

DOE/EA-1113/MAP-02

# **ANNUAL REPORT**

**CALENDAR YEAR 2002**

**IMPLEMENTATION OF MITIGATION ACTION PLAN  
FOR LEASE OF PARCEL ED-1  
ON THE OAK RIDGE RESERVATION  
OAK RIDGE, TENNESSEE**

May 2003

U.S. Department of Energy  
Oak Ridge Operations Office  
Oak Ridge, Tennessee

**LIST OF ACRONYMS ..... 5**

**1. EXECUTIVE SUMMARY ..... 6**

**2. INTRODUCTION..... 7**

**3. SITE ACTIVITIES..... 10**

    3.1 Construction..... 10

    3.2 Public and Agency Involvement..... 10

    3.3 Mitigation Activities ..... 11

**4. ECOLOGICAL MONITORING ..... 12**

    4.1 Fish Census ..... 12

        4.1.1 Fish Census Study Area and Methods ..... 12

        4.1.2 Results and Discussion of Fish Census of Dace Branch..... 13

    4.2 Amphibian and Reptile Habitats ..... 14

        4.2.1 Amphibian and Reptile Study Areas and Methods..... 14

        4.2.2 Results and Discussion of Amphibian and Reptile Surveys..... 15

    4.3 Mammal Observations ..... 16

        4.3.1 Avian Census ..... 17

        4.3.2 Avian Census Area ..... 17

        4.3.3 Avian Census Methods ..... 18

        4.3.4 Results and Discussion of Avian Census..... 19

    4.4 Benthic Macroinvertebrates Census ..... 21

        4.4.1 Benthic Macroinvertebrate Censuses Methods..... 22

        4.4.2 Results and Discussion of Benthic Macroinvertebrate Census..... 22

    4.5 Protected Aquatic Invertebrates ..... 27

    4.6 General Vegetation Surveys ..... 28

    4.7 Sensitive Community Surveys ..... 29

        4.7.1 Beech-Maple Forest..... 29

        4.7.2 Limestone Cliffs..... 30

        4.7.3 Limestone Barrens ..... 31

        4.7.4 Canebrakes..... 33

        4.7.5 Walnut Plantations..... 33

        4.7.6 Threatened and Endangered Plant Species ..... 34

        4.7.7 Yellow Lily and Golden Seal Populations..... 34

        4.7.8 Additional Golden Seal Population ..... 35

        4.7.9 Pink Lady Slipper Population ..... 35

        4.7.10 Beak Rush Community ..... 36

        4.7.11 Ginseng Population..... 36

        4.7.12 Cave Entrance ..... 36

        4.7.13 Springs ..... 36

        4.7.14 Sinkholes..... 37

        4.7.15 Wetlands ..... 37

4.7.16	Buffer Zones .....	37
4.8	Game Species.....	38
<b>5.</b>	<b>CULTURAL RESOURCES.....</b>	<b>40</b>
<b>6.</b>	<b>ENVIRONMENTAL PERMITS.....</b>	<b>41</b>
<b>7.</b>	<b>REFERENCES.....</b>	<b>42</b>
<b>APPENDIX A (DATA TABLES).....</b>		<b>43</b>
Table 1.	Number of fish collected on April 24, 2002, at Dace Branch (DBK 0.3) in millimeter (mm) size classes.....	44
Table 2.	Number of fish collected on April 24, 2002, in pool of Dace Branch at SR95 reported in millimeter (mm) size classes. ....	44
Table 3.	Summary of Terrestrial Vertebrates Captured or Observed on the Horizon Center in the Spring and Summer of 2002.....	45
Table 4.	Matrix of Vertebrates Captured or Observed at Sites on Horizon Center in the Spring and Summer 2002.....	47
Table 5.	Relative Intensity of Amphibian Calling Activity on Horizon Center for 2002.....	49
Table 6.	Mammals Observed on the Horizon Center in 2002. ....	51
Table 7.	Birds observed on the Horizon Center in the 1996 baseline studies and 2002. ....	52
Table 8.	Birds Observed at Periphery Stations 92 and 93 in Baseline Studies (1996), 2000, and 2002.....	56
Table 9.	Birds Observed at Floodplain Stations 509 and 516 in Baseline Studies (1996), 2000, and 2002. ....	58
Table 10.	Composite of Quantitative and Qualitative Macroinvertebrate macroinvertebrates at each monitoring location in April 2002 and Functional Feeding Group (FFG) and North Carolina Tolerance Value (TV) designations of each taxon. 60	
Table 11.	Summary of Benthic Macroinvertebrates from Surber Sample Data for Streams on Horizon Center, April 2002. ....	67
Table 12.	Composite of Quantitative and Qualitative Macroinvertebrate macroinvertebrates at each monitoring location in September 2002 and Functional Feeding Group (FFG) and North Carolina Tolerance Value (TV) designations of each taxon.....	68
Table 13.	Summary of Benthic Macroinvertebrates from Surber Sample Data for Streams on Horizon Center, September 2002.....	75
Table 14.	Trees forming the canopy at each monitoring site within the Beech-Maple forest. ....	76
Table 15.	The estimated number of stems of each species of shrubs and seedlings per hectare observed in each of the Beech-Maple Forest monitoring plots.....	76
Table 16.	Percent of groundcover contributed by each groundcover species observed in each of the Beech-Maple Forest monitoring plots.....	77
Table 17.	Plants found on the face and top of Limestone Cliff # 4. ....	78

Figure 1. Amphibian call listening sites on Horizon Center..... 80

Figure 2. Amphibian and reptile monitoring trap sites on Horizon Center. .... 81

Figure 3. Avian survey routes on the Horizon Center. .... 82

Figure 4. Macroinvertebrate collection stations on Horizon Center..... 83

Figure 6. Historical trends for macroinvertebrates at EFK 5.1..... 84

Figure 6. Historical trends for macroinvertebrates at EFK 5.1..... 85

Figure 7. Historical trends for macroinvertebrates at BCK 0.1 ..... 85

Figure 7. Historical trends for macroinvertebrates at BCK 0.1 ..... 86

Figure 8. Historical trends for macroinvertebrates at BCK 3.3. .... 86

Figure 8. Historical trends for macroinvertebrates at BCK 3.3. .... 87

Figure 9. Historical trends for macroinvertebrates at DBK 0.3. Figure 10. Historical trends for macroinvertebrates at MLK 1.43..... 87

Figure 9. Historical trends for macroinvertebrates at DBK 0.3. Figure 10. Historical trends for macroinvertebrates at MLK 1.43..... 88

Figure 10. Historical trends for macroinvertebrates at MLK 1.43 ..... 89

Figure 11. Comparisons of machrobenthos in Horizon Center with Control On Mitchel Branch. .... 89

Figure 11. Comparisons of machrobenthos in Horizon Center with Control On Mitchel Branch. .... 90

Figure 12. General vegetation community Monitoring sites in Horizon Center. .... 91

## LIST OF ACRONYMS

BI	Biotic Index
BMAP	Biological Monitoring and Abatement Program
CROET	Community Reuse Organization of East Tennessee
DOE	U.S. Department of Energy
EA	Environmental Assessment
EPT	Ephemeroptera – Plecoptera - Tricoptera
FONSI	Finding of No Significant Impact
MAP	Mitigation Action Plan
NEPA	National Environmental Policy Act
ORNL	Oak Ridge National Laboratory
TDEC	Tennessee Department of Environment and Conservation
TV	Tolerance Values
TWRA	Tennessee Wildlife Resources Agency

## 1. EXECUTIVE SUMMARY

In preparation for the transfer of Horizon Center, formerly Parcel ED-1, to the Community Reuse Organization of East Tennessee (CROET), an environmental review committee was established to evaluate the Mitigation Action Plan and determine its effectiveness. The committee recommended an environmental investigation for 2002 that included monitoring of the Tennessee dace (*Phoxinus tennesseensis*), benthic macroinvertebrates, and birds. In addition, it was recommended that a baseline be established for amphibians in planned corridors. This report is in compliance with the committee's recommendation.

Fish surveys were restricted to Dace Branch where the state protected Tennessee dace has been monitored. While the population was low, it was equal to pre-lease conditions. The flame chub, a protected species, was found for the first time in Dace Branch. At this time it is not considered to comprise a breeding population.

Herpetological surveys in 2002 indicate the diversity, distribution, and concentrations of amphibians and reptiles were as good as those found in pre-lease surveys.

The avian data collected in each year have some losses and gains that may be anomalies of sampling. However there were increases in numbers of species observed at all stations in 2002 over previous years. Since diversity and concentrations of birds have fluctuated through the sampling years, increases in 2002, only suggests a healthy bird community during this sampling period.

Macroinvertebrate communities in the streams on the Horizon Center were more diverse and more concentrated when compared with macroinvertebrate communities in baseline studies conducted in 1997 and to an offsite stream used as a control.

Vegetation monitoring sites, established in baseline studies, were analyzed and found to be equal to pre-lease conditions. Protected habitats and sites with protected species were marked for protection and present conditions are described.

## 2. INTRODUCTION

The U. S. Department of Energy (DOE) executed a lease for the 957.16 acre Parcel ED-1 of the Oak Ridge Reservation to the Community Reuse Organization of East Tennessee (CROET) for development of an industrial park (now known as Horizon Center) in January 1996. The lease subsequently became effective in April 1998. This action was preceded by a National Environmental Policy Act (NEPA) Environmental Assessment (EA) (DOE 1996A) resulting in a mitigated Finding of No Significant Impact (FONSI) and accompanied by a Mitigation Action Plan (MAP) (DOE 1996B).

The FONSI specifies that mitigation measures be implemented to prevent significant adverse impacts to ecological resources, floodplains, wetlands, water resources, and historic and archaeological resources. These measures were comprised of (1) excluding areas of the Horizon Center from disturbance and development and (2) conducting surveys and monitoring of industrial development areas prior to disturbance, during construction, and during facilities operations.

In December 1997 DOE published a report (DOE 1997) documenting and discussing progress toward meeting these objectives from June 1996 through September 1997. The report documented pre-construction conditions to use as a baseline and established monitoring sites for future use. In December 1998 DOE published a report (DOE 1998) of progress toward meeting these objectives during the site development planning and early construction phases. Specifically, it addressed least environmentally damaging alternatives for development, pre-construction surveys, and monitoring during the first phase of construction.

A plan was developed that would meet economic development goals while adhering to the NEPA commitments. Master planning and layout of the site relied heavily on several ecological studies designed to avoid state or federally listed species and critical or unique habitats and to minimize impact to stream and floodplain crossings. The plan was accepted by DOE and was implemented.

In preparation for the transfer of Horizon Center to CROET in 2002, DOE appointed a Peer Review Team to review the existing MAP. The goals of the Team were the following:

1. Assess the monitoring data collected to date and establish if the requirements of the MAP have been met.
2. Determine if changes to the MAP are warranted due to the intended future use of the Horizon Center and plans for activities adjacent to the parcels.
3. Clarify the future monitoring and mitigation requirements, including defining when mitigation is necessary.
4. Identify when the next review of the MAP should be conducted.

After an analytical review of the MAP, annual monitoring reports, and conducting interviews, the Team recommended an environmental investigation for 2002 that included monitoring of the Tennessee dace (*Phoxinus tennesseensis*), benthic

macroinvertebrates, and birds. In addition, it was recommended that a baseline be established for amphibians in planned corridors.

The initial MAP (DOE 1997B) required the following activities. All of these were conducted and reported in 2002. The fish survey followed the recommendations of the Peer Review Team and sampled only in Dace Branch.

- Quarterly surveys of plants and wildlife in protected areas,
- Triennial vegetation and wetland surveys,
- Annual monitoring of game populations,
- Annual survey of birds in the terrestrial ecosystem,
- Annual fish surveys, and
- Annual benthic macroinvertebrate surveys.

A revised MAP was developed following the recommendations of the DOE peer review. It contains revised monitoring requirements and mitigation measures for ecological and cultural resources. The objectives of these measures include: (1) to assess whether the integrity of the sensitive resources within the Natural Area is being maintained and to identify encroachments and any necessary maintenance or potential mitigation; (2) continuation of monitoring to detect and characterize changes from the baseline condition and to determine if significant adverse impacts are occurring; and (3) mitigation as needed, to help avoid, minimize, or remediate any adverse impacts to the sensitive areas. It also describes review and reporting requirements.

The revised MAP includes the following requirements. Each of these were accomplished in the 2002 survey.

A. Inspection of sensitive areas within Natural Area (3 times per year including

December-January; April-June; September-October)

- Perimeter boundary of the Natural Area,
- Cave,
- Sinkholes,
- Canebrakes,
- Springs,
- Wetlands,
- Rare species locations,
- East and west corridors,
- Walnut plantations,
- Beech-maple forest, and
- East Fork Poplar Creek and Dace Branch buffer zones.

Report

1. General condition of the vegetation within each area, (major changes or perturbations should be recorded).
2. Observations of any wildlife.
3. General condition of streams and springs.

## B. Monitoring

- Bird surveys
- Amphibians ( to be conducted during onsite inspections)
- Benthic macroinvertebrates (spring samples at sampling locations EFK 6.3, EFK 2.3)
- Fish (Dace Branch each spring)
- Monitoring is to occur for at least three more years, with the first of those three years to include the 2002 data. The need for furthering monitoring (beyond the three years) will be evaluated using the available data.

## C. Mitigation

- Follow requirements as defined in 40 CFR 1500-1508

## D. Cultural Resources

- Continued stewardship and maintenance of the McKamey-Carmichael cemetery and sites 40RE195 and 40RE200

## E. Reporting

- Preparing and publish an Annual Report
- Conduct reviews of the Mitigation Action Plan (MAP) if there is a potential for direct or indirect significant impact of any sensitive resources found on the Horizon Center. This is to be coordinated with the responsible DOE Program office. It is to include, but not be limited to:
  1. A new occupant constructing on the Horizon Center,
  2. A change to an existing operation that has the potential to adversely impact any sensitive resources contained within the Natural Area,
  3. A significant change to the habitat that is adjacent to the Horizon Center.

### **3. SITE ACTIVITIES**

The 2000 report (DOE 2000) briefly summarizes clearing and construction activities associated with roads, utilities, soil borrow areas, and the Theragenics Corporation facility. It reported that vegetation was established in a timely manner in all exposed areas to reduce erosion. In 2001 additional areas were cleared in preparation for new industries. Selection of these sites was in accordance with the Mitigation Action Plan MAP (DOE, 1996B) and avoided direct or indirect impact to sensitive areas.

While exceptionally sturdy silt abatement structures were installed, extraordinary heavy storm events in early spring of 1999 breached the silt fences. This resulted in heavy loads of sediments entering Dace Branch near the site of the Theragenics facility. These fences were replaced as soon as weather conditions permitted on-site activities. Diligent monitoring of silt abatement structures and proactive maintenance prevented further breaches in 2000, 2001, and 2002. However, the area was subjected to extraordinary storm events in late winter of 2002 that caused all streams in the area to exceed flood stage. Although the silt fences on the Horizon Center held, exceptionally heavy silt loads entered the streams on the Horizon Center from offsite upstream sources. No mitigation or remediation was required.

#### **3.1 Construction**

There were no new construction efforts begun in 2001 or 2002.

#### **3.2 Public and Agency Involvement**

DOE established a Peer Review Team to evaluate the MAP and determine its effectiveness. The committee concluded that a good faith effort has been made in meeting the requirements of the MAP. They did recommend that an environmental investigation be conducted in 2002 that included monitoring of the Tennessee dace, benthic macroinvertebrates, and birds. In addition, it was recommended that a baseline be established for amphibians in planned corridors. To support title transfer DOE performed a technical review of existing monitoring data and revised the MAP. In addition, an Addendum to the EA was prepared and both the Addendum and revised MAP were released on May 17, 2002 for a 30-day public comment period. Comments received have been factored into revisions of the documents. A mitigated FONSI was signed on April 2, 2003.

No other formal public or agency involvement was required for this phase of development. However, various agencies and groups have been kept informed of actions and have offered recommendations for improvement of ecological conditions as development proceeded. CROET has an "open door" policy whereby representatives of responsible agencies and groups are welcome to tour the site. Because this is a construction site, requests should be made prior to the visit so that a guide can provide a safe tour.

### 3.3 Mitigation Activities

Both the existing FONSI and MAP require use of natural species to accelerate succession and to landscape industrial site grounds, common areas, and infrastructure right-of-ways. In 1999 (DOE 1999) CROET and DOE decided to adopt the principles of the Southeast Exotic Pest Plant Council of not introducing exotic species (DOE 1999). Instead, native plants will be used in all landscaping. The Declaration of Covenants, Conditions, and Restrictions for Horizon Center mandate that development follow the recommendations of the Council's Landscaping with Native Plants. Other than seeding grass on cleared areas, no landscaping activities were conducted in 2001 and 2002.

DOE and CROET agreed to mark all environmentally sensitive areas defined during the establishment of the ecological baseline condition. The purpose was to provide field markers that would be visible to construction and maintenance personnel to facilitate avoidance of the areas. These were flagged and latitude-longitude boundaries were mapped during the appropriate seasons during 2002.

## **4. ECOLOGICAL MONITORING**

The sites used for ecological monitoring in 2002 were the same as those established in the 1997 baseline studies and used each year thereafter. In addition, the same monitoring techniques were employed. Data are presented in tables and figures in the attached appendix.

### **4.1 Fish Census**

Fish communities are indicators of ecological impacts, of changes in water quality on habitat, and biological integrity. Fish surveys have been conducted on the Horizon Center property since 1997 to: (1) characterize the fish communities during the initial phase of construction; (2) compare community structures with pre-construction communities; (3) document the presence of any federally or state listed threatened, endangered, or in-need-of management species; and (4) document the size distribution of fishes in these communities. In general, the community structure at each of the sampling locations has had minor fluctuations within given seasons. The small decrease in numbers of individuals and species diversity witnessed during construction (1998) was a little lower than those observed prior to construction (1996-97). By 2000 each of the communities was as good as, or better than, the baseline status. For these reasons the Peer Review Team did not recommend further monitoring of fish, except the Tennessee dace.

The Tennessee dace has been deemed in-need-of management as determined by the State of Tennessee. The population of Tennessee dace at station DBK-0.3 in Dace Branch experienced huge increases from two in 1997 to 19 in 1998. However, it progressively declined to four in 1999 and none in 2000. Due to its status and decline in numbers, the Peer Review Team recommended Dace Branch continue to be surveyed for the Tennessee dace.

#### **4.1.1 Fish Census Study Area and Methods**

Dace Branch is a small tributary of East Fork Poplar Creek that flows year round. At the time Dace Branch was surveyed, it varied from two feet to three feet in width and ranged from one to six inches in depth. The substrate was sandy loam with gravel bars in some locations. Vegetation overhung the Dace Branch in many locations.

Block nets were placed across Dace Branch at DBK-0.3 to limit the movement of fish out of the area to be sampled. A backpack electrofishing unit was used to stun fish. The fish were then netted and placed in plastic buckets filled with creek water. Three passes were made through the sample areas to assure all fish had been captured. Fish were then identified, and counted.

Following the quantitative sampling at DBK-0.3, biologists electrofished Dace Branch from its confluence with East Fork Poplar Creek to the culvert at Tennessee State Route 95 (SR 95). Tennessee dace were found in a pool near the highway at the boundary of

the Horizon Center. At that location 39.5 square meters of stream was boxed in with netting and another depletion analysis was conducted.

#### 4.1.2 Results and Discussion of Fish Census of Dace Branch

Tables 1 and 2 list the species, size range, and numbers of fish collected at DBK-0.3 and the pool at SR 95 on April 24, 2002. The Tennessee dace was not collected at DBK-0.3 where it had been in the spring of years prior to 2000. However, it was collected from the pool where it had been found in the fall of 2000 (DOE 2000).

The fish community at DBK-03 was very different from previous sampling periods. The community was dominated by the saffron shiner (*Notropis rubricroceus*), a species that has not been reported in Dace Branch. The populations of central stonerollers and blacknose dace, that had dominated the pool in previous years, were present in approximately half the concentration found there in the spring of 2000. In addition, the banded sculpin was approximately 10 percent of the population size reported in 2000. These dramatic shifts in population numbers indicate severe undetermined habitat changes.

The dominant fish at the pool were central stonerollers (*Campostoma anomaium*) and creek chubs (*Semotilus atromaculatus*). Small numbers of blacknose dace (*Rhinichthys atratulus*) and banded sculpin (*Cottus carolinae*) were also collected. In addition, there were two Tennessee dace collected; the same number reported in the fall of 2000. The low density of fish and species mix in this pool reflected the stress of sediment loads from upstream sources.

The sizes of the fish found at these two locations (Tables 1 and 2) were similar to those found at these locations in previous years. With the possible exception of the banded sculpin the size ranges did not suggest a selection or vulnerability of any size class. In the sculpin population there were no young, nor were there large adults.

Historically the numbers of Tennessee dace in samples taken at DBK-0.3 have varied by year and season. The baseline study in the spring of 1997 reported four Tennessee dace at this site (DOE 1997). The 19 individuals collected in the fall of 1998 was highest number of Tennessee dace recorded (DOE, 98). In the spring of 1999 there were four individuals found (DOE, 99). In October 1999 there were only two individuals collected. There were none found in the spring 2000 census (DOE 2000). However, in the spring of 2000, five (5) Tennessee dace were found in a small pool upstream from influences of construction and downstream from culverts under SR 95. In the spring of 2002 only two Tennessee dace were found in that pool.

Tennessee dace are endemic to pools in small to medium woodland streams of the upper Tennessee River. Locally it has been reported to be widespread in small first order tributaries of Bear Creek and East Fork Poplar Creek (DOE 1997). On the Horizon Center historical populations of Tennessee dace have been reported in East Fork Poplar Creek (EFK-6.3 and EFK-10.0), in Bear Creek (probably BCK-0.1), and in the Dace

Branch headwaters (Dace Branch, Frog Branch, and Walden spring) (DOE 1997). From 1997 to present they have only been found in Dace Branch. Their periodic occurrence in East Fork Poplar Creek and Bear Creek has been interpreted as migratory behavior of the fish in transit between small tributaries (DOE 1997).

In baseline studies Tennessee dace habitat in Dace Branch was considered to be minimal. Dace Branch is a slow moving stream along a substrate dominated by clays and high concentrations of silts. Optimum habitat for Tennessee dace includes moderately swift flow over a substrate where small gravel and coarse sand predominates. That condition was seldom observed in Dace Branch.

In the late winter and early spring of 2000 and 2002, extreme weather resulted in severe siltation in Dace Branch. Tennessee dace are sensitive to siltation, particularly during the spawning season. In addition to the probable impact to individuals in the population during the flood periods, their food sources and breeding habitat has had long-term impacts on the population.

The flame chub (*Hemitremia flammea*), a species deemed in-need-of management by the State of Tennessee, was collected at DBK-01 near the confluence with East Fork Poplar Creek. The flame chub has not been previously reported to occur in waters on the Horizon Center. However, a sample in the 1930's found a population in Bear Creek (DOE 1997). Literature indicate biologists, who have access to extensive fish survey data, believe the flame chub was extirpated in the Bear Creek and East Fork Poplar Creek watershed due to upstream development (DOE 1997). The collection of a single flame chub at a given time in the spring of 2002 defied further interpretation. However, since intensive search methods were employed, and no other flame chubs collected, it was unlikely that a flame chub community exists in Dace Branch.

## **4.2 Amphibian and Reptile Habitats**

Several state and federal listed threatened and endangered amphibians, reptiles, and mammals occur in Roane and Anderson Counties, Tennessee (Kroodsma 1987, Mitchell et al. 1996). The extensive bottomland forests in riparian areas, upland forests, limestone barrens, and springs present on the Horizon Center are typical habitats for these species.

### **4.2.1 Amphibian and Reptile Study Areas and Methods**

The same 16 sites used in the 1996 (DOE 1997) baseline studies were selected for the 2002 study. These areas represent the major habitat types that occur at the Horizon Center and are most likely to include populations of federal or state listed amphibians and reptiles reported in the region. Three types of searches were conducted. One type was active herpetological area searches during early spring, mid-to late spring, and mid-summer. Another included the trapping methods and regime followed in the baseline studies. The third was to listen for frog calls in the pre-dawn hours, daylight hours, and twilight hours at established monitoring stations (Figure 1).

