Quarterly Progress Report

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Biological Monitoring Program for East Fork Poplar Creek

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DISCLAIMER

1. INTRODUCTION

In May 1985, a National Pollutant Discharge Elimination System (NPDES) permit was issued for the Oak Ridge Y-12 National Security Complex (formerly the Oak Ridge Y-12 Plant). As a condition of the permit, a Biological Monitoring and Abatement Program (BMAP) was developed to demonstrate that the effluent limitations established for the Y-12 Complex protect the classified uses of the receiving stream (East Fork Poplar Creek; EFPC), in particular, the growth and propagation of aquatic life (Loar et al. 1989). A second objective of the BMAP is to document the ecological effects resulting from the implementation of a water pollution control program designed to eliminate direct discharges of wastewaters to EFPC and to minimize the inadvertent release of pollutants to the environment. Because of the complex nature of the discharges to EFPC and the temporal and spatial variability in the composition of the discharges, a comprehensive, integrated approach to biological monitoring was developed. A new permit was issued to the Y-12 Complex on April 28, 1995 and became effective on July 1, 1995. Biological monitoring continues to be required under the new permit. The BMAP consists of four major tasks that reflect different but complementary approaches to evaluating the effects of the Y-12 Complex discharges on the aquatic integrity of EFPC. These tasks are (1) toxicity monitoring, (2) biological indicator studies, (3) bioaccumulation studies, and (4) ecological surveys of the periphyton, benthic macroinvertebrate, and fish communities.

Monitoring is currently being conducted at five primary EFPC sites, although sites may be excluded or added depending upon the specific objectives of the various tasks. Criteria used in selecting the sites include: (1) location of sampling sites used in other studies, (2) known or suspected sources of downstream impacts, (3) proximity to U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) boundaries, (4) concentration of mercury in the adjacent floodplain, (5) appropriate habitat distribution, and (6) access. The primary sampling sites include upper EFPC at kilometers (EFKs) 24.4 and 23.4 [upstream and downstream of Lake Reality (LR) respectively]; EFK 18.7 (also EFK 18 and 19), located off the ORR and below an area of intensive commercial and light industrial development; EFK 13.8 (also EFK 14), located upstream from the Oak Ridge Wastewater Treatment Facility (ORWTF); and EFK 6.3 located approximately 1.4 km below the ORR boundary (Fig. 1.1). Brushy Fork (BF) at kilometer (BFK) 7.6 is used as a reference stream in most tasks of the BMAP. Additional sites off the ORR are also occasionally used for reference, including Beaver Creek, Bull Run, Hinds Creek, Paint Rock Creek, and the Emory River in Watts Bar Reservoir (Fig. 1.2).

2. TOXICITY MONITORING (*M. S. Greeley, Jr., and A. J. Stewart*)

2.1. Introduction

Toxicity monitoring uses U.S. Environmental Protection Agency (EPA) approved methods with *Ceriodaphnia dubia* and fathead larvae to provide systematic information that can be used to determine changes in the biological quality of EFPC through time. Toxicity monitoring at EFK 24.1, a site just upstream of Lake Reality, is conducted quarterly. Monitoring of EFK 23.8, immediately downstream of Lake Reality, has been discontinued as the bypass of Lake Reality made this site nearly synonymous with EFK 24.1. As required by the Y-12 Complex's National Pollutant Discharge Elimination System (NPDES) permit, quarterly toxicity tests with fathead minnows and *Ceriodaphnia* are conducted at Outfall 201 (an instream NPDES location in upper EFPC). The Outfall 201 tests meet the intent of the

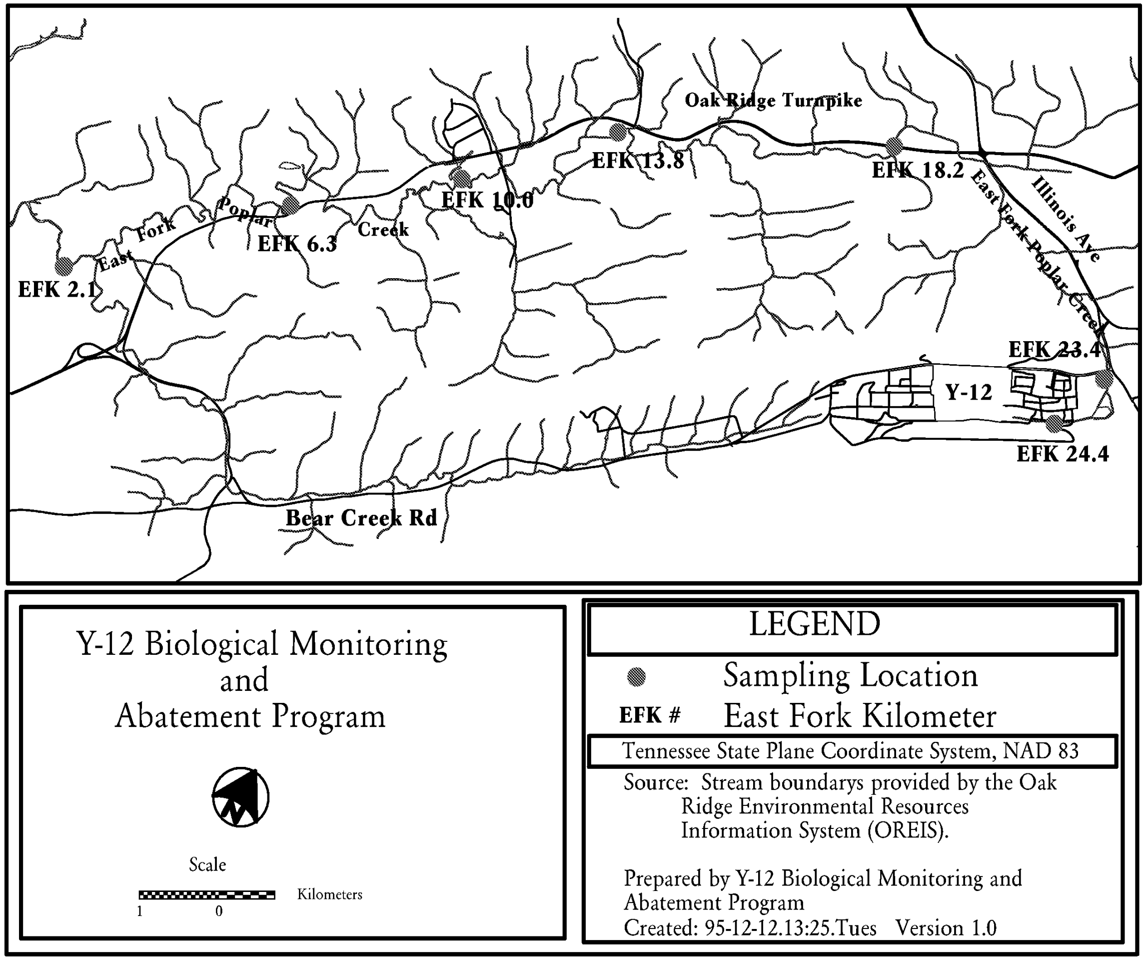

Figure 1.1. Location of biological monitoring sites on East Fork Poplar Creek in relation to the Oak Ridge Y-12 National Security Complex.

