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Quarterly Progress Report

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Biological Monitoring Program for East Fork Poplar Creek

Submitted to

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1. Introduction

In May 1985, a National Pollutant Discharge Elimination System (NPDES) permit was issued for 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 Plant 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 Plant 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 Plant 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 sites, although sites may be excluded and/or others 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 sampling sites include EFPC at kilometers (EFKs) 24.4 and 23.4 [upstream and downstream of Lake Reality (LR) respectively]; EFK 18.7, located off the ORR and below an area of intensive commercial and limited light industrial development; EFK 13.8, 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 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 (*L. A. Kszos, D. S. Cicerone, A. J. Stewart and L. F. Wicker*)

2.1. Introduction

The ambient toxicity monitoring task includes three subtasks: toxicity monitoring, toxicity experiments, and supporting studies. Toxicity monitoring uses U.S. Environmental Protection Agency (EPA) approved methods with *Ceriodaphnia dubia* to provide systematic information that can be used to determine changes in the biological quality of EFPC through time. Toxicity experiments are conducted to test specific hypotheses about stream water quality. The hypotheses are addressed experimentally by the systematic application of ambient toxicity test methods. Supporting studies are used to (1) investigate the relationship between the physicochemical and biological conditions in EFPC, particularly as they relate to processes or rates of ecological recovery and (2) develop better methods for accurately predicting ecological recovery with changes in water quality in EFPC. Toxicity monitoring at the upstream sites from Bear Creek Road [Lake Reality outfall or LR-o (EFK 23.8), LR inlet or

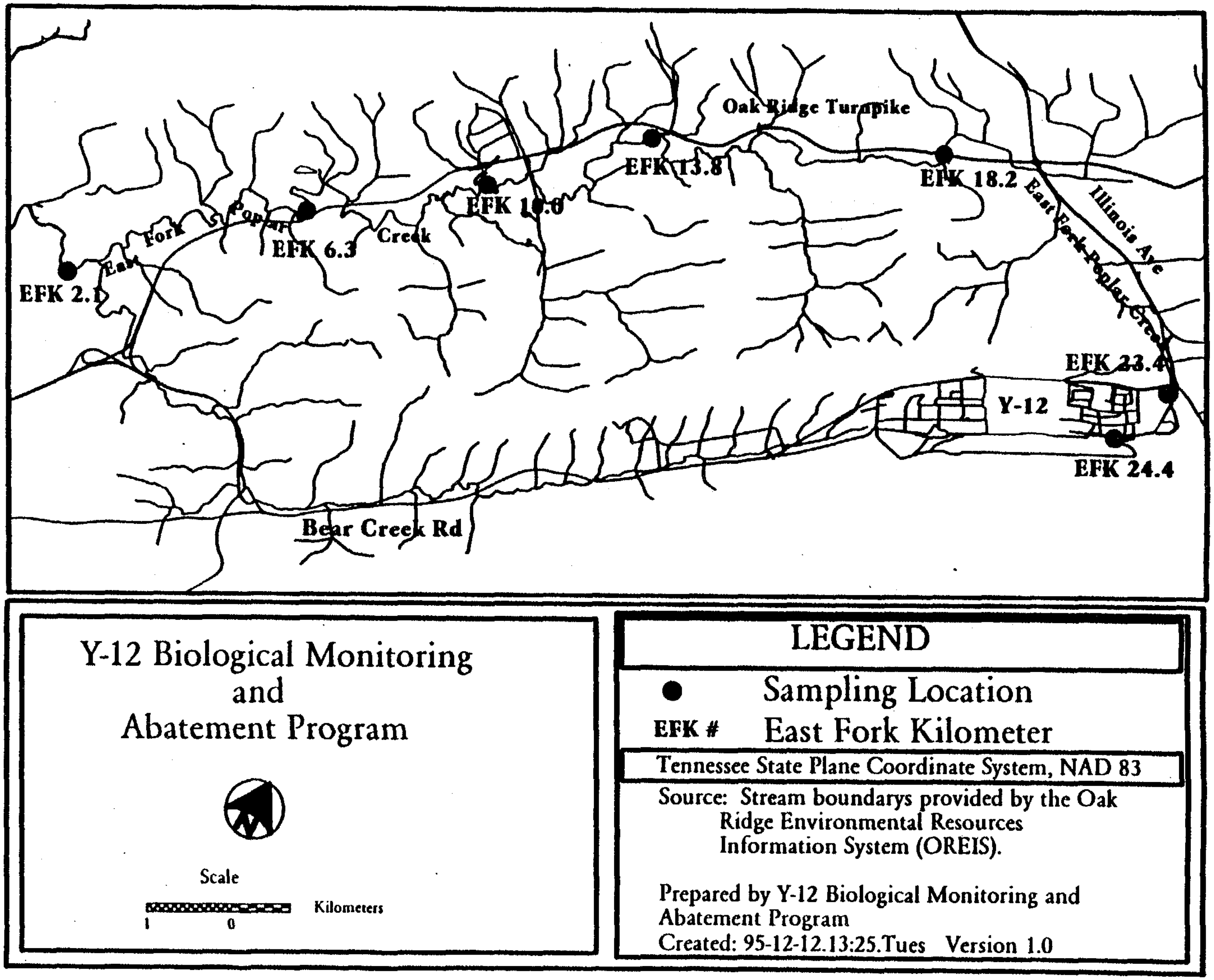

Figure 1.1. Location of biological monitoring sites on East Fork Poplar Creek in relation to the Oak Ridge Y-12 Plant.

