

***Flint Creek Power Plant
Impingement Monitoring Data Report
Benton County, Arkansas***



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**FLINT CREEK POWER PLANT
IMPINGEMENT MONITORING DATA REPORT
BENTON COUNTY, ARKANSAS**

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Executive Summary

Flint Creek Power Plant is an American Electric Power facility located on SWEPCO Lake in Benton County in northwest Arkansas. Fish impinged on the facility's intake screens were sampled by PBS&J biologists on 26 dates from November 8, 2005, to October 24, 2006. Water temperature, pH, conductivity and dissolved oxygen levels were measured when impingement samples were collected.

Over 20,000 fish were collected in impingement samples and approximately 98% of those were threadfin shad. Bluegill was the second most numerous (2%) fish. More than 96% of the fish were collected on one day, April 22, 2006, suggesting that impingement tended to be episodic rather than occurring evenly over time. All threadfin shad were dead upon collection and over 90% of the specimens of other species were dead upon collection. An impingement rate of largemouth bass was low and generally restricted to Age-0 individuals that were collected in the spring and early summer. State and federally listed threatened, endangered, or species of concern are not known to exist in SWEPCO Lake, nor were any collected in impingement samples.

A wide range of facility and environmental variables were analyzed with observed impingement and there were no statistically significant relationships found. Impingement was highest in the spring, primarily due to the high impingement on April 22. There was also diurnal variation in impingement with fish impinging at a higher rate during the night and early morning hours than during the day.

The large number of threadfin shad impinged on April 22, 2006, did not appear to be related to any unusual facility or environmental changes. All of the threadfin shad impinged on this date appeared to be Age-0 fish that were spawned during warm weather in late winter or early spring. After April 22, 2006, normal cooling-water flow was discontinued for facility maintenance. Large numbers of threadfin shad were not collected after the facility resumed operations in late June 2006.

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
μS/cm	microSiemens (unit of conductance equal to the reciprocal of an ohm) (1 mho is equal to 1 Siemens)
ac	acres
ac-ft	acre-feet
ADEQ	Arkansas Department of Environmental Quality
AEP	American Electric Power
AGFC	Arkansas Game and Fish Commission
CDS	Comprehensive Demonstration Study
CFR	Code of Federal Regulations
cm	centimeters
CPUE	Number and Catch Rate
CW	circulating water
CWIS	Cooling Water Intake Structure
DO	Dissolved Oxygen
EPA	U.S. Environmental Protection Agency
FCPP	Flint Creek Power Plant
ft	feet/foot
ft/s	feet per second
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gpm	gallons per minute
ha	hectares
I&E	Impingement Mortality and Entrainment
in	inch(es)
km	kilometer(s)
m	meters
m/s	meter/second
m ³ /min	cubic meters per minute
mg	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
mm	millimeter(s)
msl	mean sea level
NOAA	National Oceanic and Atmospheric Administration
pH	degree of acidity or alkalinity (0 to 14 scale) (in standard units [s.u.]
PIC	Proposal for Information Collection
PSD	Proportional Stock Density
QA/QC	quality assurance/quality control
RSD16	Relative Stock Density 16
Wr	relative weight

FLINT CREEK POWER PLANT IMPINGEMENT MONITORING DATA REPORT

BACKGROUND

The new Clean Water Act Section 316 (b), Phase II requirements regulate impingement mortality and entrainment of aquatic life at power-generating facilities that withdraw from waters of the U.S. for cooling purposes. These requirements were implemented in 2004 by the U.S. Environmental Protection Agency (EPA) and regulate existing facilities that withdraw more than 50 million gallons of water per day (mgd).

Flint Creek Power Plant (FCPP) withdraws cooling water from SWEPCO Lake (also known as Flint Creek Reservoir and is an existing facility that meets all the criteria for regulation under the Phase II rule [40 CFR 125.91(a), (b), (c), and (d)]. Because FCPP is located on a reservoir, it is subject to the impingement mortality standard only [40 CFR 125.94(b)]. The impingement mortality reduction standard requires facilities to reduce impingement mortality between 80% and 95% from the calculation baseline (40 CFR 125.93). Calculation baselines can be determined from historic data or from data gathered by conducting an Impingement Mortality and/or Entrainment Characterization Study [40 CFR 125.95(b)(3)]. Historic impingement mortality data are not available for FCPP; therefore, PBS&J was retained by American Electric Power (AEP) to conduct an impingement mortality characterization study.

This study was performed in accordance with the Proposal for Information Collection (PIC) prepared and submitted by AEP to Arkansas Department of Environmental Quality (ADEQ). The PIC was accepted with minor revisions requested by ADEQ. As described in the PIC, this study was conducted over the course of a year from November 8, 2005, through October 24, 2006. Data obtained from this study are presented in this report. Selected facility descriptions, study methods and Quality Assurance are also presented in this report and are covered in detail in the facility PIC and the Operator's Procedures (Appendix A).

Analysis of observed impingement and facility operations and environmental variables are also presented. Estimates of annual impingement mortality in relation to predicted facility operations and important variables will be provided in the Comprehensive Demonstration Study (CDS).

FACILITY DESCRIPTION

A detailed description of FCPP, source water physical data, cooling water intake structure (CWIS), cooling-water system, and site plans are provided in the facility PIC (AEP, 2005). FCPP is a base-loaded, coal-fired facility consisting of one generating unit that is rated at 528 gross megawatts. The facility is located 4 miles north of Siloam Springs in Benton County, Arkansas. FCPP is located on SWEPCO Lake, which is an impoundment of Flint Creek and various tributaries (Figure 1). The facility has a single

CWIS, which is located on the northern shore of the southern arm of SWEPCO Lake (Figure 2). Cooling water is withdrawn through trash racks that protect the screens from large debris.

The facility has three circulating-water (CW) pumps, each with a design capacity of 101,000 gallons per minute (gpm) (382 cubic meters per minute [m^3/min]), totaling approximately 432 million gallons per day (mgd) ($1,140 \text{ m}^3/\text{min}$). Each circulator is served by a single traveling-water screen (screen) with 3/8-inch (in) square steel mesh. Calculated maximum through-screen velocities (velocity) at low lake elevation (1,116.0 feet [ft] above mean sea level [msl]) (340 meters [m] above msl) for each of the screens are estimated at 2.39 feet/second (ft/s) (0.73 m/s).

The CW pumps are operated continuously, but the number of CW pumps in service can change with season. The 5-year mean (± 1 standard deviation) cooling water withdrawal rate (flow) is shown on Figure 3. Under normal operating conditions, the screens remain stationary, but are rotated and washed once per eight hour shift for approximately 20 minutes (1 hour per day throughout the year) to remove accumulated debris. Screen wash water from the unit is transported through a sluice, then to a debris sump, and then into the cooling-water outfall, which is on the western shore of the central arm of the reservoir (see Figure 2).

RESERVOIR CHARACTERIZATION

SWEPCO Lake is located on Flint Creek in Benton County in northwest Arkansas, approximately 4 miles (mi) (6.4 kilometers [km]) north of Siloam Springs. Little Flint Creek flows into SWEPCO Lake with additional flow (make-up water) from the Lake Siloam Springs. SWEPCO Lake has a normal pool elevation of 1,140 ft (347 m) above msl with a storage capacity of 18,300 acre-ft (2,260 hectare-m [ha-m]) and a surface area of approximately 530 acres (214 ha).

Since SWEPCO Lake is used as a cooling pond, water temperature ranges from 65°F (18.3°C) to 105°F (40.6°C) at the facility intake. These warm temperatures result favorable growing conditions for a variety of warm-water species. As a result, SWEPCO Lake is managed as a trophy fish reservoir and is well known for trophy-sized largemouth bass (Arkansas Game and Fish Commission [AGFC], 2000).

FISHERIES RESOURCES

To supplement the baseline characterization of the lake's fishery, fisheries data were acquired through AGFC (2006a). Data obtained from AGFC includes nighttime annual electrofishing survey results from the past 7 years (2000–2006). These surveys were normally conducted in March or April with one survey conducted in January. These data include number and catch per unit effort (CPUE) by size class for largemouth bass (*Micropterus salmoides*). However, data from other species were not recorded.

AGFC employs the use of shoreline boat electrofishing at fixed stations throughout the reservoir. The number of stations sampled per trip ranged from 1 to 4. According to these data, largemouth bass CPUE

(number collected/hour of electrofishing) ranged from 95 in 2001 to 259 in 2006 with a mean CPUE of 166 over the 7-year period (Figure 4).

Other species such as gizzard shad (*Dorosoma cepedianum*), threadfin shad (*D. petenense*), channel catfish (*Ictalurus punctatus*), green sunfish (*Lepomis cyanellus*), warmouth (*L. gulosus*), bluegill (*L. macrochirus*), and redear sunfish (*L. microlophus*) are known to exist in the lake through impingement monitoring. There are no known federally or state-listed threatened or endangered fish species in SWEPCO Lake.

According to AGFC (AGFC, 2006b), the lake did not have any special harvest restrictions other than the statewide creel limit of ten fish until 1993. In order to increase trophy potential, a trophy slot limit was implemented in 1993, prohibiting harvest of largemouth bass between 16 and 21 in (406 and 533 mm) in length while reducing the creel limit to four. In 1997, electrofished largemouth CPUE declined from >200 fish per hour to 30 fish per hour (AGFC, 2006a). A severe winter in conjunction with no discharge from FCPP (due to repairs) caused a severe decrease in water temperature and a subsequent die-off of threadfin shad occurred (AGFC, 2006b). The die-off of threadfin shad limited the primary forage fish for largemouth bass and caused a decline in the population (AGFC, 2006b). Due to the decline in the largemouth bass population, a catch and release regulation was implemented in 1999. While electrofishing catch rates for largemouth bass increased since the implementation of the catch-and-release regulation, the quality of the relative weight (Wr) of the population has declined in recent years. Wr is a measure of body condition where values lower than 100 indicate lean fish. The Wr of largemouth bass sampled in 2005 was 91 while the mean Wr of largemouth bass sampled in 2006 was 83 (Figure 4). This was the lowest mean Wr observed in the past 7 years (Figure 5).

Proportional Stock Density (PSD) and Relative Stock Density 16 (RSD16) were metrics used to evaluate the size structure of the largemouth bass population (AGFC, 2006a). PSD is the proportion of largemouth bass ≥ 12 inches (305 mm) to the total number of largemouth bass ≥ 8 inches (203 mm). RSD16 is the proportion of largemouth bass ≥ 16 inches (406 mm) to the total number of largemouth bass ≥ 8 inches (203 mm). As shown on Figure 5, RSD16 declined from 66 in 2004 to 32 in 2006. AGFC attributes this decline in mean weight and RSD16 to overcrowding of the bass population and a shift in population structure to higher density of small fish (AGFC, 2006a). Therefore, on January 1, 2007, AGFC will change the bag limit to 10 fish per day where only one of those fish can be ≥ 18 in (457 mm) (AGFC, 2006b).

IMPINGEMENT STUDY METHODS

IMPINGEMENT MONITORING

Impingement sampling was in accordance with the FCPP PIC. Arkansas Tech University was retained to assist with the impingement collections. A student with coursework in fish taxonomy conducted the

impingement samples under the supervision of Dr. Joe Stoeckel (Arkansas Tech University). FCPP staff operated the screen-wash system to facilitate sample collection.

Samples were collected once every two weeks starting November 8, 2005, and ending October 24, 2006. A total of 26 samples were collected over this period. Each sample period began with a pre-wash of all screens to be sampled. Only screens serving circulators that were running were sampled. All three screens were sampled the majority of the time with the exception occurring May 6, 2006–June 3, 2006, when only two screens were sampled. Twelve hours after the initial screen wash, a second screen wash was conducted and a sample was collected. A third screen wash was conducted 24 hours after the initial screen wash and a final sample was collected for the sample event. As such, sample events included the collection of morning samples to represent fauna impinged during the night and evening samples to represent fauna impinged during the day. Sample times were established on a sliding scale to reflect changing day length and time changes, as shown in Table 1.

Table 1. Impingement Sampling Dates and Times

Date	Prewash time	Sample wash time	Date	Prewash time	Sample wash time
Monday, November 07, 2005	4:45 PM		Friday, May 05, 2006	7:00 PM	
Tuesday, November 08, 2005		7:45 AM 4:45 PM	Saturday, May 06, 2006		7:45 AM 7:00 PM
Monday, November 21, 2005	4:30 PM		Friday, May 19, 2006	7:15 PM	
Tuesday, November 22, 2005		8:00 AM 4:30 PM	Saturday, May 20, 2006		7:30 AM 7:15 PM
Monday, December 05, 2005	4:30 PM		Friday, June 02, 2006	7:30 PM	
Tuesday, December 06, 2005		8:00 AM 4:30 PM	Saturday, June 03, 2006		7:30 AM 7:30 PM
Monday, December 19, 2005	4:30 PM		Friday, June 16, 2006	7:30 PM	
Tuesday, December 20, 2005		8:15 AM 4:30 PM	Saturday, June 17, 2006		7:30 AM 7:30 PM
Monday, January 02, 2006	4:45 PM		Friday, June 30, 2006	7:30 PM	
Tuesday, January 03, 2006		8:15 AM 4:45 PM	Saturday, July 01, 2006		7:30 AM 7:30 PM
Monday, January 16, 2006	4:45 PM		Friday, July 14, 2006	7:30 PM	
Tuesday, January 17, 2006		8:30 AM 4:45 PM	Saturday, July 15, 2006		7:30 AM 7:30 PM
Friday, January 27, 2006	5:00 PM		Friday, July 28, 2006	7:30 PM	
Saturday, January 28, 2006		8:30 AM 5:00 PM	Saturday, July 29, 2006		7:45 AM 7:30 PM
Friday, February 10, 2006	5:15 PM		Friday, August 11, 2006	7:15 PM	
Saturday, February 11, 2006		8:15 AM 5:15 PM	Saturday, August 12, 2006		7:45 AM 7:15 PM
Friday, February 24, 2006	5:30 PM		Friday, August 25, 2006	7:00 PM	
Saturday, February 25, 2006		8:00 AM 5:30 PM	Saturday, August 26, 2006		8:00 AM 7:00 PM
Friday, March 10, 2006	5:30 PM		Friday, September 08, 2006	6:30 PM	
Saturday, March 11, 2006		7:45 AM 5:30 PM	Saturday, September 09, 2006		8:15 AM 6:30 PM
Friday, March 24, 2006	5:45 PM		Friday, September 22, 2006	6:30 PM	
Saturday, March 25, 2006		7:30 AM 5:45 PM	Saturday, September 23, 2006		8:15 AM 6:30 PM
Friday, April 07, 2006	6:45 PM		Friday, October 06, 2006	6:00 PM	
Saturday, April 08, 2006		8:15 AM 6:45 PM	Saturday, October 07, 2006		8:30 AM 6:00 PM
Friday, April 21, 2006	7:00 PM		Friday, October 20, 2006	6:00 PM	
Saturday, April 22, 2006		8:00 AM 7:00 PM	Saturday, October 21, 2006		8:30 AM 6:00 PM

Prior to the start of the study, frames and nets were custom built to fit into the debris sump. The frames fit into the debris sump with tolerances less than 1/16 in (1.6 mm). The nets were sewn to the frames and consisted of a bag constructed of 1/4 in (6.4 mm) heavy delta mesh. Prior to sample collection, the collection nets were placed in the debris sump.

All screens serving circulators in operation were washed in unison. The screens were washed for 10 minutes, which allowed the screens to make one complete revolution and ensure that all organisms had

adequate time to reach the collection nets. The samples were sorted by species, measured to total length (mm) and weighed (± 1 g) in the field. When possible, observations were made of the condition of the fish at the time of sampling. Individuals were characterized as alive, dead, moribund, or dead upon arrival. Fish that were possibly alive were placed in a bucket of water to help determine whether they were alive or moribund. Live fish exhibited normal reactions and active movement. Moribund fish had normal coloration but only slightly moved opercular flaps or fins and did not respond substantially to being touched. Dead fish had near normal coloration but no movement and no response to touch. Dead fish probably died minutes or hours before sampling. Dead-on-arrival fish have lost normal coloration and may have signs of injury not related to impingement. Dead-on-arrival fish died prior to impinging. During periods of high impingement rates, it was not always possible to obtain an accurate estimate of the number of live and moribund fish.

All fish were sorted according to species. If the number of individuals of any one species exceeded 100, 100 individuals were randomly selected from the group and processed. The remainder of the individuals were either weighed or counted. Subsampling was required during one sample event for threadfin shad. To obtain an estimate of the total number of fish collected in the sample, the entire sample was weighed and then 10% of the sample was processed. The total number of fish in the sample was estimated by obtaining the mean individual weight and dividing the total weight of the entire sample by the mean individual weight. All other species were removed from the entire sample and processed individually.

Impingement data included date, unique sample period code, wash times, unit number, screen number/letter, field crew, weather observations, fish condition, and length and weight of the first 100 individuals of each species. Total lengths of all fish were measured. Weights for fish ≥ 3 in (76 mm) were obtained. Fish < 3 in were measured and a bulk weight was obtained. Other aquatic organisms were identified and counted.

WATER QUALITY MONITORING

During each sample period, temperature ($^{\circ}\text{C}$), conductivity ($\mu\text{mhos/cm}$), and dissolved oxygen (milligrams per liter [mg/L]) were measured with an YSI Series 85[®]. An YSI Series pH100[®] was used to measure pH (standard units). Water quality was obtained at the surface and mid-depth. In order to prevent damage to the meter, bottom readings were not taken during every sample event.

Daily mean intake water temperatures, as measured prior to entering the condenser, were provided by FCPP. Due to the short residence time from the intake embayment to the condensers, these temperatures are believed to represent the mean temperatures at the CWIS.

Weather conditions were observed and recorded during each sample event. In addition, selected weather conditions for the study period were obtained from the National Oceanic and Atmospheric Administration (NOAA) station in Gravette, Arkansas, and from weather monitoring at FCPP.

QUALITY ASSURANCE / QUALITY CONTROL

Quality Assurance and Quality Control guidelines are described in the facility PIC and are not repeated in this document. However, some measures were added to help ensure quality data and are described in the sections below.

SITE INSPECTION AND COLLECTION-EFFICIENCY STUDIES

Prior to the beginning of the study, each of the screens was visually inspected and the spray-wash systems were operated to identify any problems that might result in poor recovery of impinged fish. Actions were taken to adjust spray nozzles in the wash system and debris was removed from the sluice to ensure unobstructed water flow and delivery of impinged fish into the collection nets.

Shortly after the start of the study, a collection-efficiency study (efficiency study) was conducted, as recommended by EPA (1977). The purpose of the efficiency study was to identify factors that might result in poor recovery of impinged fish, as described above. The general method for evaluating collection efficiency is to introduce marked or tagged dead fish immediately in front of the screens and then follow the normal sample process. In the absence of scavenging of introduced fish, the number of fish collected through sampling should be similar to the number of fish released in front of the screens.

For this study, two instantaneous efficiency studies were conducted using groups of 20 and 25 dead, fin-clipped golden shiner (*Notemigonus chrysoleucas*) and sunfish (*Lepomis* spp.) for each screen. Each study consisted of releasing the study fish immediately prior to sample events on November 8, 2005, and October 24, 2006. Results of the efficiency studies are shown in Table 2. For the first study, mean collection efficiency was 87% and for the second study, mean collection efficiency was 93%. Inspection of the screen-wash system indicated that few, if any, study fish remained on the screens after washing. The fate of the study fish not recovered was unclear. However, it is possible that the missing study fish either did not make it to the screens after being released or were consumed by scavengers (e.g. channel catfish).

Table 2. Efficiency Study Results for Flint Creek Power Plant

Date	Long Term or Short Term	Unit	Screens Washed	# Fish Released	# Fish Recovered	% Efficiency
November 8, 2005	Short Term	1	A	25	24	96
		1	B	25	24	96
		1	C	25	17	68
October 24, 2006	Short Term	1	A	20	20	100
		1	B	20	20	100
		1	C	20	16	80

DATA MANAGEMENT

Field datasheets were used by field staff during each sample event (Appendix B). Data were transferred into a database and all datasheets were maintained by the QA/QC officer. Once entered into the database, data were checked for any errors made during data entry. This QA/QC check was conducted by the QA/QC officer after each sample event. The datasheets were signed by the QA/QC officer after each sample event and a log recording any data discrepancies was kept by the QA/QC officer. A summary of the total number of fish by species was also maintained in a separate spreadsheet and was compared to the database and field datasheets to check for gross errors.

