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Assessment of Sediment Quality in the Black River Watershed

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by

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Executive Summary

The U.S. EPA Great Lakes National Program Office funded Wright State University to assess the sediment quality in the lower Black River in collaboration with the Ohio EPA and Dr. Paul Bauman (USGS). The one year study was designed to assess the effectiveness of the previous remedial dredging activity which was aimed at removing sediments contaminated with polycyclic aromatic hydrocarbons. Dredging occurred in the late 1989 and early 1990 below the Kobe Steel outfalls at river miles (RM) 2.83 to 3.55. The U.S. Army Corps of Engineers (COE) also routinely does maintenance dredging from the mouth of the river up to RM 2.5 in the Turning Basin. This dredging occurs only in the main channel of the river. Wright State University focused on measuring the toxicity of the sediments and overlying waters in the lower 5 miles of the river and comparing those findings to upstream reference stations. Depositional sediments were sampled near the river banks and outside of COE dredging areas. Surficial and deeper buried sediments were analyzed to determine contaminant gradients exist in the river. Toxicity testing included both laboratory and *in situ* (field) exposures of four aquatic species: *Pimephales promelas* (fathead minnow), *Ceriodaphnia dubia* (water flea), *Hyalella azteca* (amphipod), and *Chironomus tentans* (midge).

The Fall 1997 a survey was conducted during base flow conditions. The survey revealed a wide range of toxicity existing in the sediments and/or overlying waters. The highest levels of sediment toxicity noted in laboratory exposures occurred at River Miles (RM) 15.0, 2.9, 2.5, 0.5 and 0.3. The East Branch of the Black River RM 18.9, and the lower Black River at RM 11.6, 5.2, 4.6, and 2.4 showed little to no mortality. Growth of the amphipod and midge in the upper reference site was good. For the amphipod growth was lowest at RM 0.3, 2.4, and 5.2; while for the midge, growth was lowest at RM 0.3, 2.5, and 9.8. Surficial sediments tended to be less toxic (survival and growth (amphipod only)) than deeper, more historical sediments in most cases. *In situ* toxicity testing allowed for more realistic exposures to both sediments and overlying waters and showed better survival of organisms overall. However, high mortality of some test organisms was observed at RM 2.4 and 0.3. Initial findings indicated that photo-induced toxicity from polycyclic aromatic hydrocarbons may be a factor at some of these sites, as there was lower survival in near-surface water exposures.

A survey of the indigenous snail, *Physella gyrina*, in the study area showed genetic patterns indicative of stress at 2 locations. When the DNA pattern of individuals with a population becomes similar, then it suggests the population has been adversely impacted and is less diverse. This loss of genetic diversity can equate to greater susceptibility to stress and general population decline. At RM 5.2 above Kobe and French Creek and in Kline Ditch (a tributary of French Creek) a high degree of genetic similarity was observed. The Kline Ditch area has had water quality problems attributed to nearby fly ash disposal sites (Ohio EPA, personal communication). In addition, there was a significant relationship in the Black River study area between declining fish health (IBI scores) and snail genetic patterns.

In the Spring of 1998, *in situ* exposures of test organisms during a high flow event showed little to no acute toxicity existing at most test sites. This survey did not focus on sediments, rather organisms were only exposed to near surface waters during very turbid conditions. Photo-induced toxicity due to PAHs is not a factor when turbidity is high (Ireland et al. 1996). Therefore, the greater toxicity observed at base flow conditions, when turbidity is lower, appears to be a PAH effect. This effect can occur at PAH concentrations at the low to sub microgram per liter level.

The water column acute toxicity at base flow and the sediment acute toxicity (survival and/or growth) observed in the downstream areas suggest the PAHs may still be a primary stressor in the lower Black River. Sediments that were several centimeters deep tended to be more toxic than surficial sediments and may be exposed during resuspension events (e.g., storms, boat traffic, dredging). However, chemical analyses of sediments did not show elevated levels of PAHs. Total sediment metal concentrations were elevated and tended to be higher downstream. Acute toxicity during high flow suggests that the impacts of nonpoint source runoff and stormwater inputs are less severe. However, since only acute toxicity was measured, it is unknown whether chronic toxicity may exist due to nonpoint source runoff.

Introduction

The objectives of the 1992 Great Lakes 5 Year Strategy are unlikely to be met in the Black River Area of Concern (AOC) unless there is a thorough evaluation of what role contaminated sediments are having on the system. The Black River Remedial Action Plan (RAP) Strategy Plan (1997 - 2001) and 1997 Draft Annual Plan state that contaminated sediments and related toxicity are a significant issue in the system, yet no studies have been developed for assessing sediment toxicity. The Black River's infamous history of severe sediment contamination from polycyclic aromatic hydrocarbon (PAH) below USS/Kobe Steel and associated impacts on the fish community, the land use and hydrologic characteristics which result in extensive sediment loading and deposition, and past and present pollution sources clearly suggest sediments may, in fact, be the dominant stressor in the system. Controls are being implemented (through the RAP process) to reduce sediment and contaminant loading. However, the effectiveness of any controls or past dredging, the contribution of existing sediment contamination to use impairment, or documentation for use impairment delisiting, cannot be accurately assessed without a comprehensive assessment of sediment toxicity.

This project was designed to be an integral component of the RAP Strategic Plan, and as such, effectively promotes U.S. EPA project criteria of helping the multiple stakeholders involved in the clean-up of this complex AOC. A comprehensive assessment of contaminated sediments will assist the RAP process in identification of significant pollution sources, effective remedial designs, and education and outreach program directions. The current project integrates with the 5 year goals of the RAP in the 4 primary areas of Partnership, Stewardship, Resource, and Habitat.

The Black River basin in north central Ohio has multiple land uses, all of which have components that are causing beneficial use impairments. Significant amounts of pollution continue to enter the Black River and its major tributaries from numerous sources, including: urban and suburban storm water runoff; construction site, river bank, feedlot and agricultural runoff; septic systems; combined and separate sewer overflows; and inadequate point source treatment (Ohio EPA 1994). In addition, historical landfills, municipal wastewater treatment plants, and other unknown sources appear to be contributing toxicants and responsible for non-attainment in some stream segments. All these pollution sources have contributed, in varying degrees, to seven beneficial use impairments. Sediments which were severely contaminated with PAHs were dredged in the lower mainstem in 1990. Recent studies by Dr. Paul Baumann (U.S. Geological Survey/Ohio St. Univ. (USGS/OSU)) show that the incidence of fish tumors may be improving; however, fish are still adversely affected. Further documentation of improvement is required for cancellation of the fish advisory and delisting of the use impairment. However, it has been noted that significant PAH loadings are continuing from a variety of urban sources. This on-going contamination may prevent any further improvements (and subsequent delisting), as new surficial sediments will continue to be contaminated.

Our understanding of sediment contamination and how to properly assess its ecological significance has greatly improved in the past few years. Half of beneficial uses which are impaired in the Black River AOC are likely linked to sediment contamination. For example, the contamination of fish and associated advisories, the impaired benthic biological communities, and impacts on fishing are strongly associated with contact and bioaccumulation of sediment contaminants. In order to delist the beneficial use impairments, it will be necessary to use a suite of environmental indicators/criteria to track improvement in the system contamination. This study sought to assess the apparent role of contaminated sediments on beneficial use impairment. The assessment considered the following: the severity and spatial extent of sediment contamination, its ecological and human health significance, and the sources of and their relative contribution to the sediment contamination.

Project Description

The project utilized a suite of environmental indicators to define the degree and spatial extent of sediment and runoff contamination in the mainstem of the Black River. Since ecologically significant chemical concentrations in waters and sediments have often been found to be site-specific, and unrelated to existing criteria guidelines, an integrated assessment was conducted in a "weight-of-evidence" approach. The environmental indicators used in this integrated approach will include: 1) water (low flow and first flush) and sediment contaminant concentrations (using criteria or guidelines) (USGS/OSU & OEPA); 2) resident benthic macroinvertebrate populations (using multiple indices) (OEPA); 3) *fish tissue residue analysis of target contaminants* (using advisory levels) (WSU, OEPA, USGS/OSU); 4) presence of fish tumors or other deformities (OEPA and USGS/OSU); 4) sediment toxicity testing (using U.S. EPA standard methods for *Hyalella azteca* and *Chironomus tentans*) (WSU); 5) *in situ* toxicity testing (using *H. azteca, C. tentans, Ceriodaphnia dubia*, and *Pimephales promelas)* during dry and wet weather conditions (to determine the temporal impacts from runoff) (WSU); and 6) genotoxicity effects in benthic macroinvertebrate and fish species (using the RAPD assay) (WSU). *In situ* toxicity testing allowed differentiation of PAH-related photo-induced toxicity. The following report documents those portions of the study conducted by WSU.

Methods

Sampling site locations focused on establishing whether the Black River mouth has improved in quality since the dredging which took place below the Kobe outfalls and determine if improvements are occurring for beneficial use delisting. Sediment contamination and toxicity was characterized as recent (surficial sediments) or historical (deep sediments) to provide crucial information for remedial design strategies, (*e.g.*, dredging scenarios, management of on-going CSO and/or urban runoff, and risk from resuspension of historical contamination. The test area extended from the lower end of the Black River to the confluence with the East and West Branches with upstream reference stations (Table 1, Figure 1). Sediment and water sampling was conducted in coordination with the OEPA Intensive Survey (1997 Study Plan for the Black River Basin, Draft, June 6, 1997), the RAP Process, and Dr. Paul Baumann (USGS/OSU).

Sediment cores were collected from a minimum of 12 locations within the study area by WSU, Dr. Baumann, and the OEPA (Table 1). All sediment collection for WSU, Dr. Baumann, and the OEPA was conducted simultaneously by OEPA, U.S. EPA and WSU using U.S. EPA draft protocols (1997) and ASTM (1994) protocols. For this proposal, toxicity testing was conducted on upper (recent) and lower (historical) layers of sediment. The upper 2 centimeters of the sediment core will be removed and analyzed for PAHs and the remaining core frozen for possible future analysis. Two core depths were tested (0 - 2 and 8 - 10 centimeters) by placing into 300 mL beakers for 10 day laboratory toxicity exposures (*H. azteca* and *C. tentans* simultaneously following modified U.S. EPA 1994).

Sediments for toxicity testing were collected with a Ponar dredge from the same location and at the same time as core samples were collected. The Ponar collects from 2 to 10 cm of the upper sediment, depending on the nature of the sediment. These sediments were homogenized (by hand mixing), placed in high density polyethylene bottles and stored on ice until refrigeration. Sediment sampling occurred on one occasion during the October 1997 test period.

Field (*in situ)* toxicity studies followed previous published protocols of the PI (Chappie and Burton 1996, Ireland et al 1996, Burton et al. 1996) testing *H. azteca, C. tentans, C. dubia,* and *P. promelas* at base and high flow conditions to evaluate the relative contribution of toxicity from continuous (*e.g.*, bedded sediments, WWTP effluents) vs. non-continuous (*e.g.*, stormwater runoff) sources. Briefly, triplicate chambers (polyethylene core tubes with 74 micron nylon mesh windows) were deployed containing the early life stages of the test organisms (10 organisms/chamber) and exposed for 2 to 7 day periods. Toxicity was partitioned into overlying water only exposures and also sediment exposures by altering the design and placement of the exposure chambers. In addition, the effect of PAH contamination was assessed by focusing on photo-induced toxicity (which results from PAH interaction with ultraviolet light) using light and dark exposure chambers. Exposures were conducted in the Fall of 1997 and the late Spring of 1998 to assess seasonal variation.

The project and all procedures followed accepted quality assurance and quality control guidelines. These are fully described in a separate quality assurance project plan (QAPP).

Laboratory Toxicity Test Methods: Fall 1997

Sediment toxicity was measured using the U.S. Environmental Protection Agency methods (USEPA 1994). The 10 day *growth* and survival bioassays using the amphipod *Hyalella azteca* and the midge *Chironomus tentans* were conducted on 18 field sediments.

For the Fall 1997 test period, sediment samples were collected on September 30 and October 1, 1997. The Grafton Road sediment (upstream reference) was collected on October 2, 1997. Sediment samples were collected using an Ekman dredge and placed into a plastic pan. The upper 0 to 2 cm layer was gently scrapped using a spatula and placed into a labeled sample bottle (high density polyethylene). The lower 8 to 10 cm layer was also subsampled and placed into a separate labeled sample bottle. These same sediment samples were also subsampled for chemical analyses by Dr. Paul Bauman, USGS, Columbus, Ohio. Sample bottles were immediately placed into ice-filled coolers and transported back to the laboratory for refrigeration.

Toxicity testing was initiated on October 31, 1997 using 7 to 14 day old *H. azteca* and 8 to 12 day old *C. tentans*. At test initiation, sediment samples were thoroughly homogenized with any overlying water that had separated out during storage. Sediments were distributed (100 mL) to 300 mL glass beakers (4 replicates). Overlying water (175 mL) of culture water (hardness ~130 mg/L $CaCO3$) was gently added to each beaker containing sediment and allowed to settle overnight prior to test organism addition. Laboratory controls consisted of culture water with synthetic mesh or sand for the amphipods and midge, respectively. An additional laboratory control consisted of culture water with Florissant soil. After a 24 hr settling period, the overlying water was sampled and tested for dissolved oxygen, pH, temperature, conductivity, alkalinity, hardness, and ammonia. The overlying water was renewed and then 10 organisms were randomly added to each test beaker below the water surface. Each test chamber was provided the appropriate food ratio then placed into a Zumwalt dilutor system for daily water renewals. Daily monitoring included water renewal, observance of test organism behavior, feeding, and measurement of water quality parameters. At test termination, overlying waters were collected for physicochemical analyses and individual test sediments sieved with a 45 micron standard sieve for organism enumeration and collection. Surviving organisms were placed into labeled, preweighed, aluminum weigh boats and dried at 100 C for 24 hr prior to weighing.

***In situ* Toxicity Testing: Fall 1997**

The Black River *in situ* study sites were chosen on the basis of bottom sediment consistencies as well as proximity to known point source runoff areas of concern. A total of eleven field locations (including a possible control site) and a laboratory control were evaluated for potential toxic response. An initial reconnaissance visit and site evaluation preceded *in situ* field testing.

Due to variable organism sensitivities to the myriad of contaminants believed to exist at the host of test sites, four surrogate test species were chosen for *in situ* evaluation and included: the fathead minnow *Pimephales promelas* (24 hours post hatch), the daphnid, *Ceriodaphnia dubia* (24 hours old), the midge *Chironomus tentans* (8-12 days post hatch) and the amphipod, *Hyalella azteca* (7-14 days old). Organisms were transported from cultures maintained at Wright State University, Dayton, Ohio (traceable to USEPA stocks) to the test sites on the Black River in Cleveland, Ohio.

The *in situ* chambers used for this study were constructed of clear core sampling tubes (cellulose acetate butyrate) cut to a length of approximately 15 cm. Polyethylene closures capped each end. Two rectangular windows (~85% of the core surface area) covered with 74 micron Nitex mesh were incorporated into the core tube, opposite each other.

In situ chambers were deployed at all field locations on the afternoon of 29 September, 1997 and collected in the afternoon of 2 October, 1997 after 72 hours of exposure. A laboratory water control was maintained at the field (hotel) laboratory for standard quality control purposes. Prior to chamber deployment, ten of each organism was gently added to 50 ml test tubes of culture water for ease of transport to field locations (one test tube contained one species only). Transportation of organisms to field sites by this method has proven to minimize handling and travel related stressors. In the field, site water temperatures were measured and organisms were slowly acclimated to the lower temperature field conditions. Upon acclimation, *in situ* chambers capped on one end were immersed into the river and test organisms were slowly delivered from the test tubes to the chambers then capped. Before placement into mesh dip bags, chambers were held below the water surface and all internal air was expelled. At each test site, *in situ* chambers were placed just below the waters surface, on the sediment bottom or both for 72 hours of exposure. After 72 hours of exposure, *in situ* chambers were gently lifted out of the river in the intact mesh bags and returned to the field laboratory in coolers of site water. Upon arrival to the lab, chambers were individually emptied into crystallizing dishes and the survivors of each species enumerated and logged.

***In situ* Toxicity Testing: Spring 1998**

The spring/high flow Black River *in situ* study revisited the same field study sites characterized in the fall/low flow *in situ* study, however, chambers were located in the upper water column only as the primary aim of this study was to measure water column toxicity as a result of storm water runoff loadings but not sediment toxicity. Original field study sites were chosen based upon potential point and non-point source influences. A total of six field locations (including a reference site) and a laboratory control were evaluated for potential toxic response.

The same test species were used as in the Fall sampling period, including: the fathead minnow *P. promelas* (24 hours post hatch), the daphnid, *C. dubia* (<24 hours old), the midge *C. tentans* (8-21 days post hatch) and the amphipod, *H. azteca* (7-14 days old). Organisms were transported from cultures maintained at Wright State University, Dayton, Ohio (traceable to USEPA stocks) to the test sites on the Black River in Cleveland, Ohio.

The *in situ* chambers used for this study were constructed of clear core sampling tubes (cellulose acetate butyrate) cut to a length of approximately 15 cm. Polyethylene closures capped each end. Two rectangular windows (~85% of the core surface area) covered with 74 micron Nitex mesh were incorporated into the core tube, opposite each other. To decrease the stress of swift flow through chambers and assure stabilization of *in situ* chambers at field locations during periods of runoff and increased flow, chambers were place in flow traps and that were weighted down by bricks for this study. Flow traps were constructed of poly snap top boxes containing holes for water exchange. Four chambers fit in one flow trap box.

In situ chambers were deployed at all field locations on the afternoon of 11 June, 1998 and collected in the afternoon of 13 June, 1998 after 48 hours of exposure. A laboratory water control was maintained at the hotel laboratory for standard quality control purposes.

Prior to chamber deployment, ten of each organism were gently added to 50 ml test tubes of culture water for ease of transport to field locations (each test tube contained one species only). Prior to transportation of organisms to the field sites, test tube confined organisms were slowly acclimated to the temperature of each field site as determined during the previous days field measurements. Acclimation was one degree or less per hour and took a total of 3-5 hours. Organisms were separated and transported to field sites in coolers of culture water, additional acclimation took place in the field when necessary. Transportation of organisms to field sites by this method has proven to minimize handling and travel related stressors. Upon acclimation to field temperatures within one degree, *in situ* chambers capped on one end were immersed into the river and test organisms were slowly delivered from the test tubes into the open end then capped. Capped chambers were then held below the water surface and all internal air was gently expelled before being placed in flow traps. Flow traps were sealed with poly twine, located just below the waters surface then secured in place by tying to stabilized objects (trees, rocks, etc.). Chambers remained in place for the entire 48 hour period and were not removed before that time. After 48 hours of exposure, *in situ* chambers were gently lifted out of the river, removed from the flow traps and transported to the hotel laboratory in coolers of site water. Upon arrival to the lab, chambers were checked for damage then individually emptied into crystallizing dishes and the survivors of each species enumerated and logged.

Water quality samples were collected upon test initiation (June 11, 1998), twice during the first 24 hour period (June 12, 1998) and then again at test termination (June 23, 1998). Typical physico-chemical parameters conducted included; temperature, dissolved oxygen, pH, hardness, alkalinity, turbidity, conductivity and ammonia. All field water quality monitoring equipment was calibrated prior to each use according to EPA and or instrument specifications.

During the Spring sampling period a high flow event occurred. Rain had not occurred during the preceding couple of weeks. On June 12, 1.23 inches ($\pm$ 0.28) of rain fell and on June 13, 0.62 inches ($\pm$ 0.08) fell in the lower Black River area. The river was noticeably higher with increased turbidity.

DNA Fingerprinting

Populations (N=24) of native snails (*Physella gyrina*) were collected from 6 test sites on the Black River. Genomic DNA was isolated with QIAquick PCR purification kits (Qiagen). The resulting DNA pellets were washed with 70% ethanol, dried and resuspended in 50 uL of TE [10mM TRIS (pH 8.3), 1mM EDTA]. The quantities of DNA isolated for each sample were estimated by electrophoresis on 1% agarose yield gels. Upon dilution to make DNA concentrations consistent between samples, all isolates were either used immediately or stored at –20 C.

RAPD-PCR prfiles were generated from total genomic DNA as described by Williams et al. (1990). Final reaction volumes were 10mL and contained 2mL of diluted genomic DNA, 1.5 units of KT1 KlenTaq (Wayne Barnes, Washinton University, St. Louis, MO), 20mM Tris, pH 8.0, 2.5 mM MgCl2, 16 mM (NH4)2SO4, 150 mg/mL bovine serum albumin, 0.2 mM of a single primer (either B-01: 5'-CAGGCCCTTC-3' or B-02: 5'TGATCCCTGG-3') and 60 mM dNTP. MJ Research thermocyclers (PTC-100 and Mini-cycler models) were used for the amplifications for 45 cycles consisting of the following steps: 92 C for 1 minute, 36 C for 1 minute, 68 C for 2 minutes. An additional extension at 68 C for 5 minutes followed the last round of amplification. These conditions were chosen due to their ability to generate DNA profiles from individual snal in a highly reproducible fashion (each profile was generated on at least two separate occasions and scored independently by at least two observers). All samples were held at 4 C until RAPD-PCR products could be resolved by gel electrophoresis. RAPD products were electrophoresed in 2% agarose gels in TBE buffer (10 mM Tris, pH 8.3, 10 mM boric acid, 1mM EDTA) at 4 C. Gels were stained in ethidium bromide for one half –hour and destained in water for one hour. Bands were visualized with a UV lamp and documented using a Gel Print 1000I imaging system. Each RAPD-DNA profile was scored twice, independently, and the RAPD-PCR amplification of a sample was repeated in cases where scorings were not in complete agreement. A measure of the genetic similarity of individual crayfish to others collected at the same site was obtained by determining the fraction (f) of markers it shared with other snails from the same site using the following equation:

$$F = 2\left\{\frac{mxy}{mx+my}\right\}$$

where mxy is the number of bands any two samples share and mx and my are the number of bands amplified in each organism.

The Jonckheere test for ordered alternatives was performed using a custom-written FORTRAN program. A probability value was determined based on an analysis of 5,000 random permutations of the data set with the null hypothesis stating that there is no difference among the mean pairwise genetic similarities from the 8 sites used in this study ($Ho: u_1=u_2=u_3=\ldots=u_n$) and the alternative hypothesis that there is a monotonic trend based on a priori information ($HA: u_1 \geq u_2 \geq u_3 \geq \ldots \geq u_n$, where at least one of the inequalities is a strict inequality).

Results of the genetic similarity analyses were compared with the Ohio EPA Index of Biotic Integrity (IBI) (a measure of fish community health) and the Ohio EPA Invertebrate Community Index (ICI) (a measure of benthic macroinvertebrate community health). Both of the Ohio EPA indexes are based on multiple metrics of species diversity, presence/absence, functional groups, abundance, and group ratios. These data were obtained from Ohio EPA (1994). A regression analysis was conducted comparing the average value of all pairwise similarities for each snail vs. all others with either the IBI or ICI values from the same sampling locations.

Results and Discussion

Site water quality 1997

During the 1997 sampling event the Black River was at base flow conditions. No rain occurred during the sampling; however strong winds were blowing from Lake Erie upstream. The river was relatively turbid, as exists during base flow conditions.

Fall 1997 Laboratory Testing

Whole sediment toxicity was measured following standard U.S. EPA protocols for *H. azteca* and *C. tentans* in 10 day laboratory exposures. Survival and growth (dry weight) were measured in both organisms at test termination (Figs. 2-5). Survival was greater than 80% in the laboratory sediment control (Florissant) for both species (Table 3, Figs. 2 and 4). The water control showed poor survival for both organisms, suggesting a water related stress was ameliorated in the presence of sediment. The upstream reference sites showed the East Branch (RM 18.9) to have the best survival and growth for both species, while only *H. azteca* survived well (>80%) at RM 15 and *C. tentans* survived poorly (30%). Poor survival occurred at the most downstream site in the river mouth at RM 0.3 for *C. tentans* with 47.5% survival in deep sediments and 65% survival in near surface sediments. Similar poor survival occurred at RM 4.6 with survivals of 52.5 and 60% in deep and surficial sediments, respectively. The amphipod also had poor survival downstream with lowest survival at RM 2.5 (15 and 30%, lower and upper sediments), and poor survival also in the upper sediments from the harbor (RM 0.2). The deep sediments at RM 2.4 were also toxic to the amphipod with a survival of 60%.

A comparison of upper (0-2 cm) and deeper (8-10 cm) sediments showed a tendency for greater toxicity in the more historic sediments. Five of 7 of the amphipod exposures to deep sediments were more toxic than the surficial sediment. The two sites near the Lake (RM 0.5 and 0.3) had an opposite response with greater toxicity in the surficial sediments. The midge showed a similar pattern with 4 of 5 deeper sediments being more toxic; however, in contrast to the amphipod surficial sediments at RM 0.3 were not as toxic as deeper ones.

Growth of the amphipod and midge in the upper reference site was good (Figs. 3 and 5). For the amphipod growth was lowest at RM 0.3, 2.4, and 5.2; while for the midge, growth was lowest at RM 0.3, 2.5, and 9.8. Surficial sediments tended to be less toxic (survival and growth (amphipod only)) than deeper, more historical sediments in most cases.