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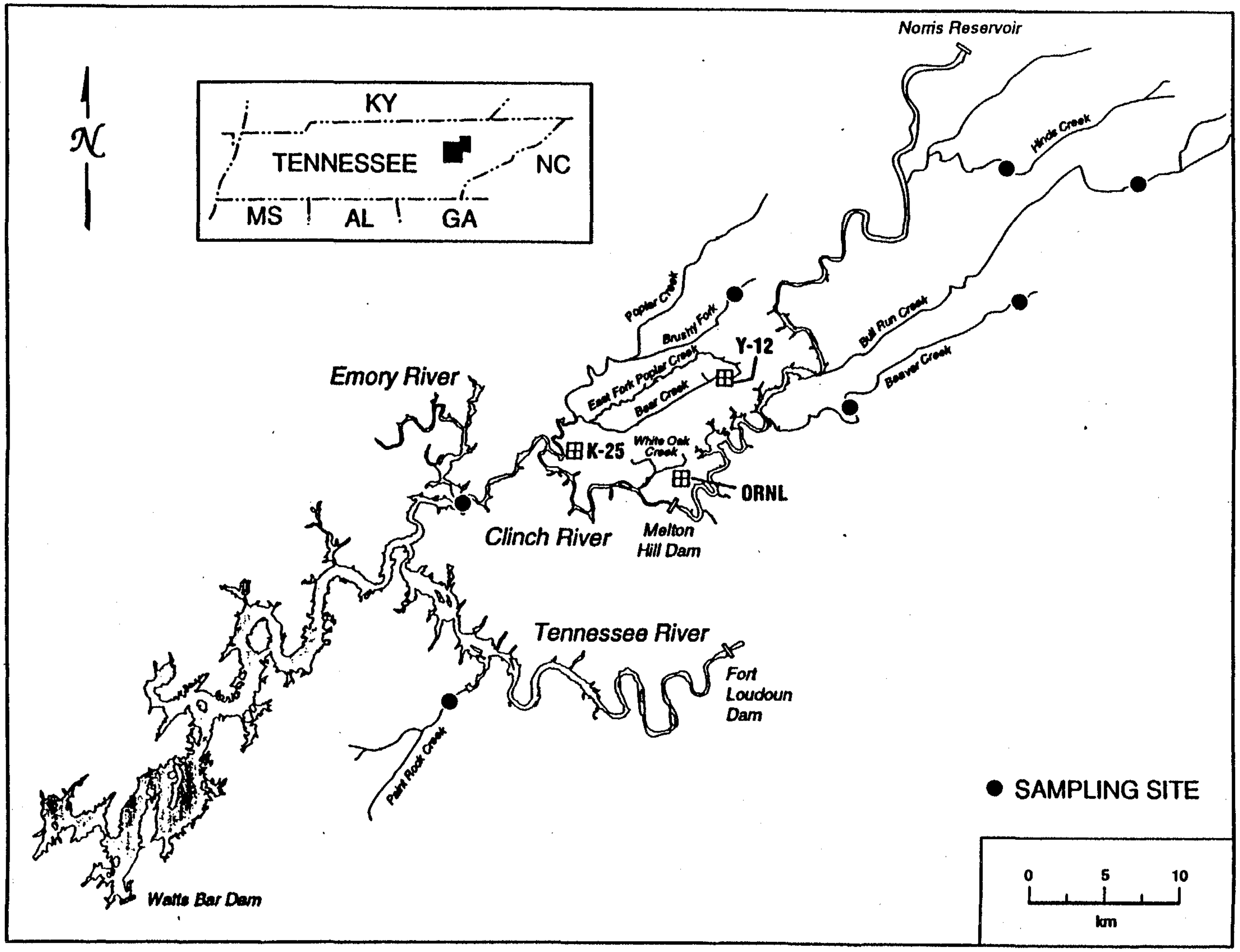

Figure 1.2. Location of reference sites in relation to the Oak Ridge Y-12 Plant.

LR-i (EFK 24.1) and Area Source Study Site 8 or AS-8 (EFK 24.6)] are conducted monthly. Ambient monitoring at six sites downstream from Bear Creek Road (EFKs 22.8, 21.9, 20.5, 18.2, 13.8, and 10.9) are tested quarterly.

2.2 Results/Progress

2.2.1 Toxicity Monitoring

Ambient water samples from EFK 24.6, EFK 24.1, and EFK 23.8 were evaluated for acute and chronic toxicity to *Ceriodaphnia dubia* during December 11-17, 1996 and January 22-28, 1997. During a February 19-25 testing period, ambient water samples from EFK 24.6, EFK 24.1, and EFK 23.8 and downstream sites (EFKs 22.8, 21.9, 18.2, 13.8, and 10.9) were also tested with *Ceriodaphnia dubia*. In each sampling period, daily grab samples from the ambient sites were collected by ESD personnel for testing. Results of ambient toxicity tests and chemical analyses are shown in Tables 2.1 and 2.2. During all test periods, *Ceriodaphnia* survival in water from each site was equal to 100%. *Ceriodaphnia* reproduction in the water samples was not significantly reduced compared to the controls.

