creek Mile 7.0 (~6,500/m^2), Spring Creek Mile 5.8 (~4,295/m^2), Drakes Creek Mile 4.9 (~3,222/m^2) and Barton's Creek Mile 7.1 with ~2,875/m^2.

The six inflow (wadable) sites (Barton's Creek Mile 7.1, Drakes Creek Mile 4.9, Cedar Creek Mile 7.0, Bledsoe Creek Mile 10.3, Round Lick Creek Mile 8.3 and Spring Creek Mile 5.8) were fairly species rich with high density and diverse with an abundance of sensitive species. The six inflow locations supported benthic communities representative of "fair" at Spring Creek Mile 5.8 to "good or very good", water quality conditions at the other five inflow

locations. When scored against the bioregion reference data, all wadable sites scored as non-impaired or supporting. Conversely, the three main-stem/embayment reservoir sites (Cumberland River Miles 216.9 and 245.0 and Drakes Creek Mile 1.9) supported fewer species and benthic communities dominated by tubificid worms and other species tolerant of degraded conditions. The benthic communities at the three main stem/embayment locations are indicative of "fairly poor" to "poor" water conditions and/or habitat conditions.

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INTRODUCTION

On September 4, October 28, and November 4, 21 and 22, 2002, personnel from the Nashville District, Corps of Engineers Water Management Section (Hydrology and Hydraulics Branch, Engineering-Construction Division) collected water quality and benthic macroinvertebrate samples from nine locations in the Old Hickory Reservoir Project area. The Water Management Section maintains a baseline, water quality data collection and monitoring program. A wide range of physical, chemical and biological data is collected, analyzed and reported from various locations representing tailwaters, impounded sites and reservoir inflows for the ten Nashville District reservoirs in the Cumberland River Basin. During 2002, biological data collections included extensive quantitative sampling for benthic macroinvertebrates at six of the Cumberland River Basin projects.

SAMPLING LOCATIONS

Sampling locations in the Old Hickory Project area in the Cumberland River Basin are shown in Figure 1. The following is a brief description of the nine benthic macroinvertebrate sampling sites.

3OLD10050 - Drakes Creek Mile 4.9, Latitude $36^0$19'00", Longitude $86^0$23'10", inflow location

3OLD10054 – Bledsoe Creek Mile 10.3, Latitude $36^0$26'45", Longitude $86^0$19'57", inflow location

3OLD10055 – Cedar Creek Mile 7.0, Latitude $36^0$13'53", Longitude $86^0$20'22, inflow location

3**OLD10056** - Barton's Creek Mile 7.1, Latitude $36^0$15'12", Longitude $86^0$19'54", inflow location

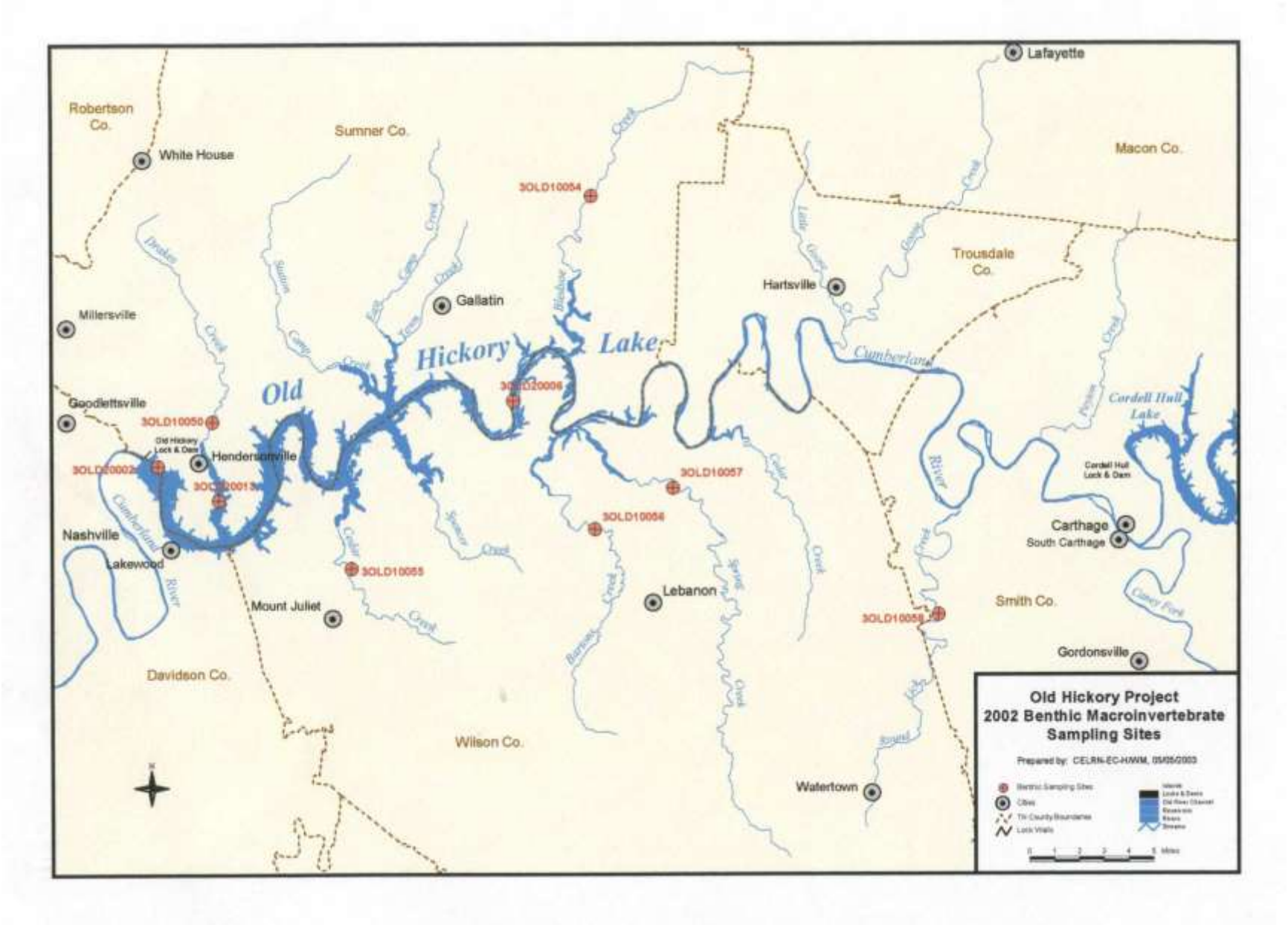
3OLD10057 – Spring Creek Mile 5.8, Latitude $36^0$16'50.0", Longitude $86^0$16'30.0", inflow location.

3OLD10058 – Round Lick Creek Mile 8.3, Latitude $36^0$12'06.6", Longitude $86^0$05'6.9", inflow location.

3OLD20002 - Cumberland River Mile 216.9, Latitude $36^0$17'26", Longitude $86^0$39'48", main channel location

3OLD20006 - Cumberland River Mile 245.0, Latitude $36^0$19'46", longitude $86^0$23'52", main channel location

3OLD20013 - Drake's Creek Mile 1.9, Latitude $36^0$16'16", Longitude $86^0$36'04", embayment location.


Old Hickory Project
2002 Benthic Macroinvertebrate Sampling Sites
Prepared by: CELRN-EC-HWM, 05/05/2003
Old Hickory Lake
Cordell Hull Lake
Cumberland River
Robertson Co.
Sumner Co.
Macon Co.
Trousdale Co.
Smith Co.
Davidson Co.
Wilson Co.
White House
Millersville
Goodlettsville
Nashville
Lakewood
Mount Juliet
Gallatin
Hendersonville
Old Hickory Lock & Dam
Cordell Hull Lock & Dam
Hartsville
Lebanon
Carthage
South Carthage
Gordonsville
Watertown
Lafayette
3OLD10054
3OLD10050
3OLD10002
3OLD10013
3OLD10055
3OLD10056
3OLD10057
3OLD10058

BACKGROUND

As found in other similar studies, the alteration of the physical or chemical norms of an aquatic environment has the potential to influence nearly all organisms residing in that environment (Goodnight 1973). A community represented by numerous species with no particular numerical domination evident in the population is usually indicative of an unstressed environment (Weber 1973, Klemm etal. 1990). Conversely, a benthic community composed of a few species with large numbers of individuals typifies a stressed community from which intolerant species have been reduced or eliminated by a pollutant or substrate change. The populations of tolerant species expand due to reduced competition or increased resources, or both. The often dramatic benthic community shifts, which can occur in stressed ecosystems, are due to the varying sensitivities of the different macroinvertebrate species. Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) or EPT species, which spend most of their lives in an aquatic environment, are generally less tolerant of most types of pollution, whereas many flies (Diptera) and worms (Oligochaeta) are more tolerant of stressful environmental conditions (Brinkhurst 1962, Beck 1977, and Merritt and Cummins 1996). Stream reaches may be divided into several ecological categories depending upon whether or not they are subject to stressful agents and, if they are, to what extent or type. They can also be divided into these categories on the basis of the benthic fauna that is supported in that reach.

Attention is usually focused on the macroinvertebrate species because they are more indicative of the relative health of a stream. In addition, macroinvertebrates are found in all habitats, less mobile than other groups of aquatic organisms, easily collected, and most have relatively long periods of development in the aquatic environment. Thus, macroinvertebrate species can be used to indicate deleterious events that have occurred in an aquatic system during any stage of their development.

Clean water streams with variable habitat features often have a high diversity of species with each species represented by a few individuals. Streams receiving organic pollution generally show a decrease in diversity and an increase in density (Gaufin and Tarzwell 1956), while streams receiving toxic products frequently show a decrease in both diversity and density (Cairns et al. 1971).

Increased sedimentation in streams is a problem most often the result of poor agriculture practices, mining and/or construction activities in the watershed (Waters 1995). The effects of increased sedimentation vary, but the primary effect is habitat loss caused by the filling of cracks and crevices with sand and silt and general decrease in habitat diversity.

MATERIALS AND METHODS

At stations Drakes Creek Mile 4.9, Bledsoe Creek Mile 10.3, Barton's Creek Mile 7.1, Cedar Creek Mile 7.0, Spring Creek Mile 5.8 and Round Lick Creek Mile 8.3, four replicate quantitative samples were taken with a 500-micron mesh Hess sampler ($0.09m^2$) from the riffle/run habitat of the stream. Organisms within each area encompassed by the Hess were collected by physically detaching them from the substrate (usually by hand picking or gently sweeping substrate materials with a brush) and/or agitating the substrate and allowing the current to carry dislodged organisms into the net. No sorting of organisms and debris was attempted in the field. Organisms and debris were carefully transferred into a storage jar and the entire contents preserved with formalin. Labels bearing unique numbers were applied to the exterior of the jars. These numbers and associated information were then recorded on a chain of custody form. All samples were returned to the Nashville District's Water Management Support Center for storage before delivery to Pennington and Associates, Inc. Storage times for the samples ranged from a maximum of five months to a minimum of three months. No deterioration of sample quality was observed during this holding time.