Fall 1997 *In situ* Exposures

The field laboratory control survival for all organisms ranged from 92.5 to 100% in the Sept. 29 – Oct. 2, 1997 field exposures. Survival at the upstream reference sites (East Branch RM 18.9 and Mainstem RM 15.0) ranged from 82.5 to 100% (Table 2, Figs. 6-9). Spurious results were obtained with the *C. dubia* reference samples and were deleted. Conditions in the river during the exposures were at base flow. No rain events occurred during the test period.

Survival of the 4 test species varied at the downstream test sites from a low of 40% *P. promelas* survival at RM 0.5 (Erie St. Bridge, upper exposure) to a high of 97.5% *P. promelas* survival at RM 2.4 (upper exposure) (Fig. 8). Three of the four test organisms had lowest survival at RM 0.5. *Hyalella azteca* exhibited lowest survival at RM 0.3 and second lowest at RM 2.4 (Fig. 6). The midge *C. tentans* survived better than the other 3 organisms overall, ranging from 72.5 to 95% at the downstream test sites (Fig. 7).

At four test sites, organisms were exposed near the water surface (upper) and in chambers placed on the sediment surface where there was minimal contact possible through the chamber mesh. *C. dubia* was the only organism not exposed in the upper water column. There was a strong trend towards lower survival of organisms in the upper water column exposures, than on the sediment surface. Of the four test sites and 3 organisms, survival was lower in 9 of 12 responses in the upper water column. The differences were not extreme, but suggest greater toxicity exists in the near surface area of the water column.

Fall 1997 DNA Fingerprinting

When the DNA pattern of individuals with a population becomes similar, then it suggests the population has been adversely impacted and is less diverse. This loss of genetic diversity can equate to greater susceptibility to stress and general population decline. A survey of the DNA fingerprints of the indigenous snail *Physella gyrina* was conducted at 6 sites along the Black River. The test sites and genetic similarity measures are shown in Table 4. Genetic similarities ranged from 0.80 to 0.88. The high similarity index indicates that the population is being stressed, which was observed at the French Creek tributary (Kline Ditch). The Kline Ditch area has had water quality problems attributed to nearby fly ash disposal sites (Ohio EPA, personal communication). The other site with a high value was from snails collected from River Mile 5.2 with a genetic similarity of 0.85. This site is above Kobe and French Creek. A regression analyses between the mean genetic similarity at 5 sites with the IBI revealed a highly significant correlation of 0.92 ($p<0.01$) (Fig. 10). This suggests that the DNA fingerprinting approach may be a useful surrogate indicator of overall aquatic ecosystem health. The regression analyses with the ICI was not statistically significant.

Spring 1998 *In situ* Exposures

In the Spring of 1998, *in situ* exposures of test organisms during a high flow event showed little to no acute toxicity existing at most test sites (Table 5, Figs. 11-14). This survey did not focus on sediments, rather organisms were only exposed to near surface waters during very turbid conditions. For the majority of test sites, all organisms met or exceeded EPA survival performance criteria exhibiting greater than 80% survival. The only deviation was *C. tentans* at the Cascade site (RM 15.0) in which the average survival was 70%. Upon test termination, greater than 90% of dead organisms were accounted for.

Two field references (river mile 15.0 (Cascade) and 18.9 (East Branch - Grafton)) and one laboratory control were run concurrent with the test. Since a field reference for *in situ* storm water runoff assay is preferential, two potential reference sites were chosen based upon USEPA historical data. A laboratory control is standard protocol as back up in the event of chamber loss due to high flow or vandalism at any of the field reference locations and to verify organism health. The 18.9 Mile field location is the farthest site upstream on the Black River and proved to provide the best reference conditions. Both field reference conditions, however, exhibited acceptable *in situ* test survival criteria.

Hyalella azteca exhibited greater than 90% survival at all of the field locations and 97.5% survival at the 18.9 Mile field reference site (Fig. 11). *Ceriodaphnia dubia* exhibited greater than 82.5% at all of the field locations and 92.5% survival at the field reference site (Fig. 14). The cladoceran survival appeared to be greater than 100% (107.5%) at the 15.0 Mile location but was attributed to inclusion of indigenous cladoceran during the loading of organisms into the chambers at this particular site. It was impossible to distinguish which organisms originated from the laboratory and which were indigenous. Poor survival of the field control of *C. dubia* was unexplained; however, the good survival *in situ* verified organism health. *Chironomus tentans* also exhibited greater than 80% survival at all of the field locations with the exception of the 15.0 Mile site in which survival was 70% (Fig. 12). All dead organisms were located eliminating the possibility of escape. Midge control survival was 92.5%. The fathead minnow, *P. promelas*, exhibited the most variability between sites, yet had greater than 77% survival on average at all the sites (Fig. 13). The lowest survival was at the 4.8 Mile site (French Creek mouth) where an oil smell and droplets emanating from the sediment was noted; however, survival was still 77.5%. One chamber at each of the 2.3 Mile and 5.2 Mile field locations had zero and one organism, respectively, which were determined to be outliers and not included in the summary statistics. *P. promelas* reference survival was 100% at the 18.9 Mile site.

Photo-induced toxicity due to PAHs is not a factor when turbidity is high (Ireland et al. 1996). Therefore, the greater toxicity observed at base flow conditions, when turbidity is lower, appears to be a PAH effect. This effect can occur at PAH concentrations at the low to sub microgram per liter level.

The water column acute toxicity at base flow and the sediment acute toxicity (survival and/or growth) observed in the downstream areas suggest the PAHs may still be a primary stressor in the lower Black River. Sediments that were several centimeters deep tended to be more toxic than surficial sediments and may be exposed during resuspension events (e.g., storms, boat traffic, dredging). However, chemical analyses of sediments did not show elevated levels of PAHs (Table 5). It appears the remedial dredging which took place from 1989-1990 was effective in reducing PAH concentrations and likely associated toxicity. Total sediment metal concentrations were elevated and tended to be higher downstream (Table 6). The lack of acute toxicity during high flow suggests that the impacts of nonpoint source runoff and stormwater inputs are less severe. However, since only acute toxicity was measured, it is unknown whether chronic toxicity may exist due to nonpoint source runoff.

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Table 1. Black River Sample Stations and Sample Types*

River Mile	*Location*	*Sampling Type*
0.3	Harbor mouth at boat gas station	S, LT
0.5	Ust. Erie St., Dst. Kobe West bank	LT, FT
2.4	Kobe (dst dredging) East bank, lake side of Turning Basin	S, LT, FT
2.5	East bank, Turning Basin	LT
2.9	Ust Turning Basin. West Bank of Kobe	S, LT, D
3.6-4.8	Kobe area. Broad area sampling for snails	D
4.6	West Bank of Kobe near coal pile	S
4.9	Mouth of French Creek	LT, FT
2.5 (Tributary)	Kline Ditch: tributary of French Creek @ RM 3.9	D
5.2	Ust. Kobe and French Creek	S, LT, FT, D
8.3	St. Rt. 254	D
9.8	Ford Rd. (Dst. Elyria WWTP)	S, LT
11.6	Spring Valley Country Club (Ust. Elyria WWTP)	S, LT, FT, D
15.0	Dst. confluence East and West Branches at Cascade Park	LT, FT, D
18.9 (East Br)	Ust. Grafton (East Fk, East Branch)	LT,FT
Not Applicable	Field Laboratory Controls	FT
	Laboratory Controls	LT

Sampling Codes: S - sediment chemistry by Ohio EPA and USGS
LT - laboratory sediment toxicity
FT - field (*in situ)* toxicity (water and sediment)
D – DNA fingerprinting of snails

Table 2. In Situ Exposures on the Black River, Fall 1997.

Black River--In situ Survivals September 29-October 2, 1997											
	Hotel cont	0.3 Mi (U)	0.3 Mi (L)	0.5 Mi (U)	0.5 Mi (L)	2.4 (U)	2.4 (L)	5.2 (U)	5.2 (L)	15.0 Mi	18.9 Mi
H. azteca	10	0	9	7	10	5	7	5	7	10	7
	10	9	0	10	7		10	9	5	9	9
	10	0	7	6	8		10	9	10	10	10
	10	9	5	8	8		10	11	9	7	11
Ave. surviv	10	4.5	5.25	7.75	8.25	5	9.25	8.5	7.75	9	9.25
% surviv	100	45	52.5	77.5	82.5	50	92.5	85	77.5	90	92.5
St. dev.	0	5.1962	3.8622	1.7078	1.2583	NA	1.5	2.5166	2.2174	1.4142	1.7078
Coeff. var	0	115.470054	73.5659062	22.0364533	15.2521908	NA	16.2162162	29.6071939	28.6110424	15.713484	18.4629744
C. tentans	9	6	6	6	8	9	10	10	8	9	7
	10	8	10	6	6		9	10	10	8	8
	9	10	8	8	10		9	10	9	10	10
	9	8	11	9	8		8	7	11	8	10
Ave. surv	9.25	8	8.75	7.25	8	9	9	9.25	9.5	8.75	8.75
% surviv	92.5	80	87.5	72.5	80	90	90	92.5	95	87.5	87.5
St. dev.	0.5	1.6330	2.2174	1.5	1.6330	0	0.8165	1.5	1.2910	0.9574	1.5
Coeff. var	5.4054	20.4124	25.3412	20.6897	20.4124	0.0000	9.0722	16.2162	13.5894	10.9420	17.1429
P. promelas	10	9	6	0	10	0	9	7	6	9	10
	10	10	10	0	10	7	10	9	9	10	10
	10	10	10	9	9		10	9	10	2	8
	10	3	9	7	10		10	8	10	10	5
Ave. surviv	10	8.000	8.750	4	9.75	3.5	9.75	8.25	8.75	7.75	8.25
% surviv	100	80.000	87.500	40	97.5	35	97.5	82.5	87.5	77.5	82.5
St. dev.	3.8622	1.8930	1.8930	0.5	3.3665	0.5	4.6904	1.8930	1.8930	2.3629	0.9574
Coeff. var	38.6221	23.6621	21.6339	12.5000	34.5282	14.2857	48.1068	22.9451	21.6339	30.4891	11.6052
C. dubia	9		11		5		8		9	11	10
	10		10		7		7		9		
	10										
	8										
Ave. surviv	9.25		10.5		6		7.5		9	11	10
% surviv	92.5		105		60		75		90	110	100
St. dev.	0.9574		0.7071		1.4142		0.7071		0.0000	0.0000	0.0000
Coeff. var	10.3506		6.7344		23.5702		9.4281		0.0000	0.0000	0.0000
U=upper level-water											
L=Lower level-sediment											
***Chamber mesh broken											

Table 3. Laboratory Sediment Toxicity on the Black River, Fall 1997

							Black River 10 Day Laboratory Test - Survivals												
							October 31, 1997- November 10, 1997												
			0-2 cm.	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**			
	Florissant	**18.9 Mi (EB)**	**0.3 Mi (U)**	**0.3 Mi (L)**	**0.5 Mi (U)**	**0.5 Mi (L)**	**2.4 Mile (U)**	**2.4 Mile (L)**	**2.5 Mile (U)**	**2.5 Mile (L)**	**2.9 Mile (U)**	**2.9 Mile (L)**	**4.6 Mile (U)**	**4.6 Mile (L)**	**5.2 Mile (U)**	**5.2 Mile (L)**	**9.8 Mi**	**11.6 Mi**	**15.0 Mi**
H. azteca	8	7	1	6	7	8	10	6	6	2	5	6	8	6	7	5	6	6	8
	7	7	3	5	5	7	8	3	2	2	8	3	8	6	8	6	7	6	8
	5	8	3	5	5	7	7	4	2	0	4	5	5	7	8	7	7	5	2
	7	7	6	6	6	6	6	6	2	2	7	9	7	6	8	8	11	6	8
Ave. surviv	6.75	7.25	3.25	5.5	5.75	7	7.75	4.75	3	1.5	6	5.75	7	6.25	7.75	6.5	7.75	5.75	6.5
% surviv	84.375	90.625	40.625	68.75	71.875	87.5	96.875	59.375	37.5	18.75	75	71.875	87.5	78.125	96.875	81.25	96.875	71.875	81.25
St. dev.	1.26	0.50	2.06	0.58	0.96	0.82	1.71	1.50	2.00	1.00	1.83	2.50	1.41	0.50	0.50	1.29	2.22	0.50	3.00
Coeff. var	18.64	6.90	63.43	10.50	16.65	11.66	22.04	31.58	66.67	66.67	30.43	43.48	20.20	8.00	6.45	19.86	28.61	8.70	46.15
C. tentans	8	10	7	3			8	6	10	6			7	4	7	10	3	8	1
	10	7	6	3			6	8	8	7			6	7	8	8	4	8	6
	9	10	7	6			4	5	6	10			4	5	7	7	6	9	3
	8	8	6	7			10	6	8	7			7	5	8	6	6	7	2
Ave. surv	8.75	8.75	6.5	4.75	0	0	7	6.25	8	7.5	0	0	6	5.25	7.5	7.75	4.75	8	3
% surviv	87.5	87.5	65	47.5	0	0	70	62.5	80	75	0	0	60	52.5	75	77.5	47.5	80	30
St. dev.	0.96	1.50	0.58	2.06			2.58	1.26	1.63	1.73			1.41	1.26	0.58	1.71	1.50	0.82	2.16
Coeff. var	10.94	17.14	8.88	43.40			36.89	20.13	20.41	23.09			23.57	23.97	7.70	22.04	31.58	10.21	72.01
							Black River 10 Day Laboratory Test - Dry Weights												
							October 31, 1997- November 10, 1997												
			0-2 cm.	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**	**0-2 cm.**	**8-10 cm.**			
	Florissant	**18.9 Mi (EB)**	**0.3 Mi (U)**	**0.3 Mi (L)**	**0.5 Mi (U)**	**0.5 Mi (L)**	**2.4 Mile (U)**	**2.4 Mi (L)**	**2.5 Mile (U)**	**2.5 Mile (L)**	**2.9 Mile (U)**	**2.9 Mile (L)**	**4.6 Mile (U)**	**4.6 Mile (L)**	**5.2 Mi (U)**	**5.2 Mile (L)**	**9.8 Mi**	**11.6 Mi**	**15.0 Mi**
H. azteca	0.0628571	0.18714	0.138	0.08	0.06	0.115	0.1075	0.05	0.06167	0.095	0.112	0.09667	0.1475	0.08833	0.09286	0.09	0.114	0.0725	0.15375
	0.0542857	0.30143	0.076	0.14667	0.145	0.23333	0.1025	0.03	0.06	0.125	0.04125	0.188	0.08375	0.12833	0.10375	0.02667	0.0917	0.215	0.08125
	0.044	0.252	0.102	0.08	0.12	0.07714	0.10714	0.0975	0.195	0.22	0.1175	0.01	0.098	0.10143	0.06429	0.08	0.09	0.0725	0.09
	0.1222	0.19	0.10667	0.07333	0.12667	0.08667		0.085			0.09054	0.09889	0.11	0.10167	0.12125	0.11375	0.1756	0.195	0.11875
Ave. dry wt	0.0708357	0.2326425	0.1056675	0.095	0.1129175	0.128035	0.10571333	0.065625	0.10555667	0.14666667	0.0903225	0.09839	0.1098125	0.10494	0.0955375	0.077605	0.1178	0.1388	0.1109
St. dev.	0.04	0.05	0.03	0.03	0.04	0.07	0.00	0.03	0.08	0.07	0.03	0.07	0.03	0.02	0.02	0.04	0.04	0.08	0.03
Coeff. var	49.55	23.54	24.07	36.41	32.61	56.25	2.63	47.42	.73.38	44.49	38.44	73.87	24.88	16.00	25.01	47.40	33.98	55.45	29.50
C. tentans	1.7025	1.95	1.39286	0.46333			0.942	1.46667	1.181	1.11429			1.85429	1.58571	1.55574	1.81	0.8167	1.28625	0.82
	1.782	2.33143	1.364	0.658			1.44375	1.83	0.83125	1.24714			2.08333	1.822	1.72	2.335	0.915	1.425	1.795
	1.3025	1.535	0.94714	0.838333			1.00143	3.33333	0.92167	0.915			1.284	2.3675	1.76514	1.86	0.7533	1.18111	1.08333
	1.6725	2.03	1.91833	0.515			0.93667	1.00333	0.575	1.544			3.5075		1.55375	2.375	0.575	1.47571	2.885
Ave. dry wt	1.614875	1.9616075	1.4055825	0.6186658	0	0	1.0809625	1.9083325	0.87723	1.2051075	0	0	2.18228	1.92507	1.6486575	2.095	0.765	1.342	1.6458
St. dev.	0.21	0.33	0.40	0.17			0.24	1.01	0.25	0.26			0.95	0.40	0.11	0.30	0.14	0.13	0.92
Coeff. var	13.21	16.74	28.31	27.16			22.54	52.84	28.51	21.90			43.31	20.83	6.67	14.38	18.70	9.98	56.09

Table 4. RAPD Genetic Similarity in the Snail, *Physella gyrina,* on the Black River, Fall 1997

Station (River Mile)	*Mean Genetic Similarity (Std. Dev.)*
2.9	0.821 (0.043)
3.6-4.8	0.810 (0.045)
5.2	0.853 (0.048)
Tributary (2.5) of French Creek (4.9)	0.882 (0.041)
15.0	0.815 (0.061)
18.9 (East Br.)	0.831 (0.042)

Table 5. In Situ Exposures in the Black River, Spring 1998.

Black River--*In situ* Survivals 11 June - 13 June, 1998							
	Hotel cont	0.5 Mi	2.4 Mi	4.9 Mi	5.2 Mi	15.0 Mi	18.9 Mi
H. azteca	10	10	9	9	10	10	10
	8	10	8	10	10	10	10
	7	9	9	9	10	9	9
	7	10	10	10	8	10	10
Ave. surviv	8	9.75	9	9.5	9.5	9.75	9.75
% surviv	80	97.5	90	95	95	97.5	97.5
St. dev.	1.41421356	0.5000	0.8165	0.5774	1.0000	0.5000	0.5000
Coeff. var	17.6776695	5.12820513	9.07218423	6.07737125	10.5263158	5.12820513	5.12820513
C. tentans	10	8	6	10	7	9	8
	4	9	8	8	8	10	6
	9	9	10	7	9	8	5
	8	9	9	8	8	10	9
Ave. surv	7.75	8.75	8.25	8.25	8	9.25	7
% surviv	77.5	87.5	82.5	82.5	80	92.5	70
St. dev.	2.62995564	0.5	2	1.3	0.8	0.9574	1.8257
Coeff. var	33.9349	5.7143	20.7009	15.2522	10.2062	10.3506	26.0820
P. promelas	10	8		9	9	10	10
	10	10	9	10	7	10	10
	10	9	9	6	9	10	9
	10	7	7	6		10	8
Ave. surviv	10	8.5	8.33333333	7.75	8.33333333	10.000	9.250
% surviv	100	85	83.3333333	77.5	83.3333333	100.000	92.500
St. dev.	0	1.29099445	1.15470054	2.06155281	1.15470054	0	0.95742711
Coeff. var	0	15.18817	13.8564065	26.6006815	13.8564065	0	10.3505633
C. dubia	15	8	9	8	10	9	13
	2	9	8	9	10	10	4
	1	10	8	9	9	8	9
	7	8	8	8	10	10	17
Ave. surviv	6.25	8.75	8.25	8.5	9.75	9.25	10.75
% surviv	62.5	87.5	82.5	85	97.5	92.5	107.5
St. dev.	6.3966	0.9574	0.5000	0.5774	0.5000	0.9574	5.5603
Coeff. var	102.3458	10.9420	6.0606	6.7924	5.1282	10.3506	51.7235

Table 6 Concentrations of organic compounds in sediments from the Black River, 1997. All concentrations in $\mu g/kg$.

Compound (CAS#)	River Mile							
	11.60	9.81	5.20	4.80	2.90	2.90 dup.	2.32	0.42
Semi-volatile Organics								
Benzo(a)anthracene (56-55-3)	<0.5	<0.5	<0.7	<0.9	0.8	<0.7	1.6	<0.7
Benzo(a)pyrene (50-32-8)	<0.5	<0.5	<0.7	<0.9	0.8	<0.7	1.7	<0.7
Benzo(b)fluoranthene (205-99-2)	<0.5	<0.5	<0.7	0.9	0.9	0.7	2.0	<0.07
Benzo(g,h,i)perylene (191-24-2)	<0.5	<0.5	<0.7	<0.9	<0.8	<0.7	1.7	<0.7
Benzo(k)fluoranthene (207-08-9)	<0.5	<0.5	<0.7	<0.9	<0.8	<0.7	1.5	<0.7
bis (2-ethylhexyl) phthalate (117-81-7)	<0.5	<0.5	0.7	1.2	<0.8	<0.7	<0.7	1.5
Chrysene (218-01-9)	0.6	<0.5	0.7	1.1	1.1	1.0	2.0	<0.7
Fluoranthene (206-44-0)	1.1	0.8	1.2	1.7	2.0	1.6	2.2	<0.7
Indeno(1,2,3-cd)pyrene (193-39-5)	<0.5	<0.5	<0.7	<0.9	<0.8	<0.7	1.8	<0.7
3 & 4 Methylphenol (106-44-5)	<0.5	<0.5	<0.7	1.9	1.1	1.3	<0.7	<0.7
Naphthalene (91-20-3)	<0.5	<0.5	<0.7	<0.9	<0.8	<0.7	0.7	<0.7
Phenanthrene (85-01-8)	0.7	0.6	<0.7	<0.9	1.2	0.9	1.0	<0.7
Pyrene (129-00-0)	1.0	0.7	1.0	1.4	1.6	1.4	1.7	<0.7

Table 6 Concentrations of organic compounds in sediments from the Black River, 1997. All concentrations in $\mu g/kg$ (continued).

Compound (CAS#)	River Mile							
	11.60	**9.81**	**5.20**	**4.80**	**2.90**	**2.90 dup.**	**2.32**	**0.42**
Volatile Organics								
Acetone (67-64-1)	<0.07	<0.06	<0.08	0.1	<0.13	0.1	<0.09	<0.09
Toluene (108-88-3)	<0.06	<0.05	<0.06	<0.09	1.0	1.0	<0.07	<0.07
Organochlorine Pesticides and PCB's								
4,4' - DDE (72-55-9)	<5.7	<4.9	<7.1	10	<7.6	<7.8	<7	<7.4
4,4' - DDT (50-29-3)	<5.7	<4.9	<7.1	9.8	<7.6	<7.8	<7	<7.4
PCB-1254 (11097-69-1)	99	45	41	<45	58	68	<35	<37
PCB-1260 (11096-82-5)	<28	<24	<35	<45	46	<39	<35	<37

Table 7 Sediment sample particle size characteristics, concentrations (mg/kg dry weight) of heavy metals, and percent total organic carbon for the sediments of the Black River Study Area, 1996 and 1997[a].

DRAFT

River Mile	Particle Size Characteristics	Percent TOC	Percent Solids	Arsenic	Barium	Cadmium	Chromium
Black River							
0.19[b]	Sand/Silt	2.0	45.6	NA	79.7	**3.4**	*26.3*
0.42	Sand/Silt	1.9	54.8	8.73	*231*	1.3	*23.6*
2.32	Silt/Sand	1.9	52.6	16.5	*174*	**10.4**[c]	**63.2**
2.90	Silt/Sand	1.9	44.8	9.25	*136*	**3.69**	**45.4**
4.80	Silt/Sand	2.2	39.8	15.6	**274**	**4.94**	**74.1**
5.20	Sand/Silt	1.4	52.8	9.77	*153*	**3.41**	**45.4**
5.80[b]	Sand/Silt	1.2	56.5	NA	40.2	**3.1**	*22.5*
9.81	Sand	1.3	73.8	9.79	71.9	**5.06**	**60.3**
11.60	Sand/Silt	1.1	68.4	10.5	*102*	**6.05**	**55.9**
W. Branch Black River							
19.60[b]	Sand/Silt	0.5	69.4	NA	22.8	0.1	5.4
E. Branch Black River							
11.40[b]	Sand/Silt	1.0	43.1	NA	52.8	0.2	10.1
18.90	Sand	0.5	85.6	6.13	62.6	<0.0882	*15*
30.00[b]	Sand/Silt	1.0	58.8	NA	58.3	0.2	9.8
32.50	Sand	0.3	84.0	4.03	28.8	0.114	<13.7
Willow Creek							
2.90	Sand	1.1	76.8	9.29	98	0.23	*15.3*
French Creek							
3.20[b]	Sand	0.1	68.7	NA	15.9	0.4	4.9
6.10[b]	Sand	0.2	69.7	NA	22.0	0.2	4.7

Key to data: Non-elevated; *Slightly elevated;* ***Elevated***; **Highly elevated**; **Extremely elevated**[d]

[a]Samples collected in 1997 unless otherwise noted.

[b]Sample collected in 1996.

[c]Exceeds Ontario severe effect level (Persuad, et al., 1993).

[d]Data comparisons are made to Ohio EPA reference sites except for mercury for which Illinois stream data are used for comparison (Illinois EPA, 1984).