Active herpetological searches included moving logs, leaf-cover, and rocks in each of the selected habitat types. Holes and crevices were probed and investigated. Wet areas, depressions, and springs were examined for vertebrates, eggs, and larvae.

Trap site designations, trap types, and habitat types are listed in Table 3 and are shown on the map in Figure 2. The trapping procedures included pitfall traps in arrays and transects with and without drift fences and artificial covers. Pitfalls were constructed by digging holes and placing one and five gallon buckets or plastic flower pots with slick vertical sides in the hole and back filling so the lip was level with surrounding ground. The pits were covered to provide shelter from weather and sun. Traps were checked three times a week from March through mid-July.

Artificial covers that provided micro-habitats for small vertebrates were placed directly on the ground in combinations and locations as described in baseline studies (DOE 1997). These were 3/8-inch plywood sheets ranging in size from 4 square feet to 32 square feet in size. These were also checked three times a week from March through mid-July.

Mammals were often captured or observed during the amphibian and reptile surveys. These were recorded as coincidental observations.

#### **4.2.2 Results and Discussion of Amphibian and Reptile Surveys**

Table 3 defines the type of trap used; identifies the type of habitat; and lists the amphibians, reptiles, and small mammals found at each location. Table 4 compares the vertebrates caught or observed at the sites. No amphibian or reptile on the state or federal lists of animals in-need-of management, threatened, or endangered were caught or observed in this study.

The baseline study conducted on the Horizon Center listed 11 species of amphibians and 11 species of reptiles in the area. It also stated that there may have been more species that were not caught or observed. The study stated that the sampling was limited and was to be considered only a snapshot within a short time span. The same was true for the 2002 survey. In 2002, there were 11 species of amphibians and 9 species of reptiles caught. With the exception of the absence of the northern two-lined salamander (*Eurycea bislineata*) and the presence of the long-tailed salamander (*Eurycea longicauda longicauda*), the amphibians were the same as 1997. Three snakes found in 1997 were not found. They include northern brown snake (*Storeria dekayi dekayi*), smooth earth snake (*Virginia valeriae*), and northern redbelly snake (*Storeria occipitomaculata occipitomaculata*). However, in 2002 the northern copperhead (*Agkistrodon contortrix mokasen*) was present.

The diversity and abundance in both studies was based on unit efforts with each trap site having equal opportunity because the arrays and coverboards were set on the same day and run on the same schedule. Therefore the diversity and abundance data are comparable from station to station and year to year. As in the baseline studies, the greater diversity and abundance of amphibians and reptiles were found in the hardwood-forested

floodplains. The lowest diversity was observed in the limestone cliff and hardwood plantations.

The active searches in secondary succession areas were difficult to accomplish and yielded no vertebrates captured or observed. The coverboards in those areas also produced low yields. These findings suggested low use of these areas by reptiles and, due to their dry nature, were probably not used by amphibians. The baseline study had reported similar results and conclusions.

Listening surveys at the established listening stations (Figure 1) found ten species of frogs making breeding calls between March and July (Table 5). These species of frogs were also found to be breeding in 1996 (DOE 1997) and 1999 (DOE 1999). The winter and spring of 2002 was mild and possibly resulted in some frogs breeding a little earlier than usual.

Listening Station 1 was near the rock quarry lake. Station 4 was in the sinkhole where there were numerous holes of water and spans of wet vegetation, and Station 5 was located in the wetlands bordering East Fork Poplar Creek. These had a variety of frogs throughout the months. The other listening Stations were along depressions and streams and had less diversity and intensity of frogs calling. In all cases, the species calling and intensity was similar to those observed in the baseline studies of 1996 and during construction of the site infrastructure in 1999.

Other areas at the Horizon Center also had frogs that were actively making breeding calls. They included areas along Dace Branch, Bear Creek, and broader areas of East Fork Poplar Creek. This indicated a wide distribution of frog species over the Horizon Center.

#### 4.3 Mammal Observations

There was no special attempt to trap mammals as in the 1997 baseline study. However, incidental observations were made by biologists while conducting other studies and are recorded in Table 6. White-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus maniculatus*), Southeastern shrew (*Sorex longirostris*), and short-tail shrew (*Blarina brevicauda*) were found in pitfalls and under coverboards. No estimates of populations, sizes, or densities were attempted.

The southeastern shrew has been listed as in-need-of management by the state of Tennessee. They were common in the 1997 baseline studies and were found in two bottomland hardwood forested areas in 2002. Habitat favorable for the southeastern shrew was found to be common throughout wetter areas of the floodplain and larger sinkholes at the Horizon Center.

With the exception of the bobcat (*Lynx rufus*) and swamp rabbit (*Sylvilagus aquaticus*) all of these have been reported at the Horizon Center in past studies. While no effort was made to quantify mammals, there appeared to be an increase in the population of

Whitetail deer (*Odocoileus virginianus*) and Eastern cottontail rabbit (*Sylvilagus floridanus*). This increase was possibly the result of increasing type habitat for these mammals by clearing vegetation from much of the area and by the elimination of hunting at the Horizon Center.

#### 4.3.1 Avian Census

A series of bird censuses were conducted prior to the onset of construction activities to establish baseline data for bird life throughout the parcel. That survey has been followed by surveys using the same routes and stations during and following the first phase of construction. The following compare data collected along the established routes in the spring and summer of 2002 with data collected in previous years.

The objectives of the avian census were to (1) continue collecting data for comparisons of avian populations, and (2) gain information that could prevent or minimize potential impacts on birds (including threatened and endangered species) resulting from site activities on the Horizon Center.

#### 4.3.2 Avian Census Area

Permanent 50-meter fixed-radius plots have been established at 300-meter intervals along the Periphery Route and the Floodplain Route as monitoring posts for birds (Figure 3). Each post has been permanently marked with an individual identification number on a 10-cm x 10-cm orange placard. The Periphery Route originally had 19 sites. Site 92 no longer exists due to extensive clearing of that part of the Horizon Center, leaving 18 sites on the Periphery Route.

The Periphery Route combined parts of two previously existing Partners-in-Flight routes. This route was adapted to include areas that, for the most part, skirt the upland portions of the Natural Area. This route was chosen to provide information on birds that: (1) use the edge of the Natural Area, (2) move across habitats (in and out of the Natural Area) during the breeding season, and (3) use this habitat during spring migration. Fifteen of the 18 monitoring posts were within or border the Natural Area. Although some areas covered during the survey of this route lie outside of the Natural Area, this route proved to be the most efficient and standardized way to sample birds along the edge of the zone. The Floodplain Route was established along the length of the protected floodplain entirely within the Natural Area. This route was selected to provide information on birds that breed exclusively in the Natural Area and to verify the validity of the Periphery Route. Both routes are approximately 6-km (4 miles) long.

The Periphery Route has several habitat types including areas of timber harvest, upland forest, and wetlands. It also borders large portions of the Natural Area. Timber was harvested in this area during the early 1990s. These areas were characterized by piled brush, log debris, snags, sparsely scattered hardwoods and standing dead pines. Dense ground vegetation was observed and included honeysuckle (*Lonicera* spp.), sourwood

(*Oxydendrum arboreum*), sumac (*Rhus* spp.), and brambles (*Rubus* spp.). In 2002 these areas were in various stages of succession leading to hardwood forests. Young sapling and pole-sized hardwood trees were on several of the sites. Upland forests were well-drained areas with mixed deciduous trees. The three strata that were present in these upland forests were canopy, understory or shrub layer, and ground cover. Canopy trees included oaks (*Quercus* spp.), hickories (*Carya* spp.), maples (*Acer* spp.), tulip poplar (*Liriodendron tulipifera*) and American beech (*Fagus grandifolia*) in varying combinations depending on slope and aspect. The understory and shrub layers contained saplings and pole-sized trees including dogwood (*Cornus* spp.), oak, hickory, maple, and beech. The ground cover consisted of seedlings of canopy or understory species, ferns, and various herbaceous plants.

The Floodplain Route was composed of a mixed deciduous forest in the valley bottom on East Fork Poplar Creek and had poorly drained soils. It had at least three strata with varied flora, including canopy, understory or shrub layer, and ground cover. Canopy species included sweetgum (*Liquidambar styraciflua*), American sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), elms (*Ulmus* spp.), ash (*Fraxinus* spp.), black willow (*Salix nigra*) and, infrequently oak and pine (*Pinus* spp.). The understory and shrub layer contained saplings and pole-sized trees of the canopy species, ironwood (*Carpinus caroliniana*), hop hornbeam (*Ostrya virginiana*), and red maple (*Acer rubrum*). The ground cover was dense in most areas and contains grasses, vines, and canes. Steep and low exposed banks of bare soil and small rock cliffs and ledges were common.

#### 4.3.3 Avian Census Methods

In April 2002, five surveys were conducted along the Periphery Route and one survey was conducted along the Floodplain Route. In June 2002, two surveys were conducted along the Periphery Route and two surveys were conducted along the Floodplain Route. All birds seen or heard inside or outside the 50-m radius were noted. Birds flushed during the ingress and egress of the 50-m radius and fly-over were also included and noted. To avoid counting birds more than once, birds noted in the ingress, egress and fly-over columns of the log were in addition to the numbers shown in the <50m and >50m columns. The five minutes at each site were divided into two periods, the first three minutes and the last two minutes. Sex and maturity were designated when known. At the beginning of each route and at each site the time, temperature and weather conditions were noted.

Listening posts were established along roads throughout the Horizon Center for birds calling at pre-dawn and dusk. In addition, birds sighted or heard while investigators conducted other investigations were recorded as incidental.

#### 4.3.4 Results and Discussion of Avian Census

Table 7 is a summary of the birds observed on the Floodplain and Peripheral Routes at the Horizon Center during April and June of 2002 compared to those recorded in the baseline study conducted during the spring and summers of 1996 and 1997 (COE 1997). Most of the birds observed in April 2002 were considered to be migrants, whereas, those observed in June were breeding residents. Many are known to be secretive and inhabit dense floodplain and upland forest habitats. Others are known to be gregarious and flourish in developed areas.

There were 29 species of birds observed at the Horizon Center in 2002 that were not observed in the baseline studies. On the other hand, there were 12 species of birds that were reported in the baseline study that were not observed in 2002.

In addition there were 44 more species in 2002 than in 2000. The increased diversity over the years can be attributed to several factors such as an increase in open space, edge effects, secondary succession due to the death of pine forests, and cessation of construction activities. However, the increases observed include additional species in each type of habitat at the Horizon Center.

Four species of birds observed in 2000 were not observed in 2002. Among these were mallard ducks. Mallard ducks were not reported as occurring on the Horizon Center in the baseline census (DOE 1997) or the first year following construction of the infrastructure (DOE 1999). In 2000 they had nested and reared young in the wetlands along East Fork Poplar Creek and had been observed on other occasions throughout the year (DOE 2000).

Cooper's hawk, a species in-need-of management, are dependent on a healthy pine forest for cover, feed and nesting requirements. They were first reported on the Horizon Center in 1997 (COE 1997). They were observed again in 1999 (COE 1999) and at least one breeding pair was observed in 2000 (COE 2000). Since 2000, the pine beetle has killed most of the pine trees on the Horizon Center depriving Cooper's hawk of preferred habitat. No Cooper's hawk was found during the spring, summer, or fall of 2002.

The sharp-shinned hawk, another species in-need-of management, has been reported at the Horizon Center (COE 1997). This hawk was not observed in 1999 or 2000 but was observed along the Peripheral Route in 2002. The woodlands and woodland-open area margins that are abundant on the Horizon Center provide excellent habitat for this hawk.

The cerulean warbler, a species of special concern on the federal list, was reported as a neotropical migrant in the spring of 1996 and 1999. They were not observed in 2000 or 2002. This is not considered unusual because the cerulean warbler is a rare bird that

occasionally migrates through the region and primarily nests outside the Ridge and Valley Province. Also, the sampling techniques used in this survey could miss birds that are occasional migrants.

Clearing land and constructing bridges and buildings have provided new types of habitat for birds on the Horizon Center. Swallows, chimney swifts, least flycatcher, and house wren used construction components (e.g. bridges and buildings) for nesting and perches. The least flycatcher, swallows, and house wren were found nesting under bridges crossing East Fork Poplar Creek in the late spring and summer of 2002. The chimney swifts frequently fed over cleared areas from mid-afternoon to near dark. Killdeer, spotted sandpiper, common grackle, and European starling also used open space for feeding. Several killdeer nests were observed in many locations throughout the spring and summer.

The spring 2000 avian census reported four bird-monitoring sites as having been altered due to the development activities at the Horizon Center. Site 92 on the Periphery Route had been mostly cleared of vegetation and was not monitored in 2002. While site 93 was mostly cleared, there was sufficient vegetation remaining to warrant monitoring in 2002. Sites 509 and 516 on the Floodplain Route are the bridge crossings and were both monitored in 2002. Tables 8 and 9 compare the presence or absence of bird species at these four locations to provide an historical perspective of bird communities at these sites as influenced by habitat disturbances.

In each of the previous years most of the birds present at Stations 92 and 93 were characteristic of deep woods. However, previous studies also reported bobwhite, mourning dove, American crow, and white-throated sparrow that frequent open areas and the margins between wooded and open areas. Whereas, the baseline survey reported 17 species of birds at Station 93, there were 38 species of birds in the 2002 survey. With the exceptions of eastern tufted titmouse, red-eyed vireo, worm-eating warbler, northern parula warbler, and common grackle, species reported in the baseline study were observed at Station 93 in 2002. None of these species are critical habitat indicators and were found in other areas along the upland corridor.

Even though the habitat at this location had been altered from the baseline condition, diversity of the migratory and nesting bird species increased. Most of the increase included birds associated with habitat margins and open spaces such as catbird, northern mockingbird, house wren, indigo bunting, and northern cardinals that have occupied the additional margin created by clearing. However, pine warblers, hooded warblers, blue jay, and swamp sparrow (birds generally associated with deep woods) were new to this station in 2002.

The clearing of the bottomland forest across the creek corridor and construction of bridges in 1998 and 1999 provided more diverse habitat types that include the deep woods, open roadways and bridges, and margins. Stations 509 and 516 were located at these types of habitats. Table 9 compares the birds observed at Station 509 and 516 throughout the springs and summers of 1996, 2000, and 2002. While the diversity of species at both stations was similar when the baseline was compared with the 2000

survey, the composition was different. There had been a shift from bird species generally found in forested riverine corridors to a community with more birds common to forest edge habitats. This phenomenon was more pronounced in 2002. There were 35 species of birds present at Station 509 in 2002 and only 15 in the baseline study. The increase included the addition of 23 species generally associated with forest margins and open land. Simultaneously there was a loss of four species generally associated with deep forests. There were 18 species recorded in the baseline study at Station 516 and 22 in 2002. Only four species of birds were common to both surveys. The difference in species composition was due to the loss of ten deep woodland species and addition of 14 species more common to open habitat.

During planning stages there had been considerable concern that bridge corridors would fragment the riverine bottomland forest and prevent neotropical song birds from migrating. The numbers of neotropical migratory species increased on both sides of the bridges over observations in these locations in previous years. Thus, suggesting the roadway crossing the floodplain did not negatively impact habitat continuity, an important factor in migration.

Incidental observations found two pair of ruff grouse (*Banasa umbellus*) in the upland forests. These have not been reported at the Horizon Center in previous years. The habitat requirements of this bird are abundant at the Horizon Center and surrounding hillsides to the west and north.

Four breeding pairs of whip-poor-wills (*Caprimulgus vociferus*) were observed on two different occasions in the pine barren on the eastern end of the perimeter road. These have not been reported breeding on the site in previous years.

Environmentalists have expressed concern that there would be an invasion of European starlings and brown-headed cowbirds after the first phase of construction was completed. While these birds were present in 2002, the numbers were not greater than in previous years. There have been no studies to evaluate penetration of forests by the brown-headed cowbirds and their impacts on nesting neotropical migrants.

In summary, there have been some changes in the bird life of the Horizon Center due to human activities and natural events. The habitat types in the floodplain corridor were diverse and supported a diverse community of breeding birds in 2002. In the spring the Horizon Center was well used as a migration corridor typical of unfragmented bottomland forests of the region. The crossing of road right-of-ways and bridges did not appear to adversely impact the bird community along the East Fork Poplar Creek corridor. The upland corridors supported bird communities that connect the bottomland corridor along East Fork Poplar Creek and the uplands of the ridges. This upland corridor was also influenced by secondary succession habitats resulting from deforestation brought on by pine beetle infestation.

Benthic macroinvertebrates are small animals large enough to be seen with the unaided eye that live on or among the substrate particles in bodies of water. Their intimate contact with the environment and their life span of several months make them ideal for use in following long-term ecological trends associated with impacts. However, the high variability of macroinvertebrates makes causes of short-term fluctuations difficult to identify.

The objectives of the stream benthic macroinvertebrate study were to: (1) characterize the benthic macroinvertebrate communities of East Fork Poplar Creek, Bear Creek, and Dace Branch within the Horizon Center; (2) compare community structures with those observed during the collection of baseline data in 1996 (DOE 1997); and (3) document the presence of any federal or state listed threatened, endangered, or in-need-of management species.

#### **4.4.1 Benthic Macroinvertebrate Censuses Methods**

Macroinvertebrate surveys were conducted at the same stream sites (Figure 4) sampled in previous studies. Two sites were located on East Fork Poplar Creek at kilometer 2.3 (EFK-2.3) and kilometer 5.1 (EFK-5.1). Two sites were on Bear Creek at kilometer 0.1 (BCK-0.1) and kilometer 3.3 (BCK-3.3). One site was located on Dace Branch at kilometer 0.3 (DBK-0.3). An offsite station on Mitchell Branch at kilometer 1.43 (MIK-1.43) was used as a reference because it was similar to Dace Branch and had a long-term historical database available for comparisons.

Surber samplers equipped with a 363-micrometer mesh net were used to collect quantitative samples in triplicate at each station. Kick nets were used to collect qualitative samples throughout each site. Samples were placed in jars and preserved with 95 percent ethyl alcohol and taken to the laboratory. To avoid sample decomposition caused by dilution of the original preservative, the ethanol was replaced with a permanent preservative. Organisms were picked from the debris in the samples, identified to the lowest practical taxon, and enumerated.

#### **4.4.2 Results and Discussion of Benthic Macroinvertebrate Census**

Tables 10 and 12 are composite checklists of the benthic macroinvertebrates collected by qualitative kick net and quantitative surber samples from all of the stations in the spring and fall of 2002, respectively. The reported number represents the number of each type of organism per 0.3 square meters of stream bottom. Additional types of organisms observed in the qualitative samples are represented by "X" in the tables. In addition, each taxon is annotated by its Functional Feeding Group (FFG) and a Tolerance Value (TV).

The North Carolina Tolerance Values and Hilsenhoff Tolerance Values have been established for most of the organisms and are recorded as Tolerance Values (TV). These values range from 0.0 for organisms very intolerant to organic wastes to 10 for organisms

that are very tolerant to organic wastes. These values have been used to calculate a North Carolina Biotic Index (BI); thus, applying the normalized scale to each stream station.

Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera)] are generally intolerant to organic wastes and sediments and are indicators of good water quality. Chironomids are generally tolerant to organic wastes and sediments. Thus, richness of Ephemeroptera+Plecoptera+Trichoptera (EPT) and chironomids are reported for each station in Tables 11 and 13.

Dynamics of these indicators have been compiled for all sampling periods beginning with the baseline study through the fall of 2002 and are represented in Figures 5 through 10. These graphically show local macroinvertebrate conditions at certain points in time as well as trends over six years.

EFK-2.3 - At this location, East Fork Poplar Creek was composed of alternating shallow pools and riffles in 2002. The flow was slow to moderate. Substrate of the pools was predominantly sandy with a small amount of gravel. The riffles were predominantly rough bedrock covered with small to medium cobble with a mixture of gravel and sand. Qualitative samples were taken throughout the site, while the quantitative surber samples were only taken in the riffle areas.

There were 79 types of macroinvertebrates found at EFK-2.3 in April 2002. This was considerably richer than in spring samples in any previous monitoring year (Figure 5). The diversity was due, in part, to a five-fold increase (4 species in spring of 1997 to 20 in the spring of 2002) in the EPT species that are intolerant to organic wastes and sediments. The variety of EPT species was greater than other group of macroinvertebrates in the community. The diversity was accompanied by an increase in the percent of individuals belonging to EPT species from 2.5 percent in the spring of 1997 to 6.58 percent in the spring of 2002.

The percent of individuals in the community that belonged to the chironomids continued to be high (90.1 percent) and dominated the sample in the spring of 2002. Chironomids generally tolerate organic wastes and sediments; however, they are also indicators of clean water. The abundance of organic leaf materials in East Fork Poplar Creek provided ideal habitat for chironomids from late fall through the spring. The numbers and concentration of chironomids were greatly reduced (to 21.5 percent) in the fall when leaves were not as abundant on the stream bottom.

The composite BI of 5.13 also indicated relatively good water quality at EFK-2.3 in the spring of 2002. The low BI was accomplished by the high number of chironomids, with high TV, in the benthic community being counterbalanced with even higher numbers of organisms with low TV. An organism with a high TV can live in clean water; however, an organism with low TV cannot live in polluted waters.

The density of organisms was greatly reduced (by 81 percent) in September (Table 12). This was accompanied by a reduction of numbers of species by 50 percent from the spring survey. However, the highest concentrations of survivors were intolerant EPT

species (47.7 percent) at the expense of high tolerant chironomids (21.5 percent). In addition, the 11 EPT species observed in the fall of 2002 was greater than the five EPT species recorded at that site in baseline studies.

Historical data in Figure 5 indicates the macroinvertebrate community in this reach of East Fork Poplar Creek has been unstable. The relatively high diversity in the spring and fall of 2002 suggests an improved condition over the last few years. However, these results only represent conditions at the time of sampling.

EFK-5.1 - East Fork Poplar Creek at this location was similar to EFK 2.3. It was composed of alternating shallow pools and riffles at this site at the time it was sampled in 2002. The flow was slow to moderate. Substrate of the pools was predominantly coarse sand. The riffles were predominantly rough bedrock intermittently covered with small to medium cobble. Qualitative samples were taken throughout the site, while quantitative surber samples were only collected in the riffles.

The benthic macroinvertebrate community at EFK-5.1 has been relatively good through the years (1996-2002) and it continues to improve with respect to diversity (Figure 6). In the Spring 2002 samples there were 80 different types of organisms with a community density of 808 individuals per 0.1 square meter. In the spring samples of previous years, the highest number of species at this site was in 2000. Twenty four types of organisms were recorded with a density of 597. The baseline study reported 12 taxa (classification strata) and a density of 400.

As in most other years, chironomids dominated (55 percent) in the spring of 2002, but many of these were intolerant to organic wastes and sediments. The 12 EPT species were more than double those in spring samples of previous years. A large number of these species are known to have low TVs; thus, contributing to a BI of 5.57, which indicated relatively healthy water conditions.

In September 2002 the 37 taxa identified were greater than in any previous fall sampling event prior to 2002. The low density of organisms (Figure 6) was comprised of many EPT species (58.9 percent) intolerant to sediments and few chironomid species (17 percent) tolerant to organic wastes and sediments. This combination is indicative of good water quality.

Macroinvertebrate communities in the spring and fall were composed of all Functional Feeding groups. Thus, all nutrient opportunities were being utilized and not being limited by local conditions.

BCK-0.1 - Bear Creek had slow moving shallow water with some riffle at the sampling location when sampled in 2002. The substrate varied from bedrock to sand-covered bedrock that was partially covered with cobble.

The historical trend (Figure 7) indicates a general decline in the spring macroinvertebrate communities at this site. However the data suggests there was some improvement in

diversity in 2002. The 91 types of organisms at this site was more than double the diversity observed for samples for any period since reporting began in 1996. The 27 EPT species was also doubled over previous spring samples. Even though the EPT species comprised 33-percent of the species, they made up only 25.8-percent of the individuals in the sample. Conversely, the percentage of chironomid species was lower than any previous year, but the density of individuals was 32 percent higher. This may be due to the large quantities of organic leaf litter throughout the East Fork Poplar Creek system during the winter and spring.