FISH IDENTIFICATION

All fish identifications in the field were conducted by a degreed fisheries biologist knowledgeable in fish taxonomy. Fish not identified in the field were preserved and delivered to Arkansas Tech University for identification. Dr. Joe Stoeckel (Director of Fisheries and Wildlife, Arkansas Tech University) verified identification of any species that were not identified in the field. A preserved voucher collection was retained.

WATER QUALITY METER CALIBRATION

Water quality meters used during the study were calibrated to the manufacturer's specifications prior to sampling and post-calibrated after sampling. Calibration information was recorded after each calibration in a calibration log. Calibration logs included date, time, staff, pre-calibration readings, post-calibration readings, and any maintenance or repairs.

DATA ANALYSIS

Impingement can be a function of facility operations, environmental conditions, and/or species-specific fish behavior. To screen the importance of each of these, several variables were compared to the total number of fish collected in impingement samples. In some cases, data were not available and comparisons could not be made. The list below shows the variables in which data were available and comparisons were made. T-Test analysis was conducted for each of these variables and total impingement at the $p = 0.5$ level (unless otherwise specified). In addition, multivariate analysis was performed to identify possible relationships between various combinations of variables and impingement by groups of species (e.g., sunfish, shad, largemouth bass, and catfish). Methods for this analysis are provided in the corresponding section.

Air temperature	Reservoir elevation
Conductivity	Screen velocity
Daily precipitation	Season
Dissolved oxygen	Species composition
Flow	Water temperature
Monthly precipitation	Weekly precipitation
pH	

RESULTS

The following sections provide the results of impingement monitoring and variable analysis at FCPP. The results are presented in a variety of ways, including observations and analysis of relationships between environmental and facility variables and impingement. While variables that influence impingement are important and are described, results of analysis in which there are no relationships are also provided. Results of multivariate analysis indicated no relationships with individual or groups of species and only summary results are included. A summary of statistical results is provided in the discussion. Scatterplots were generated to facilitate these comparisons. Because the number of pumps and/or screens varied between samples, impingement estimates were normalized for use in the attached scatterplots and statistical analysis. These values represent actual impingement and impingement rates only for the sample dates.

IMPINGEMENT TOTALS

A total of 26 sample events were conducted at FCPP in which 22 samples were collected from all three screens and four samples collected from only two screens. The total number of fish collected during each sample event is shown on Figure 6. Over the course of the study, a total of 20,127 fish consisting of eight species were collected in impingement samples (Table 3). The majority of fish collected were threadfin shad (98%) followed by bluegill (2%) (Figure 7). The remaining species comprised <1% of the impingement samples. The overwhelming majority (97%) of fish (threadfin shad) were collected during one sample event – April 22, 2006 (see Figure 6). The minimum number of fish collected per sample event was zero and this occurred on February 25, 2005, September 12 and 26, 2005, and October 10, 2006. On each of these dates, all of the CW pumps were in operation. The kurtosis for the distribution of fish impinged on the sample dates was 26; indicating more of the variance in the number of fish impinged was due to infrequent extreme deviations (e.g., the April 22, 2006, impingement event). Excluding the April 22, 2006, sample event, the mean number of fish collected per 24-hour period was 25.

Table 3. Species and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant, November 8, 2005, through October 24, 2006

Common name	Scientific name	Number Collected
Gizzard shad	<i>Dorosoma cepedianum</i>	4
Threadfin shad	<i>D. petenense</i>	19,683
Channel catfish	<i>Ictalurus punctatus</i>	1
Green sunfish	<i>Lepomis cyanellus</i>	20
Warmouth	<i>L. gulosus</i>	1
Bluegill	<i>L. macrochirus</i>	344
Redear sunfish	<i>L. microlophus</i>	2
Largemouth bass	<i>Micropterus salmoides</i>	72
Total		20,127

The large number of threadfin shad collected in impingement samples on April 22, 2006, was apparently an infrequent, but not unusual event. Anecdotal information by facility staff indicated that impingement numbers are usually very low at FCPP, but occasional “shad runs” have occurred. This high impingement rate was probably the result of a sudden presence of a large number of juvenile (Age-0) threadfin shad in the population. The lengths of individuals impinged were consistent with spawning that likely occurred with warm weather in late winter and early spring (Figure 8). Spawning temperature for threadfin shad is approximately 70°F (21°C) (Pflieger, 1975). As shown on Figure 8, this water temperature (intake) was attained in late January and again in February, with a substantial increase in temperature in early March.

The lengths of the threadfin shad impinged on April 22, 2006, were indicative of a cohort that was spawned over a short period of time (Figure 9). The mean length of the threadfin shad impinged on April 22, 2006, was approximately 40 mm (1.6 in) (range = 26 mm to 54 mm) [1.1 in to 2.1 in] and the median length was 40 mm (1.6 in) (Figure 10). The reproductive capacity of threadfin shad is higher than most freshwater species and synchronous spawning with high recruitment rates of juveniles is common when conditions are favorable (SRAC, no date; Houser and Netsch, 1971; McLean et al., 1982; Swingle, 1969). In general, threadfin shad reach a size susceptible to impingement at 25 to 30 mm in length (1.0 to 1.2 in) [at smaller sizes, they pass through 3/8-in (9.5 mm) screen mesh].

The sudden presence of shad in impingement samples is not unusual due to their reproductive behavior and high fecundity rates. However, the precipitous reduction in the number of threadfin shad after the April 22, 2006, impingement sample was unusual. In general, high impingement rates associated with the recruitment of juveniles into the population are generally followed by relatively high, but diminishing impingement rates in subsequent samples. As described in the following sections, there were no obvious changes in environmental conditions that might have stressed the fish preceding the April 22, 2006, sample event. In addition, the growth of the cohort probably did not play a significant factor either. The growth of the Age-0 threadfin shad can be seen on Figure 9. The mean length of the threadfin shad collected on July 15, 2006, was 64 mm (2.5 in) [n = 220]. This indicates that the Age-0 fish grew an approximate average of 4 mm (0.16 in) in length per 2-week period; therefore, it is unlikely that increase in length alone would result in lower impingement rates.

One possible factor that might, in part, explain the reduced impingement rate was the facility outage that began on April 29, 2006, and ended on June 4, 2006. During this period, the facility was not in operation, but at least one CW pump was turned on for routine impingement sampling. On May 6 and 26, 2006, one CW pump was turned on and on June 3, 2006, two CW pumps were turned on. As such, there were fewer screens sampled and it is possible that the absence of flow during the period between sample events changed the threadfin shad behavior or their distribution in the reservoir.

Bluegill were present in most impingement samples (see Figure 7), but their abundance was low (see Table 3). The length-frequency distribution of bluegill is shown on Figure 11. Excluding three large individuals, the mean bluegill length was 47 mm (1.8 in) [range = 20 to 84 mm (0.8 to 3.3 in)].

Observed largemouth bass impingement was low (n = 72) and limited to the spring. Ninety-four percent were collected during the April 8 and 22 and May 6, 2006, sample events. The length-frequency of largemouth bass is shown on Figure 12. Excluding four large individuals, mean largemouth bass length was 48 mm (1.9 in) [range = 34 to 81 mm (1.3 to 3.2 in)]. These were Age-0 fish that were likely spawned in late winter or early spring 2006. After May 6, 2006, only six individuals were collected.

Almost all fish in impingement samples were dead upon collection. All threadfin shad, gizzard shad, and green sunfish were dead upon collection. Ten percent of bluegill and one largemouth bass were alive upon collection; 9% of sunfish and 3% of largemouth bass were alive upon collection. Fish which were considered dead upon impingement were not included in the results or analysis. These included 14 threadfin shad, 36 bluegill, and two green sunfish. Four fish were considered moribund upon collection and included one channel catfish and three redear sunfish.

IMPINGEMENT AND SEASONS

The total number of fish collected in impingement samples were grouped by season (seasons are defined in Table 4). Observed mean impingement during the summer (20), fall (7.4), and winter (2.1) was far less than that observed during the spring (940). Mean impingement was much higher during the spring due to the results of the April 22, 2006, sample event, but this was an unusual occurrence when compared to the results of the remainder of the spring impingement events. Based on t-Test analysis, there were no statistical ($p \leq 0.05$) differences between any of the seasons despite the large difference in mean impingement during the spring and the remainder of the seasons.

Table 4. Impingement Rate per Sample
(Mean Number of Fish per Screen by Season)
Flint Creek Power Plant

	Unit 1
Fall (11/8/05–12/20/05)	7.4
Winter (1/3/06–3/11/06)	2.1
Spring (3/25/06–6/17/06)	940
Summer (7/1/06–9/12/06)	20
Fall (9/26/06–10/14/06)	2.6

IMPINGEMENT AND FACILITY OPERATIONS

Intake Flow

Intake flows (flow) at FCPP generally remain constant throughout the year with the exception of spring, when facility maintenance normally occurs. During this period, flows are generally restricted to the use of one or two CW pumps. Figure 3 provides the 5-year mean flow and standard deviations for 2-week periods surrounding the sampling dates and the sample event flows. Sampling was conducted within or

above normal operating flows with the exception of five events when flows were below the 5-year mean (see Figure 3).

Flow-weighted impingement (number/million gallons) was calculated by dividing the total number of fish collected by the total flow for the sample period. Mean flow-weighted impingement for FCPP was 2.07 fish/million gallons. Table 5 provides a summary of CW pump operations, flows, calculated screen velocity, and total number of fish collected in impingement samples for each sample event. Total daily flows and observed impingement for each sample event are shown on Figure 13.

Table 5. Impingement Sample Statistics for Flint Creek Power Plant

Date	No. of Screens Sampled	No. of Circulators Running	Flow (mgd)	Screen Velocity (ft/s)	No. of Fish Collected
11/8/2005	3	3	406	1.89	52
11/22/2005	3	3	406	1.91	21
12/6/2005	3	3	406	1.94	6
12/20/2005	3	3	406	1.98	10
1/3/2005	3	3	406	2.00	9
1/17/2006	3	3	406	2.00	19
1/28/2006	3	3	406	2.03	1
2/11/2006	3	3	406	2.03	3
2/25/2006	3	3	406	2.07	0
3/11/2006	3	3	406	2.06	5
3/25/2006	3	3	406	2.13	9
4/8/2006	3	3	406	2.15	49
4/22/2006	3	3	406	2.16	19,490
5/6/2006	1	1	135	2.15	13
5/20/2006	2	2	135	2.10	20
6/3/2006	2	2	271	2.06	32
6/17/2006	3	3	406	2.06	19
7/1/2006	3	3	406	2.10	16
7/15/2006	3	3	406	2.12	244
7/29/2006	3	3	406	2.21	54
8/15/2006	2	2	406	2.32	16
8/29/2006	3	3	406	2.23	16
9/12/2006	3	3	395	2.32	0
9/26/2006	3	3	371	2.34	0
10/10/2006	3	3	289	2.34	0
10/24/2006	3	3	406	2.38	23

Screen Velocity

Screen velocities were calculated based on the CW pump operations (flow), screen dimensions, and wetted screen area for each sample event. Screen velocities were adjusted for changes in reservoir pool elevation. Observed reservoir pool elevation during the sample dates ranged from 1,123.8 ft (342.5 m) msl to 1,130.6 ft (344.6 m) msl. The relationship between velocity and observed total impingement is

shown on Figure 14. Screen velocities steadily increased over the course of the study from a low of 1.89 ft/s (0.58 m/s) on November 8, 2005, to a high of 2.38 ft/s (0.72 m/s) on October 24, 2006. Despite the changes in velocity, which were solely related to reservoir pool elevation, there was no significant relationship with observed impingement.

INTAKE LOCATION

As previously described, all screens that were in operation during each sample event were washed concurrently. Therefore, identifying differences in impingement rates between the screens could not be evaluated. The CWIS at FCPP is constructed of a concrete bulkhead, which extends a short distance from the shoreline. Habitat features and water movement in and around the CWIS was observed during the study. Other than rip-rap armoring adjacent to each side of the CWIS, there appeared to be no habitats (e.g. aquatic plants or brush) that might affect fish movement or location. In addition, there appeared to be no unusual flow patterns into or around the CWIS. As such, there were no apparent physical features that might influence impingement for any one of the screens.

RESERVOIR ELEVATION

Reservoir elevation decreased steadily over the course of the study, as previously described. Changes in reservoir pool elevation may influence impingement rates indirectly (e.g., changes in screen velocity, as previously discussed or changing water quality and temperature, as discussed in following sections) or directly by altering fish behavior or their distribution. The total number of fish impinged was compared to the changes in reservoir pool elevation over the course of the study. Although the water level fell throughout the study, there was no relationship with impingement, as shown on Figure 15.

IMPINGEMENT AND WATER QUALITY

Dissolved oxygen (DO), temperature, conductivity, and pH data applied in analysis were collected by field staff during impingement collections. Daily mean intake temperatures (prior to entering the condensers) were provided by FCPP staff. Since SWEPCO Lake is a cooling pond, routine water quality monitoring on the reservoirs is not conducted by local or state agencies and no other water-quality data were available for analysis.

Dissolved Oxygen

DO concentrations observed at both depths (surface and mid-depth) by sample event and by morning and afternoon were averaged. Total observed impingement and the mean DO concentrations for each sample event are shown on Figure 16. Mean DO concentration ranged from 3.43 mg/l during the morning of July 15, 2006 (AM), to 9.51 mg/l on May 20, 2006 (PM). The second largest number of fish (244) collected in impingement samples was on July 15, 2006, which was the date with the lowest observed DO levels. However, 20 fish were collected in impingement samples on the date with the highest observed DO concentrations. The relationship between total observed impingement and DO concentration is

shown on Figure 17. Despite variability in DO levels over the course of the study, total impingement did not appear to be significantly related to DO concentrations. However, critically low DO concentrations (e.g., <2.0 mg/L) were not observed during the sample events that might have stressed fish, possibly increasing impingement.

Temperature

Observed water temperature at the CWIS during the sample events ranged from 19.1°C (66.3°F) on December 6, 2005, to 40.2°C (104.4°F) on July 15, 2006. Temperature observed at both depths (surface and mid-depth) for each period (morning and afternoon) and for each sample event was averaged. Total observed impingement and the mean temperature concentrations for each sample event are shown on Figure 18. As previously discussed, the highest observed impingement (19,490) occurred on April 22, 2006, when there was a notable rise in water temperature (see Figure 8) and the second highest observed impingement (244) was on the sample date with the highest temperature (see Figure 18). However, there was no significant relationship between observed total impingement and mean observed water temperature (Figure 19). Total impingement was also compared to changes in mean daily intake water temperature change and absolute weekly intake temperature change. Daily intake temperature change is defined as the difference between the mean daily intake temperature on the day prior to the sample event and the mean daily intake temperature on the day of the sample event (24-hour temperature change). Absolute additive weekly intake temperature change was calculated by summing the difference between the daily mean intake temperatures for the 6 days prior to each sample event. There was no significant relationship between daily or weekly changes in water temperature and total impingement (Figures 20 and 21).

Mean daily air temperatures for the study period as observed at Gravette, Arkansas (NOAA, 2006), and total observed impingement are shown on Figure 22. As seen on Figure 8, temperatures in SWEPCO Lake remain warm throughout the winter months. Despite mean daily air temperature dropping below -6°C (20°F), the lowest observed mean intake temperature was 18.6°C (65.5°F). SWEPCO Lake is located at approximately the northern-most range for threadfin shad (Pflieger, 1975; Robison and Buchanan, 1988). Threadfin shad are particularly susceptible to low temperatures and become lethargic or die at temperatures around 5°C (40°F) (SRAC, n.d.; Pflieger, 1975), potentially increasing impingement. Due to the warm water discharged into the reservoir by the facility, the temperatures remained well above the lower thermal limits for threadfin shad. Other species that occur in the reservoir are less susceptible to low temperatures and occur at latitudes farther north than SWEPCO Lake (Pflieger, 1975). Conversely, intake temperatures reach levels higher than other surface waters that do not receive cooling water. However, there did not appear to be any noticeable increase in impingement when compared to intake temperature or season (discussed in following sections).

Conductivity and pH

Conductivity observed at both depths (surface and mid-depth) and for each sample period (morning and afternoon) was averaged. The relationship between observed total impingement and mean conductivity is shown on Figure 23. There was no relationship between impingement and conductivity. In general, conductivity increased with decreasing reservoir elevation. The lowest observed mean conductivity was 348 $\mu\text{mhos/cm}$ on December 6, 2005, and the highest observed mean conductivity was 469 $\mu\text{mhos/cm}$ on June 17, 2006.

Observed pH ranged from 7.3 to 8.6 standard units during the study period. Fluctuation in pH occurred between the sample periods (morning and evening) and between sample events, indicating at least moderate levels of primary productivity. Morning and afternoon and surface and mid-depth pH results were averaged together by sample event and were compared to total observed impingement. As seen on Figure 24, there was no relationship between mean pH for each sample event and observed impingement.

IMPINGEMENT AND WEATHER

Precipitation

Precipitation is monitored daily at FCPP and data were provided for this study. The 30-year annual mean precipitation total for Gravette, Arkansas, is 47 in (120 cm) (NOAA, 2006) and the precipitation total observed at FCPP for the study period was 38 in (96 cm), which was approximately 10 in (25 cm) below normal (Figures 25 and 26). While precipitation for most months was below normal, precipitation totals for April, May, and August 2006 were above normal, as shown on Figure 26 (NOAA, 2006). Daily precipitation totals and the total observed impingement for each sample event are shown on Figure 27. There were five sample dates in which measurable amounts of rainfall fell. The highest rainfall total was 0.3 in (0.8 cm) and a total of five fish were collected on that day. The highest observed impingement (19,490) occurred on a date (April 22, 2006) in which there was no rain. There was no significant relationship between daily, weekly, and monthly precipitation totals and observed impingement (Figures 28, 29, and 30).

IMPINGEMENT AND DIURNAL VARIATION

Impingement sample collection was scheduled in order to estimate diurnal impingement patterns. Morning impingement samples were collected between 0700 and 0830 hours with most samples collected near 0800 hours. Morning sample collection took 18 minutes to allow the screens to complete one revolution during the wash. Screens were pre-washed the evening before the morning sample at times ranging from 1645 hours (Central Standard Time) to 1930 hours (Daylight Savings Central Standard Time). The average time from pre-wash to the morning sample was about 14 hours.

Daytime impingement began from 0700 to 0830 hours with most sample days beginning around 0800 hours and typically lasting until about 1630 hours (Central Standard Time) to 1930 hours (Daylight

Savings Central Standard Time). The average time from the morning sample to the evening sample was 10 hours.

Total impingement for each period was divided by the amount of time (nearest hour) and the number of screens sampled. The highest night-time rate of impingement was 11 fish/screen/hour during the spring while the highest day-time rate of impingement was 1.7 fish/screen/hour also during the spring. The mean rate of impingement was higher during the night (0.67 fish/screen/hour) than during the day (0.13 fish/hour/day). The mean number of fish collected in impingement samples during the day and night and between seasons is shown in Table 6.

Table 6. Diurnal Impingement Rate Measured as Number of Fish Impinged per Screen per Hour Flint Creek Power Plant

	Unit 1	
	Night	Day
Entire Sample Period Mean	0.673	0.127
Fall (11/8/05-12/20/05)	0.111	0.017
Winter (1/3/06-3/11/06)	0.139	0.011
Spring (3/25/06-6/17/06)	11.376	1.673
Summer (7/1/06-9/12/06)	0.187	0.093
Fall (9/26/06-10/14/06)	0.052	0.011

MULTIVARIATE ANALYSIS

Impingement Analysis Methods

Impingement can be an artifact of the sudden presence of numerous individuals of one or several species, potentially responding to an environmental or biological stimulus or facility operations. As such, predictive modeling of impingement by groups of similar species was performed to distinguish potentially different responses of each of the groups to abiotic predictive variables. Analysis was conducted with largemouth bass, threadfin shad, and all sunfish combined.

Linear, multiple regression was used to assess correlations of predictor variables in relation to the response variable and species (or group) impingement. Stepwise model selection methods were employed to generate and assess best models. An approach was used during model building in which variables were entered into the model at $p = 0.10$ and removed if $p \geq 0.25$ with the stepwise method. All analyses were performed with SPSS 12.0.

Each individual analysis consisted of an initial set of predictor variables forming a global model. The predictor variables included the variables previously listed. Some variables were eliminated for reasons of potentially confounded analyses. For example, multicollinearity of predictor variables was addressed by elimination of the “less ecologically meaningful” variable of a pair that were correlated at $r^2 \geq 0.60$ via

Pearson correlation tests. Additionally, best models were assessed for overfitting and associated spurious effects by examining various indicative statistics (e.g., R values in relation to number of parameters, change in r^2 values in each model in relation to an added or removed variable, t-statistic of an added variable, ratio of regression and residual values, etc.).