At stations Cumberland River Miles 216.9 and 245.0 and Drakes Creek Mile 1.9, samples were collected by use of a 6" x 6" Petite Ponar grab ($0.02322m^2$) lowered from a boat. Reservoir sites were sampled on a transect at multiple locations. Sampling sites on the transect always represented the old main channel (thalweg) and both of the following locations: right over bank and left overbank. Typically the sampling process involved anchoring and then lowering the Ponar grab to the bottom, taking care to allow the Ponar grab to gently contact the bottom. This was done to minimize "blow out" of the topmost sediments and associated organisms. The Ponar was then retrieved and the contents brought to the surface, dumped into a plastic tub, and processed through a sieve bucket with a 583-micron stainless steel mesh screen. Retained debris and organisms were then placed in a container. The normal procedure was to collect six grab samples at each site along the transect. Grab samples at each transect site were then composited into one sample for laboratory analysis. The samples were preserved with formalin, labeled with a unique number, and recorded on a chain of custody form. Brief field notes were made. All samples were returned to the Nashville District's Water Management Support Center for storage

prior to delivery to the analytical laboratory. Storage times for samples taken at reservoir sites were approximately three months.

In the laboratory, all benthic samples were washed in a 120-micron mesh screen. After washing, the macroinvertebrates were removed from the detritus under 5x magnification and preserved in 85% ethanol. The organisms were identified to the lowest practical taxonomic level using available keys (Pennington and Associates, Inc. 1994) and counted. Identifications were made with a stereomicroscope (7X to 60X). Slide mounts were made of the chironomids, simuliids, oligochaetes and small crustaceans, and identifications were made with a compound microscope. The chironomids, simuliids, and oligochaetes were cleared for 24 hours in cold 10% KOH. Temporary mounts were made in glycerine and the animals returned to 80% ethanol after identification. When permanent mounts were desired, the organisms were transferred to 95% ethanol for 30 minutes and mounted in euperol.

COMMUNITY STRUCTURE MEASURES

Core benthic macroinvertebrate community metrics were calculated for each station for comparison to Tennessee and Kentucky ecoregion reference data (TDEC 2002 and KDOW 2002). Nine core metrics were calculated and include:

1. **Taxa Richness** – Total number of distinct taxa (genera for comparison to Tennessee ecoregion data). In general, increasing taxa richness reflects increasing water quality, habitat diversity and habitat suitability (KDOW 2002).

2. **Ephemeroptera, Plecoptera, and Trichoptera Richness** (EPT) – Total number of distinct taxa within the generally pollution sensitive insect orders of EPT. This index value will usually increase with increasing water quality, habitat diversity and habitat stability. (Plafkin et al. 1989).

3. **North Carolina Biotic Index** (NCBI) – The Biotic Index was originally developed by Hilsenhoff (1982) as a rapid method for evaluating water quality in Wisconsin streams by summarizing the overall pollution tolerance of a benthic arthropod community with a single value from 0-5. Hilsenhoff (1987) later refined the index and expanded the scale

from 0-10. The biotic index is an average of tolerance values, and measures saprobity (pertaining to tolerance of organic enrichment) and to some extent trophism. Range of the index ranges from 0 (no apparent organic pollution) to 10 (severe organic pollution). Tennessee and KDOW use tolerance values developed by North Carolina Division of Environmental Management (NCDEM) (NCDENR 2001) and these values were used in this study. An increasing Biotic Index value indicates decreasing water quality. The formula for the Biotic Index is as follows:

$$\text{NCBI} = \sum \frac{x_i t_i}{n}$$

Where: x_i = number of individuals within a taxon
t_i = tolerance value of a taxon
n = total number of individuals in the sample

According to Hilsenhoff (1987) the calculated Biotic Index values for Wisconsin streams reflect the following:

Biotic Index	**Water Quality**	**Degree of Organic Pollution**
0.00 - 3.50	Excellent	No apparent organic pollution
3.51 - 4.50	Very Good	Possibly slight organic pollution
4.51 - 5.50	Good	Some Organic Pollution
5.51 - 6.50	Fair	Fairly significant organic pollution
6.51 - 7.50	Fairly Poor	Significant organic pollution
7.51 - 8.50	Poor	Very significant organic pollution
8.51 - 10.00	Very Poor	Severe organic pollution

Historically, NCDEM used the following modified Hilsenhoff Biotic Index scale to assign water quality condition in North Carolina streams of three ecoregions.

Condition	**Mountain**	**Piedmont**	**Coastal Plain**
Excellent	<4.05	<5.19	<5.47
Good	4.06-4.88	5.19-5.78	5.47-6.05
Good to Fair	4.89-5.74	5.79-6.48	6.06-6.72
Fair	5.75-7.00	6.49-7.48	6.73-7.73
Poor	>7.00	>7.48	>7.73

The state of Tennessee uses a four tier scoring criteria which is based of Hilsenhoff's values calibrated for each Tennessee ecoregion. TDEC's scoring criteria for biotic index values for streams of the interior plateau ecoregions are as follows.

Ecoregion	**Non-impaired**	**Slightly Impaired**	**Moderately Impaired**	**Severely Impaired**
Western Pennyroyal Karst (71e)	<5.05	5.05-6.69	6.70-8.34	>8.34
Western Highland Rim (71g)	<4.74	4.74-6.49	6.50-8.25	>8.25
Eastern Highland Rim (71f)	"	"	"	"
Outer Nashville Basin (71h)	"	"	"	"
Inner Nashville Basin (71i)	<5.54	5.54-7.02	7.03-8.51	>8.51

4. **Percent Ephemeroptera, Plecoptera and Trichoptera** (EPT Abundance):

$$\% \text{ EPT} = \frac{\text{Number of EPT individuals}}{\text{Total Number of individuals}} \text{ X } 100$$

5. **Modified Percent EPT abundance** (m% EPT) – Calculate as % EPT abundance with the relatively tolerant and ubiquitous caddisfly *Cheumatopsyche sp.* excluded from the calculation. As with %EPT, increasing values indicate increasing water quality and habitat conditions.

6. **Percent Ephemeroptera** (%E) – The abundance of mayflies (Ephemeroptera) is calculated by KDOW (2002) to show impacts of metals and high conductivity associated with mining and oil well impacts. Mayfly abundances normally declines in the presence of brine, metal and other toxic contaminants.

7. **Percent Oligochaeta and Chironomidae** (%OC) – This metric measures the relative abundance of these generally pollution tolerant organisms. Increasing abundances of

oligochaetes and chironomids suggests decreasing water quality and/or habitat conditions.

8. **Percent Dominant** (Percent contribution of the most dominant taxon) –

$$\% \text{ Dominant} = \frac{\text{Total number of individuals of most dominant taxon}}{\text{Total individuals in sample}} \text{ X100}$$

9. **Percent Clingers** (Percent contribution of organisms that build fixed retreats or have adaptations to attach to surfaces in flowing water)-

$$\% \text{ Clingers} = \frac{\text{Total number of clinger individuals}}{\text{Total individuals in sample}} \text{ X100}$$

The seven metrics; **1**. Taxa richness, **2**. EPT taxa, **3**. NCBI, **4**. % EPT, **7**. %OC, **8**. % Dominant and **9**. % Clingers calculated for the six stream locations in the Old Hickory Project area were compared to the Tennessee ecoregion reference streams. The data for the inflow stream sites were equalized by assigning a score of 0 (non-impaired), 2 (slightly impaired), 4 (moderately impaired), or 6 (severely impaired) based on comparison to the Tennessee Ecoregion reference data base (TDEC 2002). The scores were summed to determine biological condition of each of the six streams. No ecoregion reference database exists for comparison to the non-wadable locations.

Brower and Zar (1984) provide a detailed discussion of a variety of techniques for measuring community structure. The use of diversity indices is based upon the observation that normally undisturbed environments support communities with large numbers of species having no individuals present in overwhelming abundance. If the species of a disturbed community are ranked by numerical abundance, there may be relatively few species with large numbers of individuals. Mean diversity is affected by both "richness" of species (or abundance of different species) and by the distribution of individuals among the species. High species diversity indicates a highly complex community.

Species diversity was estimated using Shannon's Index of Diversity (H):

$$H = -\sum p_i \log p_i$$

where p_i is the proportion of the total number of individuals occurring in species i ($p_i=n_i/N$), N is the total number of individuals in all species.

Diversity indices take into account both the species richness and the evenness of the individuals' distribution among the species. Separate measures of these two components of diversity are often desirable. Species richness can be expressed simply as the number of species in the community. Evenness may be expressed by considering how close a set of observed species abundance are to those from an aggregation of species having maximum possible diversity for a given N and s (Brower and Zar 1984).

Evenness is calculated as follows:

$$\text{Pielou } J' = H/H_{max}$$

where H is calculated diversity and H_{max} is maximum possible diversity.

Community similarity between sites is measured by Jaccards Coefficient and Percent Similarity.

$$\text{Jaccards Coefficient} = \frac{C}{S_1 + S_2 - C}$$

where S = Species in each community (S_1 is reference Community in Community loss Index)

C = Species common to both communities

Percent Similarity, for a two-community comparison, is calculated as follows: The number of individuals in each species is calculated as a fractional portion of the total community. The value for species i in community 1 is compared to the value for species i in community 2. The lower of the two is tabulated. This procedure is followed for each species. The tabulated list (of the lower of each pair of values) is summed. The sum is defined as the Percent Similarity of the two communities.

The software package Number Cruncher Statistical Systems version 5.03 was used to evaluate community similarity (Hintze 1992). Cluster analysis sorts sampling units into groups

based on the overall resemblance to each other (Lundwig and Reynolds 1988). By using 1-Jaccards Coefficient and Percent Dissimilarity, sampling units are sorted to permit grouping. The cluster analysis combines the distances between sampling units into a matrix table, and two strategies of clustering are used to calculate a distance for N-1 cycles (N=number of sampling units). The cluster analysis is interpreted graphically on a dendrogram to relate the similar communities (Hintze 1992, Ludwig and Reynolds 1988).