The community structure resulted in a BI of 5.89, which indicates relatively healthy water conditions. The BI also indicated that the relatively high TV of most chironomids was counter balanced with the few organisms with very low TV. The tolerant organisms can live in clean water, but the intolerant species cannot live in high organic waste or silts.

In the fall of 2002 the 82 species in the macroinvertebrate community was also approximately double that in previous fall samples. Thirty percent were EPT species. Furthermore, the majority of individuals (71.4 percent) were members of EPT species. When the high number of these intolerant invertebrates was contrasted with the low number of tolerant chironomids (13 percent) good water quality in this segment of East Fork Poplar Creek during the fall of 2002 was indicated.

BCK-3.3 - Bear Creek had slow moving shallow water with some riffle at this location at the time of sampling. The substrate varied from bedrock to sand covered bedrock that was partially covered with cobble.

Like the macroinvertebrate community at BCK-0.1, BCK-3.3 had a high variety of organisms (105 taxa) in the spring. Much of which was attributed to the number of EPT species (38). The density of individuals (482 per 0.1 sq. meters) was lower than observed in other stations in East Fork Poplar Creek but was higher than in the control station on Mitchell Branch (355 per 0.1 sq. meter). The number of individuals per 0.1 sq. meters was high in the spring of 1997 (900) and 1999 (567); but was lower in the spring of 2000 (300).

The low number of individual chironomids (34-percent) was counterbalanced by the moderate number of EPT individuals (48.5 percent). This resulted in a BI of 5.1 that was indicative of relatively good water quality.

Unlike BCK-01, the macroinvertebrate community at BCK-3.3 in the fall of 2002 was very dense (1545 per 0.1 square meters). A majority of the macroinvertebrates was composed of intolerant EPT individuals (71.8 percent), which also comprised 35-percent of the species in the fall sample. The tolerant chironomids during this sampling event was at the lowest level on record at this station.

DBK-0.3 - Dace Branch is a small tributary of East Fork Poplar Creek that flows year round. In 2002 it varied from two feet to three feet in width and ranged from one to six inches in depth. The substrate was sandy loam with gravel bars in some locations.

Vegetation overhung the branch in many locations. Much of the watershed of this stream has been cleared and siltation has occurred from offsite.

The benthic community in Dace Branch appeared to be resilient following silt loading during storm events in 2002. The size, continuous flow, and close association with surrounding vegetation has allowed Dace Branch to be swept clean of sediments and become repopulated with a wide array of benthic organisms. However, these conditions also made it very susceptible to short-term impacts. The breaks in silt fences in 1998 led to heavy silt loading that greatly reduced the productivity in 1999 and 2000. Following the heavy silt loads from upstream sources in March of 2002, the stream corrected conditions sufficient to provide habitat for a diverse macroinvertebrate community in the spring and fall of 2002 (Tables 10 and 12).

Of the 101 species found at the site in the spring of 2002, 32 were EPT species that comprised 22 percent of the individuals (Table 11). At 33.5 percent the chironomid density was considered low, but was higher than in previous years (Figure 9). The dynamics of the spring macroinvertebrate community resulted in a BI (5.35) that was indicative of relatively good water quality.

In September the density of organisms was lower than in the spring (Table 13). This was accompanied by a reduction in diversity by approximately 15 percent. A 20 percent reduction in EPT species was observed. However, the 26 species of EPT at this station was the highest recorded of any of the previous fall samples. In addition, the percentage of the total community that was EPT species was higher than recorded in the baseline studies (Figure 9).

The percentage of chironomids (35 percent) in the fall was similar to that in the spring (33.5 percent). Both were considerably below the 59 percent recorded in the baseline studies (DOE 1997). The high numbers of individual chironomids in the baseline studies were responsible for the high density recorded in the fall of 1996 (Figure 9) and contributed to the low diversity as expressed by the total number of species.

In both spring and fall, macroinvertebrate communities were composed of all Functional Feeding groups. Thus, all nutrient opportunities were being utilized and were not being limited by local conditions.

MIK-1.43 – This station on Mitchell Creek was established as an offsite control for macroinvertebrate monitoring in the baseline studies in 1996 (DOE 1997). Mitchell Creek varies from two to three feet in width and ranges from three to 12 inches in depth. The year round flow is over a sandy loam substrate with occasional gravel and sand bars. The flood plain is vegetated with forbes and shrubs that often overhang the creek. Sampling of this station was conducted by a different party than the sampling in East Fork Poplar Creek, Bear Creek and Dace Branch.

In the spring of 2002 the density (355 per 0.1 sq.m.) of the macroinvertebrate community was lower than in any spring sample recorded (Figure 10). Furthermore, it was lower than at any station on the Horizon Center for the spring of 2002 (Figure 11). These

results were consistent with respect to the 44 types of organisms present, which reflects comparatively low community diversity. However, 43-percent of the species were intolerant EPT species that composed 26.1-percent of the individuals. Almost half (48.7-percent) of the organisms were intolerant chironomids.

In the fall the density was lower (266 per 0.1 square meter), but the diversity was increased. The shift was due to fewer intolerant EPT individuals (3.4-percent) and more tolerant chironomids (58.3-percent).

#### 4.5 Protected Aquatic Invertebrates

Oak Ridge National Laboratory conducted an extensive mollusk survey of the waters within the boundaries of the Horizon Center and control streams in June and July of 1997 (DOE 1997). The procedures used in the baseline studies were followed while searching the same locations during the summer of 2002.

In 1997 a shell of *Fusconaia cor*, a bivalve mollusk listed by state and federal agencies as endangered, was found in East Fork Poplar Creek between EFK-5.1 and the bridge on SR 95. The shell was very eroded indicating the animal had been dead for some time before the shell was discovered. No living *Fusconaia cor* were found. During the summer of 2002, a search for this mollusk was made in the same stretch of stream with no living or dead *Fusconaia cor* being found.

There was an abundance of the imported Asian clam *Corbicula fluminea* throughout East Fork Poplar Creek and at BCK-3.3 in Bear Creek. This invasive species is very tolerant of organic pollutants and sediments and is not considered to be stressed in Tennessee waters.

The only other bivalve mollusk found in the waters at the Horizon Center was *Pisidium* sp. It was found at EFK-2.3 and in abundance at BCK-0.1. This clam was not found in the 1997 surveys. It is not a protected species.

No state or federal listed snails were found during the 1997 or 2002 surveys. In the summer of 2002, representatives of five genera of snails were found. Only one of these, *Elimia* sp., was found in baseline surveys. *Pleurocera* sp. was found in the baseline study but was not found in 2002. None of the snails found in either survey were protected species.

The most common snail found was *Elimia clavaeformis*. *Elimia clavaeformis* is a scraper that feeds on algae and microbial growth on surfaces of rock, leaves, and twigs. Its tolerance is medium (TV=5). Thus, it is well suited to most aquatic habitats within the Horizon Center. *Elimia clavaeformis* is not a protected species.

The 2002 survey, like the 1997 survey, was sufficiently thorough to provide strong evidence that if protected species of mollusks existed at the Horizon Center, they were extremely rare. ORNL concluded that all unionid mussels had been extirpated from these

streams by multiple stresses induced offsite over several decades (DOE 1996A). The results of the 2002 survey supported this conclusion for the waters of the Horizon Center.

#### 4.6 General Vegetation Surveys

Aerial photos taken in the early 1940's show most of this parcel was used for agriculture purposes at the time the government acquired it in 1943. Subsequent use by the government, soil conditions, underlying geology, and other occurrences like the recent pine beetle infestation has resulted in the mixture of vegetation communities now present. Vegetation communities at the Horizon Center include stages of old field succession, immature second-growth forest, mature mesic forest, floodplain forests, black s, yellow poplar plantations, and limestone cedar barrens.

In 1993-94 some of the loblolly pine plantations on the Horizon Center were logged due to pending damage by pine beetle infestations. However, because the majority of the pine plantations were not mature, all were not harvested. As the remaining pine trees matured they suffered almost complete kill-off by the pine beetle infestation. Even though some areas have been cleared for development sites and infrastructure, most of the cut-over areas and timber-kill areas have been left to natural succession. By 2002 these areas were dominated by early succession plants, such as the exotic Japanese honeysuckle (*Lonicera japonica*), blackberry (*Rubus* sp.), tulip poplar (*Liriodendron tulipifera*), and sweetgum (*liquidambar styraciflua*).

General vegetation monitoring sites were established at four locations along East Fork Poplar Creek and two upland locations for the baseline studies in 1997. Each had three plots spaced approximately 75 meters apart. Locations of these sites and plots are described in the baseline study (DOE 1997) and are identified in Figure 12.

Repeated examinations of these plots were made from April through August of 2002 to determine if there had been adverse impacts since the baseline studies. Established quadrants were evaluated for herbaceous species, vines, and woody seedlings. Percent cover of each species was estimated using a pre-transformed rating scale described by Little and Hills (1978).

In 2002 almost all plant communities at the Horizon Center had some exotic plants. Most of the forest floor on the floodplain was dominated by aggressive exotic invaders. These included microstegium (*Eulalia viminea*), privet (*Ligustrum sineses* and *L. vulgare*), and Oriental bittersweet (*Celastrus orbiculatus*). The successional stages of upland forests were dominated by honeysuckle, autumn olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*).

The domination of the plant communities by these exotic species is not unique to the Horizon Center. Awl et al. (1996) listed 167 exotic plant species known to occur on the DOE Oak Ridge Reservation. Of these, 43 species were considered to be very invasive and aggressive.

## 4.7 Sensitive Community Surveys

DOE found five types of sensitive plant communities on the property prior to leasing it to CROET (DOE, 1997). In 2002 the boundaries for these areas were reestablished and marked to protect the sites in perpetuity. In addition the cave entrance, three springs, sinkholes, wetlands, and buffer zones were inspected on a seasonal schedule.

### 4.7.1 Beech-Maple Forest

The area designated as the beech-maple forest at the Horizon Center is unusual for the ridge and valley providence and does not occur anywhere else on the Oak Ridge Reservation. Aerial photographs taken in 1942 show the Beech-Maple Forest area to be intact, although it was completely surrounded by agriculture at the time. The area has not been disturbed since. Due to its longevity and to the vegetation composition, it is considered to be approaching the status of a climax forest. In the Midwest, forests of this type have been ranked critically imperiled globally because of extreme rarity (Grossman et al. 1994).

The land surrounding the beech-maple forest has poor and eroded soils that were either left to natural succession or were forested by the government. Sixty years of succession have resulted in a clear transition zone between the beech-maple forest and surrounding forests. In the summer of 2002 the boundary of the beech-maple forest was delineated and marked.

Three permanent monitoring plots were established within the beech-maple forest in 1996 (DOE 1997). Tables 14, 15, and 16 show the relative dominance of mature trees, understory, and groundcover plants in the three monitoring plots. Each plot was characterized by large hardwood trees that formed a closed canopy. The reduction of light has limited the understory and groundcover.

Neither American beech (*Fagus grandifolia*), nor sugar maple (*Acer saccharum*) dominated the area. Instead, there were several hardwood species that made up the canopy of this forest. All monitoring sites had mature American beech. Sugar maple was present throughout the area, but was found in only one of the monitoring plots (BM1). Both tree types were represented in relatively high numbers in the understory of all three monitoring sites. Thus, this forest is continuing to mature and become a true beech-maple forest.

The second most common tree in the area was white ash (*Fraxinus americana*). These trees were found in two of the three monitoring sites. White ash was an invader species that begins growth during the early stages of succession. The shade produced by the canopy limited seedling growth. This explains why white ash was not present in the sapling category and very few were found in the groundcover. The large trees in this grove began their growth when the area was open ground. As they die they will be

replaced by beech and sugar maple, which have shade tolerant seedlings and are abundant in the understory (Table 15) and groundcover (Table 16).

There have been no disturbances since the original monitoring plots were established in 1997. The vegetation at these monitoring sites was similar to that found in the 1997 baseline surveys. As expected, there has been a small increase in tree diameter. There has been no invasion by exotic species as was found to be common throughout the Horizon Center.

#### **4.7.2 Limestone Cliffs**

Limestone cliffs are formed by streams that erode into limestone bearing geologic formations. Local soils erode from the surface of the exposed limestone and are typically dry with the exception of some seepage zones. Plant community structures are characteristic of local aspect and conditions. While limestone cliffs are considered globally threatened, they are widely distributed within the southern Appalachians. Limestone cliffs occur at several sites on the Oak Ridge Reservation (DOE 1996A).

There are four limestone cliffs along the bank of East Fork Poplar Creek. Two of these are noted in Figures 3-13 and 3-14 in the Environmental Assessment (DOE 1996A). The others were described in the annual monitoring reports (DOE 1997 and DOE 1998).

In general, the limestone cliffs were characterized by areas of bare rocks interspersed by crevices filled with soils and organic litter. In 2002 trees, shrubs, and ground cover were often established in these soil filled pockets, but were not sufficiently dense to form a closed canopy. Calciphilic herbs, ferns, and mosses grew on thin soil and in cracks. Mosses and lichens often grew on bare limestone.

The limestone cliffs identified in the Environmental Assessment (DOE 1996A) are along the left-bank-descending of East Fork Poplar Creek. The cliffs are not high and are intermittent. They are dry. In most of these areas the soils on the banks are deeper than most limestone cliffs. Aerial photographs taken in 1943 show the surrounding areas to be cultivated at that time. After the government acquired the land, natural succession vegetated farmland surrounding the upper banks of the limestone cliffs. In latter years the government planted hardwood and pine plantations in the previously farmed lands adjacent to these limestone cliffs. Thus, the makeup of mature vegetation on these limestone cliffs in 2002 was similar to the surrounding forests.

There have been no man-made disturbances along these limestone cliffs since the baseline studies (DOE 1997).

A similar region of limestone outcrops is on the right-bank-descending of East Fork Poplar Creek. The cliffs along this zone are very intermittent and short. They too are dry. The soils on the upper banks are deep. The 1943 aerial photograph indicates the surrounding area was mature forest in 1943. Here too, the vegetation community of the

upper banks was similar to the surrounding forest. There were no indications of this area being disturbed since the government acquired the property.

The fourth limestone cliff was described in the baseline report (DOE 1997) as being in a steep curve along the right-bank-descending of East Fork Poplar Creek. Portions of this area were in cultivation to the upper margin of the cliff prior to 1943. Much of this cliff face was wet from seeps and periodic flooding of East Fork Poplar Creek. A result of this moisture was a high concentration of moss, lichen, and algae on the bare rock surfaces. The vegetation was widely varied and not similar to surrounding forests. A progression of vegetation changes occurred from the top of the cliffs to the water's edge.

Table 17 compares the plant communities of the cliff face and the ledge at the bottom with the plant communities at the top of the limestone cliff. Fourteen species were common to the two areas. However, each type habitat had differences. The cliff face had areas of bare rock and areas of shallow-loose soils high in organic matter over bedrock. Plant associations that grew on the face formed a mosaic of plants that survive in these soils, wet places, and bare rock. The top of the limestone cliff had deeper soils and vegetation was similar to surrounding forests.

#### **4.7.3 Limestone Barrens**

The baseline study (DOE 1997) described a single limestone barren from observations made in 1996. A second area designated as a limestone barren was referenced in the Environmental Assessment (DOE 1996A) and is described in this report. Conditions for both are probably man induced due to previous farming and logging practices. In the summer of 2002 the boundaries were difficult to delineate because there was a gradual change in soil thickness and underlying geology accompanied by an irregular progression of changes in vegetation. Neither area meets the requirements of the Nature Conservancy to be listed as being a unique community. Several higher quality limestone barrens on the Oak Ridge Reservation as well as throughout the Ridge and Valley Province of southwestern Virginia, Tennessee, northwestern Georgia, and northern Alabama were referenced in the EA and baseline study (DOE 1996A and 1997).

Aerial photographs indicate the area designated as a limestone barren in the baseline study was actively used for agriculture at the time the U.S. Government acquired the property. The topography and the agricultural practices contributed to erosion of the thin topsoil and exposed the limestone bedrock. Left to natural succession following government acquisition, the community type developed there contained high concentrations of xeric plants and plants common to waste areas.

Exposed limestone and gravelly limestone was very common throughout the area. Soils that did exist were thin and dry throughout most of the growing season. This condition supported very little vegetation and approximately half of the area was barren. The vegetation that did exist was dwarfed due to the lack of moisture and nutrients. Many shrubs and trees died when they reached 10-15 feet in height as was evidenced by standing and fallen snags.

The dominant tree on the limestone barren was red cedar (*Juniperus virginiana*). Other types of trees and shrubs included tulip poplar (*Liriodendron tulipifera*), redbud (*Cercis canadensis*), post oak (*Quercus stellata*), yellow chestnut oak (*Q. muehlenbergii*), buckthorn (*Rhamnus caroliniana*), blue haw (*Viburnum rufidulum*), and beech (*Fagus grandifolia*). The beech and yellow chestnut oak are usually found in moist woodlands. Tulip poplar and redbud prefer deeper soils with residual moisture available. Other species are tolerant of dry conditions.

Like most limestone barrens, the vegetation on the floor was sparse and was dominated with mosses and lichens. In areas with deeper soils and near the boundaries were several exotic species that included: wild sage (*Salvia lyrata*), japanese honeysuckle (*Lonicera japonica*), Queen Anne's lace (*Daucus carota*), loblolly pine (*Pinus taeda*), and bumblebee weed (*Prunella vulgaris*). In addition, there were patches of native poison ivy (*Toxicodendron radicans*) in these areas.

The area has not been disturbed since the 1996 evaluations. *In situ* decay of leaf fall from surrounding forest was prevalent and contributed to formation of deeper soils near the boundaries.

Figures 3-13 and 3-14 of the Environmental Assessment (DOE 1996A) show the location of a limestone barren on the western side of the southern portion of Herrell Road. No previous description of this site has been found. In the summer of 2002 the boundary was delineated and marked and is described below.

As expected, this area was also actively used for agricultural purposes at the time the U.S. Government acquired the property. In early 1990s this region of Horizon Center was logged and this ridge was used as a staging area and for loading trucks. This resulted in denuding the ridge and contributing to extensive erosion. This erosion was uneven, leaving areas of bare limestone and other areas with deep soils. Left to natural succession, the community type developed reflects local seed sources intermixed with xeric species.

In 2002 the dominant trees in this area were pine trees. The remaining trees were mixed hardwoods with an occasional red cedar. The mix reflected the availability of seed from surrounding forests. The vegetation on the floor was diverse and reflected the soil conditions. In the drier areas, mosses and lichens dominate. In other areas poison ivy and Japanese honeysuckle had invaded from the surrounding forests. Little blue stem (*Andropogon scoparius*) was found scattered throughout the area.

There was evidence that new soils were being deposited throughout the area as the concentration of vegetation increases and larger trees grow around the perimeter contributing leaf litter. This area is considered to be a low quality example of limestone barren because of the deeper soils and diversity of vegetation.

#### 4.7.4 Canebrakes

Canebrake communities are composed of understory and forest floor vegetation that lay within the sycamore+green ash+willow bottomland forest community throughout the foothills of Appalachia. These canebrakes have been reduced by 95 percent, largely due to free-range livestock, drainage, conversion to agriculture, and fire suppression (Grossman et al. 1994). The Environmental Assessment (DOE 1996A) stated the canebrake communities along East Fork Poplar Creek were the most extensive on the Oak Ridge Reservation at that time.

Forested canebrakes were reported in various locations along floodplains of East Fork Poplar Creek and its tributaries in the Environmental Assessment (DOE 1996A) and the baseline studies (DOE 1997). The canebrakes existed as discrete patches in a bottomland mosaic. By the summer of 2002 the canebrakes had expanded throughout the floodplains. For example, increased sun light in the areas cleared for bridge construction has caused cane to flourish.

The canopy of the forested area containing canebrakes was dominated by sycamore (*platanus occidentalis*), American elm (*Ulmus americana*), and box elder (*Acer negundo*). The subcanopy and understory was dominated by box elder. The groundcover was dominated by cane, windstem (*verbessina alternifolia*), and exotic ground ivy (*Glechoma hederacea*). In many areas the major competitor was privet (*Ligustrum sineses*), which is an aggressive exotic in this region of Tennessee.

#### 4.7.5 Walnut Plantations

Two walnut plantations were planted prior to 1977. Walnut Plantation 1 is located within the floodplain of East Fork Poplar Creek and Walnut Plantation 2 is upland and borders the North Perimeter Road. They differ in growth and ecological character.

Aerial photographs show the site now occupied by Walnut Plantation 1 was actively used for agriculture in 1942. Due to the high likelihood of flooding, it was used for grazing and as a hay meadow. It was almost completely surrounded by narrow strips of forest along the East Fork Poplar Creek and steep slopes to the west. Following government acquisition this parcel entered active succession. By the time it was planted in walnut (*Juglans nigra*), the parcel was surrounded by highly invasive primary and secondary succession species.

The invasion was so rapid and strong that the planted walnut trees were overgrown. Many were so heavily shaded they died. Others walnut trees were unable to bear the weight of climbing vines and bent toward the ground or fell to the ground. A few continued to compete. In 2002 most of the surviving walnuts were less than two inches in diameter at four feet from the base.

Exotic species such as Japanese honeysuckle, Nepal grass, stinging nettle (*Urtica dioica*), multiflora rose (*Rosa multiflora*), and privet (*Ligustrum sinense* and *L. vulgare*) composed approximately 50 percent of the vegetation in Walnut Plantation 1. Other plants that dominated the area included blackberry (*Rubus* sp.), Virginia creeper (*Parthenocissus quinquefolia*), virgin's bower (*Clematis virginiana*), tulip poplar, and sweetgum (*Liquidambar styraciflua*).

While there have been no human influences on this parcel of land in the last decade, the parcel should no longer be identified as a walnut plantation. However, it will continue to be protected as a part of the Natural Area.

Prior to the government's acquisition, the land in Walnut Plantation 2 was actively used for row crop agriculture. The southern border was wooded, while the northern boundary was adjacent to perimeter road. Here, the succession was less aggressive. This was due, in part, to the soil type, moisture availability, and types of plants available for invasion.

By 2002 only a small portion of Walnut Plantation 2 had succumbed to succession. The invasion that had occurred was restricted to groundcover species. Nepal grass was prevalent throughout this. Japanese honeysuckle was common but not pervasive. The groundcover provided excellent habitat for many game mammals and birds.

Most of the walnut trees in Walnut Plantation 2 were and attained a diameter of approximately four inches at four feet above the ground. Many produced nuts in 2002.

#### **4.7.6 Threatened and Endangered Plant Species**

The baseline study (DOE 1997) reported the presence of five plant species having state or federal protection on the Horizon Center. During the late spring and early summer of 2002, protection zones were established around each area where these were reported. Below is a description of each of these sites.

#### **4.7.7 Yellow Lily and Golden Seal Populations**

A plant community containing yellow lily (*Cypripedium acaule*) and golden seal (*hydrastis canadensis*) is located in hardwood dominated mesic forest on limestone slopes adjacent to Walnut Plantation 1. The slope has approximately 10-percent exposed limestone. There has been sufficient seepage to keep the soils moist in the earlier portion of the growing season. The area is bounded on the bottom of the slope by the floodplain of East Fork Poplar Creek and on the top of the slope by a former pine plantation that is now in secondary succession in 2002. The 30 meter wide floodplain was observed to be flooded to the edge of the slope on four different occasions from late spring to late fall of 2002.

The open canopy was primarily composed of white oak and white ash. Filtered light was abundant during much of the day. The understory was moderate and composed of sugar

maple, American elm, and dogwood. The herbaceous layer was very diverse with such plants as wild ginger, Jacob's ladder, rattlebrush grass, Virginia creeper, trillium, bloodroot, and poison ivy. Exotic species include sparse populations of Japanese honeysuckle and microstigmum. In 2002, approximately 150 golden seal were observed and most were located on the lower half of the slope. In addition, the approximate 200 yellow lilies were distributed throughout.