2.2.2 Special Studies

Water-quality monitoring studies conducted *in situ* during August 12-20, 1996 and November 13-20, 1996, showed that pH and pCa (activity of calcium ions) varies over daily cycles in Lake Reality due to algae photosynthesis and respiration. During the day, increases in pH in Lake Reality (and, from prior monitoring, in upper EFPC) were great enough to encourage the formation of calcite (a particulate form of calcium carbonate) from dissolved-phase calcium. Since calcite surfaces compete effectively with binding sites on other minerals and on organic matter for dissolved-phase contaminants, the production and surface-activity of calcite can alter contaminant fate.

After *in situ* monitoring of water-column conditions, sediment samples from six locations in Lake Reality were collected and analyzed by X-ray diffraction (for mineralogy), scanning electron microscopy (SEM; for particle morphology), and electron dispersion spectroscopy (EDS; for surface elemental composition). The samples were also analyzed for extractable metals by inductively coupled plasma spectrometry. Calcite was definitely present in the sediments. Other minerals detected in the sediments included quartz, dolomite, siderite, illite, chlinochlore, kaolinite and vermiculite. SEM photographs showing well-cleaved faces characteristic of biogenically precipitated calcite particles, with overgrowths of different sizes. Overgrowth of calcite on aluminum silicate particles was also evident, showing that calicite "surface area" was greater than might be expected based on measurements of calcite mass alone.

Studies now in progress are designed to explore the influence of biotic processes on the adsorption and desorption of contaminants from calcite surfaces, and on the dissolution and formation of calcite particles. The central hypothesis of this study is that variables under biotic control, such as pH and pCa, can alter calcite production-dissolution dynamics and contaminant sorption-desorption processes at time scales of < 24 h. If so, daily changes in photosynthesis (which affect pH and concentrations of dissolved carbon dioxide in upper EFPC and Lake Reality) can be expected to alter the biological availability of various toxic heavy metals.

The laboratory tests now in progress use fine suspended particles of calcite (1-50 μm in

Table 2.1. Results of *Ceriodaphnia dubia* toxicity tests of ambient sites from East Fork Poplar Creek conducted December 1996 through February, 1997

Sample	Concentration (%)	*Ceriodaphnia dubia*	
		Survival (%)	Mean Reproduction (offspring/surviving female ± SD)
	December 11-17, 1996		
Control	100	100	27.2 ± 5.3
EFK 24.6	100	100	32.1 ± 2.8
EFK 24.1	100	100	31.9 ± 2.5
EFK 23.8	100	100	33.4 ± 2.1
	January 22-28, 1997		
Control	100	100	33.8 ± 2.9
EFK 24.6	100	100	30.5 ± 4.0
EFK 24.1	100	100	30.1 ± 2.6
EFK 23.8	100	100	31.4 ± 2.8
	February 19 - 25, 1997		
Control	100	100	34.1 ± 1.9
EFK 24.6	100	100	31.8 ± 3.2
EFK 24.1	100	100	32.4 ± 1.5
EFK 23.8	100	100	35.3 ± 1.6
EFK 22.8	100	100	31.1 ± 1.7
EFK 21.9	100	100	31.8 ± 1.8
EFK 20.5	100	100	32.3 ± 2.5
EFK 18.2	100	100	32.2 ± 3.4
EFK 13.8	100	100	31.2 ± 3.0
EFK 10.9	100	100	31.5 ± 3.5

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

diameter) in equilibrated aqueous solutions of known chemical composition, under controlled conditions of temperature, ionic strength and calcium concentration. Adsorption-desorption processes are being followed by use of tracer-level concentrations of ^{109}Cd, a gamma-emitting cadmium isotope. In separate experiments, we found that addition of carbon dioxide to the solution very rapidly releases cadmium previously bound to calcite, and that at pH 9.2, ^{109}Cd rapidly sorbs to calcite (>95% bound in about 4 h). In the latter experiment, concentrations of free calcium did not change much when cadmium was being sorbed, indicating the significance of pCa, rather than the formation of new calcite from dissolved-phase calcium, as an important sorption-controlling factor.

3. Biological Indicators of Fish Health

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 examined 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

The typical sample for basic bioindicator analyses consists of 15-20 individual adult redbreast sunfish fish of each gender collected from each of 4 sites in EFPC and 2 reference streams. Additional redbreast sunfish of all sizes and ages are also collected for population-level analyses. All sampled fish are lengthed and weighed, then scale samples are collected from at least 10 fish in each 1 cm size class in order to establish size-age relationships for the population. The length and/or age distribution of the population among the various size classes reflects the overall success or health of a fish population. A population composed of fish from all the expected size classes or ages is generally a good indication that the population is reproducing successfully and has not incurred serious impacts from environmental stressors.

The length-frequency distributions of redbreast sunfish collected over a six year period from 1991-1996 from a reference site (Brushy Fork), from immediately below Lake Reality (EFK 23), and from lower EFPC (EFK 5) are plotted in Fig. 3.1. Size distributions at the reference site are characterized by the presence of individuals in all size classes, a relative large number of individuals in the intermediate sizes, and comparably few individuals in the smallest and largest size classes. This type of distribution is to be expected of a relatively healthy fish population.