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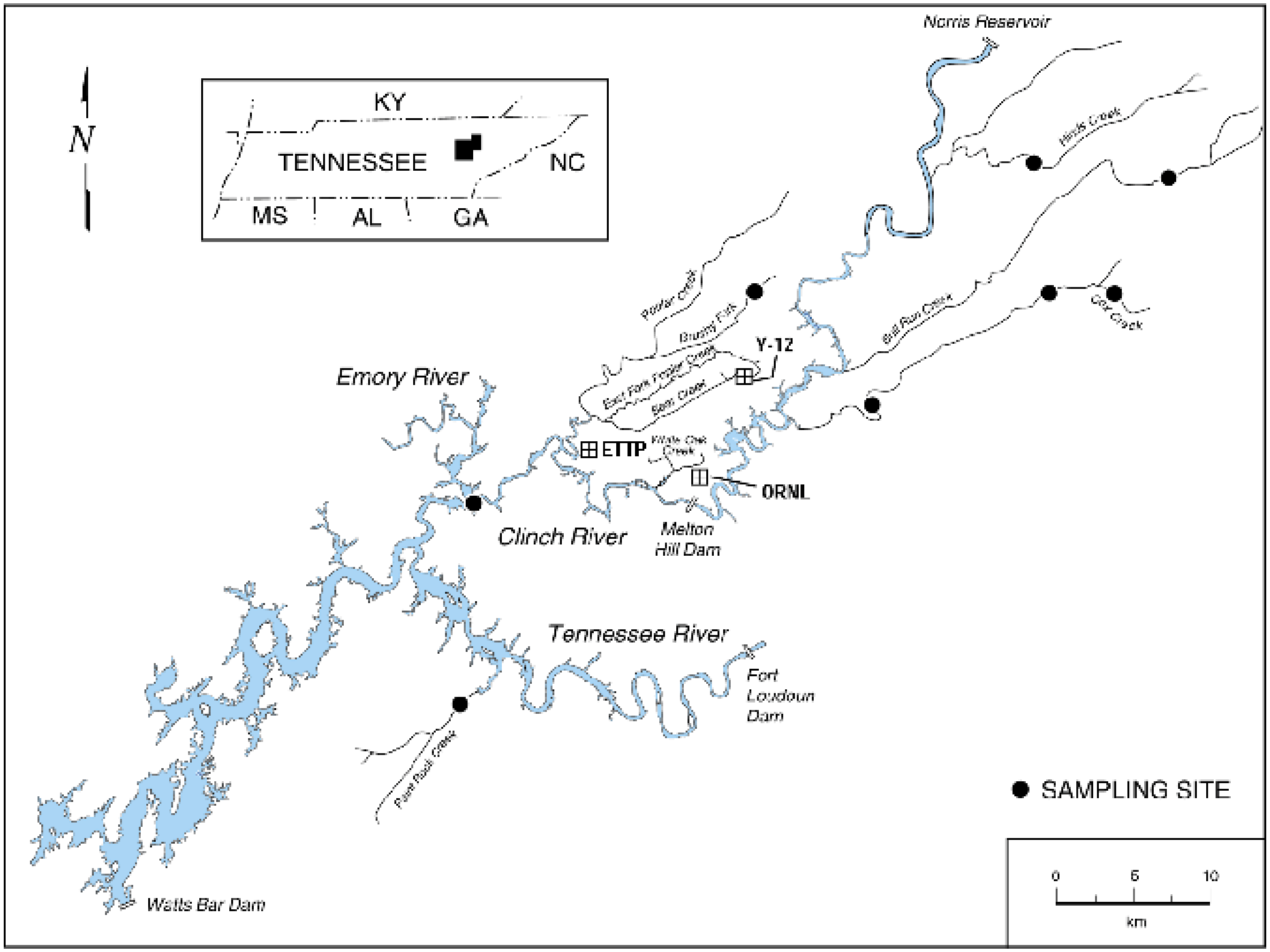

Figure 1.2. Location of biological monitoring reference sites in relation to the Oak Ridge Y-12 National Security Complex.

BMAP Plan to conduct quarterly toxicity tests at a nearby location, EFK 25.1. The results of the Outfall 201 tests are reported both here and on Discharge Monitoring Reports issued by the Y-12 Complex to the Tennessee Department of Environment and Conservation.

2.2 Results/Progress

2.2.1 Toxicity monitoring

Ambient water samples from EFK 24.1 and effluent samples from Outfall 201 were evaluated for toxicity to *Ceriodaphnia dubia* during October 18 – 24, 2000. On each sampling day, grab samples of stream water or 24-h time-proportional composite samples from Outfall 201 were collected for testing. Results of the toxicity tests and attendant water-quality chemical analyses are shown in Tables 2.1 and 2.2. During the test period, *Ceriodaphnia* survival was 100% in all samples. *Ceriodaphnia* reproduction in the stream water or effluent samples was not significantly different from the control. Samples from Outfall 201 were also evaluated for toxicity to fathead minnows (*Pimephales promelas*). Mean survival was 100% in both 100% and 80% concentrations of Outfall 201 effluent, and growth in both concentrations (0.64 mg/larvae) exceeded growth of minnows in the control water (0.63 mg/larvae).

Table 2.1. Results of *Ceriodaphnia dubia* toxicity tests of ambient sites from East Fork Poplar Creek and Outfall 201 conducted October 18 – 24, 2000

Sample	Concentration (%)	Survival (%)	Mean Reproduction (offspring/surviving female ± SD)
		Ambient sites	
Control	100	100	19.7 ± 2.36
EFK 24.1	100	100	26.3 ± 3.06
		Outfall 201	
Control	100	100	19.7 ± 2.36
Outfall 201	100	100	21.9 ± 4.41
Outfall 201	80	100	23.1 ± 1.73

Note: EFK = East Fork Poplar Creek kilometer. SD = standard deviation.

Table 2.2. Summary (mean ± SD) of water chemistry analyses conducted during *Ceriodaphnia dubia* toxicity tests of ambient samples from East Fork Poplar Creek, October 18 – 24, 2000

Sample	pH (su)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Conductivity (µS/cm)
Control	8.1 ± 0.1	79.6 ± 1.1	96.3 ± 2.4	194.7 ± 1.5
Outfall 201	7.9 ± 0.1	117.7 ± 1.3	146.3 ± 2.7	306.4 ± 4.5
EFK 24.1	7.9 ± 0.1	119.8 ± 0.8	152.3 ± 5.0	326.8 ± 6.7

Note: EFK = East Fork Poplar Creek kilometer. SD = standard deviation.