Multivariate Analysis Results

The suite of predictor variables failed to accurately predict impingement or explain any significant level of variability for any of the species. Although weak relationships were observed through analysis of individual variables and total impingement, more robust analysis at the species grouping level did not demonstrate any significant relationships.

DISCUSSION

With the exception of one sample event (April 22, 2006), observed impingement was low, averaging about 25 fish per sample event. An overwhelming majority (97%) of impinged fish consisted of threadfin shad and 99% of these were collected during the April 22, 2006, sample event. A total of eight species were collected with bluegill representing the second most abundant species, comprising slightly less than 2% of the total sample. Largemouth bass and channel catfish were the only sport fish collected, although sunfish can be recreationally important. A large majority (94%) of the largemouth bass were newly spawned juveniles with a mean size of 48 mm (1.9 in). Only one catfish was observed in impingement samples. There are no state or federally listed species of concern known to exist in SWEPCO Lake, nor were any collected in impingement samples.

The large number of threadfin shad collected in impingement samples was probably the result of synchronous spawning in late winter or early spring prior to April 22, 2006. Spawning temperatures were reached in late winter, with a sharp increase in temperature in early March. The average length of the threadfin shad was similar and their size was indicative of Age-0 fish. Under favorable conditions, recruitment of large numbers of threadfin shad into sizes susceptible to impingement (>25 mm [1 in]) is common. However, a precipitous reduction in impingement followed the April 22, 2006, sample event. The reason for the substantial decline in impingement is largely unknown and there appeared to be no unusual change in environmental conditions that might influence impingement rates. One possible explanation might have been the facility outage that took place after this event. Thermal and flow changes might have altered threadfin shad behavior or location in the reservoir, possibly influencing impingement patterns. Although the reservoir is important as a recreational fishery, there are no population data for forage species available that could be used for analysis.

There were no significant relationships between observed impingement and environmental variables or facility operations (Table 7). Multivariate analysis, which tested the significance between individual species and combinations of variables, did not indicate any relationships. Some observations were drawn from the results, which could not be supported statistically. With the exception of higher than normal temperatures, observed water quality remained within normal ranges during the study. Excluding the

April 22, 2006, impingement event, the highest observed impingement occurred on the date with the highest temperature and lowest DO. However, this observation was not consistent for other events with higher than average temperatures and lower than average DO. In addition, impingement was generally higher during the spring as compared to other seasons and was higher during the night. The higher impingement during the spring was, in part, the result of Age-0 largemouth bass reaching sizes susceptible to impingement. However, the this species generally remained in impingement samples for approximately 1 month. It is likely that largemouth bass spawn over a short period in late winter or early spring and the Age-0 cohort either change behavior as over time or become less susceptible to impingement as they grow.

The absence of a relationship between facility operations and impingement was notable. The number of CW pumps in operation varied throughout the study, which resulted in changes in flow and number of screens. However, these changes were not proportional to impingement rates. This observation indicates that other factors, such as recruitment of juvenile fish into the population better explains impingement than changes in facility operations.

Table 7. Impingement and Variable Statistics Summary
Flint Creek Power Plant

Variable	Figure	p	r ²	Significant Relationship (p≤0.05)
Daily flow	13	0.643	0.009	No
Through-screen velocity	14	0.762	0.003	No
Reservoir pool elevation	15	0.679	0.007	No
Dissolved oxygen	17	0.286	0.047	No
Observed water temperature	19	0.567	0.014	No
24-hour change in intake temperature	20	0.484	0.021	No
Additive weekly intake temperature change	21	0.350	0.036	No
Conductivity	23	0.072	0.139	No
pH	24	0.333	0.039	No
Daily precipitation	28	0.692	0.007	No
Weekly precipitation	29	0.449	0.024	No
Monthly precipitation	30	0.443	-0.016	No



Discharge

Flint Creek Power Plant

CWIS

SWEPCO Lake

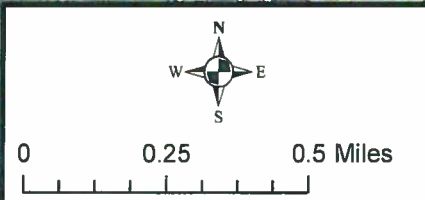


Figure 1. SWEPCO Lake and Flint Creek Power Plant
Benton County, Arkansas



Discharge

SWEPCO Lake

CWIS

SWEPCO Lake



0 270 540 Feet



Figure 2. Flint Creek Power Plant
Benton County, Arkansas

Figure 3. 5-Year (2001-2006) 2-Week Means,
 Mean \pm 1 Standard Deviation, and Sample Event Flows, Flint Creek Power Plant

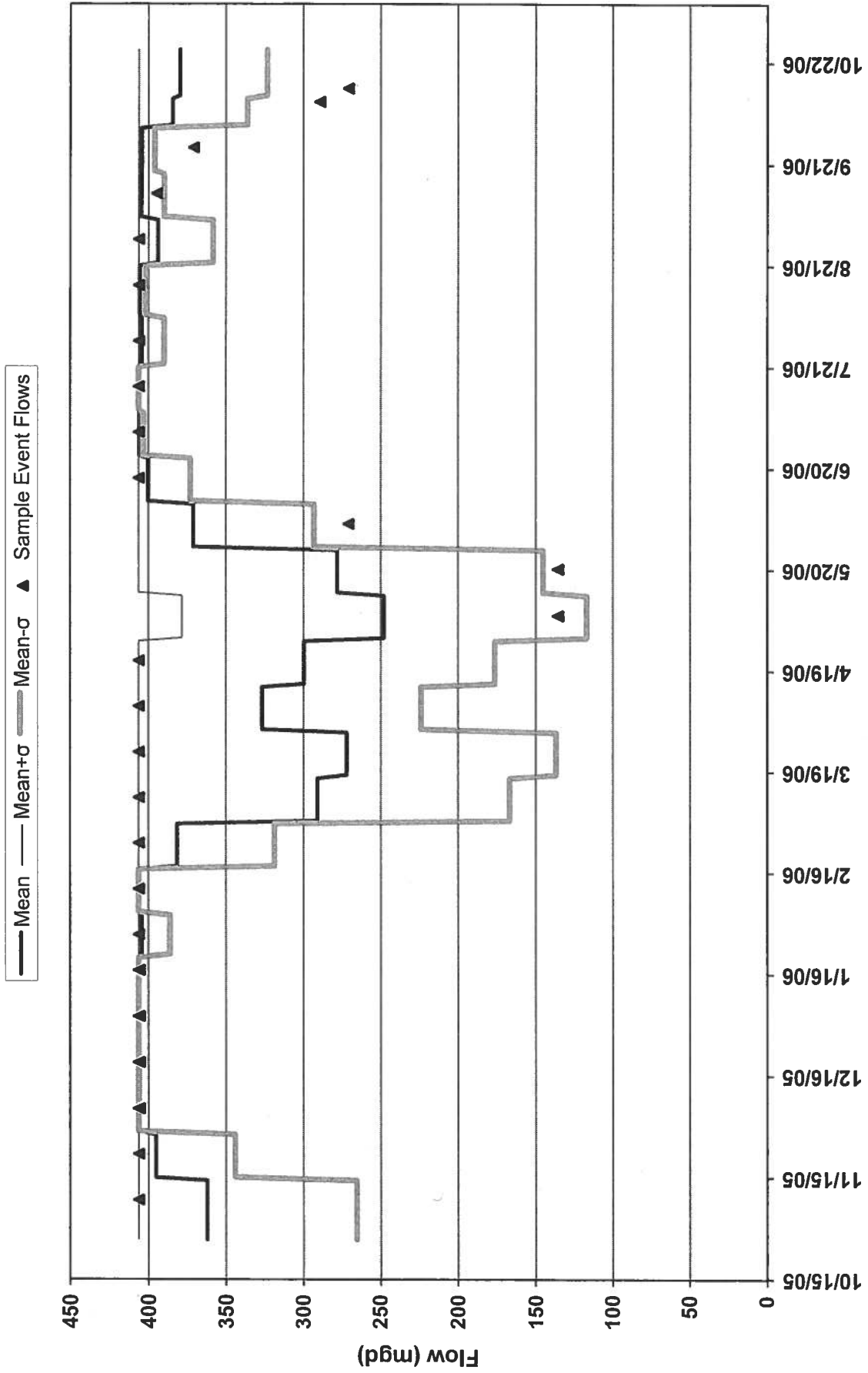


Figure 4. Catch Rate (CPUE) and Mean Relative Weight (Wr) of Largemouth Bass Collected from Electrofishing, SWEPCO Lake, 2000-2006 (AGFC, 2006)

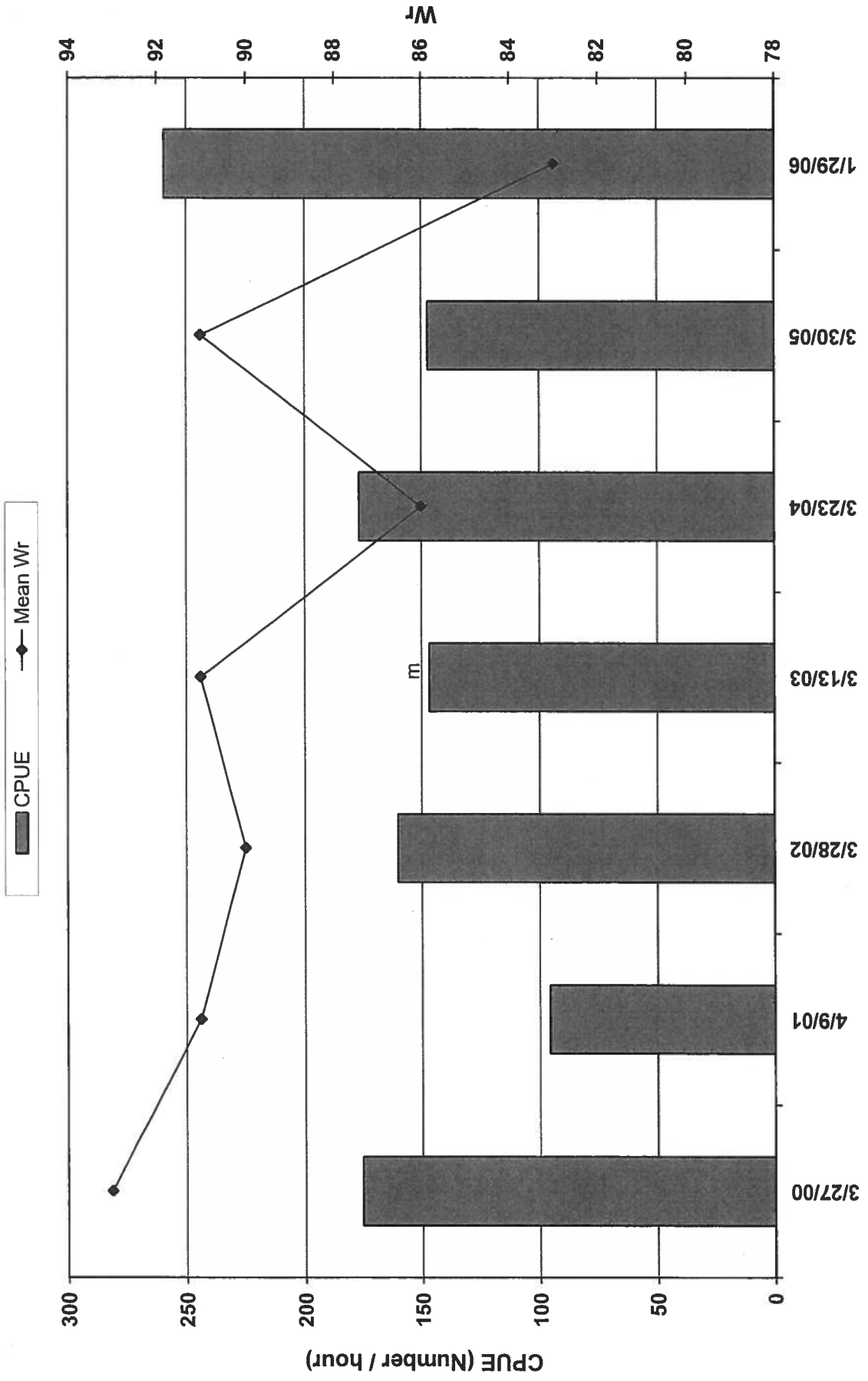


Figure 5. Proportional Stock Density (PSD) and Relative Stock Density-16 (RSD16) for Largemouth Bass, SWEPCO Lake (AFGC, 2006)

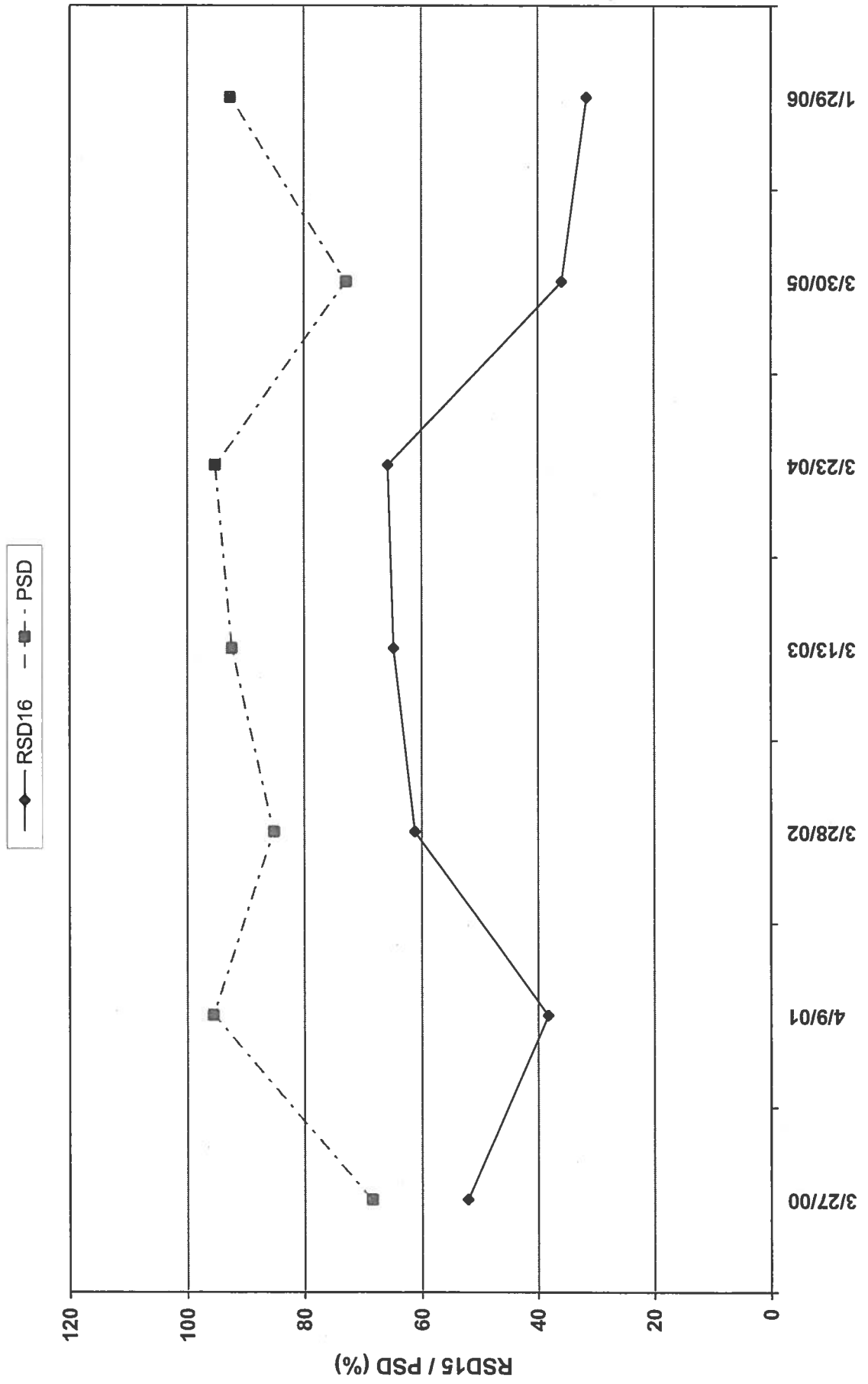


Figure 6. Total Number of Fish Collected in Impingement Samples by Sample Event, Flint Creek Power Plant

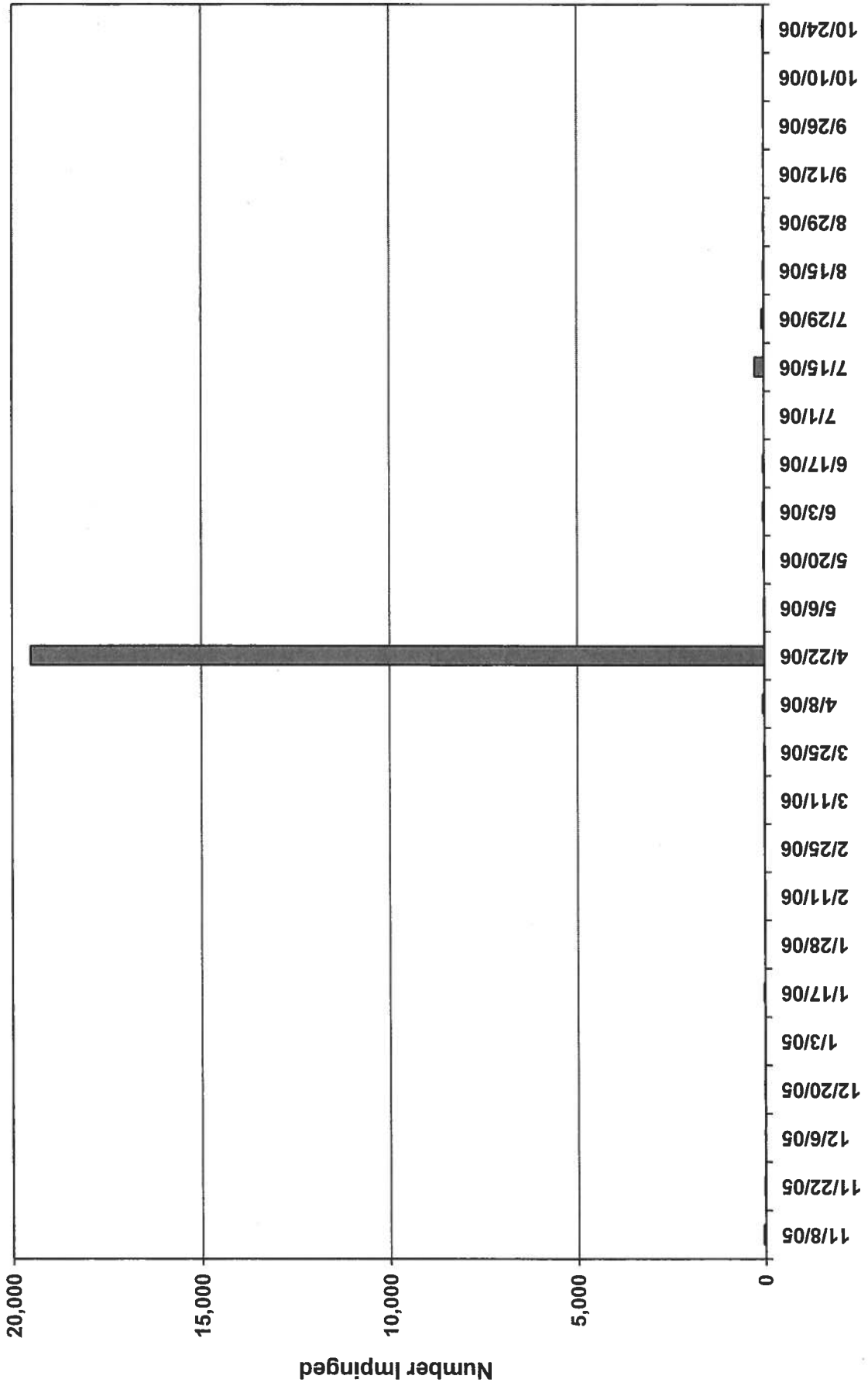


Figure 7. Total Number of Fish Collected in Impingement Samples by Species, Flint Creek Power Plant