At the upper EFPC site, almost all size classes are represented in 1993 and 1996, with the exception of the 2 cm class. The relatively large number of intermediate sized-individuals suggests relatively normal recruitment of smaller individuals into the population, although the absence of the smallest size class could reflect immigration of young fish from adjacent areas of EFPC and/or Lake Reality rather than active reproduction at this site.

At the lower EFPC site, smaller individuals were present in low numbers until 1996. The large increase in abundance of the smaller sunfish at EFK 05 from 1993 to 1996 indicates improvements in

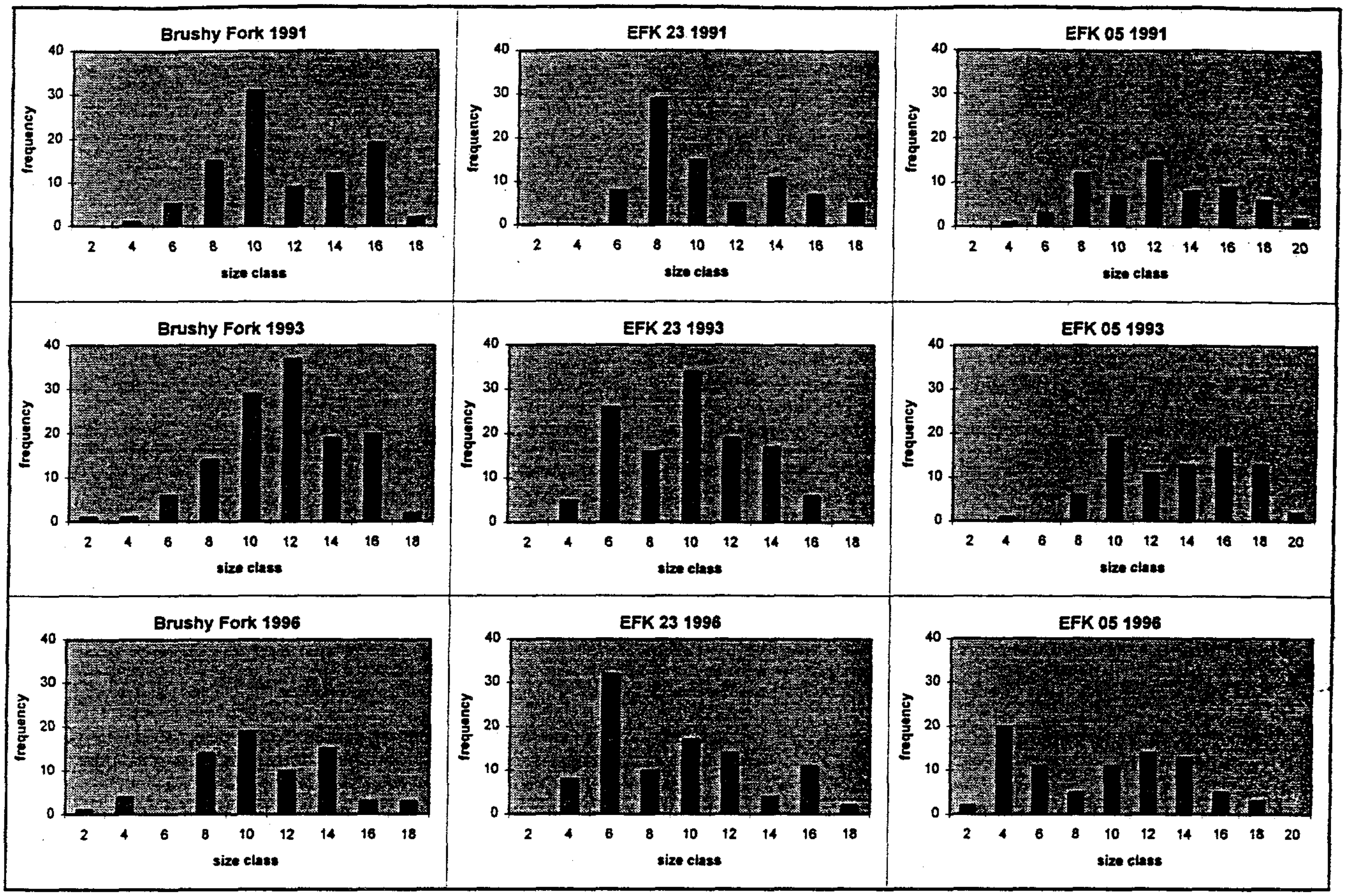

Figure 3.1. Distribution of different size classes in redbreast sunfish sampled over several years from a reference site (Brushy Fork) and 2 sites in EFPC. Size class labels represent the beginning of 2 cm increments of total length (ex. "2" for fish ranging in length from 2.0-3.9 cm).

reproductive and recruitment capacity in the lower reaches of the stream. Future reports will present growth data for redbreast sunfish from EFPC over this same time period to better evaluate the health status and effects of remediation at the Y-12 facility on this sentinel fish species.