3. BIOLOGICAL INDICATOR MONITORING

3.1 Bioindicators of Fish Health (*S. M. Adams*)

3.1.1 Introduction

This task involves the use and application of bioindicators of fish health, in addition to other investigative approaches, to evaluate the effects of water quality and other environmental variables on fish in EFPC. A suite of diverse bioindicators of fish health has been monitored since fall 1985 to evaluate the health of a sentinel species, the redbreast sunfish (*Lepomis auritus*), as a component of the BMAP program.

3.1.2 Results/Progress

Analysis of blood, tissue and scale samples collected from redbreast sunfish during the spring/summer sampling period of 2000 continue to be analyzed for seriological indicators, detoxification enzyme activities, and age and growth analysis, respectively. Quality control analysis was satisfactorily performed on the 1999 bioindicator data to verify accuracy of the final data set.

Primary activities for the next quarter will include continued laboratory processing/analysis of the 2000 samples, particularly the age and growth samples and liver tissue for the detoxification enzyme analysis.

3.2 Bioindicators of Reproductive Competence (*M. S. Greeley, Jr.*)

3.2.1 Introduction

Successful reproduction of fish populations requires that adult fish be capable of producing and spawning viable gametes. To address the reproductive competence of fish in EFPC, various reproductive indicators, representing several different levels of reproductive organization related to gamete production, have been routinely examined in redbreast sunfish sampled from EFPC and reference streams at the beginning of each annual breeding season since 1988. Establishment and maintenance of stable fish populations also require that offspring be able to develop normally into subsequent reproductive cohorts. Beginning in 1990, water samples from several sites in EFPC and other streams on and about the ORR have been tested for their effects on fish developmental processes utilizing a variation of an EPA-standard medaka (*Oryzias latipes*) fish embryo-larval test (Benoit et al., 1991).

3.2.2 Results/Progress

Tissue and blood samples from the annual monitoring of fish health and reproductive competence conducted during May and June 2000 continue to be analyzed.

A medaka embryo-larval developmental toxicity test was conducted on grab samples of water collected October 26, 2000 from seven sites in EFPC. Since recent tests had seen poor survival of embryos in water from all EFPC sites, the current test was conducted on both full- and quarter-strength water samples. Somewhat unexpectedly, embryo survival did not differ significantly from the control for any EFPC sites, even with full-strength samples (Tables 3.1 and 3.2). Because these results differed markedly from previous tests, a follow-up medaka embryo-larval test of the same EFPC sites was initiated on December 20, 2000. Survival values in the follow-up test again did not differ significantly from the control in the quarter-strength samples, but were reduced significantly in the case of full-strength samples from four EFPC sites. Nevertheless, the results of both tests were much improved over the results of previous tests conducted during the last several years. For example, in a test conducted January 2000 (see 1st Quarter 2000 Report), medaka survival was significantly reduced in full-strength samples from each of the tested EFPC sites and in quarter-strength samples from a total of four sites. An additional medaka embryo-larval test will be conducted during the 1st quarter 2001 to determine whether this significant improvement in medaka embryo-larval test results continues.

Table 3.1. Results of Medaka developmental toxicity tests of ambient sites from East Fork Poplar Creek initiated in the 4th Quarter, 2000

Sample	October 26, 2000		December 20, 2000	
	Survival in 100% sample (%)	Survival in 25% sample (%)	Survival in 100% sample (%)	Survival in 25% sample (%)
Control	90	n.a.	90	n.a.
EFK 25.1	65	75	65	75
EFK 24.6	70	100	35*	65
EFK 23.4	65	85	60*	100
EFK 18.2	85	90	90	100
EFK 13.8	85	100	75	100
EFK 10.0	65	85	25*	70
EFK 6.3	70	70	30*	70

Note: EFK = East Fork Poplar Creek kilometer. Asterisk signifies a significant difference from the control at $p = 0.05$.

4. BIOACCUMULATION MONITORING

4.1 Routine Bioaccumulation Monitoring (*M. J. Peterson and G. R. Southworth*)

4.1.1 Introduction

Bioaccumulation monitoring of EFPC has identified mercury and polychlorinated biphenyls (PCBs) as substances that accumulate to concentrations in fish that may pose health concerns to human consumers. Redbreast sunfish or bluegill are collected twice annually from the middle to upper reaches of EFPC to evaluate spatial and temporal trends in mercury and PCB contamination. On an annual basis, largemouth bass (*Micropterus salmoides*) are collected to evaluate the maximum human health risks in EFPC and stoneroller minnows (*Campostoma anomalum*) are collected to evaluate the potential ecological concerns due to metal accumulation.

The routine fall collection of fish for the bioaccumulation task was conducted during the 4th quarter 2000. In this report, PCB results from the spring 2000 fish collection are presented and discussed.

Table 3.2. Summary of water chemistry analyses conducted during Medaka developmental toxicity tests of ambient sites from East Fork Poplar Creek initiated in the 4th Quarter, 2000

Sample	pH (su)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Conductivity (µS/cm)
		October 26, 2000		
EFK 25.1	7.84	126	145	342
EFK 24.6	7.91	118	158	305
EFK 23.4	8.03	120	144	327
EFK 18.2	7.99	122	150	323
EFK 13.8	7.97	128	159	331
EFK 10.0	7.99	124	166	371
EFK 6.3	7.96	123	168	411
		December 20, 2000		
EFK 25.1	8.15	116	165	374
EFK 24.6	8.22	108	135	317
EFK 23.4	8.19	114	144	335
EFK 18.2	8.22	134	165	381
EFK 13.8	8.27	143	174	396
EFK 10.0	8.18	154	182	461
EFK 6.3	8.22	139	179	444

Note: EFK = East Fork Poplar Creek kilometer.

4.1.2 Results/Progress

Fall/Winter sampling — Fall/winter sampling of EFPC for the bioaccumulation studies task began November 15 and was completed on December 14, 2000. Six redbreast sunfish of a size likely to be taken by fisherman (50-150 g) were collected from each of five EFPC sites. Six bluegill were collected from Lake Reality. Increasingly since the bypass of Lake Reality, bluegill appear to be the dominant sunfish species in the lake (apparently out-competing redbreast sunfish). Sunfish were fileted in the laboratory and processed prior to preparation of mercury and PCB analysis samples.

Largemouth bass and stonerollers were also collected from upper EFPC, but additional collecting is required to obtain the required number of largemouth bass samples. Sampling success will likely improve once the beaver dam downstream of Lake Reality is removed. Collection of reference fish is also continuing into January 2001.