Table 7 (cont.). Sediment sample particle size characteristics, concentrations (mg/kg dry weight) of heavy metals, and percent total organic carbon for the sediments of the Black River Study Area, 1996 and 1997[a].

DRAFT

River Mile	Copper	Iron	Lead	Mercury	Nickel	Zinc
Black River						
0.19[b]	**248.4**[c]	**120,830**	35.9	***0.129***	***29.8***	**757.3**
0.42	*20.8*	24,900	100	0.0506	<28.6	***137***
2.32	**39.9**	**57,100**	***67.4***	***0.166***	***35.6***	**402**
2.90	**40.6**	*26,900*	***50.3***	**0.224**	***34.9***	***171***
4.80	**52.8**	***37,000***	***56.2***	*0.0925*	**51.1**	**245**
5.20	**35.6**	24,700	*40.2*	*0.0756*	***35.6***	***158***
5.80[b]	**131.6**	**65,957**	23.4	*0.0852*	*21.9*	**430.5**
9.81	**48.7**	17,100	*39.3*	***0.116***	***33.7***	*126*
11.60	**48.7**	*29,300*	*30.3*	**0.196**	***36.9***	*134*
W. Branch Black River						
19.60[b]	7.1	11,324	5.9	<0.0301	9.4	36.3
E. Branch Black River						
11.40[b]	**36.8**	***46,666***	10.9	0.0320	15.9	***149.9***
18.90	11.5	18,400	<17.6	0.0507	<17.6	43.2
30.00[b]	8.0	16,480	10.1	0.0357	16.5	50.1
32.50	<4.58	8,390	<18.3	<0.0192	<18.3	42.6
Willow Creek						
2.90	11.7	16,300	26	<0.0282	<20.4	63.8
French Creek						
3.20[b]	**41.8**	***47,624***	7.8	0.0232	10.9	**221.0**
6.10[b]	**38.7**	15,802	10.1	<0.0216	9.9	78.9

Key to data: Non-elevated; *Slightly elevated*; ***Elevated***; **Highly elevated**; **Extremely elevated**[d]

---

[a]Samples collected in 1997 unless otherwise noted.

[b]Sample collected in 1996.

[c]Exceeds Ontario severe effect level (Persuad, et al., 1993).

[d]Data comparisons are made to Ohio EPA reference sites except for mercury for which Illinois stream data are used for comparison (Illinois EPA, 1984).

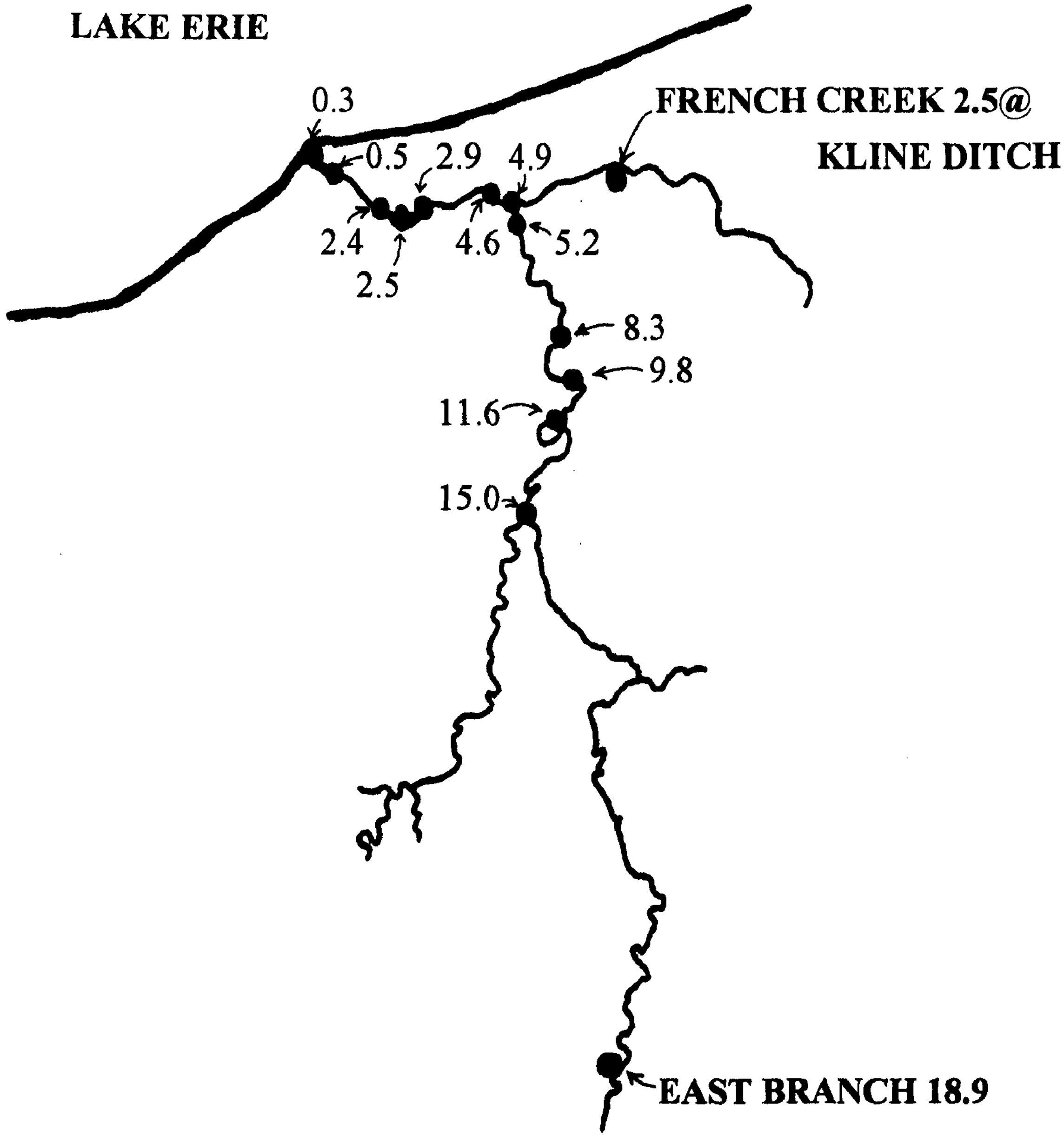
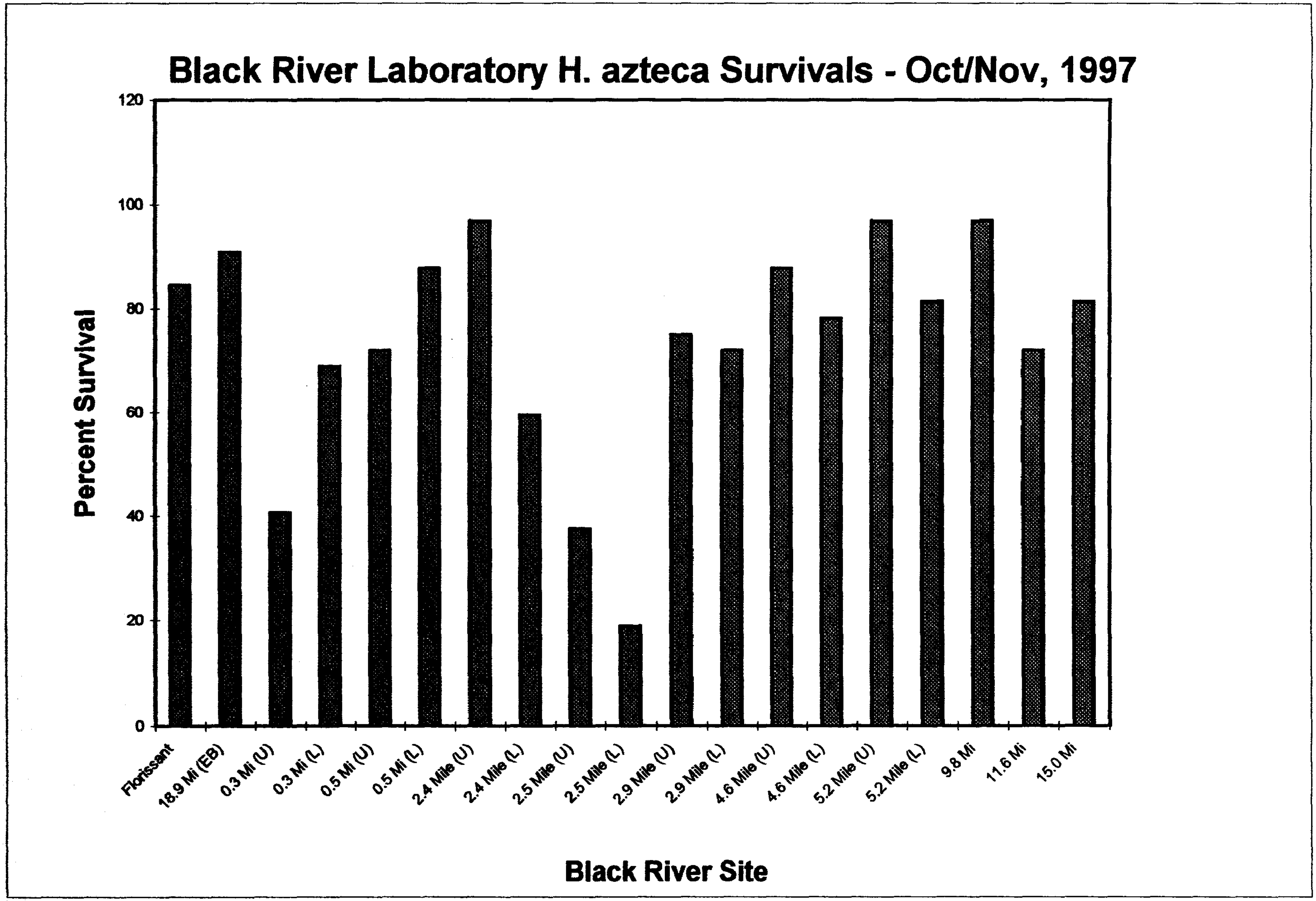


Figure 1. Black River and Sample Stations (1997-1998) as River Miles (RM).

Figure 2. Survival of *Hyalella azteca* in Laboratory Sediment Toxicity Tests, Black River, Fall 1997.



Black River Laboratory H. azteca Survivals - Oct/Nov, 1997
Percent Survival
120
100
80
60
40
20
0
Florissant
18.9 Mi (EB)
0.3 Mi (U)
0.3 Mi (L)
0.5 Mi (U)
0.5 Mi (L)
2.4 Mile (U)
2.4 Mile (L)
2.5 Mile (U)
2.5 Mile (L)
2.9 Mile (U)
2.9 Mile (L)
4.6 Mile (U)
4.6 Mile (L)
5.2 Mile (U)
5.2 Mile (L)
9.8 Mi
11.6 Mi
15.0 Mi
Black River Site

Figure 3. Growth of *Hyalella azteca* in Laboratory Sediment Toxicity Tests, Black River, Fall 1997.

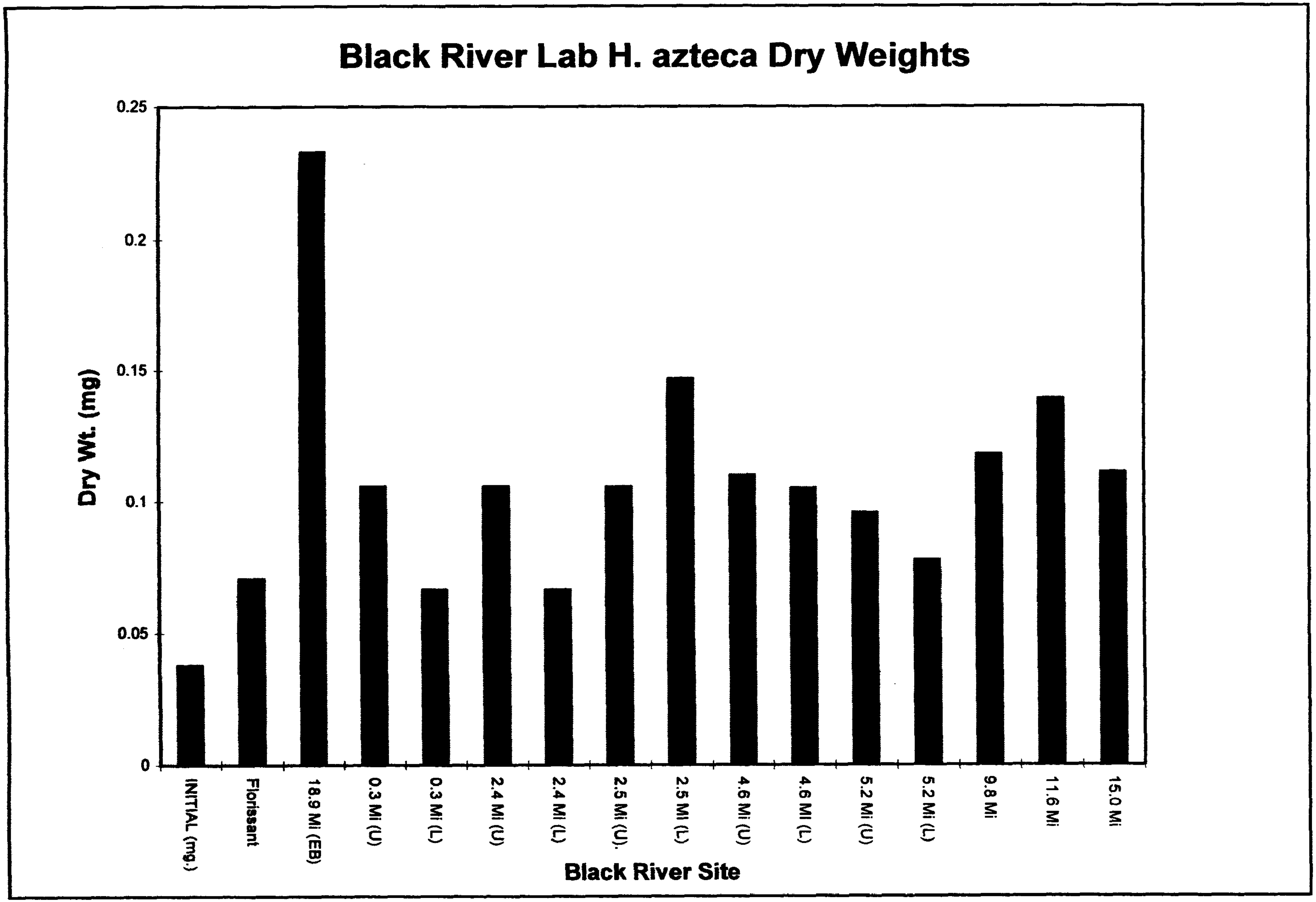
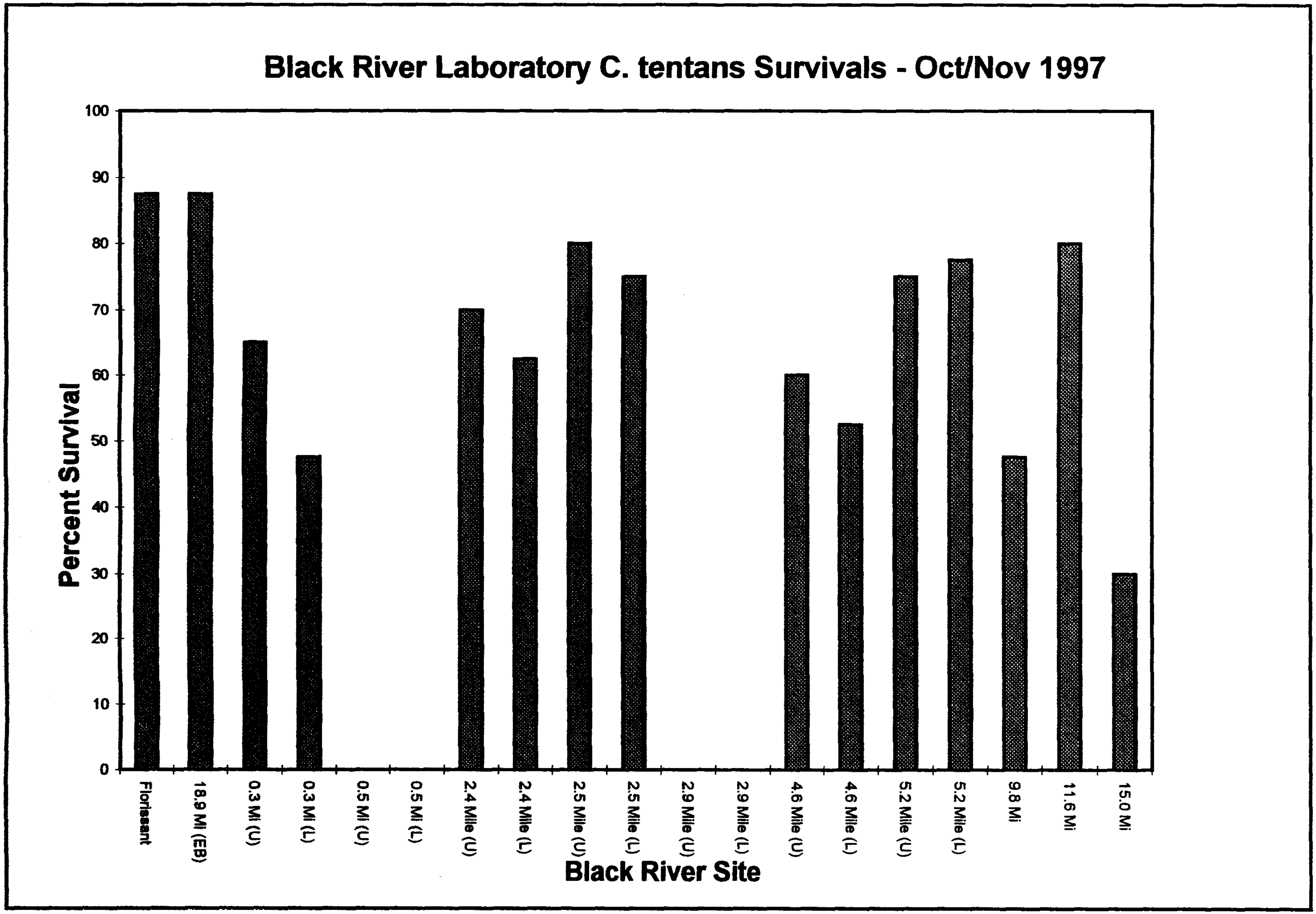

Black River Lab H. azteca Dry Weights
Dry Wt. (mg)
0.25
0.2
0.15
0.1
0.05
0
INITIAL (mg.)
Florissant
18.9 Mi (EB)
0.3 Mi (U)
0.3 Mi (L)
2.4 Mi (U)
2.4 Mi (L)
2.5 Mi (U).
2.5 Mi (L)
4.6 Mi (U)
4.6 Mi (L)
5.2 Mi (U)
5.2 Mi (L)
9.8 Mi
11.6 Mi
15.0 Mi
Black River Site

Figure 4. Survival of *Chironomus tentans* in Laboratory Sediment Toxicity Tests, Black River, Fall 1997.



Black River Laboratory C. tentans Survivals - Oct/Nov 1997
Percent Survival
100
90
80
70
60
50
40
30
20
10
0
Florissant
18.9 Mi (EB)
0.3 Mi (U)
0.3 Mi (L)
0.5 Mi (U)
0.5 Mi (L)
2.4 Mile (U)
2.4 Mile (L)
2.5 Mile (U)
2.5 Mile (L)
2.9 Mile (U)
2.9 Mile (L)
4.6 Mile (U)
4.6 Mile (L)
5.2 Mile (U)
5.2 Mile (L)
9.8 Mi
11.6 Mi
15.0 Mi
Black River Site

Figure 5. Growth of *Chironomus tentans* in Laboratory Sediment Toxicity Tests, Black River, Fall 1997.

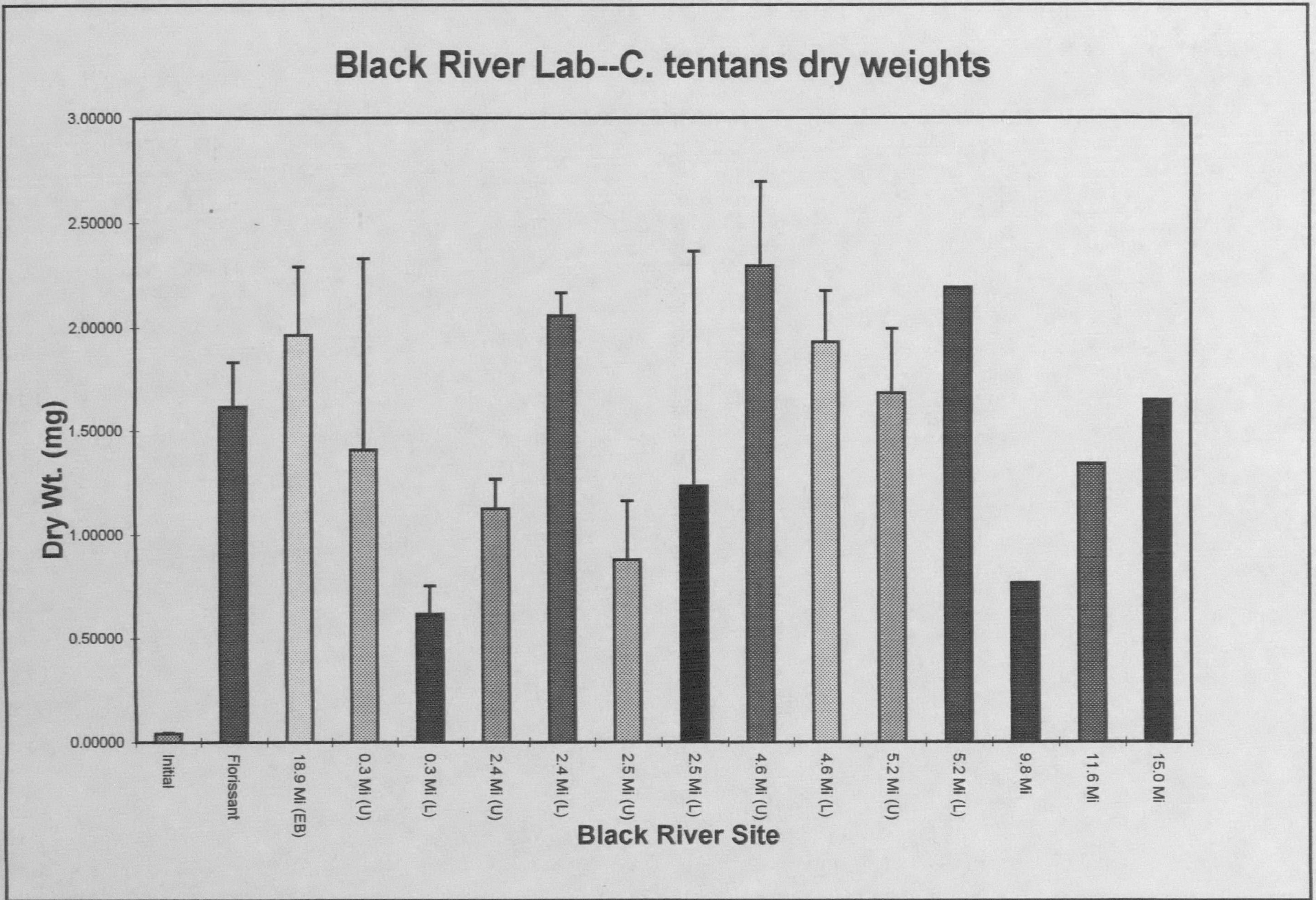
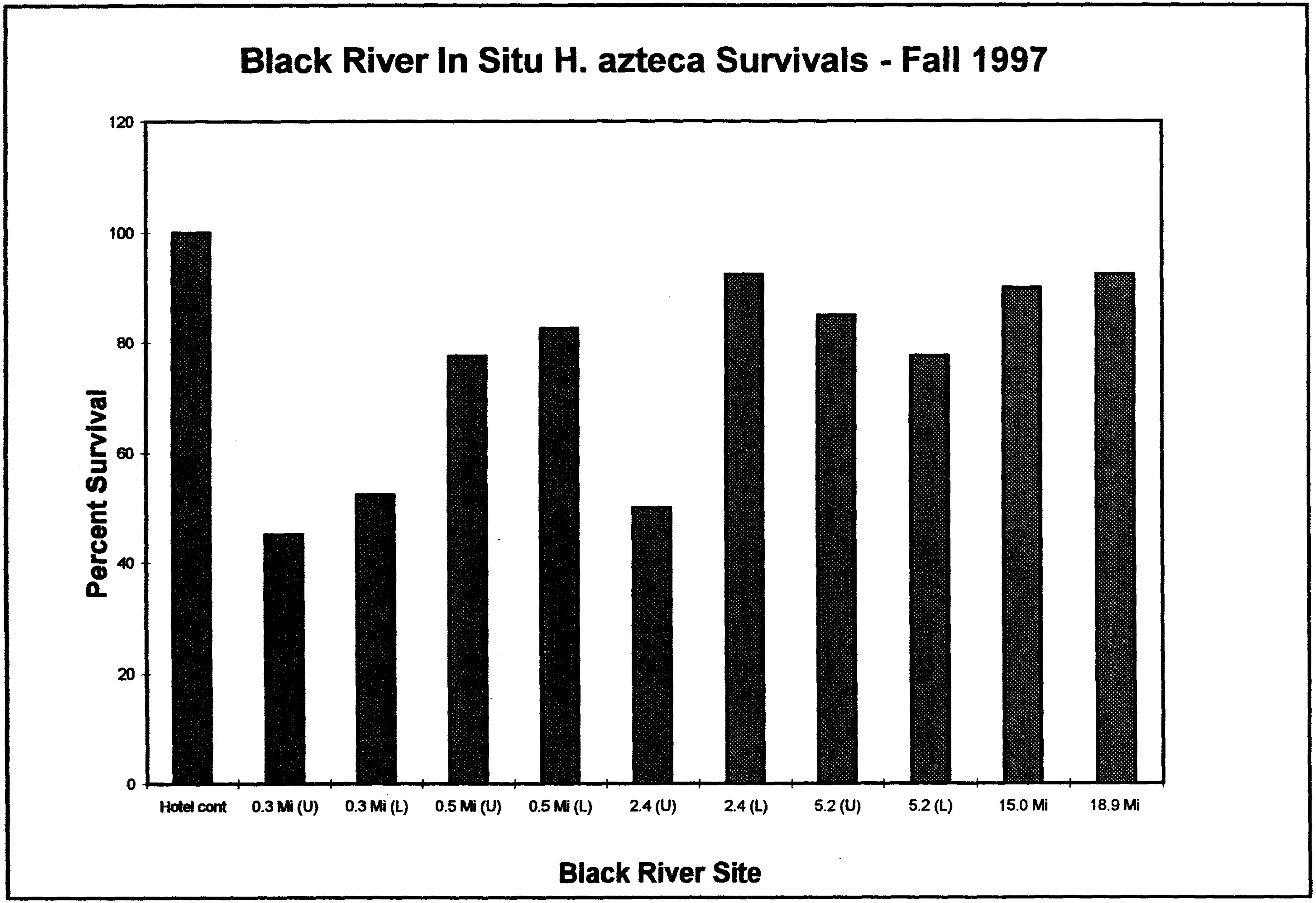

Black River Lab--C. tentans dry weights
3.00000
2.50000
2.00000
1.50000
1.00000
0.50000
0.00000
Dry Wt. (mg)
Initial
Florissant
18.9 Mi (EB)
0.3 Mi (U)
0.3 Mi (L)
2.4 Mi (U)
2.4 Mi (L)
2.5 Mi (U)
2.5 Mi (L)
4.6 Mi (U)
4.6 Mi (L)
5.2 Mi (U)
5.2 Mi (L)
9.8 Mi
11.6 Mi
15.0 Mi
Black River Site

Figure 6. Survival of *Hyalella azteca* in 48 hr *In situ* Exposures, Black River, Fall 1997.