RESULTS AND DISCUSSION

A list of all aquatic benthic macroinvertebrate species, assigned tolerance values, functional feeding groups, list of clingers and numbers of individuals of each species collected from each stream location are presented in Table 1. A summary of benthic community measures is presented in Table 2. Determination of biological condition based on bioregion reference data is found in Table 3. A comparison of the stations using Percent Dissimilarity is found in Figure 2 while similar comparisons using 1-Jaccard's Coefficient is clustered in Figure 3.

A minimum of 98 species of benthic macroinvertebrates was taken from the nine locations in the Old Hickory Project area (Table 1). The fauna represented 5 phyla, 25 orders and 53 families with 30 families being aquatic insects. As expected from other surveys, the inflow or wadable locations had the highest numbers of species while the reservoir sites had the least. Bledsoe Creek Mile 10.3 had the most with 46 followed by Round Lick Creek Mile 8.3 with 41, Spring Creek Mile 5.8 (36), Drakes Creek Mile 4.9 (28), Cedar Creek Mile 7.0 (25), Barton's Creek Mile 7.1 (21), Cumberland River Mile (CRM) 245.0 (24), Drakes Creek Mile 1.9 (18), and CRM 216.9 (15).

In terms of density, the embayment location Drakes Creek Mile 1.9 had the highest population density with ~12,339/m^2 followed by CRM 216.9 with ~2,206/m^2 and CRM 245.0 with ~2,125/m^2. The inflow location Round Lick Creek Mile 8.3 had a population density of ~8,907/m^2 followed by Bledsoe Creek Mile 10.3 (~7,195/m^2), Cedar Creek Mile 7.0 (~6,500/m^2), Spring Creek Mile 5.8 (~4,295/m^2), Drakes Creek Mile 4.9 (~3,222/m^2) and Barton's Creek Mile 7.1 with ~2,875/m^2.

Bledsoe Creek Mile 10.3 (OLD10054), an inflow site draining mostly undeveloped rural land, had a minimum of 46 benthic macroinvertebrate species present in the Hess samples (Table 1). Population densities at this site were ~7,195/m^2. The midge *Eukiefferiella claripennis* gp. (46.0%) was dominant at this location with the stonefly *Allocapnia* sp. (20.0%) also common in the fauna. This location had 17 EPT species and a Biotic Index value (3.83) representative of "very good" water quality with only slight organic pollution and/or fairly diverse habitat present. This location scored as supporting and non-impaired when compared to the Tennessee bioregion reference streams.

Round Lick Creek Mile 8.3 (3OLD10058) had the second highest number of species with 41. Population densities at this site were the highest of any inflow location with ~8,907/m^2. The midge *Eukiefferiella claripennis* gp. (23.1%) was the most abundant species followed by the mayfly *Caenis* sp. (11.3%), the riffle beetle *Stenelmis* (10.5%) and the small stonefly *Allocapnia* sp. (7.8%). There were 12 EPT species present. The Biotic Index value (5.34) for this site is representative of "good" water quality with some organic pollution. When compared to the Tennessee bioregion data base, this site scored as non-impaired or supporting.

Spring Creek Mile 5.8 (3OLD10057) had a minimum of 36 benthic macroinvertebrates present in the Hess samples (Tables 1 and 2). Population densities of the benthic fauna was estimated at ~4,295/m^2. The midge *Eukiefferiella claripennis* gp. (22.7%) and the isopod *Lirceus* sp. (16.1%) were the most represented in the benthic fauna. There were 11 EPT species found at this location. The Biotic Index value (5.81) is indicative of "fair" water quality conditions. A comparison to the Tennessee reference database for this bioregion scores Spring Creek as non-impaired or supporting.

Drakes Creek Mile 4.9 (3OLD10050), an inflow location in the lower reservoir, supports a reduced number of species (29) when compared to the 49 found during the 2000 survey. The population density for this location (~3,222/m^2) was also reduced when compared to the 2000 survey. The riffle beetle *Stenelmis* sp. (43.0%) was abundant at this site with the beetle *Psephenus herricki* (17.0%) and the snail *Elimia* sp. (10.3%) also very common. This site had 9 EPT species. The Biotic Index value (4.60) is considered to represent a benthic fauna existing under "very good" water quality conditions. This location also scored as non-impaired when compared to Tennessee's reference stream data.

Cedar Creek Mile 7.0 (3OLD10055) had a reduced number of species with 25 when compared to the 48 benthic species found in 2000 at this site and a reduced number of individuals with ~6,500/m^2 when compared to last survey (~13,894/m^2). The beetle *Stenelmis* sp. (32.1%) was dominant in the benthic community with the snail *Elimia laqueata* (21.6%) also well represented. The benthic fauna at this location had 6 EPT species. The Biotic Index value for this site (4.94) is representative of "good" water quality. This site was considered "excellent" in the 2000 survey, but is still improved over the 1998 study where the site scored "fair". This location was considered as non-impaired when compared against the Tennessee reference data (Table 3).

Barton's Creek Mile 7.1 (3OLD10056) had 22 species, which was reduced when compared to the 2000 survey (46) and much lower than the 55 benthic species seen in 1997 and the 37 in 1998. This site also had the lowest population densities of the inflow locations with an estimate of ~2,875 individuals/m^2. Barton's Creek, as in 1997, 1998 and 2000, had an abundance of the pleurocerid snail *Elimia* sp. (42.9%), and the riffle beetles *Psephenus herricki* (16.2%) and *Stenelmis sp*. (10.8%). There were 6 EPT species present and the biotic index value (4.94) for this location is considered representative of "good" water quality conditions which is less than that seen in the 2000 survey when it was considered as "very good". The site was considered as non-impaired when compared to the Tennessee reference database.

Cumberland River Mile 245.0 (3OLD20006), the most upstream main channel reservoir location, had 24 benthic species present and an overall population density of ~2,125 individuals/m^2 (Table 1). Tubificid worms were dominant at the main-channel (39.4%) and the left over bank (58.9%), while the right over bank had a few midges and *Hexagenia* sp. present. The mayfly *Hexagenia* sp. was the only EPT species taken at the site. The fauna according to Biotic Index scores for the transect sites (6.58-8.5) is considered to exist under "fairly poor" to "poor" water quality conditions.

Cumberland River Mile 216.9 (3OLD20002), just upstream of Old Hickory Lock and Dam, had a total of 15 species of benthic macroinvertebrates present in the Ponar grab samples (Table 1). Tubificid worms were again abundant throughout the site (41.3% at LOB, 15.9% at ROB and 61.5% at MC) with the midge *Coelotanypus* sp., also as in 1997, 1998 and 2000, abundant at all locations (36.8% at LOB, 68.8% at ROB and MC with 28.9%). There were no EPT species found in the Ponar grab samples during this survey. The Biotic Index values (8.25-8.90) for CRM 216.9 are indicative of "poor" water quality conditions with very significant organic pollution and/or poor habitat conditions.

The embayment location near the mouth of Drakes Creek at Mile 1.9 (3OLD20013), as in 1997, 1998 and 2000 had a low number of species present with 18. Population densities ranged from ~5,269 individuals/m^2 at the right over bank location to ~23,655/m^2 in the main channel (Table 1). Tubificid worms were again abundant at all locations including the right over bank (27.8%), left over bank (22.0%), and the main channel (58.9%). The midge *Chironomus* sp. (13.9% LOB, 31.6% ROB and 30.5% MC) was also abundant at all locations. There were again

no EPT species found at this site and the Biotic Index values (8.44-8.85) indicated "poor" water quality conditions with very significant organic pollution.

A comparison of the locations using Percent Dissimilarity (Figure 2) and Jaccard's Coefficient (Figure 3) groups the locations as inflow (wadable, upper reservoir and lower tributaries) or main stem/embayment sites. As stated in previous studies, this is a function of two distinct habitat types, high velocity riffle/run hard substrates at the wadable sites, as opposed to low velocities and soft sediments of the reservoir locations. The secondary clusters between locations of the main channel/embayment sites are a reflection of similarity of species and habitat type between the various locations.

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 216.9 3OLD20002 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
PLATYHELMINTHES											
Turbellaria											
Tricladida											
Planariidae											
Cura foremanii		**7.23**									
NEMATODA		***6.02**									
MOLLUSCA											
Bivalvia											
Unionoida											
Unionidae											
Leptodea fragilis			**FC**								
Veneroida											
Corbiculidae											
Corbicula fluminea		**6.12**	**FC**	2	14.28					2	4.8
Sphaeriidae											
Musculium sp.		**6.6**	**FC**			1	7.14			1	2.4
Musculium transversum		**6.6**	**FC**	3	21.42					3	7.1
Pisidium sp.		**6.48**	**FC**	3	21.42					3	7.1
Sphaerium sp.		**7.58**	**FC**								
Gastropoda											
Mesogastropoda											
Hydrobiidae		**5.78**	**SC**								
Amnicola sp.		**5.78**	**SC**								
Pleuroceridae		**3.4**									
Elimia laqueata		**2.46**	**SC**								
Basommatophora											
Physidae											
Physella sp.		**8.84**	**CG**								
ANNELIDA											
Oligochaeta											
Haplotaxida											
Enchytraidae		**9.84**	**CG**								
Lumbricidae			**CG**								
Naididae		***8**	**CG**								
Nais communis		**8.88**	**CG**								
Pristina sp.		**9.56**	**CG**								
Tubificidae w.h.c.		**7.11**	**CG**	16	114.24	4	28.56	20	142.8	40	95.2
Branchiura sowerbyi		**8.28**	**CG**			2	14.28			2	4.8
Tubificidae w.o.h.c.		**9.5**	**CG**	297	2120.58	22	157.08	75	535.5	394	937.7
Limnodrilus hoffmeisteri		**9.5**	**CG**					5	35.7	5	11.9

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 216.9 3OLD20002 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Lumbriculida											
Lumbriculidae		**7.03**	**CG**								
Lumbriculus sp.		**7.03**	**CG**								
Hirudinea											
Erpobdellidae		***8**	**P**								
Glossiphoniidae			**P**								
Helobdella stagnalis		**9.1**	**P**								
ARTHROPODA											
Arachnoidea											
Acariformes		**5.53**									
Crustacea											
Ostracoda						3	21.42	4	28.56	7	16.7
Copepoda						2	14.28			2	4.8
Cyclopoida											
Isopoda											
Asellidae											
Lirceus sp.		**7.85**	**CG**								
Amphipoda											
Crangonyctidae											
Crangonyx sp.		**7.87**	**CG**								
Gammaridae											
Gammarus sp.		**9.1**	**SH**								
Talitridae											
Hyalella azteca		**7.75**	**CG**								
Decapoda											
Cambaridae											
Orconectes sp.		**2.6**	**SH**								
Insecta											
Collembola											
Ephemeroptera											
Baetidae		**6.1**	**CG**								
Acentrella ampla		**3.6**	**CG**								
Baetis intercalaris		**4.99**	**CG**								
Plauditus sp.		**4.51**	**CG**								
Pseudocloeon sp.			**CG**								
Caenidae											
Caenis sp.		**7.41**	**CG**								
Ephemeridae											
Hexagenia sp.		**4.9**	**CG**								
Ephemerellidae											

