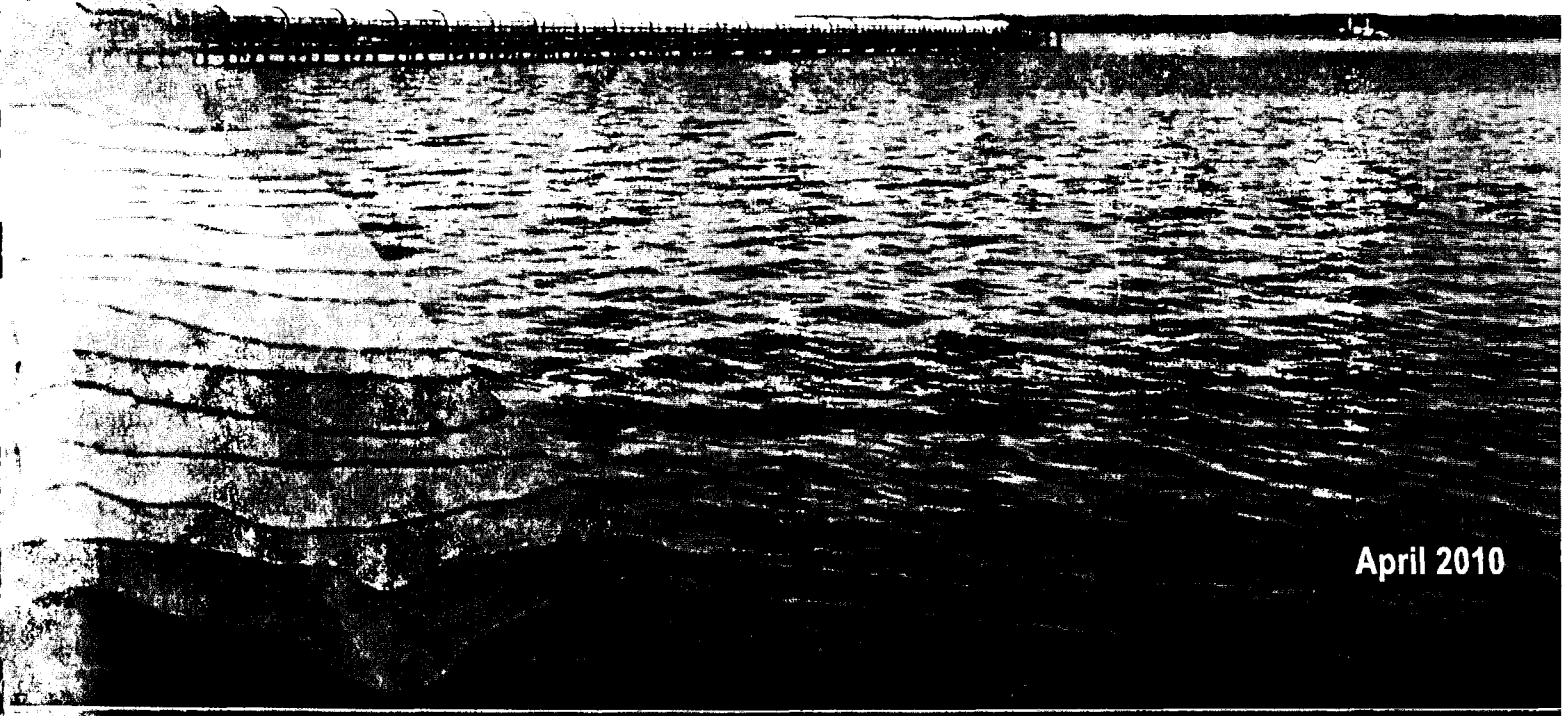
AES

GREENIDGE GENERATING STATION

Impingement and Entrainment Characterization Study



April 2010

HDR

AES Greenidge

April 29, 2010

Chuck Nieder
Steam Electric Unit Leader
New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
Bureau of Habitat, 5th Floor
625 Broadway
Albany, New York 12233-4756

Re: AES Greenidge, LLC
SPDES Permit Number NY-0001325

Dear Mr. Nieder:

Pursuant to the requirements contained in the above referenced State Pollution Discharge Elimination System Permit ("SPDES Permit"), enclosed for filing with the New York State Department of Environmental Conservation ("NYSDEC") are two (2) copies of Biological Requirement 1 (page 14 of 28), the AES Greenidge *Impingement and Entrainment Characterization Study* ("IECS"). According to the SPDES Permit, the IECS is to be submitted to NYSDEC by 1 May 2010 and has the following requirements:

> "The report shall contain an estimate of the abundance of adult and juvenile fish, and ichthyoplankton impinged or entrained through the station's cooling water intake system at current operating conditions and at full flow calculation baseline conditions over the study period. Each flow scenario shall provide an estimate, in tabular form, of the total numbers of organisms impinged or entrained each month and over a one year period. Biota shall be identified to species, or lowest practical taxon, and each taxonomic group entrained shall also be subdivided by life stage."

The two (2) enclosed hard copy reports meet the specific requirements set forth above.

Also in accordance with the Permit (page 14 of 28), one (1) copy of this cover letter is being provided to the:

- Division of Water, State Pollution Discharge Elimination System Compliance Information Section; and
- Regional Water Engineer

We thank the Department in advance for its review of this submission and look forward to receiving any comments you may have.

Sincerely,

Jim Hastings

cc:
John Weidman (NYSDEC – Division of Water, State Pollution Discharge Elimination System Compliance Information Section)
Dixon Rollins (NYSDEC – Regional Water Engineer)
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AES GREENIDGE GENERATING STATION

IMPINGEMENT AND ENTRAINMENT CHARACTERIZATION STUDY

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April 29, 2010

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1.0 INTRODUCTION

AES Greenidge Generating Station (hereafter AES Greenidge) is a coal-fired facility located on the western shore of Seneca Lake in Yates County, New York. During 2006 and 2007, when the most recent biological and waterbody studies were conducted, AES Greenidge consisted of two generating units (Units 3 and 4) that began operating in the 1950's and had a combined generating capacity of 161-megawatts (MW). At that time the station's once through condenser cooling water system had a maximum flow of 125.4 thousand gallons per minute (kgpm) and provided cooling water for both Units 3 and 4. A NYS Department of Environmental Conservation (DEC) Consent Decree required that Unit 3 shut down, repower, or be retrofitted with air emission controls after 31 December 2009. With consideration of the cost of the air emission controls, and additionally the potential for expensive modifications to the cooling water intakes to satisfy 6NYCRR §704.5 and Clean Water Act §316(b), AES chose to retire Unit 3 from service on December 31, 2009. The current generating capacity for the single unit in operation at AES Greenidge (Unit 4) is 107 MW with a once through cooling water maximum flow of 91.2 kgpm. As was done prior to the retirement of Unit 3, cooling water is drawn from Seneca Lake through offshore intake pipes and discharged into the Keuka Outlet through a discharge canal upstream of Seneca Lake.

AES Greenidge currently operates under State Pollutant Discharge Elimination System (SPDES) permit number NY0001325, with a 1 February 2010 Effective Date (EDP). Section B of the permit calls for AES to submit a series of reports demonstrating how they will meet the requirements of 6NYCRR §704.5 and Clean Water Act §316(b). These reports are identified in Biological Monitoring Requirements 1 through 6 in the permit. Biological Monitoring Requirement 1, the *Impingement and Entrainment Characterization Study (IECS)*, is to be submitted to NYS Department of Environmental Conservation (DEC) by EDP plus three months, or 1 May 2010, and has the following requirements:

> "The report shall contain an estimate of the abundance of adult and juvenile fish, and ichthyoplankton impinged or entrained through the station's cooling water intake system at current operating conditions and at full flow calculation baseline conditions over the study period. Each flow scenario shall provide an estimate, in tabular form, of the total numbers of organisms impinged or entrained each month

> and over a one year period. Biota shall be identified to species, or lowest practical taxon, and each taxonomic group entrained shall also be subdivided by life stage."

This report is being submitted to meet the requirements listed in Biological Requirement 1. Three technical reports are being submitted as appendices to this report that provide detailed methods, results and findings from the AES Greenidge biological and waterbody sampling conducted during 2006 and 2007. Biological sampling conducted at AES Greenidge during 2006 and 2007 included early life stage entrainment and ichthyoplankton studies (Appendix I) and an impingement study (Appendix II). Seneca Lake finfish community and waterbody studies were also conducted and included bottom trawl, beach seine, and hydroacoustic surveys as well as water quality, bathymetric and hydrodynamic studies conducted in the vicinity of the station's cooling water intake (Appendix III).

1.1 Objective

The objective of this report is to fulfill Biological Monitoring Requirement 1 of the AES Greenidge SPDES Permit (NY0001325) by providing:

- Taxonomic identification of those species of fish and their life stages subject to entrainment and impingement at AES Greenidge;
- Characterization of entrainment and impingement of these species in terms of annual, seasonal and diel variation; and
- Estimation of monthly and annual total entrainment and impingement of all life stages of fish at the facility based on actual and full rated cooling water flows.

1.1.1 Defining "Entrainment" and "Impingement" at AES Greenidge Unit 3 and Unit 4

With regard to characterizing entrainment and impingement at AES Greenidge it is important to note certain differences in the configuration of the Unit 3 and Unit 4 cooling water systems. The Unit 3 intake can be characterized as more typical, with 3/8-inch mesh traveling screens filtering the cooling water before it reaches the circulating water pumps. This results in the potential for entrainment of fish small enough to pass through the traveling screen mesh (e.g. eggs and larvae) and impingement of those fish large enough to be retained on the traveling screens (e.g., juveniles and adults). The Unit 4 intake, alternatively, is atypical in that it relies on suction to convey water from the lake, through the elevated intake pipe, and on to the circulating water

pumps. This configuration does not allow for any type of componentry, including traveling screens, that would interrupt the suction upstream of the circulating water pumps. A result of this configuration is that fish (potentially including eggs, larvae, juveniles, and adults) that enter the Unit 4 cooling water intake are ultimately entrained through the facility. Some fish may be impinged on the condenser tube face for a period of time, but backwashing of the condenser will ultimately convey these fish to the discharge. The configuration of Unit 4 also does not allow for entrainment or impingement sampling upstream of the circulating water pumps. As a result, entrainment and impingement sampling at AES Greenidge has been conducted at Unit 3 and these data are used as the basis for characterizing potential entrainment and impingement at Unit 3 and Unit 4, where "impingement" at Unit 4 as reported herein represents potential entrainment of juvenile and adult fish at that unit.

Unit 3 = 34,200 gpm
Unit 4 = 91,200 gpm
125,400 gpm
27% Rel.

1.2 Station Description and CWI Operation

AES Greenidge is located in Yates County, New York on the western shoreline of Seneca Lake (Figure 1). AES Greenidge is a steam electric generating station which consisted of three coal-fired boilers and two turbine generators (Units 3 and 4) at the time that the 2006-2007 facility and waterbody studies were conducted. As mentioned in the introduction, with consideration of the cost of the air emission controls and the potential for expensive modifications to the cooling water intakes to satisfy 6NYCRR §704.5 and Clean Water Act §316(b), AES chose to retire Unit 3 from service on December 31, 2009. Notably, two generating units (Units 1 and 2) and associated boilers were also removed from service in 1985.

The maximum dependable capacity (gross) of Unit 3 was 54 MW. This unit was equipped with two circulating water pumps with a maximum intake capacity of 34.2 kgpm (Figure 2). The generating capacity of Unit 4 is 107 MW. Cooling water is supplied to Unit 4 by three circulating pumps of which only two are typically operated outside of the summer months. The third pump is operated during summer months and acts as a backup during the remainder of the year. The maximum cooling water intake capacity of Unit 4 is 91.2 kgpm. As a result, at the time the 2006 and 2007 studies were conducted the maximum combined output capacity at AES Greenidge was 161 MW with a maximum circulating cooling water intake capacity of 125.4 kgpm. AES Greenidge uses once-through condenser cooling. Water is withdrawn from Seneca Lake and is discharged into the Keuka Outlet through a discharge canal (Figure 2 inset). The

discharge canal, which is 900-feet long, empties into the Keuka Outlet 700-feet upstream from Seneca Lake.

Unit 3 was serviced by two intake pipes which lie on the lake bottom. A 6-foot-diameter pipe extends 550 feet offshore to a water depth of approximately 8 feet and an 8-foot-diameter pipe extends 710 feet offshore to a water depth of approximately 10 feet (Figure 3). A steel cage, consisting of 1/2-inch bars on 12-inch centers, covers each intake pipe opening to screen out large debris. At the shoreline, the 6-foot and 8-foot pipes are joined into 5-foot and 6-foot diameter concrete pipes, respectively, which extend to the chlorination building. The pipes then combine into a single intake tunnel (seven feet in diameter) that leads to the traveling screens. Trash racks, composed of 1/4-inch bars on 3-inch centers are located 7 feet in front of the traveling screens. The traveling screens consist of wire panels with 3/8-inch square open mesh, and were operated automatically by a system of pressure differential controls. During the fall and spring, traveling-screen operation was generally continuous; whereas during the summer and winter, operation was usually at intervals of two or three hours. Fish and debris collected on the traveling screens were washed to a discharge tunnel and ultimately discharged to the thermal discharge canal. While these piping and screening infrastructural components are still in place at the facility, they are now only used to support the service water pumps (refer to the last paragraph in this section for a discussion of the service water system).

A third intake pipe, which supplies condenser cooling water to Unit 4, is elevated on wood pilings and extends from the pumphouse to a point 650-feet offshore (water depth of approximately 11 feet, Figure 3). The pipe opens facing downward and is surrounded by a 27-foot by 27-foot steel structure composed of 3/16-inch bars on 6-inch centers. The condenser cooling water is conveyed to Unit 4 through a 7-foot diameter concrete pipe which is reduced to four, 4-foot diameter pipes before entering the pump house and supplying each circulating water pump. The circulating water is recombined after leaving the pump house, first in a 5-foot diameter pipe and then a similarly sized concrete tunnel, and conveyed to the powerhouse and Unit 4. The Unit 4 intake relies on suction to convey water from the lake, through the elevated intake pipe, and on to the circulating water pumps. This configuration does not allow for traveling screens, or any other technology, that would interrupt the suction upstream of the circulating water pumps. Reversing valves on the condenser automatically wash out any debris

and fish that might accumulate on the condenser tube face The Unit 4 cooling water is introduced to the discharge canal via a 7-foot by 10- foot concrete tunnel where it enters the Keuka Outlet. All debris and fish that are removed from the condenser tube face during backwash events exit the facility via the discharge.

Service water is supplied to AES Greenidge by four house service water pumps (rated at 550 gpm per pump), two hydrogen cooling pumps (rated at 120 gpm per pump), and a dual Hydro-jet Pump (rated at 1,300 gpm). All service water is withdrawn from the Unit 3 intake prior to the circulators such that service water withdrawals are in addition to circulating water pump withdrawals. The Unit 3 intake is also equipped with a fire pump that is for emergency use only. If operated, the fire pump would withdraw water from the discharge, after the circulating water pumps and thus not add to the total volume withdrawn by the facility. No service water pump withdraws water from the Unit 4 intake. All of the Unit 3 service water pumps were operational prior to the shutdown of Unit 3 and are currently in operation. Intermittent operation of the traveling screens is required as a part of the service water supply. There is no detailed record of service water use available for the facility.

1.3 SOURCE WATER BODY

Seneca Lake is the second longest lake in the Finger Lakes, measuring 35.1 miles north to south. The Lake is 3.2 miles at its greatest width, with an average width of 1.9 miles. At its deepest point it is 651 feet deep, with an average depth of 290 feet. The surface area of the lake is 66.3 square miles. Seneca Lake is the second deepest lake in the country and contains the largest volume of all the Finger Lakes at over 4.2 trillion gallons of water. This glacial lake lies in a long, narrow valley between ridges which reach up to 900 feet above sea level. The ridges are the highest toward the southern end of the lake where the terrain is somewhat mountainous. The shoreline is well-developed and generally smooth, except for deltas formed by tributaries (NYSEG 1977).

The bottom of the lake drops off precipitously from the east and west shores and is relatively uniform and symmetric around the lake centerline. The northern and southern ends at Geneva and Watkins Glen, respectively, are relatively shallow with depths to about 18 feet. Depths of 500 feet or more are found in the central Lake area from 3.5 miles north of AES Greenidge to 3.5

miles north of Watkins Glen (NYSEG 1977). The drainage basin of the lake, which is a long narrow valley, is 50 miles long and 10 miles wide, and covers an area of 707 square miles. This includes the Keuka Lake drainage basin, which drains into Seneca Lake via the Keuka Outlet.

Traditionally, lake trout, smallmouth bass and yellow perch have been the mainstay of the Seneca Lake fishery. In the decades since the first survey of the lake in 1927, other species have also contributed prominently, including rainbow trout, brown trout, landlocked Atlantic salmon, northern pike and largemouth bass. Alewives, known to be abundant in Seneca Lake at the time of the first survey, and smelt, introduced in 1909, have provided a dependable forage base for salmonids. Seneca Lake's fishery has benefited greatly in recent years from steady annual stockings of hatchery-reared lake trout, brown trout and landlocked salmon.

2.0 STATION SPECIFIC IMPINGEMENT AND ENTRAINMENT STUDIES

2.1 2006-2007 Impingement Study

Impingement monitoring was conducted on a temporally stratified schedule from February 2006 through February 2007 at the Unit 3 traveling screens, yielding 40, 24-hour samples. Impingement monitoring was not conducted at Unit 4 due to the closed nature of this condenser cooling water system.