Black River In Situ H. azteca Survivals - Fall 1997
Percent Survival
0
20
40
60
80
100
120
Hotel cont
0.3 Mi (U)
0.3 Mi (L)
0.5 Mi (U)
0.5 Mi (L)
2.4 (U)
2.4 (L)
5.2 (U)
5.2 (L)
15.0 Mi
18.9 Mi
Black River Site

Figure 7. Survival of *Chironomus tentans* in 48 hr *In situ* Exposures, Black River, Fall 1997.

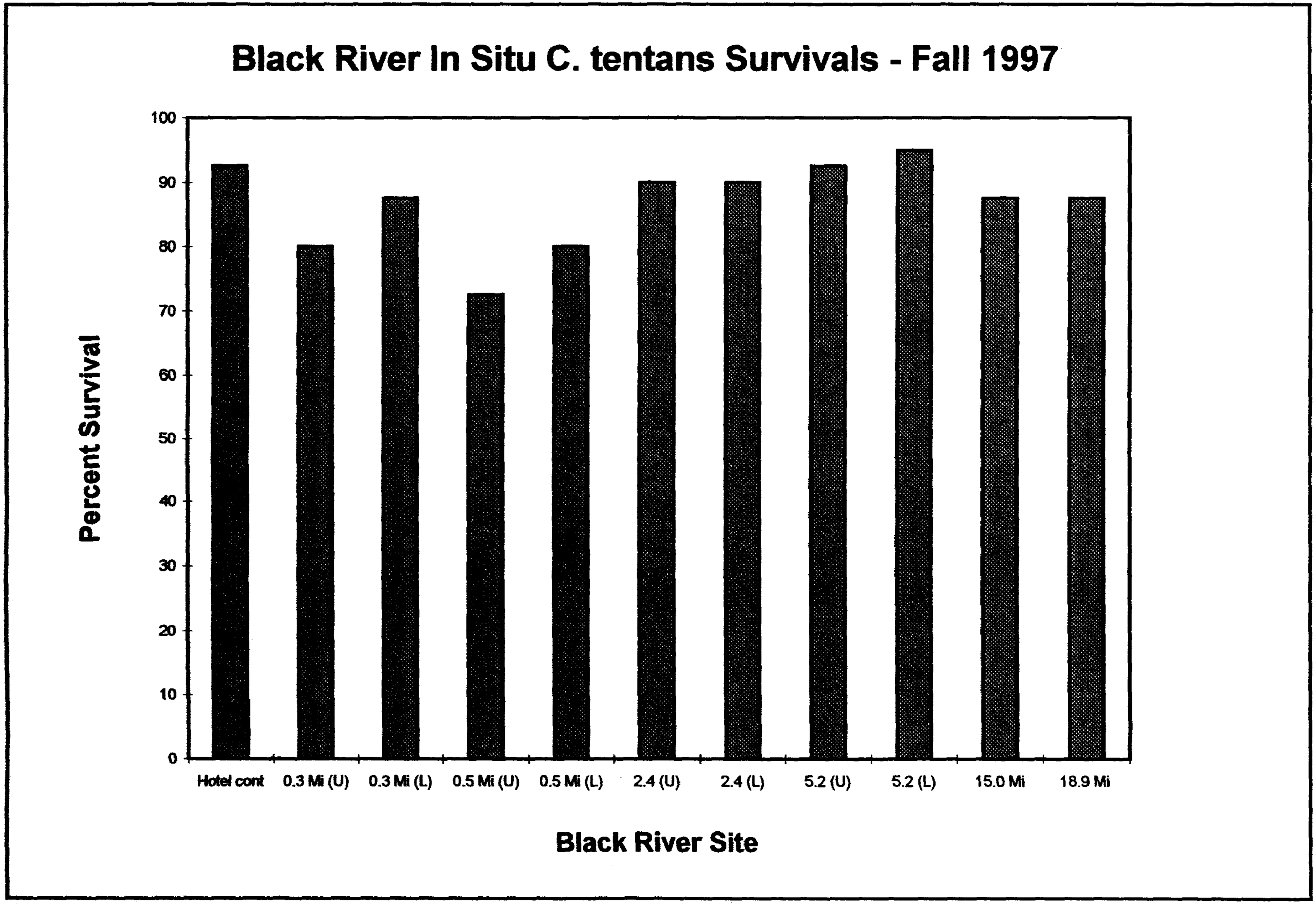
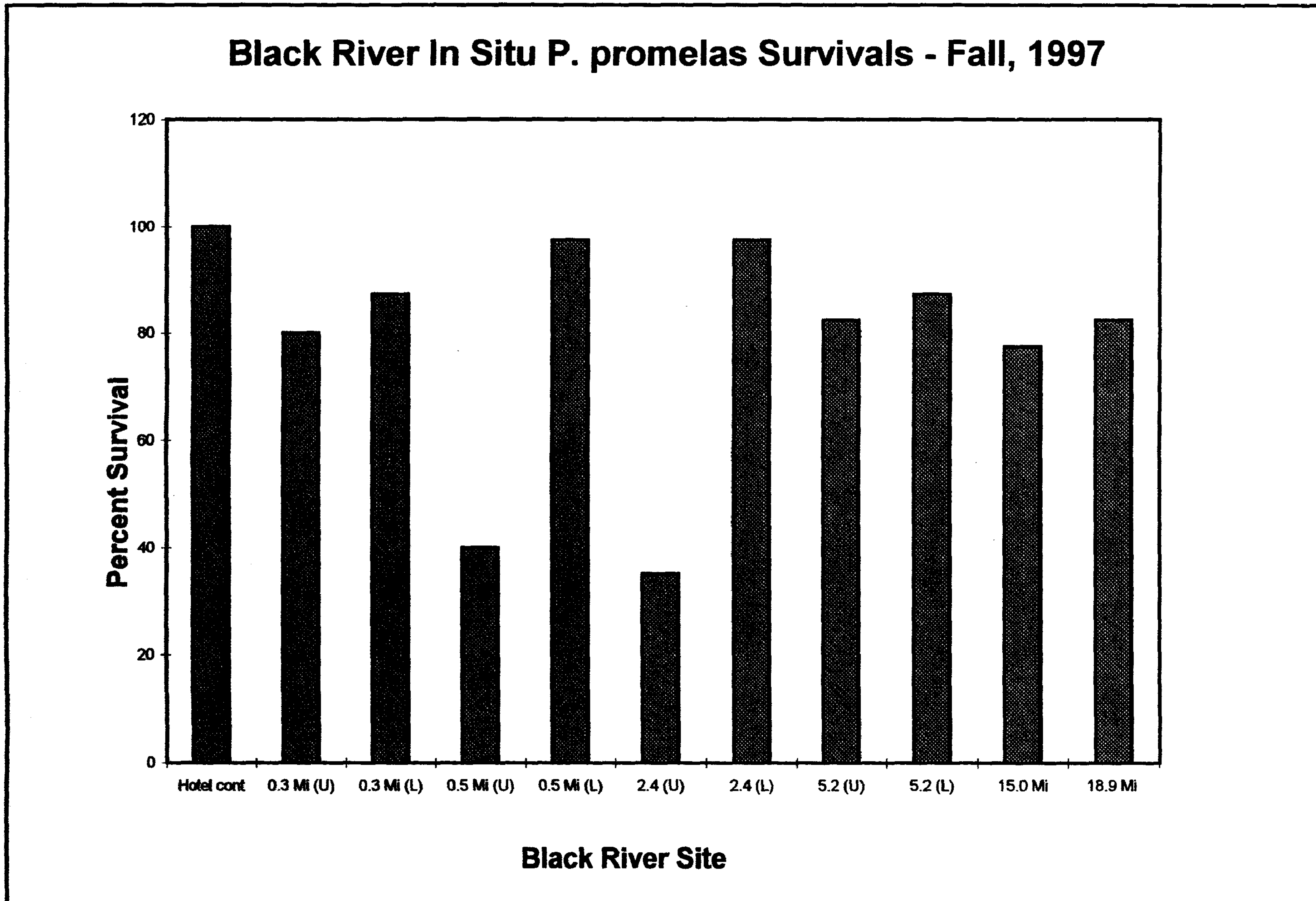

Black River In Situ C. tentans Survivals - Fall 1997
Percent Survival
100
90
80
70
60
50
40
30
20
10
0
Hotel cont
0.3 Mi (U)
0.3 Mi (L)
0.5 Mi (U)
0.5 Mi (L)
2.4 (U)
2.4 (L)
5.2 (U)
5.2 (L)
15.0 Mi
18.9 Mi
Black River Site

Figure 8. Survival of *Pimephales promelas* in 48 hr *In situ* Exposures, Black River, Fall 1997.



Black River In Situ P. promelas Survivals - Fall, 1997
120
100
80
60
40
20
0
Percent Survival
Hotel cont
0.3 Mi (U)
0.3 Mi (L)
0.5 Mi (U)
0.5 Mi (L)
2.4 (U)
2.4 (L)
5.2 (U)
5.2 (L)
15.0 Mi
18.9 Mi
Black River Site

Figure 9. Survival of *Ceriodaphnia dubia* in 48 hr *In situ* Exposures, Black River, Fall 1997.

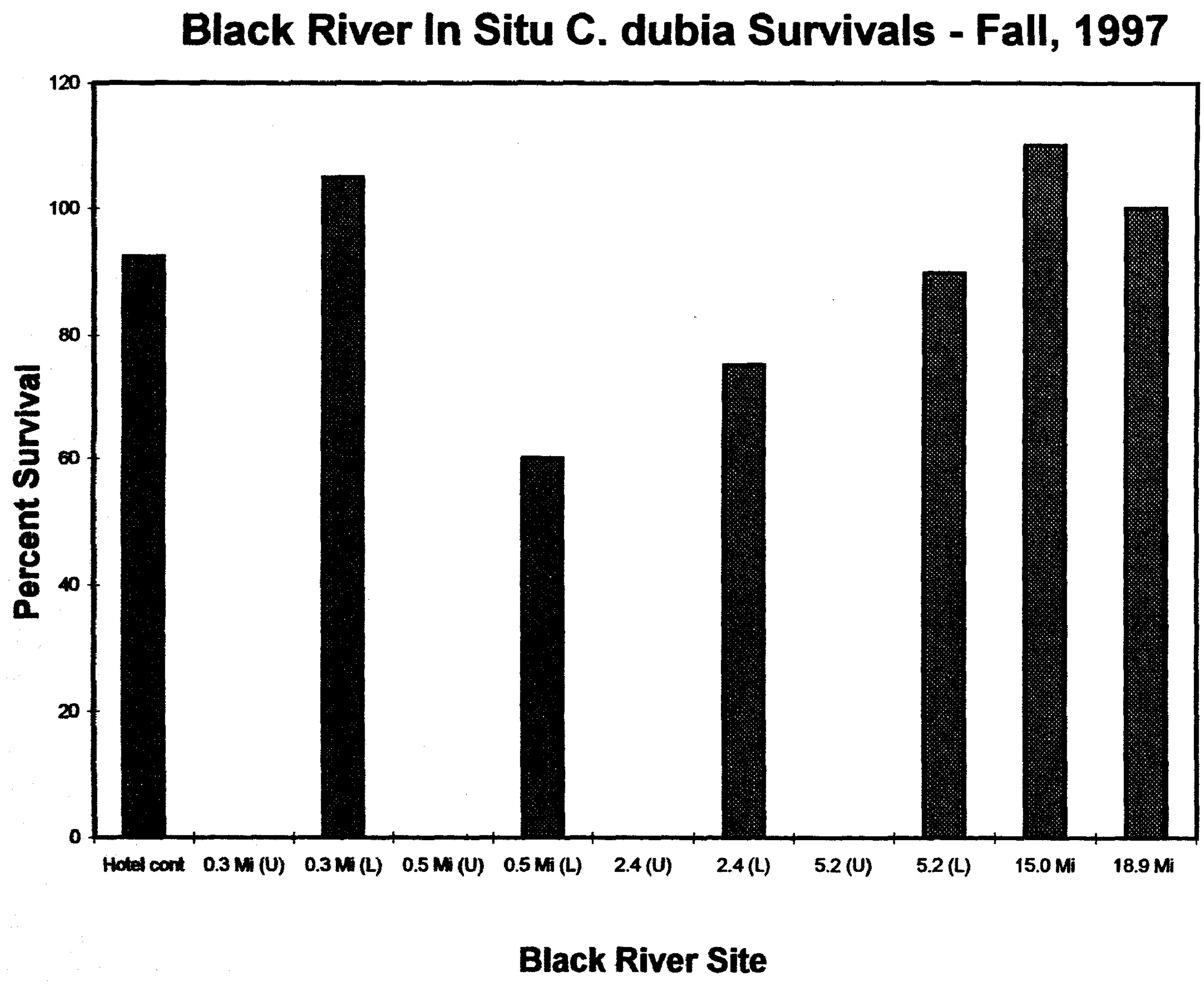
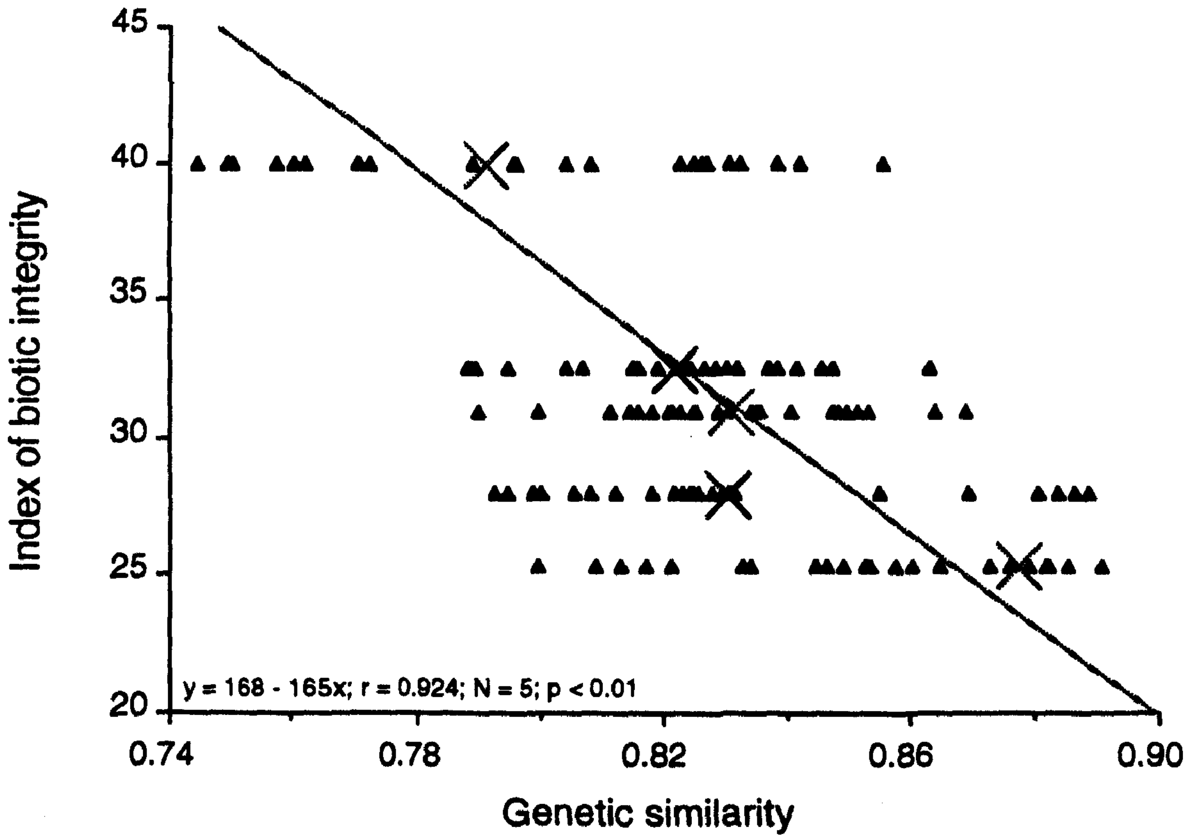
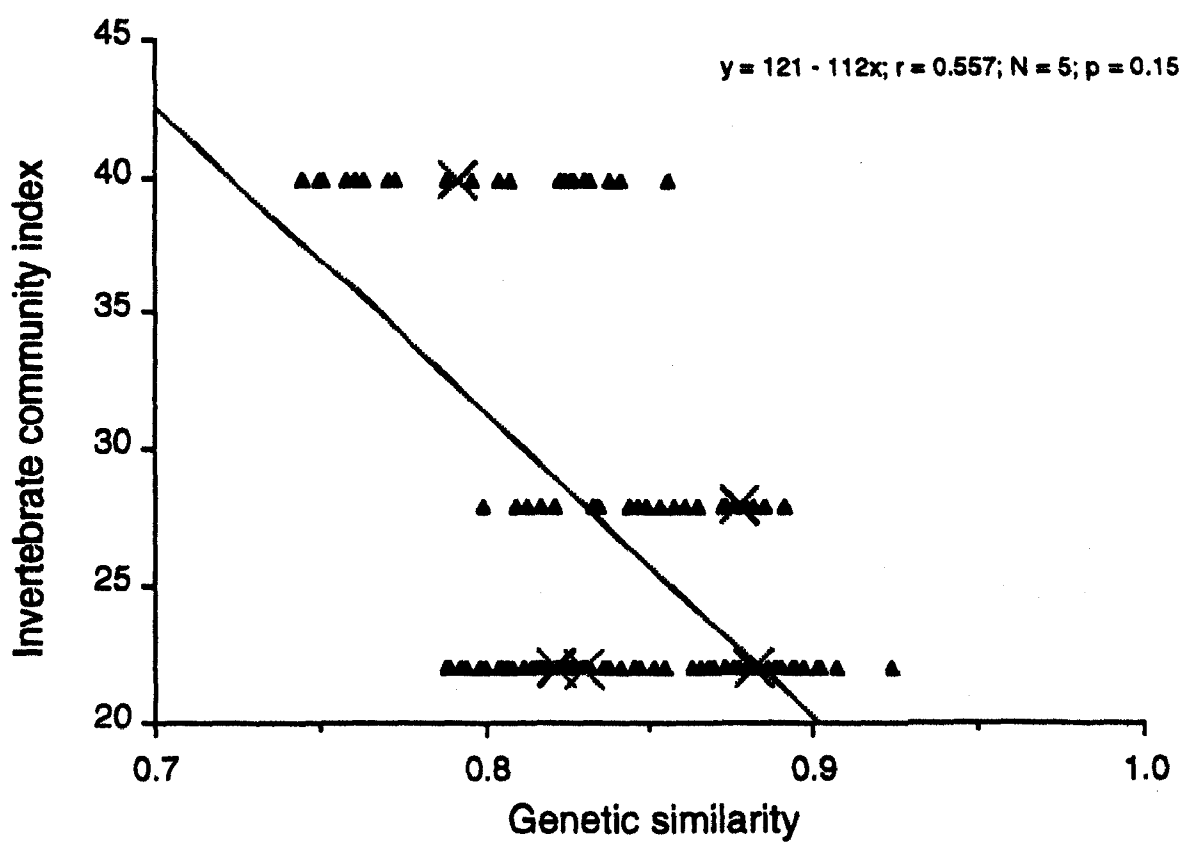

Black River In Situ C. dubia Survivals - Fall, 1997
120
100
80
60
40
20
0
Percent Survival
Hotel cont
0.3 Mi (U)
0.3 Mi (L)
0.5 Mi (U)
0.5 Mi (L)
2.4 (U)
2.4 (L)
5.2 (U)
5.2 (L)
15.0 Mi
18.9 Mi
Black River Site

Figure 10. Relationship between Genetic Similarity in the Snail, *Physella gyrina*, and Fish Communities (Index of Biotic Integrity), Black River, Fall 1997. IBI values from Ohio EPA (1994). Genetic similarity is mean of 24 pairwise comparisons.



45
40
35
30
25
20
Index of biotic integrity
y = 168 - 165x; r = 0.924; N = 5; p < 0.01
0.74
0.78
0.82
0.86
0.90
Genetic similarity



45
40
35
30
25
20
Invertebrate community index
y = 121 - 112x; r = 0.557; N = 5; p = 0.15
0.7
0.8
0.9
1.0
Genetic similarity

Figure 11. Survival of *Hyalella azteca* in 48 hr *In situ* Exposures, Black River, June, 1998.