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

3.2.1 Introduction

Successful reproduction of fish populations requires that adults be capable of producing and spawning viable gametes. To address the reproductive competence of adult fish in EFPC, various reproductive indicators, representing several different levels of reproductive organization related to gamete production, have been routinely examined in female 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 requires 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 medaka (*Oryzias latipes*) embryo-larval test.

3.2.2 Results/Progress

Redbreast sunfish were sampled from 5 sites in EFPC (EFKs 24, 23, 19, 14, and 5) and 2 sites in reference streams (Brushy Fork and Hinds Creek) during May and June, 1996, in order to compare the reproductive condition of the various populations at the beginning of the breeding season. Blood samples were obtained and frozen for later analysis of reproductive hormones. Body weights and lengths were measured and recorded. Reproductive organs were weighed, then preserved in fixative for later analyses. Testes from male fish were subsequently prepared for histopathological examination, while ovaries from female fish were directly analyzed for the occurrence of ovarian parasites, the abundance of atretic (dead or dying) oocytes, and fecundity. Partial results of these analyses are presented in Table 3.1. The remaining results will be reported as additional analyses are completed.

The condition factor is an indicator of the relative "plumpness" of a fish. Condition factors of female sunfish sampled in the spring of 1996 from EFPC upstream (EFK 24) and downstream (EFK 23) of Lake Reality were lower than at the other study sites (Table 3.1), continuing a trend observed in previous years. Lower condition factors suggest that sunfish in the upper reaches of EFPC might have less energy resources to devote to reproduction than fish from reference sites or sites farther downstream in EFPC. However, fecundities measured in fish from these sites were actually quite high, indicating instead that these fish devote a disproportionally higher percentage of their limited resources to reproduction rather than somatic growth. Similar observations have been noted previously in sunfish sampled from White Oak Creek downstream of ORNL (Adams et al. 1994)and from Mitchell Branch downstream of the K-25 Site (Greeley 1994), and might be a response of sunfish to the stressful environmental conditions at these sites.

Another reproductive characteristic of the sunfish populations in the upper EFPC sites (EFK 24 and 23) is an increased incidence of oocyte atresia, observed both in 1996 (Table 3.1) as well as in previous years (Greeley et al. 1996). Oocyte atresia can be a normal process at certain times within a fish's reproductive season, but the relative abundance of these damaged gametes immediately prior to the onset of the breeding season is suggestive of particularly stressful conditions at the two uppermost EFPC sites. Potential explanations for this elevated stress include chronic chemical toxicity, elevated water

Table 3.1. Means and standard errors for condition factors and reproductive indices measured in female redbreast sunfish sampled from EFPC and reference sites in late May or early June immediately prior to the 1996 breeding season.

Site	Condition Factor	GSI	Ovary parasites (# / g body wt)	Atretic oocytes (# / g body wt)	Fecundity (eggs/g body wt)
EFK 24	1.68 ± 0.03	9.57 ± 1.10	0.17 ± 0.09	3.02 ± 2.00	50.42± 6.41
EFK 23	1.65 ± 0.03	8.30 ± 0.49	1.66 ± 1.29	2.94 ± 1.26	41.79 ± 2.99
EFK 19	1.99 ± 0.04	7.60 ± 0.70	0.00 ± 0.00	0.10 ± 0.06	30.36 ± 2.72
EFK 14	1.86 ± 0.03	10.22 ± 0.78	0.01± 0.01	0.15 ± 0.09	29.06 ± 5.10
EFK 5	1.86 ± 0.03	10.42 ± 0.78	0.10 ± 0.06	0.62 ± 0.30	34.42 ± 3.67
Hinds Creek	1.79 ± 0.03	11.21± 0.46	0.03 ± 0.03	1.23 ± 0.31	41.05 ± 1.59
Brushy Fork	1.76 ± 0.04	9.44 ± 0.72	0.30 ± 0.21	0.56 ± 0.18	42.42± 1.81

Note: EFK = East Fork kilometer; condition factor = [(body wt -gonad wt)/(body lgth)^3] x 100 ; GSI = gonadal somatic index *or* (gonad wt/body wt) x 100.

temperatures, or relative nutritional status. It will be useful to assess the effects of flow management, which is expected to alter each of these possible environmental effectors to differing degrees, on the reproductive condition of sunfish in EFPC at the beginning of the 1997 breeding season.

4. Bioaccumulation monitoring task

4.1 Routine bioaccumulation monitoring (*M. J. Peterson and G. R. Southworth*)

4.1.1 Introduction

Bioaccumulation monitoring conducted since 1985 as part of the EFPC BMAP 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 (*Lepomis auritus*) are collected twice annually from seven sites along the length of EFPC to evaluate spatial and temporal trends in mercury and PCB contamination. The forage species (stoneroller, *Campostoma anomalum*) is collected once yearly to evaluate PCB contamination in food of fish-eating wildlife. This report presents PCB bioaccumulation results for late winter through summer 1996.

4.1.2 Results/Progress

Mean concentrations of PCBs in fish from the various sites are presented in Table 4.1. PCB concentrations in filets of redbreast sunfish fell within ranges typical of past monitoring at the collection sites. Mean concentrations were highest in Lake Reality and the reach of EFPC above Lake Reality, and fell to approximately 0.5 mg/kg in the 10 km reach downstream. PCB concentrations in sunfish declined slightly in the lowermost reaches of EFPC. All fish collected downstream from Lake Reality contained PCB concentrations of 1 mg/kg or less (maximum 1.0 mg/kg), but 40% of the sunfish (6 of 16) from Lake Reality and EFPC upstream equaled or exceeded the FDA threshold limit of 2.0 mg/kg. The highest concentration in an individual fish was 2.6 mg/kg.