Samples were collected using an aluminum sampling basket with 3/8-inch wire mesh and lined with a 1/4-inch nylon mesh bag. The basket was positioned to catch all screen wash discharge from the Unit 3 traveling screens. Screens underwent a manual wash cycle before the basket was set and before the basket was retrieved. Before sample analysis, all fish and/or decapods were separated from debris for analysis and identified to the lowest practical taxonomic level. Organisms were classified according to the following condition criteria and enumerated by category: Live Organisms, Damaged Organisms, Fresh Dead Organisms or Dead/Decaying Organisms. Up to 100 randomly selected live and fresh dead fish and/or decapods from each species collected were measured for total length to the nearest millimeter and weighed to the nearest gram. The remaining live and fresh dead fish or decapods from that species were batch weighed to the nearest gram. Debris collected during a sampling event was categorized and an estimate of volume for each category was recorded. The methodology and results from the

2006-2007 impingement study conducted at AES Greenidge are described in detail in the 2006-2007 Impingement Study report (HDR 2010, Appendix II).

2.2 2006 Entrainment Study

AES Greenidge entrainment and Seneca Lake ichthyoplankton studies were conducted as part of the 2006-2007 sampling effort at the request of the New York State Department of Environmental Conservation (NYSDEC). The surveys were designed such that ichthyoplankton and entrainment samples were collected concurrently and with the same size net mesh (500μ), but differed with respect to the water depths sampled. The Unit 3 intake, where entrainment samples were collected, draws water from depths of approximately 8 and 10 feet while ichthyoplankton samples were collected in deeper, offshore waters at a depth of approximately 30-feet. This sampling design was intended to provide information for evaluation of alternative intake locations and/or technologies. Sampling was conducted once per month during April and September and twice per month during May through August, 2006.

Entrainment samplings were collected from Unit 3 intake, upstream of the traveling screens (Figure 2). Ten samples were collected during each of ten 24-hour sampling events (approximately one sample every 2.5 hours), for a total of 100 samples collected over the length of the program. Samples were collected using a 500-μ mesh hoop plankton net with a removable PVC cod-end bucket. Intake water was pumped from mid-water depth through the net using a 4-inch diameter centrifugal trash pump and 4-inch PVC pipelines. To minimize organism damage, the water was pumped into a 200-gallon high density polyethylene water-filled buffer tank, where the plankton net was suspended. The volume of water sampled was monitored using an in-line Signet model flowmeter. The sample duration was approximately 100 minutes or until a minimum of 100 m^3 (approximately 26,400 gal) of water was sampled. Samples were preserved in a 10% Formalin solution containing the stain Rose Bengal.

Organisms collected were identified to the lowest practical taxon and life stage (egg, yolk-sac, post-yolk-sac, juvenile or adult) and enumerated. Only whole larvae, parts of larvae with a head, or pieces of larvae with a substantial portion (more than half) of the body present were counted. A total length measurement (TL) was recorded for all fish larvae identified to species for up to 25 specimens for each lifestage. If more than 25 specimens were present in the sample, a random sub-sample of no more than 25 specimens per lifestage (excluding eggs) was measured.

Total length was measured to the nearest 0.1 mm for yolk-sac and post-yolk-sac larvae and to the nearest 1.0 mm for juveniles and adults. All ichthyoplankton were preserved in 5% Formalin and stored. The methodology and results from the 2006 ichthyoplankton and entrainment studies conducted at AES Greenidge are described in detail in the 2006 Ichthyoplankton and Entrainment Studies report (HDR 2010, Appendix I).

2.3 Historical Studies

Impingement and entrainment at AES Greenidge was last studied from March 1976 through February 1977 (NYSEG 1977). During this study, sampling for impingement of fish on the traveling screens and bar racks of Units 1, 2 and 3[1] was conducted twice monthly with one sampling period consisting of 24 consecutive hours and the other of 12 consecutive hours encompassing the last six hours of daylight and the first six hours of darkness (NYSEG 1977).

Sampling for entrainment was conducted once in March 1976, twice monthly from April through September, and once a month from October through February 1977. Entrainment sampling for the 1976-1977 study was conducted in the center of the common discharge canal for Units 1-3 as opposed to the current study which was sampled at the plant's Unit 3 intake canal. Moreover, the 1976-1977 study did not identify fish eggs or discriminate between yolk-sac and post-yolk-sac larvae.

For the purposes of characterizing current impingement and entrainment at AES Greenidge, data from the 2006-2007 sampling programs present the most representative data and will be the focus of the subsequent sections in this report. Where appropriate, however, data from the 1976-1977 studies are used to supplement the most recent data.

3.0 CHARACTERIZATION OF JUVENILE AND ADULT "IMPINGEMENT"

As discussed in Section 1.1.1, the Unit 4 intake relies on suction to convey water from the lake, through the elevated intake pipe, and on to the circulating water pumps. This configuration does not allow for traveling screens, or any other technology, that would interrupt the suction upstream of the circulating water pumps. For the same reason, no entrainment or impingement

[1] Units 1 and 2 are no longer in service at AES Greenidge and were therefore not sampled during the current 2006-2007 study.

sampling can be conducted upstream of the circulating water pumps at this unit. As a result, impingement sampling conducted at Unit 3 is used to characterize potential entrainment of juvenile and adult fish at Unit 4, such that impingement, in the following sections, refers to impingement juveniles and adults at Unit 3 and entrainment of juveniles and adults at Unit 4. The term "impingement" is used for simplification and because the data were, in fact, collected from impingement samples at Unit 3.

3.1 Species Composition

A taxonomic inventory of the fish and shellfish species subject to impingement at AES Greenidge based on both the historical record and the 2006-2007 impingement study is presented in Table 1. When counting the number of distinct taxa collected, general taxonomic designations at the generic, familial, and higher taxonomic levels were dropped if there was one valid lower-level designation for that group. For example, because *Lepomis* spp., *Lepomis gibbosus*, and *Lepomis macrochirus* were all identified in the collections, *Lepomis* spp. was not counted in the total number of distinct taxa.

A total of at least 17 distinct fish taxa have been subject to impingement at AES Greenidge (Table 1). This includes the 15 fish species identified in 1977 as well as banded killifish and bluntnose minnow identified in only the 2006-2007 collections. Five species of fish were collected in 1977 but not in 2006-2007: carp, chain pickerel, golden shiner, rainbow smelt and slimy sculpin. Crayfish (Astacidae) was the only shellfish species collected in the 2006-2007 impingement sampling. Shellfish species were not identified in the 1976-1977 sampling (NYSEG 1977).

Correspondence with United States Fish and Wildlife Service (USFWS) and New York State Department of Environmental Conservation (NYSDEC) indicated that, except for occasional transient individuals, there are no State or Federal records for rare, threatened or endangered species within or immediately adjacent to the project impact area. Copies of the agency correspondence letters are provided in the Proposal for Information Collection (HDR|LMS 2006). Consistent with this, there were no threatened or endangered species collected in the extensive biological monitoring conducted in the vicinity of AES Greenidge during 2006-2007.

3.2 Size Distribution

3.2.1 Length Frequency

The average, minimum and maximum length of each taxa collected in the 2006-2007 impingement sampling program are presented in Table 2. Individual lengths ranged from a 26 mm crayfish to a 325 mm yellow perch. The largest species, ranked by average length impinged, were: yellow perch (284 mm), alewife (144 mm), largemouth bass (97 mm), and brown bullhead (81 mm). The smallest fish impinged were *Lepomis* species (46 mm), rock bass (53 mm), and bluegill (54 mm). In general, *Lepomis* species less than 50 mm were not easily distinguished in the field but were most likely young-of-the-year pumpkinseed and bluegill because both species spawn in the late spring to summer (Smith 1985) and most of the *Lepomis* were collected in October through January.

The most frequently measured taxa were *Lepomis* species (158), crayfish (60), and brown bullhead (49). Month-specific length-frequency distributions are provided for the commonly impinged species in the 2006-2007 Impingement Study report (HDR 2010, Appendix II).

3.2.2 Weight

The average, minimum and maximum weight of each taxon collected in the 2006-2007 impingement samples is also presented in Table 2. Individual weights ranged from one gram for several species to 470 g for a yellow perch. The species with the highest average weight per individual impinged were: Ictaluridae species (426 g), Petromyzontidae species (406 g), yellow perch (305 g), and largemouth bass (69 g). The smallest identifiable organisms impinged were *Lepomis* species (1 g), bluegill (2 g), and bluntnose minnow (2 g). Several other taxa were collected with an average weight of less than 5 grams, including banded killifish (3 g), Centrarchidae (3 g), rock bass (3 g), and smallmouth bass (3 g).

3.3 DIEL VARIATION

No station specific information regarding diel variation of impingement at AES Greenidge was obtained during the 2006-2007 monitoring program as individual impingement sampling events were conducted over the course of 24 consecutive hours. Impingement data from the NYSEG

1977 study were summarized between day and night sampling periods with a majority of fish impingement, 76% (556 of the 732 total fish collected), occurring at night (Table 3). Over the entire year long sampling period, the mean total number of fish collected per 6-hour period was 14.19 at night (encompassing the first six hours of darkness) as opposed to 4.46 during the day (the last six hours of daylight) (NYSEG 1977). In particular, the study noted a significantly larger catch of alewives at night which may be attributed to inshore spawning movements at night from offshore habitats during the day.

3.4 SEASONAL VARIATION

Impingement density, expressed as the number of organisms impinged per million m^3 of intake water, was calculated for each taxa and month during the 2006-2007 sampling program as described in detail in section 5.1. The seasonal impingement trends for each taxon collected are presented as mean monthly densities in Table 4. Based on the total monthly densities of all taxa collected, peak impingement at AES Greenidge occurred between October and February with those five months accounting for the five highest monthly impingement densities during the year (Table 4). The two highest months were January and October with a total impingement density of 300.3 organisms per million m^3 and 167.5 organisms per million m^3, respectively. By contrast, the three lowest monthly impingement totals occurred in the three months of spring: March (2.8 organisms per million m^3), April (19.4), and May (23.3).

Several taxa presented distinct seasonal trends including alewife which were impinged in only three months of late spring and early summer: May (2.5 organisms per million m^3), June (6.9), and July (25.6). This seasonal peak is most likely related to inshore spawning movements as alewife move out of offshore habitats (NYSEG 1977). Crayfish were impinged from April through November but presented peak abundance in June (31.8) and July (22.1). Conversely, most taxa tended to exhibit peak abundances in the winter, including banded killifish (43.7), bluegill (34.7), and *Lepomis* species (197.0) in January, and both pumpkinseed (30.5) and brown bullhead (63.6) in February.

3.5 ANNUAL VARIATION

Annual variation of impingement at AES Greenidge can be determined by comparing historical data to the most recent sampling conducted in 2006-2007. A total of 416 fish and crayfish distributed among 13 distinct taxa were collected at AES Greenidge during impingement sampling conducted between February 2006 and February 2007 (Table 5 and Figure 4). A majority of the organisms collected, 52%, were *Lepomis* species[2], pumpkinseed, and bluegill. The remaining organisms identified in the impingement collections were comprised primarily of crayfish (14%), brown bullhead (12%), banded killifish (10%), alewife (6%), largemouth bass (2%), and bluntnose minnow (1%). Each of the remaining taxa accounted for less than 1% of the total catch.

Alewife accounted for only 6% of the impingement collections in 2006 and 2007 as compared to 90% of the collections in 1977 (NYSEG 1977). Conversely, brown bullhead which represented less than 1% of the catch in 1977, accounted for nearly 12% of the collections in 2006-2007 and banded killifish, which was not collected in 1977, accounted for nearly 10% of the collections in 2006-2007. *Lepomis* species, pumpkinseed and bluegill dominated the 2006-2007 impingement collection, accounting for 52% of the catch, as compared to 1977 when pumpkinseed and bluegill contributed just 2.3% and 0.7% to the total, respectively.

The 1977 impingement study did not report impingement densities so comparisons based on number impinged per unit volume of intake water could not be made with the more current data. In terms of the total annual number impinged, the historical study estimated approximately 29,000 fish were impinged (crayfish were not reported), of which approximately 26,000 were alewife. As discussed in greater detail in section 5.2, it was estimated that approximately 8,700 fish (with 95% confidence interval of 4,183 - 16,217) were impinged during 2006, of which 5,154 were of the genus *Lepomis* (pumpkinseed and bluegill). These findings suggest annual variation in terms of the number of fish impinged as well as the species composition of impingement at AES Greenidge.

[2] In general, *Lepomis* species less than 50 mm were not easily distinguished in the field. These fish were most likely young-of-the-year pumpkinseed and bluegill because both species spawn in the late spring to summer (Smith 1985) and most of the unidentified *Lepomis* were collected in October through January.

4.0 CHARACTERIZATION OF EARLY LIFE STAGE ENTRAINMENT

4.1 Species Composition

A taxonomic inventory of the species and life stages entrained at AES Greenidge based on both the 1976-1977 and 2006 entrainment studies is presented in Table 6. Based on these studies, a total of at least 11 distinct fish taxa have been entrained at AES Greenidge. As per the protocol described in section 3.1, this total does not include Catostomidae spp. (sucker family) or Cyprinidae spp. (minnow and carp family) since white sucker and common carp were also identified in the collections.

Four distinct taxa were collected in the 1976-1977 entrainment survey (common carp, Catostomidea spp., *Lepomis* spp. and rainbow smelt) while total of eight distinct taxa (alewife, *Ameiurus* spp. (bullheads), banded killifish, brook silverside, common carp, *Etheostoma* spp. (darters), white sucker, and yellow perch) were collected in the 2006 entrainment survey. No shellfish species were collected during the 2006 entrainment sampling program at AES Greenidge.

As noted in section 3.1, based on agency correspondence, except for the occasional transient individual, there are expected to be no threatened or endangered fish species within the boundaries of the project impact area. Additionally, no threatened or endangered fish species were collected in 1976-1977 and 2006 entrainment sampling conducted at the Station.

4.2 Size Distribution

The minimum, mean and maximum lengths of larvae and juveniles collected in 2006 entrainment samples at AES Greenidge are presented in Table 7. Length measurements are based on 22 individuals distributed among five taxa: white sucker, *Etheostoma* spp., yellow perch, banded killifish and carp. Individual lengths ranged from a 4.3 mm *Etheostoma* spp. yolk-sac larvae collected in June to a 25.3 mm carp juvenile collected in July.

4.3 Diel Variation

Collection densities, expressed as number per 100 m^3, were calculated from entrainment data for each species and life stage by two hour intervals over 0000 to 2400 hours (e.g., 0000-0159, 0200-0359 hours, etc.) across all sampling events. Calculation of diel densities provide trends in

abundance throughout a day based on all samples combined. Densities (number per 100 m^3) were calculated as the sum of the total collected divided by the total sample volume in m^3, for the relevant interval, times 100.

Examination of diel trends (Table 8) indicates that the entrainment density of most species and life stages in the 2006 collections were generally higher during nighttime hours with peak total entrainment occurring between 2200-2359 (2.63 organisms/100 m^3) and 0600-0759 (0.98 organisms/100 m^3). By contrast, the two lowest two-hour intervals were observed from 1000-1159 (0.06 organisms/100 m^3) and from 1200-1359 (0.10 organisms/100 m^3).

Several species and life stages (e.g., white sucker post-yolk sac larvae, banded killifish juveniles, and Cyprinid eggs and post-yolk sac larvae) were almost exclusively collected from 2200 to 0759 hours. Alewife eggs, the most abundant species and life stage collected in the 2006 entrainment program at AES Greenidge, were often collected during daylight sampling hours but predominated at night (Table 8).

4.4 Seasonal Variation

Entrainment sampling was conducted April through September, 2006. Entrainment densities were highest during June (1.47 organisms per 100 m^3) and July (1.22 organisms per 100 m^3) (Table 9) and lowest during August (0.10 organisms per 100 m^3) and September (0.10 organisms per 100 m^3). White sucker post-yolk-sac larvae predominated in the collections, during April and May, accounting for 59% and 81% of the total density during those two months, respectively. June samples were dominated by alewife eggs, which accounted for 76% of the entrainment density that month while juvenile banded killifish (40% of the total density) were the most common taxa collected in July. The low densities recorded for August and September were comprised of a single taxon and life stage collected each month: unidentified post-yolk-sac larvae in August and *Ameiurus* species juveniles in September. The number of taxa entrained each month trended similar to the total densities and ranged from one taxon in May, August and September to five taxa collected in June.

4.5 Annual Variation

Annual variation of early life stage entrainment at AES Greenidge can be determined by comparing historical data to the most recent sampling conducted in 2006. Unlike the current 2006 entrainment study, however, NYSEG (1977) did not identify fish eggs and juveniles or discriminate between yolk-sac and post-yolk-sac larvae. Therefore, annual entrainment comparisons can only be made using larvae. A total of 252 larval fish, representing four taxa were collected during entrainment sampling at AES Greenidge in 1976-1977 (Table 10; Figures 5a and 5b). The majority (68.6%) of the larvae entrained in that study was damaged and unidentified but was likely, according to the authors, rainbow smelt which accounted for 27.8% of the collections. Carp, *Lepomis* species and Catostomidae species accounted for the remaining larvae in the 1976-1977 study. By comparison, 29 larvae were collected in the 2006 entrainment study with white sucker (48.3%) dominating the collections (Table 10). Banded killifish (10.3%) and Cyprinid species (10.3%) as well as Catostomidae species (6.9%), *Etheostoma* species (6.9%), and yellow perch (3.4%) were also collected in 2006.