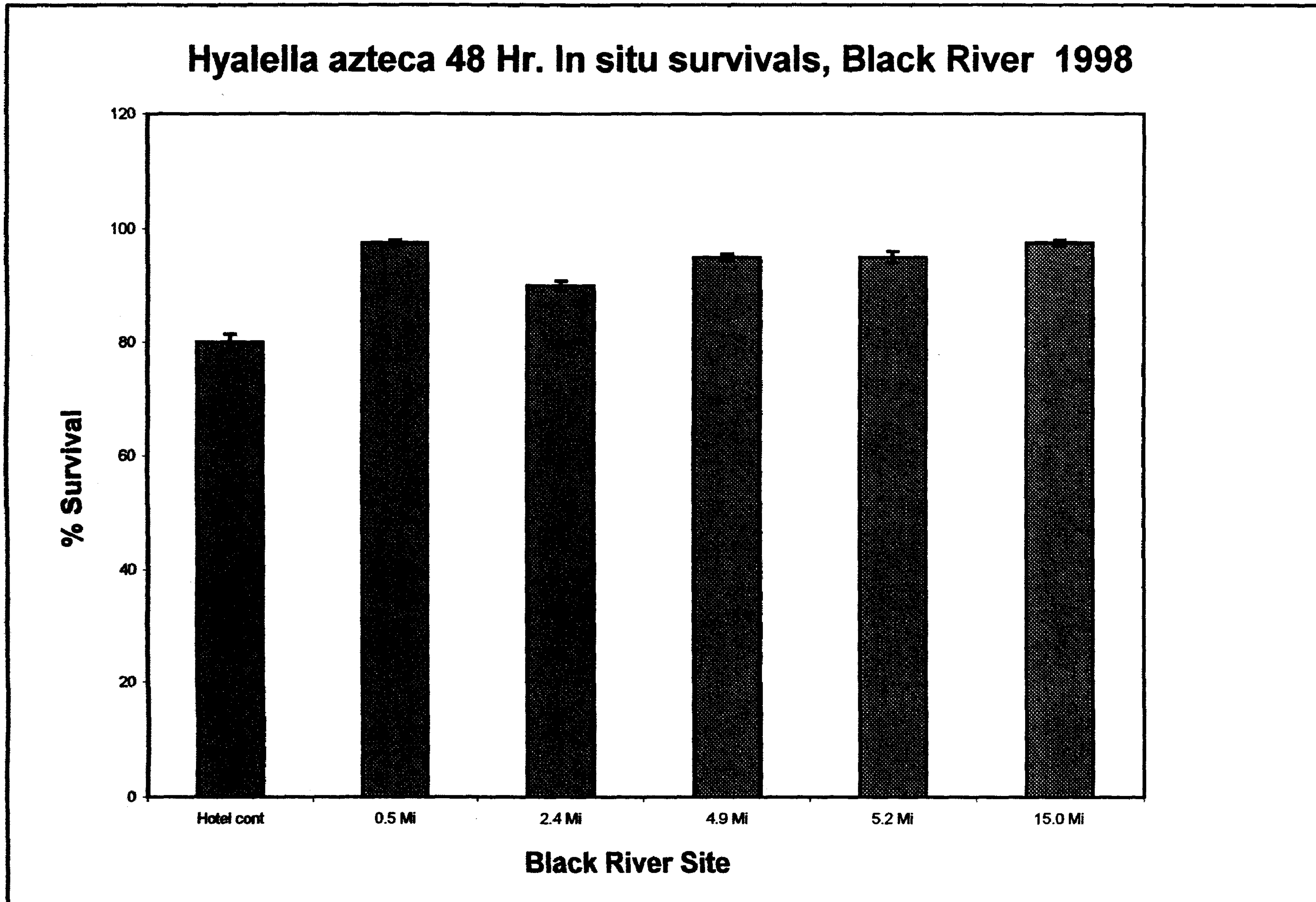

Hyalella azteca 48 Hr. In situ survivals, Black River 1998
% Survival
120
100
80
60
40
20
0
Hotel cont
0.5 Mi
2.4 Mi
4.9 Mi
5.2 Mi
15.0 Mi
Black River Site

Figure 12. Survival of *Chironomus tentans* in 48 hr *In situ* Exposures, Black River, June 1998.

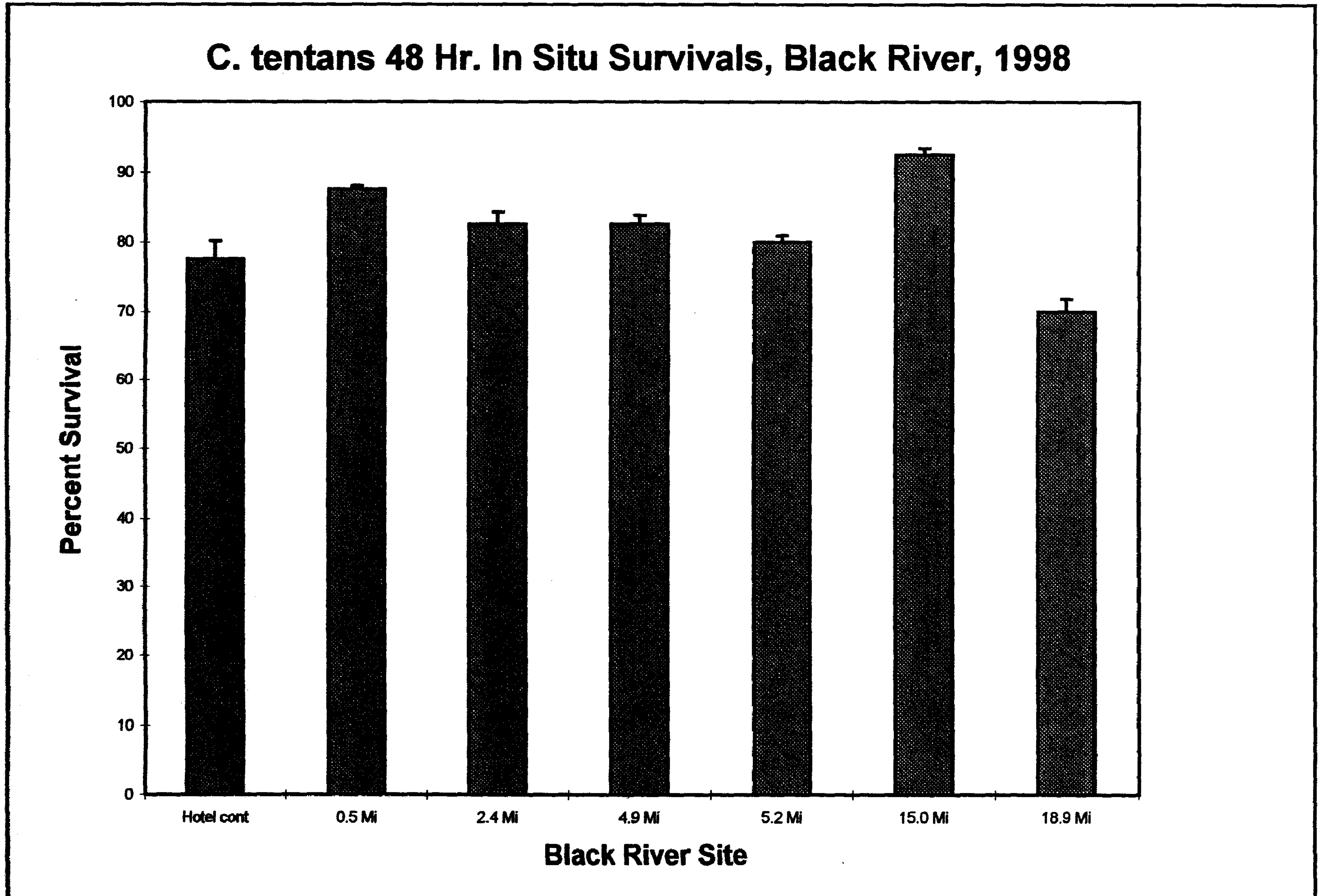
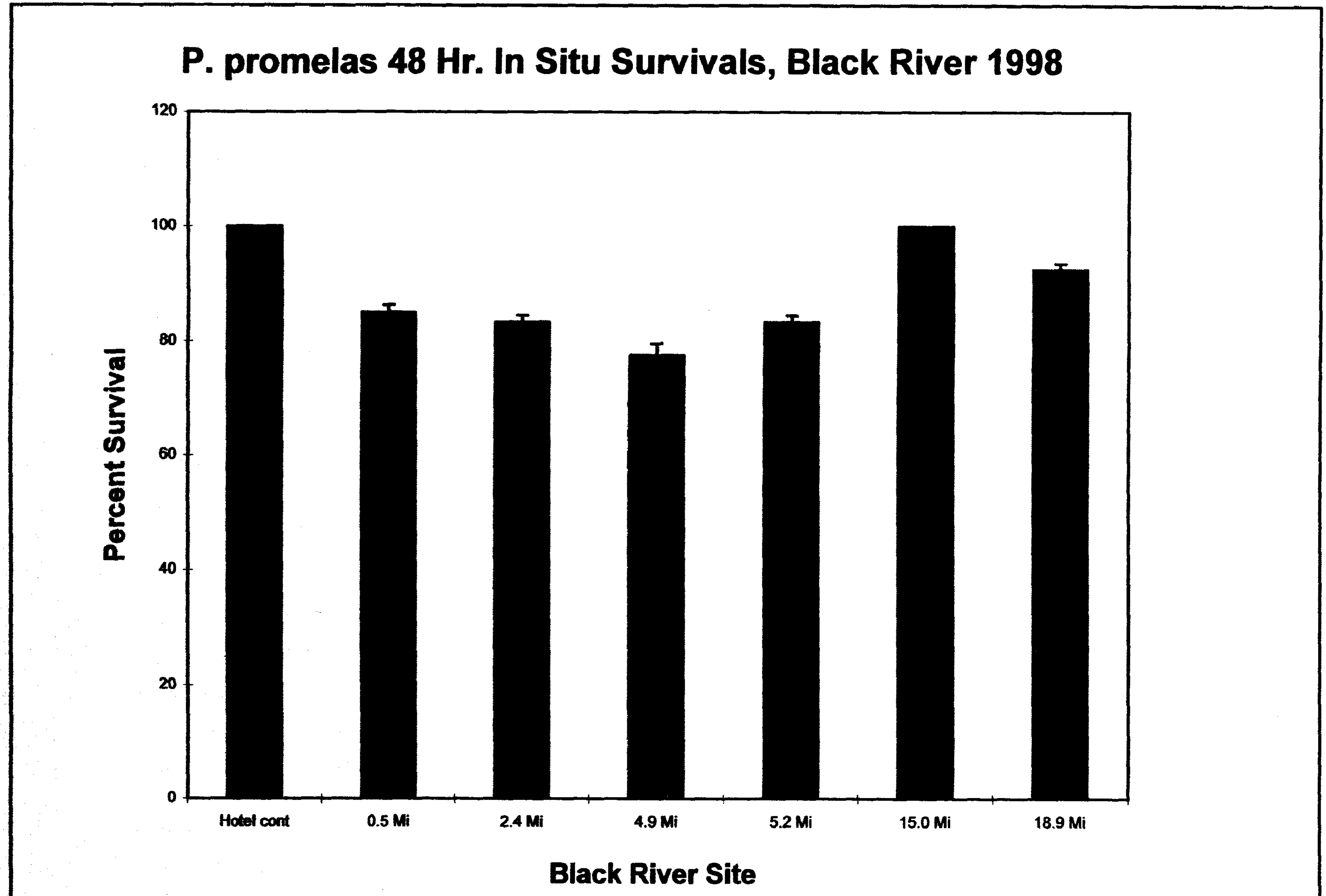
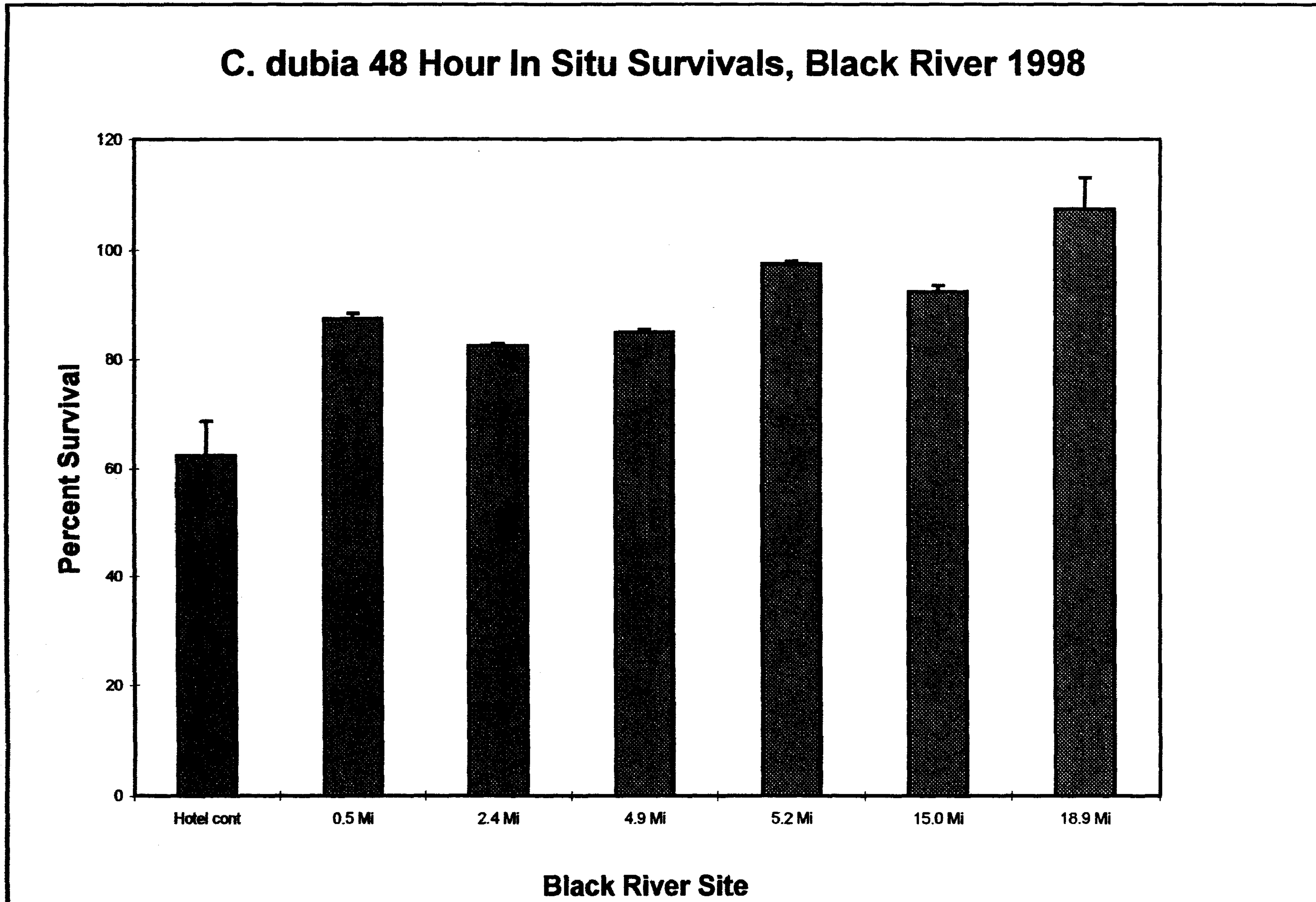

C. tentans 48 Hr. In Situ Survivals, Black River, 1998
Percent Survival
100
90
80
70
60
50
40
30
20
10
0
Hotel cont
0.5 Mi
2.4 Mi
4.9 Mi
5.2 Mi
15.0 Mi
18.9 Mi
Black River Site

Figure 13. Survival of *Pimephales promelas* in 48 hr *In situ* Exposures, Black River, June 1997.



P. promelas 48 Hr. In Situ Survivals, Black River 1998
Percent Survival
120
100
80
60
40
20
0
Hotel cont
0.5 Mi
2.4 Mi
4.9 Mi
5.2 Mi
15.0 Mi
18.9 Mi
Black River Site

Figure 14. Survival of *Ceriodaphnia dubia* in 48 hr *In situ* Exposures, Black River, June 1998.


C. dubia 48 Hour In Situ Survivals, Black River 1998
Percent Survival
120
100
80
60
40
20
0
Hotel cont
0.5 Mi
2.4 Mi
4.9 Mi
5.2 Mi
15.0 Mi
18.9 Mi
Black River Site

Appendix

1. Statistical analyses of toxicity data.
2. Water chemistry from laboratory and *in situ* toxicity tests.
3. GPS locations of stations.
4. Hydrolab continuous monitoring data and figure, June 1998
5. RAPD genetic similarity analyses, Fall 1997

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Black River--Insitu Survivals H.A.
File: Black River Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Hotel	4	10.000	10.000	10.000
2	Cascade	4	7.000	10.000	9.000
3	Grafton	4	7.000	11.000	9.250
4	5.0(U)	4	5.000	11.000	8.500
5	5.0(L)	4	5.000	10.000	7.750
6	2.3(L)	4	7.000	10.000	9.250
7	Erie(U)	4	6.000	10.000	7.750
8	Erie(L)	4	7.000	10.000	8.250
9	French(U)	4	0.000	9.000	4.500
10	French(L)	4	0.000	9.000	5.250

Black River--Insitu Survivals H.A.
File: Black River Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Hotel	0.000	0.000	0.000	0.00
2	Cascade	2.000	1.414	0.707	15.71
3	Grafton	2.917	1.708	0.854	18.46
4	5.0(U)	6.333	2.517	1.258	29.61
5	5.0(L)	4.917	2.217	1.109	28.61
6	2.3(L)	2.250	1.500	0.750	16.22
7	Erie(U)	2.917	1.708	0.854	22.04
8	Erie(L)	1.583	1.258	0.629	15.25
9	French(U)	27.000	5.196	2.598	115.47
10	French(L)	14.917	3.862	1.931	73.57

Black River--Insitu Survivals H.A.
File: Black River Transform: NO TRANSFORMATION

Hartley's test for homogeneity of variance
Bartlett's test for homogeneity of variance

These two tests can not be performed because at least one group has zero variance.

Data *FAIL* to meet homogeneity of variance assumption.
Additional transformations are useless.

Black River--Insitu Survivals H.A.
File: Black River Transform: NO TRANSFORMATION

STEEL'S MANY-ONE RANK TEST - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	Hotel	10.000				
2	Cascade	9.000	14.00	None	4.00	
3	Grafton	9.250	16.00	None	4.00	
4	5.0(U)	8.500	14.00	None	4.00	
5	5.0(L)	7.750	12.00	None	4.00	
6	2.3(L)	9.250	16.00	None	4.00	
7	Erie(U)	7.750	12.00	None	4.00	
8	Erie(L)	8.250	12.00	None	4.00	
9	French(U)	4.500	10.00	None	4.00	
10	French(L)	5.250	10.00	None	4.00	

Critical values use k = 9, are 1 tailed, and alpha = 0.05

WARNING - There are no critical values for this combination of groups and replicates.

Black River--Insitu survivals C. tentans
File: C.tentans Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Hotel	4	9.000	10.000	9.750
2	Cascade	4	8.000	10.000	8.750
3	Grafton	4	7.000	10.000	8.750
4	5.2(U)	4	7.000	10.000	9.250
5	5.2(L)	4	8.000	11.000	9.500
6	2.3(L)	4	9.000	10.000	9.250
7	Erie(U)	4	6.000	9.000	7.250
8	Erie(L)	4	6.000	10.000	8.000
9	French(U)	4	6.000	10.000	8.000
10	French(L)	4	6.000	11.000	8.750

Black River--Insitu survivals C. tentans
File: C.tentans Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Hotel	0.250	0.500	0.250	5.13
2	Cascade	0.917	0.957	0.479	10.94
3	Grafton	2.250	1.500	0.750	17.14
4	5.2(U)	2.250	1.500	0.750	16.22
5	5.2(L)	1.667	1.291	0.645	13.59
6	2.3(L)	0.250	0.500	0.250	5.41
7	Erie(U)	2.250	1.500	0.750	20.69
8	Erie(L)	2.667	1.633	0.816	20.41
9	French(U)	2.667	1.633	0.816	20.41
10	French(L)	4.917	2.217	1.109	25.34

```
Black River--Insitu survivals C. tentans
File: C.tentans        Transform: NO TRANSFORMATION

Shapiro - Wilk's test for normality
-------------------------------------------------------------------------------

D =   60.250

W =    0.973

Critical W (P = 0.05) (n = 40) = 0.940
Critical W (P = 0.01) (n = 40) = 0.919
-------------------------------------------------------------------------------

Data PASS normality test at P=0.01 level. Continue analysis.



Black River--Insitu survivals C. tentans
File: C.tentans        Transform: NO TRANSFORMATION

-------------------------------------------------------------------------------
Bartlett's test for homogeneity of variance
Calculated B1 statistic =    8.91

-------------------------------------------------------------------------------
Table Chi-square value =   21.67  (alpha = 0.01, df =   9)
Table Chi-square value =   16.92  (alpha = 0.05, df =   9)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.
```

Black River--Insitu survivals C. tentans
File: C.tentans   Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	9	21.725	2.414	1.202
Within (Error)	30	60.250	2.008	
Total	39	81.975		

Critical F value = 2.21 (0.05,9,30)
Since F < Critical F FAIL TO REJECT Ho: All equal

Black River--Insitu survivals C. tentans
File: C.tentans   Transform: NO TRANSFORMATION

DUNNETT'S TEST - TABLE 1 OF 2   Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Hotel	9.750	9.750		
2	Cascade	8.750	8.750	0.998	
3	Grafton	8.750	8.750	0.998	
4	5.2(U)	9.250	9.250	0.499	
5	5.2(L)	9.500	9.500	0.249	
6	2.3(L)	9.250	9.250	0.499	
7	Erie(U)	7.250	7.250	2.495	
8	Erie(L)	8.000	8.000	1.746	
9	French(U)	8.000	8.000	1.746	
10	French(L)	8.750	8.750	0.998	

Dunnett table value = 2.54 (1 Tailed Value, P=0.05, df=30,9)

Black River--Insitu survivals C. tentans
File: C.tentans   Transform: NO TRANSFORMATION

DUNNETT'S TEST - TABLE 2 OF 2   Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Hotel	4			
2	Cascade	4	2.545	26.1	1.000
3	Grafton	4	2.545	26.1	1.000
4	5.2(U)	4	2.545	26.1	0.500
5	5.2(L)	4	2.545	26.1	0.250
6	2.3(L)	4	2.545	26.1	0.500
7	Erie(U)	4	2.545	26.1	2.500
8	Erie(L)	4	2.545	26.1	1.750
9	French(U)	4	2.545	26.1	1.750
10	French(L)	4	2.545	26.1	1.000

Black River Insitu Survivals P. promelas
File: fish Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Hotel	4	10.000	10.000	10.000
2	Cascade	4	2.000	11.000	8.000
3	Grafton	4	5.000	11.000	8.500
4	5.2(U)	4	7.000	9.000	8.250
5	5.2(L)	4	6.000	11.000	9.000
6	2.3(L)	4	9.000	10.000	9.750
7	Erie(U)	4	0.000	9.000	4.000
8	Eriie(L)	4	9.000	10.000	9.750
9	French(U)	4	3.000	10.000	8.000
10	French(L)	4	6.000	10.000	8.750

Black River Insitu Survivals P. promelas
File: fish Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Hotel	0.000	0.000	0.000	0.00
2	Cascade	16.667	4.082	2.041	51.03
3	Grafton	7.000	2.646	1.323	31.13
4	5.2(U)	0.917	0.957	0.479	11.61
5	5.2(L)	4.667	2.160	1.080	24.00
6	2.3(L)	0.250	0.500	0.250	5.13
7	Erie(U)	22.000	4.690	2.345	117.26
8	Eriie(L)	0.250	0.500	0.250	5.13
9	French(U)	11.333	3.367	1.683	42.08
10	French(L)	3.583	1.893	0.946	21.63

Black River Insitu Survivals P. promelas
File: fish   Transform: NO TRANSFORMATION

Shapiro - Wilk's test for normality

D = 200.000

W =   0.928

Critical W (P = 0.05) (n = 40) = 0.940
Critical W (P = 0.01) (n = 40) = 0.919

Data PASS normality test at P=0.01 level. Continue analysis.

Black River Insitu Survivals P. promelas
File: fish   Transform: NO TRANSFORMATION

Hartley's test for homogeneity of variance
Bartlett's test for homogeneity of variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Black River Insitu Survivals P. promelas
File: fish   Transform: NO TRANSFORMATION

STEEL'S MANY-ONE RANK TEST - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	Hotel	10.000				
2	Cascade	8.000	16.00	None	4.00	
3	Grafton	8.500	16.00	None	4.00	
4	5.2(U)	8.250	10.00	None	4.00	
5	5.2(L)	9.000	16.00	None	4.00	
6	2.3(L)	9.750	16.00	None	4.00	
7	Erie(U)	4.000	10.00	None	4.00	
8	Eriie(L)	9.750	16.00	None	4.00	
9	French(U)	8.000	14.00	None	4.00	
10	French(L)	8.750	14.00	None	4.00	

Critical values use k = 9, are 1 tailed, and alpha = 0.05

WARNING - There are no critical values for this combination of groups and replicates.

Black River Insitu Survivals C. dubia
File: P.fish Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Hotel	4	8.000	10.000	9.250
2	Cascade	2	1.000	11.000	6.000
3	Grafton	2	0.000	10.000	5.000
4	5.2(L)	2	9.000	9.000	9.000
5	2.3(L)	2	7.000	8.000	7.500
6	Erie(L)	2	5.000	7.000	6.000
7	French(L)	2	10.000	11.000	10.500

Black River Insitu Survivals C. dubia
File: P.fish Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Hotel	0.917	0.957	0.479	10.35
2	Cascade	50.000	7.071	5.000	117.85
3	Grafton	50.000	7.071	5.000	141.42
4	5.2(L)	0.000	0.000	0.000	0.00
5	2.3(L)	0.500	0.707	0.500	9.43
6	Erie(L)	2.000	1.414	1.000	23.57
7	French(L)	0.500	0.707	0.500	6.73

Black River Insitu Survivals C. dubia
File: P.fish Transform: NO TRANSFORMATION

Shapiro - Wilk's test for normality

D = 105.750

W = 0.868

Critical W (P = 0.05) (n = 16) = 0.887
Critical W (P = 0.01) (n = 16) = 0.844

Data PASS normality test at P=0.01 level. Continue analysis.