Since this site was not used for agricultural purposes prior to government acquisition, had steep rocky slopes, and extended into the floodplain, the vegetation on the area has been protected for at least half a century.

#### **4.7.8 Additional Golden Seal Population**

The slope that supports the golden seal and yellow lily continues to the northeast and provides habitat for a moderate population of golden seal. The 20-30 percent slope was too steep for agriculture; thus, it was wooded at the time of government acquisition.

The slope had a narrow hardwood dominated mesic forest bounded at the top by a red cedar-pine second growth forest and at the bottom by Walnut Plantation 1. The understory was sparse and is composed of sugar maple, American elm, and dogwood. The herbaceous layer was also sparse with such plants as wild ginger, Jacob's ladder, Virginia creeper, trillium, and poison ivy.

The slope had approximately 20-percent exposed limestone and thin soils over limestone. Portions of the slope had sufficient seepage to keep local soils moist in the earlier portion of the growing season. However, most of the slope dried quickly. The open canopy allowed filtered light on the forest floor during much of the day.

Approximately 25 small plants were observed over an area approximately 100 meters by 10 meters on the lower half of the slope. The 1996 investigators stated the habitat was marginal for continued survival. There were no observed evidence of changes or disturbances by man since the baseline studies and the population appears to be stable.

#### **4.7.9 Pink Lady Slipper Population**

A large population of pink lady slipper (*Cypripedium acaule*) was found on the left-bank-descending along the lower portion of East Fork Poplar Creek in June of 1996 (DOE 1997). The site was adjacent to a pine plantation that had been devastated by the pine beetle. As reported in 1997, many of the trees were dead and fallen with the early stages of succession underway. The probability for survival of the lady slipper was stated to be marginal.

In 2002 all of the pine were dead and the entire area had a dense cover of low-lying vegetation. No lady slippers were found in 2002. Additional searches for lady slippers will be conducted in the future.

#### **4.7.10 Beak Rush Community**

Table 1 of the baseline study (DOE 1997) identifies the location for beak rush (*Rhynchospora colorata*) and plots the position on a map in Figure 2 of that document. The appendix of the 1997 report describes the beak rush community and states the size of the area to be approximately 20 square feet. No beak rush were found in the spring and summer of 2002. Additional searches for the beak rush will be conducted in the future.

#### **4.7.11 Ginseng Population**

Nine ginseng (*Panax quinquefolius*) plants were found in 1996 and marked on a map in the baseline studies (DOE 1997). Descriptions of site and location were vague and the field markings could not be located. The general location was in a pine thicket that had succumbed to the pine beetle by 2002. Tree trunks and limbs had fallen to the ground and were overgrown with honeysuckle, blackberry, grape, etc. Throughout the spring, summer, and fall of 2002 efforts were made to locate the ginseng but they were unsuccessful.

#### **4.7.12 Cave Entrance**

The EA (DOE 1997A) and the baseline study (DOE 1997) reference a cave entrance along North Perimeter Road. However, they do not describe the entrance or its condition. The entrance was located and marked in 2002. The narrow elongated opening was approximately one meter wide and half a meter high and was situated in the side of the North Perimeter Road drainage ditch. It was open and not obstructed. The surrounding vegetation was primarily privet and Japanese honeysuckle.

The ditch is a wet weather conveyance that brings water from both directions to the cave entrance during and following a storm event. Water was observed flowing into the cave during several storm events spanning all seasons of 2002. Due to the topography of the watershed, the flow abates soon after the storm ends.

#### **4.7.13 Springs**

The EA (DOE 1996A) and the MAP references two springs in the lower reaches of the East Fork Poplar Creek floodplain. These, plus an additional spring, were located and marked in 2002. All of these produced large flows of clear water throughout the year. Each was in a protected cove with small surface watersheds; thus, their downstream flows were not impacted by surface conditions. Each had tracks of several types of wildlife around their perimeters.

#### **4.7.14 Sinkholes**

Several small sinkholes and one large one have been located on the Horizon Center. The only one of these actively inspected was the large sinkhole along the North Perimeter Road. Amphibian traps were laid and active herpetological searches were conducted throughout this sinkhole. Heavy equipment had left deep ruts throughout the logged area. (Much of it had been logged in the early 1990s.) In 2002 the area was in secondary succession. Privet, green ash, and box elder were dominant vegetation. Other areas were more mature with box elder and green ash being the dominant tree.

No disturbances have occurred in this sinkhole since the logging operation. It is within the Natural Area that is to be protected.

#### **4.7.15 Wetlands**

All known wetlands are in Natural Areas that are to be protected. Several wetlands were observed on a casual basis to discern whether they were stressed or being impacted from external influences. All appear to be healthy and well used by wildlife.

#### **4.7.16 Buffer Zones**

Buffer zones around the Horizon Center, Natural Areas, sensitive areas, and cultural resources were examined during each season of 2002. There were no encroachments or need of special maintenance found. Outer margins of buffers for beech-maple forest, s, the five state or federal listed plant sites, and the cultural resource mill sites (40RE195 and 40RE200) were marked. The McKamey-Carmichael cemetery already had a fence around it.

## 4.8 Game Species

As was the case in previous reports only casual observations of game species were made in 2002. Thus, no attempts were made to quantify populations of rabbits (*Sylvilagus floridana* and *S. aquaticus*), whitetail deer (*Odocoileus virginiana*), wild turkey (*Meleagris gallopavo*), wood duck (*Aix sponsa*), mallard duck (*Anas platyrhynchos*), ruffed grouse (*Banasa umbellus*), and northern bobwhite (*colinus virginianus*). A description of the species observed in 2002 is provided below.

Rabbit – In past years only eastern cottontail rabbits have been reported. However, during the spring of 2002 several swamp rabbits were also seen in the floodplain and sinkhole. The eastern cottontail appears to be increasing due to the increase of open land and succession.

White-tail deer – In the baseline study (DOE 1997) the white-tail deer population was roughly estimated at one deer per 15 acres of land. The estimate was based on the hunting records for the Oak Ridge Reservation in general, and may have been low for the high carrying capacity at the Horizon Center. No deer hunting was permitted during the past five hunting seasons; therefore, no recent harvest records were available.

Observations indicated white-tail deer were common at the Horizon Center during 2002. Deer moved over most of the parcel. Tracks of buck, doe, and young were observed in roadways, clearings, and around water holes. Several doe with young were observed during the summer and fall months; thus, indicating a viable breeding herd of white-tail deer on the Horizon Center in 2002.

Wild turkey – Wild turkey were re-introduced into the Oak Ridge Reservation in the mid-1980s. At that time, the Horizon Center provided prime habitat for turkey production and the population quickly expanded. The secondary succession resulting from pine beetle destruction of timber reduced prime habitat at the Horizon Center and construction of infrastructure further reduced the acres of range that support the birds. However, the increased open area for building sites and infrastructure and the increased edge along boundaries between secondary growth and mature forest increased the quality of the habitat available.

Wild turkey were seen throughout the Horizon Center in all months of the year. Several broods of young poults were observed during late spring and early summer of 2002.

Wood duck – From 1993 through 2002 breeding wood ducks were observed along East Fork Poplar Creek. In 2000 three breeding pairs were identified and groups of wood ducks were seen during the winter. At least four pair of breeding wood ducks were observed on the Horizon Center in the summer of 2002. Throughout the year single ducks and pairs were seen along Bear Creek and East Fork Poplar Creek. In the fall there were several wood ducks observed feeding in the wetlands near the confluence of East Fork Poplar Creek with Poplar Creek. Thus, the East Fork Poplar Creek continues to provide suitable year-round habitat for wood ducks.

Mallard duck –Breeding mallard ducks were reported in East Fork Poplar Creek in the summer of 2000. They were also heard and seen on other occasions in that summer, fall, and winter. However, no breeding mallard ducks were seen in 2002.

Northern bobwhite – Northern bobwhite has been considered to be a declining species on the Oak Ridge Reservation (DOE 1997). There were none reported on the Horizon Center in the 1999 census, and the bobwhite population in 2000 was less than reported in the baseline study. Bobwhite were observed in several locations on the Horizon Center in the spring and summer of 2002. The increased open areas, edges, and areas in secondary succession provided habitat that supported a partial recovery of this game bird.

Ruffed Grouse – Ruffed grouse has not been reported at the Horizon Center in previous years, even though surrounding lands had sparse scattered populations. In 2002, mating pairs were seen in the Walnut Plantation 2 adjacent to the perimeter road and near McKamey-Carmichael Cemetery. No nests of young were observed.

## **5. CULTURAL RESOURCES**

All known cultural resources at the Horizon Center continued to be protected. The 100-foot buffer placed around the McKamey-Carmichael and Silvey cemeteries have been maintained.

Mill sites 40RE195 (975C) and 40RE200 (939B) along East Fork Poplar Creek, including 100-foot buffers, were marked as a precaution to encroachment.

## **6. ENVIRONMENTAL PERMITS**

No environmental permits were required in 2001 or 2002.

## 7. REFERENCES

- Awl, D.J., L. R. Pounds, B. A. Rosensteel, A. L. King, and P. A. Hamlett. 1996. *Survey of protected vascular plants on the Oak Ridge Reservation, Oak Ridge, Tennessee*. ES/ER/TM-194. W.S. Doe, Office of Environmental Management, Oak Ridge, Tennessee.
- DOE. 1996A. *Environmental Assessment – Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council*. DOE/EA-1113, April 1996.
- DOE. 1996B. *Mitigation Action Plan – Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council*. DOE/EA-1113, April 1996.
- DOE. 1997. *Annual Report – Implementation of Mitigation Action Plan for DOE/EA-1113: Lease of Parcel ED-1 of the Oak Ridge Reservation, Oak Ridge, Tennessee. Pre-Development Ecological surveys*, DOE/EA-1113/MAP-97. November 1997.
- DOE. 1998. *Annual Report – Implementation of Mitigation action Plan for DOE/EA-1113: Lease of Parcel ED-1 of the Oak Ridge Reservation, Oak Ridge, Tennessee. Pre-Development Ecological surveys*, DOE/EA-1113/MAP-98. December 1998.
- DOE. 1999. *Annual Report – Implementation of Mitigation action Plan for DOE/EA-1113: Lease of Parcel ED-1 of the Oak Ridge Reservation, Oak Ridge, Tennessee. Pre-Development Ecological surveys*, DOE/EA-1113/MAP-99. December 1999.
- DOE. 2000. *Annual Report – Implementation of Mitigation action Plan for DOE/EA-1113: Lease of Parcel ED-1 of the Oak Ridge Reservation, Oak Ridge, Tennessee. Pre-Development Ecological surveys*, DOE/EA-1113/MAP-99. December 2000.
- Grossman, D. H., K. L. Goodin, and C. L. Reuss, eds. 1994. *Rare Plant Communities of the Conterminous United States: An Initial Survey*. Idaho Cooperative U.S. Fish and Wildlife Research Unit. The Nature Conservancy, Arlington, Va.
- Kroodsma, R. L. 1987. *Resource Management Plan for the Oak Ridge Reservation. Volume 24: Threatened and Endangered Animal Species*. ORNL/ESH-1/V24. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Little, T. M. And F. Jackson Hills. 1978. *Agricultural Experimentation: Design and analysis*. John Wiley and Sons, New York, New York.
- Mitchell, J. M., E. R. Vail, J. W. Webb, J. W. Evans, A. L. King and P. A. Hamlett. 1996. *Survey of protected terrestrial vertebrates on the Oak Ridge Reservation. Final Report*. Environmental Restoration Division. U. S. Dept. of Energy. ES/ER/TM-188/R1. Oak Ridge, Tennessee. 60p.

**U.S. Department of Energy  
Oak Ridge Operations Office  
Document/Web Text Approval Form**

REQUESTED APPROVAL ACTION:  
(check all that apply)

Place in DOE Information Center  
Place on ORO Homepage  
Issue to Requestor via Public Affairs Office  
Return to originator

Date of Request May 23, 2003 Date Approval Required May 27, 2003

Document or Web Text Title Annual Report - CY 2002 - Implementation of Mitigation Action Plan for Lease of Parcel ED-1 on the ORR

Document Number(s) DOE/EA-1113/MAP-02 Document Date May 2003

Person Requesting Release Susan Cunge

ORO Mail Code: AV-61 Building/Room Number Federal Building

Phone 576-0334 Fax \_\_\_\_\_ Email \_\_\_\_\_

Type of Document:

- |  |                                     |   |   |
|--|-------------------------------------|---|---|
| <input checked="" type="checkbox"/> Report | <input type="checkbox"/> Map        | <input type="checkbox"/> Correspondence | <input type="checkbox"/> ORO Internet Homepage WebText      |
| <input type="checkbox"/> Brochure          | <input type="checkbox"/> Fact Sheet | <input type="checkbox"/> News Release   | <input type="checkbox"/> Slides/Handouts/Briefing Materials |
| <input type="checkbox"/> Videotape         | <input type="checkbox"/> Photo      | <input type="checkbox"/> Other _____    |   |

Purpose of Release:

- |   |  |   |   |
|---|--|---|---|
| <input checked="" type="checkbox"/> Citizen Request | <input checked="" type="checkbox"/> ORO Homepage | <input type="checkbox"/> Elected Official | <input type="checkbox"/> Public Meeting Use |
| <input checked="" type="checkbox"/> DOE Info Center | <input type="checkbox"/> Media Request           | <input type="checkbox"/> FOIA Request     | <input type="checkbox"/> Other _____        |

Comments

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

ORO APPROVALS SECTION:

Minimum of either Public Affairs or Safeguards and Security required:

Public Affairs *[Signature]* Date 5-23-03

Safeguards and Security \_\_\_\_\_ Date \_\_\_\_\_

Others (as Requested)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ Date \_\_\_\_\_  
\_\_\_\_\_ Date \_\_\_\_\_  
\_\_\_\_\_ Date \_\_\_\_\_

APPENDIX A

DATA TABLES

**Table 1. Number of fish collected on April 24, 2002, at Dace Branch (DBK 0.3) in millimeter (mm) size classes.**

Species	Size Class (mm)	Number
Central stoneroller <i>Compostoma anomalum</i>	50-74	7
	75-99	5
	100-124	<u>4</u>
		Total = 16
Creek Chub <i>Semotilus atamaculatus</i>	75-99	4
	100-124	3
	125-149	<u>1</u>
		Total = 8
Blacknose dace <i>Rhinichthys atratulus</i>	50-74	9
	75-99	4
	100-124	<u>3</u>
		Total = 16
Banded Sculpin <i>Cottus carolinae</i>	50-74	4
Saffron Shiner <i>Notropis ribricroceus</i>	1-24	5
	25-49	16
	50-74	<u>1</u>
		Total = 22
Bluegill <i>Lepomis macrochirus</i>	75-99	2
Flame chub <i>Hemitremia flammea</i>	25-49	1

**Table 2. Number of fish collected on April 24, 2002, in pool of Dace Branch at SR95 reported in millimeter (mm) size classes.**

Species	Size Class (mm)	Number
Central stoneroller <i>Compostoma anomalum</i>	50-74	9
	75-99	8
	100-124	<u>2</u>
		Total = 19
Creek Chub <i>Semotilus atamaculatus</i>	75-99	7
	100-124	8
	125-149	<u>4</u>
		Total = 19
Blacknose dace <i>Rhinichthys atratulus</i>	50-74	4
	75-99	<u>5</u>
		Total = 9
Tennessee dace <i>Phoxinus tennesseensis</i>	75-99	2

**Table 3. Summary of Terrestrial Vertebrates Captured or Observed on the Horizon Center in the Spring and Summer of 2002.**

Site	Trap types	Habitat type	Vertebrates captured or observed
1	Array with pitfalls & 2 Coverboards  2 hr. Active search	Bottomland Forest	Amphibians: American toad (2), upland chorus frog (2), southern cricket frog (5), pickerel frog (3) Reptiles: box turtle (1) Mammals: deer mouse (6), white-footed mouse (3) Amphibians: southern leopard frog (5), pickerel frog (1), upland chorus frog (several sighted), northern dusky salamander (1), Reptiles: box turtle (2)
2	Array with pitfalls & 2 Coverboards  2 hr. Active search	Bottomland Forest	Amphibians: American toad (1), pickerel frog (1), northern dusky salamander (2) Reptiles: eastern garter snake (1), black rat snake (1) Mammals: deer mouse (4), white-footed mouse (2), southeastern shrew (2) Amphibians: dusky salamander (1) Reptiles: box turtle (2), northern black racer (1)
3	Array with pitfalls & 2 Coverboards	Oak-Hickory-Ash Limestone Woodland	Amphibians: American toad (2), eastern spadefoot (2) Reptiles: ground skink (4), five-lined skink (3), northern ringneck snake (2), eastern worm snake (1) Mammals: deer mouse (2)
4	Array with pitfalls & 4 Coverboards  2 hr. Active search	Beech-Maple Forest	Amphibians: eastern spadefoot (2) Reptiles: box turtle (1), black rat snake (1), ground skink (3) Mammals: deer mouse (5), white-footed mouse (2), short-tail shrew (2) Amphibians: American toad (1), eastern spadefoot (2)

Table 3 Continued

Site	Trap types	Habitat type	Vertebrates captured or observed
5	Array with pitfalls & 2 Coverboards	Bottomland Forest	Amphibians: bullfrog (2), leopard frog (3), northern slimy salamander (2), long-tailed salamander (1), northern dusky salamander (1) Mammals: deer mouse (1), southeastern shrew (2), short-tail shrew (1)
6	Transect with Pitfalls & 2 Coverboards	Secondary Succession	Reptiles: black rat snake (1), ground skink (1)
7	2 Coverboards 2 hr. Active Search	Hardwood Plantation	Mammals: white-footed mouse (2) Reptiles: ground skink (2)
8	4 Coverboards	Black Walnut Plantation	None :
9	4 Coverboards  2 hr. Active search	Sinkhole	Amphibians: eastern spadefoot (1), American toad (1), Reptiles: five-lined skink (3), ground skink (1), northern ringneck snake (1), eastern worm snake (1) Mammals: white-footed mouse (4), shorttail shrew (2) Amphibians: leopard frog (5) Reptiles: five-lined skink (3), ground skink (1), northern ringneck snake (2), black racer (1) Mammals: shorttail shrew (1)
10	4 Coverboards	Bottomland Forest	Mammals: white-footed mouse (2)
11	4 Coverboards 2 hr. Active search	Secondary Succession	None None
12	4 Coverboards  2 hr. Active search	Forested limestone Cliff	None None
13	4 Coverboards	Bottomland Forest	Amphibians: leopard frog (1), dusky salamander (1) Reptiles: northern copperhead (1)
14	4 Coverboards	Secondary Succession	Amphibians: Reptiles: ground skink (2), five-lined skink (1) Mammals: deer mouse (1)
16	12 Pitfalls	Sinkhole.	Amphibians: American toad (2),

Table 4. Matrix of Vertebrates Captured or Observed at Sites on Horizon Center in the Spring and Summer 2002.

Trapping Stations >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16
Southeastern shrew <i>Sorex longirostris</i>		X			X										
Shorttail shrew <i>Blarina brevicauda</i>				X	X				X						
White-footed mouse <i>Peromyscus leucopus</i>	X	X		X			X		X	X					
Deer mouse <i>Peromyscus maniculatus</i>	X	X	X	X	X									X	
Eastern box turtle <i>Terrapene carolina carolina</i>	X	X		X											
Ground skink <i>Scincella lateralis</i>		X	X	X		X	X		X					X	
Five-lined skink <i>Eumeces fasciatus</i>			X						X					X	
Eastern garter snake <i>Thamnophis sirtalis sirtalis</i>		X							X						
Northern ringneck snake <i>Diadophis punctatus edwardsii</i>			X						X						
Eastern worm snake <i>Carphophis amoenus amoenus</i>			X												
Northern black racer <i>Coluber constrictor constrictor</i>		X													
Black rat snake <i>Elaphe obsoleta obsoleta</i>		X		X		X									
Northern copperhead <i>Agkistrodon contortrix mokasen</i>													X		

Table 4 Continued

Trapping Stations >	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16
Northern dusky salamander <i>Desmognathus fuscus fuscus</i>	X	X			X								X		
Northern slimy salamander <i>Plethodon glutinosus</i>					X										
Long-tailed salamander <i>Eurycea longicauda longicauda</i>					X										
Eastern spadefoot <i>Scaphiopus holbrookii holbrookii</i>			X	X					X						
American toad <i>Bufo americanus</i>	X	X	X	X					X					X	
Upland chorus frog <i>Pseudacris triseriata feriarum</i>	X														
Northern spring peeper <i>Hyla crucifer</i>	X														
Cricket frog <i>Acris crepitans</i>	X														
Bullfrog <i>Rana catesbeinana</i>					X										
Southern leopard frog <i>Rana utricularia utricularia</i>	X				X				X				X		
Pickerel frog <i>Rana palustris</i>	X	X													

**Table 5. Relative Intensity of Amphibian Calling Activity on Horizon Center for 2002.**

Species	Station 1	Station 2	Station 3	Station 4	Station 5
American toad <i>Bufo americanus</i>	March 4	March 2	March 1	March 0	March 2
	April 2	April 1	April 4	April 0	April 4
	May 2	May 1	May 2	May 0	May 2
	June 0	June 0	June 0	June 0	June 0
	July 0	July 0	July 0	July 0	July 0
Cope's gray treefrog <i>Hyla chrysoscelis</i>	March 0	March 0	March 0	March 0	March 0
	April 0	April 0	April 0	April 0	April 0
	May 4	May 4	May 3	May 2	May 4
	June 4	June 5	June 3	June 3	June 5
	July 3	July 3	July 3	July 3	July 4
Spring peeper <i>Pseudacris cricifer</i>	March 0	March 0	March 4	March 0	March 5
	April 4	April 0	April 5	April 2	April 5
	May 3	May 0	May 3	May 0	May 3
	June 1	June 0	June 1	June 0	June 0
	July 0	July 0	July 0	July 0	July 0
Upland chorus frog <i>Pseudacris triseriata</i>	March 0	March 0	March 3	March 0	March 0
	April 0	April 3	April 4	April 2	April 0
	May 0	May 1	May 0	May 0	May 0
	June 0	June 0	June 0	June 0	June 0
	July 0	July 0	July 0	July 0	July 0
Eastern narrowmouth toad <i>Gastrophryne carolinensis</i>	March 0	March 0	March 0	March 0	March 0
	April 0	April 0	April 0	April 0	April 0
	May 2	May 0	May 2	May 0	May 0
	June 2	June 0	June 2	June 0	June 0
	July 2	July 0	July 0	July 0	July 0

Table 5 Continued

Species	Station 1	Station 2	Station 3	Station 4	Station 5
Eastern spadefoot <i>Scaphiopus holbrookii</i>	March 0	March 0	March 0	March 0	March 0
	April 0	April 0	April 0	April 0	April 0
	May 0	May 0	May 0	May 2	May 2
	June 2	June 0	June 0	June 3	June 4
	July 0	July 0	July 0	July 2	July 2
Bull frog <i>Rana catesbeiana</i>	March 0	March 0	March 0	March 0	March 0
	April 0	April 0	April 0	April 0	April 0
	May 3	May 0	May 0	May 0	May 3
	June 2	June 0	June 0	June 0	June 3
	July 0	July 0	July 0	July 0	July 0
Green frog <i>Rana clamitans</i>	March 0	March 0	March 0	March 0	March 0
	April 0	April 0	April 0	April 0	April 0
	May 2	May 0	May 3	May 2	May 2
	June 2	June 0	June 5	June 2	June 3
	July 1	July 0	July 2	July 0	July 2
Pickerel frog <i>Rana palustris</i>	March 3	March 0	March 0	March 2	March 1
	April 0	April 0	April 0	April 0	April 0
	May 0	May 0	May 0	May 0	May 0
	June 0	June 0	June 0	June 0	June 0
	July 0	July 0	July 0	July 0	July 0
Southern leopard frog <i>Rana utricularia</i>	March 0	March 0	March 0	March 2	March 2
	April 0	April 0	April 0	April 2	April 2
	May 0	May 0	May 0	May 0	May 0
	June 0	June 0	June 0	June 0	June 0
	July 0	July 0	July 0	July 0	July 0