Whole stonerollers contained strikingly higher concentrations of PCBs than sunfish filets (Table 4.1). The highest average concentration (12 mg/kg) was at EFK 23.4, immediately downstream from the Lake Reality discharge. A sharp decrease occurred between that site and EFK 18.2, as was the case for sunfish. Direct utilization of PCB concentrations in sunfish filets for the estimation of ecological risk to fish eating wildlife in EFPC will result in underestimating risk by several fold. The high concentrations of PCBs in largemouth bass (mean 4.4 mg/kg) collected from Lake Reality and EFK 23.4 in fall 1995 are consistent with the high PCB concentrations in forage fish at those sites.

Table 4.1. Concentrations of PCBs (mg/kg wet wt.) in redbreast sunfish and stonerollers collected in winter/spring 1996. Stoneroller data are means of three composites of ten fish each, and sunfish collections are eight fish per site.

Site	Redbreast sunfish		Stoneroller composite
	Mean ± SE	Range	Mean ± SE
EFK 24.8	1.64 ± 0.26	0.16 - 2.60	5.7 ± 0.24
Lake Reality	1.55 ± 0.26	0.63 - 2.40	
EFK 23.4	0.45 ± 0.09	0.19 - 0.79	12.0 ± 2.2
EFK 18.2	0.56 ± 0.10	0.33 - 1.03	1.9 ± 0.26
EFK 13.8	0.51 ± 0.08	0.27 - 0.90	
EFK 6.3	0.22 ± 0.09	0.15 - 0.42	
EFK 2.1	0.37 ± 0.51	<0.02 - 0.52	

4.2 Special Studies

4.2.1 Relationship between mercury in water and fish in EFPC *(G. R. Southworth and M. J. Peterson)*

4.2.1.1 Introduction

Mercury and methylmercury concentrations were measured in February 1997 at sites in EFPC where fish are routinely monitored for mercury bioaccumulation. These studies are conducted by the Y-12 RMPE program, and provide data that is essential to the BMAP efforts to establish a predictive relationship between mercury concentrations in fish and mercury in water. The February 1997 data represent the first data on methylmercury concentrations in EFPC following the Lake Reality bypass.

4.2.1.2 Results/Progress

Previously, total methylmercury concentrations in EFPC water have been highest at EFK 23.4 as a consequence of production and export of methylmercury from Lake Reality. Following the bypass, total methylmercury concentrations in EFPC at EFK 23.4 were lower than at upstream sites, and more than five fold lower than concentrations in Lake Reality (which would have been exported under the normal flow regime). Dry weather total mercury concentrations in EFPC at EFK 23.4 (Station 17) have now been reduced to 200 to 400 ng/L. The empirical bioaccumulation model being developed by BMAP predicts that reduction of baseflow mercury concentrations to this range will result in decreased mercury bioaccumulation in fish. Time lags in such a response are expected; however, it is hoped that a decrease will become evident in the 1997 monitoring results.

4.2.2 Effects of Methylmercury on Fish-Eating Birds in EFPC *(T. L. Ashwood)*

4.2.2.1 Introduction

Kingfishers are highly piscivorous birds that consume up to half their body weight each day in fish or crayfish. Because kingfishers are territorial during the breeding season, their food intake and the food they provide their nestlings all comes from a relatively small area of a stream or lake. If fish within these territories are contaminated, then the adults and nestlings are highly exposed. For two years, the Oak Ridge Reservation (ORR) ecological risk assessment (Sample et al. 1995, 1996) has identified kingfishers as being highly at risk on all ORR streams.

4.2.2.2 Results/Progress

Field work related to the study of kingfisher nesting success was initiated in March. Adult birds with feeding/nesting territories have been located in upper EFPC, but no nesting burrows have yet been located along the creek.

4.2.3 PCB Source Identification *(J. F. McCarthy)*

Semi-permeable membrane devices (SPMDs) were deployed December 1996-January 1997 at 21 sites in upper EFPC and within the storm drain network in an attempt to identify the sources of PCB being bioaccumulated by fish and clams. Many of the SPMD's retrieved from several sites during the deployment had small holes in the edge of the polyethylene tubing. Since the theory underlying the use of the SPMD as a PCB monitor requires that the polyethylene membrane be an intact barrier separating the water from the inside of the tubing, these SPMDs could not be used. Most of the damaged SPMDs were deployed at sites within the storm drain system and may have been damaged when rapid flow during a December storm caused the tubing to rub against the edge of the metal pipe that the SPMDs were deployed in. To address this problem, a new design has been developed for deploying the SPMD. This design will immobilize the SPMD on a plastic rack within a metal cage, and should prevent damage to the membrane even in high energy flow environments such as might be encountered in the storm drains. Construction of these devices is being completed, and the SPMDs will be re-deployed in the near future.

5. Community Studies

5.1 Periphyton (*W. R. Hill and J. Richmond*)

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*) and rate of photosynthesis (^{14}C incorporation).