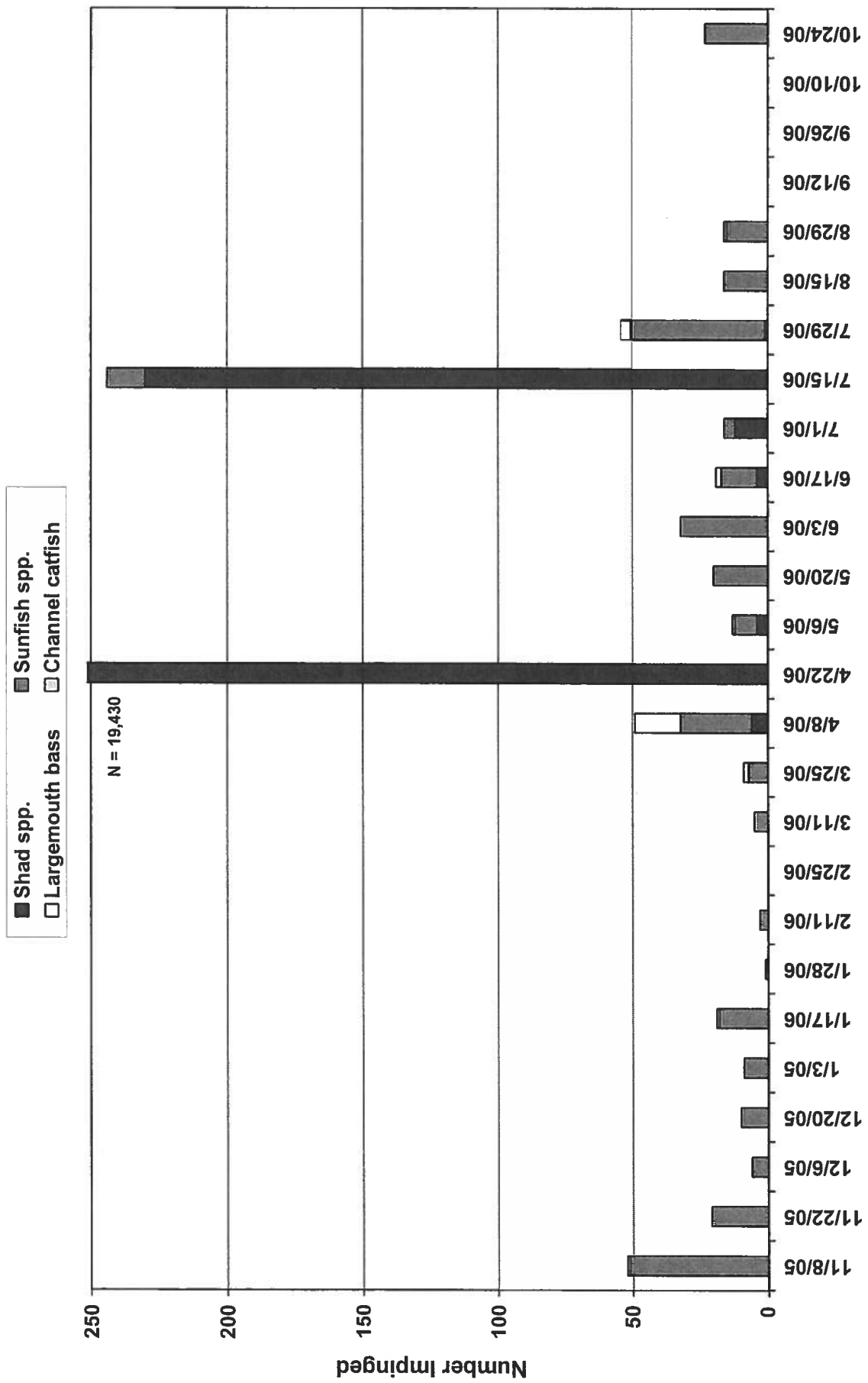


Figure 8. Daily Mean Air Temperature (NOAA, 2007) and Daily Mean Intake Water Temperature at Flint Creek Power Plant, November 1, 2005 through October 24, 2006

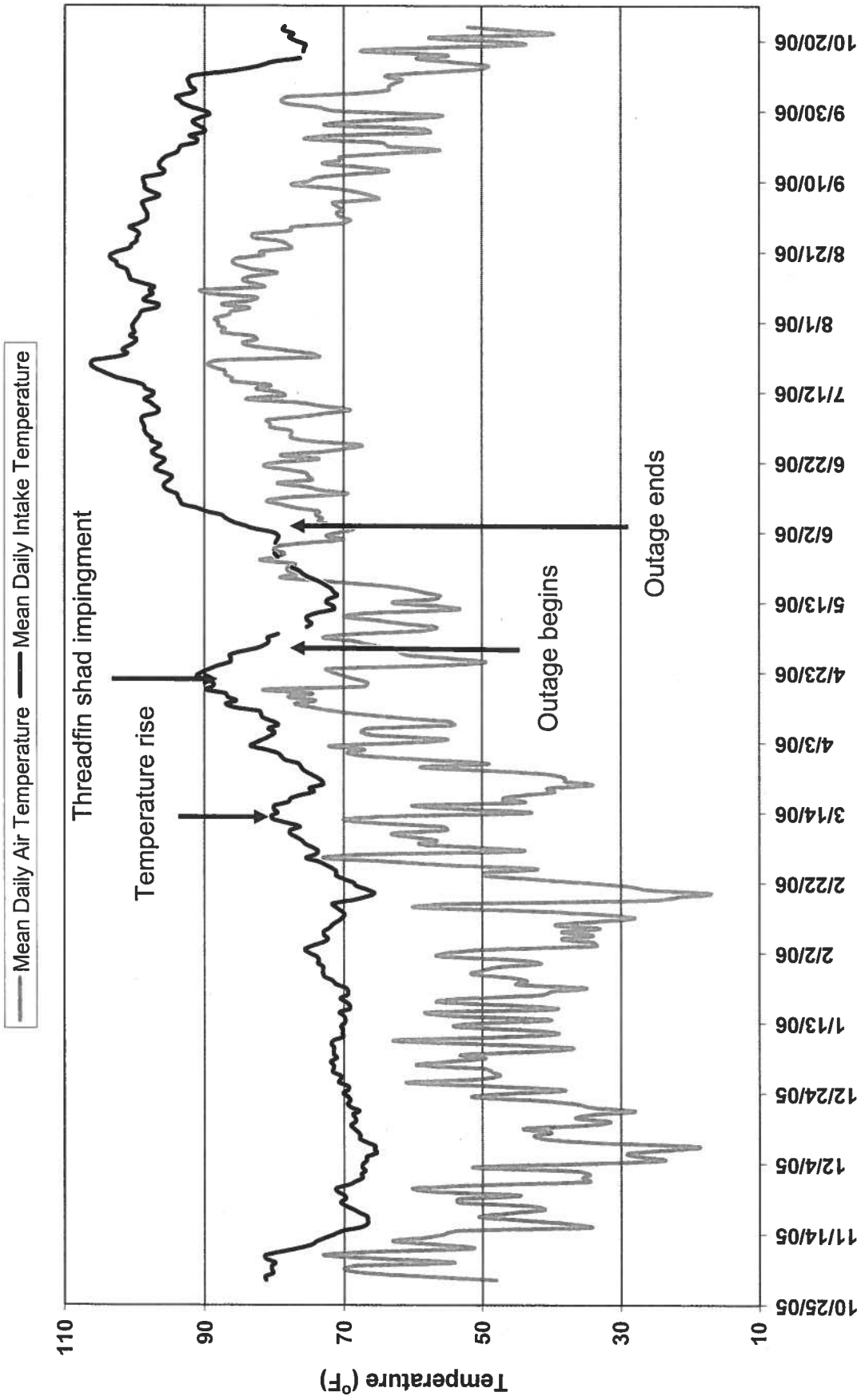


Figure 9. Length-Frequency Distribution (Percent Composition) of Threadfin Shad Collected in Impingement Samples on April 22, 2006 and July 15, 2006, Flint Creek Power Plant

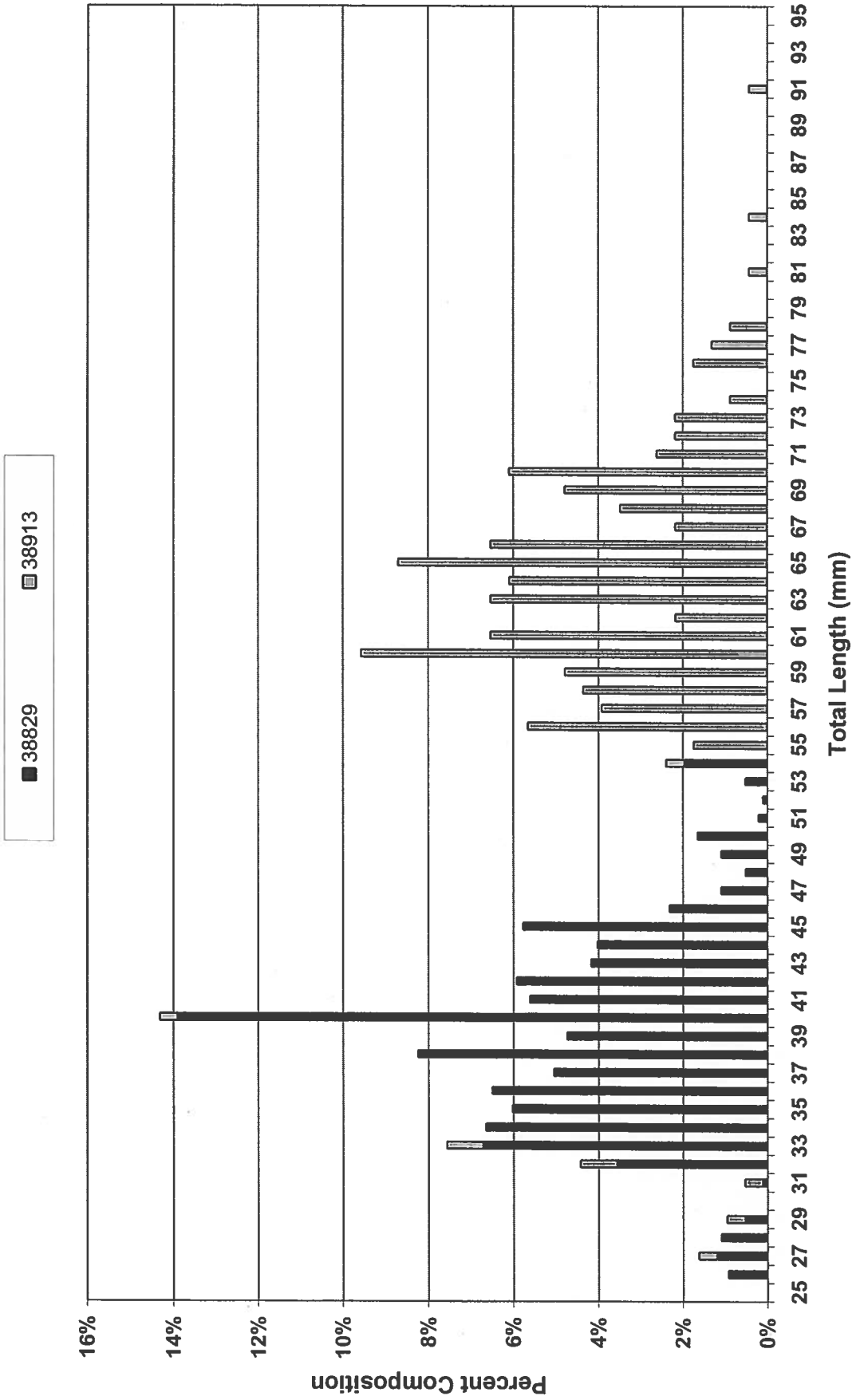


Figure 10. Length-Frequency Distribution of Threadfin Shad Collected in Impingement Samples for the Study Period, Flint Creek Power Plant

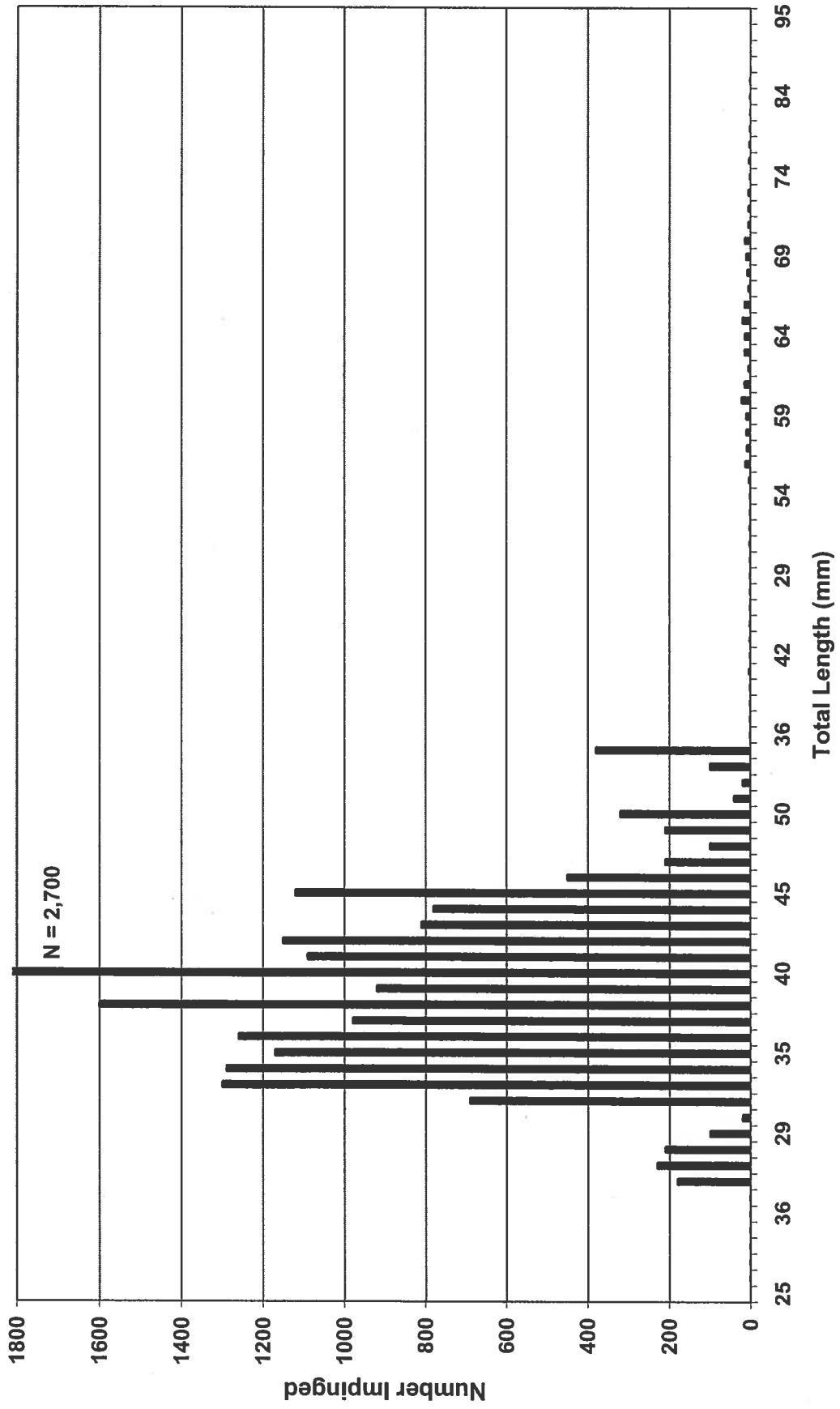


Figure 11. Length-Frequency Distribution of Bluegill Collected in Impingement Samples for the Study Period at Flint Creek Power Plant

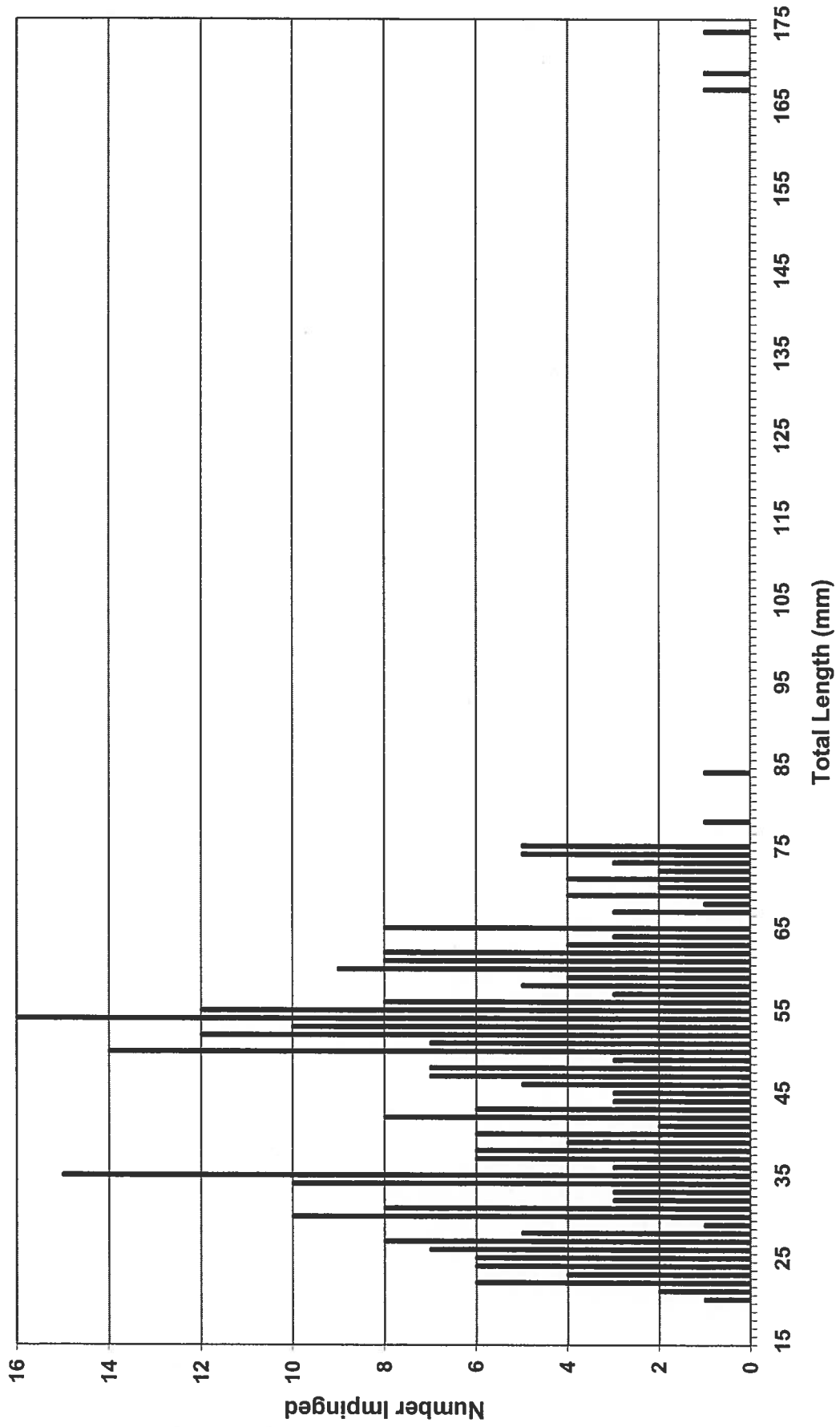


Figure 12. Length-Frequency Distribution of Largemouth Bass Collected in Impingement Samples for the Study Period, Flint Creek Power Plant