Table 4.1 Concentrations of PCBs (mean ± SE, µg/g wet wt.) in fillets of redbreast sunfish (exceptions noted) from East Fork Poplar Creek in the spring of 2000, in comparison to concentrations in fish in the fall of 1999. The second row (in parentheses) is the range of values at each site. N = 6 at all sites except EFK 24.0 in spring of 2000, where n =7.

Site	Fall 1999	Spring 2000
EFK 24.2 to 24.5	1.42 ± 0.29	1.71 ± 0.50
	(0.5 - 2.75)	(0.72 - 3.57)
EFK 24.0	1.83 ± 0.58[a]	2.98 ± 0.77[b]
(Lake Reality)	(0.54 - 3.4)	(0.96 - 6.22)
EFK 23.4	1.25 ± 0.30	0.68 ± 0.21
	(0.48 - 2.36)	(0.12 - 1.47)
EFK 18.2	0.34 ± 0.04	0.32 ± 0.03
	(0.18 - 0.40)	(0.18 - 0.42)
EFK 13.8	0.31 ± 0.05	0.19 ± 0.03
	(0.11 - 0.45)	(0.11 - 0.30)
EFK 6.3	0.25 ±0.06	0.33 ± 0.06
	(0.10 - 0.47)	(0.14 - 0.54)
Hinds Creek	<0.01	<0.01

Note: SE = Standard Error

[a] all six fish were bluegill

[b] 4 bluegill, 3 redbreast sunfish

PCBs in sunfish — Mean PCB concentrations in redbreast sunfish collected from EFPC in May/June 2000 are presented in Table 4.1 along with results from the previous collection period. In general, EFPC fish average one to two orders of magnitude higher PCBs than fish from similar east Tennessee reference streams. The lowest average concentration in sunfish in the spring of 2000 (0.19 µg/g) was observed at EFK 13.8; the highest average (2.98 µg/g) was at Lake Reality (EFK 24.0). Six individual fish from EFPC exceeded the 2 ppm level, and one fish exceeded 6 ppm (6.22 µg/g). In contrast, the average PCB concentration in sunfish collected from Hinds Creek in spring of 2000 was less than 0.01 µg/g.

Sunfish monitoring continues to indicate that locations near the Y-12 Complex are the major sources of PCBs to EFPC fish. In spring 2000, mean PCB concentrations were highest in fish from the three sites nearest the Y-12 Complex (upstream of Bear Creek road). The mean PCB concentration in fish decreased by a factor of two between EFK 23.4 and EFK 18.2. Mean PCB concentrations in fish were similar at the lower three sites in EFPC (EFK 6.3, EFK 13.8, EFK 18.2). In general, average PCB concentrations in EFPC sunfish in spring of 2000 were similar to those concentrations in fish from the fall of 1999, with two notable exceptions. The mean PCB concentration in Lake Reality sunfish was approximately 1 µg/g higher in the spring of 2000 than in the fall of 1999, and the average level in EFK 23.4 sunfish was about 2-fold lower in the spring of 2000. As observed in the previous sampling period, contaminant variability was still high at the upstream sites (see SEs and ranges in Table 4.1), suggesting fish near Y-12 may be highly mobile as the fish populations continue to adjust to various changes in water quality and habitat in upper EFPC. Field observations of fish populations at the upper three sites also support this hypothesis; in some sampling periods sunfish are readily collected, while in other seasons obtaining sufficient fish can be very difficult.

5. COMMUNITY STUDIES

5.1 Periphyton (*S. M. Adams*)

5.1.1 Introduction

Periphyton monitoring in EFPC occurs four times a year (as close to a quarterly sampling regime as environmental conditions will allow). Rocks and their associated periphyton are collected from three sites on EFPC (EFKs 24.4, 23.4, 6.3) and one site on Brushy Fork (BFK 7.6). Four rocks from each site are used in determining algal biomass (chlorophyll *a* or chl*a*) and the rate of photosynthesis (^{14}C incorporation). To compare photosynthesis (PS) rates for periphyton among sites with different areal biomass, the PS data are divided by the chlorophyll *a* amounts. The resulting chlorophyll-specific photosynthetic rates provide an index of the health of the algal component of the periphyton**.**

5.1.2 Results/Progress

Periphyton biomass and photosynthesis was measured in EFPC on August 28, 2000. The results of these measurements appear in Table 5.1. Chlorophyll *a*, photosynthesis, and chlorophyll-specific photosynthesis in EFPC and Brushy Fork (reference) periphyton were similar to previous measurements made recently, and well within the range of historical values. The next sampling for biomass and photosynthesis will occur in January 2001; the specific date will depend on flow conditions.

Periphyton collected September 19-20 are currently being processed for metals analysis.

Table 5.1. Means and standard errors for biomass, photosynthesis, and chlorophyll-specific photosynthesis rates of periphyton collected from EFPC and Brushy Fork, August 28, 2000

Site	Algal biomass (FgChla/cm^2)	Photosynthesis (FgC/cm^2/h)	Chlorophyll-specific photosynthesis (FgC/FgChla/h)
EFK 24.4	60.5 ± 8.2	12.6 ± 0.8	0.22 ± 0.03
EFK 23.4	37.3 ± 3.9	9.4 ± 0.3	0.26 ± 0.02
EFK 6.3	36.2 ± 2.4	7.1 ± 0.5	0.20 ± 0.01
BFK 7.6	13.4 ± 4.3	3.9 ± 0.9	0.34 ± 0.05

Note: EFK = East Fork kilometer, BFK = Brushy Fork kilometer

5.2 Benthic Macroinvertebrate Community (*J. G. Smith*)

5.2.1 Introduction

The objectives of the benthic macroinvertebrate task are to monitor the benthic macroinvertebrate community in EFPC in order to provide information on the ecological condition of the stream, and to evaluate the responses of macroinvertebrates to operational changes, abatement activities, or remedial actions at the Y-12 Complex as a measure of the effectiveness of these actions. To meet these objectives, quantitative benthic macroinvertebrate samples have been collected at least twice each year (April and October) since 1985 from four sites in EFPC (EFKs 24.4, 23.4, 18.7, and 13.8), although only EFKs 24.4, 23.4, and 13.8 samples are routinely processed. Additionally, samples are collected once annually from EFK 6.3 (in April) and processed. Since 1986, up to two reference sites unimpacted by industrial discharges have also been monitored, including one site each on Brushy Fork (BFK 7.6) and Hinds Creek (HCK 20.6) (Figs.1.1 and 1.2). In addition to routine benthic macroinvertebrate community studies, an *in situ* bioassay, using a locally available clam as the test organism, is also conducted periodically.

In this progress report, results are presented of a more detailed data analysis that specifically examined temporal trends in EFPC for evidence of macroinvertebrate community changes potentially associated with several of the major abatement actions that have been completed at the Y-12 Complex; only those data from the April and October sampling periods since 1985 are included.