Black River Insitu Survivals C. dubia
File: P.fish Transform: NO TRANSFORMATION

Hartley's test for homogeneity of variance
Bartlett's test for homogeneity of variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Black River-In Laboratory Water Chemistries - Chironomus tentans							
October 31, 1997-November 10,1997							
	D.O.	**Temp.**	**pH**	**Cond.**	**Alkalinity**	**Hardness**	**Ammonia**
	(mg/L)	**(C)**		**(umhos)**	**(mg/L CaCO3)**	**(mg/L CaCO3)**	**(mg/L)**
Treatment-Day0							
Water Control	7.8	22	8.15	280	92	187	0.0537
Florissant	7.6	22	7.56	350	68	255	0.266
0.3 mi 0-2cm.	6.3	22	7.86	450	204	347	4.77
0.3 mi 8-10cm.	6.5	22	7.67	550	216	315	10.5
0.5 mi 0-2 cm.	6.2	22	8.02	320	100	258	2.64
0.5 mi 8-10 cm.	5.4	22	8.12	300	88	242	1.12
2.4 mi 0-2 cm.	6.05	22	8.01	540	44	269	1.76
2.4 mi 8-10cm.	5.8	22	8.02	540	108	269	1.62
2.5 mi 0-2 cm.	5.7	22	7.99	450	148	296	1.25
2.5 mi 8-10cm.	4.4	22	7.93	420	180	283	3.31
2.9 mi 0-2cm.	6.2	22	7.83	420	184	289	5.23
2.9 mi 8-10 cm.	6	22	7.83	400	172	283	4.71
4.6 mi 0-2cm.	6.25	22	8.09	548	156	306	6.1
4.6 mi 8-10 cm.	6.25	22	7.95	550	216	315	6.05
5.2 mi 0-2 cm.	6	22	8.05	540	176	255	1.51
5.2 mi 8-10 cm.	5.5	22	8.02	550	68	319	
9.8 mi	6.5	22	8.01	400	120	269	0.182
11.6 mi	6.5	22	7.95	380	128	260	0.888
15.0 mi	6.8	22	8.09	400	180	269	0.804
18.9 mi	6.5	22	8	350	116	264	0.369
	D.O.	**Temp.**	**pH**	**Cond.**	**Alkalinity**	**Hardness**	**Ammonia**
	(mg/L)	**(C)**		**(umhos)**	**(mg/L CaCO3)**	**(mg/L CaCO3)**	**(mg/L)**
Treatment-Day10							
Water Control	7.9	24	8.21	340	160	288	1.97
Florissant	8.3	24	8.25	320	140	235	1.76
0.3 mi 0-2cm.	7.8	22	8.15	335	170	272	4.34
0.3 mi 8-10cm.	7.4	22	8.24	340	170	252	0.969
0.5 mi 0-2 cm.	8.4	22	8.38	350	140	227	1.38
0.5 mi 8-10 cm.	8.5	22	8.43	500	200	293	1.02
2.4 mi 0-2 cm.	8.3	24	8.28	360	160	247	1.1
2.4 mi 8-10cm.	7.9	24	8.43	400	180	268	1.73
2.5 mi 0-2 cm.	8.1	24	8.45	350	120	209	0.219
2.5 mi 8-10cm.	8.4	24	8.43	400	180	248	0.25
2.9 mi 0-2cm.	7.2	22	8.58	600	280	375	0.837
2.9 mi 8-10 cm.	7.8	22	8.42	400	180	256	0.767
4.6 mi 0-2cm.	7.6	24	8.4	450	200	272	2.56
4.6 mi 8-10 cm.	7.6	24	8.36	400	180	252	1.12
5.2 mi 0-2 cm.	8.4	24	8.48	400	180	264	1.33
5.2 mi 8-10 cm.	8	24	8.52	430	180	264	1.43
9.8 mi	8.4	22	8.17	310	140	218	0.725
11.6 mi	8.5	22	7.97	340	160	235	0.743
15.0 mi	8.5	22	8.22	390	160	255	0.45
18.9 mi	8.3	22	8.32	380	170	264	1.93

Black River-In Laboratory Water Chemistries - Chironomus tentans							
October 31, 1997-November 10,1997							
	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)
Treatment-Day0							
Water Control	7.8	22	8.15	280	92	187	0.0537
Florissant	7.6	22	7.56	350	68	255	0.266
0.4 mi 0-2cm.	6.3	22	7.86	450	204	347	4.77
0.4 mi 8-10cm.	6.5	22	7.67	550	216	315	10.5
0.9 mi 0-2 cm.	6.2	22	8.02	320	100	258	2.64
0.9 mi 8-10 cm.	5.4	22	8.12	300	88	242	1.12
2.3 mi 0-2 cm.	6.05	22	8.01	540	44	269	1.76
2.3 mi 8-10cm.	5.8	22	8.02	540	108	269	1.62
2.4 mi 0-2 cm.	5.7	22	7.99	450	148	296	1.25
2.4 mi 8-10cm.	4.4	22	7.93	420	180	283	3.31
2.9 mi 0-2cm.	6.2	22	7.83	420	184	289	5.23
2.9 mi 8-10 cm.	6	22	7.83	400	172	283	4.71
4.8 mi 0-2cm.	6.25	22	8.09	548	156	306	6.1
4.8 mi 8-10 cm.	6.25	22	7.95	550	216	315	6.05
5.2 mi 0-2 cm.	6	22	8.05	540	176	255	1.51
5.2 mi 8-10 cm.	5.5	22	8.02	550	68	319	
9.8 mi	6.5	22	8.01	400	120	269	0.182
11.6 mi	6.5	22	7.95	380	128	260	0.888
15.0 mi	6.8	22	8.09	400	180	269	0.804
18.9 mi	6.5	22	8	350	116	264	0.369
	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)
Treatment-Day10							
Water Control	7.9	24	8.21	340	160	288	1.97
Florissant	8.3	24	8.25	320	140	235	1.76
0.4 mi 0-2cm.	7.8	22	8.15	335	170	272	4.34
0.4 mi 8-10cm.	7.4	22	8.24	340	170	252	0.969
0.9 mi 0-2 cm.	8.4	22	8.38	350	140	227	1.38
0.9 mi 8-10 cm.	8.5	22	8.43	500	200	293	1.02
2.3 mi 0-2 cm.	8.3	24	8.28	380	160	247	1.1
2.3 mi 8-10cm.	7.9	24	8.43	400	180	268	1.73
2.4 mi 0-2 cm.	8.1	24	8.45	350	120	209	0.219
2.4 mi 8-10cm.	8.4	24	8.43	400	180	248	0.25
2.9 mi 0-2cm.	7.2	22	8.58	600	280	375	0.837
2.9 mi 8-10 cm.	7.8	22	8.42	400	180	256	0.767
4.8 mi 0-2cm.	7.6	24	8.4	450	200	272	2.56
4.8 mi 8-10 cm.	7.6	24	8.36	400	180	252	1.12
5.2 mi 0-2 cm.	8.4	24	8.48	400	180	264	1.33
5.2 mi 8-10 cm.	8	24	8.52	430	180	264	1.43
9.8 mi	8.4	22	8.17	310	140	218	0.725
11.6 mi	8.5	22	7.97	340	160	235	0.743
15.0 mi	8.5	22	8.22	390	160	255	0.45
18.9 mi	8.3	22	8.32	380	170	264	1.93

Black River-In Laboratory Water Chemistries - Hyalella azteca							
October 31, 1997-November 10,1997							
	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)
Treatment-Day0							
Water Control	7.8	22	8.15	280	92	187	0.0537
Florissant	7.6	22	7.56	350	68	255	0.266
0.3 mi 0-2cm.	6.3	22	7.86	450	204	347	4.77
0.3 mi8-10cm.	6.5	22	7.67	550	216	315	10.5
0.5 mi 0-2 cm.	6.2	22	8.02	320	100	258	2.64
0.5 mi 8-10 cm.	5.4	22	8.12	300	88	242	1.12
2.4 mi 0-2 cm.	6.05	22	8.01	540	44	269	1.76
2.4 mi 8-10cm.	5.8	22	8.02	540	108	269	1.62
2.5 mi 0-2 cm.	5.7	22	7.99	450	148	296	1.25
2.5 mi 8-10cm.	4.4	22	7.93	420	180	283	3.31
2.9 mi 0-2cm.	6.2	22	7.83	420	184	289	5.23
2.9 mi 8-10 cm.	6	22	7.83	400	172	283	4.71
4.6 mi 0-2cm.	6.25	22	8.09	548	156	306	6.1
4.6 mi 8-10 cm.	6.25	22	7.95	550	216	315	6.05
5.2 mi 0-2 cm.	6	22	8.05	540	176	255	1.51
5.2 mi 8-10 cm.	5.5	22	8.02	550	68	319	
9.8 mi	6.5	22	8.01	400	120	269	0.182
11.6 mi	6.5	22	7.95	380	128	260	0.888
15.0 mi	6.8	22	8.09	400	180	269	0.804
18.9 mi	6.5	22	8	350	116	264	0.369
	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)
Treatment-Day10							
Water Control	8.5	23	8.25	250	120	202	1.54
Florissant	8.5	23	8.26	280	120	198	0.708
0.3 mi 0-2cm.	8.1	23	8	340	160	227	0.408
0.3 mi 8-10cm.	8	23	7.2	300	110	218	1.22
0.5 mi 0-2 cm.	8.2	23	8.29	350	160	227	1.15
0.5 mi 8-10 cm.	8.3	23	8.47	370	160	248	0.834
2.4 mi 0-2 cm.	8.1	23	8.26	390	200	268	1.44
2.4 mi 8-10cm.	8.3	23	8.23	340	160	239	0.197
2.5 mi 0-2 cm.	8.1	23	8.29	380	200	260	0.325
2.5 mi 8-10cm.	7.2	23	8.22	335	160	223	1.26
3.0 mi 0-2cm.	8	23	8.27	370	200	252	1.36
3.0 mi 8-10 cm.	8.2	23	8.29	330	160	235	0.667
4.6 mi 0-2cm.	7.9	23	8.43	450	160	202	1.12
4.6 mi 8-10 cm.	8.1	23	8.36	400	200	272	1.51
5.2 mi 0-2 cm.	7.8	23	8.55	390	200	272	0.213
5.2 mi 8-10 cm.	8.2	23	8.33	380	180	264	0.384
9.8 mi	8.2	23	8.25	290	120	206	0.295
11.6 mi	7.6	23	8.24	310	140	619	0.406
15.0 mi	8	23	8.25	320	150	231	0.199
18.9 mi	8.2	23	8.3	295	180	211	2.47

Black River-In Laboratory Water Chemistries - Hyalella azteca
October 31, 1997-November 10,1997

	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)
Treatment-Day0							
Water Control	7.8	22	8.15	280	92	187	0.0537
Florissant	7.6	22	7.56	350	68	255	0.266
0.4 mi 0-2cm.	6.3	22	7.86	450	204	347	4.77
0.4 mi8-10cm.	6.5	22	7.67	550	216	315	10.5
0.9 mi 0-2 cm.	6.2	22	8.02	320	100	258	2.64
0.9 mi 8-10 cm.	5.4	22	8.12	300	88	242	1.12
2.3 mi 0-2 cm.	6.05	22	8.01	540	44	269	1.76
2.3 mi 8-10cm.	5.8	22	8.02	540	108	269	1.62
2.4 mi 0-2 cm.	5.7	22	7.99	450	148	296	1.25
2.4 mi 8-10cm.	4.4	22	7.93	420	180	283	3.31
2.9 mi 0-2cm.	6.2	22	7.83	420	184	289	5.23
2.9 mi 8-10 cm.	6	22	7.83	400	172	283	4.71
4.8 mi 0-2cm.	6.25	22	8.09	548	156	306	6.1
4.8 mi 8-10 cm.	6.25	22	7.95	550	216	315	6.05
5.2 mi 0-2 cm.	6	22	8.05	540	176	255	1.51
5.2 mi 8-10 cm.	5.5	22	8.02	550	68	319	
9.8 mi	6.5	22	8.01	400	120	269	0.182
11.6 mi	6.5	22	7.95	380	128	260	0.888
15.0 mi	6.8	22	8.09	400	180	269	0.804
18.9 mi	6.5	22	8	350	116	264	0.369

	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)
Treatment-Day10							
Water Control	8.5	23	8.25	250	120	202	1.54
Florissant	8.5	23	8.26	280	120	198	0.708
0.4 mi 0-2cm.	8.1	23	8	340	160	227	0.408
0.4 mi 8-10cm.	8	23	7.2	300	110	218	1.22
0.9 mi 0-2 cm.	8.2	23	8.29	350	160	227	1.15
0.9 mi 8-10 cm.	8.3	23	8.47	370	160	248	0.834
2.3 mi 0-2 cm.	8.1	23	8.26	390	200	268	1.44
2.3 mi 8-10cm.	8.3	23	8.23	340	160	239	0.197
2.4 mi 0-2 cm.	8.1	23	8.29	380	200	260	0.325
2.4 mi 8-10cm.	7.2	23	8.22	335	160	223	1.26
3.0 mi 0-2cm.	8	23	8.27	370	200	252	1.36
3.0 mi 8-10 cm.	8.2	23	8.29	330	160	235	0.667
4.8 mi 0-2cm.	7.9	23	8.43	450	160	202	1.12
4.8 mi 8-10 cm.	8.1	23	8.36	400	200	272	1.51
5.2 mi 0-2 cm.	7.8	23	8.55	390	200	272	0.213
5.2 mi 8-10 cm.	8.2	23	8.33	380	180	264	0.384
9.8 mi	8.2	23	8.25	290	120	206	0.295
11.6 mi	7.6	23	8.24	310	140	619	0.406
15.0 mi	8	23	8.25	320	150	231	0.199
18.9 mi	8.2	23	8.3	295	180	211	2.47

Black River *In Situ* Water Quality
June 11 - June 13, 1998

Day 0	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
Lab Control	8.65	22	8	361.5	160	180		2
0.3 Miles	5.89	20.5	7.7	475.6	120	160		13.1
2.4 Miles	4.53	21.8	7.7	454.1	120	200		49.2
4.6 Miles	8.78	20.3	8.3	1068	140	300		21
5.2 Miles	11.67	19.7	8.5	1414	180	240		12.5
15.0 Miles	8.45	19	8.3	767	200	220		14.4
18.9 Miles	8.12	18	8	820	200	220		15.4

Day 1 A.M.	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
Lab Control	5.6	22.2	7.3	362.4	120	160	0.11	2.1
0.3 Miles	7.45	22	7.8	467.6	120	160	0.42	44.2
2.4 Miles	6.69	24	7.7	591	120	180	0.55	37.1
4.6 Miles	7.27	19	7.7	558	120	180		949
5.2 Miles	7.52	21	7.8	780	120	240	0.91	84
15.0 Miles	7.92	20.5	8	511	140	180	0.02	47.8
18.9 Miles	7.49	18	8	825	220	300	0.08	41.8

Day 1 P.M.	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
Lab Control	6.8	20.1	7.9	365	13	180	0.1214	1.17
0.3 Miles	7.03	22	7.9	457	120	160	0.594	19.6
2.4 Miles	6.83	24	8	608	11	160	0.461	27.8
4.6 Miles	7.77	23	7.8	588	95	180		190
5.2 Miles	3.37	22	7.6	676	120	200		84.6
15.0 Miles	7.3	22	8.2	584	130	240	0.898	37.4
18.9 Miles	7.51	22	8.3	810	265	340		25.3

Day 2 Final	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
0.3 Miles	8.9	23	7.72	400	108	159	0.413	
2.4 Miles	8.6	23	7.86	600	128	224	0.072	
4.6 Miles	8.5	23	7.71	400	100	180	0.286	
5.2 Miles	8.1	23	7.87	500	108	183	0.067	
15.0 Miles	8.6	23	7.82	500	140	200	0.153	
18.9 Miles	8	23	7.71	600	144	261	0.231	

Black River *In Situ* Water Quality
June 11 - June 13, 1998

Day 0	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
Lab Control	8.65	22	8	361.5	160	180		2
0.4 Miles	5.89	20.5	7.7	475.6	120	160		13.1
2.3 Miles	4.53	21.8	7.7	454.1	120	200		49.2
4.8 Miles	8.78	20.3	8.3	1068	140	300		21
5.2 Miles	11.67	19.7	8.5	1414	180	240		12.5
15.0 Miles	8.45	19	8.3	767	200	220		14.4
18.9 Miles	8.12	18	8	820	200	220		15.4

Day 1 A.M.	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
Lab Control	5.6	22.2	7.3	362.4	120	160	0.11	2.1
0.4 Miles	7.45	22	7.8	467.6	120	160	0.42	44.2
2.3 Miles	6.69	24	7.7	591	120	180	0.55	37.1
4.8 Miles	7.27	19	7.7	558	120	180		949
5.2 Miles	7.52	21	7.8	780	120	240	0.91	84
15.0 Miles	7.92	20.5	8	511	140	180	0.02	47.8
18.9 Miles	7.49	18	8	825	220	300	0.08	41.8

Day 1 P.M.	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
Lab Control	6.8	20.1	7.9	365	13	180	0.1214	1.17
0.4 Miles	7.03	22	7.9	457	120	160	0.594	19.6
2.3 Miles	6.83	24	8	608	11	160	0.461	27.8
4.8 Miles	7.77	23	7.8	588	95	180		190
5.2 Miles	3.37	22	7.6	676	120	200		84.6
15.0 Miles	7.3	22	8.2	584	130	240	0.898	37.4
18.9 Miles	7.51	22	8.3	810	265	340		25.3

Day 2 Final	D.O. (mg/L)	Temp. (C)	pH	Cond. (umhos)	Alkalinity (mg/L CaCO3)	Hardness (mg/L CaCO3)	Ammonia (mg/L)	Turbidity (NTU)
0.4 Miles	8.9	23	7.72	400	108	159	0.413	
2.3 Miles	8.6	23	7.86	600	128	224	0.072	
4.8 Miles	8.5	23	7.71	400	100	180	0.286	
5.2 Miles	8.1	23	7.87	500	108	183	0.067	
15.0 Miles	8.6	23	7.82	500	140	200	0.153	
18.9 Miles	8	23	7.71	600	144	261	0.231	

Black River Site Descriptions:

WSU Code	OEPA Mile	Mi from Dock	GPS coordinates	
Hotel control	0	0		
U Erie B	0.5	0.8 mi north	41°28'172"	82°10'512"
TB Log	2.4	0.9 mi south	41°27'207"	82°09'152"
French	4.9	3.6 mi south	41°27'294"	82°06'817"
PVC	5.2	3.7 mi south	41°27'270"	82°06'816"
Cascade	15			
Grafton	18.9			

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WSU Code	OEPA Mile	Mi from Dock	GPS coordinates	
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Cascade	15			
Grafton	18.9			

Black River
Hydrolab Data
June 10, 1998 - June 13, 1998

Log File Name : Black River Project
Setup Date (MMDDYY) : 061098
Setup Time (HHMMSS) : 171321
Starting Date (MMDDYY) : 061098
Starting Time (HHMMSS) : 180000
Stopping Date (MMDDYY) : 061398
Stopping Time (HHMMSS) : 180000
Interval (HHMMSS) : 003000
Warmup : Disable

==> Follow Variable and Calibration Change(s) <==

Date MMDDYY	Time HHMMSS	Temp degC	pH units	SpCond mS/cm	TDS Kmg/l	DO mg/l	Turb NTU	Depth feet	Batt volts
61098	180000	23.23	6.82	0.4	0.256	6.08	3.1 @	3.4	12.1
61098	183000	23.38	6.81	0.404	0.258	6.08	1.7 @	3.4	12.1
61098	190000	23.32	6.79	0.408	0.261	6.31	2.5 @	3.4	12.1
61098	193000	23.7	7.31	0.608	0.389	5.16	113 @	3.6	17.8
61098	200000	23.37	7.36	0.612	0.392	5.04	7.9 @	3.6	17.8
61098	203000	23.41	7.39	0.615	0.393	5.29	3.5 @	3.7	17.7
61098	210000	23.3	7.38	0.615	0.394	5.29	7 @	3.5	17.8
61098	213000	23.2	7.35	0.612	0.392	5.19	9.9 @	3.8	17.8
61098	220000	23.07	7.36	0.616	0.394	5.25	8.6 @	3.7	17.8
61098	223000	22.96	7.36	0.613	0.393	5.3	79.5 @	3.7	17.7
61098	230000	22.37	7.32	0.606	0.388	4.81	0.2 @	3.7	17.8
61098	233000	22.78	7.32	0.611	0.391	4.96	0 @	3.8	17.7
61198	0	22.83	7.35	0.614	0.393	4.85	0.8 @	3.6	17.7
61198	3000	22.77	7.35	0.613	0.392	4.99	0 @	3.8	17.7
61198	10000	22.82	7.34	0.615	0.394	5.06	0 @	3.6	17.8
61198	13000	22.82	7.37	0.617	0.395	4.99	0.5 @	3.6	17.8
61198	20000	22.6	7.33	0.611	0.391	4.65	0 @	3.7	17.8
61198	23000	22.65	7.33	0.615	0.393	4.93	0 @	3.5	17.8
61198	30000	22.71	7.35	0.621	0.397	5.38	0 @	3.5	17.8
61198	33000	22.47	7.33	0.614	0.393	5.08	0 @	3.4	17.7
61198	40000	22.23	7.32	0.606	0.388	4.53	0.3 @	3.5	17.8
61198	43000	22.01	7.33	0.592	0.379	4.67	0 @	3.4	17.7
61198	50000	21.99	7.32	0.599	0.383	4.92	0 @	3.5	17.7
61198	53000	22.04	7.33	0.604	0.386	5.08	0 @	3.4	17.8
61198	60000	22	7.33	0.606	0.388	4.85	0 @	3.4	17.7
61198	63000	21.84	7.32	0.59	0.378	4.84	0 @	3.5	17.7
61198	70000	21.95	7.32	0.604	0.387	4.86	0 @	3.4	17.7

[illegible]
Trur in [illegible]
[illegible] – Rain
[illegible] @ 1:03 pm

Black River
Hydrolab Data
June 10, 1998 - June 13, 1998

Date MMDDYY	Time HHMMSS	Temp degC	pH units	SpCond mS/cm	TDS Kmg/l	DO mg/l	Turb NTU		Depth feet	Batt volts
61198	73000	21.88	7.31	0.6	0.384	5.19	0 @		3.5	17.7
61198	80000	20.98	7.28	0.545	0.349	4.85	0 @		3.5	17.7
61198	83000	20.93	7.28	0.541	0.346	4.65	0 @		3.6	17.7
61198	90000	21.08	7.27	0.549	0.351	4.57	0 @		3.6	17.7
61198	93000	21.18	7.28	0.551	0.353	4.41	0 @		3.6	17.7
61198	100000	21.29	7.28	0.556	0.356	4.94	0 @		3.7	17.7
61198	103000	21.5	7.3	0.56	0.358	4.81	0 @		3.6	17.7
61198	110000	21.17	7.27	0.536	0.343	4.5	0 @		3.7	17.7
61198	113000	21.21	7.28	0.544	0.348	4.34	0 @		3.7	17.6
61198	120000	21.47	7.28	0.549	0.351	4.35	0 @		3.8	17.6
61198	123000	21.41	7.28	0.549	0.352	4.44	0 @		3.7	17.6
61198	130000	21.33	7.28	0.548	0.35	4.35	0 @		3.7	17.6
61198	133000	21.39	7.29	0.549	0.351	4.31	0 @		3.7	17.6
61198	140000	21.17	7.26	0.546	0.349	4.29	0 @		3.6	17.6
61198	143000	21.15	7.25	0.544	0.348	4.36	0 @		3.5	17.6
61198	150000	21.29	7.25	0.547	0.35	4.21	0 @		3.4	17.6
61198	153000	21.55	7.27	0.552	0.353	4.45	0 @		3.6	17.6
61198	160000	21.62	7.27	0.551	0.352	4.28	0 @		3.5	17.7
61198	163000	21.68	7.28	0.551	0.353	4.39	0 @		3.6	17.7
61198	170000	21.91	7.29	0.552	0.353	4.86	0 @		3.4	17.6
61198	173000	21.77	7.29	0.553	0.354	4.45	0 @		3.4	17.6
61198	180000	21.8	7.28	0.554	0.354	4.37	0 @		3.4	17.6
61198	183000	21.8	7.27	0.554	0.354	4.25	0 @		3.3	17.6
61198	190000	21.85	7.3	0.555	0.355	4.4	0 @		3.4	17.6
61198	193000	21.56	7.29	0.548	0.351	4.34	0 @		3.4	17.6
61198	200000	21.54	7.29	0.549	0.351	4.62	0 @		3.3	17.6
61198	203000	21.67	7.27	0.552	0.354	4.24	0 @		3.4	17.6
61198	210000	21.48	7.3	0.548	0.35	4.42	0 @		3.5	17.6
61198	213000	21.37	7.29	0.544	0.348	4.43	0 @		3.4	17.6
61198	220000	21.56	7.27	0.551	0.353	4.4	0 @		3.5	17.6
61198	223000	21.21	7.29	0.543	0.348	4.56	0 @		3.4	17.6
61198	230000	21.55	7.3	0.548	0.351	4.67	0 @		3.3	17.6
61198	233000	21.43	7.29	0.546	0.35	4.69	0 @		3.4	17.6
61298	0	21.43	7.28	0.547	0.35	4.76	0 @		3.1	17.6
61298	3000	21.57	7.28	0.548	0.351	4.91	0 @		3.2	17.5
61298	10000	22.06	7.36	0.562	0.36	5.27	0 @		3.1	17.6
61298	13000	21.72	7.34	0.553	0.354	5.22	0 @		3.1	17.6
61298	20000	21.29	7.28	0.542	0.347	4.49	0 @		3	17.6
61298	23000	21.93	7.36	0.563	0.36	5.1	0 @		3.4	17.6