5.1.2 Results/Progress

Periphyton biomass and photosynthesis was measured March 13, 1997. The results of these measurements appear in Table 5.1. Biomass and photosynthesis at all sites in EFPC and Brushy Fork were significantly lower (30-60%) than in late October 1996. Biomass and photosynthesis were also lower than the 8-year averages of these parameters at all sites except EFK 23.4. The low values for biomass and photosynthesis were probably due at least in part to the unusually wet winter in 1996/1997. Numerous spates occurred during this time; moderate to large spates reduce periphyton biomass (and consequently, photosynthesis) through scour and rock tumbling. Spates at upstream sites, such as EFK 24.4 and EFK 23.4, tend to be of shorter duration than at downstream sites, so periphyton at upstream sites tends to recover quicker than at downstream sites. The relatively low biomass and photosynthesis at EFK 24.4 were therefore somewhat surprising, even though the winter was wet. It is possible that colder water temperatures resulting from flow augmentation also contributed to low biomass and photosynthesis at EFK 24.4. The combined effects of a wet winter and flow management on periphyton production may be manifest in lower growth rates, survival, and reproduction of fish at EFK 24.4.

The next sampling of periphyton biomass and photosynthesis in EFPC is scheduled for June 1997. This upcoming sampling episode should provide an interesting point of comparison for investigating flow management effects. Because water for flow management is drawn from the cool hypolimnion of the Clinch River/Melton Hill Reservoir, stream temperature at EFK 24.4 should be substantially lower in June than in previous years. Lower stream temperatures should decrease primary production at EFK 24.4, where periphyton experiences saturating levels of light and nutrients.

The next sampling of periphyton for metals analysis will occur in April or May, depending on weather conditions. Samples taken at EFK 23.4 may demonstrate early effects of the Lake Reality bypass that became operable after the previous periphyton metals sampling in Fall 1997.

Table 5.1. Means and standard errors for biomass, photosynthesis, and chlorophyll-specific photosynthesis rates of periphyton collected from EFPC and Brushy Fork, March 13, 1997.

Site	Algal biomass (μg chla/cm^2)	Photosynthesis (μgC/cm^2/h)	Chlorophyll-specific photosynthesis (μgC/μgchla/cm^2/h)
EFK 24.4	36.9 ± 8.3	6.75 ± 0.96	0.21 ± 0.03
EFK 23.4	36.2 ± 5.8	7.46 ± 0.36	0.22 ± 0.03
EFK 6.3	15.3 ± 5.1	6.70 ± 1.56	0.49 ± 0.09
BFK 7.6	3.88 ± 1.80	1.08 ± 0.31	0.45 ± 0.15

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

5.2 Benthic Macroinvertebrate Community Monitoring (*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 response of macroinvertebrates to operational changes, abatement activities, or remedial actions at the Y-12 Plant as a measure of the effectiveness of these actions. To meet these objectives, routine quantitative benthic macroinvertebrate samples have been collected at least twice annually (April and October) since 1985 from four sites on EFPC (EFK 24.4, EFK 23.4, EFK 13.8, and EFK 6.3). Since 1986, two reference sites unimpacted by industrial discharges have also been monitored: one site each on BF at kilometer 7.6 (BFK 7.6) and Hinds Creek at kilometer 20.6 (HCK 20.6) (Figs. 1.1 and 1.2).

5.2.2 Results/Progress

Samples from previous collections were analyzed during the last quarter. New samples will be collected in April 1997 as scheduled.

5.3 Fish community monitoring (*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 Plant. The quantitative sampling of the fish populations at sites is conducted by electrofishing in March–April and September–October. 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 of observed mortality.

5.3.2 Results/Progress

This quarter, data from the Fall, 1996, quantitative fish community sampling was processed for the EFPC sites and reference sites as per the plan schedule. These data were entered into computer databases and run through quality assurance procedures. The data are shown in Table 5-1.

In general, conditions in the EFPC fish community continue to improve. The presence of two sensitive species, the northern hog sucker and the snubnose darter, at EFK 23.4 is an example of improved conditions, as is the continued presence of the redline darter at a downstream site, EFK 13.8. It would be expected that further improvement will be observed based on the reduced stream temperatures associated with flow management. The new temperature regime in upper EFPC now closely matches other area streams and is no longer elevated to potentially stressful levels. These cooler temperatures should lead to the observation of new species at sites closer to the Y-12 Plant. Whether additional species can be found above Lake Reality is more questionable, due primarily to the difficulty for fish to migrate through the current siphon by-pass arrangement used to shunt water around the lake.

As a result of low numbers of dead fish in background surveys of upper EFPC in September 1996, bimonthly surveys have been made of this area. Five daily surveys were made during December 17-27, 1996 and February 10-14, 1997. The surveys covered EFPC above Bear Creek Rd. to the north-south pipes. A total of 5 dead stonerollers were found in December; 2 stonerollers and 1 striped shiner were found in February. The average dead per survey was less than 1 fish, which was similar to the background mortality levels of the September 1996 survey. The continuation of this lower mortality rate suggests improved conditions associated with the flow management instituted in the summer of 1996. The absence, at least to this date, of any substantial fish kills particularly in the late November time frame also is notable. Because of this possible improved rate of mortality, bimonthly surveys will be conducted through the spring to provide additional data.