0= Absence of calling

1= Single individual calling

2= Occasional calling by individuals

3= Low intensity, relatively frequent calling

4= Medium intensity, continuous calling

5= High intensity, continuous calling

**Table 6. Mammals Observed on the Horizon Center in 2002.**

Southeaster shrew <i>Sorex longirostris</i>	Eastern gray squirrel <i>Sciurus carolinensis</i>
Shorttail shrew <i>Blarina brevicauda</i>	Southern flying squirrel <i>Glaucomys volans</i>
O'possum <i>Didelphius virginiana</i>	Deer mouse <i>Peromyscus maniculatus</i>
Raccon <i>Procyon lotor</i>	White-footed mouse <i>Peromyscus leucopus</i>
Mink <i>Mustela vison</i>	Muskrat <i>Ondatra zivethica</i>
Striped skink <i>Mephitis mephitis</i>	Beaver <i>Castor canadensis</i>
Coyote <i>Canis latrans</i>	Eastern cottontail rabbit <i>Sylvilagus floridanus</i>
Gray fox <i>Urocyon cinereoargenteus</i>	Swamp rabbit <i>Sylvilagus aquaticus</i>
Bob cat <i>Lynx rufus</i>	Whitetail deer <i>Odocoileus virginianus</i>
Woodchuck <i>Marmota monax</i>	Feral domestic dog <i>Canis familiaris</i>
Eastern Chipmunk <i>Tamias striatus</i>	Feral domestic cat <i>Felis domestica</i>

**Table 7. Birds observed on the Horizon Center in the 1996 baseline studies and 2002.**

Bird type	2002 Bird Census				Night and Incidental	1996
	Periphery		Floodplain			
	April	June	April	June		
Wood Duck	X		X	X		X
Canada Goose	X	X	X			X
Great Blue Heron	X	X	X	X		X
Green Heron	X					
Black Vulture	X		X			X
Turkey Vulture	X		X	X		
Barred Owl					X	X
American Kistrel					X	X
Broad-winged Hawk	X	X	X	X		
Cooper's Hawk						X
Red-shouldered Hawk	X	X		X	X	X
Red-tailed Hawk	X	X		X		X
Sharp-shinned Hawk	X					X
Osprey		X			X	
Ruffed Grouse					X	X
Wild Turkey	X	X	X	X	X	X
Northern Bobwhite	X			X	X	X
Killdeer			X		X	X
Ring-billed Gull	X					
Spotted Sandpiper			X			
Belted Kingfisher	X		X	X		
Common Snipe						
American Woodcock					X	X
Mourning Dove	X	X	X	X	X	X
Common Nighthawk					X	X
Chuck-will's-widow					X	X
Whip-poor-will					X	X
Black-billed Cuckoo	X					
Yellow-billed Cuckoo	X	X		X	X	X
Chimney Swift			X	X	X	X
Ruby-throated Hummingbird	X	X	X	X	X	X
Barn Swallow	X					
Northern Rough-winged Swallow	X					
Downy Woodpecker	X	X	X	X		X
Hairy Woodpecker						X
Northern Flicker	X	X		X		X

Table 7 Continued

Bird type	2002 Bird Census				Night and Incident	1996
	Periphery		Floodplain			
	April	June	April	June		
Pileated Woodpecker	X	X	X	X	X	X
Red-bellied Woodpecker	X	X	X	X		X
Acadian Flycatcher	X	X	X	X	X	X
Eastern Kingbird	X	X		X	X	X
Great Crested Flycatcher	X		X			X
Least Flycatcher	X					
Willow Flycatcher	X					
Eastern Phoebe	X	X	X	X	X	X
Eastern Wood-Pewee	X				X	
American Crow	X	X	X	X	X	X
Blue Jay	X	X		X	X	X
Carolina Chickadee	X	X	X	X	X	X
Tufted Titmouse	X	X	X	X	X	X
White-breasted Nuthatch	X	X	X	X	X	X
Carolina Wren	X	X	X	X	X	X
House Wren	X				X	X
Golden-crowned Kinglet	X					
Ruby-crowned Kinglet	X					X
Blue-gray Gnatcatcher	X	X	X	X	X	X
Eastern Bluebird	X	X		X	X	X
American Robin					X	X
Hermit Thrush	X					
Swainson's Thrush	X		X			X
Wood Thrush	X	X	X	X		X
Brown Thrasher	X				X	
Gray Catbird	X	X		X	X	X
Northern Mockingbird	X		X		X	X
Cedar Waxwing		X			X	X
European Starling	X		X		X	X
Red-eyed Vireo	X	X	X	X	X	X
Solitary Vireo						X
White-eyed Vireo	X	X	X	X	X	X
Yellow-throated Vireo	X	X	X	X		X
Bay-breasted Warbler						X
Black-and-white Warbler	X			X		X
Blackburnian Warbler						X
Blackpoll Warbler						X
Black-throated Green Warbler	X					X

Table 7 Continued

Bird type	2002 Bird Census				Night and Incident	1996
	Periphery		Floodplain			
	April	June	April	June		
Blue-winged Warbler	X	X	X	X	X	X
Canada Warbler						X
Cape May Warbler						X
Cerulean Warbler						X
Chestnut-sided Warbler	X					
Common Yellowthroat	X		X		X	X
Golden-winged Warbler	X					
Hooded Warbler	X	X	X	X	X	X
Hooded Warbler	X	X	X	X	X	
Kentucky Warbler	X	X	X	X	X	X
Magnolia Warbler	X	X			X	X
Nashville Warbler	X					
Northern Parula	X	X	X	X	X	X
Ovenbird	X					X
Palm Warbler	X	X				
Pine Warbler	X	X	X	X	X	X
Prairie Warbler	X	X	X	X	X	X
Prothonotary Warbler	X	X				X
Swainson's Warbler			X	X		
Tennessee Warbler	X					
Wilson's Warbler						X
Worm-eating Warbler	X					X
Yellow-rumped Warbler	X	X				X
Yellow-throated Warbler	X	X	X	X	X	X
American Redstart						X
Louisiana Waterthrush	X					
Northern Waterthrush		X				X
Yellow-breasted Chat	X	X	X		X	X
Scarlet Tanager	X	X	X	X	X	X
Summer Tanager	X	X	X	X	X	X
Indigo Bunting	X	X	X	X	X	X
Northern Cardinal	X	X	X	X	X	X
Rose-breasted Grosbeak	X	X			X	
Eastern Towhee	X	X	X	X	X	X

Table 7 Continued

Bird type	2002 Bird Census				Night and Incident	1996
	Periphery		Floodplain			
	April	June	April	June		
Chipping Sparrow	X	X		X	X	
Field Sparrow	X	X	X	X	X	X
Song Sparrow	X	X		X	X	
Swamp Sparrow	X					X
White-throated Sparrow	X	X	X		X	X
American Goldfinch	X	X	X	X	X	X
Red-winged Blackbird					X	
Common Grackle					X	X
Brown-headed Cowbird	X	X	X			X

**Table 8. Birds Observed at Periphery Stations 92 and 93 in Baseline Studies (1996), 2000, and 2002.**

Bird type	Station 92			Station 93		
	1996	2000		1996	2000	2002
Great blue heron		X				
Black Vulture						X
Turkey vulture						X
Red-shouldered hawk						X
Red-tailed hawk		X				X
Northern Bobwhite		X		X	X	X
Killdeer		X				
Mourning Dove		X		X	X	X
Black-billed cuckoo						X
Yellow-billed Cuckoo					X	
Downey Woodpecker	X	X		X	X	X
Hairy woodpecker		X				
Northern Flicker		X		X		X
Pileated woodpecker		X		X	X	X
Red-bellied Woodpecker					X	X
American Crow	X	X		X	X	X
Blue Jay	X	X			X	X
Carolina Chickadee	X	X		X	X	X
Eastern Tufted Titmouse	X			X	X	
Carolina Wren	X	X		X	X	X
House wren						X
Blue-gray Gnatcatcher	X	X			X	X
Eastern Bluebird	X	X		X		X
Gray catbird						X
Northern Mockingbird						X
Cedar waxwing		X			X	
Red-eyed Vireo	X	X		X	X	
White-eyed Vireo	X	X		X	X	X
Blackburnian warbler		X				
Blue-winged Warbler						X
Common yellow throat	X	X		X	X	X
Hooded Warbler						X
Kentucky Warbler		X		X		
Magnolia warbler		X				
Northern Parula Warbler				X		
Palm warbler						X
Pine Warbler						X
Prairie Warbler	X	X		X	X	X
Wormeating Warbler				X		

Table 8 Continued

Bird type	Station 92			Station 93		
	1996	2000		1996	2000	2002
Yellow-breasted Chat		X			X	X
Scarlet Tanager	X	X		X	X	X
Summer Tanager		X			X	X
Indigo Bunting	X	X			X	X
Northern Cardinal	X	X			X	X
Eastern Towhee	X	X		X	X	X
Field sparrow	X	X		X	X	X
Swamp sparrow						X
White-throated sparrow				X		X
American Goldfinch		X		X	X	X
Common Grackle				X		
Brown-headed Cowbird		X			X	X

**Table 9. Birds Observed at Floodplain Stations 509 and 516 in Baseline Studies (1996), 2000, and 2002.**

Bird type	Station 509			Station 516		
	1996	2000	2002	1996	2000	2002
Black Vulture						X
Northern Bobwhite	X	X			X	
Killdeer			X			
Mourning Dove		X	X			X
Yellow-billed Cuckoo			X			
Barn Swallow			X			
Chimney Swifts			X			X
Downey Woodpecker	X	X	X		X	X
Hairy Woodpecker				X		
Northern Flicker					X	
Pileated Woodpecker	X					
Red-bellied Woodpecker			X	X	X	
Eastern Phoebe		X	X			X
American Crow			X	X		X
Blue Jay			X	X	X	
Carolina Chickadee	X		X		X	X
Eastern Tufted Titmouse		X	X		X	
White-breasted Nuthatch		X				
Carolina Wren		X	X		X	X
Blue-gray Gnatcatcher	X	X	X			
Eastern Bluebird		X	X			X
Wood Thrush			X	X		
Northern Mockingbird			X			
Red-eyed Vireo		X	X	X	X	X
White-eyed Vireo			X	X	X	
Yellow-throated Vireo	X		X			X
Black-and-white Warbler			X			
Blue-winged Warbler	X		X	X		
Common yellow throat	X			X	X	
Hooded Warbler			X			X
Kentucky Warbler	X		X		X	

Table 9 Continued

Bird type	Station 509			Station 516		
	1996	2000	2002	1996	2000	2002
Northern Parula		X	X	X	X	
Ovenbird				X		
Pine Warbler						X
Prairie Warbler	X		X	X		X
Yellow-throated Warbler		X		X		X
Yellow-breasted Chat	X	X	X	X	X	X
Scarlet Tanager		X	X			X
Summer Tanager						X
Indigo Bunting	X	X	X	X	X	X
Northern Cardinal	X	X	X	X	X	
Eastern Towhee	X	X	X	X	X	X
Chipping Sparrow			X			
Field Sparrow	X			X		
Song Sparrow		X	X			X
American Goldfinch			X		X	X
Brown-headed Cowbird			X			

**Table 10. Composite of Quantitative and Qualitative Macroinvertebrate macroinvertebrates at each monitoring location in April 2002 and Functional Feeding Group (FFG) and North Carolina Tolerance Value (TV) designations of each taxon.**

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>PLATYHELMINTHES</b>								
<b>Turbellaria</b>								2
<b>Tricladida</b>								
Planariidae								
<i>Cura foremanii</i>	4.97				3		10	
<i>Dugesia tigrina</i>	7.23		1	X			X	
<b>NEMATODA</b>	6.02		1	2		3	1	
<b>MOLLUSCA</b>								
<b>Bivalvia</b>								
<b>Veneroida</b>								
Corbiculidae								
<i>Corbicula fluminea</i>	6.12	FC	13	11	2			
Sphaeriidae	8	FC						
<i>Pisidium</i> sp.	6.48	FC		X			13	
<b>Gastropoda</b>								
<b>Mesogastropoda</b>								
Hydrobiidae								
<i>Amnicola</i> sp.	5.2	SC	1					
Pleuroceridae								
<i>Elimia clavaeformis</i>	5	SC	X	135	38	13		
<b>Basommatophora</b>								
Ancylidae								
<i>Ferrissia rivularis</i>	6.55	SC	X	3			X	
Physidae								
<i>Physella</i> sp.	8.84	CG		X	X			
Planorbidae	6	SC						
<i>Menetus dilatatus</i>	8.23	SC					X	

Numbers = number of individuals of respective taxon found in three surber samples,  
X = Representative of Taxa observed in the qualitative sample but was not observed in the  
Surber samples, CG = Collector/Gathers, FC = Filtering/Collectors, SC = Scrapers, SH =  
Shredders, P = Predators, PI = Piercers

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>ANNELIDA</b>								
<b>Oligochaeta</b>	10	CG						55
<b>Haplotaxida</b>								
Lumbricidae		CG	15	32	2		1	
Enchytraidae	9.84	CG	1					
Naididae	8	CG	1	67	1	X	4	
<i>Nais behningi</i>	8.89	CG	13	101	1		30	
<i>Nais bretscheri</i>	8.88	CG	7	393		5		
<i>Nais communis</i>	8.81	CG	8				13	
<i>Nais</i> sp.	8.88	CG			X	X	X	
<i>Ophidonais serpentina</i>	6	CG		X		X		
<i>Slavina appendiculata</i>	7.06	CG	22	32	3	X	1	
<i>Stylaria lacustris</i>	9.38	CG	1	666		1		
Tubificidae w.h.c.	7.11	CG	X	47	X	4	33	
Tubificidae w.o.h.c.	7.11	CG	X	X	1	4	34	
<i>Branchiura sowerbyi</i>	8.28	CG			X			
<b>Limnodrilus</b>	9.5	CG		X				
<i>Claparedianus</i>								
<i>Limnodrilus hoffmeisteri</i>	9.47	CG	X				X	
<b>Lumbriculida</b>								
Lumbriculidae	7.03	CG	4	412	20	X	8	
<b>Hirudinea</b>	8	P	1	32			X	
<b>Branchiobdellida</b>						2	X	
<b>ARTHROPODA</b>								
<b>Crustacea</b>								
<b>Isopoda</b>								
Asellidae	8	SH						
<i>Caecidotea</i> sp.	9.11	CG	10	2	X			
<i>Lirceus</i> sp.	7.85	CG	10	1	599	46	492	13
<b>Amphipoda</b>					1			
Crangonyctidae								
<i>Crangonyx</i> sp.	7.87	CG				1		4
<b>Decapoda</b>								
Cambaridae						X		
<i>Cambarus</i> sp.	7.62	CG	X	1	X	2	X	
<b>Arachnoidea</b>								
<b>Acariformes</b>			1	1		1		
Hydrachnidia								X

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>Insecta</b>								
<b>Collembola</b>							4	
Isotomidae				3			5	
<b>Ephemeroptera</b>								
Baetidae	4	CG			56	60		2
<i>Acentrella ampla</i>	3.61	CG	9		53	165	4	
<i>Acerpenna</i> sp.							85	
<i>Acerpenna pygmaea</i>								2
<i>Baetis</i> sp.	4	CG				102	347	4
<i>Baetis c.f. flavistriga</i>	6.58	CG	80	607	135	13	19	
<i>Baetis tricaudatus</i>	1.63	CG				X		
<i>Dipheter hageni</i>								60
<i>Plauditus</i> sp.	4	CG			X	63	11	
Caenidae	7	CG						
<i>Caenis</i> sp.	7.41	CG	X		X	X		2
<i>Centroptilum</i> sp.	6.66	CG				X		
Ephemeridae	4	CG						
<i>Ephemera</i> sp.	3	CG				X	X	
Ephemerellidae	1	SC						
<i>Ephemerella</i> sp.	2	SC	1					
<i>Ephemerella invaria</i> gp.					10	1		
<i>Eurylophella</i> sp.	4.34	SC	X	4	X	X	X	
Heptageniidae	4	SC						
<i>Stenacron</i> <i>Interpunctatum</i>	6.87	SC	X	43	1	3		
<i>Stenonema</i> sp.	4	SC	2		X			
<i>Stenonema femoratum</i>	7.18	SC	X			X		
<i>Stenonema</i> <i>Mediopunctatum</i>	3.77	SC	3	157	10		X	
Isonychiidae	2	FC						
<i>Isonychia</i> sp.	3.45	FC			11	45		
Leptophlebiidae	2	CG					X	
<i>Habrophlebiodes</i> sp.								52
<i>Paraleptophlebia</i> sp.	0.94	CG				1		
<b>Odonata</b>								
Aeshnidae	3	P		X	1		1	
<i>Boyeria vinosa</i>	5.89	P	X	X		X		12
Calopterygidae	5	P						
<i>Calopteryx maculata</i>	7.78	P					X	
<i>Calopteryx</i> sp.				X	X	X		

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
Coenagrionidae	9	P						
<i>Argia</i> sp.	8.17	P	X	X	X			
<i>Enallagma</i> sp.	8.91	P		X				
Corduliidae	5	P						
<i>Cordulegaster</i> sp.	5.73	P					X	
Macromiinae								
<i>Macromia</i> sp.	6.16	P	X	X		X		
Gomphidae	1	P				1	X	
<i>Gomphus</i> sp.	5.8	P	X	X				
<i>Hagenius brevistylus</i>	3.99	P		X	X			
<i>Lanthus</i> sp.	1.77	P	X	2		1	X	
<i>Dromogomphus</i> sp.	5.92	P	X					
<i>Stylogomphus albistylus</i>	4.72	P					X	2
<b>Plecoptera</b>			2					
Capniidae								
<i>Allocapnia</i> sp.								4
Chloroperlidae	1	P						1
<i>Haploperla</i> sp.	0.98	SC					18	
<i>Suwallia</i> sp.	1.18	CG					2	
Leuctridae	0	SH						
<i>Leuctra</i> sp.	0.67	SH	1	1		17		20
Nemouridae	2	SH				55		
<i>Amphinemura</i> sp.	3.33	SH	4		37	X	25	82
<i>Amphinemura delosa</i>	3.33	SH					113	
Peltoperlidae	-	SH						
<i>Tallaperla</i> sp.	1.18	SH			4	13		
Perlidae	1	P	3		X	65		10
<i>Acroneuria evoluta</i>		P				3		
<i>Acroneuria</i> sp.	1	P				1		
<i>Beloneuria</i> sp.	0						73	
<i>Eccoptura xanthenes</i>	3.74	P				2	1	6
<i>Perlesta</i> sp.	4.7	P			22	38	158	20
Perlodidae		P						
<i>Isoperla bilineata</i>	5.44	P			X	X		
<i>Isoperla</i> sp.	2	P				2		
Taeniopterygidae	2	SH						
<i>Taeniopteryx</i> sp.	5.37	SH	1		20	28	20	

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>Hemiptera</b>							X	
Veliidae	-	P						
<i>Microvelia</i> sp.	-	P					X	
<i>Rhagovelia obesa</i>	-	P		X	X			
<b>Megaloptera</b>								
Corydalidae	0	P						
<i>Nigronia serricornis</i>	4.95	P					X	
Sialidae	4	P						
<i>Sialis</i> sp.	7.17	P			2		2	
<b>Trichoptera</b>			X					
Glossosomatidae	0	SC			2		8	
<i>Agapetus</i> sp.	0	SC					157	1
<i>Protophila</i> sp.	2.55	SC			1		81	
Hydropsychidae	4	FC	79	67	83	2	31	
<i>Cheumatopsyche</i> sp.	6.22	FC	13	132	23	4	97	1
<i>Diplectrona modesta</i>	2.21	FC	9				5	4
<i>Hydropsyche</i> sp.	5	FC	X	111	1	X	2	
<i>Hydropsyche betteni</i> gp.	7.78	FC		1		X		
Hydroptilidae								
<i>Hydroptila</i> sp.	6.22	PI		2			35	
<i>Ochrotrichia</i> sp.	3.95	PI			2	1	8	X
Lepidostomatidae	1	SH						
<i>Lepidostoma</i> sp.	6.22	FC					X	
<i>Mystacides</i> sp.	2	CG			X			
Leptoceridae	4	CG						
<i>Triaenodes</i> sp.	4.46	SH		X			X	
Limnephilidae	4	SH						
<i>Ironoquia</i> sp.	3	-					X	
<i>Pycnopsyche</i> sp.	2.52	SH	X			X	1	
Odontoceridae	0	SC						
<i>Psilotreta</i> sp.	6.37	SC					6	
Philopotamidae	3	FC						
<i>Dolophilodes</i> sp.	0.81	FC				1		
Psychomyiidae	2	CG						
<i>Lype diversa</i>	4.05	SC		X	X	X		
Rhyacophilidae	0	P						
<i>Rhyacophila</i> sp.	1	P			1	7		1
Uenoidae								
<i>Neophylax</i> sp.	2.2	SC	7		5	8	11	1
<i>Neophylax mitchelli</i>	0	SC				2	2	

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>Coleoptera</b>								
Curculionidae								1
Dryopidae	5							
<i>Helichus</i> sp.								4
<i>Helichus basalis</i>	4.63	SC	X			X	X	2
Dytiscidae								
<i>Hydroporus</i> sp.								14
Elmidae	5	CG						
<i>Ancyronyx variegata</i>	6.49	SC	X	2	X			
<i>Dubiraphia</i> sp.	5.93	SC		X	2	X	58	
<i>Dubiraphia vittata</i>	4.05	SC		1		X	4	
<i>Macronychus</i> sp.			X					
<i>Macronychus glabratus</i>	4.58	SH		1	X	X		
<i>Microcylloepus pusillus</i>	2.11	SC		2	X	1		
<i>Optioservus</i> sp.	2.36	SC	5	11	11	48	395	3
<i>Optioservus ovalis</i>	2.36	SC				4	5	
<i>Stenelmis</i> sp.	5.1	SC		9	4	2	198	130
Haliplidae								
<i>Peltodytes</i> sp.	8.73	SH		X				
Hydrophilidae		P					5	X
Psephenidae	4	SC						
<i>Psephenus herricki</i>	2.35	SC	2		10	22		
Ptilodactylidae		SH						
<i>Anchytarsus bicolor</i>	3.64	SH				2		
Staphylinidae					X			
<b>Diptera</b>	5	P						
Ceratopogonidae	6.86	P						13
<i>Bezzia/Palpomyia</i> gp.					2	5	4	52
Chironomidae			270	173	17	22	7	X
<b>ORTHOCLADIINAE</b>	5.8	SH						146
<i>Brillia flavifrons</i>	5	P	X	X	2	X	X	
<i>Cardiocladius obscurus</i>	6.01	CG	9					
<i>Chaetocladius</i> sp.	10	CG					X	
<i>Corynoneura</i> sp.	7	CG		35	20	2	16	
<i>Cricotopus</i> sp.	2.84	CG	1079	560	13	131	10	
<i>Cricotopus trifascia</i>	5.58	CG	621	1537		5	1	
<i>Eukiefferiella claripennis</i>	2.59	CG		X			1	
<i>Eukiefferiella devonica</i>	7.07	CG	195	431	4	10	2	
<i>Limnophyes</i> sp.	7.43	CG					X	