Black River
Hydrolab Data
June 10, 1998 - June 13, 1998

Date MMDDYY	Time HHMMSS	Temp degC	pH units	SpCond mS/cm	TDS Kmg/l	DO mg/l	Turb NTU		Depth feet	Batt volts
61298	30000	21.59	7.34	0.557	0.357	4.69	0 @		3.3	17.6
61298	33000	21.66	7.33	0.563	0.36	4.71	0 @		3.2	17.6
61298	40000	21.82	7.35	0.57	0.365	4.99	0 @		3.4	17.5
61298	43000	21.81	7.35	0.579	0.371	4.83	0 @		3.2	17.5
61298	50000	21.66	7.33	0.573	0.367	4.86	0 @		3.1	17.5
61298	53000	22.02	7.38	0.593	0.38	5.12	0 @		3.2	17.6
61298	60000	22.04	7.37	0.601	0.384	5.03	0 @		3.1	17.5
61298	63000	22.35	7.39	0.631	0.404	5.28	0 @		3.1	17.5
61298	70000	22.2	7.4	0.637	0.408	5.18	0 @		3.1	17.5
61298	73000	22.45	7.41	0.667	0.427	5.28	0 @		3	17.6
61298	80000	22.47	7.41	0.676	0.433	5.52	0 @		3.1	17.5
61298	83000	22.74	7.44	0.702	0.449	5.74	0 @		3.1	17.5
61298	90000	22.88	7.49	0.723	0.462	6.02	0 @		3.2	17.5
61298	93000	22.89	7.49	0.725	0.464	5.9	0 @		3.2	17.5
61298	100000	23.13	7.52	0.727	0.465	6.16	0 @		3	17.5
61298	103000	23.28	7.53	0.724	0.463	6.03	0 @		3	17.5
61298	110000	23.61	7.54	0.709	0.454	6.17	0 @		3.1	17.5
61298	113000	23.59	7.52	0.686	0.439	6.4	0 @		3.3	17.5
61298	120000	23.42	7.5	0.681	0.436	6	0 @		3.3	17.5
61298	123000	23.52	7.52	0.728	0.466	5.63	0 @		3	17.5
61298	130000	23.72	7.49	0.701	0.449	5.84	0 @		3.1	17.5
61298	133000	23.94	7.55	0.681	0.436	6.5	0 @		3.2	17.5
61298	140000	24.49	7.52	0.673	0.431	6.24	0 @		3.1	17.5
61298	143000	24.41	7.52	0.662	0.424	6.13	0 @		3.1	17.5
61298	150000	24.6	7.52	0.652	0.417	6.07	0 @		3.1	17.5
61298	153000	24.84	7.48	0.659	0.422	5.99	0 @		3.2	17.5
61298	160000	24.9	7.54	0.643	0.411	6.24	0 @		3.2	17.5
61298	163000	24.88	7.52	0.656	0.42	6.08	0 @		3.1	17.5
61298	170000	24.88	7.61	0.663	0.424	6.54	0 @		3.3	17.4
61298	173000	24.93	7.59	0.662	0.423	6.1	0 @		3.3	17.5
61298	180000	23.51	7.5	0.733	0.469	5.85	0 @		3.1	17.6
61298	183000	23.8	7.49	0.705	0.451	5.78	0 @		3.1	17.4
61298	190000	23.55	7.45	0.678	0.434	5.41	0 @		3.4	17.4
61298	193000	23.93	7.52	0.715	0.457	5.58	0 @		3.4	17.5
61298	200000	23.91	7.61	0.704	0.451	7.08	0 @		4.1	17.5
61298	203000	22.79	7.42	0.715	0.457	6.07	0 @		2.7	17.5
61298	210000	23.64	7.57	0.734	0.47	6.35	0 @		3.8	17.5
61298	213000	23.85	7.61	0.774	0.495	6.05	0 @		3.6	17.5
61298	220000	23.84	7.59	0.783	0.501	6.46	0 @		2.9	17.5

Black River
Hydrolab Data
June 10, 1998 - June 13, 1998

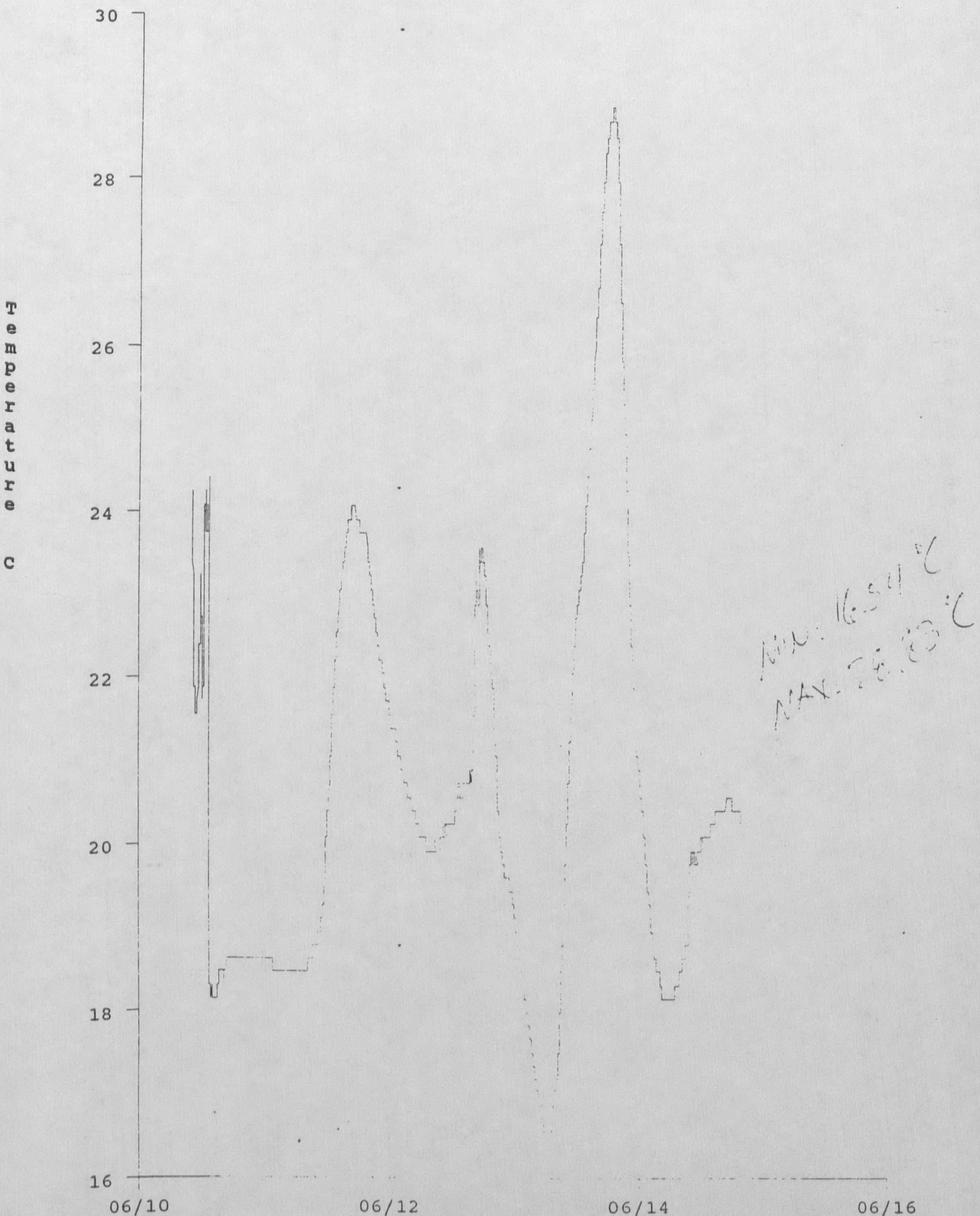
Date MMDDYY	Time HHMMSS	Temp degC	pH units	SpCond mS/cm	TDS Kmg/l	DO mg/l	Turb NTU	Depth feet	Batt volts
61298	223000	24.68	7.7	0.883	0.565	6.4	0 @	3	17.5
61298	230000	23.77	7.57	0.838	0.536	5.98	0 @	3	17.5
61298	233000	23.98	7.63	0.877	0.561	6	0 @	3.1	17.5
61398	0	24.33	7.73	0.925	0.592	6.38	0 @	3	17.5
61398	3000	23.95	7.63	0.914	0.585	5.98	0 @	3.1	17.4
61398	10000	23.88	7.65	0.92	0.589	6.51	0 @	2.8	17.4
61398	13000	23.84	7.62	0.917	0.587	6.45	0 @	3.1	17.4
61398	20000	23.49	7.68	0.93	0.595	6.37	0 @	2.6	17.4
61398	23000	23.4	7.61	0.907	0.58	6.13	0 @	2.9	17.4
61398	30000	23.39	7.61	0.924	0.591	5.96	0 @	3.3	17.4
61398	33000	23.3	7.61	0.924	0.591	6.16	0 @	2.9	17.4
61398	40000	23.14	7.59	0.923	0.591	6.08	0 @	2.6	17.4
61398	43000	23.03	7.61	0.921	0.59	6.17	0 @	3.4	17.4
61398	50000	23.31	7.62	0.896	0.573	6.23	0 @	2.7	17.4
61398	53000	22.97	7.57	0.903	0.578	6.08	0 @	3	17.4
61398	60000	22.97	7.58	0.891	0.571	5.86	0 @	3.2	17.4
61398	63000	22.86	7.57	0.876	0.561	5.88	0 @	3.1	17.4
61398	70000	22.87	7.56	0.883	0.565	6.28	0 @	3.2	17.4
61398	73000	22.8	7.57	0.882	0.564	5.96	0 @	3.3	17.4
61398	80000	22.55	7.53	0.872	0.558	5.85	0 @	2.9	17.4
61398	83000	22.91	7.6	0.873	0.559	6.22	0 @	3.6	17.4
61398	90000	22.83	7.59	0.874	0.559	6.12	0 @	3.4	17.4
61398	93000	22.93	7.61	0.873	0.559	6.48	0 @	3.1	17.4
61398	100000	23.04	7.62	0.871	0.557	6.25	0 @	3.4	17.4
61398	103000	23.06	7.6	0.869	0.556	6.66	0 @	3.4	17.4
61398	110000	22.98	7.67	0.881	0.564	7.15	0 @	3.2	17.4
61398	113000	22.97	7.67	0.889	0.569	7.07	0 @	3.2	17.4
61398	120000	23.13	7.67	0.893	0.572	6.74	0 @	3.3	17.4
61398	123000	23.22	7.66	0.889	0.569	6.63	0 @	3.4	17.4
61398	130000	19.16	7.85	0.007	0.0045	10.98	11.9 @	0.7	17.4
61398	133000	22.84	7.68	0.891	0.57	6.47	71.6 @	9.6	12.1
61398	140000	22.96	7.65	0.894	0.572	6.47	50.6 @	9.3	12.2
61398	143000	23.35	7.63	0.896	0.573	6.35	45.3 @	9	12.2
61398	150000	23.58	7.6	0.897	0.574	6.32	41.6 @	8.7	12.2
61398	153000	23.8	7.58	0.898	0.575	6.14	36.3 @	8.6	12.1
61398	160000	23.98	7.55	0.899	0.575	5.73	38.2 @	8.5	12.1
61398	163000	24.19	7.52	0.901	0.577	5.87	35.2 @	8.4	12.1
61398	170000	24.35	7.51	0.902	0.577	5.65	31.7 @	8.4	12.1
61398	173000	24.25	7.51	0.912	0.584	5.73	31.7 @	8.1	12.1

Black River
Hydrolab Data
June 10, 1998 - June 13, 1998

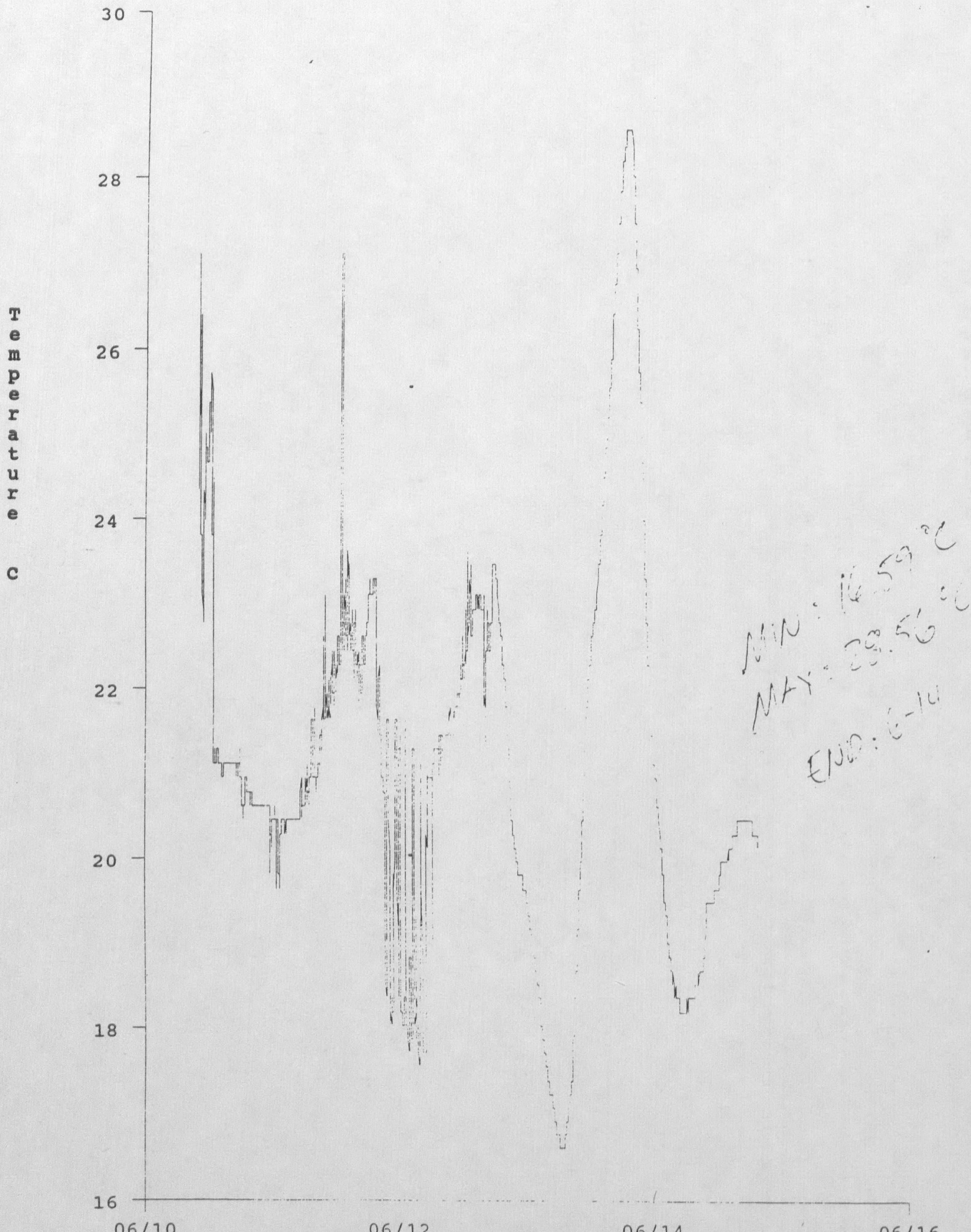
Date	Time	Temp	pH	SpCond	TDS	DO	Turb		Depth	Batt
MMDDYY	HHMMSS	degC	units	mS/cm	Kmg/l	mg/l	NTU		feet	volts
61398	180000	24.02	7.49	0.916	0.586	5.73	28.3 @		7.8	12.1

Recovery finished at 061698 120054

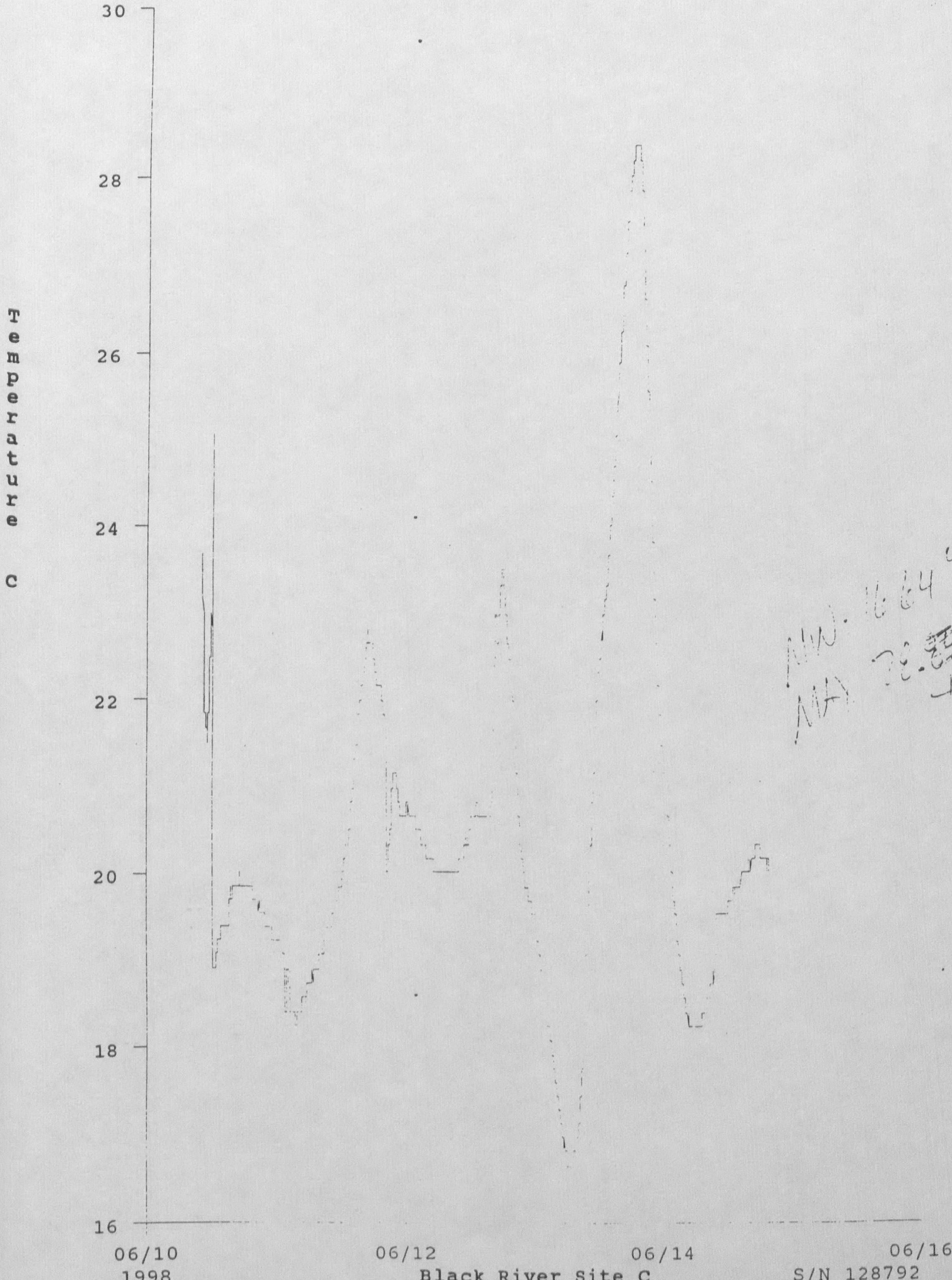
File: Blackhydr.xls
15-Jun-98



Black River Site A S/N 152995

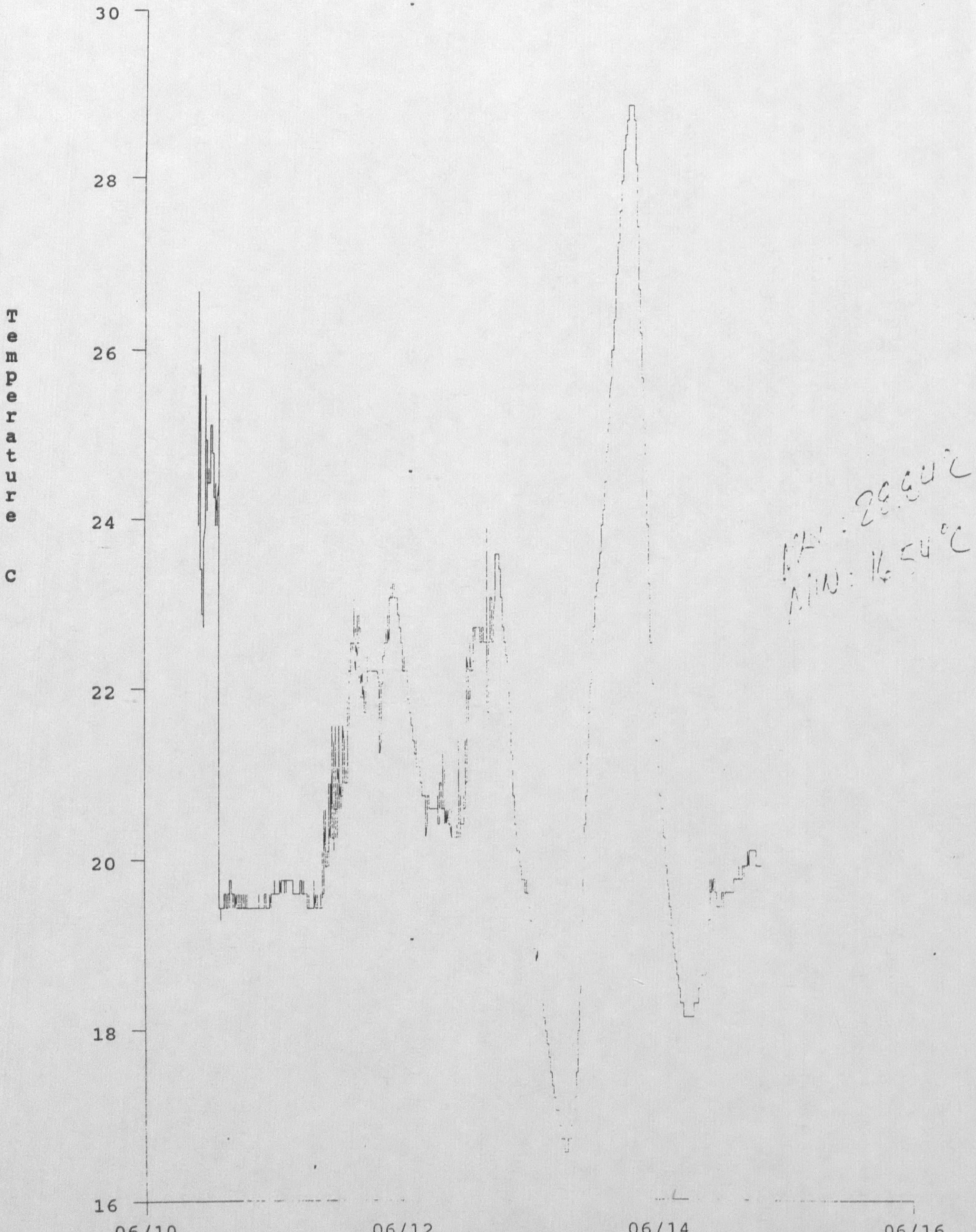


Black River Site B S/N 152993



Black River Site C S/N 128792

CASCADE



Black River Site D

S/N 128796

* Black River Snails 1 BO1 Filename1 is: a:\br1sb1.in
* Black River 1 Snails B02 Filename2 is: a:\br1sb02