In terms of entrainment densities, which were reported as monthly average density in both the 1976-1977 and 2006 studies, values tended to be higher in the 1976-1977 study. For example, the peak monthly density in the 1970s study occurred in May with 112.3 larvae per 100 m^3, while the more recent study peaked in July at 0.93 larvae per 100 m^3. The next highest monthly density from the earlier study occurred in July with 6.5 larvae per 100 m^3, considerably higher than any value from the 2006 entrainment study. As described previously in this section, species composition and relative abundance were quite different between the studies as well. Densities of entrained larvae from the 1976-1977 study was comprised largely of unidentified larvae (69% compared to 12% in the 2006 study), limiting the extent to which valid taxa-specific density comparisons can be made between these studies.

5.0 CURRENT ANNUAL JUVENILE AND ADULT "IMPINGEMENT" AND EARLY LIFE STAGE ENTRAINMENT

This section provides the most current estimates of juvenile and adult "impingement" (i.e., juvenile and adult impingement at Unit 3 and juvenile and adult entrainment at Unit 4) and early life stage entrainment for AES Greenidge. The most current data that can be used to characterize juvenile and adult impingement at AES Greenidge is that available from the 2006-2007

impingement study. The February 2006 through February 2007 sampling effort provides species- and month-specific total numbers impinged. For early life stage entrainment, data from the 2006 entrainment study is most appropriate as it provides species- and life-stage-specific total numbers entrained at AES Greenidge from April through September 2006.

Evaluation of initial survival (i.e., documented condition of fish in the collection basket according to the categories described in Section 2.1) of fishes impinged at AES Greenidge showed substantial percent survival for certain species during certain months (Table 11). However, because all juvenile and adult fish impinged at AES Greenidge are sluiced to the heated discharge prior to return to the lake for Unit 3, or entrained through the cooling water system at Unit 4, actual survival accounting for latent effects is unknown. As a result, annual estimates of impingement and entrainment are provided herein as total annual numbers intercepted at the station. For impingement, because of the large variation in size of fish impinged (juvenile to mature adult), biomass is provided in addition to the total number. These metrics are provided as species- and month-specific values with confidence intervals on the annual values for each species and the annual total across all species as described in the next section.

5.1 Impingement and Entrainment Estimation Methodology

As mentioned previously and noted in the results tables for this section, juvenile and adult fish are not actually impinged at Unit 4 as they are at Unit 3, but instead they are entrained. The term "impingement" is used in the generic sense throughout the remaining sections of this report to refer to the juvenile and adult fish potentially impacted by AES Greenidge operations.

Estimates of the total number of fish entrained or impinged in number and weight (for impingement only), along with the associated 95% confidence intervals, were estimated based on the most current data collected at AES Greenidge in 2006 and 2007. Fish occurrence throughout the year was divided into monthly intervals. During these monthly intervals, the abundance of a given species was relatively homogeneous (by comparison to annual variability).

Total entrained or impinged by species and the associated 95% confidence limits were calculated as follows. First, the average concentration of organisms (number and biomass) per unit volume in the h^{th} stratum (i.e., month sampled), $\bar{x}_h$, was calculated as:

$$\bar{x}_h = \frac{1}{n_h}\sum_{i=1}^{n_h} x_{hi}$$

where:

n_h = the number of samples in the h^{th} stratum

x_{hi} = density in the i^{th} observation in the h^{th} stratum; adjusted for split fractions (f_s) where required (x_{hi}/f_s).

The total entrained or impinged (A) is then,

$$A = \sum_{h=1}^{H} V_h \bar{x}_h$$

where:

H = total number of strata sampled

V_h = volume of water withdrawn by the station in the h^{th} stratum.

The volume of water withdrawn by the facility includes the actual circulating water pump flows for Units 3 and 4 as provided by AES Greenidge for the current flow condition (Figure 6) and 125.4 kgpm for the full rated flow condition. Service water was not included in V_h because there is no record of service water use available for the facility. The variance of the estimated total is:

$$Var(A) = \sum_{h=1}^{H} V_h^2 (1 - f_h)\frac{S_h^2}{n_h}$$

where:

S_h^2 = variance of the h^{th} stratum

$$= \frac{\sum_{i=1}^{n_h}(x_{hi} - \bar{x}_h)^2}{n_h - 1}$$

and f_h = finite population correction for the h^{th} stratum. The finite population correction was computed as the volume of plant flow sampled in the month (i.e., h^{th} stratum) divided by the total

plant flow during the month. This factor only becomes important when a substantial percentage (>10%) of the total flow is sampled.

The 95% confidence interval is computed as:

$$A_{Upper} = A + t_{\alpha,df}\sqrt{Var(A)}$$

$$A_{Lower} = A - t_{\alpha,df}\sqrt{Var(A)}$$

where:

α = specified probability of Type I error, in this case 0.05

df = degrees of freedom, *n*-1

The above computations were carried out using the SURVEYMEANS procedure within the SAS (Statistical Analysis System) version 9.1 software. It should be noted that the above procedure gives equal weight to each sample regardless of the volume sampled. This will yield slightly different results than the method of obtaining the mean from the sum of the catch divided by the sum of the volume sampled. The latter method inherently weights the mean by the volume sampled.

5.2 Impingement

5.2.1 Current and Full Flow Annual Impingement (Numbers)

An annual total of 9,996 (with a 95% confidence interval of 4,183 - 16,217) fish and crayfish were estimated to have been impinged at AES Greenidge based on the 2006-2007 study (Table 12a). This estimate, which accounts for the total cooling water intake volume at Unit 3 and Unit 4, was comprised of 8,706 fish and 1,290 crayfish. Of this total, 3,813 organisms (approximately 38%) were attributable to the Unit 3 intake flow and 6,183 organisms (approximately 62%) were attributable to Unit 4 (Tables 12b and 12c, respectively). Total impingement peaked in January and February with those months contributing 3,325 and 1,495 organisms to the total, respectively (Table 12a). The three lowest monthly impingement estimates occurred in the spring with March, April, and May contributing 40, 297, and 284 organisms to the total, respectively.

Lepomis species were impinged in the greatest number with a total estimate of 3,498 individuals. Pumpkinseed and bluegill, which are of the genus *Lepomis,* contributed an additional 694 and

962 organisms to the total, respectively (Table 12a). When taken together, *Lepomis* accounts for 52% of the total estimated annual impingement. Other taxa contributing to impingement included brown bullhead (1,308), crayfish (1,290), banded killifish (1,028), alewife (563), largemouth bass (226), and bluntnose minnow (107). All other taxa contributed less than 1% to the estimated total impinged (Table 12a).

Under full rated flow of the Unit 3 and Unit 4 circulating water pumps (125.4 kgpm), it is estimated that annual impingement at AES Greenidge would be 20,186 individuals, of which 18,295 (91%) are fish and 1,891 (9%) are crayfish (Table 12d). Impingement would be highest during the months of January (6,364) and October (3,547) and lowest during March (59) and April (398). In terms of the fishes, sunfish species would be impinged at the highest annual rate (8,640/year), followed by banded killifish (2,312/year), brown bullhead (2,285/year), bluegill (1764/year) and pumpkinseed (1,376/year); all other fishes would be impinged at a rate of less than 1,000/year.

5.2.2 Current and Full Flow Annual Impingement (Biomass)

An annual total of 114.5 kg (with a 95% confidence interval of 20 - 241) of fish and crayfish were estimated to have been impinged at AES Greenidge based on the 2006-2007 study (Table 13a). This estimate, which accounts for the total cooling water intake at Unit 3 and Unit 4, was comprised of 11.9 kg of decapods (crayfish) and 102.6 kg of fish. Of this total, 33.3 kg (approximately 29%) was attributable to the Unit 3 intake flow and 81.2 kg (approximately 71%) was attributable to Unit 4 (Tables 13b and 13c, respectively). Total biomass impinged peaked in June at 23.9 kg with alewife accounting for 72% of the impinged biomass in that month (Table 13a). The three next highest months for impinged biomass were May (21.2 kg), January (20.2 kg) and July (17.4 kg). Ictaluridae species accounted for 91% of the biomass in May while largemouth bass (76%) and alewife (43%) accounted for the largest percentage of biomass in January and July, respectively. The two lowest monthly biomass estimates occurred in March (0.04 kg) and April (1.6 kg).

The estimated annual biomass impinged consisted primarily of brown bullhead (24.2 kg), Ictaluridae species (19.3 kg), and largemouth bass (15.7 kg), which together accounted for 52%

of the estimated total (Table 13a). Other taxa contributing to the impinged biomass totals included crayfish (11.9 kg), Petromyzontidae (11.5 kg), alewife (9.9 kg), pumpkinseed (6.2 kg), yellow perch (5.5 kg), *Lepomis* species (4.6 kg), banded killifish (2.8 kg), and bluegill (2.1 kg). All other taxa combined contributed less than 1% to the estimated total biomass impinged (Table 13a).

Under full rated flow of the Unit 3 and Unit 4 circulating water pumps (125.4 kgpm), it is estimated that annual impingement at AES Greenidge would be 199 kg, of which 182.2 kg (92%) is fish and 16.8 kg (8%) is crayfish (Table 13d). Impingement would be highest during the months of January (38.6 kg) and May (36.7 kg) and lowest during March (0.06 kg) and April (2.2 kg). In terms of the fishes, brown bullhead contributed the most to the impinged biomass with 35.9 kg per year followed by bullheads and catfishes and largemouth bass with an estimated 33.4 kg and 30.0 kg per year, respectively. All other fishes contributed less than, and more often much less than, 20 kg per year.

5.3 ENTRAINMENT

5.3.1 Current and Full Flow Annual Entrainment

A total of more than 591,000 early lifestage fish were estimated to have been entrained at AES Greenidge during April through September, 2006 (Table 14a). Of the total, 165,852 (28%) individuals are attributable to the flow from the now retired Unit 3 while 425,848 (72%) are attributable to Unit 4 (Table 14b and 14c). The total combined Units estimate, which accounts for the total cooling water intake flows (i.e., Unit 3 and Unit 4 cooling water intake volumes), is comprised of approximately 236,000 eggs, 28,000 yolk-sac larvae, 164,000 post-yolk-sac larvae, 53,000 unidentified-life stage (YS/PYS) larvae, and 111,000 juveniles. Total entrainment peaked in June (216,000 organisms) and July (206,000). Alewife eggs and post-yolk-sac white sucker larvae were entrained in the greatest number with a total of 165,000 and 99,000, respectively. Other species and life stages contributing to entrainment were juvenile (82,000) and post-yolk-sac (25,000) banded killifish, and unidentified eggs (57,000). All other species and life stages contributed less than 17,000 individuals, or less than 3%, to the estimated total entrainment.

Under full rated flow of the Unit 3 and Unit 4 circulating water pumps (125.4 kgpm) during April through September, an estimated 813,200 early life stage fish would be entrained at AES Westover (Table 14d). Of these months, entrainment would be highest during June (300,400) and July (258,400). June entrainment would include a number of species, but be comprised mostly of alewife eggs (77%) while July entrainment would be distributed primarily among banded killifish juveniles (40%) and post yolk sac larvae (12%) and unidentified eggs (24%). Alewife (eggs only) would be entrained in the largest numbers (230,400) followed by white sucker (174,100) and banded killifish (134,100); all other taxa would be entrained at a rate of approximately 40,000 or less per year.

6.0 LITERATURE CITED

HDR|LMS. 2006. AES Greenidge Generating Station: Proposal for Information Collection in Compliance with Section 316 (b) Phase II-Requirements of the Clean Water Act. February, 6 2006.

Henningson, Durham & Richardson Architecture and Engineering, P.C. In Association with HDR Engineering, Inc. (HDR). 2010. AES Greenidge Generating Station Impingement and Entrainment Characterization Study. April 29, 2010.

Appendix I. AES Greenidge Generating Station 2006 Ichthyoplankton and Entrainment Studies.

Appendix II. AES Greenidge Generating Station 2006-2007 Impingement Study.

Appendix III. AES Greenidge Generating Station 2006-2007 Finfish Community and Waterbody Studies.

New York State Electric & Gas Corporation (NYSEG). 1977. Environmental Assessment of Impingement and Entrainment, Greenidge Station. August 1977.

Smith, C. Lavett. 1985. The Inland Fishes of New York State. New York State Department of Environmental Conservation.

7.0 TABLES

Table 1 - Taxonomic Inventory of Fish and Shellfish Species Collected in Impingement Sampling at AES Greenidge Generating Station from March 1976 through February 1977 (NYSEG 1977) and from February 2006 through February 2007 (HDR 2010, Appendix II)

Common Name	Scientific Name	NYSEG 1977	HDR 2010
Alewife	*Alosa pseudoharengus*	X	X
Banded Killifish	*Fundulus diaphanus*		X
Bluegill	*Lepomis macrochirus*	X	X
Bluntnose Minnow	*Pimephales notatus*		X
Brown Bullhead	*Ameiurus nebulosus*	X	X
Bullheads and Catfishes	Ictaluridae spp.		X
Bighead Carp	*Aristichthys nobilis*	X	
Basses and Sunfishes	Centrarchidae spp.		X
Chain pickerel	*Esox niger*	X	
Crayfish	Astacidae		X
Golden shiner	*Notemigonus crysoleucas*	X	
Lamprey species	Petromyzontidae spp.		X
Largemouth Bass	*Micropterus salmoides*	X	X
Pumpkinseed	*Lepomis gibbosus*	X	X
Rainbow smelt	*Osmerus mordax mordax*	X	
Rock Bass	*Ambloplites rupestris*	X	X
Sea lamprey	*Petromyzon marinus*	X	
Slimy sculpin	*Cottus cognatus*	X	
Smallmouth Bass	*Micropterus dolomieu*	X	X
Spottail Shiner	*Notropis hudsonius*	X	X
Sunfish species	*Lepomis* spp.		X
Yellow Perch	*Perca flavescens*	X	X
Total Distinct Taxa		**15**	**13***

*higher taxa not counted when lower taxa present; for example, bullhead and catfishes not counted in total because brown bullhead present.

Table 2 - Minimum, Average and Maximum Length (mm) and Weight (g) for Taxa Collected in Impingement Samples at AES Greenidge Generating Station, 2006-2007

Common Name	ScientificName	Length (mm)			Number Measured	Weight (g)			Number Weighed
		Min	Avg	Max		Min	Avg	Max	
Alewife	*Alosa pseudoharengus*	84	144	164	25	2	18	25	26
Banded Killifish	*Fundulus diaphanus*	30	66	91	39	1	3	6	40
Basses and Sunfishes	Centrarchidae spp.	57	57	57	1	3	3	3	1
Bluegill	*Lepomis macrochirus*	42	54	106	26	1	2	20	26
Bluntnose Minnow	*Pimephales notatus*	55	60	75	4	1	2	3	4
Brown Bullhead	*Ameiurus nebulosus*	46	81	317	49	1	24	469	49
Bullheads and Catfishes	Ictaluridae spp.				0	426	426	426	1
Crayfish	Astacidae	26	63	96	60	1	9	29	60
Lamprey species*	Petromyzontidae spp.				0	406	406	406	0
Largemouth Bass	*Micropterus salmoides*	45	97	237	6	1	69	388	6
Pumpkinseed	*Lepomis gibbosus*	46	68	158	31	1	9	97	31
Rock Bass	*Ambloplites rupestris*	51	53	55	2	2	3	3	2
Smallmouth Bass	*Micropterus dolomieu*	56	63	70	2	2	3	4	2
Spottail Shiner	*Notropis hudsonius*	57	79	108	3	2	6	12	3
Sunfish species	*Lepomis* spp.	38	46	75	158	1	1	9	158
Unidentified	Unidentified	40	40	40	1	1	1	1	1
Yellow Perch	*Perca flavescens*	243	284	325	2	140	305	470	2

*estimated weight

Table 3 - Number of Fish Collected in Day and Night 1976-1977 Impingement Collections at AES Greenidge Generating Station (from NYSEG 1977)

Date	Mean Intake	Day		Night	
	Temperature (C)	Total Number	Fish/6-hr Period	Total Number	Fish/6-hr Period
3/18/1976	3.9	0	0	0	0
3/25/1976	6.7	0	0	0	0
4/8/1976	7.8	0	0	0	0
4/22/1976	9.4	2	1	1	0.5
5/6/1976	7.8	1	1	0	0
5/20/1976	8.9	23	11.5	21	10.5
6/10/1976	14.4	0	0	0	0
6/24/1976	17.8	49	24.5	293	146.5
7/9/1976	22.8	24	24	74	74
7/22/1976	23.3	55	27.5	76	38
8/5/1976	19.4	9	9	41	41
8/19/1976	22.2	2	1	17	8.5
9/10/1976	20.0	0	0	4	4
9/23/1976	17.2	0	0	16	8
10/7/1976	17.2	4	4	5	5
10/21/1976	12.2	6	3	5	2.5
11/4/1976	9.4	0	0	0	0
11/18/1976	6.1	0	0	0	0
12/9/1976	5.6	0	0	0	0
12/21/1976	5.6	1	0.5	1	0.5
1/6/1977	5.6	0	0	0	0
1/20/1977	5.0	0	0	0	0
2/10/1977	3.3	0	0	1	1
2/24/1977	3.9	0	0	1	0.5
Total Number Impinged/Mean fish/6-hr period		**176**	**4.46**	**556**	**14.19**
Percent of Total Number Impinged		**24%**		**76%**	