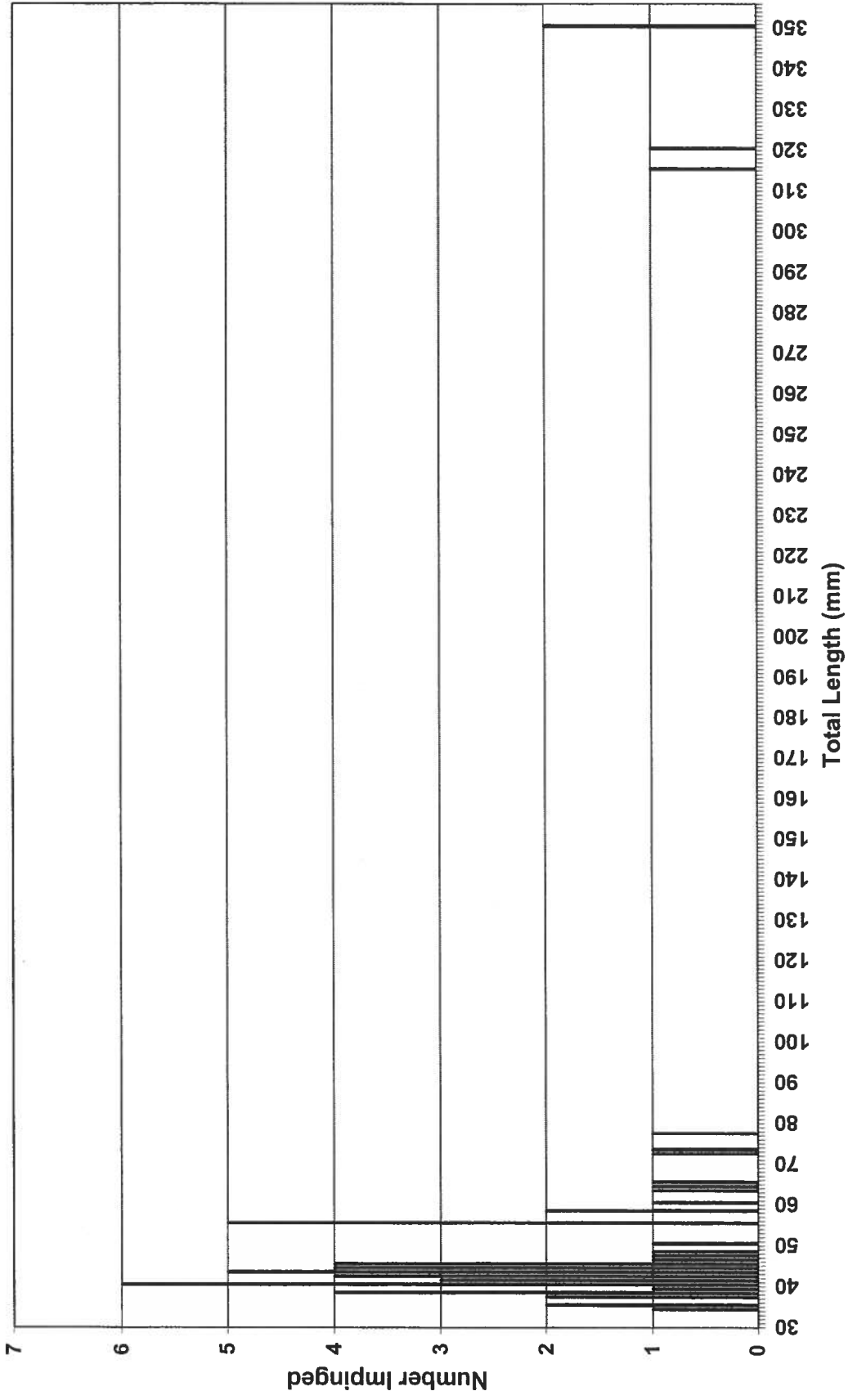


Figure 13. Total Daily Flow and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

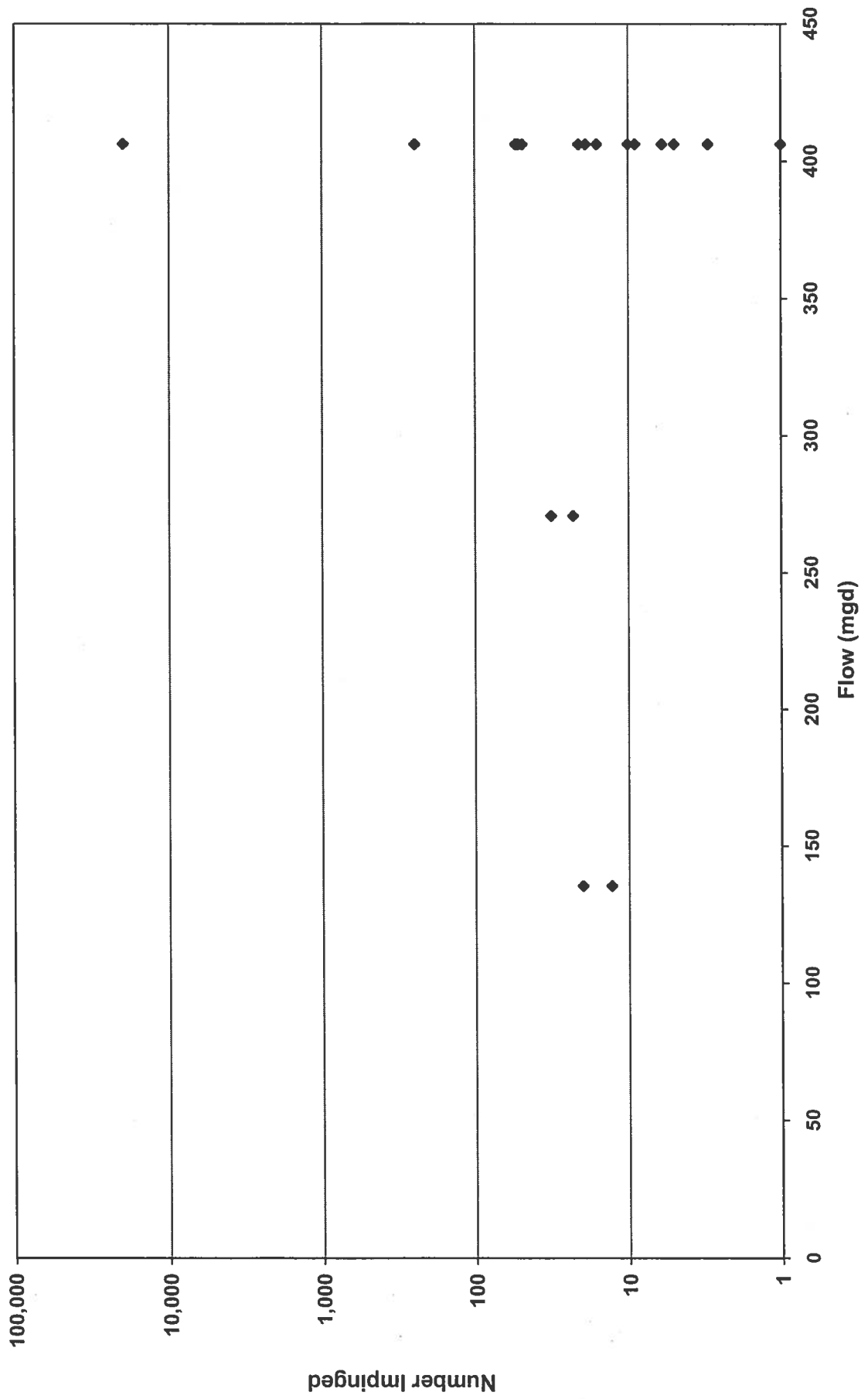


Figure 14. Through-Screen Velocity and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

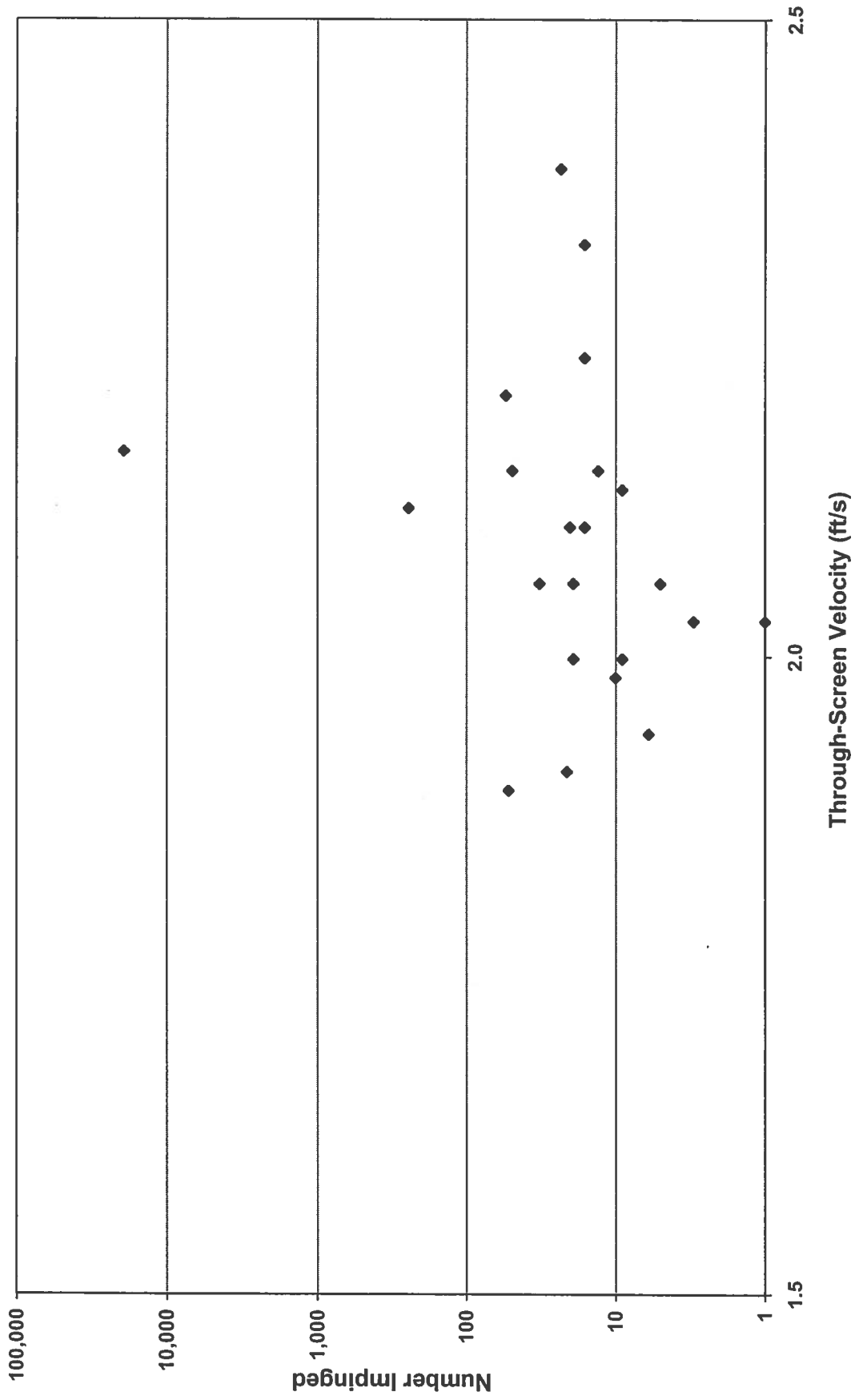


Figure 15. Reservoir Pool Elevation and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

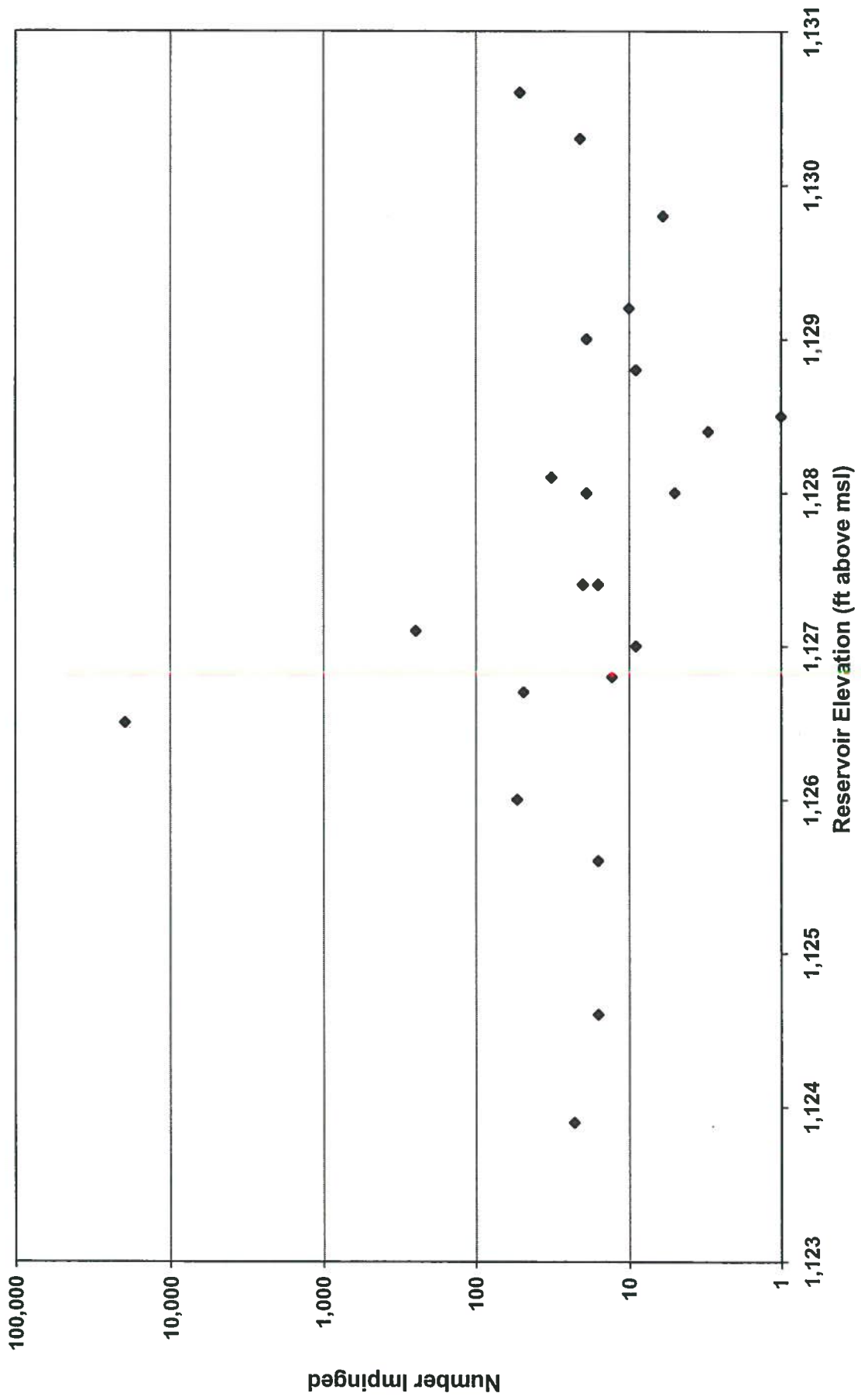


Figure 16. Mean Dissolved Oxygen and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

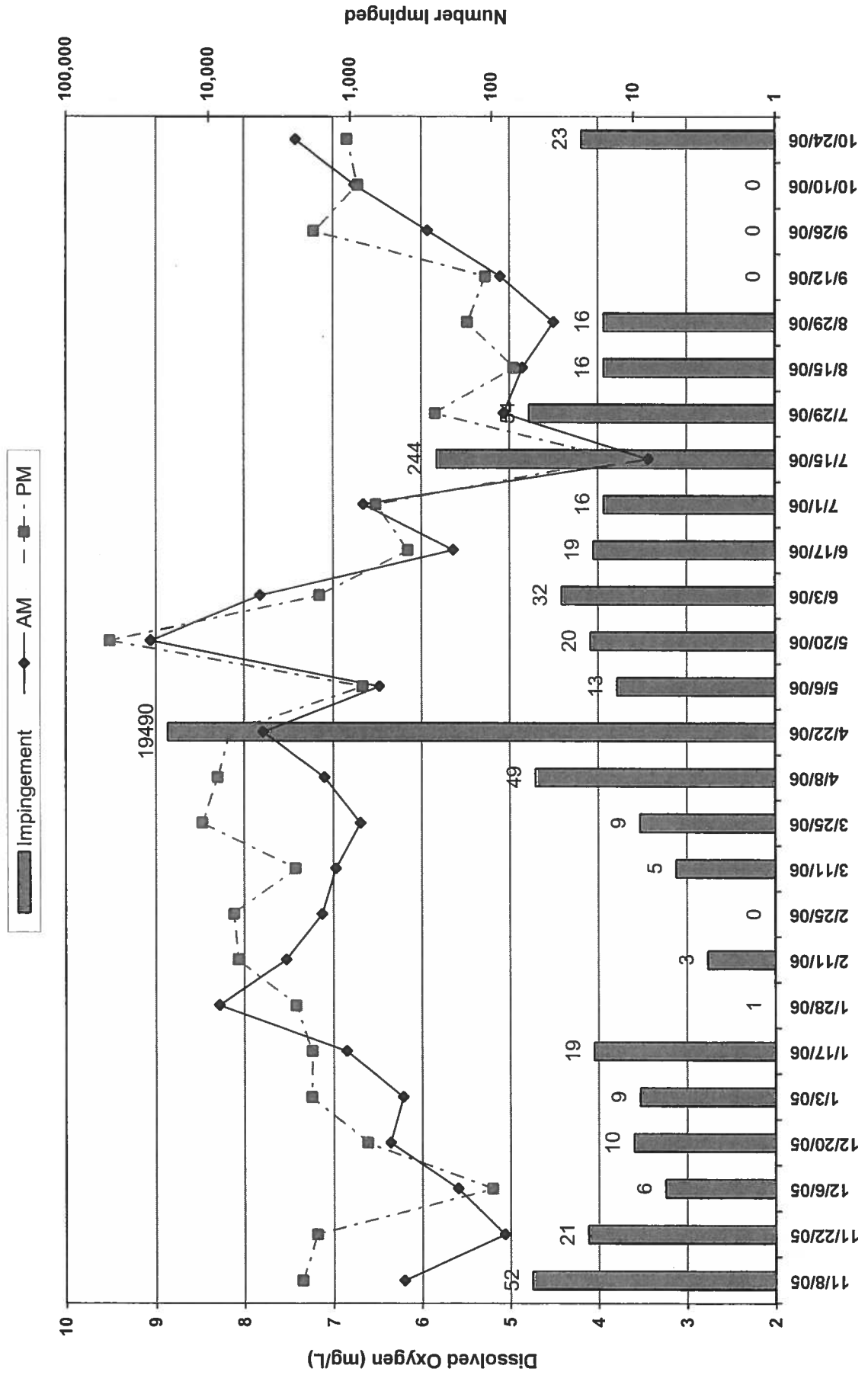


Figure 17. Mean Dissolved Oxygen and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

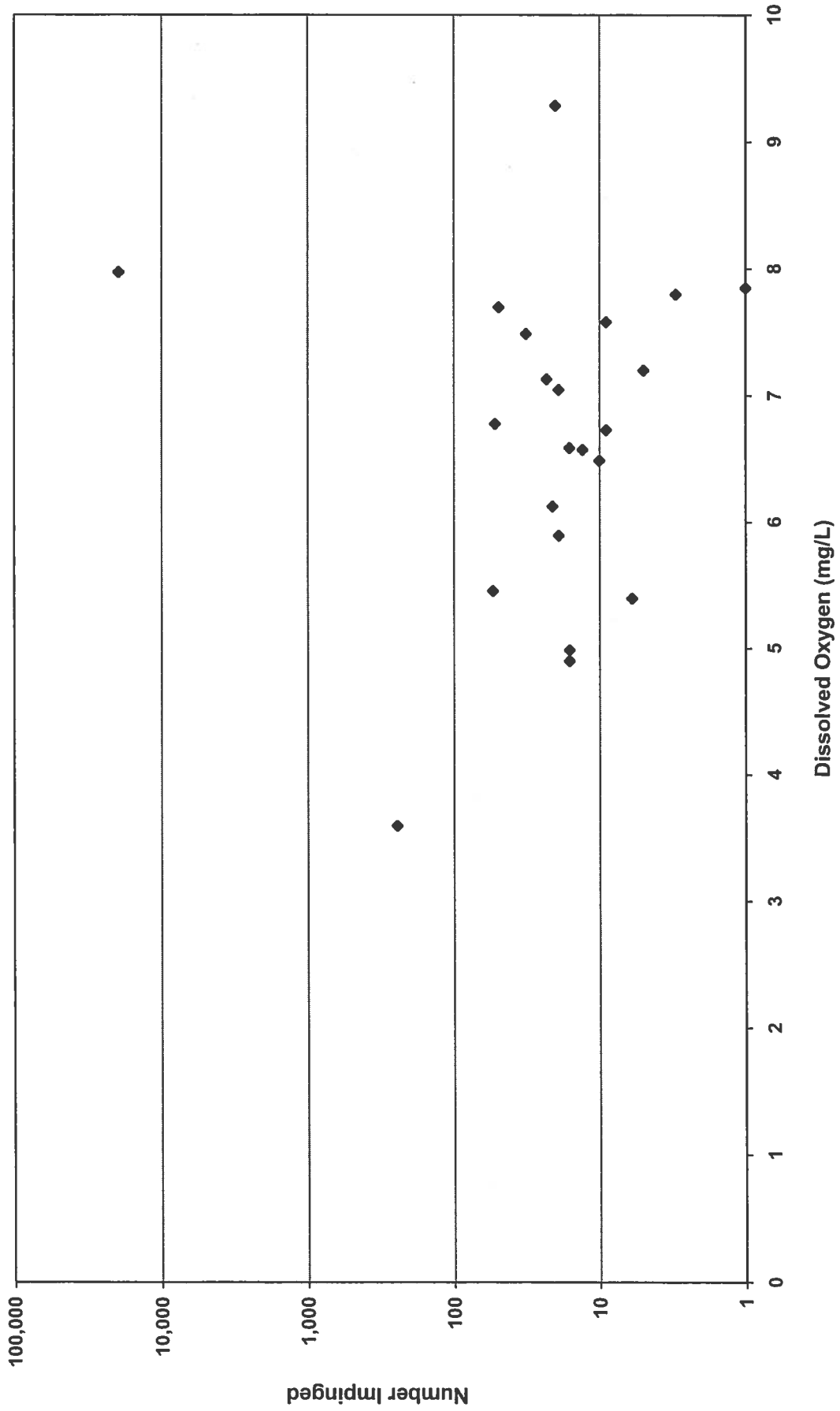


Figure 18. Mean Water Temperature and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

(Sampling was conducted but no fish were collected on 1/28/06, 2/25/06, 9/12/06, 9/26/06, and 10/10/06.)