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<i>Nanocladius</i> sp.	5.34	CG				1		
<i>Orthocladius</i> sp.	5.4	CG	207	65		51	3	
<i>Parakiefferiella</i> sp.	3.65	CG	X					
<i>Parametriocnemus lundbecki</i>	7.28	CG	450	327	263	102	125	
<i>Rheocricotopus robacki</i>	4.36	CG	202	170	54	65	18	
<i>Synorthocladius semivirens</i>	5.86	CG	108	52	X	1		
<i>Thienemanniella xena</i>	3.61	CG	115	93	13		21	
<i>Tvetenia bavarica</i> gp.			255	231	58	80	79	
CHIRONOMINI	6.38	P						79
<i>Cryptochironomus fulvus</i>	8.1	CG		13	2			
<i>Dicrotendipes</i> sp.	4.77	CG		45				
<i>Microtendipes</i> sp.	5.53	CG			X	X	X	
<i>Paralauterborniella Nigrohalteralis</i>	5.11	CG					5	
<i>Paratendipes</i> sp.	6.5	SC	X	X	3	X		
<i>Phaenopsectra</i> sp.	4.93	SH	8	X	X	X		
<i>Polypedilum fallax</i>	6.39	SH			X	X		
<i>Polypedilum flavum(convictum)</i>	7.31	SH	51	X	109	40	X	
<i>Polypedilum halterale</i>	9	SH			4		X	
<i>Polypedilum illinoense</i>	5.89	FC	15	X	8	X	X	
<i>Rheotanytarsus</i> sp.	6.52		141	207	X	12	X	
<i>Stenochironomus</i> sp.	6.45	SH				X		
<i>Stictochironomus</i> sp.				X				
TANYTARSINI								144
<i>Tanytarsus</i> sp.	6.76	FC	X	51	6	3	2	
<i>Zavrelia</i> sp.	5.3	CG	8			5	15	
PODONOMINAE								6
TANYPODINAE								92
<i>Ablabesmyia mallochi</i>	7.19	P	X	X	X	X		
<i>Labrundinia</i> sp.	5.9	P			4			
<i>Nilotanypus</i> sp.	3.9	P				11	7	
<i>Thienemannimyia</i> gp.	8.42	P	X	10	12	12	17	
Dixidae		CG						
<i>Dixa</i> sp.	2.55	CG				X	13	5
<i>Dixella</i> sp.					1			
Empididae	7.57	P	1		X			
<i>Hemerodromia</i> sp.	7.57	P			1		1	2
Muscidae	6	FC			X			
Simuliidae	8.4			32		1		
<i>Simulium</i> sp.	4	FC	49	109	69	18	119	1

Table 10 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
Stratiomyidae		CG					1	
<i>Nemotelus</i> sp.		PI				X		
Tabanidae		CG					X	
<i>Chrysops</i> sp.	6.73	PI				X	1	
Tipulidae	3	SH					X	
<i>Antocha</i> sp.	4.25	CG	27	38		3		
<i>Hexatoma</i> sp.	4.31	P			1	1	6	1
<i>Limnophila</i> sp.	4	P					7	
<i>Ormosia</i> sp.		P			X			
<i>Pseudolimnophila</i> sp.	7.22	CG				X	10	
<i>Tipula</i> sp.	7.33	SH	X			X		
<b>CHORDATA</b>								
Caudata				X	X	X	X	
Osteichthyes			11		X	X	X	
Cottidae								
<i>Cottis carolina</i>			X					
<b>Total # of Taxa for Station</b>			82	85	90	96	95	43

**Table 11. Summary of Benthic Macroinvertebrates from Surber Sample Data for Streams on Horizon Center, April 2002.**

Site	Total Taxa	Total Organisms	Total EPT	% EPT	% Chironomidae	% Other Taxa	Density Per 0.1 sq.m.
BCK 0.1	59	1850	19	25.8%	32.0%	42.2%	616.7
BCK 3.3	67	1446	26	48.5%	38.2%	13.2%	482
DBK 0.3	74	3129	26	42.2%	10.5%	47.3%	1064.3
EFK 2.3	52	4142	14	5.2%	90.1%	4.7%	1380.7
EFK 5.1	54	7273	10	15.5%	55.0%	29.5%	2439.3
MIK 1.43	42	1065	18	26.1%	48.7%	25.2%	355

**Table 12. Composite of Quantitative and Qualitative Macroinvertebrate macroinvertebrates at each monitoring location in September 2002 and Functional Feeding Group (FFG) and North Carolina Tolerance Value (TV) designations of each taxon.**

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>PLATYHELMINTHES</b>								
<b>Turbellaria</b>								
<b>Tricladida</b>								
Planariidae								
<i>Cura foremanii</i>	4.97						18	6
<i>Dugesia tigrina</i>	7.23		3	1	1			
<b>NEMATODA</b>	6.02		3			3		6
<b>MOLLUSCA</b>								
<b>Bivalvia</b>								
<b>Veneroida</b>								
Corbiculidae								
<i>Corbicula fluminea</i>	6.12	FC	13	14	4	4		
Sphaeriidae	8	FC						
<i>Pisidium</i> sp.	6.48	FC	3	1	X		4	4
<i>Sphaerium</i> sp.	7.58	FC			1			
<b>Gastropoda</b>								
<b>Mesogastropoda</b>								
Hydrobiidae	8	SC						
<i>Amnicola</i> sp.	5.2	SC	6		X		1	1
Pleuroceridae								
<i>Elimia clavaeformis</i>	5	SC	107	95	73	40		X
<b>Basommatophora</b>								
Ancylidae		SC						
<i>Ferrissia rivularis</i>	6.55	SC		X			X	X
Lymnaeidae		SC						
<i>Fossaria</i> sp.	7	SC	X				X	
Physidae								
<i>Physella</i> sp.	8.84	CG		X	X			
Planorbidae	6	SC						
<i>Menetus dilatatus</i>	8.23	SC	1	X			X	

Numbers = number of individuals of respective taxon found in three surber samples,  
 X = Representative of Taxa observed in the qualitative sample but was not observed in the  
 Surber samples, CG = Collector/Gathers, FC = Filtering/Collectors, SC = Scrapers, SH =  
 Shredders, P = Predators, PI = Piercers

Table 12 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>ANNELIDA</b>								
<b>Oligochaeta</b>	10	CG						
<b>Haplotaxida</b>								
Lumbricidae		CG	34	6	5	1	3	10
Naididae				1		X	5	
<i>Nais</i> sp.	8.88	CG					9	
<i>Nais behningi</i>	8.89	CG					1	
<i>Nais communis</i>	8.81	CG			4		4	
<i>Nais simplex</i>	8.88	CG			16			
<i>Pristina</i> sp.	9.56	CG						1
<i>Slavina appendiculata</i>	7.06	CG	10	2	4	X		
<i>Stylaria lacustris</i>	9.38	CG				X		
Tubificidae w.h.c.	7.11	CG	1	X	1		5	26
Tubificidae w.o.h.c.	7.11	CG	X	X	1		18	24
<i>Branchiura sowerbyi</i>	8.28	CG	X	X				
<b>Lumbriculida</b>								
Lumbriculidae	7.03	CG		4	1	3	3	
<b>Hirudinea</b>	8	P	1		8	X	1	
<b>Branchiobdellida</b>						X		
<b>ARTHROPODA</b>								
<b>Crustacea</b>								
<b>Copepoda</b>							1	
<b>Isopoda</b>								
Asellidae	8	SH						
<i>Caecidotea</i> sp.	9.11	CG	X	X		X		
<i>Lirceus</i> sp.	7.85	CG	X		8	16	100	31
<b>Amphipoda</b>								
Crangonyctidae								
<i>Crangonyx</i> sp.	7.87	CG					1	2
<b>Decapoda</b>								
Cambaridae								
<i>Cambarus</i> sp.	7.62	CG	X	1	1	2	X	X
<b>Arachnoidea</b>								
<b>Acariformes</b>			1					1
<b>Insecta</b>								
<b>Collembola</b>								
Isotomidae							2	

Table 12 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<b>Ephemeroptera</b>								
Baetidae	4	CG				60	139	
<i>Acentrella ampla</i>	3.61	CG				34		
<i>Acerpenna</i> sp.							58	
<i>Baetis</i> sp.	4	CG			15	265	7	
<i>Baetis c.f. flavistriga</i>	6.58	CG	13	65	13	367	3	X
<i>Centroptilum</i> sp.	6.66	CG				X	X	
<i>Dipheter hageni</i>							81	
<i>Pseudocloeon</i> sp.	5	CG		X				
Caenidae	7	CG						
<i>Caenis</i> sp.	7.41	CG			9			
Ephemeridae	4	CG						
<i>Ephemera</i> sp.	3	CG					18	X
Ephemerellidae	1	SC				10		
<i>Eurylophella</i> sp.	4.34	SC			1	X	2	2
Heptageniidae	4	SC				X		
<i>Stenacron interpunctatum</i>	6.87	SC			1	X	5	
<i>Stenonema</i> sp.	4	SC	47	41	261	258	4	
<i>Stenonema femoratum</i>	7.18	SC				X		
<i>Stenonema mediopunctatum</i>	3.77	SC		2				
Isonychiidae	2	FC						
<i>Isonychia</i> sp.	3.45	FC	1	4	42	280	1	
Leptophlebiidae	2	CG						1
<i>Paraleptophlebia</i> sp.	0.94	CG					1	10
Tricorythidae	4	CG						
<i>Tricorythodes</i> sp.	5.06	CG	26	2	1			
<b>Odonata</b>								
Aeshnidae	3	P						
<i>Boyeria grafiana</i>	6.05	P	X					
<i>Boyeria vinosa</i>	5.89	P	X		X	X	4	X
Calopterygidae	5	P						
<i>Calopteryx</i> sp.	7.78	P	X	X	X		1	1
<i>Hetaerina</i> sp.	5.61	P				X	3	
Coenagrionidae	9	P						
<i>Argia</i> sp.	8.17	P	X	X	X	X		
<i>Enallagma</i> sp.	8.91	P	X	X		X		
Corduliidae	5	P						
<i>Cordulegaster</i> sp.	5.73	P				X	X	X
<i>Epicordulia princeps</i>	5.6	P						X

Table 12 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
Libellulidae	9	P						
Macromiinae								
<i>Macromia</i> sp.	6.16	P	X					
Gomphidae	1	P		1		1	2	3
<i>Gomphus</i> sp.	5.8	P	X					
<i>Ophiogomphus</i> sp.	5.54	P			X			
<i>Stylogomphus albistylus</i>	4.72	P			X			X
<b>Plecoptera</b>								
Capnidae	1	SH				5		
Chloroperlidae	1	P				10	1	
<i>Sweltsa</i> sp.	0	P					6	1
Leuctridae	0	SH						
<i>Leuctra</i> sp.	0.67	SH				3	3	6
Peltoperlidae	-	SH						
<i>Tallaperla</i> sp.	1.18	SH			4		X	
Perlidae	1	P				10		
<i>Acroneuria evoluta</i>		P			2	5	2	X
<i>Beloneuria</i> sp.	0						X	
<i>Eccoctura xanthenes</i>	3.74	P					X	1
<b>Hemiptera</b>			X					
Gerridae	-	P			X			
<i>Trepobates</i> sp.	-	P	X					
Veliidae	-	P		X			X	
<i>Microvelia</i> sp.	-	P			X	X	4	X
<i>Rhagovelia obesa</i>	-	P	X		1	10	1	
<b>Megaloptera</b>								
Corydalidae	0	P						
<i>Corydalus cornutus</i>	5.16	P			1	5		
<i>Nigronia fasciatus</i>	5.55	P						27
<i>Nigronia serricornis</i>	4.95	P			2	2	3	
Sialidae	4	P						
<i>Sialis</i> sp.	7.17	P					X	2
<b>Trichoptera</b>								
Brachycentridae	1	SH				X	18	
Hydropsychidae	4	FC	94	46	185	847	9	1
<i>Ceratopsyche</i> sp.	4	FC		1				
<i>Ceratopsyche sparna</i>	2.72	FC				1		
<i>Cheumatopsyche</i> sp.	6.22	FC	115	138	247	513	34	3
<i>Diplectrona modesta</i>	2.21	FC					39	2
<i>Hydropsyche</i> sp.	5	FC	15	3	3	13		
<i>Hydropsyche betteni</i> gp.	7.78	FC	1				2	

Table 12 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
Hydroptilidae		PI						
<i>Hydroptila</i> sp.	6.22	PI	1	1				
Leptoceridae	4	CG		X				
<i>Nectopsyche</i> sp.	2.94	SH					X	
<i>Triaenodes</i> sp.	4.46	SH	X		X			
Limnephilidae	4	SH						
<i>Pycnopsyche</i> sp.	2.52	SH					X	
Molannidae	6	-						
<i>Molanna</i> sp.	6	SC					2	X
Odontoceridae	0	SC						
<i>Psilotreta</i> sp.	6.37	SC					48	
Philopotamidae	3	FC						
<i>Chimarra</i> sp.	2.76	FC			14	200		
<i>Chimarra aterrima</i>	2.76	FC	1		264	446	22	
Phryganeidae	4	SH						
<i>Ptilostomis</i> sp.	6.37	SH					X	
Polycentropodidae	6	FC					1	
<i>Neureclipsis</i> sp.	3	FC	2					
<i>Polycentropus</i> sp.	3.53	FC		X	1	2	X	
Psychomyiidae	2	CG						
<i>Lype diversa</i>	4.05	SC	X	X			4	
Uenoidae								
<i>Neophylax</i> sp.	2.2	SC					6	
<b>Coleoptera</b>								
Curculionidae								1
Dryopidae	5							
<i>Helichus basalis</i>	4.63	SC	X		1	X	2	7
Dytiscidae	5	P			X			
Elmidae	5	CG						
<i>Ancyronyx variegata</i>	6.49	SC	X	X				
<i>Dubiraphia</i> sp.	5.93	SC	X	1	X		11	
<i>Dubiraphia vittata</i>	4.05	SC	X			X		
<i>Macronychus glabratus</i>	4.58	SH	X	X	X	1		
<i>Microcylloepus pusillus</i>	2.11	SC	X	X	X	X	X	
<i>Optioservus</i> sp.	2.36	SC	4	5	20	150	243	6
<i>Optioservus ovalis</i>	2.36	SC			X	7	86	1
<i>Oulimnius latiusculus</i>	1.78	CG				1		
<i>Stenelmis</i> sp.	5.1	SC		1	5	8	146	117
Hydrophilidae		P		2			5	

Table 12 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
Psephenidae	4	SC						
<i>Ectopria</i> sp.	4.16	SC	X		X	X		
<i>Psephenus herricki</i>	2.35	SC	1		59	288	8	
<b>Diptera</b>								
Ceratopogonidae	5	P						
<i>Atrichopogon</i> sp.	6.49	P	X		X	6	X	
<i>Bezzia/Palpomyia</i> gp.	6.86	P						11
Chironomidae			3	6	6	4	22	2
ORTHOCLADIINAE								1
<i>Brillia flavifrons</i>	5.8	SH				X	4	
<i>Cardiocladius obscurus</i>	5	P					X	
<i>Corynoneura</i> sp.	6.01	CG	3	3	14	28	44	
<i>Cricotopus</i> sp.	7	CG	14	10				1
<i>Cricotopus bicinctus</i>	8.54	CG	13					
<i>Heleniella</i> sp.							X	53
<i>Heterotrissocladius</i> sp.	5.23	CG						3
<i>Limnophyes</i> sp.	7.43	CG					4	
<i>Nanocladius distinctus</i>	7.07	CG				1		
<i>Orthocladius lignicola</i>	4.36	CG	X				X	X
<i>Parachaetocladius hudsoni</i>	0	CG						3
<i>Parametriocnemus lundbecki</i>	3.65	CG			2	15	76	28
<i>Parasmittia</i> sp.					X			
<i>Psectrocladius</i> sp.	3.59	SH			1			
<i>Rheocricotopus robacki</i>	7.28	CG	1	4	7		6	
<i>Synorthocladius semivirens</i>	4.36	CG			1			
<i>Thienemanniella xena</i>	5.86	CG	14	30	32	61	8	11
<i>Tvetenia bavarica</i> gp.	3.61	CG		1	10	95	4	1
<i>Xylotopus par</i>	5.99	SH					X	
CHIRONOMINI								
<i>Chironomus</i> sp.	9.63	CG			X		X	
<i>Cladopelma</i> sp.	3.49	CG					4	
<i>Cladotanytarsus</i> sp.	4.09	FC				10	X	21
<i>Cryptochironomus</i> sp.	6.4	P					2	
<i>Cryptotendipes</i> sp.	6.19	CG						3
<i>Dicrotendipes neomodestus</i>	8.1	CG				X	X	
<i>Microtendipes</i> sp.	5.53	CG		1			41	3
<i>Paratendipes</i> sp.	5.11	CG		X	X			3
<i>Phaenopsectra</i> sp.	6.5	SC					2	
<i>Polypedilum fallax</i>	6.39	SH		X	X		X	
<i>Polypedilum flavum</i>	4.93	SH			1	16	120	68
<i>Polypedilum halterale</i>	7.31	SH						16

Table 12 Continued

Taxa	Indices		Monitoring Locations					
	TV	FFG	EFK 2.3	EFK 5.1	BCK 0.1	BCK 3.3	DBK 0.3	MIK 1.43
<i>Polypedilum illinoense</i>	9	SH	4	2	4	16	120	107
<i>Rheotanytarsus</i> sp.	5.89	FC	74	29	26	420	18	60
<i>Stenochironomus</i> sp.	6.45	SH	1		X			9
<i>Tanytarsus</i> sp.	6.76	FC	12	13	17	11	48	43
<i>Zavrelia</i> sp.	5.3	CG					87	
TANYPODINAE								
<i>Labrundinia</i> sp.	5.9	P					2	1
<i>Larsia</i> sp.	9.3	P			X		13	3
<i>Nilotanypus</i> sp.	3.9	P			10	12	24	6
<i>Nilothauma</i> sp.	5.03	CG					X	
<i>Procladius</i> sp.	9.1	P	X	X				
<i>Thienemannimyia</i> sp.	8.42	P	3		60	38	48	20
Culicidae	*8	FC						
<i>Anopheles</i> sp.	8.58	FC			X	X	X	1
Dixidae		CG						
<i>Dixa</i> sp.	2.55	CG					1	2
<i>Dixella</i> sp.					X		3	
Dolichopodidae	*5	P						X
Empididae	7.57	P				1		
<i>Hemerodromia</i> sp.	7.57	P			2		2	1
<i>Neoplasta</i> sp.	7.57	P					X	
Simuliidae	*6	FC				X		
<i>Simulium</i> sp.	4	FC	7	3	13	20		
Stratiomyidae		CG						
<i>Allognasta</i> sp.							1	
<i>Odontomyia</i> sp.							2	
Tabanidae		PI						
<i>Chrysops</i> sp.	6.73	PI			X	6	10	2
Tipulidae	3	SH	X					
<i>Antocha</i> sp.	4.25	CG	8	1		5		
<i>Hexatoma</i> sp.	4.31	P			X		7	9
<i>Pseudolimmophila</i> sp.	7.22	P				X	1	2
<i>Tipula</i> sp.	7.33	SH	1	1	2	X	35	1

**Table 13. Summary of Benthic Macroinvertebrates from Surber Sample Data for Streams on Horizon Center, September 2002.**

Site	Total Taxa	Total Organisms	Total EPT	% EPT	% Chironomidae	% Other Taxa	Density Per 0.1 sq.m.
BCK 0.1	54	1488	16	71.4%	12.8%	15.7%	496.0
BCK 3.3	54	4636	19	71.8%	15.7%	12.5%	1545.3
DBK 0.3	86	1970	26	26.2%	35.4%	38.4%	656.7
EFK 2.3	39	662	11	47.7%	21.5%	30.8%	220.7
EFK 5.1	37	582	10	58.9%	17.0%	24.1%	194.0
MK 1.43	60	799	9	3.4%	58.3%	38.3%	266.3

**Table 14.** Trees forming the canopy at each monitoring site within the Beech-Maple forest.

Plants		Monitoring Plots					
		BM1		BM2		BM3	
Common name	Species name	B.A.	T.D.	B.A.	T.D.	B.A.	T.D.
Sugar maple	<i>Acer saccharum</i>	2.6	10				
Mockernut hickory	<i>Carya tomentosa</i>			2.6	16	2.5	25
American beech	<i>Fagus grandifolia</i>	7.8	56	5	25	8	50
White ash	<i>Fraxinus americana</i>	7.8	79	3	22		
Tulip poplar	<i>Liriodendron tulipifera</i>					5.5	115
Sourwood	<i>Oxydendrum arboreum</i>					2.7	70
White oak	<i>Quercus alba</i>	5.2	50			2.6	7
Scarlet oak	<i>Quercus coccinea</i>					2.6	5
Southern red oak	<i>Quercus falcata</i>	2.6	78	5.2	32		
Northern red oak	<i>Quercus rubra</i>			2.7	11		

B.A. = Basal Area in square meters (measured at chest height) per hectare. T.D. = Total Density is the estimated number of trees per hectare.

**Table 15.** The estimated number of stems of each species of shrubs and seedlings per hectare observed in each of the Beech-Maple Forest monitoring plots.

Plants		Monitoring Plots		
Common name	Species name	BM1	BM2	BM3
Sugar maple	<i>Acer saccharum</i>	520	230	800
Ironwood	<i>Carpinus caroliniana</i>	20		
Redbud	<i>Cercis canadensis</i>	100	120	
Flowering dogwood	<i>Cornus florida</i>		120	150
American beech	<i>Fagus grandifolia</i>	150	70	150
Tulip poplar	<i>Liriodendron tulipifera</i>	50		
Sourwood	<i>Oxydendrum arboreum</i>			75
Black cherry	<i>Prunus serotina</i>		70	
White oak	<i>Quercus alba</i>	30		
Slippery elm	<i>Ulmus rubra</i>	20		

**Table 16.** Percent of groundcover contributed by each groundcover species observed in each of the Beech-Maple Forest monitoring plots.