Source: Table 5-5 from NYSEG (1977)

Table 4 - Mean Monthly Impingement Density (Number per million m³) at AES Greenidge Generating Station, 2006-2007

Common Name	Scientific Name	Mean Monthly Impingement Density (Number per million m^3)*												Monthly Average
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Sunfish species	*Lepomis* spp.	197.0	8.3		1.4	3.7			2.7	7.1	119.1	34.6	36.0	**34.2**
Brown Bullhead	*Ameiurus nebulosus*	3.5	63.6				2.8		10.9	4.2	11.5	15.5	2.8	**9.6**
Banded Killifish	*Fundulus diaphanus*	43.7			6.9			1.5	1.1		9.7	36.6	11.1	**9.2**
Crayfish	Astacidae				8.3	11.2	31.8	22.1	3.9	6.2	4.1	3.2		**7.6**
Bluegill	*Lepomis macrochirus*	34.7	13.7	2.8							3.0		30.4	**7.0**
Pumpkinseed	*Lepomis gibbosus*		30.5		2.8			4.2	1.1	1.7	14.3	11.1	2.8	**5.7**
Alewife	*Alosa pseudoharengus*					2.5	6.9	25.6						**2.9**
Largemouth Bass	*Micropterus salmoides*	14.6						1.4	2.2		1.4			**1.6**
Bluntnose Minnow	*Pimephales notatus*								1.6	4.2	1.5	2.8		**0.8**
Smallmouth Bass	*Micropterus dolomieu*	6.9												**0.6**
Spottail Shiner	*Notropis hudsonius*						2.8	1.3						**0.3**
Bullheads and Catfishes	Ictaluridae spp.					3.7								**0.3**
Rock Bass	*Ambloplites rupestris*									2.1	1.5			**0.3**
Yellow Perch	*Perca flavescens*							1.5			1.5			**0.2**
Basses and Sunfishes	Centrarchidae spp.					2.1								**0.2**
Lamprey species	Petromyzontidae spp.									2.1				**0.2**
Unidentified	Unidentified								1.1					**0.1**
Total Monthly Impingement		**300.3**	**116.2**	**2.8**	**19.4**	**23.3**	**44.2**	**57.6**	**24.7**	**27.5**	**167.5**	**103.7**	**83.0**	**80.8**

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Table 5 - Composition of Impingement Collections based on 1976-1977 (NYSEG 1977) and 2006-2007 (HDR 2010, Appendix II) AES Greenidge Generating Station Sampling

Common Name	Scientific Name	NYSEG 1977*	HDR 2010
Sunfish Species	*Lepomis* spp.		38.2%
Crayfish	Astacidae		14.4%
Brown Bullhead	*Ameiurus nebulosus*	0.7%	11.8%
Banded Killifish	*Fundulus diaphanus*		9.6%
Pumpkinseed	*Lepomis gibbosus*	2.3%	7.5%
Alewife	*Alosa pseudoharengus*	89.6%	6.3%
Bluegill	*Lepomis macrochirus*	0.7%	6.3%
Largemouth Bass	*Micropterus salmoides*	0.7%	1.7%
Bluntnose Minnow	*Pimephales notatus*		1.2%
Spottail Shiner	*Notropis hudsonius*	1.4%	0.7%
Rock Bass	*Ambloplites rupestris*	0.3%	0.5%
Smallmouth Bass	*Micropterus dolomieu*	0.5%	0.5%
Yellow Perch	*Perca flavescens*	1.5%	0.5%
Basses and Sunfishes	Centrarchidae spp.		0.2%
Bullheads and Catfishes	Ictaluridae spp.		0.2%
Lamprey species	Petromyzontidae spp.		0.2%
Unidentified	Unidentified		0.2%
Bighead Carp	*Aristichthys nobilis*	0.1%	
Chain pickerel	*Esox niger*	0.1%	
Golden shiner	*Notemigonus crysoleucas*	0.3%	
Rainbow smelt	*Osmerus mordax mordax*	1.4%	
Sea lamprey	*Petromyzon marinus*	0.1%	
Slimy sculpin	*Cottus cognatus*	0.3%	
Total Organisms Collected		**732**	**416**

*Table 5-1 from NYSEG (1977)

Table 6 - Taxonomic Inventory of Species and Life Stages Subject to Entrainment at AES Greenidge Generating Station from March 1976 through February 1977 (NYSEG 1977) and from Entrainment Samples Collected in 2006 (HDR 2010, Appendix I)

Common Name	Scientific Name	NYSEG 1977	HDR 2010
Alewife	*Alosa pseudoharengus*		E
Bullhead Species	*Ameiurus* spp.		J
Banded Killifish	*Fundulus diaphanus*		PYS, J
Brook Silverside	*Labidesthes sicculus*		E
Carp	*Cyprinus carpio*	YS/PYS	J
Suckers	Catostomidae spp.	YS/PYS	YS/PYS
Carps and Minnows	Cyprinidae spp.		E, YS, PYS
Darters	*Etheostoma* spp.		YS
Sunfish Species	*Lepomis* spp.	YS/PYS	
Rainbow Smelt	*Osmerus mordax mordax*	YS/PYS	
White Sucker	*Catostomus commersonii*		YS, PYS, YS/PYS
Yellow Perch	*Perca flavescens*		PYS

Life Stage Codes:

(E) = Egg

(YS) = Yolk-sac larvae

(PYS) = Post-yolk-sac larvae

(YS/PYS) = Unidentified-life stage larvae

(J) = Juvenile

Table 7 - Minimum, Mean and Maximum Length (mm) of Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS) and Juvenile (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	LifeStage	Month	Length (mm)			Number Measured
				Min	Mean	Max	
White Sucker	*Catostomus commersonii*	PYS	April	13.5	13.7	13.9	3
		YS	May	13.7	13.7	13.7	1
		PYS	May	13.7	14.0	14.4	2
		YS/PYS	May	13.8	13.8	13.8	1
Darters	Etheostoma spp.	YS	June	4.3	4.8	5.3	2
Yellow Perch	*Perca flavescens*	PYS	June	6.7	6.7	6.7	1
Banded Killifish	*Fundulus diaphanus*	PYS	July	7.7	8.9	11.0	3
		JUV	July	14.3	16.1	20.3	8
Carp	*Cyprinus carpio*	JUV	July	25.3	25.3	25.3	1

Table 8 - Diel Trends in Density (Number per 100 m^3) of Eggs (E), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	Life Stage	Average Entrainment Density (Number per 100 m^3) per Hour Interval*											
			0	2	4	6	8	10	12	14	16	18	20	22
Alewife	*Alosa pseudoharengus*	Egg	0.3879	0.2921	0.2925	0.2444		0.1222		0.3261	0.2171			0.6914
Banded Killifish	*Fundulus diaphanus*	PYS				0.1222					0.1085			0.1383
		JUV	0.0970	0.1947										0.9680
Brook silverside	*Labidesthes sicculus*	Egg										0.1080		
Bullhead Species	*Ameiurus* spp.	JUV												0.1383
Carp	*Cyprinus carpio*	JUV												0.2766
Carps and Minnows	Cyprinidae spp.	Egg			0.0975									
		YS												0.1383
		PYS	0.1939											
Darters	Etheostoma spp.	YS												0.2766
Suckers	Catostomidae spp.	YS/PYS			0.1950									
White Sucker	*Catostomus commersonii*	YS	0.0970											
		PYS			0.4876	0.4889	0.6201					0.1080		
		YS/PYS	0.0970											
Yellow Perch	*Perca flavescens*	PYS								0.1087				
Unidentified	Unidentified	Egg				0.1222		0.4888		0.1087			0.1626	
		PYS		0.0974							0.1085			
		YS/PYS							0.0977		0.1085			
Total Entrainment Density			**0.8727**	**0.5841**	**1.0727**	**0.9777**	**0.6201**	**0.6110**	**0.0977**	**0.5435**	**0.5427**	**0.2160**	**0.1626**	**2.6274**

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Table 9 - Mean Monthly Entrainment Density (Number per 100 m³) at AES Greenidge Generating Station, 2006

Common Name	Scientific Name	Life Stage	Entrainment Density (Number per 100m³)*						Average
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			1.12				**0.19**
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				0.15			**0.02**
		YS/PYS							
		JUV				0.49			**0.08**
Brook silverside	*Labidesthes sicculus*	EGG			0.05				**0.01**
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						0.10	**0.02**
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				0.10			**0.02**
Carps and Minnows	Cyprinidae spp.	EGG			0.05				**0.01**
		YS			0.05				**0.01**
		PYS				0.10			**0.02**
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			0.10				**0.02**
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	0.20						**0.03**
		JUV							
Unidentified	Unidentified	EGG			0.05	0.29			**0.06**
		YS							
		PYS					0.10		**0.02**
		YS/PYS				0.10			**0.02**
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		0.05					**0.01**
		PYS	0.29	0.44					**0.12**
		YS/PYS		0.05					**0.01**
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			0.05				**0.01**
		YS/PYS							
		JUV							
Total Entrainment Density		**EGG**			**1.27**	**0.29**			**0.26**
		YS		**0.05**	**0.15**				**0.03**
		PYS	**0.29**	**0.44**	**0.05**	**0.24**	**0.10**		**0.19**
		YS/PYS	**0.20**	**0.05**		**0.10**			**0.06**
		JUV				**0.58**		**0.10**	**0.11**
		ALL	**0.49**	**0.54**	**1.47**	**1.22**	**0.10**	**0.10**	**0.65**

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Table 10 - Composition of Entrainment Collections based on 1976-1977 (NYSEG 1977) and 2006 Entrainment Sampling (HDR 2010, Appendix I) at AES Greenidge Generating Station

Common Name	Scientific Name	NYSEG 1977*	HDR 2010
White Sucker	*Catostomus commersonii*		48.3%
Unidentified	Unidentified	68.6%	13.8%
Banded Killifish	*Fundulus diaphanus*		10.3%
Carps and Minnows	Cyprinidae spp.		10.3%
Suckers	Catostomidae spp.	0.4%	6.9%
Darters	*Etheostoma* spp.		6.9%
Yellow Perch	*Perca flavescens*		3.4%
Common Carp	*Cyprinus carpio*	2.4%	
Sunfish Species	*Lepomis* spp.	0.8%	
Rainbow smelt	*Osmerus mordax mordax*	27.8%	
Total Larvae Collected		**252**	**29**

*Table 6-1 from NYSEG (1977)

Table 11 - Month- and Taxa-specific Initial Impingement Survival Values Calculated from AES Greenidge Generating Station Unit 3 Impingement Samples, 2006-2007 (Only Those Organisms Classified as Live and Undamaged were Assumed to Survive)

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Alewife	*Alosa pseudoharengus*					0%	0%	0%					
Banded Killifish	*Fundulus diaphanus*	25%			80%			0%	0%		0%	38%	50%
Basses and Sunfishes	Centrarchidae spp.					0%							
Bluegill	*Lepomis macrochirus*	57%	100%	100%							0%		91%
Bluntnose Minnow	*Pimephales notatus*								0%	50%	0%	100%	
Brown Bullhead	*Ameiurus nebulosus*	100%	100%				50%		14%	100%	100%	100%	100%
Bullheads and Catfishes	Ictaluridae spp.					0%							
Crayfish	Astacidae				100%	100%	95%	75%	67%	100%	100%	100%	
Lamprey species	Petromyzontidae spp.									0%			
Largemouth Bass	*Micropterus salmoides*	0%						0%	0%		0%		
Pumpkinseed	*Lepomis gibbosus*		82%		0%			0%	0%	0%	38%	75%	100%
Rock Bass	*Ambloplites rupestris*									100%	100%		
Smallmouth Bass	*Micropterus dolomieu*	0%											
Spottail Shiner	*Notropis hudsonius*						0%	0%					
Sunfish species	*Lepomis* spp.	20%	67%		0%	0%			0%	0%	24%	17%	23%
Unidentified	Unidentified								0%				
Yellow Perch	*Perca flavescens*							0%			100%		

Note: blank cells indicate no data are available

Table 12a - Estimated Annual Impingement (Expressed as Numbers of Organisms) at AES Greenidge Generating Station, Units 3 and 4 Combined, 2006-2007

Common Name	Scientific Name	Estimated Annual Impingement, Combined Units 3 and 4*												Total Est.	Lower	Upper
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged	95% C.I.	95% C.I.
Alewife	*Alosa pseudoharengus*					31	101	432						**563**	**95**	**1,032**
Banded Killifish	*Fundulus diaphanus*	484			106			25	19		29	237	128	**1,028**	**261**	**1,794**
Basses and Sunfishes	Centrarchidae spp.					26								**26**		**68**
Bluegill	*Lepomis macrochirus*	384	176	40							9		353	**962**	**239**	**1,685**
Bluntnose Minnow	*Pimephales notatus*								28	57	4	18		**107**		**220**
Brown Bullhead	*Ameiurus nebulosus*	38	819				41		187	57	35	100	32	**1,308**		**2,764**
Bullheads and Catfishes	Ictaluridae spp.					45								**45**		**117**
Crayfish	Astacidae				127	137	468	373	66	85	12	21		**1,290**	**879**	**1,700**
Lamprey species	Petromyzontidae spp.									28				**28**		**77**
Largemouth Bass	*Micropterus salmoides*	161						23	38		4			**226**	**51**	**401**
Pumpkinseed	*Lepomis gibbosus*		393		43			70	19	23	43	72	32	**694**		**1,451**
Rock Bass	*Ambloplites rupestris*									28	4			**33**		**82**
Smallmouth Bass	*Micropterus dolomieu*	77												**77**		**219**
Spottail Shiner	*Notropis hudsonius*						41	22						**63**		**145**
Sunfish species	*Lepomis* spp.	2,181	107		21	45			47	97	357	224	418	**3,498**	**2,658**	**4,338**
Unidentified	Unidentified								19					**19**		**51**
Yellow Perch	*Perca flavescens*							25			4			**29**		**73**
Total Estimated Number Impinged		**3,325**	**1,495**	**40**	**297**	**284**	**651**	**970**	**423**	**375**	**501**	**672**	**963**	**9,996**	**4,183**	**16,217**

*blank cells have a value of zero

Note: estimates are based on 2006-2007 Unit 3 impingement collections; Unit 4 has no traveling screens such that "impingement" attributable to flow at this unit would actually be entrainment.

Table 12b - Estimated Annual Impingement (Expressed as Numbers of Organisms) at AES Greenidge Generating Station, Unit 3, 2006-2007

Common Name	Scientific Name	Estimated Annual Impingement, Unit 3*												Total Est.
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged
Alewife	*Alosa pseudoharengus*					3	29	143						**175**
Banded Killifish	*Fundulus diaphanus*	156			30			8	6		28	179	52	**460**
Basses and Sunfishes	Centrarchidae spp.					3								**3**
Bluegill	*Lepomis macrochirus*	124	60	11							9		143	**347**
Bluntnose Minnow	*Pimephales notatus*								9	11	4	14		**38**
Brown Bullhead	*Ameiurus nebulosus*	12	279				12		61	11	34	75	13	**498**
Bullheads and Catfishes	Ictaluridae spp.					5								**5**
Crayfish	Astacidae				36	15	134	123	22	16	12	16		**373**
Lamprey species	Petromyzontidae spp.									5				**5**
Largemouth Bass	*Micropterus salmoides*	52						8	12		4			**76**
Pumpkinseed	*Lepomis gibbosus*		134		12			23	6	4	42	54	13	**289**
Rock Bass	*Ambloplites rupestris*									5	4			**9**
Smallmouth Bass	*Micropterus dolomieu*	25												**25**
Spottail Shiner	*Notropis hudsonius*						12	7						**19**
Sunfish species	*Lepomis* spp.	705	36		6	5			15	19	348	169	170	**1,472**
Unidentified	Unidentified								6					**6**
Yellow Perch	*Perca flavescens*							8			4			**12**
Total Estimated Number Impinged		**1,075**	**510**	**11**	**84**	**31**	**186**	**321**	**139**	**72**	**488**	**506**	**391**	**3,813**

*blank cells have a value of zero

Table 12c - Estimated Annual "Impingement" (Expressed as Numbers of Organisms) at AES Greenidge Generating Station, Unit 4, 2006-2007

Common Name	Scientific Name	Estimated Annual Impingement, Unit 4*												Total Est.
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged
Alewife	*Alosa pseudoharengus*					28	72	289						**389**
Banded Killifish	*Fundulus diaphanus*	328			76			17	13		1	58	76	**568**
Basses and Sunfishes	Centrarchidae spp.					23								**23**
Bluegill	*Lepomis macrochirus*	260	116	29							0		210	**615**
Bluntnose Minnow	*Pimephales notatus*								19	46	0	4		**69**
Brown Bullhead	*Ameiurus nebulosus*	26	540				29		126	46	1	25	19	**811**
Bullheads and Catfishes	Ictaluridae spp.					40								**40**
Crayfish	Astacidae				91	122	334	250	44	69	0	5		**916**
Lamprey species	Petromyzontidae spp.									23				**23**
Largemouth Bass	*Micropterus salmoides*	109						15	26		0			**150**
Pumpkinseed	*Lepomis gibbosus*		259		31			47	13	19	1	18	19	**406**
Rock Bass	*Ambloplites rupestris*									23	0			**23**
Smallmouth Bass	*Micropterus dolomieu*	52												**52**
Spottail Shiner	*Notropis hudsonius*						29	15						**44**
Sunfish species	*Lepomis* spp.	1,476	71		15	40			32	78	9	55	248	**2,025**
Unidentified	Unidentified								13					**13**
Yellow Perch	*Perca flavescens*							17			0			**17**
Total Estimated Number Impinged		**2,250**	**985**	**29**	**213**	**253**	**465**	**649**	**284**	**303**	**13**	**166**	**572**	**6,183**

*blank cells have a value of zero

Note: estimates are based on 2006-2007 Unit 3 impingement collections; Unit 4 has no traveling screens such that these "impinged" fish would actually be entrained at this unit.