5.2.2 Results/Progress

The routine collection of benthic macroinvertebrate samples from three sites in EFPC (EFKs 24.4, 23.4, and 13.8) and two reference sites (Brushy Fork (BFK 7.6) and Hinds Creek (HCK 20.6)) was completed on schedule in October 2000. The process of establishing a subcontract to have these samples and those collected in April 2001 processed, was initiated in late CY00; samples collected in October 2000 will be delivered for processing in January 2001.

Figure 5.1 shows the relative abundances (based on total community density) of the following broad taxonomic groups: Chironomidae (non-biting midges), Oligochaeta (aquatic worms), the combined total for the Ephemeroptera, Plecoptera, and Trichoptera (i.e., mayflies, stoneflies, and caddisflies, or EPT) taxa, and all other taxa; the EPT taxa are generally comprised of some of the most pollution insensitive species of invertebrates. Only those EFPC sites with the greatest importance for assessing the effectiveness of abatement actions at the Y-12 Complex are included (i.e., EFKs 24.4, 23.4, and 13.8). There were minimal differences between the two reference sites, therefore, the only reference results presented are those for Brushy Fork (BFK 7.6). The vertical arrows for the EFPC site-graphs show the approximate periods when major abatement/remedial actions were taken by the Y-12 Complex (Fig. 5.1). Only those actions thought to have the most potential for changing water quality were included (i.e., replacement of New Hope Pond with Lake Reality in late 1988; dechlorination of three major effluents in late 1992; implementation of flow management in late 1996; and beginning operation of the Central Mercury Treatment Facility also in late 1996.

The most distinctive difference between the EFPC sites and Brushy Fork was in the relative abundances of the EPT taxa. At BFK 7.6, the EPT taxa consistently accounted for 10% to 25% of the total community abundance in *both* seasons. At all three EFPC sites in contrast, the community composition was clearly different in the spring versus fall sampling periods. In the spring, EPT relative abundances were normally low or they were virtually absent. During the fall, the proportion of the EPT taxa has remained high at EFK 13.8 throughout the study, while at EFKs 24.4 and 23.4, the EPT taxa were virtually absent at the beginning of the study, but increased considerably through time. These results indicate the presence of an impact that is negatively affecting the invertebrate community at all sites in EFPC in the spring that either does not exist in the fall or is less severe.

Within about 1.5 yr after New Hope Pond was replaced, the relative abundances of the EPT taxa increased considerably at EFK 23.4 in the fall, but there was no discernable response evident from the spring data. After dechlorinating three of the major effluents in late 1992, the relative abundance of the EPT taxa clearly increased in the fall at EFK 24.4, but there was no detectable change during the spring. At EFK 23.4, the relative abundances appeared to increase slightly in both seasons within a couple of years after dechlorination. However, it is not clear if this increase was associated with dechlorination or some other activity(ies) since this site is most likely too far downstream of the affected effluents for chlorine to remain at toxic concentrations. Flow management and/or the Central Mercury Treatment Facility may have had some beneficial effects at EFKs 24.4 and 23.4, as the relative abundances of the EPT taxa at these sites increased noticeably by the spring the year following these actions. However, there were no clear, sustained trends in change during the fall periods after these actions were taken that were indicative of either positive or negative responses. At EFK 13.8 there was no evidence of change following the replacement of New Hope Pond, effluent dechlorination, implementation of flow management or startup of the Central Mercury Treatment Facility.

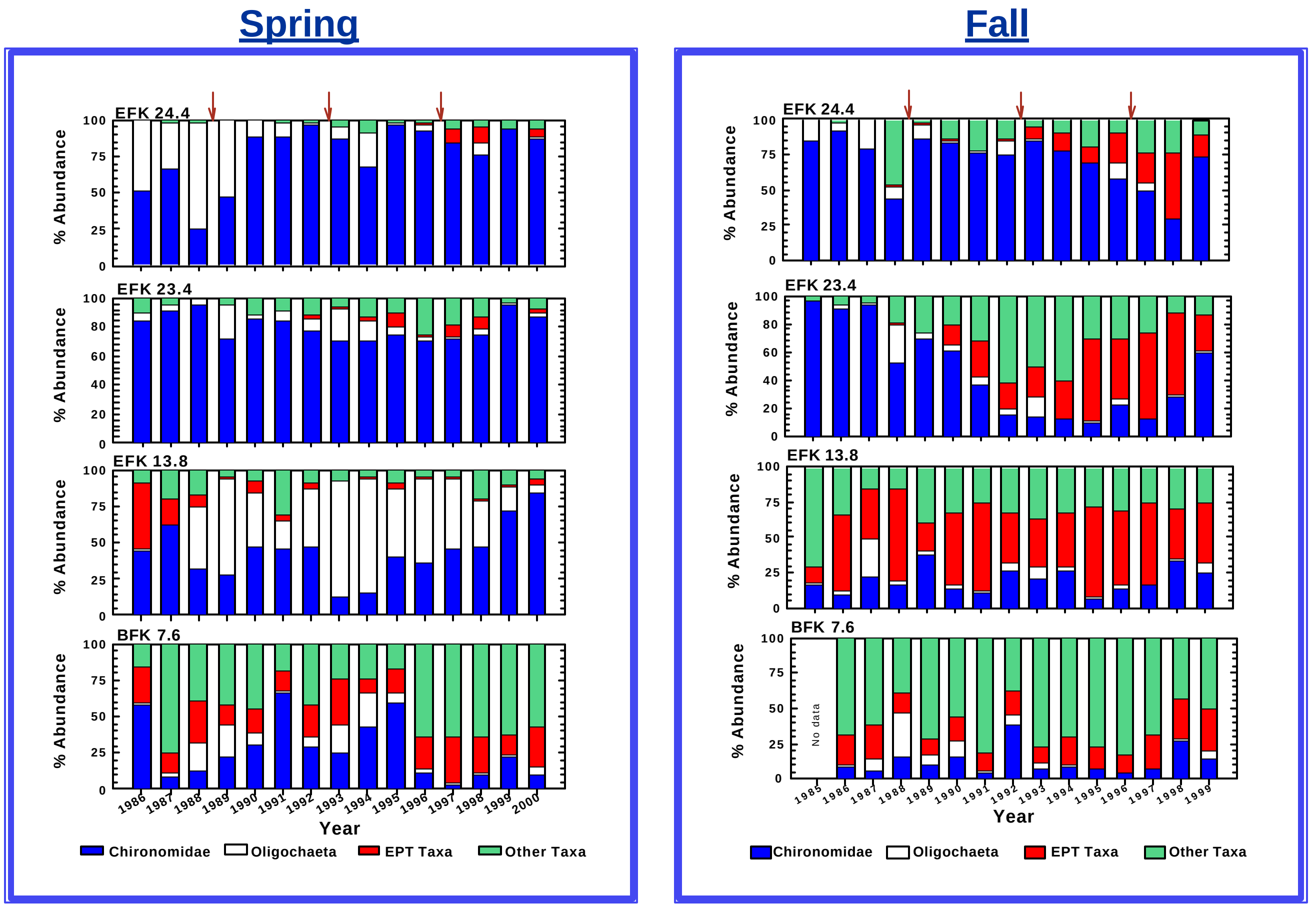

Figure 5.1. Relative abundances (based on total community abundances), by season, of the Chironomidae, Oligochaeta, EPT taxa, and Other taxa (i.e., all remaining taxa not included in the first 3 categories) in EFKs 24.4, 23,4, and 13.8, and BFK 7.6. Arrows between bars show approximate times of the following abatement actions: replacement of New Hope Pond with Lake Reality in late 1988; dechlorination of three major effluents in late 1992; implementation of flow management in late 1996; and beginning operation of the Central Mercury Treatment Facility, also in late 1996.