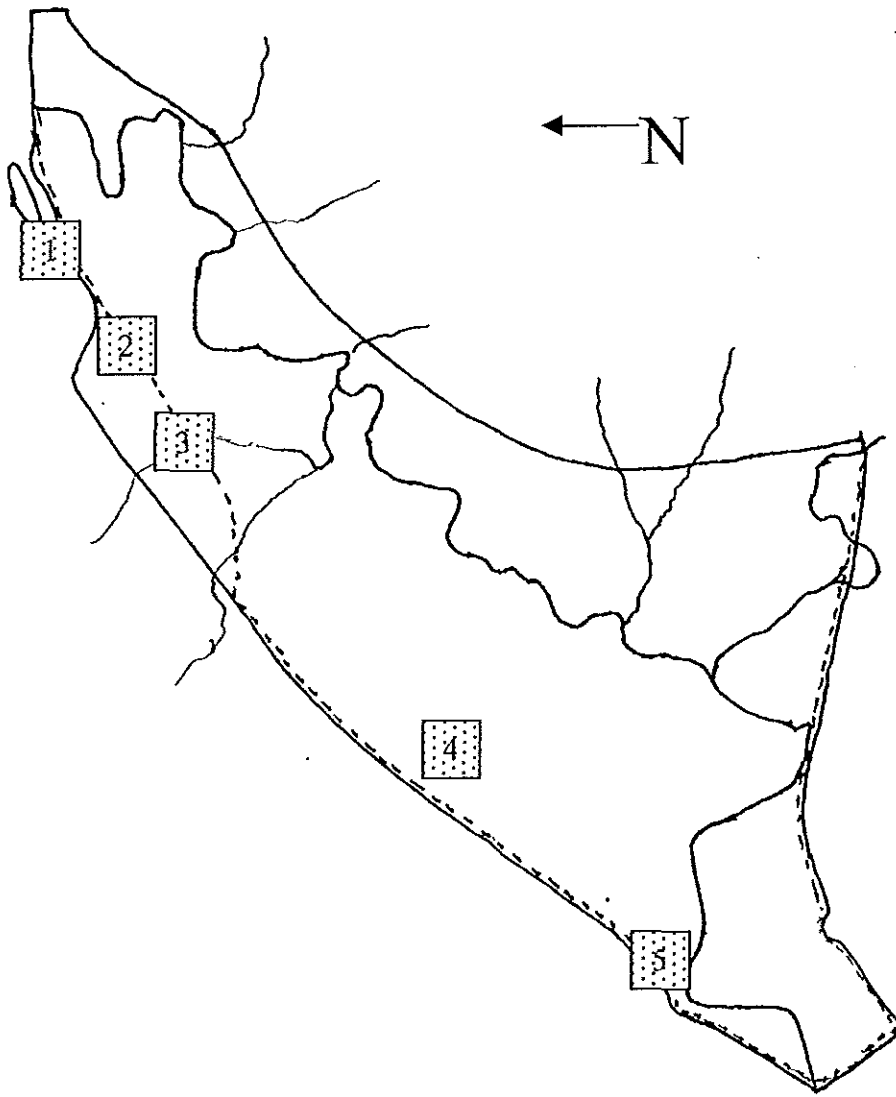
Plants		Monitoring Plots		
Common name	Species name	BM1	BM2	BM3
Sugar maple	<i>Acer saccharum</i>	>5%	>5%	5%
Ironwood	<i>Capinus caroliniana</i>	>5%		
Flowering dogwood	<i>Cornus florida</i>			10%
American beech	<i>Fagus grandifolia</i>		15%	
White ash	<i>Faxinus americana</i>	>5%		
Tulip poplar	<i>Liriodendron tulipifera</i>			>1%
Crossvine	<i>Binonia capriolata</i>	>1%		
Strawberry bush	<i>Euonymus americanus</i>	>1%		>1%
Wild geranium	<i>Geranium maculatum</i>	>5%		
Little brown jug	<i>Hexastylis arifolia</i>	>1%		
Japanese honeysuckle	<i>Lonicera japonica</i>		>2%	
Virginia creeper	<i>Parthenocissus quinquefolia</i>	>5%	10%	10%
Mayapple	<i>Podophyllum peltatum</i>			>5%
Greenbrier	<i>Smilax</i> sp.	>1%		>1%
Poison ivy	<i>Toxicodendron radicans</i>		>2%	
Perfoliate bellwort	<i>Uvularia perfoliata</i>		8%	
Sessile bellwort	<i>Uvularia sessilifolia</i>	>1%	>2%	

**Table 17. Plants found on the face and top of Limestone Cliff # 4.**

American elm	<i>Ulmus americana</i>	Face	
American hornbeam	<i>Carpinus caroliniana</i>	Face	Top
Boxelder	<i>Acer negundo</i>	Face	
Sugar maple	<i>Acer saccharum</i>	Face	Top
Fringetree	<i>Chionanthus virginica</i>	Face	Top
Hickory	<i>Carya</i> sp.		Top
Hop hornbeam	<i>Ostrya virginiana</i>		Top
Pawpaw	<i>Asimina triloba</i>	Face	
Redbud	<i>Cercis canadensis</i>		Top
Sycamore	<i>Plantanus occidentalis</i>	Face	
White ash	<i>Fraxinus americana</i>		Top
Wild black cherry	<i>Prunus serotina</i>	Face	
Witch hazel	<i>Hamamelis virginiana</i>		Top
Alumroot	<i>Heuchera americana</i>	Face	
Chestnut fern	<i>Cheilanthes castanea</i>	Face	
Christmas fern	<i>Polystichum aerostichoides</i>		Top
Resurrection fern	<i>Polypodium polypodioides</i>		Top
Cane	<i>Arundinarie gigantea</i>		Top
Clearweed	<i>Pilea pumila</i>	Face	
Crested iris	<i>Iris crestata</i>	Face	Top
Barren strawberry	<i>Waldsternia fragarioides</i>	Face	
Bedstraw	<i>Galium</i> sp.	Face	
Columbine	<i>Aquilegia canadensis</i>	Face	
Common greenbrier	<i>Smilax rotundifolia</i>		Top
Crossvine	<i>Bignonia capreolata</i>	Face	
Japanese honeysuckle	<i>Lonicera japonica</i>	Face	Top
Poison ivy	<i>Toxicodendron radicans</i>	Face	Top
Walking fern	<i>Camptosorus rhizophyllus</i>	Face	Top
Wild yam	<i>Dioscorea quaternata</i>		Top
Erect grass	<i>Brachyelytrum erectum</i>		Top
False Solomon seal	<i>Smilacina racemosa</i>	Face	Top
False nettle	<i>Boehmeria cylindrica</i>	Face	
Goldenrod	<i>solidago</i> sp.	Face	Top
Indian pinks	<i>Spigelia marilandica</i>	Face	Top
Knotweed	<i>Polygonium</i> sp.	Face	
Sedge	<i>Carex</i> sp.	Face	
Two-flowered melis	<i>Melica mutica</i>		Top
Wood sorrel	<i>Oxalis</i> sp.	Face	
Round lobed hepatica	<i>Hepatica americana</i>	Face	Top
Rue anemone	<i>Anemonella thalictroides</i>	Face	Top
Smooth rockcress	<i>Arabis laevigata</i>		Top
Solomon seal	<i>Polygonatum biflorum</i>	Face	Top
Violet	<i>Viola</i> sp.	Face	
Virginia Creeper	<i>Parthenocissus quinquefolia</i>	Face	Top
Virgin's bower	<i>Clematis virginiana</i>		Top
White avens	<i>Geum canadense</i>	Face	
Wild onion	<i>Allium</i> sp.		Top
Wild stone crop	<i>Sedum ternatum</i>	Face	


## APPENDIX B

### LIST OF FIGURES



**Figure 1. Amphibian call listening sites on Horizon Center.**

**Legend**

 Listening Site

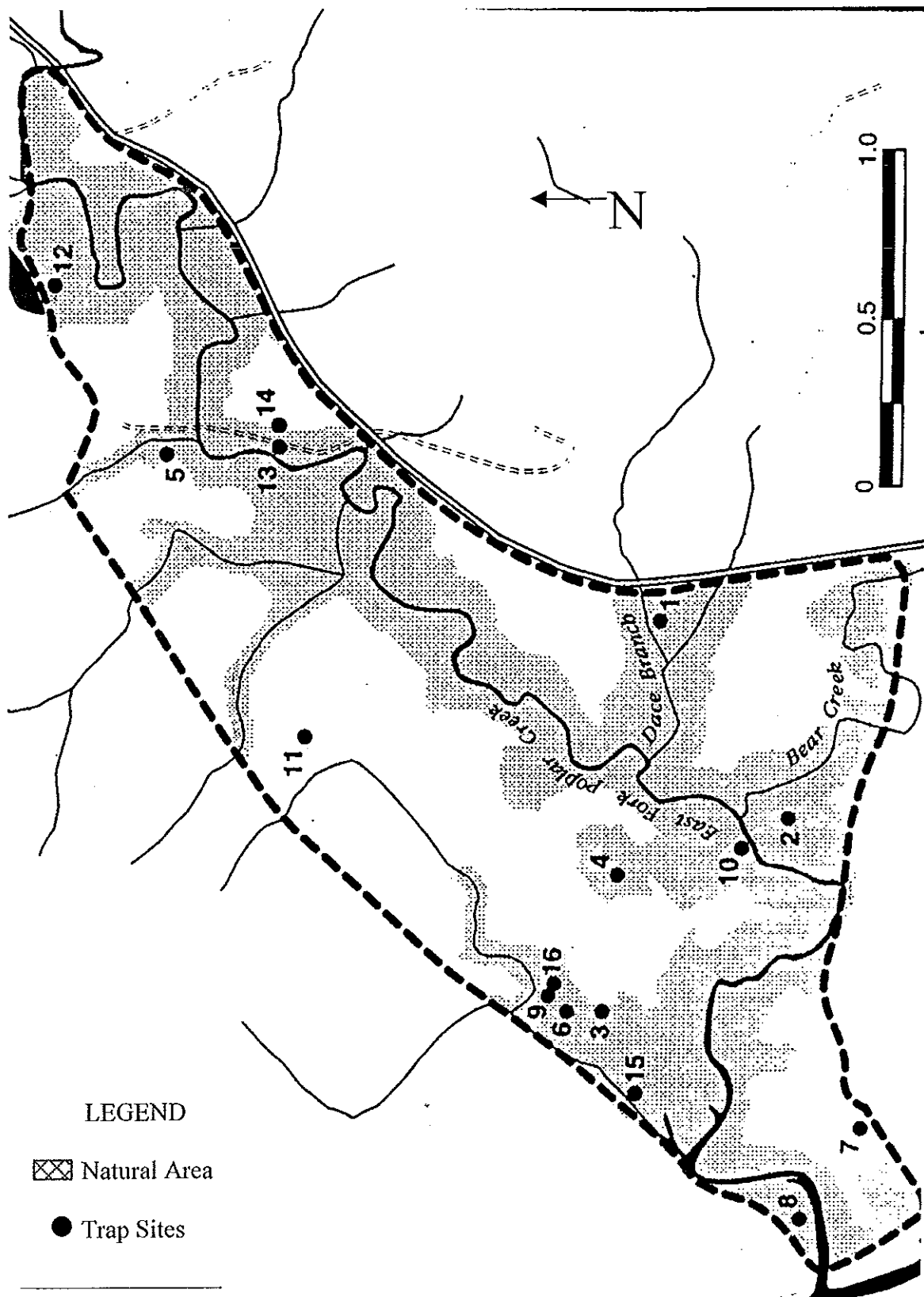


Figure 2. Amphibian and reptile monitoring trap sites on Horizon Center.

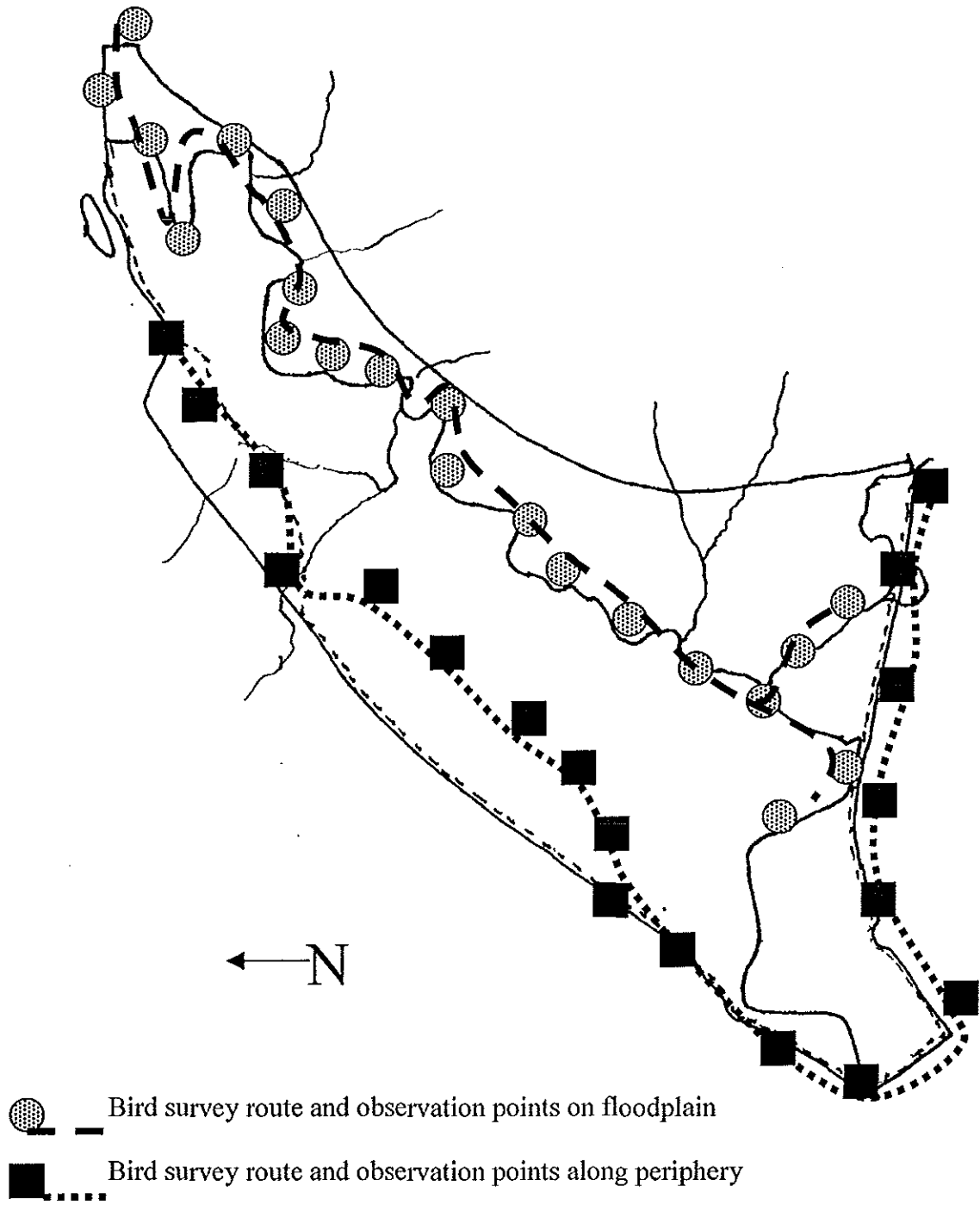


Figure 3. Avian survey routes on the Horizon Center.

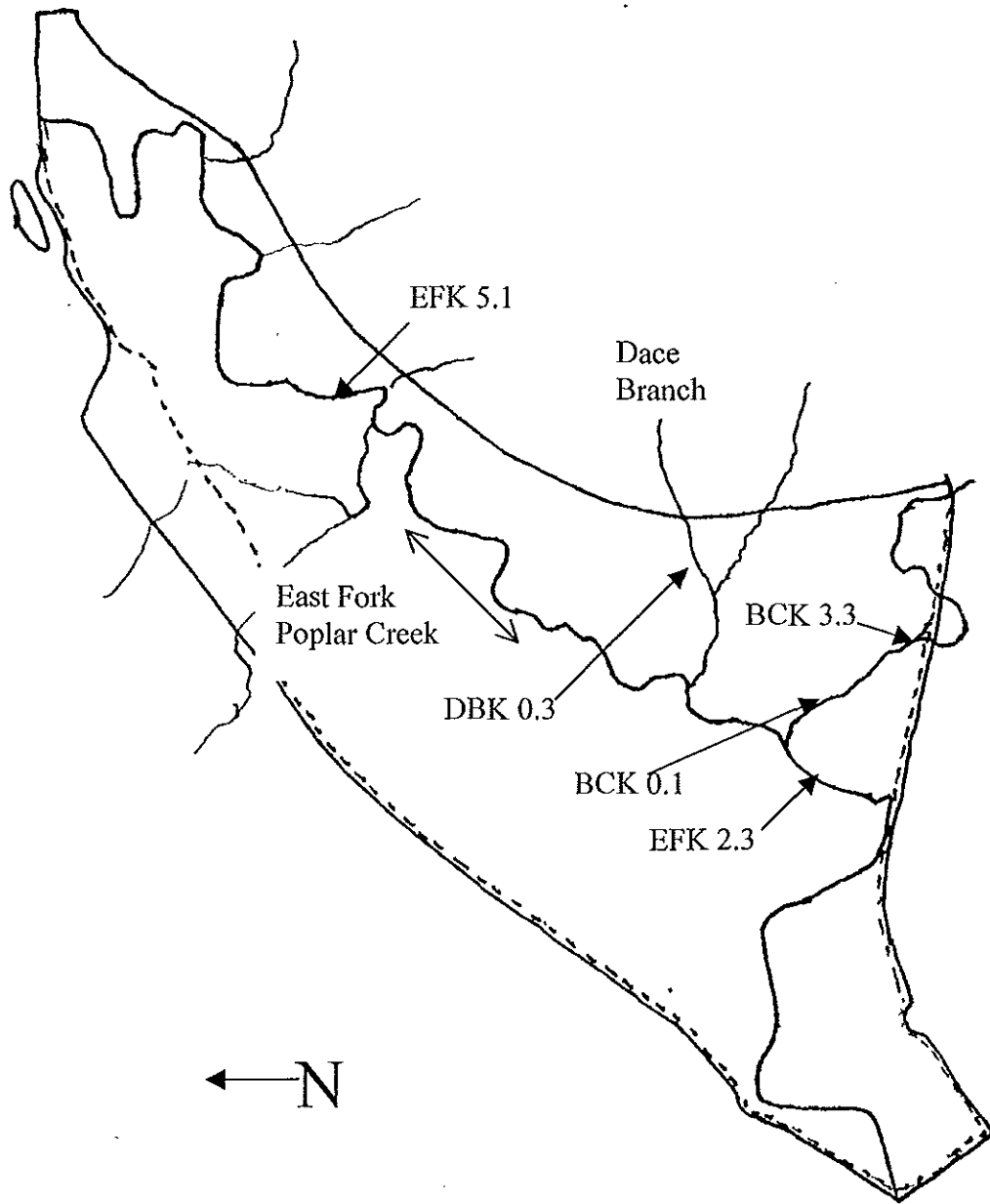


Figure 4. Macroinvertebrate collection stations on Horizon Center.

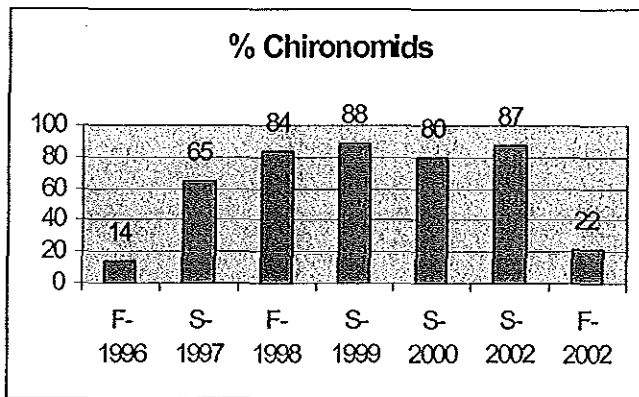
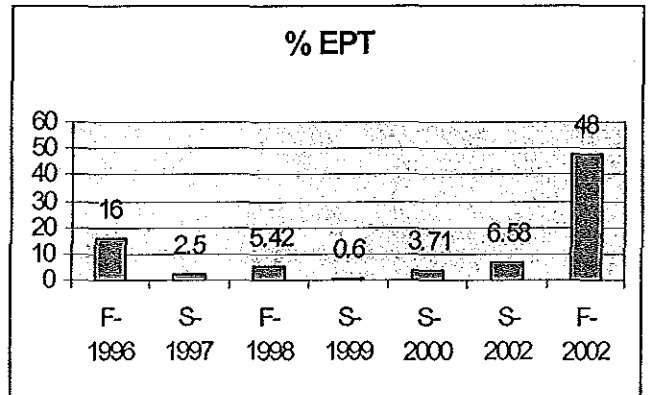
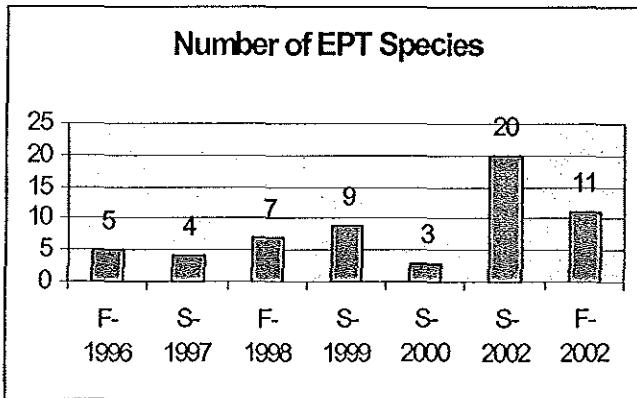
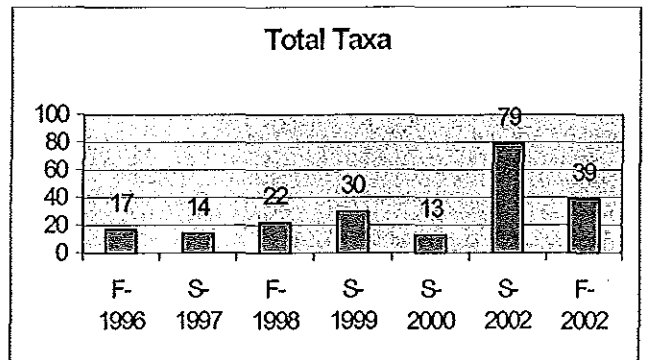
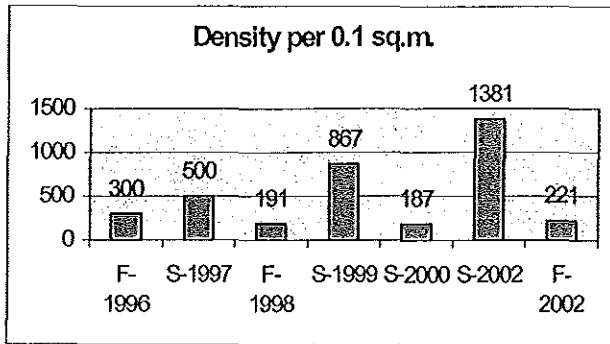


Figure 5. Historical trends for macroinvertebrates at EFK 2.3.

F = Fall sample  
 S = Spring sample

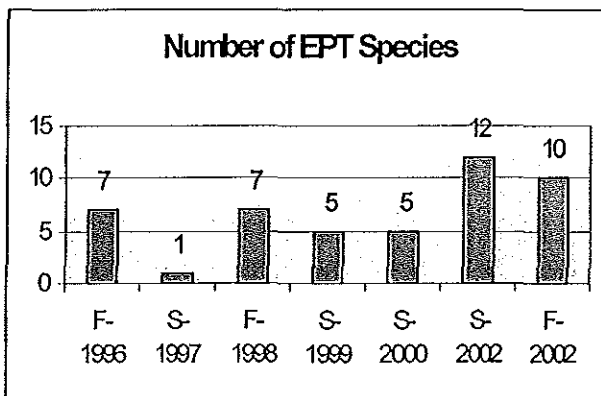
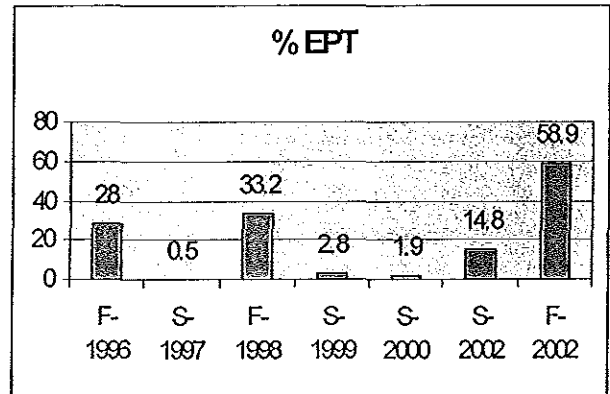
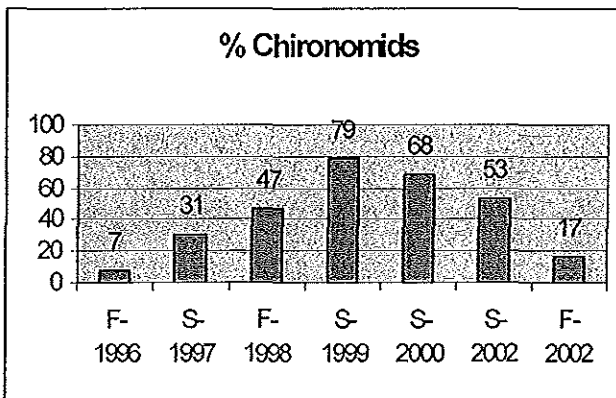
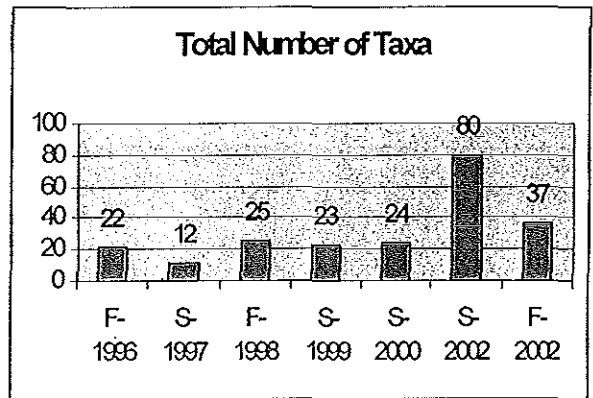
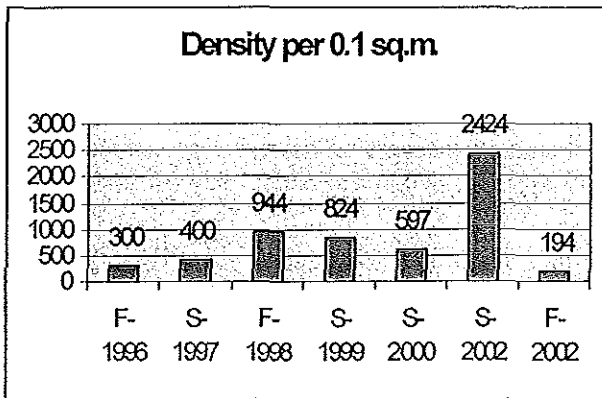


Figure 6. Historical trends for macroinvertebrates at EFK 5.1.