	1	2	3	4	5	6	7	8	9	10	11	12
1	*	*	*	*	*	*	*	*	*	*	*	*
2	0.811594	*	*	*	*	*	*	*	*	*	*	*
3	0.8	0.777778	*	*	*	*	*	*	*	*	*	*
4	0.80597	0.837838	0.828572	*	*	*	*	*	*	*	*	*
5	0.75	0.886076	0.853333	0.883117	*	*	*	*	*	*	*	*
6	0.84058	0.921053	0.805556	0.864865	0.86076	*	*	*	*	*	*	*
7	0.787879	0.90411	0.782609	0.84507	0.842105	0.90411	*	*	*	*	*	*
8	0.77612	0.891892	0.828572	0.777778	0.883117	0.864865	0.816901	*	*	*	*	*
9	0.764706	0.853333	0.84507	0.849315	0.871795	0.853333	0.805556	0.849315	*	*	*	*
10	0.811594	0.894737	0.805556	0.837838	0.886076	0.894737	0.90411	0.864865	0.826667	*	*	*
11	0.77612	0.810811	0.8	0.861111	0.909091	0.783784	0.732394	0.805556	0.849315	0.783784	*	*
12	0.757576	0.821918	0.811594	0.816901	0.921053	0.767123	0.771429	0.816901	0.805556	0.876712	0.901408	*
13	0.741936	0.84058	0.738462	0.77612	0.805556	0.84058	0.818182	0.835821	0.82353	0.782609	0.77612	0.757576
14	0.794118	0.853333	0.816901	0.794521	0.923077	0.826667	0.805556	0.876712	0.783784	0.853333	0.876712	0.888889
15	0.774194	0.782609	0.769231	0.835821	0.833333	0.753623	0.757576	0.80597	0.764706	0.782609	0.865672	0.848485
16	0.8125	0.816901	0.746269	0.811594	0.810811	0.84507	0.852941	0.782609	0.8	0.873239	0.84058	0.82353
17	0.8125	0.816901	0.77612	0.84058	0.783784	0.84507	0.82353	0.782609	0.8	0.84507	0.782609	0.794118
18	0.721312	0.764706	0.8125	0.848485	0.816901	0.82353	0.830769	0.787879	0.77612	0.82353	0.727273	0.769231
19	0.818182	0.821918	0.84058	0.816901	0.868421	0.821918	0.8	0.816901	0.777778	0.876712	0.816901	0.885714
20	0.738462	0.833333	0.82353	0.857143	0.906667	0.777778	0.84058	0.8	0.816901	0.805556	0.857143	0.869565
21	0.818182	0.821918	0.869565	0.929578	0.842105	0.849315	0.828572	0.760563	0.833333	0.821918	0.84507	0.828572
22	0.818182	0.821918	0.811594	0.873239	0.868421	0.849315	0.885714	0.788733	0.805556	0.849315	0.816901	0.828572
23	0.857143	0.831169	0.876712	0.88	0.9	0.857143	0.837838	0.853333	0.81579	0.883117	0.853333	0.837838
24	0.769231	0.833333	0.735294	0.885714	0.853333	0.833333	0.84058	0.771429	0.788733	0.861111	0.771429	0.811594

AVERAGE 0.821374
STD DEV: 0.04318

13	14	15	16	17	18	19	20	21	22	23	24
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
0.735294	*	*	*	*	*	*	*	*	*	*	*
0.709677	0.794118	*	*	*	*	*	*	*	*	*	*
0.84375	0.828572	0.78125	*	*	*	*	*	*	*	*	*
0.78125	0.771429	0.71875	0.818182	*	*	*	*	*	*	*	*
0.819672	0.77612	0.754098	0.825397	0.793651	*	*	*	*	*	*	*
0.787879	0.833333	0.757576	0.764706	0.852941	0.8	*	*	*	*	*	*
0.861539	0.816901	0.830769	0.80597	0.716418	0.8125	0.811594	*	*	*	*	*
0.757576	0.777778	0.818182	0.82353	0.882353	0.8	0.828572	0.84058	*	*	*	*
0.787879	0.833333	0.787879	0.82353	0.794118	0.769231	0.8	0.898551	0.857143	*	*	*
0.742857	0.894737	0.8	0.805556	0.861111	0.782609	0.891892	0.821918	0.864865	0.891892	*	*
0.769231	0.788733	0.8	0.80597	0.80597	0.84375	0.84058	0.82353	0.84058	0.84058	0.849315	*

*	Black	River	Snails		2 BO1	Filename1 is:		a:\br2sb1.in				
*	Black	River		2 Snails	B02	Filename2 is:		a:\br2sb02				
	1	2	3	4	5	6	7	8	9	10	11	12
1	*	*	*	*	*	*	*	*	*	*	*	*
2	0.78125	*	*	*	*	*	*	*	*	*	*	*
3	0.806452	0.78125	*	*	*	*	*	*	*	*	*	*
4	0.806452	0.8125	0.806452	*	*	*	*	*	*	*	*	*
5	0.793651	0.830769	0.857143	0.793651	*	*	*	*	*	*	*	*
6	0.852459	0.730159	0.819672	0.754098	0.806452	*	*	*	*	*	*	*
7	0.724138	0.766667	0.689655	0.793104	0.813559	0.736842	*	*	*	*	*	*
8	0.875	0.787879	0.8125	0.84375	0.830769	0.888889	0.8	*	*	*	*	*
9	0.761905	0.830769	0.761905	0.730159	0.8125	0.83871	0.779661	0.830769	*	*	*	*
10	0.852941	0.857143	0.82353	0.794118	0.84058	0.865672	0.84375	0.857143	0.898551	*	*	*
11	0.793651	0.738462	0.825397	0.857143	0.84375	0.774194	0.813559	0.830769	0.78125	0.84058	*	*
12	0.779661	0.754098	0.813559	0.745763	0.9	0.793104	0.8	0.819672	0.8	0.8	0.8	*
13	0.875	0.818182	0.8125	0.8125	0.8	0.793651	0.766667	0.818182	0.830769	0.914286	0.830769	0.786885
14	0.818182	0.852941	0.818182	0.818182	0.865672	0.769231	0.774194	0.794118	0.835821	0.888889	0.835821	0.793651
15	0.83871	0.78125	0.83871	0.806452	0.825397	0.852459	0.793104	0.875	0.825397	0.882353	0.857143	0.813559
16	0.870968	0.78125	0.903226	0.83871	0.857143	0.885246	0.758621	0.875	0.793651	0.852941	0.857143	0.847458
17	0.78125	0.848485	0.78125	0.875	0.8	0.793651	0.733333	0.818182	0.8	0.828572	0.8	0.721312
18	0.733333	0.741936	0.8	0.733333	0.786885	0.779661	0.714286	0.806452	0.819672	0.818182	0.721312	0.842105
19	0.766667	0.741936	0.733333	0.8	0.786885	0.779661	0.821429	0.870968	0.819672	0.848485	0.754098	0.736842
20	0.793651	0.830769	0.793651	0.825397	0.78125	0.806452	0.847458	0.8	0.84375	0.927536	0.84375	0.8
21	0.84375	0.787879	0.8125	0.84375	0.8	0.825397	0.766667	0.818182	0.830769	0.885714	0.892308	0.754098
22	0.8	0.774194	0.8	0.866667	0.786885	0.779661	0.75	0.806452	0.754098	0.787879	0.852459	0.77193
23	0.8	0.80597	0.8	0.830769	0.818182	0.84375	0.852459	0.835821	0.909091	0.901408	0.848485	0.806452
24	0.774194	0.84375	0.709677	0.806452	0.857143	0.754098	0.793104	0.78125	0.793651	0.852941	0.825397	0.745763

AVERAGE: 0.809982
STDDEV: 0.045179

13	14	15	16	17	18	19	20	21	22	23	24
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
0.852941	*	*	*	*	*	*	*	*	*	*	*
0.84375	0.848485	*	*	*	*	*	*	*	*	*	*
0.8125	0.818182	0.870968	*	*	*	*	*	*	*	*	*
0.818182	0.82353	0.78125	0.8125	*	*	*	*	*	*	*	*
0.741936	0.78125	0.8	0.833333	0.741936	*	*	*	*	*	*	*
0.806452	0.78125	0.766667	0.766667	0.741936	0.827586	*	*	*	*	*	*
0.923077	0.835821	0.888889	0.793651	0.830769	0.754098	0.786885	*	*	*	*	*
0.878788	0.882353	0.90625	0.84375	0.848485	0.741936	0.774194	0.892308	*	*	*	*
0.774194	0.8125	0.733333	0.833333	0.774194	0.689655	0.724138	0.754098	0.806452	*	*	*
0.80597	0.84058	0.8	0.830769	0.835821	0.825397	0.825397	0.848485	0.835821	0.825397	*	*
0.8125	0.848485	0.741936	0.774194	0.78125	0.666667	0.766667	0.761905	0.8125	0.833333	0.8	*

* Black River Snails 3 BO1 Filename1 is: a:\br3sb1.in
* Black River 3 Snails B02 Filename2 is: a:\br3sb02

	1	2	3	4	5	6	7	8	9	10	11	12
1	*	*	*	*	*	*	*	*	*	*	*	*
2	0.821429	*	*	*	*	*	*	*	*	*	*	*
3	0.819672	0.754098	*	*	*	*	*	*	*	*	*	*
4	0.813559	0.813559	0.84375	*	*	*	*	*	*	*	*	*
5	0.84375	0.875	0.811594	0.865672	*	*	*	*	*	*	*	*
6	0.83871	0.83871	0.80597	0.861539	0.942857	*	*	*	*	*	*	*
7	0.786885	0.786885	0.848485	0.875	0.869565	0.865672	*	*	*	*	*	*
8	0.862069	0.931035	0.761905	0.819672	0.909091	0.90625	0.793651	*	*	*	*	*
9	0.857143	0.888889	0.852941	0.848485	0.901408	0.898551	0.852941	0.923077	*	*	*	*
10	0.857143	0.888889	0.852941	0.848485	0.929578	0.927536	0.82353	0.923077	0.971429	*	*	*
11	0.833333	0.8	0.830769	0.857143	0.882353	0.878788	0.830769	0.83871	0.895522	0.925373	*	*
12	0.857143	0.857143	0.82353	0.878788	0.957747	0.898551	0.911765	0.892308	0.914286	0.885714	0.865672	*
13	0.745763	0.813559	0.78125	0.806452	0.865672	0.830769	0.875	0.819672	0.848485	0.818182	0.761905	0.878788
14	0.847458	0.745763	0.84375	0.741936	0.835821	0.8	0.75	0.786885	0.818182	0.848485	0.825397	0.787879
15	0.8	0.8	0.861539	0.793651	0.82353	0.818182	0.830769	0.774194	0.80597	0.80597	0.75	0.80597
16	0.852459	0.885246	0.787879	0.84375	0.927536	0.865672	0.878788	0.888889	0.882353	0.852941	0.830769	0.970588
17	0.870968	0.870968	0.80597	0.861539	0.942857	0.941177	0.835821	0.9375	0.898551	0.927536	0.878788	0.898551
18	0.813559	0.915254	0.78125	0.806452	0.895522	0.861539	0.78125	0.885246	0.909091	0.909091	0.857143	0.878788
19	0.774194	0.83871	0.77612	0.830769	0.942857	0.911765	0.835821	0.84375	0.869565	0.898551	0.848485	0.898551
20	0.807018	0.736842	0.806452	0.833333	0.830769	0.793651	0.806452	0.779661	0.8125	0.8125	0.786885	0.84375
21	0.866667	0.8	0.830769	0.888889	0.882353	0.909091	0.861539	0.83871	0.865672	0.865672	0.84375	0.895522
22	0.885246	0.819672	0.848485	0.90625	0.898551	0.865672	0.878788	0.857143	0.882353	0.882353	0.892308	0.911765
23	0.885246	0.852459	0.848485	0.875	0.898551	0.925373	0.848485	0.920635	0.941177	0.941177	0.923077	0.911765
24	0.857143	0.825397	0.82353	0.909091	0.929578	0.898551	0.911765	0.861539	0.885714	0.885714	0.895522	0.942857

AVERAGE: 0.852932
STD DEV: 0.048412

13	14	15	16	17	18	19	20	21	22	23	24
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
0.741936	*	*	*	*	*	*	*	*	*	*	*
0.857143	0.793651	*	*	*	*	*	*	*	*	*	*
0.84375	0.75	0.830769	*	*	*	*	*	*	*	*	*
0.830769	0.8	0.848485	0.895522	*	*	*	*	*	*	*	*
0.83871	0.806452	0.793651	0.875	0.861539	*	*	*	*	*	*	*
0.830769	0.8	0.818182	0.895522	0.882353	0.892308	*	*	*	*	*	*
0.8	0.833333	0.786885	0.806452	0.793651	0.833333	0.825397	*	*	*	*	*
0.793651	0.825397	0.8125	0.861539	0.848485	0.825397	0.848485	0.885246	*	*	*	*
0.84375	0.8125	0.830769	0.878788	0.895522	0.84375	0.835821	0.83871	0.892308	*	*	*
0.8125	0.8125	0.769231	0.878788	0.925373	0.90625	0.865672	0.83871	0.892308	0.909091	*	*
0.848485	0.787879	0.80597	0.911765	0.898551	0.848485	0.869565	0.8125	0.895522	0.970588	0.911765	*

*	Black	River	Snails		4	BO1	Filename1 is:		a:\br4sb1.in			
*	Black	River		4	Snails	B02	Filename2 is:		a:\br4sb02			
	1	2	3	4	5	6	7	8	9	10	11	12
1	*	*	*	*	*	*	*	*	*	*	*	*
2	0.869565	*	*	*	*	*	*	*	*	*	*	*
3	0.918919	0.876712	*	*	*	*	*	*	*	*	*	*
4	0.898551	0.852941	0.90411	*	*	*	*	*	*	*	*	*
5	0.852941	0.865672	0.888889	0.835821	*	*	*	*	*	*	*	*
6	0.830769	0.78125	0.869565	0.8125	0.793651	*	*	*	*	*	*	*
7	0.895522	0.848485	0.873239	0.878788	0.923077	0.774194	*	*	*	*	*	*
8	0.888889	0.873239	0.921053	0.901408	0.828572	0.835821	0.84058	*	*	*	*	*
9	0.888889	0.929578	0.921053	0.901408	0.857143	0.835821	0.869565	0.918919	*	*	*	*
10	0.852941	0.835821	0.861111	0.835821	0.818182	0.793651	0.830769	0.828572	0.885714	*	*	*
11	0.911765	0.895522	0.888889	0.865672	0.848485	0.793651	0.861539	0.828572	0.885714	0.848485	*	*
12	0.911765	0.835821	0.916667	0.865672	0.848485	0.857143	0.892308	0.885714	0.885714	0.848485	0.848485	*
13	0.818182	0.830769	0.828572	0.8	0.75	0.786885	0.793651	0.882353	0.852941	0.8125	0.78125	0.78125
14	0.927536	0.882353	0.90411	0.911765	0.895522	0.8125	0.909091	0.84507	0.901408	0.835821	0.925373	0.895522
15	0.931507	0.916667	0.961039	0.916667	0.901408	0.852941	0.914286	0.906667	0.96	0.901408	0.929578	0.929578
16	0.929578	0.885714	0.933333	0.942857	0.84058	0.848485	0.882353	0.90411	0.931507	0.84058	0.898551	0.869565
17	0.873239	0.914286	0.906667	0.828572	0.927536	0.787879	0.882353	0.876712	0.931507	0.84058	0.869565	0.869565
18	0.898551	0.852941	0.90411	0.882353	0.925373	0.84375	0.939394	0.84507	0.901408	0.895522	0.865672	0.925373
19	0.916667	0.873239	0.921053	0.873239	0.885714	0.80597	0.898551	0.891892	0.918919	0.885714	0.885714	0.885714
20	0.916667	0.84507	0.947368	0.873239	0.857143	0.895522	0.84058	0.918919	0.891892	0.885714	0.857143	0.885714
21	0.927536	0.882353	0.90411	0.882353	0.865672	0.84375	0.848485	0.873239	0.873239	0.865672	0.895522	0.865672
22	0.931507	0.861111	0.961039	0.888889	0.873239	0.882353	0.857143	0.906667	0.906667	0.873239	0.901408	0.901408
23	0.927536	0.911765	0.90411	0.911765	0.865672	0.84375	0.878788	0.873239	0.929578	0.865672	0.925373	0.865672
24	0.916667	0.901408	0.947368	0.929578	0.857143	0.865672	0.869565	0.918919	0.945946	0.857143	0.885714	0.885714

AVERAGE: 0.882287

STD DEV: 0.041573

13	14	15	16	17	18	19	20	21	22	23	24
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
0.769231	*	*	*	*	*	*	*	*	*	*	*
0.84058	0.944444	*	*	*	*	*	*	*	*	*	*
0.865672	0.914286	0.945946	*	*	*	*	*	*	*	*	*
0.77612	0.914286	0.918919	0.861111	*	*	*	*	*	*	*	*
0.8	0.911765	0.944444	0.885714	0.885714	*	*	*	*	*	*	*
0.82353	0.901408	0.933333	0.90411	0.90411	0.929578	*	*	*	*	*	*
0.852941	0.873239	0.933333	0.90411	0.876712	0.901408	0.918919	*	*	*	*	*
0.830769	0.882353	0.916667	0.885714	0.857143	0.911765	0.873239	0.929578	*	*	*	*
0.811594	0.888889	0.947368	0.918919	0.891892	0.916667	0.933333	0.96	0.916667	*	*	*
0.830769	0.941177	0.944444	0.942857	0.885714	0.882353	0.901408	0.901408	0.882353	0.888889	*	*
0.882353	0.901408	0.96	0.986301	0.876712	0.901408	0.891892	0.918919	0.901408	0.933333	0.929578	*

* Black River Snails 5 BO1 Filename1 is: a:\br5sb1.in

* Black River 5 Snails B02 Filename2 is: a:\br5sb02

	1	2	3	4	5	6	7	8	9	10	11	12
1	*	*	*	*	*	*	*	*	*	*	*	*
2	0.766667	*	*	*	*	*	*	*	*	*	*	*
3	0.774194	0.709677	*	*	*	*	*	*	*	*	*	*
4	0.80597	0.80597	0.84058	*	*	*	*	*	*	*	*	*
5	0.818182	0.818182	0.794118	0.958904	*	*	*	*	*	*	*	*
6	0.870968	0.709677	0.84375	0.84058	0.82353	*	*	*	*	*	*	*
7	0.84375	0.78125	0.818182	0.873239	0.828572	0.878788	*	*	*	*	*	*
8	0.8125	0.8125	0.818182	0.84507	0.857143	0.909091	0.82353	*	*	*	*	*
9	0.766667	0.833333	0.806452	0.835821	0.818182	0.774194	0.8125	0.8125	*	*	*	*
10	0.78125	0.8125	0.848485	0.84507	0.828572	0.848485	0.852941	0.882353	0.84375	*	*	*
11	0.870968	0.774194	0.8125	0.869565	0.882353	0.84375	0.848485	0.818182	0.83871	0.878788	*	*
12	0.80597	0.80597	0.84058	0.918919	0.90411	0.869565	0.873239	0.901408	0.80597	0.84507	0.84058	*
13	0.724138	0.689655	0.7	0.8	0.8125	0.733333	0.741936	0.774194	0.793104	0.741936	0.766667	0.830769
14	0.819672	0.754098	0.825397	0.82353	0.80597	0.825397	0.769231	0.861539	0.819672	0.769231	0.793651	0.852941
15	0.882353	0.794118	0.828572	0.933333	0.945946	0.885714	0.861111	0.916667	0.82353	0.861111	0.885714	0.906667
16	0.819672	0.754098	0.825397	0.852941	0.835821	0.888889	0.830769	0.861539	0.786885	0.8	0.857143	0.882353
17	0.761905	0.793651	0.8	0.828572	0.811594	0.830769	0.835821	0.865672	0.793651	0.835821	0.738462	0.885714
18	0.785714	0.75	0.758621	0.730159	0.774194	0.793104	0.733333	0.833333	0.75	0.733333	0.758621	0.793651
19	0.835821	0.77612	0.84058	0.945946	0.90411	0.898551	0.873239	0.901408	0.80597	0.84507	0.84058	0.918919
20	0.835821	0.80597	0.869565	0.918919	0.90411	0.84058	0.84507	0.84507	0.80597	0.84507	0.869565	0.891892
21	0.84375	0.78125	0.818182	0.873239	0.857143	0.848485	0.882353	0.82353	0.78125	0.852941	0.878788	0.873239
22	0.774194	0.741936	0.75	0.84058	0.82353	0.78125	0.818182	0.818182	0.709677	0.818182	0.78125	0.84058
23	0.875	0.84375	0.757576	0.84507	0.857143	0.878788	0.852941	0.882353	0.8125	0.852941	0.848485	0.873239
24	0.714286	0.642857	0.62069	0.730159	0.709677	0.689655	0.766667	0.7	0.678571	0.7	0.724138	0.761905

AVERAGE: 0.815118

STD DEV: 0.061385

13	14	15	16	17	18	19	20	21	22	23	24
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
0.745763	*	*	*	*	*	*	*	*	*	*	*
0.848485	0.869565	*	*	*	*	*	*	*	*	*	*
0.813559	0.83871	0.869565	*	*	*	*	*	*	*	*	*
0.786885	0.8125	0.84507	0.78125	*	*	*	*	*	*	*	*
0.740741	0.807018	0.78125	0.842105	0.779661	*	*	*	*	*	*	*
0.8	0.882353	0.96	0.852941	0.857143	0.730159	*	*	*	*	*	*
0.769231	0.852941	0.933333	0.82353	0.828572	0.730159	0.918919	*	*	*	*	*
0.709677	0.769231	0.861111	0.8	0.77612	0.733333	0.84507	0.873239	*	*	*	*
0.7	0.730159	0.857143	0.761905	0.769231	0.689655	0.84058	0.811594	0.909091	*	*	*
0.83871	0.8	0.916667	0.861539	0.835821	0.8	0.873239	0.84507	0.852941	0.818182	*	*
0.666667	0.666667	0.75	0.736842	0.644068	0.653846	0.730159	0.698413	0.766667	0.758621	0.766667	*

*	Black	River	Snails		6 BO1	Filename1 is:		a:\br6sb1.in				
*	Black	River		6 Snails	B02	Filename2 is:		a:\br6sb02				
	1	2	3	4	5	6	7	8	9	10	11	12
1	*	*	*	*	*	*	*	*	*	*	*	
2	0.861539	*	*	*	*	*	*	*	*	*	*	
3	0.8	0.911765	*	*	*	*	*	*	*	*	*	
4	0.806452	0.830769	0.830769	*	*	*	*	*	*	*	*	
5	0.761905	0.818182	0.848485	0.761905	*	*	*	*	*	*	*	
6	0.825397	0.848485	0.848485	0.888889	0.875	*	*	*	*	*	*	
7	0.819672	0.8125	0.75	0.819672	0.774194	0.774194	*	*	*	*	*	
8	0.8	0.911765	0.852941	0.8	0.787879	0.787879	0.84375	*	*	*	*	
9	0.741936	0.8	0.769231	0.709677	0.761905	0.730159	0.786885	0.830769	*	*	*	
10	0.83871	0.830769	0.830769	0.83871	0.825397	0.793651	0.754098	0.8	0.774194	*	*	
11	0.865672	0.885714	0.885714	0.865672	0.82353	0.882353	0.818182	0.885714	0.80597	0.865672	*	
12	0.786885	0.84375	0.84375	0.885246	0.774194	0.870968	0.766667	0.78125	0.754098	0.852459	0.909091	*
13	0.830769	0.882353	0.82353	0.769231	0.818182	0.787879	0.84375	0.911765	0.861539	0.830769	0.914286	0.8125
14	0.825397	0.818182	0.787879	0.793651	0.90625	0.84375	0.83871	0.787879	0.761905	0.793651	0.82353	0.806452
15	0.833333	0.857143	0.761905	0.8	0.754098	0.819672	0.813559	0.825397	0.8	0.733333	0.861539	0.847458
16	0.835821	0.914286	0.885714	0.835821	0.852941	0.882353	0.818182	0.885714	0.80597	0.80597	0.861111	0.757576
17	0.825397	0.848485	0.818182	0.825397	0.78125	0.84375	0.774194	0.818182	0.825397	0.761905	0.852941	0.806452
18	0.818182	0.869565	0.869565	0.818182	0.895522	0.865672	0.8	0.869565	0.848485	0.848485	0.901408	0.8
19	0.769231	0.82353	0.82353	0.8	0.818182	0.818182	0.75	0.82353	0.830769	0.8	0.885714	0.8125
20	0.865672	0.885714	0.885714	0.925373	0.82353	0.882353	0.818182	0.857143	0.77612	0.895522	0.944444	0.909091
21	0.761905	0.818182	0.818182	0.793651	0.84375	0.84375	0.774194	0.818182	0.825397	0.793651	0.882353	0.83871
22	0.8125	0.865672	0.835821	0.84375	0.830769	0.830769	0.761905	0.835821	0.78125	0.875	0.84058	0.825397
23	0.875	0.835821	0.77612	0.84375	0.861539	0.830769	0.825397	0.80597	0.78125	0.90625	0.84058	0.793651
24	0.769231	0.852941	0.852941	0.892308	0.878788	0.848485	0.875	0.882353	0.8	0.830769	0.885714	0.8125

AVERAGE:		0.831119
STD DEV:		0.042241

13	14	15	16	17	18	19	20	21	22	23	24
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*
0.787879	*	*	*	*	*	*	*	*	*	*	*
0.888889	0.786885	*	*	*	*	*	*	*	*	*	*
0.857143	0.82353	0.8	*	*	*	*	*	*	*	*	*
0.818182	0.75	0.819672	0.82353	*	*	*	*	*	*	*	*
0.898551	0.80597	0.8125	0.873239	0.865672	*	*	*	*	*	*	*
0.852941	0.818182	0.793651	0.857143	0.878788	0.811594	*	*	*	*	*	*
0.857143	0.852941	0.830769	0.861111	0.82353	0.901408	0.828572	*	*	*	*	*
0.909091	0.78125	0.852459	0.852941	0.8125	0.835821	0.878788	0.82353	*	*	*	*
0.835821	0.861539	0.806452	0.898551	0.8	0.794118	0.865672	0.869565	0.861539	*	*	*
0.835821	0.892308	0.774194	0.84058	0.8	0.852941	0.80597	0.869565	0.8	0.878788	*	*
0.882353	0.818182	0.793651	0.857143	0.848485	0.927536	0.82353	0.885714	0.848485	0.80597	0.865672	*