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 216.9 3OLD20002 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Heptageniidae	*cl*										
Leucrocuta sp.	*cl*	**2.4**	**SC**								
Stenacron interpunctatum	*cl*	**3.58**	**SC**								
Stenonema femoratum	*cl*	**3.45**	**SC**								
Stenonema mediopunctatum	*cl*	**3.45**	**SC**								
Isonychiidae											
Isonychia sp.		**3.45**	**FC**								
Leptophlebia sp.		**6.23**	**CG**								
Tricorythidae											
Tricorythodes sp.		**5.06**	**CG**								
Odonata											
Coenagrionidae		**6.1**	**P**								
Argia sp.	*cl*	**8.17**	**P**								
Plecoptera											
Capnidae		**0.9**	**SH**								
Allocapnia sp.		**2.52**	**SH**								
Paracapnia sp.		**0.12**	**SH**								
Perlidae		**1.5**	**P**								
Perlesta placida sp. gp.		**4.7**	**P**								
Perlodidae		**1.6**	**P**								
Isoperla sp.		**1.5**	**P**								
Malirekus hastatus		**1.15**	**P**								
Taeniopterygidae		**2.7**	**SH**								
Taeniopteryx sp.		**5.37**	**SH**								
Hemiptera											
Veliidae											
Rhagovelia obesa											
Megaloptera											
Corydalidae											
Nigronia serricornis	*cl*	**5.25**	**P**								
Trichoptera											
Brachycentridae											
Micrasema sp.		**0.56**	**SH**								
Helicopsychidae		***3**	**SC**								
Helicopsyche borealis	*cl*	**0**	**SC**								
Hydropsychidae	*cl*	**2.9**	**FC**								
Ceratopsyche morosa											
Cheumatopsyche sp.	*cl*	**6.22**	**FC**								
Macrostemum sp.											

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 216.9 3OLD20002 MAIN CHANNEL		RIGHT OVERBANK		LEFT OVERBANK		TOTAL	
				Count	Density No./m²	Count	Density No./m²	Count	Density No./m²	Count	Density No./m²
Hydroptilidae		**2.5**	**PI**								
Hydroptila sp.	*cl*	**6.22**	**PI**								
Leptoceridae		**0.9**	**SH**								
Oecetis sp.	*cl*	**4.7**	**P**								
Philopotamidae	*cl*	***3**	**FC**								
Chimarra obscura	*cl*	**2.76**	**FC**								
Coleoptera											
Elmidae		***5**	**CG**								
Dubiraphia sp.	*cl*	**5.93**	**SC**								
Microcylloepus pusillus	*cl*	**2.11**	**SC**								
Optioservus sp.	*cl*	**2.36**	**SC**								
Stenelmis sp.	*cl*	**5.1**	**SC**								
Hydrophilidae		**4.6**	**P**								
Berosus sp.		**8.43**	**CG**								
Psephenidae		***4**	**SC**								
Ectopria sp.	*cl*	**4.16**	**SC**								
Psephenus herricki	*cl*	**2.35**	**SC**								
Staphylinidae											
Diptera											
Ceratopogonidae		**5.9**	**P**								
Atrichopogon sp.											
Bezzia/Palpomyia		**6**	**P**								
Chaboridae											
Chaoborus punctipennis		***8.5**	**P**	20	142.8	18	128.52	14	99.96	52	123.8
Chironomidae											
Ablabesmyia annulata		**7.2**	**P**								
Ablabesmyia mallochi											
Chironomus sp.		**9.63**	**CG**	11	78.54	3	21.42	35	249.9	49	116.6
Coelotanypus sp.		**8**	**P**	147	1049.58	121	863.94	89	635.46	357	849.7
Conchapelopia sp.		**4.5**	**P**								
Corynoneura sp.		**6.01**	**CG**								
Cricotopus sp.	*cl*	**5.78**	**CG**								
Cryptochironomus sp.		**6.4**	**P**								
Eukiefferiella claripennis gp.		**3.43**	**CG**								
Glyptotendipes sp.		**9.47**	**FC**								
Microchironomus sp.				3	21.42					3	7.1
Microtendipes sp.	*cl*	**5.53**	**CG**								
Orthocladius sp.		**5.95**	**CG**								
Parametriocnemus lundbecki		**3.65**	**CG**								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 216.9 3OLD20002 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Paratendipes sp.		**5.11**	**CG**								
Polypedilum flavum		**5.69**	**SH**								
Polypedilum halterale		**6.69**	**SH**								
Polypedilum illinoense		**7.69**	**SH**								
Procladius sp.		**9.1**	**P**	7	49.98					7	16.7
Rheotanytarsus sp.	*cl*	**5.89**	**FC**								
Stictochironomus sp.		**6.52**	**CG**								
Tanytarsus sp.		**6.76**	**FC**								
Thienemanniella xena		**5.86**	**CG**								
Zavrelia sp.		**5.3**	**CG**								
Simuliidae		**3.5**	**FC**								
Simulium sp.	*cl*	**4**	**FC**								
Tabanidae			**PI**								
Tabanus sp.		**9.22**	**PI**								
Tipulidae		***3**	**SH**								
Hexatoma sp.		**4.31**	**P**								
Tipula sp.		**7.33**	**SH**								
CHORDATA****											
Osteichthyes											
Cottidae											
Cottis carolina											
Percidae											
Etheostoma sp.											
TOTAL NO. OF ORGANISMS				**509**	**3634.26**	**176**	**1256.6**	**242**	**1727.88**	**927**	**2206.3**
TOTAL NO. OF TAXA					**10**		**9**		**7**		**15**

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
PLATYHELMINTHES											
Turbellaria											
Tricladida											
Planariidae											
Cura foremanii		**7.23**									
NEMATODA		***6.02**				3	21.42			3	7.1
MOLLUSCA											
Bivalvia											
Unionoida											
Unionidae											
Leptodea fragilis			**FC**	1	7.14					1	2.4
Veneroida											
Corbiculidae											
Corbicula fluminea		**6.12**	**FC**								
Sphaeriidae											
Musculium sp.		**6.6**	**FC**								
Musculium transversum		**6.6**	**FC**					3	21.42	3	7.1
Pisidium sp.		**6.48**	**FC**								
Sphaerium sp.		**7.58**	**FC**								
Gastropoda											
Mesogastropoda											
Hydrobiidae		**5.78**	**SC**								
Amnicola sp.		**5.78**	**SC**			3	21.42			3	7.1
Pleuroceridae		**3.4**									
Elimia laqueata		**2.46**	**SC**								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Basommatophora											
Physidae											
Physella sp.		**8.84**	**CG**								
ANNELIDA											
Oligochaeta											
Haplotaxida											
Enchytraidae		**9.84**	**CG**								
Lumbricidae			**CG**								
Naididae		***8**	**CG**			11	78.54			11	26.2
Nais communis		**8.88**	**CG**								
Pristina sp.		**9.56**	**CG**								
Tubificidae w.h.c.		**7.11**	**CG**	488	3484.3	138	985.32	198	1413.7	824	1961.1
Branchiura sowerbyi		**8.28**	**CG**					1	7.14	1	2.4
Tubificidae w.o.h.c.		**9.5**	**CG**	1462	10439	64	456.96	50	357	1576	3750.9
Limnodrilus hoffmeisteri		**9.5**	**CG**								
Lumbriculida											
Lumbriculidae		**7.03**	**CG**								
Lumbriculus sp.		**7.03**	**CG**								
Hirudinea											
Erpobdellidae		***8**	**P**								
Glossiphoniidae			**P**								
Helobdella stagnalis		**9.1**	**P**								
ARTHROPODA											
Arachnoidea											
Acariformes		**5.53**									
Crustacea											
Ostracoda						43	307.02	17	121.38	60	142.8

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Copepoda											
Cyclopoida								11	78.54	11	26.2
Isopoda											
Asellidae											
Lirceus sp.		**7.85**	**CG**								
Amphipoda											
Crangonyctidae											
Crangonyx sp.		**7.87**	**CG**								
Gammaridae											
Gammarus sp.		**9.1**	**SH**								
Talitridae											
Hyalella azteca		**7.75**	**CG**								
Decapoda											
Cambaridae											
Orconectes sp.		**2.6**	**SH**								
Insecta											
Collembola											
Ephemeroptera											
Baetidae		**6.1**	**CG**								
Acentrella ampla		**3.6**	**CG**								
Baetis intercalaris		**4.99**	**CG**								
Plauditus sp.		**4.51**	**CG**								
Pseudocloeon sp.			**CG**								
Caenidae											
Caenis sp.		**7.41**	**CG**								
Ephemeridae											
Hexagenia sp.		**4.9**	**CG**								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Ephemerellidae											
Heptageniidae	*cl*										
Leucrocuta sp.	*cl*	**2.4**	**SC**								
Stenacron interpunctatum	*cl*	**3.58**	**SC**								
Stenonema femoratum	*cl*	**3.45**	**SC**								
Stenonema mediopunctatum	*cl*	**3.45**	**SC**								
Isonychiidae											
Isonychia sp.		**3.45**	**FC**								
Leptophlebia sp.		**6.23**	**CG**								
Tricorythidae											
Tricorythodes sp.		**5.06**	**CG**								
Odonata											
Coenagrionidae		**6.1**	**P**								
Argia sp.	*cl*	**8.17**	**P**								
Plecoptera											
Capnidae		**0.9**	**SH**								
Allocapnia sp.		**2.52**	**SH**								
Paracapnia sp.		**0.12**	**SH**								
Perlidae		**1.5**	**P**								
Perlesta placida sp. gp.		**4.7**	**P**								
Perlodidae		**1.6**	**P**								
Isoperla sp.		**1.5**	**P**								
Malirekus hastatus		**1.15**	**P**								
Taeniopterygidae		**2.7**	**SH**								
Taeniopteryx sp.		**5.37**	**SH**								
Hemiptera											
Veliidae											