Conclusions — This analysis provides strong evidence that the macroinvertebrate community has responded positively to some of the major abatement actions taken by the Y-12 Complex to improve water quality in EFPC. A positive response was first detected at EFK 23.4 within 18 to 24 months after New Hope Pond was replaced with Lake Reality. Dechlorination of three of the major effluents in 1992 resulted in an even faster response at EFK 24.4, but it's not clear if the macroinvertebrate community at EFK 23.4 was affected by this action. Flow management appears to have improved conditions for invertebrates at EFKs 23.4 and 24.4, but with only 3.5 years of data, the extent of the improvement is not clear.

Not only did this analysis help identify which abatement actions were effective, it also demonstrated the importance of collecting samples in more than one season. If samples had been collected in the spring only, the effectiveness of these abatement actions would have been grossly underestimated or possibly undetected. With only fall samples, the effectiveness of these actions could have been overstated. Furthermore, if samples had been collected in the fall only, it could have been concluded that EFK 13.8 was unimpacted, while spring-only samples would have led to conclusion of significant impacts. Clearly, something is still happening between the fall and spring sampling periods that is having a significant negative effect on the macroinvertebrate community in the headwaters of EFPC as well as kilometer 13.8. While contaminants could still be a factor in retarding improvements in the spring, this seasonal difference could also be related to a physical disturbance rather than a chemical one, or it could be a combination of the two. For example, rains tend to be more frequent and heavy during the spring than in the fall. From the perspective of combined disturbances, this could mean more frequent inputs of land-based contaminants. From the perspective of physical disturbances alone, with relatively long quiescent periods with little or no rain, conditions are able to remain sufficiently stable (e.g., habitat structures) over a suitable time period for animals to recolonize. Extensive modifications of the stream channel and riparian vegetation in the past have probably contributed indirectly to stream instability through reductions in substrate stability associated with increases in siltation and sedimentation. Furthermore, with extensive areas of asphalt in EFPC's upper watershed, this instability would be exacerbated because there is little or no vegetation or other land structures to slow or reduce the volume of runoff into the stream. This leads to more rapid increases in flow at greater intensities than in more protected watersheds such as Brushy Forks. The causes of these large seasonal differences will be investigated in more detail in the future.

5.3 Fish Community (*M. G. Ryon)*

5.3.1 Introduction

Fish population and community studies can be used to assess the ecological effects of water quality and/or habitat degradation. Fish communities, for example, include several trophic levels and species that are at or near the end of food chains. Consequently, they integrate the direct effects of water quality and habitat degradation on primary producers (periphyton) and consumers (benthic invertebrates) that are utilized for food. Because of these trophic interrelationships, the well-being of fish populations has often been used as an index of water quality. Moreover, statements about the condition of the fish community are easily understood by the general public.

The two primary activities conducted by the Fish Community Studies task in EFPC are: (1) biannual, quantitative estimates of the fish community at six EFPC sites and two reference stream sites; and (2) investigative procedures in response to fish kills near the Y-12 Complex. The quantitative sampling of fish populations is conducted by electrofishing during the March–April and September–October periods. The resulting data are used to estimate population size (numbers and biomass per unit area), determine length frequency, estimate production, and calculate Index of Biotic Integrity values. Fish kill investigations are conducted in response to chemical spills, unplanned water releases, or when dead fish are observed in EFPC. The basic tool used for fish kill investigations is a survey of upper EFPC (above Bear Creek Road to the N/S Pipes) in which numbers and locations of dead, dying, and stressed fish are recorded. This baseline is supplemented by special toxicity tests, histopathological examinations, and water quality measurements in an effort to determine the cause(s) of the observed mortality.

5.3.2 Results/Progress

This quarter, data from the quantitative fish community sampling conducted in fall 2000 were entered into computer databases, processed through quality assurance procedures, and used to generate population estimates for density and biomass. Overall, the fall samples from EFPC had numbers of species and specimens at each site that were similar to, if slightly higher than, past samples. The species data continues the trend for improvement at all sites, which is statistically significant over the 15 year monitoring period (Figure 5.2). The fish communities in the upper reaches of EFPC continued to have high densities (Figure 5.3), with 4 species above Lake Reality and as many as 12 species below the lake at EFK 23.4. After a large peak in density at EFK 25.1 in 1999, the patterns in the density of fish communities at the two upper sites were very similar in 2000 sampling. Both sites have densities that are lower than at EFK 23.4, a situation last seen in 1995 sampling. This pattern reflects both an increased density at EFK 23.4 and a reduction at EFK 25.1. The presence of sensitive species such as northern hogsucker (*Hypentelium nigricans*), rock bass (*Ambloplites rupestris*), and snubnose darter (*Etheostoma simoterum*) below the lake suggests that conditions have generally returned to the improvement that followed full implementation of flow management. The expansion of sensitive species included greenside darter (*E. blenniodes*) at all sites below Lake Reality, and blueside (*E. jessiae*) and redline (*E. rufilineatum*) darters at the most downstream sites. Trends in sensitive species richness (Figure 5.4) and abundance or density (Figure 5.5) suggest recovery is still limited, because although the numbers of such species at downstream EFPC sites are approaching those found in the references, the number of specimens, or density, still lags far behind. This trend is true for downstream sites as well as for upper sites such as EFK 23.4.

No reportable fish kills occurred during this quarter and surveys of EFPC above Bear Creek Rd. were not conducted.