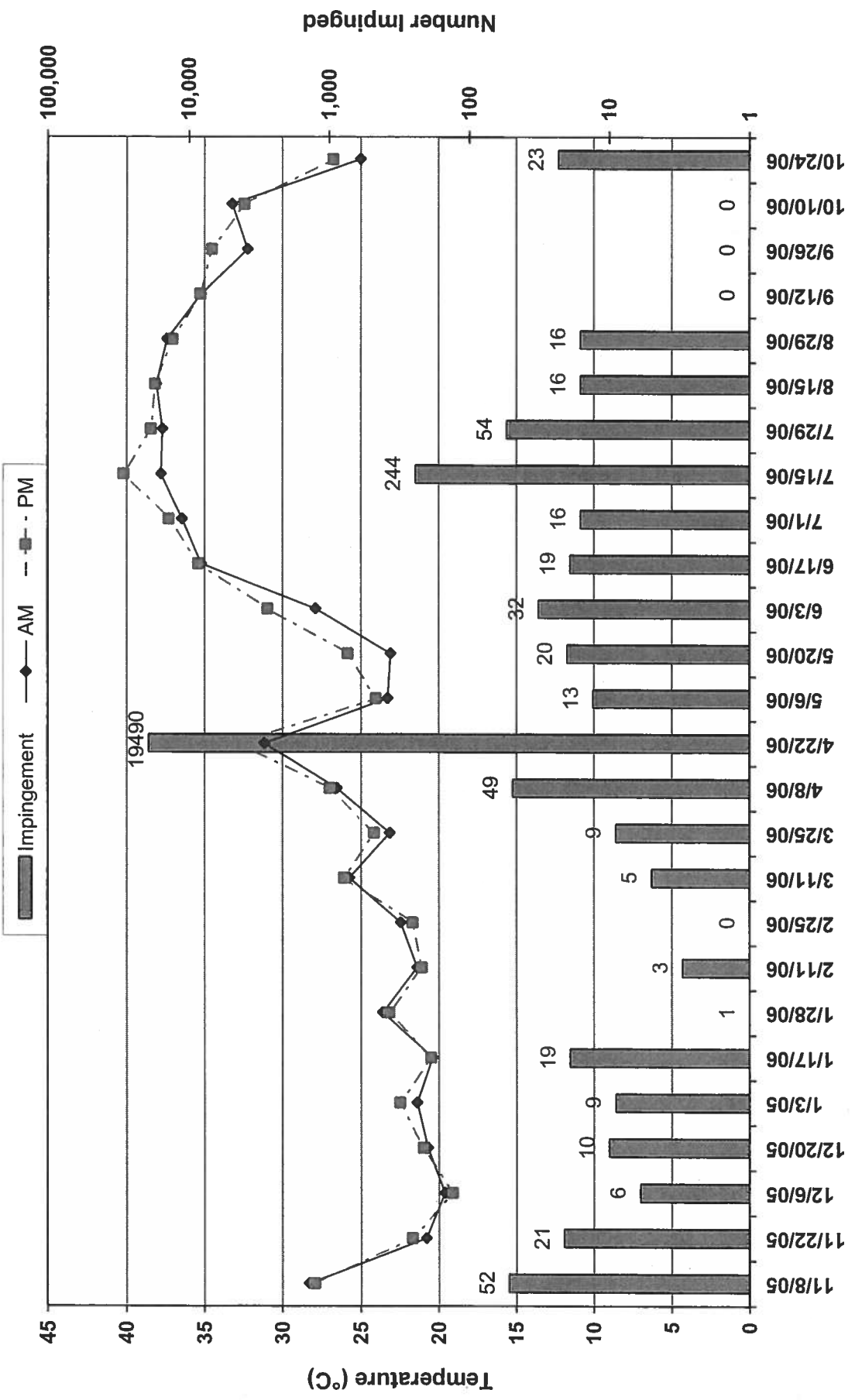


Figure 19. Mean Water Temperature and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

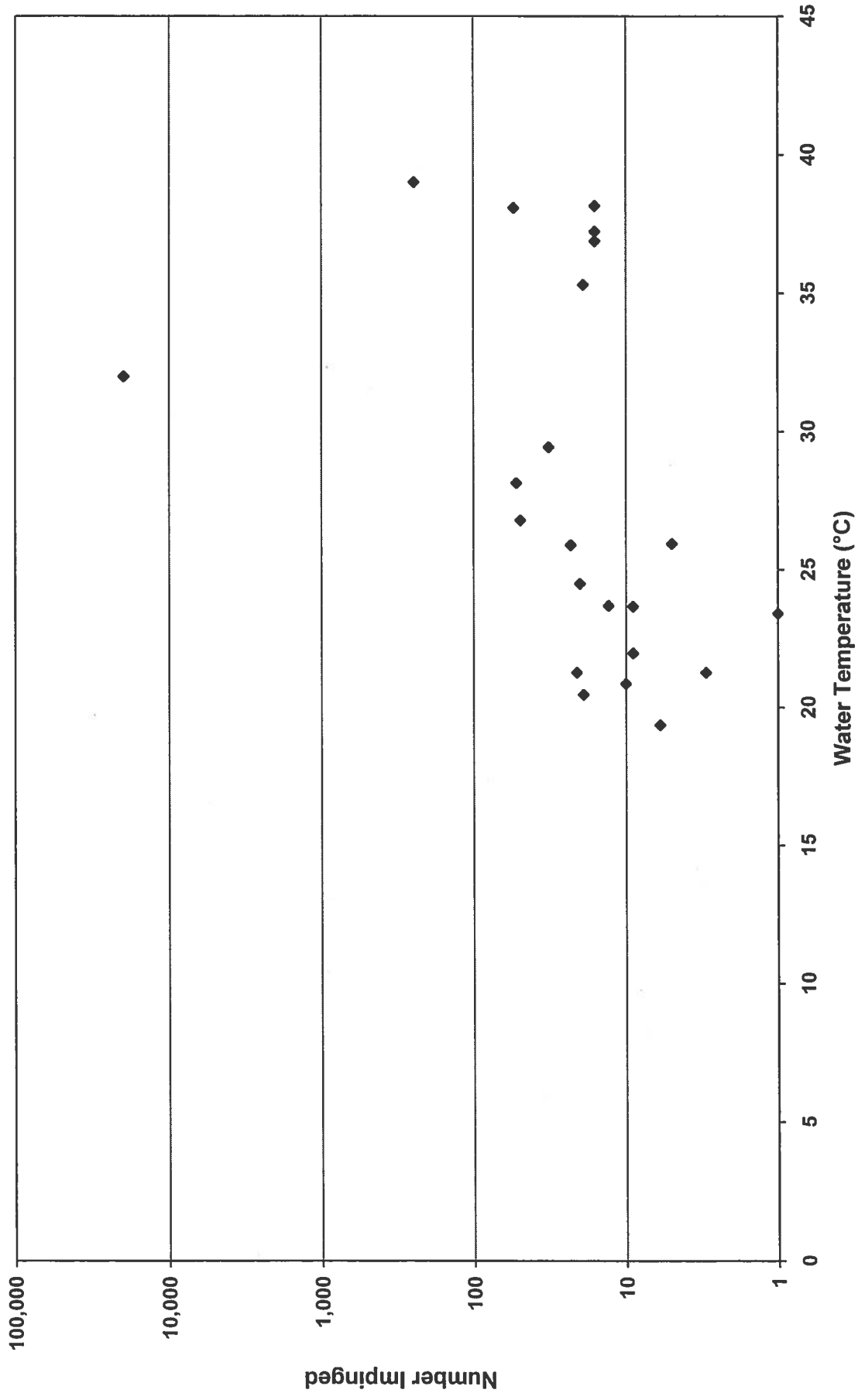


Figure 20. 24-Hour Change in Daily Mean Intake Water Temperature and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

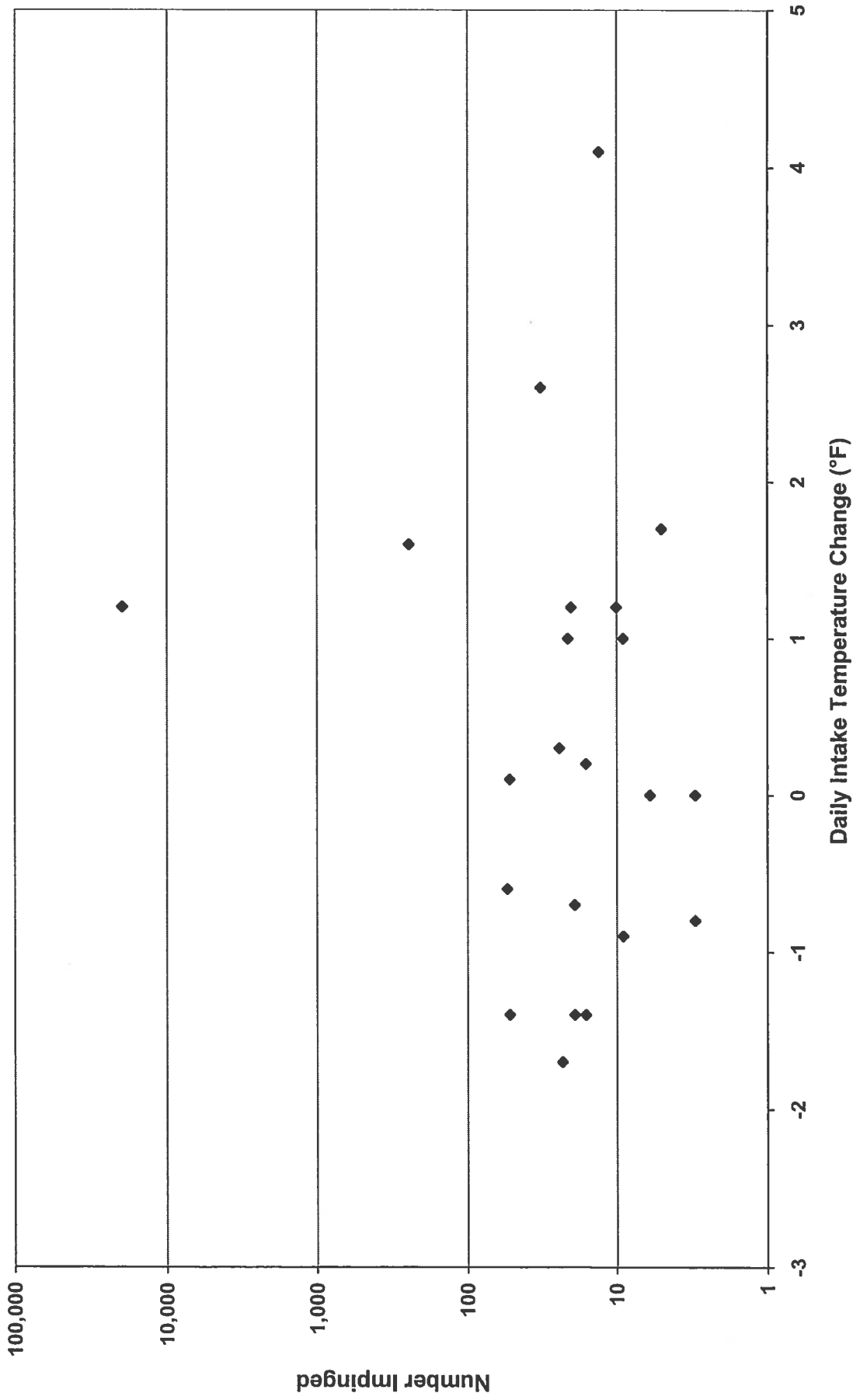


Figure 21. Absolute Additive Weekly Temperature Changes (Intake Daily Mean Temperature) and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

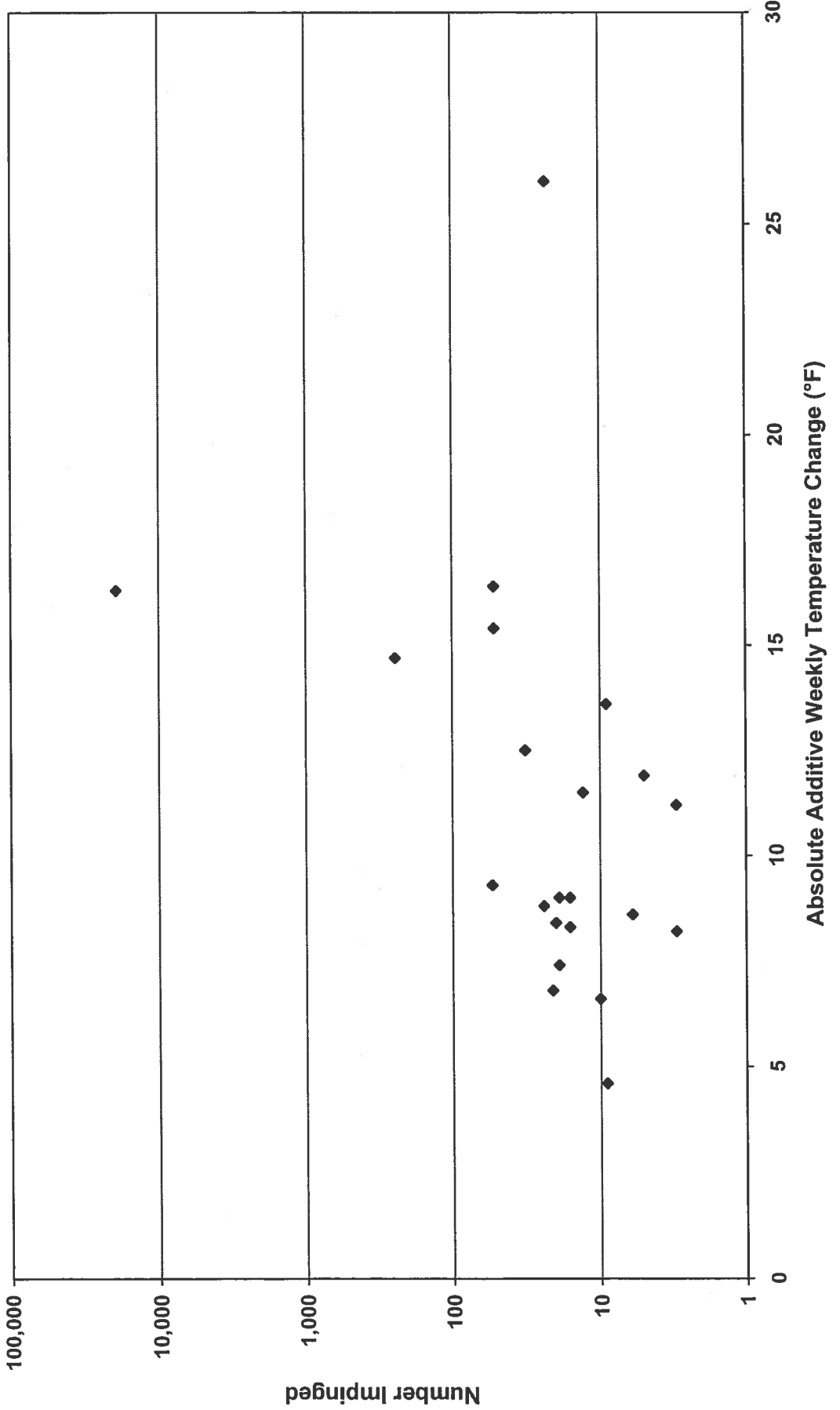


Figure 22. Mean Daily Air Temperature (NOAA, 2006) and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

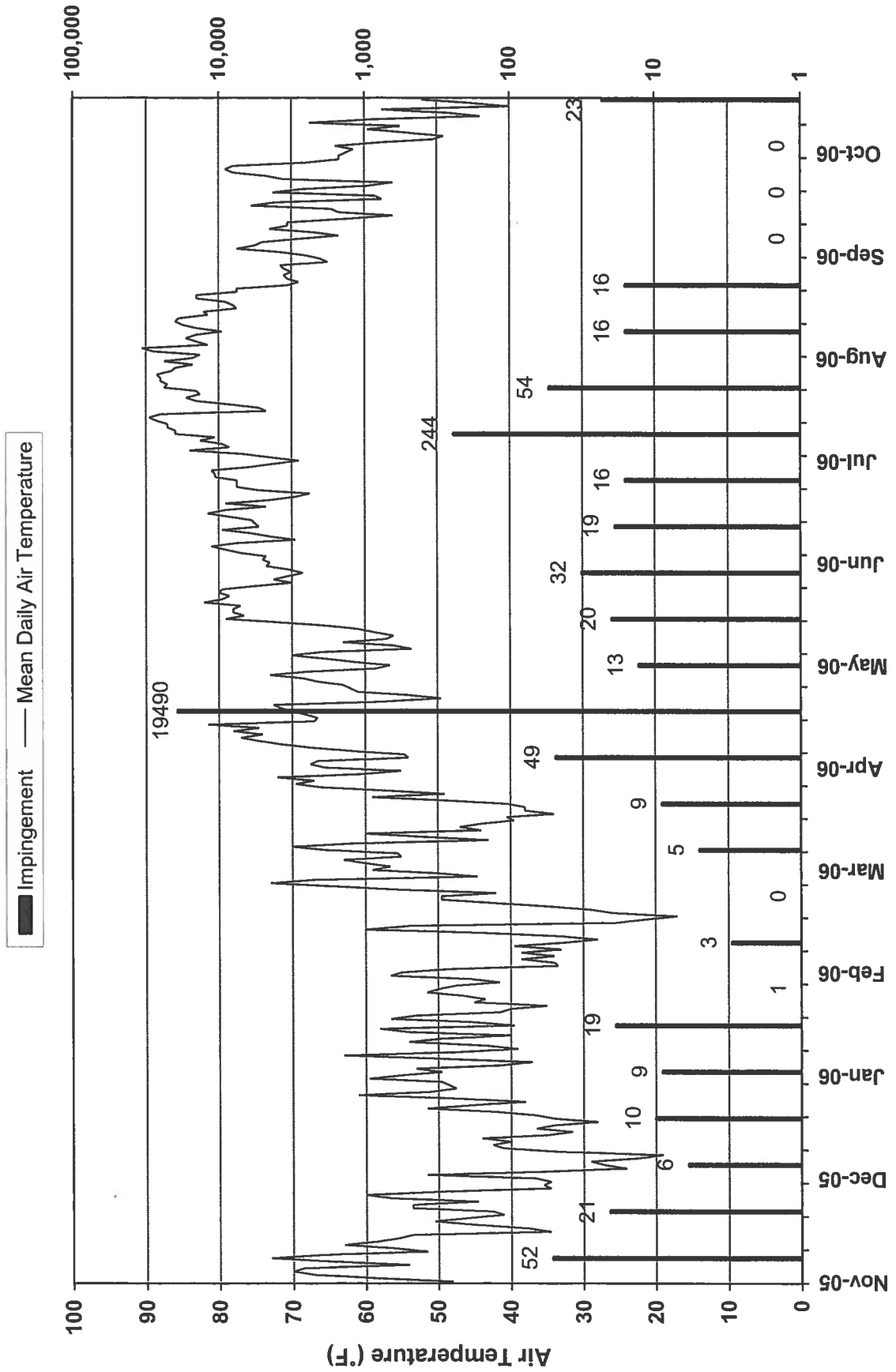


Figure 23. Mean Conductivity and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant