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Rhagovelia obesa											
Megaloptera											
Corydalidae											
Nigronia serricornis	*cl*	**5.25**	**P**								
Trichoptera											
Brachycentridae											
Micrasema sp.		**0.56**	**SH**								
Helicopsychidae		***3**	**SC**								
Helicopsyche borealis	*cl*	**0**	**SC**								
Hydropsychidae	*cl*	**2.9**	**FC**								
Ceratopsyche morosa											
Cheumatopsyche sp.	*cl*	**6.22**	**FC**								
Macrostemum sp.											
Hydroptilidae		**2.5**	**PI**								
Hydroptila sp.	*cl*	**6.22**	**PI**								
Leptoceridae		**0.9**	**SH**								
Oecetis sp.	*cl*	**4.7**	**P**								
Philopotamidae	*cl*	***3**	**FC**								
Chimarra obscura	*cl*	**2.76**	**FC**								
Coleoptera											
Elmidae		***5**	**CG**								
Dubiraphia sp.	*cl*	**5.93**	**SC**								
Microcylloepus pusillus	*cl*	**2.11**	**SC**								
Optioservus sp.	*cl*	**2.36**	**SC**								
Stenelmis sp.	*cl*	**5.1**	**SC**								
Hydrophilidae		**4.6**	**P**								
Berosus sp.		**8.43**	**CG**								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Psephenidae		*4	SC								
Ectopria sp.	*cl*	4.16	SC								
Psephenus herricki	*cl*	2.35	SC								
Staphylinidae											
Diptera											
Ceratopogonidae		5.9	P								
Atrichopogon sp.											
Bezzia/Palpomyia		6	P					1	7.14	1	2.4
Chaboridae											
Chaoborus punctipennis		*8.5	P	1012	7225.7	233	1663.6	669	4776.7	1914	4555.3
Chironomidae								2	14.28	2	4.8
Ablabesmyia annulata		7.2	P			3	21.42			3	7.1
Ablabesmyia mallochi											
Chironomus sp.		9.63	CG	340	2427.6	187	1335.2	158	1128.1	685	1630.3
Coelotanypus sp.		8	P	10	71.4	53	378.42	16	114.24	79	188.0
Conchapelopia sp.		4.5	P								
Corynoneura sp.		6.01	CG								
Cricotopus sp.	*cl*	5.78	CG								
Cryptochironomus sp.		6.4	P					1	7.14	1	2.4
Eukiefferiella claripennis gp.		3.43	CG								
Glyptotendipes sp.		9.47	FC								
Microchironomus sp.											
Microtendipes sp.	*cl*	5.53	CG								
Orthocladius sp.		5.95	CG								
Parametriocnemus lundbecki		3.65	CG								
Paratendipes sp.		5.11	CG								
Polypedilum flavum		5.69	SH								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek Embayment Mile 1.9 3OLD20013 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	Right OVERBANK Count	Right OVERBANK Density No./m²	Left OVERBANK Count	Left OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Polypedilum halterale		**6.69**	**SH**								
Polypedilum illinoense		**7.69**	**SH**								
Procladius sp.		**9.1**	**P**					6	42.84	6	14.3
Rheotanytarsus sp.	*cl*	**5.89**	**FC**								
Stictochironomus sp.		**6.52**	**CG**								
Tanytarsus sp.		**6.76**	**FC**								
Thienemanniella xena		**5.86**	**CG**								
Zavrelia sp.		**5.3**	**CG**								
Simuliidae		**3.5**	**FC**								
Simulium sp.	*cl*	**4**	**FC**								
Tabanidae			**PI**								
Tabanus sp.		**9.22**	**PI**								
Tipulidae		***3**	**SH**								
Hexatoma sp.		**4.31**	**P**								
Tipula sp.		**7.33**	**SH**								
CHORDATA****											
Osteichthyes											
Cottidae											
Cottis carolina											
Percidae											
Etheostoma sp.											
TOTAL NO. OF ORGANISMS				**3313**	**23655**	**738**	**5269.3**	**1133**	**8089.6**	**5184**	**12338**
TOTAL NO. OF TAXA				**6**	**6**	**10**	**10**	**13**	**13**	**18**	**18**

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
PLATYHELMINTHES											
Turbellaria											
Tricladida											
Planariidae											
Cura foremanii		**7.23**									
NEMATODA		***6.02**									
MOLLUSCA											
Bivalvia											
Unionoida											
Unionidae											
Leptodea fragilis			**FC**								
Veneroida											
Corbiculidae											
Corbicula fluminea		**6.12**	**FC**	2	14.28	34	242.76	2	14.28	38	90.4
Sphaeriidae											
Musculium sp.		**6.6**	**FC**								
Musculium transversum		**6.6**	**FC**	70	499.8	74	528.36			144	342.7
Pisidium sp.		**6.48**	**FC**			1	7.14			1	2.4
Sphaerium sp.		**7.58**	**FC**					3	21.42	3	7.1
Gastropoda											
Mesogastropoda											
Hydrobiidae		**5.78**	**SC**								
Amnicola sp.		**5.78**	**SC**			5	35.7			5	11.9
Pleuroceridae		**3.4**									
Elimia laqueata		**2.46**	**SC**								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Basommatophora											
Physidae											
Physella sp.		**8.84**	**CG**								
ANNELIDA											
Oligochaeta											
Haplotaxida											
Enchytraidae		**9.84**	**CG**								
Lumbricidae			**CG**								
Naididae		***8**	**CG**								
Nais communis		**8.88**	**CG**								
Pristina sp.		**9.56**	**CG**								
Tubificidae w.h.c.		**7.11**	**CG**	10	71.4	14	99.96			24	57.1
Branchiura sowerbyi		**8.28**	**CG**			18	128.52			18	42.8
Tubificidae w.o.h.c.		**9.5**	**CG**	140	999.6	301	2149.1			441	1049.6
Limnodrilus hoffmeisteri		**9.5**	**CG**	50	357					50	119.0
Lumbriculida											
Lumbriculidae		**7.03**	**CG**								
Lumbriculus sp.		**7.03**	**CG**								
Hirudinea											
Erpobdellidae		***8**	**P**			1	7.14			1	2.4
Glossiphoniidae			**P**								
Helobdella stagnalis		**9.1**	**P**	1	7.14					1	2.4
ARTHROPODA											
Arachnoidea											
Acariformes		**5.53**									
Crustacea											
Ostracoda						3	21.42			3	7.1

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Copepoda											
Cyclopoida											
Isopoda											
Asellidae											
Lirceus sp.		**7.85**	**CG**								
Amphipoda											
Crangonyctidae											
Crangonyx sp.		**7.87**	**CG**								
Gammaridae											
Gammarus sp.		**9.1**	**SH**								
Talitridae											
Hyalella azteca		**7.75**	**CG**								
Decapoda											
Cambaridae											
Orconectes sp.		**2.6**	**SH**								
Insecta											
Collembola											
Ephemeroptera											
Baetidae		**6.1**	**CG**								
Acentrella ampla		**3.6**	**CG**								
Baetis intercalaris		**4.99**	**CG**								
Plauditus sp.		**4.51**	**CG**								
Pseudocloeon sp.			**CG**								
Caenidae											
Caenis sp.		**7.41**	**CG**								
Ephemeridae											
Hexagenia sp.		**4.9**	**CG**	28	199.92	9	64.26	8	57.12	45	107.1

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Ephemerellidae								1	7.14	1	2.4
Heptageniidae	*cl*										
Leucrocuta sp.	*cl*	**2.4**	**SC**								
Stenacron interpunctatum	*cl*	**3.58**	**SC**								
Stenonema femoratum	*cl*	**3.45**	**SC**								
Stenonema mediopunctatum	*cl*	**3.45**	**SC**								
Isonychiidae											
Isonychia sp.		**3.45**	**FC**								
Leptophlebia sp.		**6.23**	**CG**								
Tricorythidae											
Tricorythodes sp.		**5.06**	**CG**								
Odonata											
Coenagrionidae		**6.1**	**P**								
Argia sp.	*cl*	**8.17**	**P**								
Plecoptera											
Capnidae		**0.9**	**SH**								
Allocapnia sp.		**2.52**	**SH**								
Paracapnia sp.		**0.12**	**SH**								
Perlidae		**1.5**	**P**								
Perlesta placida sp. gp.		**4.7**	**P**								
Perlodidae		**1.6**	**P**								
Isoperla sp.		**1.5**	**P**								
Malirekus hastatus		**1.15**	**P**								
Taeniopterygidae		**2.7**	**SH**								
Taeniopteryx sp.		**5.37**	**SH**								
Hemiptera											
Veliidae											

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Rhagovelia obesa											
Megaloptera											
Corydalidae											
Nigronia serricornis	*cl*	**5.25**	**P**								
Trichoptera											
Brachycentridae											
Micrasema sp.		**0.56**	**SH**								
Helicopsychidae		***3**	**SC**								
Helicopsyche borealis	*cl*	**0**	**SC**								
Hydropsychidae	*cl*	**2.9**	**FC**								
Ceratopsyche morosa											
Cheumatopsyche sp.	*cl*	**6.22**	**FC**								
Macrostemum sp.											
Hydroptilidae		**2.5**	**PI**								
Hydroptila sp.	*cl*	**6.22**	**PI**								
Leptoceridae		**0.9**	**SH**								
Oecetis sp.	*cl*	**4.7**	**P**					2	14.28	2	4.8
Philopotamidae	*cl*	***3**	**FC**								
Chimarra obscura	*cl*	**2.76**	**FC**								
Coleoptera											
Elmidae		***5**	**CG**								
Dubiraphia sp.	*cl*	**5.93**	**SC**								
Microcylloepus pusillus	*cl*	**2.11**	**SC**								
Optioservus sp.	*cl*	**2.36**	**SC**								
Stenelmis sp.	*cl*	**5.1**	**SC**								
Hydrophilidae		**4.6**	**P**								
Berosus sp.		**8.43**	**CG**								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Psephenidae		*4	SC								
Ectopria sp.	*cl*	4.16	SC								
Psephenus herricki	*cl*	2.35	SC								
Staphylinidae											
Diptera											
Ceratopogonidae		5.9	P								
Atrichopogon sp.											
Bezzia/Palpomyia		6	P	1	7.14					1	2.4
Chaboridae											
Chaoborus punctipennis		*8.5	P	1	7.14					1	2.4
Chironomidae											
Ablabesmyia annulata		7.2	P	19	135.66	5	35.7	4	28.56	28	66.6
Ablabesmyia mallochi											
Chironomus sp.		9.63	CG	6	42.84	25	178.5			31	73.8
Coelotanypus sp.		8	P	12	85.68	3	21.42	4	28.56	19	45.2
Conchapelopia sp.		4.5	P								
Corynoneura sp.		6.01	CG								
Cricotopus sp.	*cl*	5.78	CG								
Cryptochironomus sp.		6.4	P	11	78.54	12	85.68	1	7.14	24	57.1
Eukiefferiella claripennis gp.		3.43	CG								
Glyptotendipes sp.		9.47	FC					2	14.28	2	4.8
Microchironomus sp.											
Microtendipes sp.	*cl*	5.53	CG								
Orthocladius sp.		5.95	CG								
Parametriocnemus lundbecki		3.65	CG								
Paratendipes sp.		5.11	CG								
Polypedilum flavum		5.69	SH								