Table 5-2. Fish density (number of fish/m^2) and biomass (g/m^2, in parentheses) for September-October 1996 in East Fork Poplar Creek (EFK) and the reference sites, Brushy Fork (BFK) and Hinds Creek (HCK).

Species	EFK 25.1	EFK 24.4	EFK 23.4	EFK 18.7	EFK 13.8	EFK 6.3	HCK 12.9	BFK 7.6
American brook lamprey								0.01 (0.12)
Central stoneroller	2.72 (27.86)	1.67 (21.15)	1.22 (6.48)	0.09 (0.26)	0.24 (1.05)	0.02 (0.05)	0.73 (3.68)	0.02 (0.31)
Spotfin shiner					<0.01 (<0.01)	0.01 (0.02)		
Striped shiner	5.88 (34.78)	1.70 (5.65)	2.74 (11.02)	1.28 (6.60)	0.31 (2.61)	0.07 (0.29)	0.22 (2.26)	0.04 (0.44)
Rosefin shiner					0.05 (0.02)	<0.01 (<0.01)		0.01 (0.02)
Bigeye chub						<0.01 (0.01)	0.03 (0.05)	
Bluntnose minnow					0.04 (0.04)	<0.01 (0.01)	0.18 (0.25)	
Blacknose dace	2.37 (6.15)	1.68 (2.19)	0.59 (0.59)	0.08 (0.15)	0.03 (0.02)		0.15 (0.28)	0.02 (0.03)
Creek chub				0.01 (0.05)	0.03 (0.04)	<0.01 (<0.01)	0.03 (0.11)	<0.01 (<0.01)
White sucker			0.02 (0.55)		<0.01 (0.53)		0.02 (1.90)	0.01 (1.49)
Northern hog sucker			<0.01 (0.05)	0.05 (0.97)	0.07 (4.15)	0.02 (1.27)	0.01 (0.40)	0.02 (0.62)

Table 5-2. (Con.)

Species	EFK 25.1	EFK 24.4	EFK 23.4	EFK 18.7	EFK 13.8	EFK 6.3	HCK 12.9	BFK 7.6
Black redhorse				0.01 (0.03)	<0.01 (0.01)	<0.01 (0.67)	0.02 (0.75)	<0.01 (0.06)
Golden redhorse						<0.01 (0.27)	<0.01 (0.14)	<0.01 (0.14)
Black bullhead					<0.01 (0.04)			
Yellow bullhead			0.01 (1.35)	<0.01 (0.19)	<0.01 (0.10)		<0.01 (0.12)	
Blackspotted topminnow								<0.01 (<0.01)
Western mosquitofish			0.02 (0.01)	0.01 (<0.01)	<0.01 (<0.01)	0.01 (<0.01)		
Banded sculpin					<0.01 (<0.01)	0.03 (0.05)	0.55 (1.72)	0.21 (0.63)
Rock bass				0.01 (0.08)	0.01 (0.36)		0.01 (0.24)	0.02 (0.98)
Redbreast sunfish		0.05 (1.27)	0.34 (2.80)	0.07 (1.75)	0.11 (2.41)	0.03 (1.24)	0.01 (0.47)	0.01 (0.39)
Green sunfish					0.01 (0.12)	0.04 (0.07)		
Warmouth						<0.01 (0.10)		
Bluegill			0.62 (3.37)	0.05 (0.36)	0.04 (0.43)	0.02 (0.17)	0.05 (0.70)	0.04 (0.47)

Table 5-2. (Con.)

Species	EFK 25.1	EFK 24.4	EFK 23.4	EFK 18.7	EFK 13.8	EFK 6.3	HCK 12.9	BFK 7.6
Hybrid sunfish			<0.01 (0.02)	<0.01 (0.07)	<0.01 (0.02)	<0.01 (0.01)	<0.01 (0.03)	
Spotted bass							<0.01 (0.10)	
Largemouth bass			0.01 (0.61)	<0.01 (0.23)	0.01 (1.10)		<0.01 (0.19)	
Greenside darter							0.01 (0.06)	0.01 (0.03)
Blueside darter							0.02 (0.05)	0.02 (0.02)
Stripetail darter							0.01 (0.01)	
Redline darter					<0.01 (<0.01)		0.05 (0.06)	<0.01 (<0.01)
Snubnose darter				0.02 (0.04)	0.04 (0.04)	0.03 (0.03)	0.26 (0.32)	0.04 (0.04)
Logperch					<0.01 (0.02)	0.01 (0.07)		
Species richness	3	4	10	13	22	18	22	19
Density	10.97	5.10	5.57	1.68	1.00	0.30	2.36	0.48
Biomass	68.79	30.26	26.85	10.78	13.11	4.33	13.89	5.79

[a]Sites designated by stream kilometer.
* - Identification not verified by D. A. Etnier.

6. Data Management (*S. W. Christensen, C. C. Brandt, and T. W. Beaty*)

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 last quarter, data managers began processing fourth quarter 1996 data for fish community studies and toxicity testing tasks. These data are expected to be loaded to OREIS during the second calendar quarter of 1997. Data managers also undertook consolidation of Geographic Information System (GIS) files during the quarter.

7. References

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