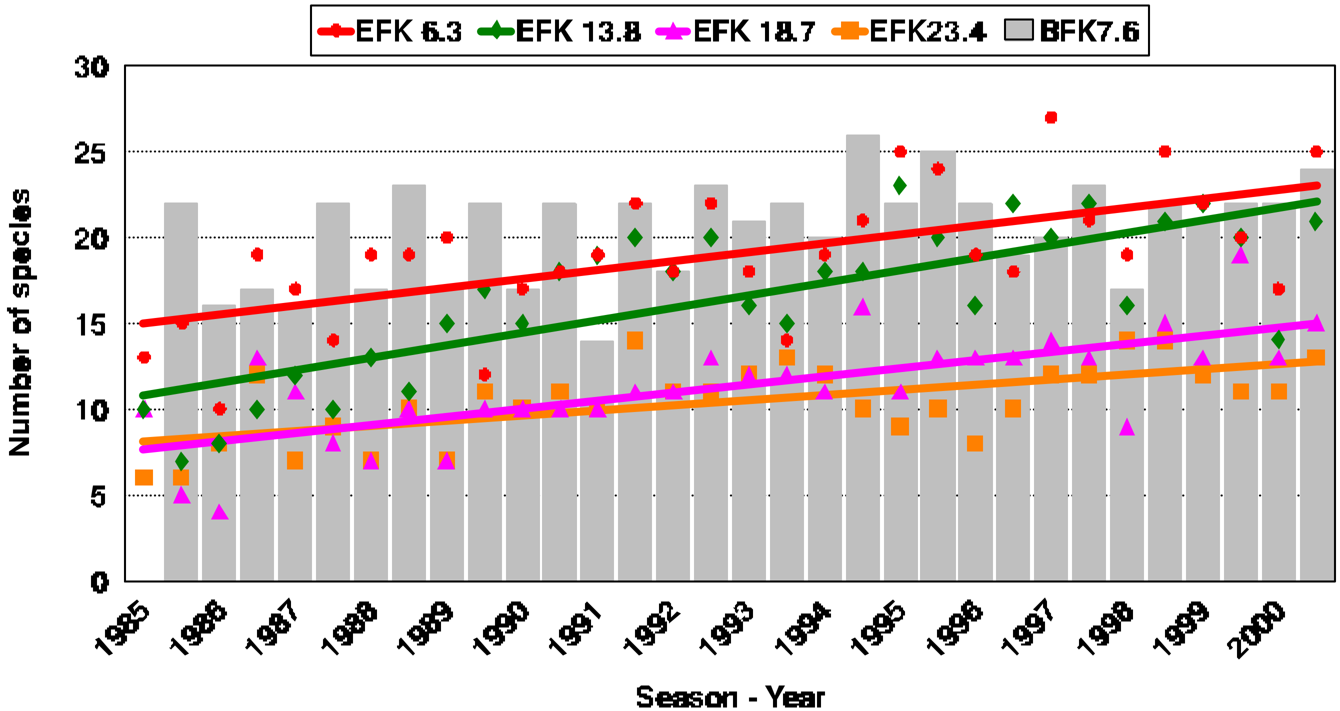

Figure 5.2. Fish species richness at sites in East Fork Poplar Creek (EFK) and a reference stream Brushy Fork (BFK) for spring and fall samples from 1985 through 2000. Significant increases in richness are shown by the trend lines.

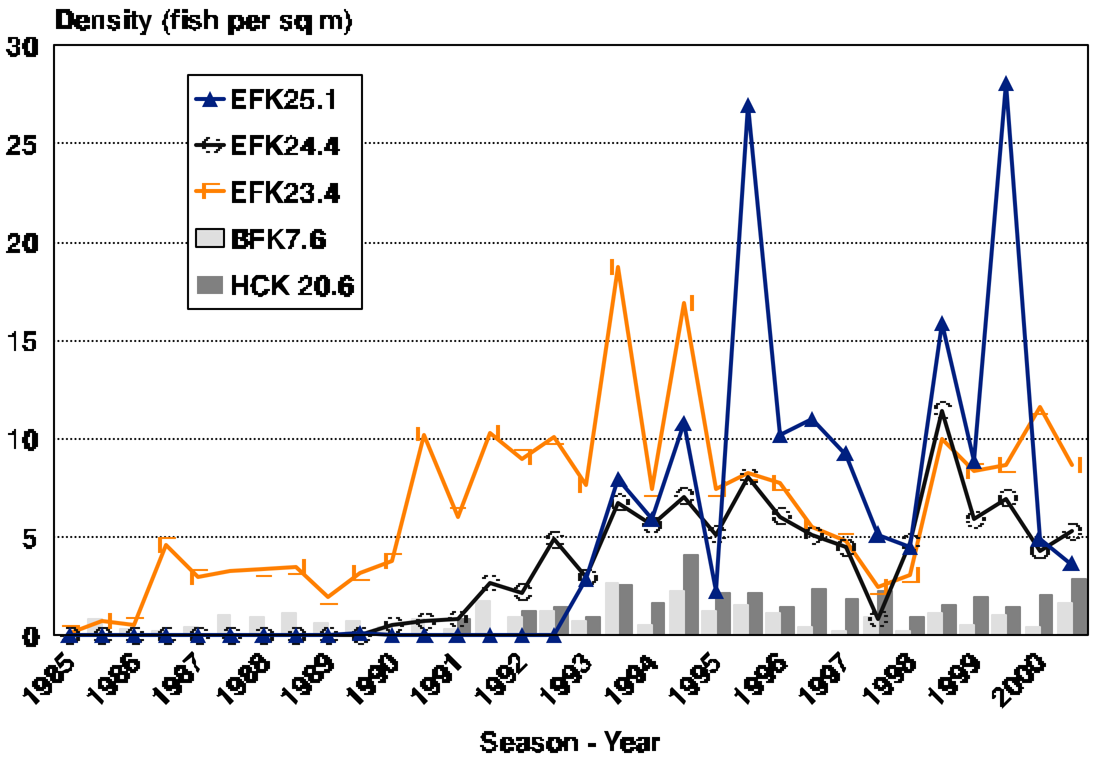

Figure 5.3. Total density of fish communities at sites in upper East Fork Poplar Creek (EFK) and two reference streams, Brushy Fork (BFK) and Hinds Creek (HCK) for spring and fall samples from 1985 through 2000.