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Cumberland River Mile 245.0 3OLD20006 MAIN CHANNEL Count	MAIN CHANNEL Density No./m²	LEFT OVERBANK Count	LEFT OVERBANK Density No./m²	RIGHT OVERBANK Count	RIGHT OVERBANK Density No./m²	TOTAL Count	TOTAL Density No./m²
Polypedilum halterale		**6.69**	**SH**	1	7.14					1	2.4
Polypedilum illinoense		**7.69**	**SH**								
Procladius sp.		**9.1**	**P**	3	21.42	6	42.84			9	21.4
Rheotanytarsus sp.	*cl*	**5.89**	**FC**								
Stictochironomus sp.		**6.52**	**CG**								
Tanytarsus sp.		**6.76**	**FC**								
Thienemanniella xena		**5.86**	**CG**								
Zavrelia sp.		**5.3**	**CG**								
Simuliidae		**3.5**	**FC**								
Simulium sp.	*cl*	**4**	**FC**								
Tabanidae			**PI**								
Tabanus sp.		**9.22**	**PI**								
Tipulidae		***3**	**SH**								
Hexatoma sp.		**4.31**	**P**								
Tipula sp.		**7.33**	**SH**								
CHORDATA**											
Osteichthyes											
Cottidae											
Cottis carolina											
Percidae											
Etheostoma sp.											
TOTAL NO. OF ORGANISMS				**355**	**2534.7**	**511**	**3648.5**	**27**	**192.8**	**893**	**2125.3**
TOTAL NO. OF TAXA					**15**		**15**		**9**		**24**

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
					N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2
PLATYHELMINTHES															
Turbellaria															
Tricladida															
Planariidae															
Cura foremanii		**7.23**				10	27.8							20	55.6
NEMATODA		***6.02**				10	27.8								
MOLLUSCA															
Bivalvia															
Unionoida															
Unionidae															
Leptodea fragilis			**FC**												
Veneroida															
Corbiculidae															
Corbicula fluminea		**6.12**	**FC**	22	61.16	5	13.9	23	63.94	37	102.86	3	8.34	25	69.5
Sphaeriidae															
Musculium sp.		**6.6**	**FC**	4	11.12					160	444.8	69	191.82	130	361.4
Musculium transversum		**6.6**	**FC**												
Pisidium sp.		**6.48**	**FC**			1	2.78	30	83.4					40	111.2
Sphaerium sp.		**7.58**	**FC**												
Gastropoda															
Mesogastropoda															
Hydrobiidae		**5.78**	**SC**												
Amnicola sp.		**5.78**	**SC**												
Pleuroceridae		**3.4**													
Elimia laqueata		**2.46**	**SC**	119	330.82	3	8.34	444	1234.3	505	1403.9	67	186.26	75	208.5
Basommatophora															

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
					N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2
Physidae															
Physella sp.		**8.84**	**CG**									10	27.8		
ANNELIDA															
Oligochaeta															
Haplotaxida															
Enchytraidae		**9.84**	**CG**			10	27.8					10	27.8		
Lumbricidae			**CG**	1	2.78					30	83.4	20	55.6		
Naididae		***8**	**CG**			10	27.8					20	55.6		
Nais communis		**8.88**	**CG**			10	27.8								
Pristina sp.		**9.56**	**CG**											80	222.4
Tubificidae w.h.c.		**7.11**	**CG**							40	111.2	90	250.2		
Branchiura sowerbyi		**8.28**	**CG**					5	13.9						
Tubificidae w.o.h.c.		**9.5**	**CG**					20	55.6	200	556	250	695	110	305.8
Limnodrilus hoffmeisteri		**9.5**	**CG**												
Lumbriculida															
Lumbriculidae		**7.03**	**CG**											10	27.8
Lumbriculus sp.		**7.03**	**CG**							10	27.8				
Hirudinea												10	27.8		
Erpobdellidae		***8**	**P**												
Glossiphoniidae			**P**												
Helobdella stagnalis		**9.1**	**P**												
ARTHROPODA															
Arachnoidea															
Acariformes		**5.53**				10	27.8								
Crustacea															
Ostracoda															
Copepoda															

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
					N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2
Cyclopoida						10	27.8								
Isopoda															
Asellidae															
Lirceus sp.		**7.85**	**CG**	14	38.92	2	5.56	5	13.9	101	280.78	172	478.16	248	689.44
Amphipoda															
Crangonyctidae															
Crangonyx sp.		**7.87**	**CG**	4	11.12	1	2.78								
Gammaridae															
Gammarus sp.		**9.1**	**SH**							10	27.8				
Talitridae															
Hyalella azteca		**7.75**	**CG**							10	27.8				
Decapoda															
Cambaridae															
Orconectes sp.		**2.6**	**SH**	1	2.78			5	13.9	5	13.9	1	2.78	1	2.78
Insecta															
Collembola												10	27.8		
Ephemeroptera															
Baetidae		**6.1**	**CG**												
Acentrella ampla		**3.6**	**CG**			20	55.6					1	2.78		
Baetis intercalaris		**4.99**	**CG**	24	66.72	1	2.78			60	166.8				
Plauditus sp.		**4.51**	**CG**			20	55.6					30	83.4	12	33.36
Pseudocloeon sp.			**CG**											1	2.78
Caenidae															
Caenis sp.		**7.41**	**CG**	42	116.76	20	55.6	30	83.4	10	27.8	361	1003.58	30	83.4
Ephemeridae															
Hexagenia sp.		**4.9**	**CG**												
Ephemerellidae															

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
					N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2
Heptageniidae	*cl*											10	27.8		
Leucrocuta sp.	*cl*	**2.4**	**SC**									30	83.4		
Stenacron interpunctatum	*cl*	**3.58**	**SC**					5	13.9					1	2.78
Stenonema femoratum	*cl*	**3.45**	**SC**			43	119.54					43	119.54	2	5.56
Stenonema mediopunctatum	*cl*	**3.45**	**SC**	38	105.64			46	127.88						
Isonychiidae															
Isonychia sp.		**3.45**	**FC**			30	83.4								
Leptophlebia sp.		**6.23**	**CG**	1	2.78										
Tricorythidae															
Tricorythodes sp.		**5.06**	**CG**	76	211.28	21	58.38					1	2.78		
Odonata															
Coenagrionidae		**6.1**	**P**												
Argia sp.	*cl*	**8.17**	**P**	45	125.1			24	66.72						
Plecoptera															
Capnidae		**0.9**	**SH**												
Allocapnia sp.		**2.52**	**SH**			518	1440					251	697.78		
Paracapnia sp.		**0.12**	**SH**											20	55.6
Perlidae		**1.5**	**P**	1	2.78	1	2.78					40	111.2		
Perlesta placida sp. gp.		**4.7**	**P**			20	55.6					40	111.2	22	61.16
Perlodidae		**1.6**	**P**			1	2.78								
Isoperla sp.		**1.5**	**P**			10	27.8					23	63.94	7	19.46
Malirekus hastatus		**1.15**	**P**			1	2.78								
Taeniopterygidae		**2.7**	**SH**												
Taeniopteryx sp.		**5.37**	**SH**			21	58.38								
Hemiptera															
Veliidae															
Rhagovelia obesa				1	2.78										

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density N0./m^2	Count	Density N0./m^2	Count	Density N0./m^2	Count	Density N0./m^2	Count	Density N0./m^2	Count	Density N0./m^2
Megaloptera															
Corydalidae															
Nigronia serricornis	*cl*	**5.25**	**P**	1	2.78	1	2.78								
Trichoptera															
Brachycentridae															
Micrasema sp.		**0.56**	**SH**							10	27.8			2	5.56
Helicopsychidae		***3**	**SC**												
Helicopsyche borealis	*cl*	**0**	**SC**					10	27.8						
Hydropsychidae	*cl*	**2.9**	**FC**												
Ceratopsyche morosa				1	2.78										
Cheumatopsyche sp.	*cl*	**6.22**	**FC**	23	63.94	33	91.74	26	72.28	30	83.4	42	116.76	59	164.02
Macrostemum sp.				4	11.12										
Hydroptilidae		**2.5**	**PI**												
Hydroptila sp.	*cl*	**6.22**	**PI**			10	27.8			10	27.8				
Leptoceridae		**0.9**	**SH**												
Oecetis sp.	*cl*	**4.7**	**P**												
Philopotamidae	*cl*	***3**	**FC**												
Chimarra obscura	*cl*	**2.76**	**FC**			2	5.56	5	13.9	20	55.6			1	2.78
Coleoptera															
Elmidae		***5**	**CG**												
Dubiraphia sp.	*cl*	**5.93**	**SC**							10	27.8			10	27.8
Microcylloepus pusillus	*cl*	**2.11**	**SC**							1	2.78				
Optioservus sp.	*cl*	**2.36**	**SC**			1	2.78								
Stenelmis sp.	*cl*	**5.1**	**SC**	498	1384.44	10	27.8	112	311.36	751	2087.8	335	931.3	114	316.92
Hydrophilidae		**4.6**	**P**												
Berosus sp.		**8.43**	**CG**					5	13.9					10	27.8
Psephenidae		***4**	**SC**												