F = Fall sample  
S = Spring sample

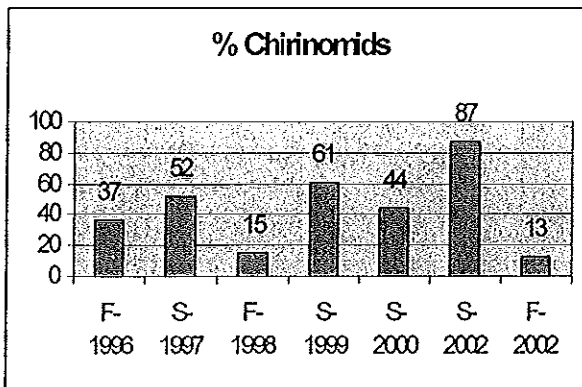
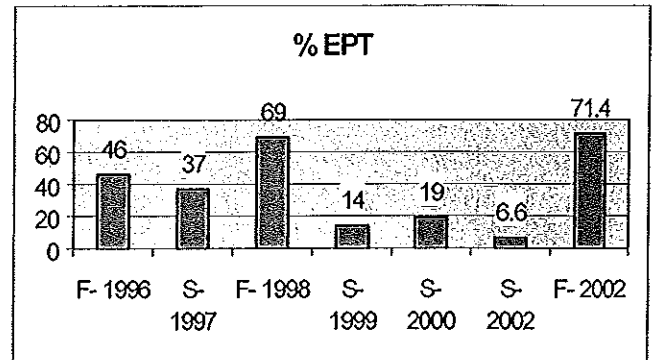
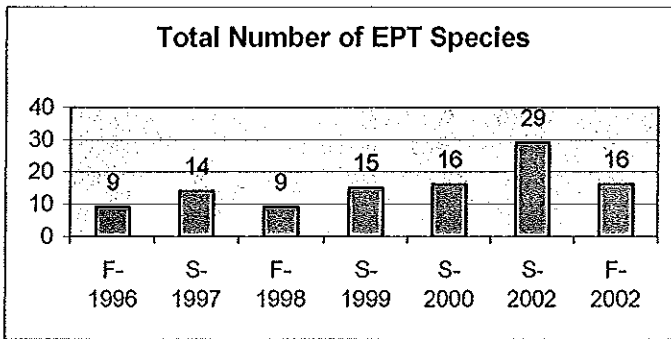
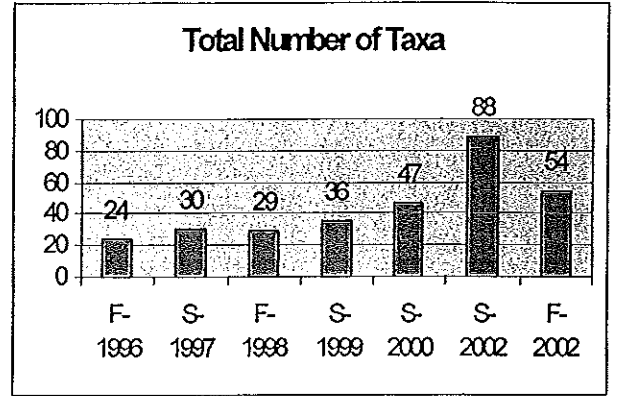
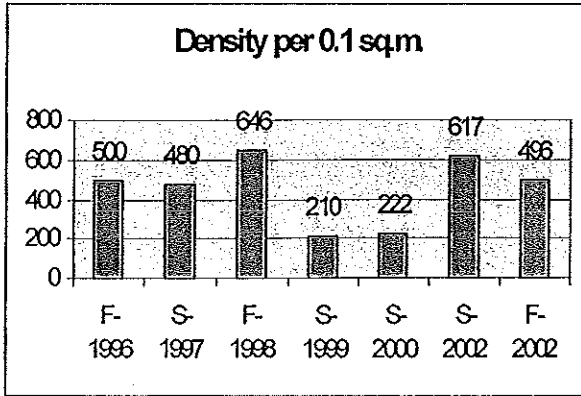


Figure 7. Historical trends for macroinvertebrates at BCK 0.1

F = Fall sample  
S = Spring sample

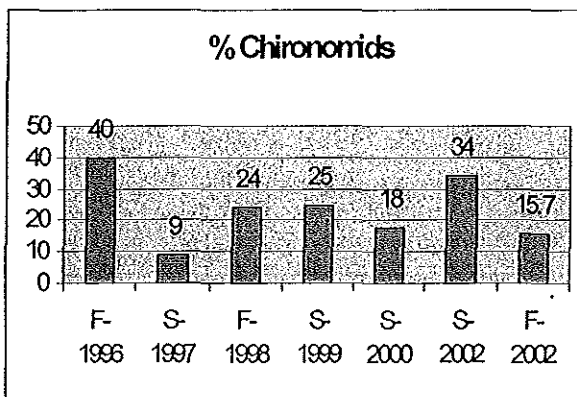
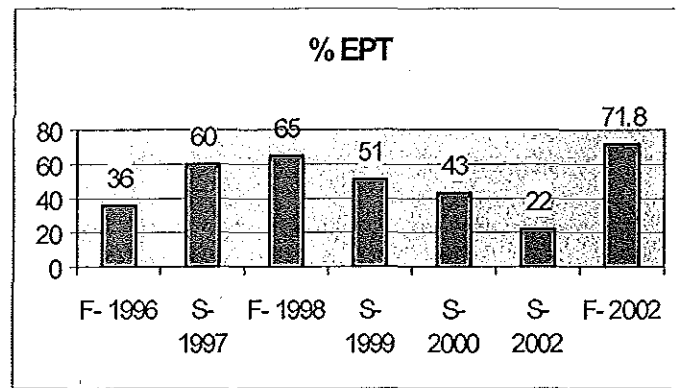
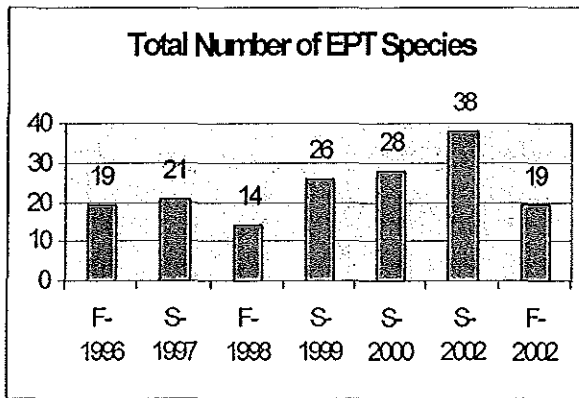
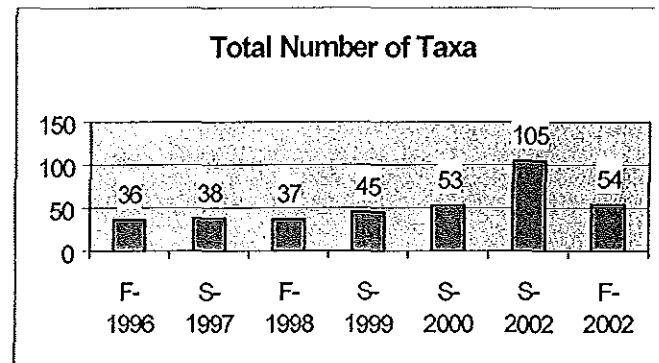
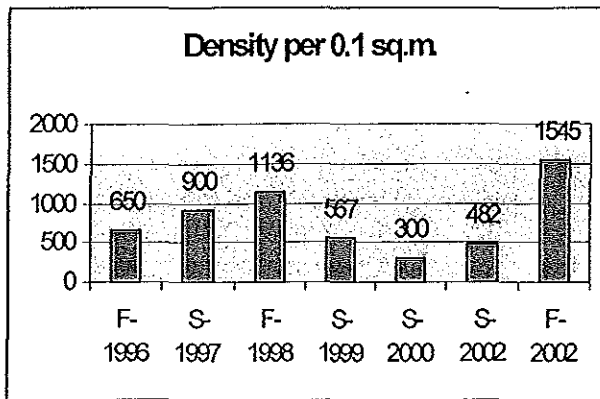


Figure 8. Historical trends for macroinvertebrates at BCK 3.3.

F = Fall sample  
S = Spring sample

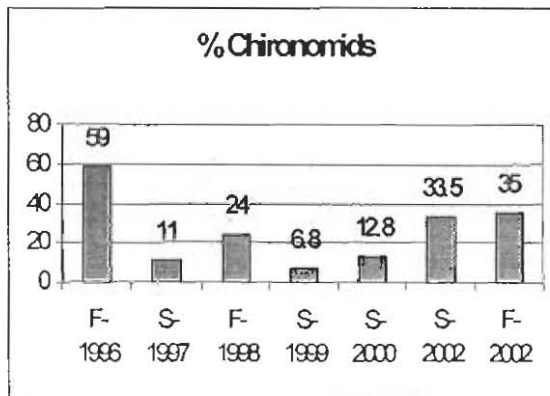
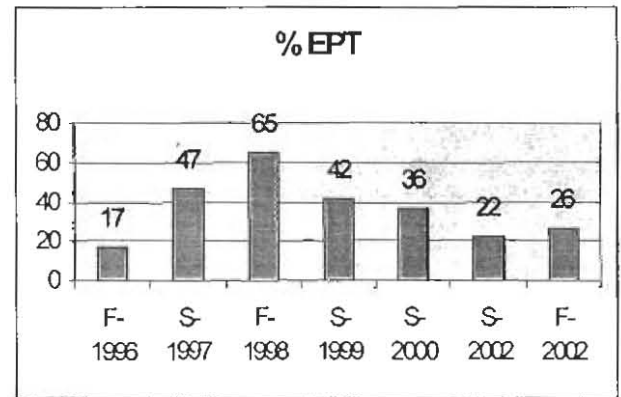
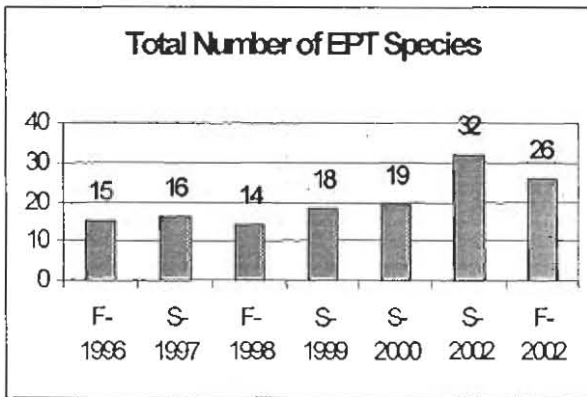
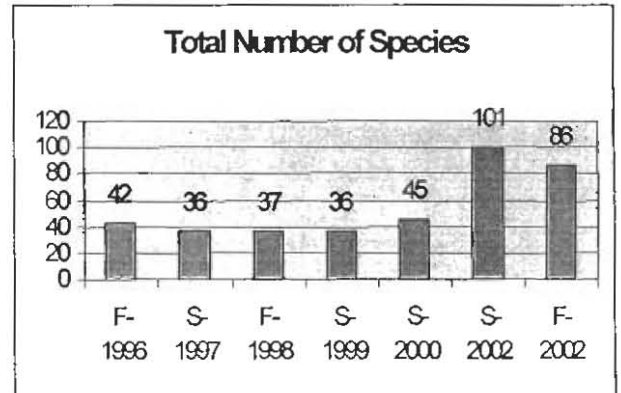
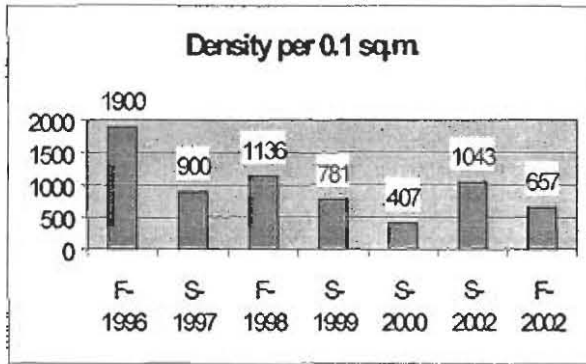


Figure 9. Historical trends for macroinvertebrates at at at DBK 0.3.

F = Fall sample  
S = Spring sample

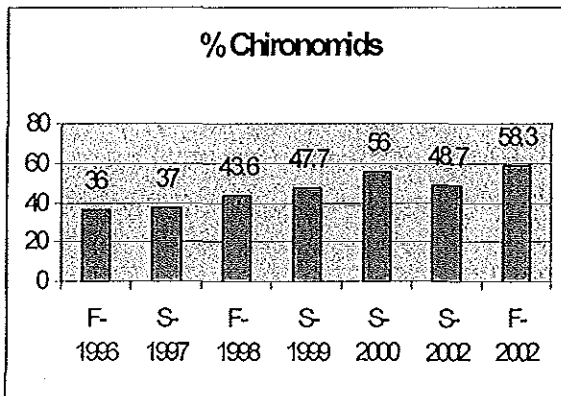
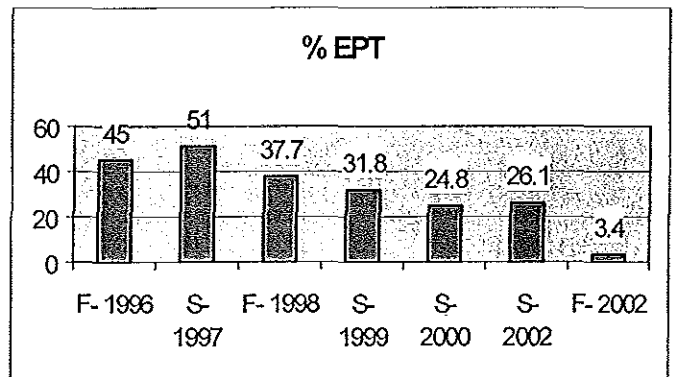
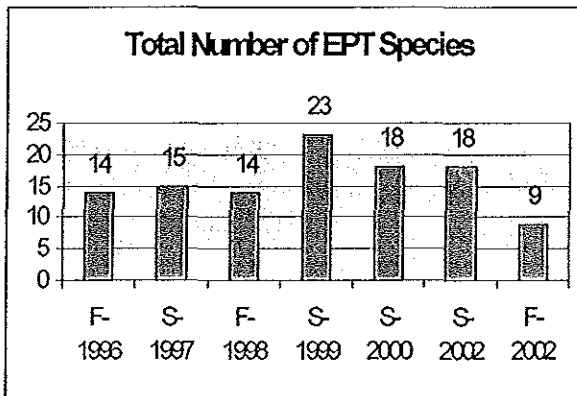
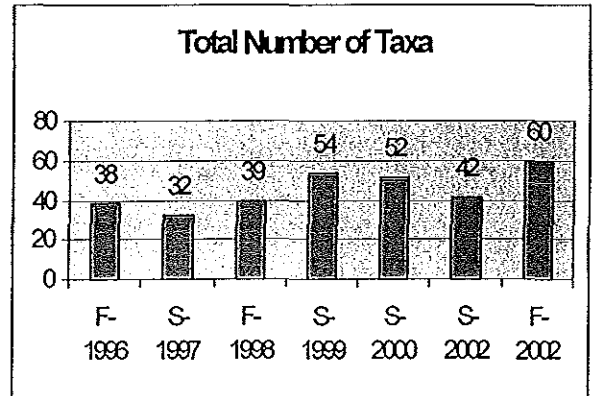
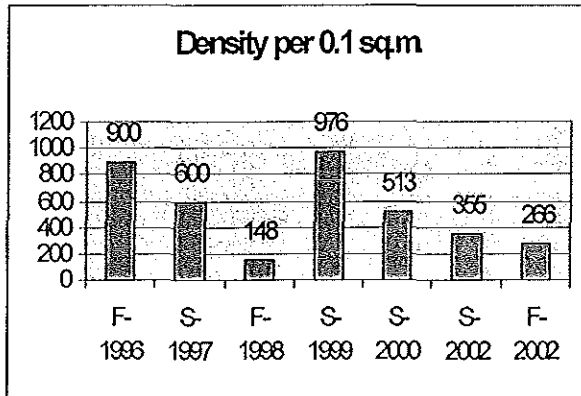


Figure 10. Historical trends for macroinvertebrates at MLK 1.43

F = Fall sample  
S = Spring sample

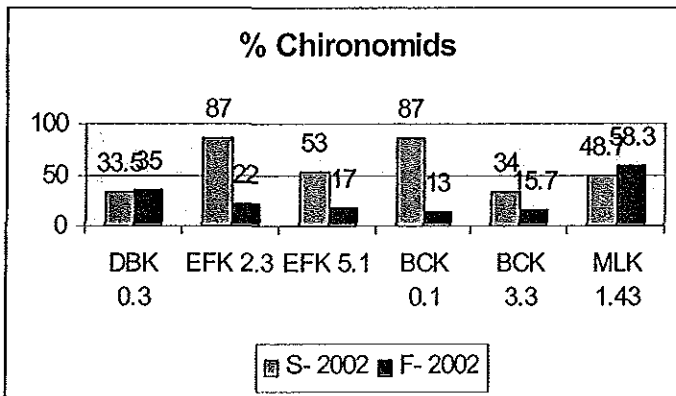
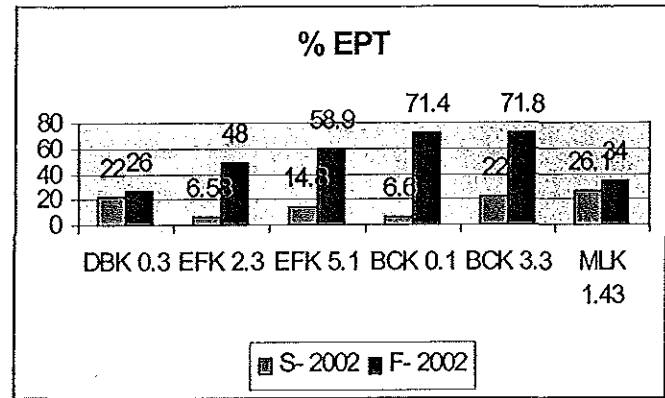
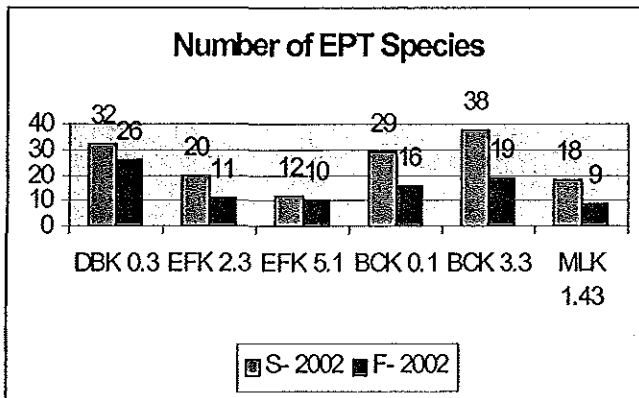
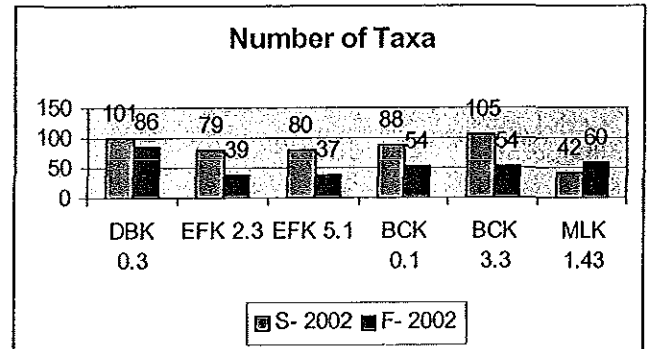
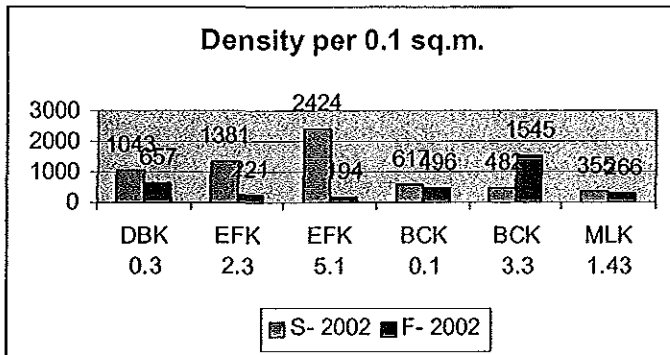


Figure 11. Comparisons of macrobenthos in Horizon Center with Control on Mitchel Branch.

F = Fall sample  
S = Spring sample

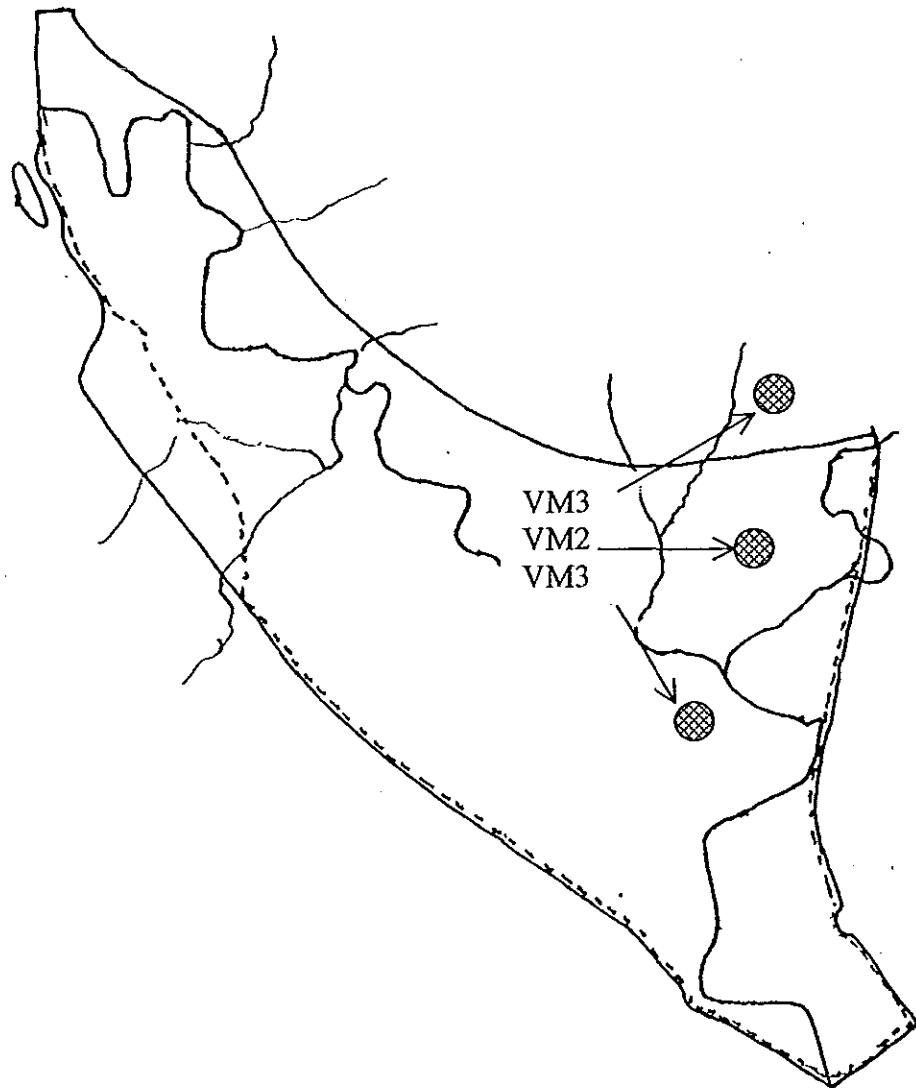


Figure 12. General vegetation community Monitoring sites in Horizon Center.