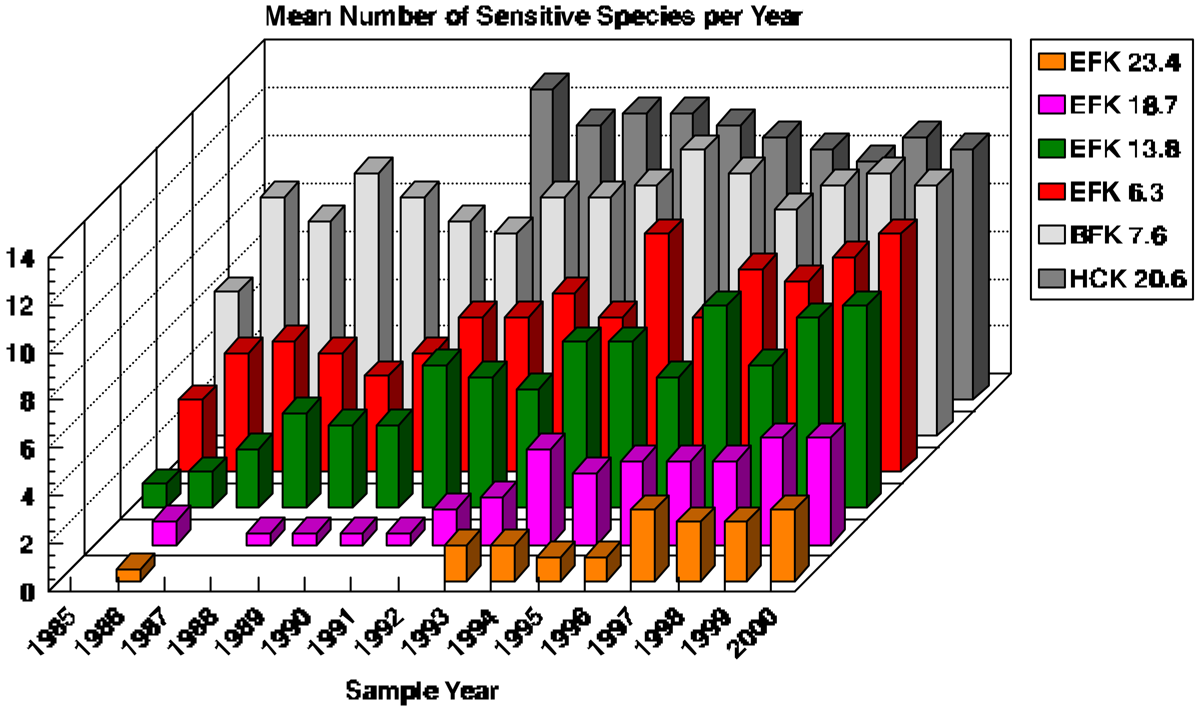

Figure 5.4. Mean number of sensitive fish species found each year in spring and fall samples of sites in East Fork Poplar Creek (EFK) and two reference streams Brushy Fork (BFK) and Hinds Creek (HCK) from 1985 through 2000.

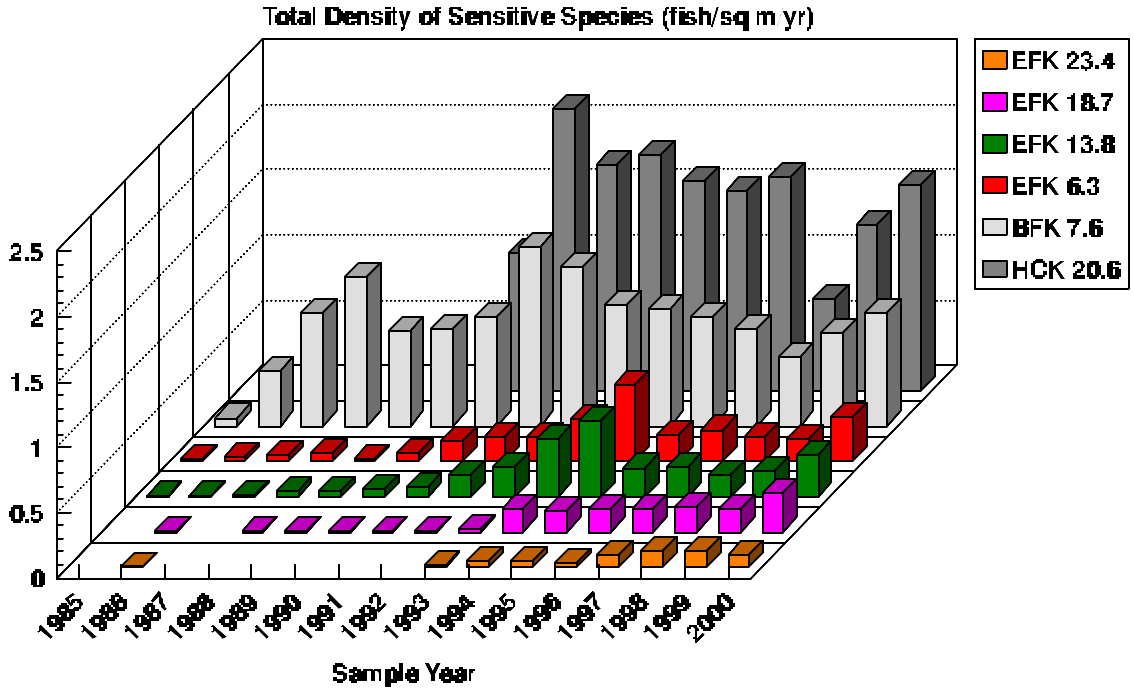

Figure 5. 5. Total density of sensitive fish species in samples of sites in East Fork Poplar Creek (EFK) and two reference streams, Brushy Fork (BFK) and Hinds Creek (HCK) from 1985 through 2000.

6. DATA MANAGEMENT (*S. W. Christensen*)

6.1. Introduction

Environmental Compliance projects are required by provisions of the Oak Ridge Reservation Federal Facilities Agreement (FFA) and the State of Tennessee Oversight Agreement (TOA) to transmit their data to the Oak Ridge Environmental Information System (OREIS). BMAP data managers receive data packages from the PIs of the other tasks, transform the data into appropriate OREIS formats, and facilitate the data transfer to OREIS. This task also administers the BMAP workstation.

6.2. Results/Progress

During the 4th quarter 2000, data managers conducted routine system maintenance activities (e.g., backups) and administered the FY 2001 subcontract with SAIC for Oracle and SAS support and system administration services.

7. FIRST QUARTER 2001 FIELD ACTIVITIES

This section of the Y-12 BMAP quarterly report is meant to provide information to the Y-12 Environmental Compliance Office and other interested parties concerning BMAP plans for field activities in upper EFPC and adjacent environs during the upcoming calendar quarter.

Toxicity — Ambient water samples from EFK 24.1 and effluent samples from Outfall 201 will be evaluated for toxicity to *Ceriodaphnia dubia* during the 1st quarter 2001.

Bioindicators — A medaka embryo-larval test will be conducted on ambient water samples from EFPC during the 1st quarter 2001.

Bioaccumulation — Fall/winter sampling of EFPC fish for bioaccumulation purposes continues into the 1st quarter 2001.

Community Studies — The next sampling for periphyton biomass and photosynthesis will occur in January 2001; the specific date will depend on flow conditions. During the 1st quarter 2001, the spring field sampling will be initiated for the fish community task.

8. REFERENCES

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Loar, J. M., S. M. Adams, L. J. Allison, J. M. Giddings, J. F. McCarthy, G. R. Southworth, J. G. Smith and A. J. Stewart. 1989. The Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for East Fork Poplar Creek. ORNL/TM-10265. Oak Ridge National Laboratory. Oak Ridge, Tennessee.