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
					N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2
Ectopria sp.	*cl*	**4.16**	**SC**					11	30.58	60	166.8	10	27.8		
Psephenus herricki	*cl*	**2.35**	**SC**	197	547.66			168	467.04	227	631.06			10	27.8
Staphylinidae						1	2.78								
Diptera															
Ceratopogonidae		**5.9**	**P**												
Atrichopogon sp.				1	2.78										
Bezzia/Palpomyia		**6**	**P**												
Chaboridae															
Chaoborus punctipennis		***8.5**	**P**												
Chironomidae				10	27.8	191	530.98					80	222.4	10	27.8
Ablabesmyia annulata		**7.2**	**P**			10	27.8								
Ablabesmyia mallochi				1	2.78										
Chironomus sp.		**9.63**	**CG**												
Coelotanypus sp.		**8**	**P**												
Conchapelopia sp.		**4.5**	**P**	6	16.68			45	125.1			10	27.8	20	55.6
Corynoneura sp.		**6.01**	**CG**			10	27.8								
Cricotopus sp.	*cl*	**5.78**	**CG**			60	166.8					20	55.6		
Cryptochironomus sp.		**6.4**	**P**												
Eukiefferiella claripennis gp.		**3.43**	**CG**			1190	3308.2					740	2057.2	350	973
Glyptotendipes sp.		**9.47**	**FC**												
Microchironomus sp.															
Microtendipes sp.	*cl*	**5.53**	**CG**			30	83.4					10	27.8	10	27.8
Orthocladius sp.		**5.95**	**CG**			120	333.6					120	333.6	10	27.8
Parametriocnemus lundbecki		**3.65**	**CG**			20	55.6								
Paratendipes sp.		**5.11**	**CG**			10	27.8					70	194.6		
Polypedilum flavum		**5.69**	**SH**	11	30.58	10	27.8	5	13.9			30	83.4	40	111.2
Polypedilum halterale		**6.69**	**SH**	4	11.12			5	13.9						

Table 1. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

SPECIES	Clingers	T.V.**	F.F.G.***	Drakes Creek 3OLD10050		Bledsoe Creek 3OLD10054		Bartons Creek 3OLD10056		Cedar Creek 3OLD10055		Round Lick Creek 3OLD10058		Spring Creek 3OLD10057	
				Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
					N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2		N0./m^2
Polypedilum illinoense		**7.69**	**SH**							30	83.4				
Procladius sp.		**9.1**	**P**												
Rheotanytarsus sp.	*cl*	**5.89**	**FC**							10	27.8	70	194.6	30	83.4
Stictochironomus sp.		**6.52**	**CG**			20	55.6								
Tanytarsus sp.		**6.76**	**FC**	5	13.9	30	83.4					60	166.8		
Thienemanniella xena		**5.86**	**CG**			20	55.6					20	55.6		
Zavrelia sp.		**5.3**	**CG**	4	11.12			5	13.9						
Simuliidae		**3.5**	**FC**												
Simulium sp.	*cl*	**4**	**FC**									10	27.8	10	27.8
Tabanidae			**PI**												
Tabanus sp.		**9.22**	**PI**									1	2.78	1	2.78
Tipulidae		***3**	**SH**												
Hexatoma sp.		**4.31**	**P**							1	2.78			23	63.94
Tipula sp.		**7.33**	**SH**									14	38.92	1	2.78
CHORDATA****															
Osteichthyes															
Cottidae															
Cottis carolina										1	2.78				
Percidae															
Etheostoma sp.				1	2.78			2	5.56						
TOTAL NO. OF ORGANISMS				**1159**	**3222.02**	**2588**	**7194.6**	**1034**	**2874.5**	**2338**	**6499.6**	**3204**	**8907.12**	**1545**	**4295.1**
TOTAL NO. OF TAXA					**29**		**46**		**22**		**25**		**41**		**36**

Table 2. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.												
BIOMETRIC	**Cumberland River Mile 216.9**				**Drakes Creek Embayment Mile 1.9**				**Cumberland River Mile 245.0**			
	3OLD20002				**3OLD20013**				**3OLD20006**			
	MC	**ROB**	**LOB**	**TOTAL**	**MC**	**ROB**	**LOB**	**TOTAL**	**MC**	**LOB**	**ROB**	**TOTAL**
Number /m^2	3634	1257	1728	2206	23655	5269	8090	12338	2535	3649	193	2125
Taxa Richness (Genera)	10 (10)	9 (9)	7 (7)	15 (13)	6 (6)	10 (10)	13 (13)	18 (16)	15 (15)	15 (15)	9 (9)	24 (21)
EPT Taxa (Genera)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)	3 (3)	3 (3)
NCBI	8.90	8.25	8.70	8.72	8.85	8.55	8.44	8.72	8.19	8.51	6.53	8.32
% EPT	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.89%	1.76%	40.74%	5.38%
M % EPT (minus *Cheumatopsyche*)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.89%	1.76%	40.74%	5.38%
Percent Ephemeroptera	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.89%	1.76%	33.33%	5.15%
% OC	94.50%	86.36%	92.56%	92.45%	69.42%	61.79%	38.13%	61.50%	70.99%	75.15%	40.74%	72.45%
% Dominant	58.35%	68.75%	36.78%	42.50%	44.13%	31.57%	59.05%	36.92%	39.44%	58.90%	29.63%	49.38%
% Clingers	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.41%	0.22%
Diversity Index (Shannon base 2)	1.678	1.597	2.207	2.003	1.816	2.484	1.832	2.115	2.665	2.197	2.875	2.688
Pielou's Index	0.505	0.504	0.786	0.513	0.703	0.748	0.495	0.507	0.682	0.562	0.907	0.586

Table 2. Summary of Benthic Macroinvertebrates Collected from Old Hickory Drainage, Fall 2002.

BIOMETRIC	Drakes Creek 3OLD10050	Bledsoe Creek 3OLD10054	Bartons Creek 3OLD10056	Cedar Creek 3OLD10055	Round Lick Creek 3OLD10058	Spring Creek 3OLD10057
Number /m^2	3222	7195	2875	6500	8907	4295
Taxa Richness (Genera)	29 (28)	46 (46)	22 (21)	25 (25)	41 (41)	36 (36)
EPT Taxa (Genera)	9 (9)	17 (17)	6 (6)	6 (6)	12 (12)	11 (11)
NCBI	4.60	3.83	3.70	4.94	5.34	5.81
% EPT	18.12%	29.83%	11.80%	5.99%	27.22%	10.16%
M % EPT (minus *Cheumatopsyche*)	16.13%	28.55%	9.28%	4.70%	25.91%	6.34%
Percent Ephemeroptera	15.62%	5.99%	7.83%	2.99%	14.86%	2.98%
% OC	3.62%	67.66%	8.22%	13.69%	50.56%	43.37%
% Dominant	42.97%	45.98%	42.94%	32.12%	23.10%	22.65%
% Clingers	69.20%	7.34%	39.36%	47.86%	18.10%	15.99%
Diversity Index (Shannon base 2)	2.9	3.001	2.951	3.159	4.064	3.915
Pielou's Index	0.597	0.543	0.662	0.68	0.758	0.757

Table 3. Determination of Biological Condition Based on Index Scores for Bioregion (TDEC 2002)												
METRIC	**Drakes Creek Mile 4.9**		**Bledsoe Creek Mile 10.3**		**Bartons Creek Mile 7.1**		**Cedar Creek Mile 7.0**		**Spring Creek Mile 5.8**		**Round Lick Creek Mile 8.3**	
	3OLD10050		**3OLD10054**		**3OLD10056**		**3OLD10055**		**3OLD10057**		**3OLD10058**	
	Metric Value	**Score**	**Metric Value**	**Score**	**Metric Value**	**Score**	**Metric Value**	**Score**	**Metric Value**	**Score**	**Metric Value**	**Score**
Taxa Richness (Genera)	29 (28)	6	46 (46)	6	22 (21)	4	25 (25)	6	41 (41)	6	36 (36)	6
EPT Taxa (Genera)	9 (9)	6	17 (17)	6	6 (6)	4	6 (6)	4	12 (12)	6	11 (11)	6
% EPT	18.12	2	29.83	4	11.80	0	5.99	0	27.22	4	10.16	0
% CO	3.62	6	67.66	2	8.22	6	13.69	6	50.56	4	43.37	4
NCBI	4.60	6	3.83	6	3.70	6	4.94	6	5.34	6	5.81	4
% Dominant	42.97	4	45.98	4	42.94	4	32.12	6	23.10	6	22.65	6
% Clinger	69.20	6	7.34	0	39.36	4	47.86	6	18.10	2	15.99	2
TOTAL SCORE	36		28		28		34		34		28	
INDEX RATING	**NON-IMPAIRED**		**NON-IMPAIRED**		**NON-IMPAIRED**		**NON-IMPAIRED**		**NON-IMPAIRED**		**NON-IMPAIRED**	
	Supporting		**Supporting**		**Supporting**		**Supporting**		**Supporting**		**Supporting**	

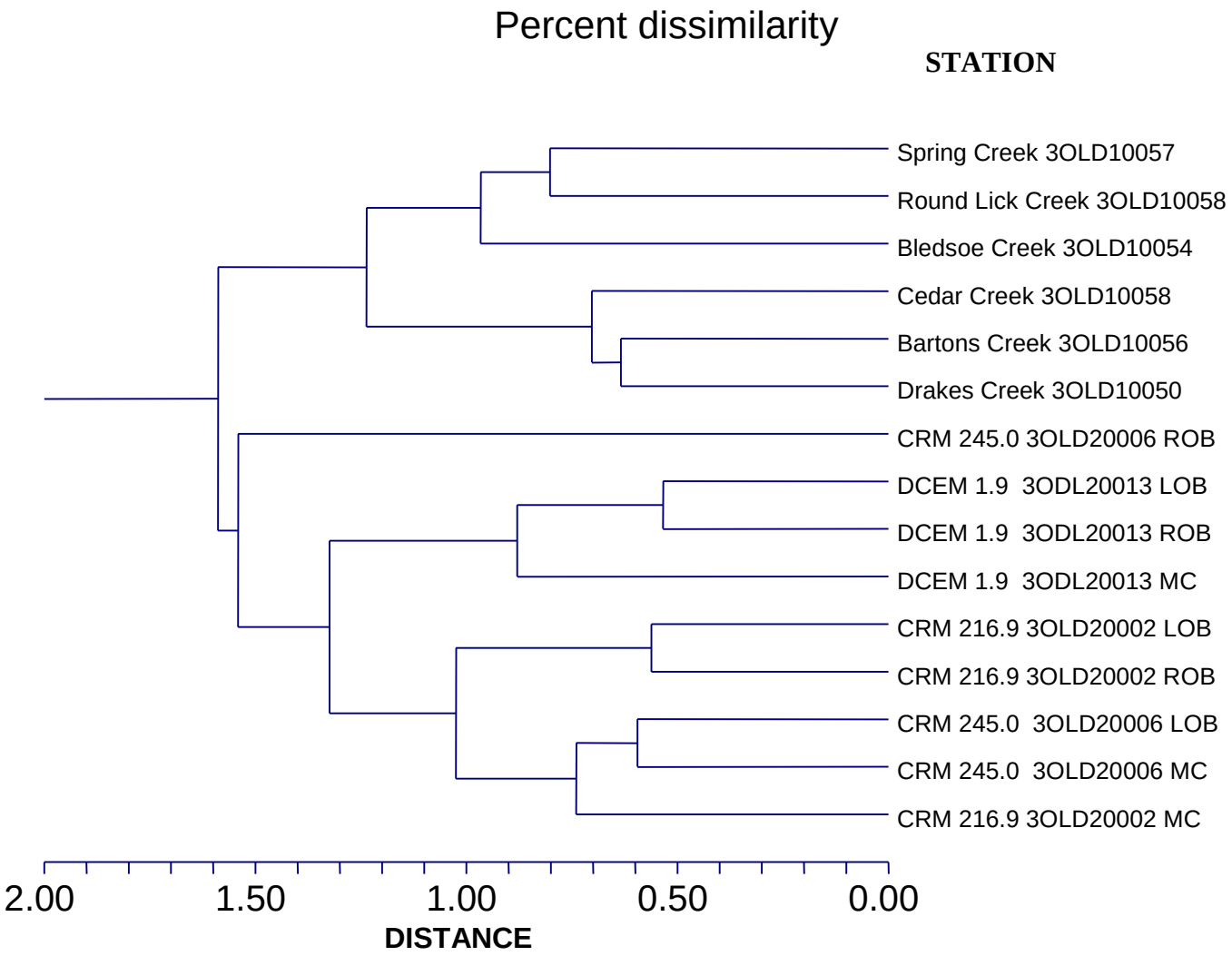


Figure 2. Percent Dissimilarity (Bray-Curtis) Cluster Analyses, Old Hickory Drainage, Fall 2002.