Table 12d - Estimated Annual Impingement (Expressed as Numbers of Organisms) at AES Greenidge Generating Station at Full Rated Flow (125.4 kgpm)

Common Name	Scientific Name	Estimated Annual Impingement, Full Rated Flow*												Total Est.
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged
Alewife	*Alosa pseudoharengus*					53	141	543						**737**
Banded Killifish	*Fundulus diaphanus*	926			142			31	23		205	750	235	**2,312**
Basses and Sunfishes	Centrarchidae spp.					45								**45**
Bluegill	*Lepomis macrochirus*	735	262	59							63		645	**1,764**
Bluntnose Minnow	*Pimephales notatus*								35	85	31	57		**209**
Brown Bullhead	*Ameiurus nebulosus*	73	1,218				57		232	85	244	317	59	**2,285**
Bullheads and Catfishes	Ictaluridae spp.					79								**79**
Crayfish	Astacidae				171	237	652	469	82	128	87	65		**1,891**
Lamprey species	Petromyzontidae spp.									43				**43**
Largemouth Bass	*Micropterus salmoides*	309						29	47		29			**414**
Pumpkinseed	*Lepomis gibbosus*		584		57			88	23	34	302	228	59	**1,376**
Rock Bass	*Ambloplites rupestris*									43	31			**74**
Smallmouth Bass	*Micropterus dolomieu*	147												**147**
Spottail Shiner	*Notropis hudsonius*						57	28						**85**
Sunfish species	*Lepomis* spp.	4,174	159		28	79			58	147	2,524	709	763	**8,640**
Unidentified	Unidentified								23					**23**
Yellow Perch	*Perca flavescens*							31			31			**62**
Total Estimated Number Impinged		**6,364**	**2,223**	**59**	**398**	**493**	**907**	**1,219**	**523**	**565**	**3,547**	**2,126**	**1,761**	**20,186**

*blank cells have a value of zero

Note: estimates are based on 2006-2007 Unit 3 impingement collections; Unit 4 has no traveling screens such that "impingement" attributable to flow at this unit would actually be entrainment.

Table 13a - Estimated Annual Impingement (Expressed as Biomass in kg) at AES Greenidge Generating Station, Units 3 and 4 Combined, 2006-2007

Common Name	Scientific Name	Estimated Annual Impingement Biomass (kg), Combined Units 3 and 4*												Biomass Est.	Lower	Upper
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged	95% C.I.	95% C.I.
Alewife	*Alosa pseudoharengus*					0.733	1.658	7.519						**9.910**	**1.703**	**18.118**
Banded Killifish	*Fundulus diaphanus*	1.175			0.297			0.049	0.038		0.051	0.817	0.321	**2.747**	**0.363**	**5.131**
Basses and Sunfishes	Centrarchidae spp.					0.079								**0.079**		**0.203**
Bluegill	*Lepomis macrochirus*	0.622	0.279	0.040							0.027		1.092	**2.059**	**1.466**	**2.652**
Bluntnose Minnow	*Pimephales notatus*								0.028	0.057	0.004	0.054		**0.143**		**0.286**
Brown Bullhead	*Ameiurus nebulosus*	0.192	2.876				17.330		2.616	0.113	0.168	0.668	0.193	**24.155**	**5.452**	**42.859**
Bullheads and Catfishes	Ictaluridae spp.					19.278								**19.278**		**49.689**
Crayfish	Astacidae				1.127	1.060	4.671	3.455	0.818	0.623	0.037	0.123		**11.914**	**6.975**	**16.853**
Lamprey species	Petromyzontidae spp.									11.485				**11.485**		**31.291**
Largemouth Bass	*Micropterus salmoides*	15.261						0.023	0.415		0.033			**15.732**		**42.717**
Pumpkinseed	*Lepomis gibbosus*		2.034		0.170			2.862	0.565	0.069	0.204	0.235	0.064	**6.203**	**0.887**	**11.520**
Rock Bass	*Ambloplites rupestris*									0.057	0.013			**0.070**		**0.168**
Smallmouth Bass	*Micropterus dolomieu*	0.230												**0.230**		**0.658**
Spottail Shiner	*Notropis hudsonius*						0.285	0.067						**0.352**		**0.866**
Sunfish species	*Lepomis* spp.	2.680	0.107		0.021	0.045			0.243	0.135	0.589	0.273	0.514	**4.606**	**3.220**	**5.993**
Unidentified	Unidentified								0.019					**0.019**		**0.051**
Yellow Perch	*Perca flavescens*							3.442			2.094			**5.536**		**11.704**
Total Estimated Biomass (kg) Impinged		**20.160**	**5.296**	**0.040**	**1.615**	**21.195**	**23.944**	**17.417**	**4.742**	**12.539**	**3.220**	**2.170**	**2.184**	**114.518**	**20.066**	**240.759**

*blank cells have a value of zero

Note: estimates are based on 2006-2007 Unit 3 impingement collections; Unit 4 has no traveling screens such that "impingement" attributable to flow at this unit would actually be entrainment.

Table 13b - Estimated Annual Impingement (Expressed as Biomass in kg) at AES Greenidge Generating Station, Unit 3, 2006-2007

Common Name	Scientific Name	Estimated Annual Impingement Biomass (kg), Unit 3*												Biomass Est.
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged
Alewife	*Alosa pseudoharengus*					0.079	0.473	2.489						**3.041**
Banded Killifish	*Fundulus diaphanus*	0.380			0.084			0.016	0.012		0.050	0.616	0.130	**1.288**
Basses and Sunfishes	Centrarchidae spp.					0.009								**0.009**
Bluegill	*Lepomis macrochirus*	0.201	0.095	0.011							0.026		0.443	**0.777**
Bluntnose Minnow	*Pimephales notatus*								0.009	0.011	0.004	0.041		**0.065**
Brown Bullhead	*Ameiurus nebulosus*	0.062	0.981				4.946		0.858	0.022	0.164	0.503	0.078	**7.614**
Bullheads and Catfishes	Ictaluridae spp.					2.087								**2.087**
Crayfish	Astacidae				0.318	0.115	1.333	1.144	0.268	0.120	0.036	0.093		**3.427**
Lamprey species	Petromyzontidae spp.									2.220				**2.220**
Largemouth Bass	*Micropterus salmoides*	4.932						0.008	0.136		0.032			**5.108**
Pumpkinseed	*Lepomis gibbosus*		0.694		0.048			0.947	0.185	0.013	0.199	0.177	0.026	**2.289**
Rock Bass	*Ambloplites rupestris*									0.011	0.013			**0.024**
Smallmouth Bass	*Micropterus dolomieu*	0.074												**0.074**
Spottail Shiner	*Notropis hudsonius*						0.081	0.022						**0.104**
Sunfish species	*Lepomis* spp.	0.866	0.036		0.006	0.005			0.080	0.026	0.574	0.206	0.209	**2.007**
Unidentified	Unidentified								0.006					**0.006**
Yellow Perch	*Perca flavescens*							1.139			2.039			**3.178**
Total Estimated Biomass (kg) Impinged		**6.515**	**1.806**	**0.011**	**0.456**	**2.294**	**6.834**	**5.765**	**1.555**	**2.423**	**3.136**	**1.635**	**0.887**	**33.317**

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Table 13c - Estimated Annual "Impingement" (Expressed as Biomass in kg) at AES Greenidge Generating Station, Unit 4, 2006-2007

Common Name	Scientific Name	Estimated Annual Impingement Biomass (kg), Unit 4*												Biomass Est.
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged
Alewife	*Alosa pseudoharengus*					0.654	1.185	5.030						**6.869**
Banded Killifish	*Fundulus diaphanus*	0.795			0.213			0.033	0.026		0.001	0.201	0.191	**1.460**
Basses and Sunfishes	Centrarchidae spp.					0.070								**0.070**
Bluegill	*Lepomis macrochirus*	0.421	0.184	0.029							0.001		0.649	**1.283**
Bluntnose Minnow	*Pimephales notatus*								0.019	0.046	0.000	0.013		**0.078**
Brown Bullhead	*Ameiurus nebulosus*	0.130	1.895				12.384		1.758	0.091	0.004	0.165	0.115	**16.542**
Bullheads and Catfishes	Ictaluridae spp.					17.191								**17.191**
Crayfish	Astacidae				0.809	0.945	3.338	2.311	0.550	0.503	0.001	0.030		**8.487**
Lamprey species	Petromyzontidae spp.									9.265				**9.265**
Largemouth Bass	*Micropterus salmoides*	10.329						0.015	0.279		0.001			**10.624**
Pumpkinseed	*Lepomis gibbosus*		1.340		0.122			1.915	0.380	0.056	0.005	0.058	0.038	**3.914**
Rock Bass	*Ambloplites rupestris*									0.046	0.000			**0.046**
Smallmouth Bass	*Micropterus dolomieu*	0.156												**0.156**
Spottail Shiner	*Notropis hudsonius*						0.204	0.045						**0.248**
Sunfish species	*Lepomis* spp.	1.814	0.071		0.015	0.040			0.163	0.109	0.015	0.067	0.305	**2.600**
Unidentified	Unidentified								0.013					**0.013**
Yellow Perch	*Perca flavescens*							2.303			0.055			**2.358**
Total Estimated Biomass (kg) Impinged		**13.645**	**3.490**	**0.029**	**1.159**	**18.901**	**17.110**	**11.652**	**3.187**	**10.116**	**0.084**	**0.535**	**1.297**	**81.205**

*blank cells have a value of zero

Note: estimates are based on 2006-2007 Unit 3 impingement collections; Unit 4 has no traveling screens such that these "impinged" fish would actually be entrained at this unit.

Table 13d - Estimated Annual Impingement (Expressed as Biomass in kg) at AES Greenidge Generating Station at Full Rated Flow (125.4 kgpm)

Common Name	Scientific Name	Estimated Annual Impingement Biomass (kg), Full Rated Flow*												Biomass Est.
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Impinged
Alewife	*Alosa pseudoharengus*					1.271	2.309	9.456						**13.036**
Banded Killifish	*Fundulus diaphanus*	2.248			0.397			0.062	0.047		0.358	2.585	0.587	**6.282**
Basses and Sunfishes	Centrarchidae spp.					0.136								**0.136**
Bluegill	*Lepomis macrochirus*	1.191	0.415	0.059							0.189		1.993	**3.847**
Bluntnose Minnow	*Pimephales notatus*								0.035	0.085	0.031	0.171		**0.323**
Brown Bullhead	*Ameiurus nebulosus*	0.367	4.279				24.140		3.251	0.170	1.189	2.112	0.352	**35.860**
Bullheads and Catfishes	Ictaluridae spp.					33.412								**33.412**
Crayfish	Astacidae				1.508	1.836	6.507	4.345	1.017	0.938	0.261	0.390		**16.802**
Lamprey species	Petromyzontidae spp.									17.288				**17.288**
Largemouth Bass	*Micropterus salmoides*	29.210						0.029	0.515		0.232			**29.987**
Pumpkinseed	*Lepomis gibbosus*		3.026		0.228			3.599	0.703	0.103	1.442	0.742	0.117	**9.961**
Rock Bass	*Ambloplites rupestris*									0.085	0.094			**0.180**
Smallmouth Bass	*Micropterus dolomieu*	0.441												**0.441**
Spottail Shiner	*Notropis hudsonius*						0.398	0.084						**0.482**
Sunfish species	*Lepomis* spp.	5.129	0.159		0.028	0.079			0.302	0.203	4.158	0.863	0.939	**11.859**
Unidentified	Unidentified								0.023					**0.023**
Yellow Perch	*Perca flavescens*							4.328			14.789			**19.117**
Total Estimated Biomass (kg) Impinged		**38.586**	**7.879**	**0.059**	**2.161**	**36.734**	**33.354**	**21.903**	**5.893**	**18.872**	**22.743**	**6.863**	**3.988**	**199.036**

*blank cells have a value of zero

Note: estimates are based on 2006-2007 Unit 3 impingement collections; Unit 4 has no traveling screens such that "impingement" attributable to flow at this unit would actually be entrainment.

Table 14a - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Entrained at AES Greenidge Generating Station, Units 3 and 4 Combined, 2006

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est. Entrained	Lower 95% C.I.	Upper 95% C.I.
			Apr	May	Jun	Jul	Aug	Sep			
Alewife	*Alosa pseudoharengus*	EGG			165,400				165,400	61,300	269,600
		YS									
		PYS									
		YS/PYS									
		JUV									
Banded Killifish	*Fundulus diaphanus*	EGG									
		YS									
		PYS				24,700			24,700		51,500
		YS/PYS									
		JUV				81,900			81,900		199,300
Brook silverside	*Labidesthes sicculus*	EGG			7,200				7,200		21,400
		YS									
		PYS									
		YS/PYS									
		JUV									
Bullhead Species	*Ameiurus* spp.	EGG									
		YS									
		PYS									
		YS/PYS									
		JUV						13,000	13,000		38,700
Carp	*Cyprinus carpio*	EGG									
		YS									
		PYS									
		YS/PYS									
		JUV				16,500			16,500		49,200
Carps and Minnows	Cyprinidae spp.	EGG			7,200				7,200		21,500
		YS			7,200				7,200		21,500
		PYS				16,500			16,500		49,200
		YS/PYS									
		JUV									
Darters	Etheostoma spp.	EGG									
		YS			14,400				14,400		42,900
		PYS									
		YS/PYS									
		JUV									
Suckers	Catostomidae spp.	EGG									
		YS									
		PYS									
		YS/PYS	30,000						30,000		89,400
		JUV									
Unidentified	Unidentified	EGG			7,200	49,400			56,600		125,600
		YS									
		PYS					16,600		16,600		39,400
		YS/PYS				16,500			16,500		39,000
		JUV									
White Sucker	*Catostomus commersoni*	EGG									
		YS		6,000					6,000		17,800
		PYS	45,000	53,800					98,800	1,200	196,400
		YS/PYS		6,000					6,000		17,800
		JUV									
Yellow Perch	*Perca flavescens*	EGG									
		YS									
		PYS			7,200				7,200		21,500
		YS/PYS									
		JUV									
Estimated Total Entrainment		**EGG**			**187,000**	**49,400**			**236,400**	**61,300**	**438,100**
		YS		**6,000**	**21,600**				**27,600**		**82,200**
		PYS	**45,000**	**53,800**	**7,200**	**41,200**	**16,600**		**163,800**	**1,200**	**358,000**
		YS/PYS	**30,000**	**6,000**		**16,500**			**52,500**		**146,200**
		JUV				**98,400**		**13,000**	**111,400**		**287,200**
		ALL	**75,000**	**65,800**	**215,800**	**205,500**	**16,600**	**13,000**	**591,700**	**62,500**	**1,311,700**

*blank cells have a value of zero

Table 14b - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Entrained at AES Greenidge Generating Station Unit 3 during 2006

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est. Entrained
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			47,209				**47,209**
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				8,176			**8,176**
		YS/PYS							
		JUV				27,109			**27,109**
Brook silverside	*Labidesthes sicculus*	EGG			2,055				**2,055**
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						2,512	**2,512**
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				5,462			**5,462**
Carps and Minnows	Cyprinidae spp.	EGG			2,055				**2,055**
		YS			2,055				**2,055**
		PYS				5,462			**5,462**
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			4,110				**4,110**
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	8,463						**8,463**
		JUV							
Unidentified	Unidentified	EGG			2,055	16,351			**18,406**
		YS							
		PYS					5,444		**5,444**
		YS/PYS				5,462			**5,462**
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		649					**649**
		PYS	12,695	5,823					**18,518**
		YS/PYS		649					**649**
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			2,055				**2,055**
		YS/PYS							
		JUV							
Estimated Total Entrainment		**EGG**			**53,374**	**16,351**			**69,726**
		YS		**649**	**6,165**				**6,815**
		PYS	**12,695**	**5,823**	**2,055**	**13,637**	**5,444**		**39,655**
		YS/PYS	**8,463**	**649**		**5,462**			**14,574**
		JUV				**32,570**		**2,512**	**35,083**
		ALL	**21,159**	**7,122**	**61,595**	**68,021**	**5,444**	**2,512**	**165,852**

*blank cells have a value of zero

Table 14c - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Entrained at AES Greenidge Generating Station Unit 4 during 2006

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est. Entrained
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			118,191				**118,191**
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				16,524			**16,524**
		YS/PYS							
		JUV				54,791			**54,791**
Brook silverside	*Labidesthes sicculus*	EGG			5,145				**5,145**
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						10,488	**10,488**
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				11,038			**11,038**
Carps and Minnows	Cyprinidae spp.	EGG			5,145				**5,145**
		YS			5,145				**5,145**
		PYS				11,038			**11,038**
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			10,290				**10,290**
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	21,537						**21,537**
		JUV							
Unidentified	Unidentified	EGG			5,145	33,049			**38,194**
		YS							
		PYS					11,156		**11,156**
		YS/PYS				11,038			**11,038**
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		5,351					**5,351**
		PYS	32,305	47,977					**80,282**
		YS/PYS		5,351					**5,351**
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			5,145				**5,145**
		YS/PYS							
		JUV							
Estimated Total Entrainment		**EGG**			**133,626**	**33,049**			**166,674**
		YS		**5,351**	**15,435**				**20,785**
		PYS	**32,305**	**47,977**	**5,145**	**27,563**	**11,156**		**124,145**
		YS/PYS	**21,537**	**5,351**		**11,038**			**37,926**
		JUV				**65,830**		**10,488**	**76,317**
		ALL	**53,841**	**58,678**	**154,205**	**137,479**	**11,156**	**10,488**	**425,848**