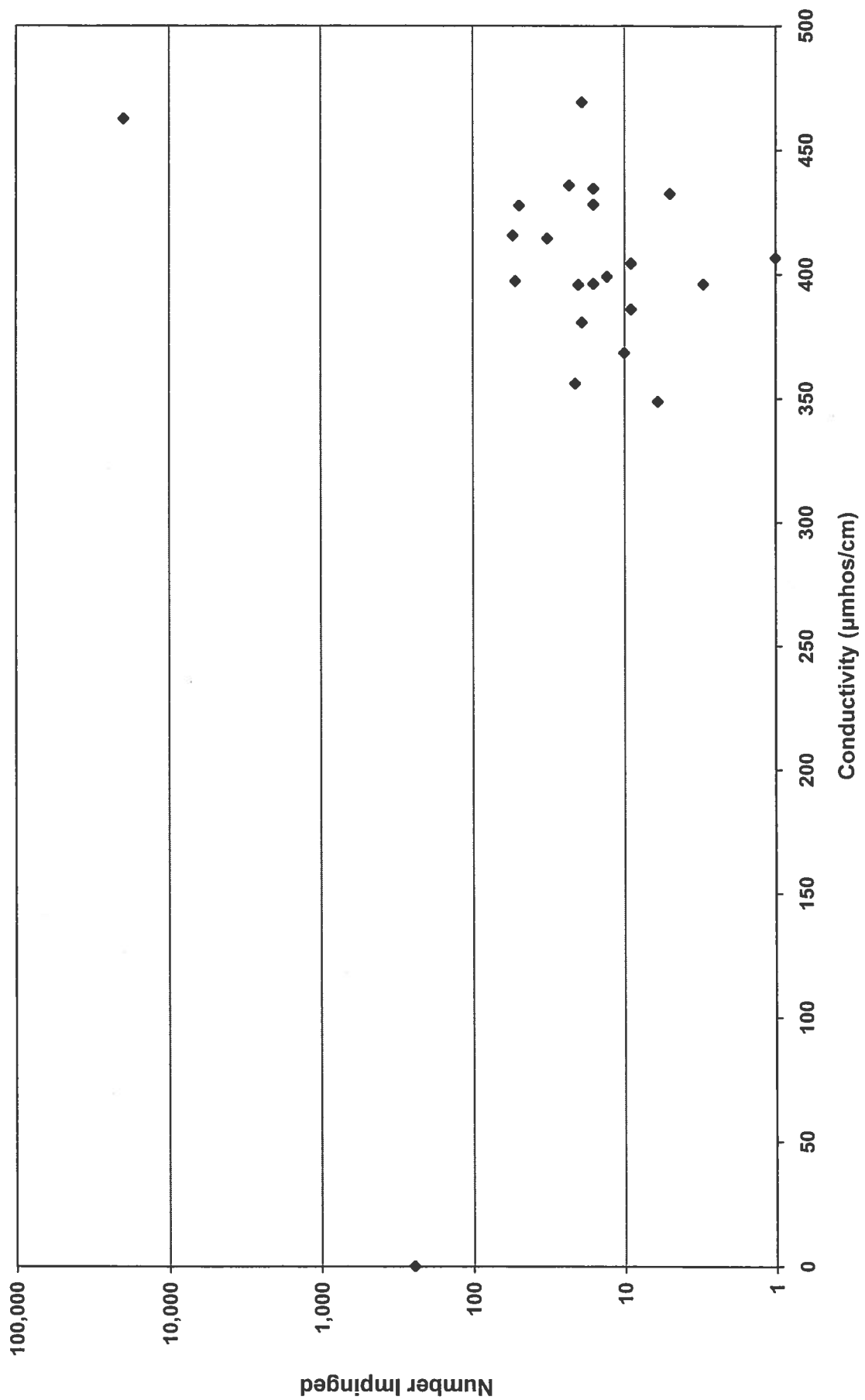
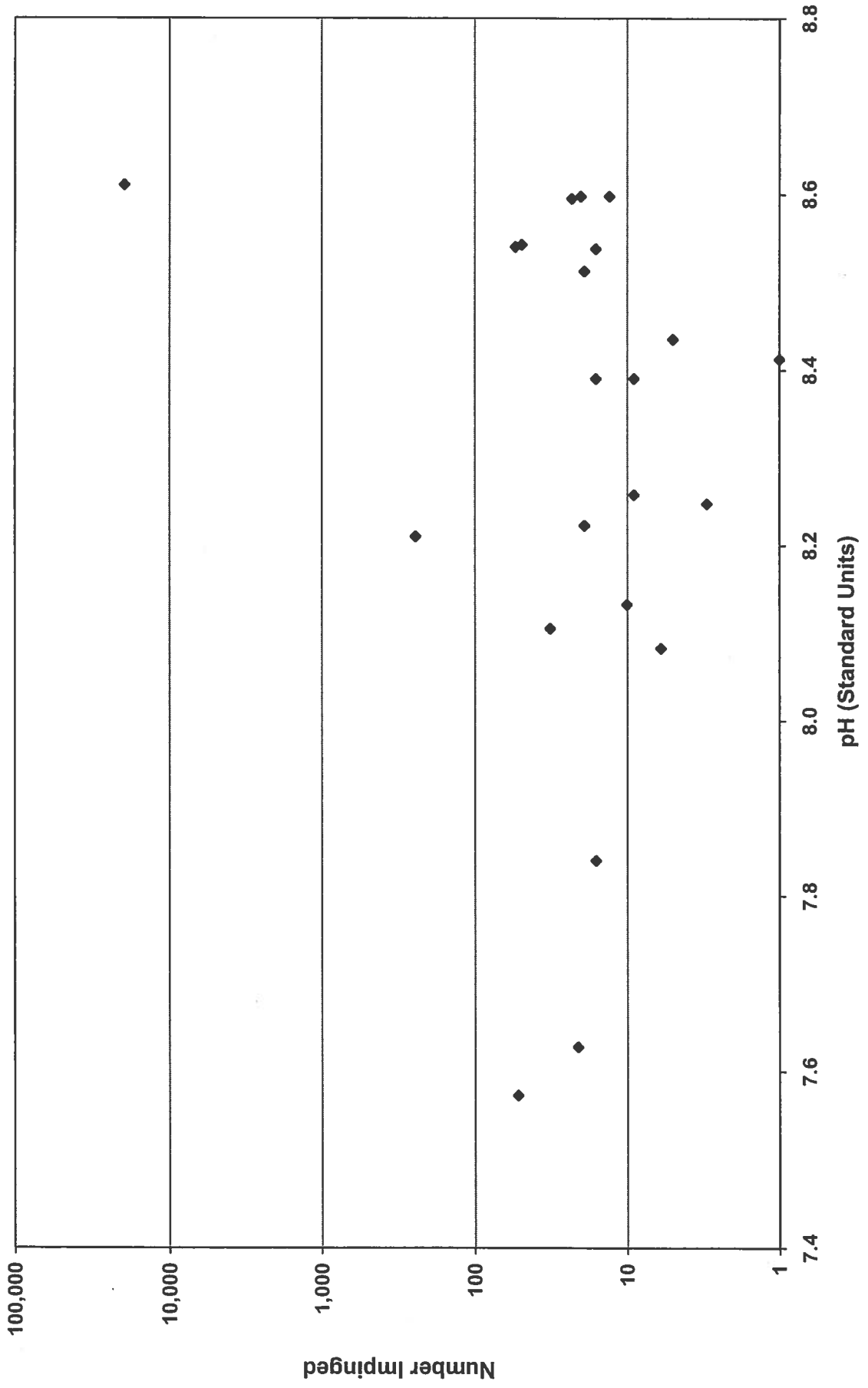


Figure 24. Mean pH and Total Number of Fish Collected in Impingement Samples, Flint Creek Power Plant



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Appendix A

Operator's Procedures

Impingement Sampling Methods for Flint Creek Power Station

The following sections provide methods for sampling and processing impinged organisms at the Flint Creek Power Station. Impingement sampling consists of scheduled operation and rinsing of the traveling water screens (screens), collection of organisms washed from the screens into collection baskets, field processing of samples, water-quality monitoring, and periodic sample-technique efficiency tests. Arkansas Tech University (ATU), subcontractor to PBS&J, has been contracted to perform the sample collection, sample processing, water-quality monitoring, and sample-technique efficiency testing. AEP facility staff will assist by operating the circulating pumps, washing the screens, addressing maintenance issues, and documenting withdrawal rates during each sample event. In the event that the circulating water pumps are not in operation during a scheduled sampling event, then an alternative sampling date may be used or the sample event will be dropped. However, due to the base-load at Flint Creek Power Station, this will probably not be an issue. Due to the logistics involved with sampling, AEP, PBS&J, and ATU staff will need to closely coordinate to ensure efficient and successful sample events.

1.0 Impingement Sampling

Impingement sampling will be conducted every-other-week (biweekly) over the course of 1 year (26 sample events per facility). However, the duration of the study might be extended if additional data are needed. ATU staff will collect and process impingement samples at the facility. It is expected that most samples can be processed at the locations in which the samples are taken. However, in the event of inclement weather, a sheltered area will be required. AEP facility staff will provide support by operating/washing the traveling water screens (screens) during each sample event. ATU staff will notify AEP facility staff prior to the pre-wash for each sample event to ensure that the pre-wash has been conducted to make sure an operator is available to operate the screens.

Each sample event will include two samples that represent impingement accruals over a 24-hour period. Samples events will include the collection of morning samples, which generally represent fauna that were impinged during the night and evening samples, which generally represent fauna that were impinged during the day. In order to collect the two samples, there will be a total of three screen washings. The first screen wash (pre-wash) will be performed in the evening to remove any accumulated debris or organisms from the screens. The second will be performed the next morning for the collection of the first sample. The third will be performed in the evening for the collection of the second (last) sample. Table 1 lists the times in which screen washing is to begin. The times are adjusted for changing day length and spring and fall time changes. ATU staff will meet with the facility staff immediately prior to the morning and evening samples.

PBS&J will provide a collection net to be inserted into the debris basket. The net will consist of a metal frame with ¼-inch delta netting attached to the frame. The collection net will be inserted

into the debris basket after the pre-wash. The net will remain in the debris basket between sample times in the event the screens auto-start. Length of screen wash will be for approximately 10 minutes or for enough time to allow for the screens to make one full revolution. Each unit/screen will be sampled independently. If a circulator is not in operation during the sample event, the screen will not be sampled. After each screen wash, ATU staff will inspect the sluiceway to make sure all organisms have been transported to the net.

ATU staff will collect all organisms from the net and process the samples on location. The organisms will be identified, counted, measured to total length (mm), and weighed (g). Each fish will be identified as alive, moribund, or dead upon collection. In the event that a large number (i.e. > 500) of fish are collected, then sub-sampling may be conducted. The method of sub-sampling will be documented. . Any organisms that cannot be identified in the field will be preserved with 10% formalin and returned to the laboratory for identification. Live fish will be returned to the lake and deceased fish will be disposed of on location.

Prior to the first sample event or at the time of the first sample event, the mechanics of the screen-wash system will be evaluated. Tagged, dead fish will be released in front of each screen in conjunction with the sample-efficiency testing described below. The sample process will be followed and during the screen wash, the screens and sluiceways will be inspected for problems such as low water pressure, misdirected spray nozzles, obstructions, etc. Any maintenance problems that might result in sample loss or prevent organisms from reaching the collection nets will need to be addressed. As discussed below, periodic efficiency testing will be conducted to ensure that the mechanics of the screen-wash system and sampling procedures are working properly.

1.3 Water Quality and Flow

Facility staff will be responsible for providing withdrawal rates for each unit at each facility for the duration of the study. For the sample events, facility staff will need to provide records of circulating pump operation to the nearest hour. In addition, any water quality parameters (including temperature) that the facility maintains at the intake over the course of the study will be provided to PBS&J.

ATU will collect basic water-quality parameters (temperature, dissolved oxygen, pH, and conductivity) with a multimeter at the time of each sample collection at about mid-depth in front of or adjacent to the bar screens. The quality assurance guidelines provided in the Proposal for Information Collection will be followed.

1.4 Sample-Technique Efficiency

Sample-technique efficiency will be demonstrated during the study by PBS&J and ATU staff. The purpose of this study will be to determine the number of fish collected/sampled from the

intake screen in relation to the total number of fish that are impinged and remain stationary on the screens. Two groups of freshly deceased fish (similar in size and species composition of fish that are normally impinged) will be introduced immediately in front of each screen. The fish will be fin-clipped (marked) to distinguish the difference between the study fish and those that are actually impinged. Each group will include at least 20 sunfish and/or shad similar in size (approximately 24 mm to 127 mm) to the fish that are normally impinged.

One group of marked fish will be released in front of the screens at the beginning of the 12-hour period and a second group of marked fish will be released in front of the screens immediately prior to sampling. Sampling will follow the same procedures previously described. This study will be conducted twice under normal operating conditions. One study will be conducted during the winter and the other study will be conducted during the summer to account for possible tissue deterioration and loss of individual organisms associated with higher water temperatures. It will be important to release the fish in front of screens that are serving pumps in operation.

Samples will be carefully checked for the presence of marked fish. Collection efficiency will be calculated for each inch-group using the equation below. Collection efficiency will be determined by averaging the two values.

$$\%e = \frac{r \times 100}{m}$$

Where: e = efficiency
m = number of marked fish
r = number of recovered fish

1.6 Data Management

ATU will collect and maintain all data described in the PICs. Field data will be recorded on field data sheets and later entered into a spreadsheet in a format specified by AEP. Data will be entered within 2 weeks of sample collection and provided with monthly reports to AEP.

IMPINGEMENT SAMPLING DATES AND TIMES

Flint Creek Power Station

Date	Prewash time	Sample wash time	Date	Prewash time	Sample wash time
Monday, November 07, 2005	4:45 PM		Friday, May 05, 2006	7:00 PM	
Tuesday, November 08, 2005		7:45 AM	Saturday, May 06, 2006		7:45 AM
Friday, November 18, 2005	4:30 PM		Friday, May 19, 2006	7:15 PM	
Saturday, November 19, 2005		8:00 AM	Saturday, May 20, 2006		7:30 AM
Friday, December 02, 2005	4:30 PM		Friday, June 02, 2006	7:30 PM	
Saturday, December 03, 2005		8:00 AM	Saturday, June 03, 2006		7:30 AM
Friday, December 16, 2005	4:30 PM		Friday, June 16, 2006	7:30 PM	
Saturday, December 17, 2005		8:15 AM	Saturday, June 17, 2006		7:30 AM
Friday, December 30, 2005	4:45 PM		Friday, June 30, 2006	7:30 PM	
Saturday, December 31, 2005		8:15 AM	Saturday, July 01, 2006		7:30 AM
Friday, January 13, 2006	4:45 PM		Friday, July 14, 2006	7:30 PM	
Saturday, January 14, 2006		8:30 AM	Saturday, July 15, 2006		7:30 AM
Friday, January 27, 2006	5:00 PM		Friday, July 28, 2006	7:30 PM	
Saturday, January 28, 2006		8:30 AM	Saturday, July 29, 2006		7:45 AM
Friday, February 10, 2006	5:15 PM		Friday, August 11, 2006	7:15 PM	
Saturday, February 11, 2006		8:15 AM	Saturday, August 12, 2006		7:45 AM
Friday, February 24, 2006	5:30 PM		Friday, August 25, 2006	7:00 PM	
Saturday, February 25, 2006		8:00 AM	Saturday, August 26, 2006		8:00 AM
Friday, March 10, 2006	5:30 PM		Friday, September 08, 2006	6:30 PM	
Saturday, March 11, 2006		7:45 AM	Saturday, September 09, 2006		8:15 AM
Friday, March 24, 2006	5:45 PM		Friday, September 22, 2006	6:30 PM	
Saturday, March 25, 2006		7:30 AM	Saturday, September 23, 2006		8:15 AM
Friday, April 07, 2006	6:45 PM		Friday, October 06, 2006	6:00 PM	
Saturday, April 08, 2006		8:15 AM	Saturday, October 07, 2006		8:30 AM
Friday, April 21, 2006	7:00 PM		Friday, October 20, 2006	6:00 PM	
Saturday, April 22, 2006		8:00 AM	Saturday, October 21, 2006		8:30 AM

Appendix B

Field Data Sheets

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 11/22/2005

Time: AM 8:00 PM 4:30

Sample Period ID Code AM: FLPP-2

Sample Period ID Code PM: FLPP-2

Field Crew: Matt Horton

Weather: AM Clear sky, no wind

PM Partly cloudy, 0-5mph wind

Total Depth: 4 m

Air Temperature: AM 8.7 °C

Air Temperature: PM 16.9 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3		7.45	20.8	
Surface	1		7.65	20.8	351.4 μ S
PM					
Mid	3		7.68	21.7	
Surface	1		7.73	21.7	

Notes: AM ~~Mid~~ Surface Mid PM Surf. Mid

%	63.6	%	47.8	%	80.5%	%	81.3%
?	5.67 mg/L		4.45 mg/L		7.24 mg/L		7.13 mg/L
calibration	383.8 μ S °C		352.8 μ S		359.4 μ S		360.0 μ S
99.6% Error	0.2 ppt		383.4 μ S °C		383.8 μ S °C		384.2 μ S °C
95.8%	351.4 μ S		0.2 ppt		0.2 ppt		0.2 ppt
cal 95.6	cal 99.6 %						cal 99.6 %

* had problems w/ pH meter upper recalibration - about .37 above 7.00
Checked / Measured scale with 1, 10, + 50g weights

Authorization Signature: [Signature]

Date: 11/28/05

12/28/05

FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
IMPINGEMENT MONITORING

Study Location: Flint Creek Date: 11/22/2005 Wash Time: 2:00 A.M.

Field Crew: Matt Horton

Sampling Period ID Code: FCPP-2

Circulating Pumps In Operation: A B C

Screens Sampled: A B C

Species	38	35	35	36	32	33	40	35	33	35	37	34	34	Total
	NA	35	35	36	32	33	40	35	33	35	37	34	34	
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0	1 DOA
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0	
Greensunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	20 Fish
														10 Fish
														1 Fish
														22 Fish #
														10g

Authorization Signature: [Signature] Date: 11/28/05

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 12/06/2005

Time: AM 8:00 PM 4:30

Sample Period ID Code AM: F CPP-3

Sample Period ID Code PM: F CPP-3

Field Crew: Matt Horton

Weather: AM clear sky, no wind, very cold!

PM clear sky, 5mph wind

Total Depth: 4 m

Air Temperature: AM -2.6 °C

Air Temperature: PM 6.6 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	5.59	8.06	19.6	350.5
Surface	1	5.59	8.10	19.6	350.0
PM					
Mid	3	5.20	8.10	19.1	347.5
Surface	1	5.20	8.07	19.1	347.0

Notes: pH seemed high? I calibrated and tested 3 times.
Tested scale w/ 1.30, +50g weights

7.08 + 4.01 98.2% EFF (PH) pH calibration

DOs lower than expected, but meter recalibrates correctly

Authorization Signature: [Signature]

Date: 12/14/05

12/28/05

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 12/20/2005

Time: AM 8:15 PM 4:30

Sample Period ID Code AM: FCPP4-AM

Sample Period ID Code PM: FCPP-4-PM

Field Crew: Matt Horton

Weather: AM 5mph wind; overcast; lightly snowing
PM 5-10mph wind; overcast

Total Depth: 4 m

Air Temperature: AM 0.0 °C

Air Temperature: PM 1.7 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	6.26	8.14	20.7	366.7
Surface	1	6.45	8.13	20.7	366.2
PM					
Mid	3	6.60	8.09	21.0	370.2
Surface	1	6.63	8.17	21.0	370.2

Notes: Screens got washed at 2:00 a.m. by accident.
1, 10, 50 g weights tested

WERE SCHEDULED @ 4:30 p.m.

Authorization Signature: [Signature]
CH

Date: 12/29/06
1/30/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 01/03/2006

Time: AM 8:15 PM 4:45

Sample Period ID Code AM: FCPP-5-AM

Sample Period ID Code PM: FCPP-5-AM

Field Crew: Matt Horton

Weather: AM Clear + Calm

PM Clear, 5mph wind

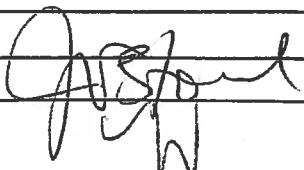
Total Depth: 4 m

Air Temperature: AM 4.0 °C

Air Temperature: PM 19.8 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	6.21	8.25	21.4	381.3
Surface	1	6.21	8.23	21.4	381.0
PM					
Mid	3	7.23	8.28	22.5	390.7
Surface	1	7.26	8.27	22.5	390.5

Notes: Weighed with 1, 10, 50g
Calibrated pH with 7.00 + 4.01 buffers

Authorization Signature: 

Date: 1/3/06
11/30/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 01/17/2006

Time: AM 8:30 PM 4:45

Sample Period ID Code AM: FLPP-6-AM

Sample Period ID Code PM: FLPP-6-PM

Field Crew: Matt Horton

Weather: AM cloudy w/15-30mph winds

PM cloudy w/15-30mph winds

Total Depth: 4 m

Air Temperature: AM 2 °C

Air Temperature: PM 4.2 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	6.85	8.22	20.4	380.0
Surface	1	6.85	8.21	20.4	380.0
PM					
Mid	3	7.18	8.24	20.5	381.1
Surface	1	7.30	8.22	20.5	381.1

Notes: Used 1, 10, 50g weights to check scale.