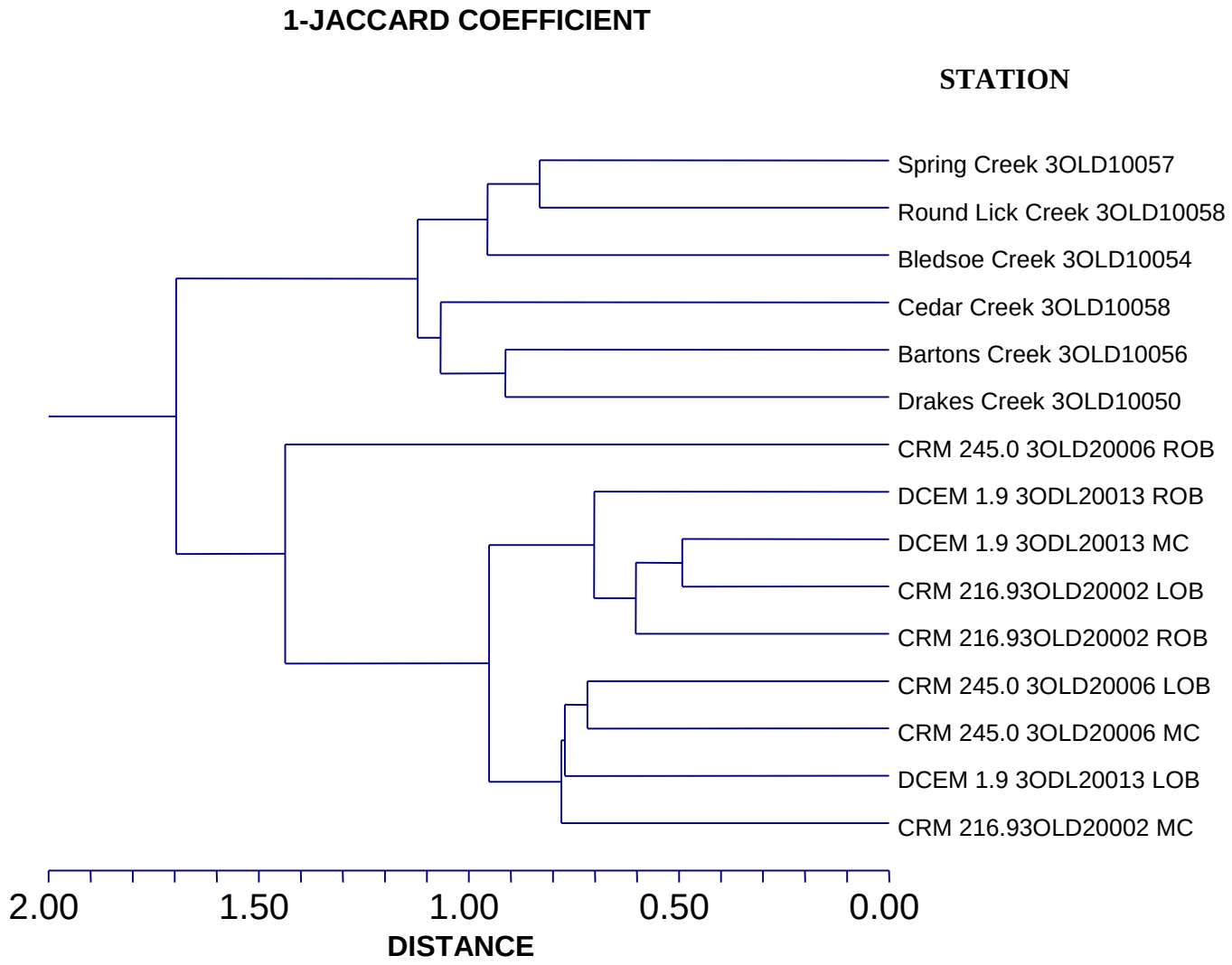


Figure 3. 1-Jaccard Coefficient Cluster Analysis, Old Hickory Drainage, Fall 2002.

REFERENCES

American Public Health Association. 1998. Standard Methods for the Examination of Water and Wastewater (20th Edition). American Public Health Association, Washington, DC.

Barbour, M.T., J.L. Plafkin, B.P. Bradley, C.G. Graves, and R.W. Wisseman. 1992. Evaluation of EPA's rapid bioassessment benthic metrics: metric redundancy and variability among reference stream sites. Environmental Toxicology and Chemistry. 11 (4):437-449.

Beck, W. M. 1977. Environmental requirements and pollution tolerance of common freshwater Chironomidae. U.S.E.P.A. Report No. EPA-600/4-77-024. Cincinnati, Ohio 261 pp.

Bode, R.W. 1988. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation.

Bray, J.R. and J.T. Curtis. 1957. An origination of the upland forest communities of southern Wisconsin. Ecol. Monogr. 27(4):325-349.

Brinkhurst, R.O. 1962. The biology of the Tubificidae with special reference to pollution. Pages 57 through 66. IN: Dr. Clarence Tarzwell, Biological Problems in Water Pollution, Third Seminar. Report A. Taft Sanitary Engineering Center.

Brower, T.E. and J.H. Zar. 1984. Field and Laboratory Methods for General Ecology. Second Edition. W.C. Brown, Dubuque. 226 pp.

Cairns, J. Jr., J.S. Crossman, Kenneth L. Dickson and Edwin E. Herricks. 1971. The recovery of damaged streams. The ASB Bulletin 18(3):79-106.

Gaufin, A.R. 1973. "Use of aquatic invertebrates in the assessment of water quality, "Biological Methods for the Assessment of Water Quality, ASTM STP 258 American Society for Testing and Materials: 96-116.

Gaufin, A.R. and C. N. Tarzwell. 1956. Aquatic macroinvertebrate communities as indicators of organic pollution in Lytle Creek. Sewage Inc. Wastes 28(7):906-924.

Goodnight, C. J. 1973. The use of aquatic macroinvertebrates as indicators of stream pollution. Trans. of the Amer. Micro. Soc. Vol. 92(1):1-13.

Harris, T. L. and T. M. Lawrence. 1978. Environmental Requirements and Pollution Tolerance of Trichoptera. U.S.A.P.A. Report No. EPA-600/4-78-063. Cincinnati, Ohio. 309 pp.

Hilsenhoff, W. L. 1982. Using a biotic index to evaluate water quality in streams. Department of Natural Resources, Madison, Wisconsin, Technical Bulletin No. 132: 22 pp.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist, Vol. 20(1):31-39.

Hintze, J.L. 1998. Number Cruncher Statistical System Version 2000. NCSS Kaysville, Utah.

Howmiller, R.P. and M.A. Scott. 1977. An environmental index based on relative abundance of oligochaete species. JWPCF 49:809-815.

Hubbard, M. D. and W. L. Peters. 1978. Environmental requirements and pollution tolerance of Ephemeroptera. U.S.E.P.A. Report No. EPA-600/4-78-061. Cincinnati, Ohio. 461 pp.

Kentucky Department of Environmental Protection, Division of Water (KDOW). 2002. Methods for Assessing Biological Integrit of Surface Waters. Frankfort, Kentucky. 182 pp.

Klemm, D.J., P.A. Lewis, F. Fulk and J.M. Lazorchak. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. USEPA/600/4-90/030, Cincinnati, Ohio. 256pp.

Ludwig, J.A. and J.F. Reynolds. 1988. Statistical Ecology: A Primer on Methods and Computing. John Wiley and sons, New York. 337 pp.

Merritt, R.W. and K.W. Cummins. 1996. An Introduction to the Aquatic Insects of North America, Third Ed. Kendall/Hunt Publishing Company, Dubuque, Iowa. 862 pp.

North Carolina Department of Environment, and Natural Resources (NCDENR). 2001. Standard Operating Procedures Biological Monitoring. 47 pp.

Pennington & Associates, Inc. 1994. Standard Operating Procedures for Processing, Identification and Enumeration of Invertebrate Samples. Pennington and Associates, Inc. Unpublished working document, Cookeville, TN. 85 pp.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic Macroinvertebrates and Fish. EPA/440/4-89/00/, Washington, D.C.

Surdick, R. F. and Arden R. Gauflin. 1978. Environmental requirements and pollution tolerance of Plecoptera. U.S.E.P.A. Report No. EPA-600/4-78-062. Cincinnati, Ohio. 417 pp.

Tennessee Department of Environment of Conservation (TDEC). 2002. Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys. Nashville, TN 58pp.

Train, R. E. 1976. Quality criteria for water. U.S.E.P.A., Washington, D.C. 256 pp.

Train, R. E. 1971. Methods for identifying and evaluating the nature and extent of nonpoint sources of pollutants. EPA Publication 430/9-73-014. Washington, D.C. 261 pp.

Waters, T.E. 1995. Sediment in Streams, Sources, Biological Effects, and Control. American Fisheries Society Monograph 7, Bethesda, Maryland. 251 pp.

Weber, C., Ed. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. U.S.E.P.A. Report No. EPA 670/4-73-001.

Wilhm, S.E. 1970. Range of diversity index in benthic macroinvertebrate populations. JWPCF 42(2):R221-R224.