*blank cells have a value of zero

Table 14d - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Entrained at AES Greenidge Generating Station at Full Rated Flow (125.4 kgpm)

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est. Entrained
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			230,400				**230,400**
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				31,100			**31,100**
		YS/PYS							
		JUV				103,000			**103,000**
Brook silverside	*Labidesthes sicculus*	EGG			10,000				**10,000**
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						19,500	**19,500**
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				20,700			**20,700**
Carps and Minnows	Cyprinidae spp.	EGG			10,000				**10,000**
		YS			10,000				**10,000**
		PYS				20,700			**20,700**
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			20,000				**20,000**
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	40,100						**40,100**
		JUV							
Unidentified	Unidentified	EGG			10,000	62,200			**72,200**
		YS							
		PYS					20,700		**20,700**
		YS/PYS				20,700			**20,700**
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		10,300					**10,300**
		PYS	60,200	93,200					**153,500**
		YS/PYS		10,300					**10,300**
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			10,000				**10,000**
		YS/PYS							
		JUV							
Estimated Total Entrainment		**EGG**			**260,400**	**62,200**			**322,600**
		YS		**10,300**	**30,000**				**40,300**
		PYS	**60,200**	**93,200**	**10,000**	**51,800**	**20,700**		**236,000**
		YS/PYS	**40,100**	**10,300**		**20,700**			**71,100**
		JUV				**123,700**		**19,500**	**143,200**
		ALL	**100,300**	**113,800**	**300,400**	**258,400**	**20,700**	**19,500**	**813,200**

*blank cells have a value of zero

8.0 FIGURES

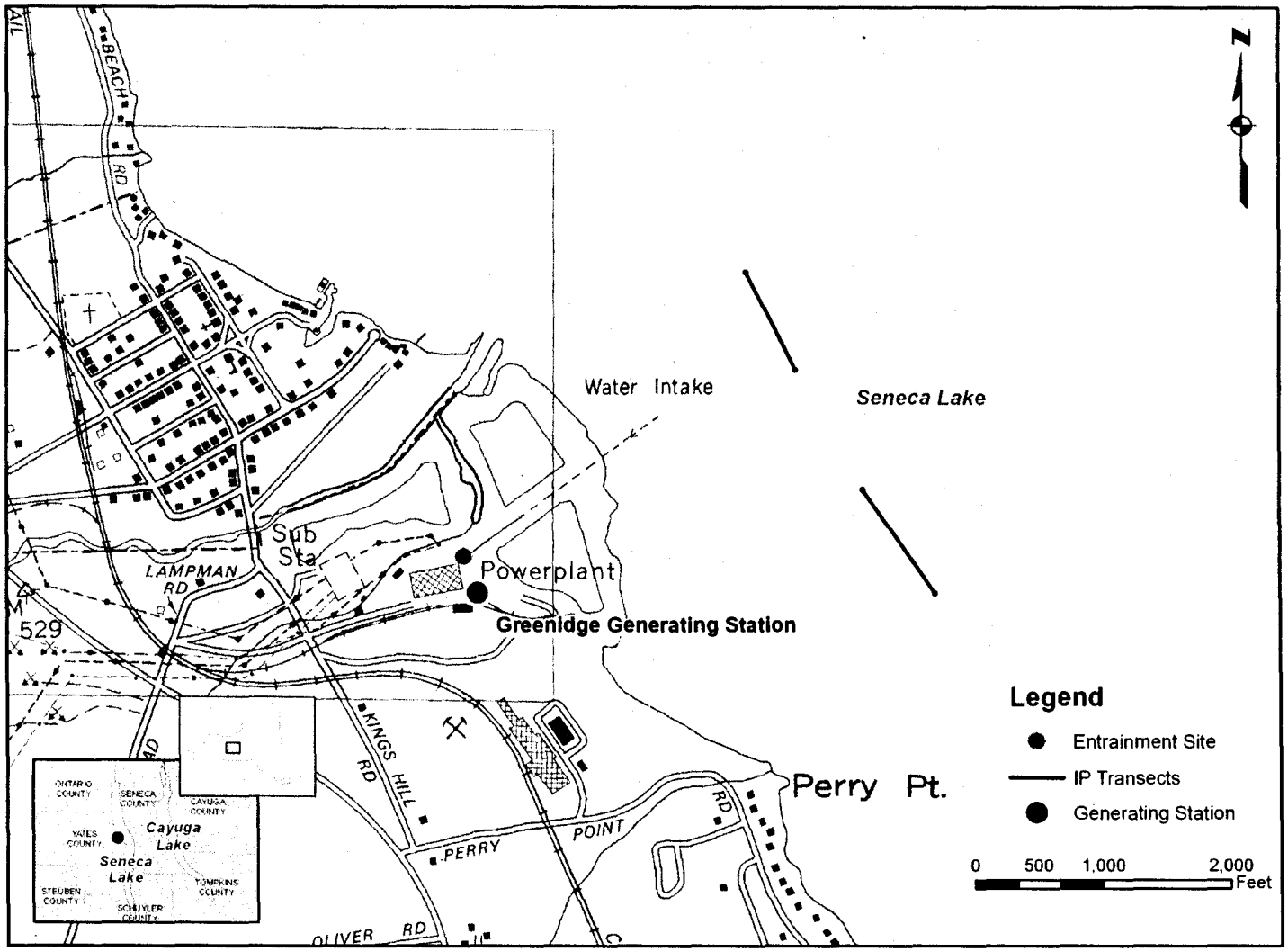


Figure 1 - Ichthyoplankton and Entrainment Sampling Locations for AES Greenidge Generating Station 2006 Sampling

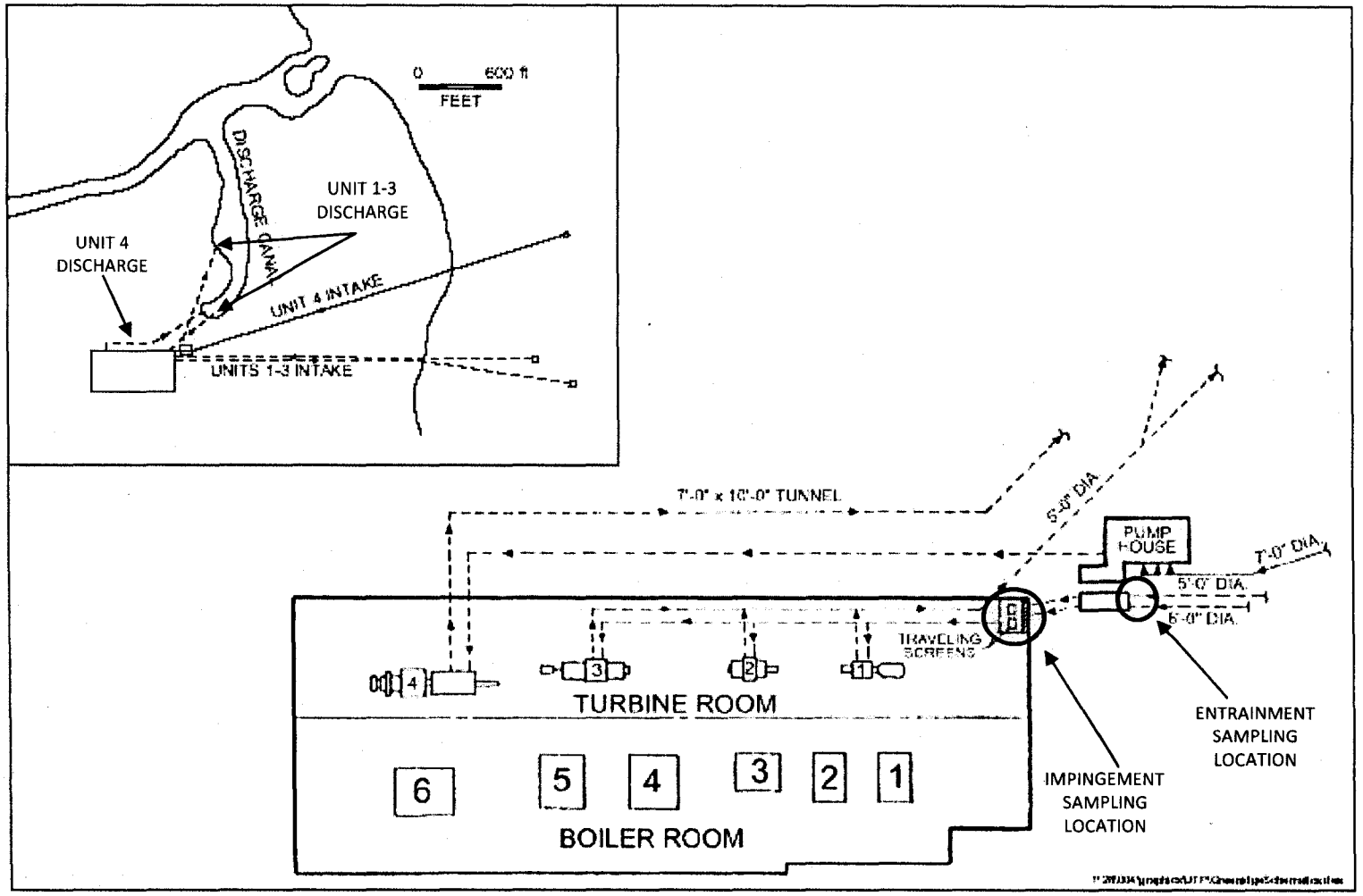


Figure 2 – Routing of Cooling Water Flow through AES Greenidge Generating Station and 2006 and 2007 Entrainment and Impingement Sampling Locations

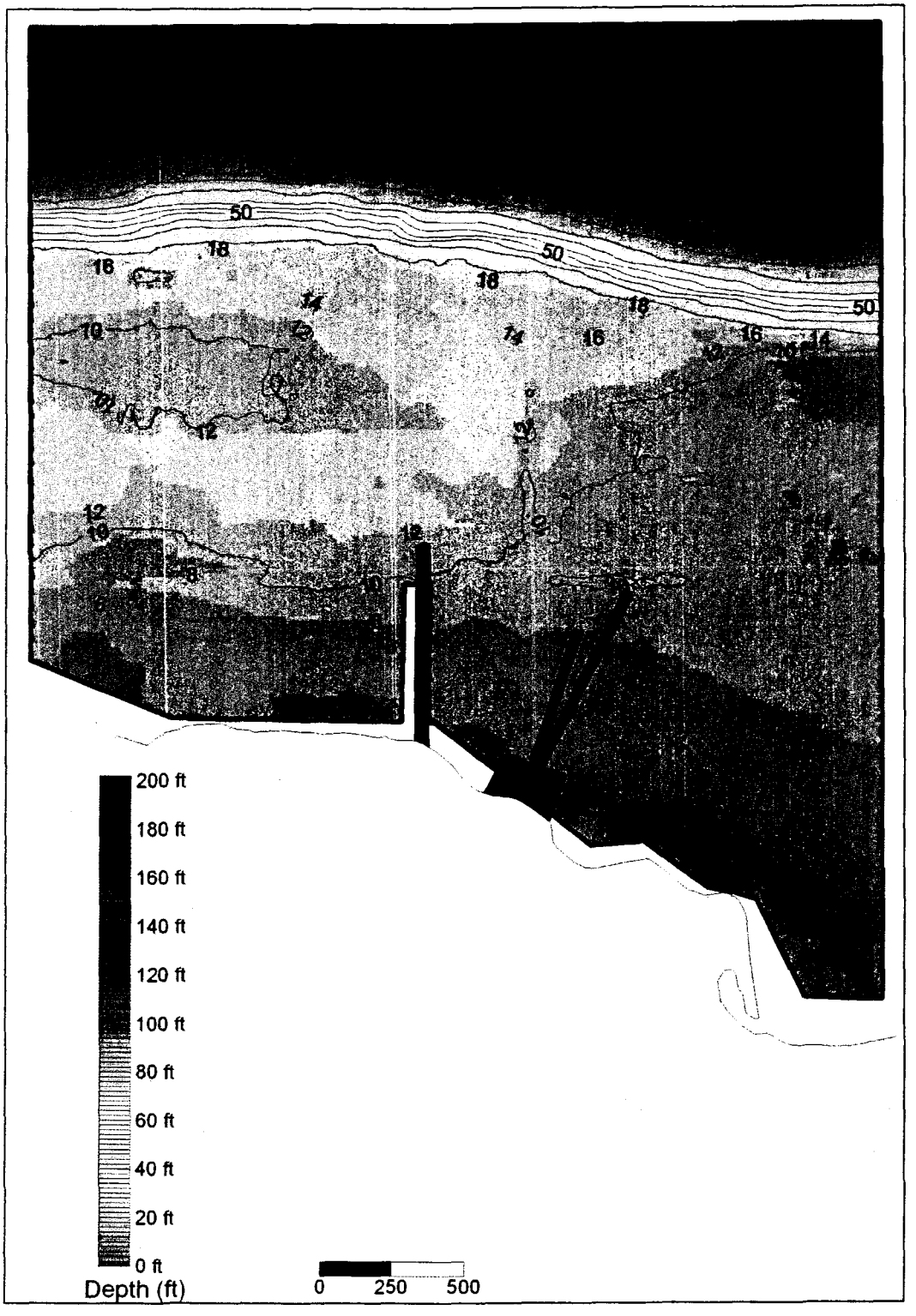
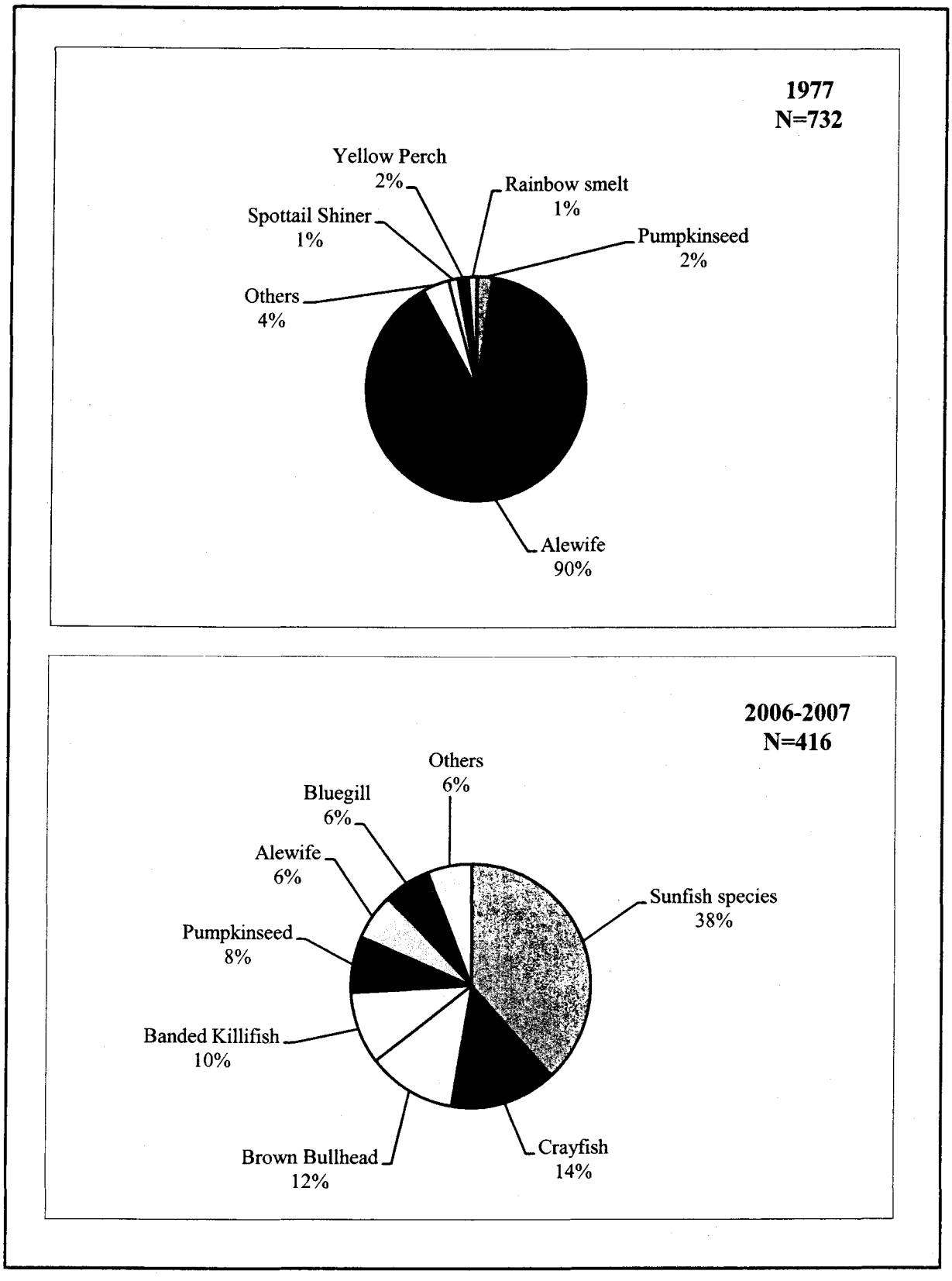