Authorization Signature: 

Date: 1/24/06

1/26/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 01/28/2006 Time: AM 8:30 PM 5:00

Sample Period ID Code AM: FLCP-7-AM Sample Period ID Code PM: FLCP-7-PM

Field Crew: Matt Horton

Weather: AM S-10mph wind, + rain

PM 5mph wind

Total Depth: 4 m Air Temperature: AM 11.1 °C

Air Temperature: PM 14.6 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	8.24	8.44	23.6	408.8
Surface	1	8.32	8.42	23.6	408.4
PM					
Mid	3	7.40	8.40	23.2	404.8
Surface	1	7.44	8.39	23.2	404.6

Notes: Calibrated weight scale w/ 1, 10 & 50 g weights

Authorization Signature: [Signature] Date: 2/1/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 02/11/2006

Time: AM 8:15 PM 5:15

Sample Period ID Code AM: FCPP-8-AM

Sample Period ID Code PM: FCPP-8-PM

Field Crew: Matt Horton

Weather: AM Cloudy, snowing, 15-30mph wind

PM Cloudy, snowing, 20-30mph winds

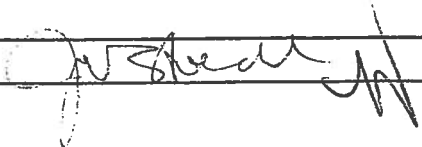
Total Depth: 4 m

Air Temperature: AM -2 °C

Air Temperature: PM -1 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	7.52	8.24	21.4	397.6
Surface	1	7.54	8.24	21.4	397.4
PM					
Mid	3	8.05	8.26	21.1	394.6
Surface	1	8.08	8.25	21.1	394.6

Notes: Used 1, 10, 50g weights to calibrate scale.

Authorization Signature: 

Date: 2/13/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 02/25/2006

Time: AM 8:00

PM 5:30

Sample Period ID Code AM: FCPP-9-AM

Sample Period ID Code PM: FCPP-9-PM

Field Crew: Matt Heston, Jason Thornberry

Weather: AM Partly cloudy 5-10 mph wind

PM Clear sky 5-10 mph wind

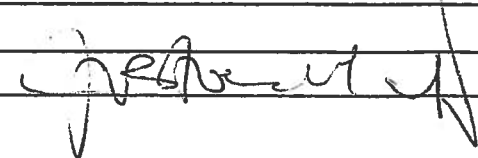
Total Depth: 4 m

Air Temperature: AM 11.7 °C

Air Temperature: PM 19.7 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	7.08	8.54	22.7	409.5
Surface	1	7.17	8.46	22.2	409.5
PM					
Mid	3	8.09	8.42	21.7	400.4
Surface	1	8.14	8.27	21.7	399.8

Notes:

Authorization Signature: 

Date: 2/28/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: March 11 2006 Time: AM 7:45 PM 5:30

Sample Period ID Code AM: FCPP-10-AM Sample Period ID Code PM: FCPP-10-PM

Field Crew: Jason Throneberry Tate Wentz

Weather: AM Partly cloudy

PM Mostly sunny; windy; followed by t-storms

Total Depth: 3 m Air Temperature: AM 18.6 °C

Air Temperature: PM 26.5 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	6.87	8.47	26.1	437.9
Surface	1	7.07	8.46	25.4	436.7
PM					
Mid	3	7.03	8.38	25.5	432.0
Surface	1	7.82	8.43	26.7	435.2

Notes: _____

Authorization Signature: J. Stoeckl Date: 3/13/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 03/25/2006

Time: AM 7:30 PM 5:45

Sample Period ID Code AM: FCPP-11-AM

Sample Period ID Code PM: FCPP-11-PM

Field Crew: Matt Horton

Weather: AM clear sky, SmpH wind

PM

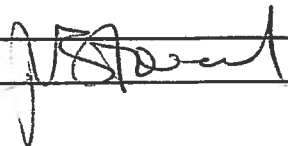
Total Depth: 4 m

Air Temperature: AM 8.8 °C

Air Temperature: PM 17.2 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	6.66	8.38	23.2	399.5
Surface	1	6.72	8.35	23.1	399.1
PM					
Mid	3	8.45	8.43	24.1	409.5
Surface	1	8.49	8.40	24.2	409.5

Notes: Used 1, 10, 50 g weights to cal. scale.
Used 7.00 & 10.00 buffers to calibrate pH meter. - data
also used 4.01 & 7.00 buffers to cal. pH meter - compared
to data 8.40 surf., 8.42 mid

Authorization Signature: 

Date: 3/28/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 04/08/2006 Time: AM 8:15 PM 6:45

Sample Period ID Code AM: F CPP-12-AM Sample Period ID Code PM: F CPP-12-PM

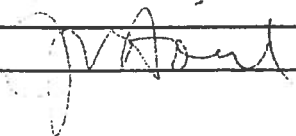
Field Crew: Matt Horton

Weather: AM cloudy, westerly wind @ 10-15 mph
PM Sunny, calm

Total Depth: 4 m Air Temperature: AM 9.1 °C
Air Temperature: PM 26.0 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	7.08	8.55	26.6	426.7
Surface	1	7.11	8.51	26.5	426.3
PM					
Mid	3	8.28	8.57	27.0	429.0
Surface	1	8.31	8.54	27.0	428.5

Notes: _____

Authorization Signature:  Date: 4/12/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 04/22/2006 Time: AM 8:00 PM 7:00

Sample Period ID Code AM: F CPP-13-AM Sample Period ID Code PM: F CPP-13-PM

Field Crew: Matt Horton

Weather: AM Clear, Calm

PM Clear, Windy 10-15mph

Total Depth: 4 m Air Temperature: AM 25.6 °C

Air Temperature: PM 30.8 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	7.76	8.57	31.0	460.0
Surface	1	7.81	8.60	31.3	459.3
PM					
Mid	3	8.13	8.62	32.8	465.4
Surface	1	8.18	8.65	32.8	465.5

Notes: Water is full of algae.

Authorization Signature: [Signature] Date: 4/25/06

Initial total weight 14728g w/ trash
~~Final total weight 11230g~~
 Estimated total weight 7300g w/ trash

AM Sample

26	27	28	29	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
18	23	21	10	65	123	100	97	110	86	148	80	252	100	95	70	63	103	37	17	6	19
2	2	1		9	30	21	22	32	21	54	30	103	63	62	50	40	70	30	14g	5g	15g

3400
 3415
 3505
 2800

10% subsample lengths (mm)

50	51	52	53	54	55
30	0	0	10	38	0
30	0	0	40	40	0 g

X10
 100%

100% Fish #s + lengths

26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
180	230	210	100	0	0	650	1230	1000	970	1100	860	1420	800	2520	1000	950	700	630	1030	370	170
10	20	20	10	0	0	90	30	210	220	320	210	540	300	1030	630	620	500	400	700	300	140 g

48	49	50	51	52	53	54	55
60	190	300	0	0	100	380	0
50	150	300	0	0	100	400	0 g

Total: 17,150 fish
 10,728g w/ trash
 7,265g estimate w/ trash

lots of trash (algae) in w/ shad.

1628g
+ 503g
2131g x .1 = 213.1g

Initial Total weight 2131g w/ trash PM Sample
Estimated total weight 1205 w/o trash
10% Subsample
213.1g

0.5
x 10
5.0

10% subsample

mm	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	mm
#	2	4	7	29	20	16	12	13	12	18	9	20	11	15	9	8	4	4	2	2	4	2	
g	25	1	2	12	9	7	6	9	4	8	4	12	6	9	7	7	3	3	2	2	4	3	

10% x 10 = 100% sample estimate

mm	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	Total	# Fish
g	20	40	70	290	200	160	120	180	120	180	90	260	110	150	90	80	40	20	20	40	20	20	2,280	
g	5	10	20	120	90	70	60	90	40	80	40	120	60	90	70	30	30	70	20	40	30	40	1,205	g

2,280 Fish

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
IMPINGEMENT MONITORING**

Study Location: Flint Creek Date: 04/22/2006 Wash Time: 8:00 PM

Field Crew: Matt Horton

Sampling Period ID Code: FCPP-13-PM

Circulating Pumps in Operation: A B C

Screens Sampled: A B C

Species	Total Length (mm)	Total Weight (g)	Returned Alive (A)	Retained Dead (D)	Morbid (M)	Dead on Arrival (DOA)	Total
LMB	77	58	57	72	D	58	1F, 36S
	43	41	42				14F, 32S
Green Sunfish							1F, 7S
BG	53	50	42	17	88		5F, 7S
Threadfin Shad	37	24	35	34	90	39	1F, 103S, 36C
FCPP 10% Subsample	42	44	45	48	40	50	1F, 88S
→	57	57	57	47	30	49	* 2280F 1200S

Authorization Signature: [Signature] Date: 4/25/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 05/06/2006

Time: AM 7:45 PM 7:00

Sample Period ID Code AM: F CPP-14-AM

Sample Period ID Code PM: F CPP-14-AM

Field Crew: Matt Horton

Weather: AM 15-20 mph wind / rainy

PM 10-15 mph wind / rainy

Total Depth: 4 m

Air Temperature: AM 18.3 °C

Air Temperature: PM 17.6 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	6.43	8.57	23.3	398.6
Surface	1	6.52	8.52	23.3	398.6
					378.6
PM					
Mid	3	6.63	8.67	24.0	399.4
Surface	1	6.70	8.63	24.1	399.5

Notes: Used 7.0 + 10.0 buffers, used 1, 10, 50 g weights to calibrate scale.

- Only screen C was washed. Other two were turned off during the AM sample

- Only screens A + C were washed during the PM sample.

Authorization Signature: [Signature]

Date: 5/11/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 5-20-06

Time: AM 8:00am PM

Sample Period ID Code AM: FCPP-15-am

Sample Period ID Code PM: FCPP-15-PM

Field Crew: Matt Horton / Tate Wentz

Weather: AM Clear + calm

PM partly cloudy

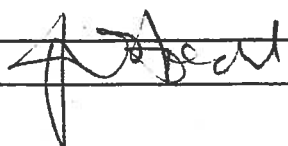
Total Depth: m

Air Temperature: AM 24.4 °C

Air Temperature: PM 32.7 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	8.43	8.63	23.0	386.8
Surface	1	9.68	8.53	23.2	386.8
PM					
Mid	3	9.38	8.61	25.2	399.2
Surface	1	9.64	8.62	26.5 26.5	410.3

Notes: _____

Authorization Signature: 

Date: 5/24/06

L
**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
 WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 13 JUNE 2006

Time: AM 8:00 PM 6:45

Sample Period ID Code AM: F CPP-16-AM

Sample Period ID Code PM: F CPP-16-PM

Field Crew: Tate Wentz

Weather: AM partly cloudy

PM partly cloudy

Total Depth: 3 m

Air Temperature: AM 20.5 °C

Air Temperature: PM 33.6 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	7.73	8.26	27.9	402.9
Surface	1	7.91	8.24	27.9	403.0
PM					
Mid	3	7.05	8.02	30.9	426.4
Surface	1	7.25	7.90	31.0	425.2

Notes: _____

Authorization Signature: [Signature]

Date: 6/17/2006

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 17 June 2006

Time: AM 8:30 PM 7:00

Sample Period ID Code AM: F CPP-17-AM

Sample Period ID Code PM: F CPP-17-PM

Field Crew: Wenta, Rigsby, McKee

Weather: AM Cloudy, rain

PM Cloudy, windy

Total Depth: 3 m

Air Temperature: AM 23.2 °C

Air Temperature: PM 29.1 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3	5.59	8.40	35.3	468.3
Surface	1	5.68	8.48	35.10	467.6
PM					
Mid	3	5.80	8.60	35.50	470.5
Surface	1	6.50	7.57	35.70	470.2

Notes: _____

Authorization Signature: A. Hocht

Date: 21 June 2006

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 7-1-06

Time: AM 7:30

PM 1921

Sample Period ID Code AM: _____

Sample Period ID Code PM: _____

Field Crew: Chris McKee

Weather: AM Sunny and clear calm to light winds

PM clear 4-7 mph winds

Total Depth: 2.5 m

Air Temperature: AM 29.5 °C

Air Temperature: PM 40.2 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	<u>2m</u>	<u>6.26</u>	<u>8.29</u>	<u>36.6</u>	<u>400.3</u>
Surface	<u>1m</u>	<u>7.05</u>	<u>8.25</u>	<u>36.3</u>	<u>399</u>
PM					
Mid	<u>2m</u>	<u>6.28</u>	<u>7.32</u>	<u>37.1</u>	<u>393.0</u>
Surface	<u>1m</u>	<u>6.75</u>	<u>7.50</u>	<u>37.5</u>	<u>392.4</u>

Notes: 7:30 PM wash was unable to continue for the full 15 minutes. Algae clogged the net causing it to overflow. The wash was stopped and continued for another 3 minutes but the problem persisted. The total wash time was 8 minutes.

The pH meter would not calibrate therefore the pH readings are most likely inaccurate

Authorization Signature: Chris McKee

Date: 7-1-06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 7-15-06 Time: AM 7:00 PM 7:00

Sample Period ID Code AM: F CPP - 19 - AM Sample Period ID Code PM: F CPP - 19 - PM

Field Crew: Rigsby

Weather: AM Overcast

PM Overcast

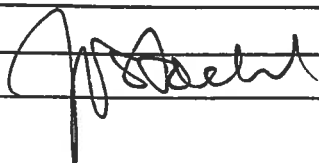
Total Depth: m Air Temperature: AM °C

Air Temperature: PM °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3 m	3.61		37.8	
Surface	1 m	3.25	8.20	37.8	
PM					
Mid	3 m	4.10		40.2	
Surface	1 m	3.41	8.22	40.2	

Notes: _____

Water sampler left behind, so pH and conductivity not taken

Authorization Signature:  Date: 7/18/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
IMPINGEMENT MONITORING**

Study Location: Flint Creek Date: 7-15-06 Wash Time: 7:00 a.m.

Field Crew: Rigsby

Sampling Period ID Code: FCPP-19-AM

Circulating Pumps in Operation: (A) (B) (C) Screens Sampled: (A) (B) (C)

Species	27	29	31	32	33	33	33	40	54	55	Total
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Threadfin shad	D	D	D	D	D	D	D	D	D	D	D
Bluegill	D	D	D	D	D	D	D	D	D	D	224g
Blue gill	D	D	D	D	D	D	D	D	D	D	13g
	D	D	D	D	D	D	D	D	D	D	10g
	D	D	D	D	D	D	D	D	D	D	4g

Authorization Signature: [Signature] Date: 7/18/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
IMPINGEMENT MONITORING**

Study Location: Flint Creek Date: 7-15-06 Wash Time: 7:00 pm

Field Crew: Rigsby

Sampling Period ID Code: FOPP-19-PM

Circulating Pumps In Operation: (A) (B) (C) Screens Sampled: (A) (B) (C)

Species	Total Length (mm)	Total Weight (g)	Returned Alive (A)	Retained Dead (D)	Morbid (M)	Dead on Arrival (DOA)	Total
Threadfin Shad	56	D	D	56	D	58	D
Threadfin Shad	59	D	D	60	D	60	D
Threadfin Shad	60	D	D	61	D	61	D
Threadfin Shad	62	D	D	63	D	65	D
Threadfin Shad	65	D	D	66	D	67	D
Threadfin Shad	68	D	D	70	D	70	D
Threadfin Shad	71	D	D	73	D	74	D
Threadfin Shad	76	2	81	2	84	2	76g
Bluegill	44	D	D	51	D	54	13g
							<u>11g</u>

Authorization Signature: [Signature] Date: 7/18/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 7-29-06 Time: (AM) PM

Sample Period ID Code AM: _____ Sample Period ID Code PM: _____

Field Crew: Jeremy Rigsby, Chris McKee

Weather: AM Overcast 3-5mph winds
PM clear and calm

Total Depth: 3 m Air Temperature: AM 28.2 °C
Air Temperature: PM 30.9 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3m	4.80	8.50	37.7	414.6
Surface	1m	5.33	8.55	37.7	418.4
PM					
Mid	3m	5.86	8.59	38.5	416.3
Surface	1m	5.82	8.52	38.4	416.0

Notes: _____

Authorization Signature: [Signature] Date: 8/1/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 8-29-06 Time: AM 8:00 PM 7:00

Sample Period ID Code AM: FCPP-22-AM Sample Period ID Code PM: FCPP-22-PM

Field Crew: Jeremy Rigby

Weather: AM Cloudy / Overcast

PM Mostly Clear / Sunny

Total Depth: m Air Temperature: AM 20.5 °C

Air Temperature: PM 25.9 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3m	4.62	8.55	37.4	435.2
Surface	1m	4.37	8.52	37.4	434.8
PM					
Mid	3m	5.70	8.58	37.1	433.9
Surface	1m	5.25	8.50	37.0	433.9

Notes: _____

AM wash continuous
PM wash continuous

Authorization Signature: [Signature] Date: 9/1/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 9-12-06

Time: AM 8:15 PM 6:30

Sample Period ID Code AM: FCPP-23-AM

Sample Period ID Code PM: FCPP-23-PM

Field Crew: Jeremy Rigby

Weather: AM drizzle rain

PM overcast

Total Depth: m

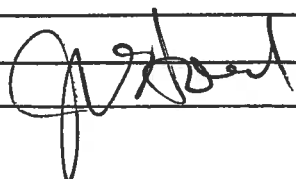
Air Temperature: AM 19.8 °C

Air Temperature: PM 18.8 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	2 m	5.26	8.44	35.6	442.1
Surface	1 m	4.94	8.44	34.8	438.2
PM					
Mid	2 m	5.30	8.46	35.2	442.0
Surface	1 m	5.24	8.45	35.3	441.8

Notes: _____

Water level was not high enough to get the YSI 85 3 m deep.
I took the pH reading at 2 m to keep data accurate.

Authorization Signature:  Date: 9/15/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 9-26-06 Time: AM 8:15 PM 6:30

Sample Period ID Code AM: FCPP-24-AM Sample Period ID Code PM: FCPP-24-PM

Field Crew: Jeremy Rigsby

Weather: AM Sunny - Clear Sky

PM Sunny - Few clouds

Total Depth: m Air Temperature: AM 21.9 °C

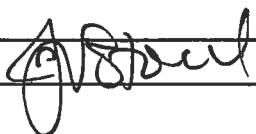
Air Temperature: PM 30.4 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3 m	5.85	8.47	32.2	1065
Surface	1 m	6.00	8.43	32.2	1071
PM					
Mid	3 m	7.18	8.59	34.5	846
Surface	1 m	7.25	8.55	34.5	842

Notes: _____

AM Wash stopped once to clean net of algae and prevent overflow.

A different YSI 85 was used to collect water quality data - the conductivity appears to be wrong.

Authorization Signature:  Date: 9/29/06

**FLINT CREEK POWER PLANT - AMERICAN ELECTRIC POWER
WATER QUALITY PARAMETERS**

Study Location: Flint Creek

Date: 10-10-06

Time: AM 8:30 PM 6:00

Sample Period ID Code AM: F CPP-25-AM

Sample Period ID Code PM: F CPP-25-PM

Field Crew: Jeremy Rigsby

Weather: AM Overcast

PM Overcast

Total Depth: m

Air Temperature: AM 21.3 °C

Air Temperature: PM 21.5 °C

Unit	Depth (m)	DO (ppm)	pH	Temp (°C)	Cond (umho)
AM					
Mid	3 m	6.74	8.57	33.3	430.9
Surface	1 m	6.77	8.61	33.1	429.6
PM					
Mid	3 m	6.76	8.65	32.5	433.8
Surface	1 m	6.67	8.66	32.3	433.8

Notes: _____

AM wash was stopped twice to clean the net of algae - no pictures of algae

Authorization Signature: 

Date: 10/16/06