Figure 3 - Bathymetry of Seneca Lake in the Vicinity of AES Greenidge Generating Station Based on 2007 Sampling (Note: average lake surface elevation associated with the hydrographic survey [444.9 ft NGVD29] was very near the 1956-2007 average lake level [444.8 ft NGVD29])



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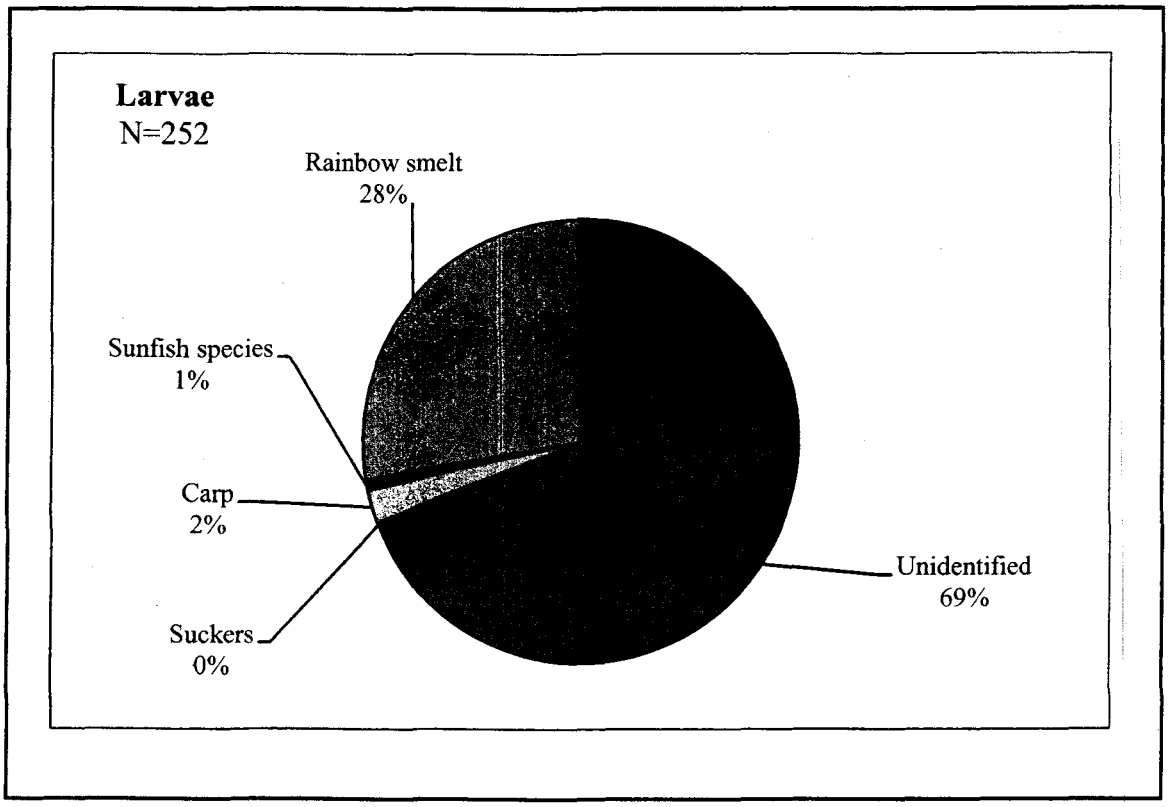

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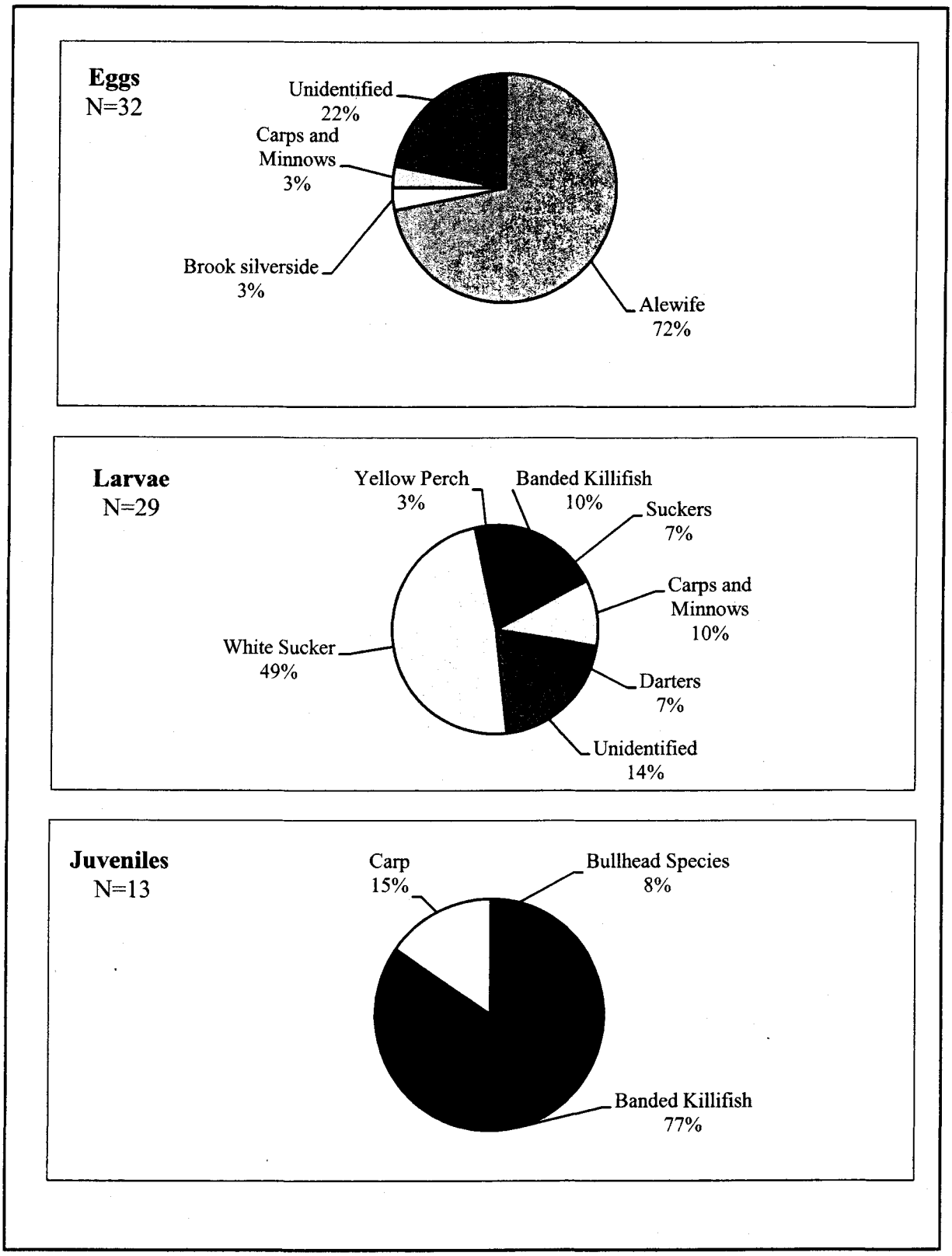

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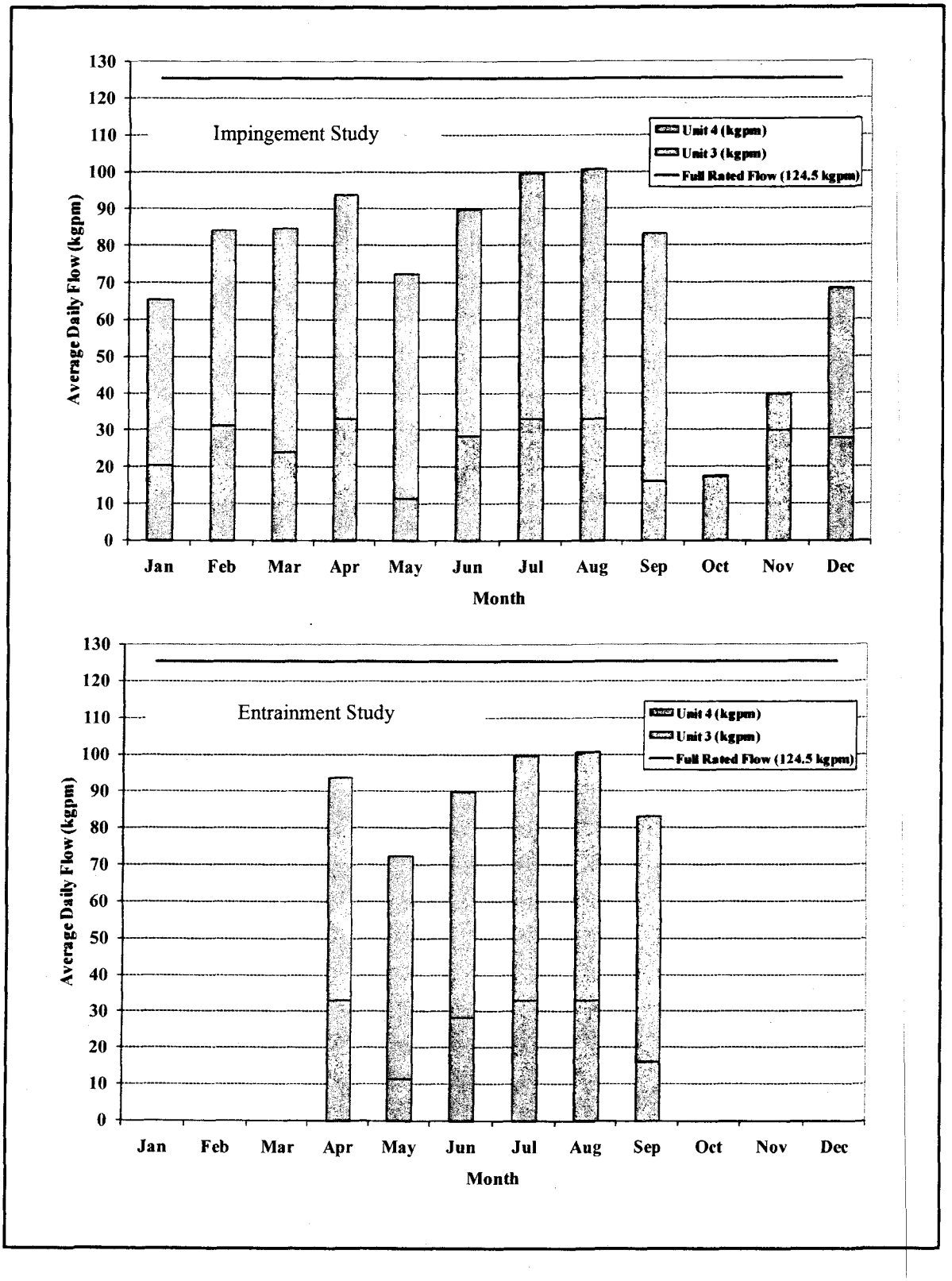

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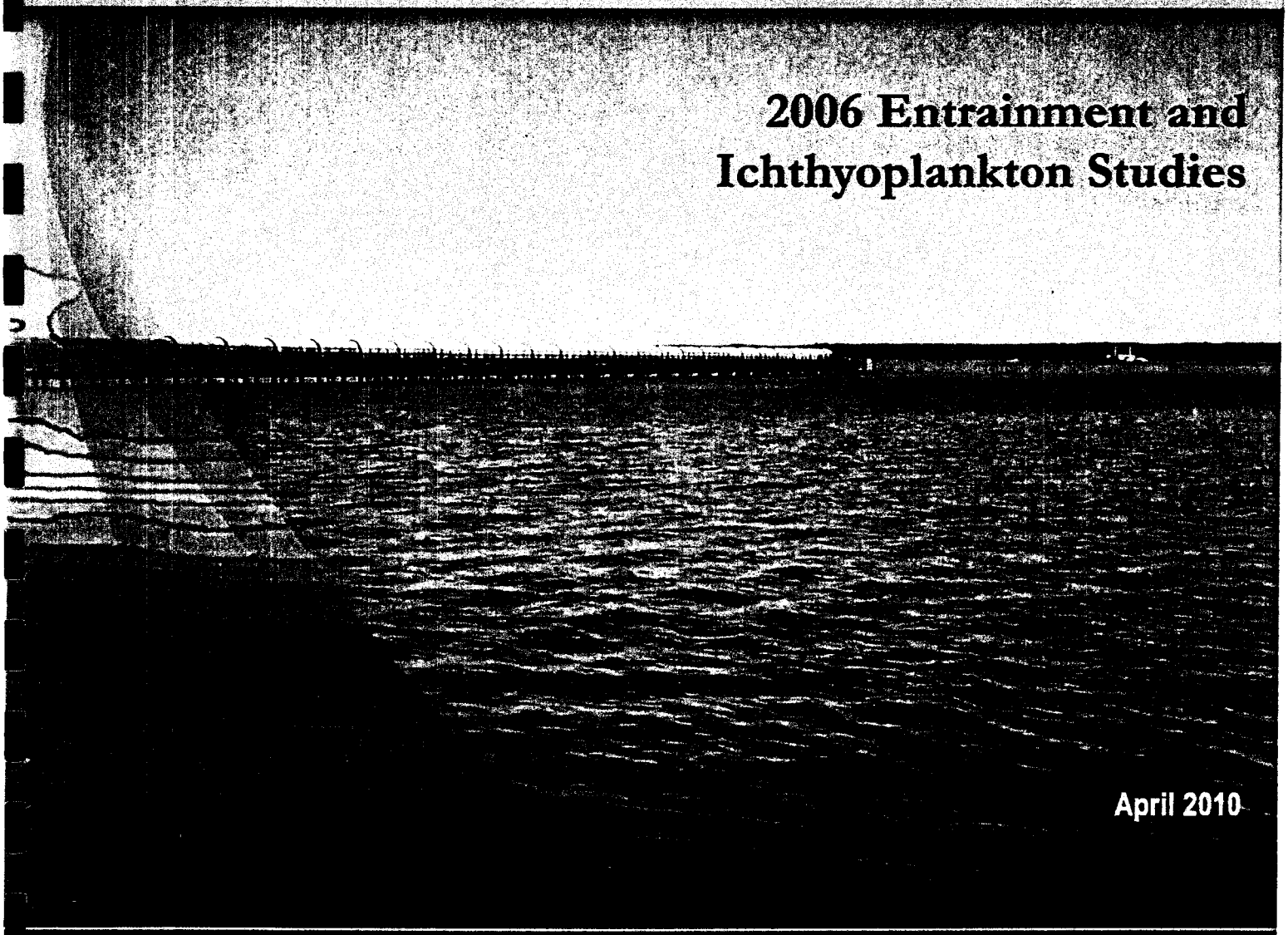
AES

GREENIDGE GENERATING STATION



2006 Entrainment and Ichthyoplankton Studies

April 2010

HDR

AES GREENIDGE GENERATING STATION

2006 ICHTHYOPLANKTON AND ENTRAINMENT STUDIES

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1.0 INTRODUCTION

AES Greenidge Generating Station (hereafter AES Greenidge) is a coal-fired facility located on the western shore of Seneca Lake in Yates County, New York. During 2006 and 2007, when the most recent biological and waterbody studies were conducted, AES Greenidge consisted of two generating units (Units 3 and 4) that began operating in the 1950's and had a combined generating capacity of 161-megawatts (MW). At that time the station's once through condenser cooling water system had a maximum flow of 125.4 thousand gallons per minute (kgpm) and provided cooling water for both Units 3 and 4. A NYS Department of Environmental Conservation (DEC) Consent Decree required that Unit 3 shut down, repower, or be retrofitted with air emission controls after 31 December 2009. With consideration of the cost of the air emission controls, and additionally the potential for expensive modifications to the cooling water intakes to satisfy 6NYCRR §704.5 and Clean Water Act §316(b), AES chose to retire Unit 3 from service on December 31, 2009. The current generating capacity for the single unit in operation at AES Greenidge (Unit 4) is 107 MW with a once through cooling water maximum flow of 91.2 kgpm. As was done prior to the retirement of Unit 3, cooling water is drawn from Seneca Lake through offshore intake pipes and discharged into the Keuka Outlet through a discharge canal upstream of Seneca Lake.

AES Greenidge operates under State Pollutant Discharge Elimination System (SPDES) permit number NY 0001325, with a 1 February 2010 Effective Date (EDP). Section B (Biological Monitoring Requirements) of the permit calls for AES to submit a series of reports demonstrating how they will meet the requirements of 6NYCRR §704.5 and Clean Water Act §316(b). These reports are identified in Biological Requirements 1 through 6 in the permit. Biological Requirement 1, the *Impingement and Entrainment Characterization Study (IMECS)*, is to be submitted to DEC by EDP plus three months, or 1 May 2010. This report, which is one of three appendices to the *IECS* (HDR 2010) to be submitted to meet Biological Requirement 1, details the methods and results of entrainment and concurrent Seneca Lake ichthyoplankton sampling conducted at AES Greenidge during 2006. AES Greenidge impingement sampling (HDR 2010, Appendix II) and AES Greenidge finfish community and waterbody studies (HDR 2010, Appendix III) are covered in separate reports.

1.1 Background

1.1.1 Station Location and Description

AES Greenidge is located in Yates County, New York on the western shoreline of Seneca Lake (Figure 1). AES Greenidge is a steam electric generating station which consisted of three coal-fired boilers and two turbine generators (Units 3 and 4) at the time that the 2006-2007 facility and waterbody studies were conducted. As mentioned in the introduction, with consideration of the cost of the air emission controls and the potential for expensive modifications to the cooling water intakes to satisfy 6NYCRR §704.5 and Clean Water Act §316(b), AES chose to retire Unit 3 from service on December 31, 2009. Notably, two generating units (Units 1 and 2) and associated boilers were also removed from service in 1985.

The maximum dependable capacity (gross) of Unit 3 was 54 MW. This unit was equipped with two circulating water pumps with a maximum intake capacity of 34.2 kgpm (Figure 2). The generating capacity of Unit 4 is 107 MW. Cooling water is supplied to Unit 4 by three circulating pumps of which only two are typically operated outside of the summer months. The third pump is operated during summer months and acts as a backup during the remainder of the year. The maximum cooling water intake capacity of Unit 4 is 91.2 kgpm. As a result, at the time the 2006 and 2007 studies were conducted the maximum combined output capacity at AES Greenidge was 161 MW with a maximum circulating cooling water intake capacity of 125.4 kgpm. AES Greenidge uses once-through condenser cooling. Water is withdrawn from Seneca Lake and is discharged into the Keuka Outlet through a discharge canal (Figure 1b inset). The discharge canal, which is 900-feet long, empties into the Keuka Outlet 700-feet upstream from Seneca Lake.

Unit 3 was serviced by two intake pipes which lie on the lake bottom. A 6-foot-diameter pipe extends 550 feet offshore to a water depth of approximately 8 feet and an 8-foot-diameter pipe extends 710 feet offshore to a water depth of approximately 10 feet (Figure 3). A steel cage, consisting of 1/2-inch bars on 12-inch centers, covers each intake pipe opening to screen out large debris. At the shoreline, the 6-foot and 8-foot pipes are joined into 5-foot and 6-foot diameter concrete pipes, respectively, which extend to the chlorination building. The pipes then combine into a single intake tunnel (seven feet in diameter) that leads to the traveling screens.

Trash racks, composed of 1/4-inch bars on 3-inch centers are located 7 feet in front of the traveling screens. The traveling screens consist of wire panels with 3/8-inch square open mesh, and were operated automatically by a system of pressure differential controls. During the fall and spring, traveling-screen operation was generally continuous; whereas during the summer and winter, operation was usually at intervals of two or three hours. Fish and debris collected on the traveling screens were washed to a discharge tunnel and ultimately discharged to the thermal discharge canal. While these piping and screening infrastructural components are still in place at the facility, they are now only used to support the service water pumps (refer to the last paragraph in this section for a discussion of the service water system).

A third intake pipe, which supplies condenser cooling water to Unit 4, is elevated on wood pilings and extends from the pumphouse to a point 650-feet offshore (water depth of approximately 11 feet, Figure 3). The pipe opens facing downward and is surrounded by a 27-foot by 27-foot steel structure composed of 3/16-inch bars on 6-inch centers. The condenser cooling water is conveyed to Unit 4 through a 7-foot diameter concrete pipe which is reduced to four, 4-foot diameter pipes before entering the pump house and supplying each circulating water pump. The circulating water is recombined after leaving the pump house, first in a 5-foot diameter pipe and then a similarly sized concrete tunnel, and conveyed to the powerhouse and Unit 4. The Unit 4 intake relies on suction to convey water from the lake, through the elevated intake pipe, and on to the circulating water pumps. This configuration does not allow for traveling screens, or any other technology, that would interrupt the suction upstream of the circulating water pumps. Reversing valves on the condenser automatically wash out any debris and fish that might accumulate on the condenser tube face The Unit 4 cooling water is introduced to the discharge canal via a 7-foot by 10- foot concrete tunnel where it enters the Keuka Outlet. All debris and fish that are removed from the condenser tube face during backwash events exit the facility via the discharge.

Service water is supplied to AES Greenidge by four house service water pumps (rated at 550 gpm per pump), two hydrogen cooling pumps (rated at 120 gpm per pump), and a dual Hydro-jet Pump (rated at 1,300 gpm). All service water is withdrawn from the Unit 3 intake prior to the circulators such that service water withdrawals are in addition to circulating water pump withdrawals. The Unit 3 intake is also equipped with a fire pump that is for emergency use only.

If operated, the fire pump would withdraw water from the discharge, after the circulating water pumps and thus not add to the total volume withdrawn by the facility. No service water pump withdraws water from the Unit 4 intake. All of the Unit 3 service water pumps were operational prior to the shutdown of Unit 3 and are currently in operation. Intermittent operation of the traveling screens is required as a part of the service water supply. There is no detailed record of service water use available for the facility.

1.1.2 Source Water Body

Seneca Lake is the second longest lake in the Finger Lakes, measuring 35.1 miles north to south. The Lake is 3.2 miles at its greatest width, with an average width of 1.9 miles. At its deepest point it is 651 feet deep, with an average depth of 290 feet. The surface area of the lake is 66.3 square miles. Seneca Lake contains the largest volume of all the Finger Lakes at over 4.2 trillion gallons of water. This glacial lake lies in a long, narrow valley between ridges which reach up to 900 feet above sea level. The ridges are the highest toward the southern end of the lake where the terrain is somewhat mountainous. The shoreline is well-developed and generally smooth, except for deltas formed by tributaries (NYSEG 1977).

The bottom of the lake drops off precipitously from the east and west shores and is relatively uniform and symmetric around the lake centerline. The northern and southern ends at Geneva and Watkins Glen, respectively, are relatively shallow with depths to about 18 feet. Depths of 500 feet or more are found in the central Lake area from 3.5 miles north of AES Greenidge to 3.5 miles north of Watkins Glen (NYSEG 1977). The drainage basin of the lake, which is a long narrow valley, is 50 miles long and 10 miles wide, and covers an area of 707 square miles. This includes the Keuka Lake drainage basin, which drains into Seneca Lake via the Keuka Outlet.

Traditionally, lake trout, smallmouth bass and yellow perch have been the mainstay of the Seneca Lake fishery. In the decades since the first survey of the lake in 1927, other species have also contributed prominently, including rainbow trout, brown trout, landlocked Atlantic salmon, northern pike and largemouth bass. Alewives, known to be abundant in Seneca Lake at the time of the first survey, and smelt, introduced in 1909, have provided a dependable forage base for

salmonids. Seneca Lake's fishery has benefited greatly in recent years from steady annual stockings of hatchery-reared lake trout, brown trout and landlocked salmon.

1.2 Objectives

The objective of this report is to characterize entrainment and the ichthyoplankton community in the vicinity of the AES Greenidge cooling water intake structure. This objective is accomplished by providing the following:

1. Characterization of the offshore (30-ft depth) and nearshore (14- to 15-ft depth) ichthyoplankton communities using data collected in the 2006 ichthyoplankton and entrainment field surveys, respectively, and
2. Calculation of entrainment at AES Greenidge based on the 2006 data collections and comparison of this estimate to that available from the most recent prior entrainment study conducted at AES Greenidge (1976-1977, NYSEG 1977).

2.0 METHODS

2.1 Seneca Lake Ichthyoplankton Monitoring

From April through September 2006, ichthyoplankton in Seneca Lake was sampled in the offshore area adjacent to the AES Greenidge Unit 3 and Unit 4 intake pipes. Twenty samples were collected during ten 24-hour sampling events, yielding a total of 200 samples throughout the sampling program. Details of sampling procedure, location and frequency are outlined below.

2.1.1 Sampling Gear and Protocol

Samples were collected onboard an 18-ft center console boat using a 0.5-m mouth diameter x 2.5-m long, 500-μ mesh plankton net, fitted with a removable 3.5-inch diameter PVC cod-end bucket. A General Oceanics (GO) Model 2030 mechanical flowmeter was installed in the mouth of the net to determine the amount of water filtered through the net during each tow. The net was towed from the stern of the vessel with the main tow line affixed to a three-point bridle assembly on the net. A 2.5-kg depressor and float line were both attached to the bridal assembly to achieve the desired sampling depth and fishing attitude. Tow speed of the sampling gear was maintained between 90 and 110 cm/sec and was monitored using a GO Model 2031 electronic

flowmeter and Model 2035 readout. The volume of water filtered during a five minute tow was approximately 60 m^3.

Before net deployment, the GO mechanical flowmeter was checked for correct operation and beginning numbers were recorded. Once deployed, the sample start time began when the net reached the desired depth. A five minute tow was timed with a stopwatch and GPS coordinates were recorded at the beginning and end of the tow. During the sample, tow velocity, depth and tow line angle were monitored to ensure the net was fishing properly and at the correct depth. At sample time completion, the net was retrieved and the GO mechanical flowmeter was checked for the number of revolutions to verify tow status. If there was damage to the net, loss of sample, or the net did not fish properly, the tow was deemed invalid and the tow was repeated. If the tow was acceptable, the net was then washed down from the outside and the sample concentrated into the removable cod-end bucket. The contents of the bucket were poured carefully into a labeled sample jar and preserved with a 10% Formalin solution containing the stain Rose Bengal.

Water quality parameters were recorded at the end of each tow at the surface, mid and bottom depth strata. Recorded parameters included temperature (°C), dissolved oxygen (mg/L), and specific conductivity (µS/cm).

2.1.2 Sampling Location and Frequency

Ichthyoplankton sampling events were conducted once per month during April and September, and twice per month during May through August, resulting in ten sampling events. Ichthyoplankton sampling locations consisted of sites in the offshore zone (30-ft contour), one north and one south of the current intake structure (Figure 1). Tows were conducted just off the lake bottom. One ichthyoplankton sample was collected at each of the north and south sites concurrent with each of ten entrainment samples (described below) collected within a 24-hour period for a total of 20 samples.

2.2 Entrainment Monitoring

Ichthyoplankton entrainment sampling was conducted from April through September 2006 at the plant's Unit 3 intake canal. Ten samples were collected during each sampling event, for a total

of 100 samples over the length of the program. No entrainment sampling has been conducted at the Unit 4 intake.

2.2.1 Sampling Gear and Protocol

Entrainment samples were collected using a 94 x 102-cm, 500-μ mesh hoop plankton net with a removable PVC cod-end bucket. Intake water was pumped from mid-water depth through the net using a gas-powered 4-inch diameter centrifugal trash pump and 4-inch PVC pipelines. To minimize organism damage, the water was pumped into a 200-gallon high density polyethylene water-filled buffer tank, where the plankton net was suspended. A pump flow calibration check was conducted before the first sample was collected and checked three additional times within each 24-hour sample period. Total flow sampled was monitored using an in-line Signet model flowmeter. Once a flow rate of 250 to 300 gpm was achieved, the sample would begin and time and start flowmeter numbers recorded. The sample duration was approximately 90 to 100 min or until a minimum of 100 m^3 (approximately 26,400 gal) of water was sampled. Sampling time was adjusted to compensate for varying pump rates. Once the sampling was completed, the time and end flowmeter numbers were recorded. The net was then washed down from the outside of the net into the cod end bucket and the sample was transferred into a labeled sample jar and preserved in a 10% Formalin solution containing the stain Rose Bengal.

Water quality parameters were recorded at the mid depth of the intake canal (via the pump apparatus) during each of the ten samples within the 24-hour sampling period. Recorded parameters included temperature (°C), dissolved oxygen (mg/L), and specific conductivity (μS/cm).

2.2.2 Sampling Location and Frequency

As with Seneca Lake ichthyoplankton sampling, entrainment sampling was conducted once per month during April and September, and twice per month during May through August. The entrainment sampling apparatus was set up on the east side of the AES Greenidge chlorine building with access to the Unit 3 intake canal through an access port in the steel plate covering the intake canal (Figure 2). Each sampling event consisted of entrainment sampling for a 24-hour collection period. Ten equally spaced 100-m^3 entrainment samples were taken throughout

the 24-hour period. The entrainment sampling ran concurrently with the Seneca Lake ichthyoplankton tows.

2.3 Laboratory Analysis

All ichthyoplankton and entrainment samples were transported to the HDR Nyack laboratory and analyzed as described in the following sections.

2.3.1 Sample Sorting

To prepare for the identification and enumeration of ichthyoplankton, each sample was washed through a 500-μ sieve in a sink under a fume hood to remove all traces of formalin. Each sample was sorted in a glass laboratory pan, which was placed on a light box. An illuminated or other type of magnifier was used to aid the sorting procedure. The organisms were sorted into groups of larvae and eggs, and enumerated. The larvae and eggs were preserved in 5% Formalin, placed in separate, labeled vials, and stored.

2.3.2 Sample Identification and Measurement

After sorting, the fish larvae and eggs were identified to the lowest practical taxon and enumerated. The fish larvae were assigned a life stage (yolk-sac (YS), post-yolk-sac (PYS), or juvenile) based on the criteria described in Table 1. If a larval life stage could not be determined because the specimen was incomplete or damaged then it was designated as a YS/PYS larvae. Only whole larvae, parts of larvae with a head, or pieces of larvae with a substantial portion (more than half) of the body present were counted. A total length measurement (TL) was recorded for all fish larvae identified to species for up to 25 specimens for each lifestage. If more than 25 specimens were present in the sample, a random sub-sample of no more than 25 specimens per lifestage (excluding eggs) was selected. Total length was measured to the nearest 0.1 mm for yolk-sac and post-yolk-sac larvae, and to the nearest 1.0 mm for juveniles. All ichthyoplankton were preserved in 5% formalin and stored.

2.4 Data Analysis

2.4.1 Sample Event Density Calculations

Collection densities, expressed as number per 100 m^3, were calculated from entrainment and ichthyoplankton data for each species and life stage by sample event (i.e., including all samples collected within a 24-hour period) as well as by two hour intervals over 0000 to 2400 hours (e.g., 0000-0159, 0200-0359 hours, etc.) across all sampling events. Calculation of sample event densities provides seasonal trends in abundance while diel densities provide trends in abundance throughout a day based on all samples combined. Densities (number per 100 m^3) were calculated as the sum of the total collected divided by the total sample volume in m^3, for the relevant interval, times 100.

2.4.2 Annual Entrainment Estimate

The estimated total number of early life stage fish entrained at AES Greenidge during April through September 2006 and the associated 95% confidence limits were calculated in the following manner. Entrainment was estimated for each of Units 3 and 4 as well as both units combined. First, the average concentration of organisms per unit volume in the h^{th} stratum (i.e., month sampled), $\bar{x}_h$, was calculated as:

$$\bar{x}_h = \frac{1}{n_h}\sum_{i=1}^{n_h} x_{hi}$$

where:

n_h = the number of samples in the h^{th} stratum

x_{hi} = density in the i^{th} sample (per unit volume) in the h^{th} stratum; adjusted for split fractions (f_s) where required (x_{hi}/f_s).

The total number entrained (E) is then,

$$E = \sum_{h=1}^{H} V_h \bar{x}_h$$

where:

H = total number of strata sampled

V_h = volume of water withdrawn by the station in the h^{th} stratum.

The volume of water withdrawn by the facility includes the actual circulating water pump flows for Units 3 and 4 as provided by AES for current flow condition (Figure 4). The variance of the estimated total is:

$$Var(E) = \sum_{h=1}^{H} V_h^2 (1 - f_h) \frac{S_h^2}{n_h}$$

where:

S_h^2 = variance of the h^{th} stratum

$$= \frac{\sum_{i=1}^{n_h} (x_{hi} - \bar{x}_h)^2}{n_h - 1}$$

and f_h = finite population correction for the h^{th} stratum. The finite population correction was computed as the volume of plant flow sampled in the month (i.e., h^{th} stratum) divided by the total plant volume during the month. This factor only becomes important when a large percentage (>10%) of the total monthly plant volume is sampled.

The 95% confidence interval is computed as:

$$E_{Upper} = E + t_{\alpha,df} \sqrt{Var(E)}$$

$$E_{Lower} = E - t_{\alpha,df} \sqrt{Var(E)}$$

where:

t = t-statistic

α = specified probability of Type I error, in this case 0.05

df = degrees of freedom, *n*-1.

The above computations were carried out using the SURVEYMEANS procedure within the SAS (Statistical Analysis System) version 9.1 software. The SURVEYMEANS procedure gives equal weight to each sample regardless of the volume sampled. This will yield slightly different results than calculating the mean from the sum of the catch divided by the sum of the volume sampled.

3.0 RESULTS

3.1 Ichthyoplankton Monitoring

3.1.1 Catch Composition

A total of 659 organisms (26 eggs and 633 larvae) distributed among six taxa was collected in the ten Seneca Lake ichthyoplankton sampling events conducted during 2006 (Table 2 and Figure 5). The majority of organisms were collected in June through early August samples. Egg collections comprised only alewife, while larvae were distributed primarily among yellow perch (95%), alewife (3%) and carps and minnows (1%) (Figure 5). Alewife eggs along with some larvae were collected from late June through late July. Yellow perch larvae, including yolk-sac, post-yolk-sac life stages and some unidentified-lifestage (YS/PYS) larvae, were collected from early June through mid-July.

3.1.2 Ichthyoplankton Sample Event Densities

Organism densities recorded during each sampling event are contained in Table 3 and Figures 6 through 12. Yellow perch yolk-sac larvae were collected in the highest abundance of any species and life stage combination at 36.8 and 8.8 per 100 m^3 in early and mid-June sampling events, respectively. Yellow perch post-yolk-sac larvae were also present during these same sampling events (~2 per 100 m^3). The only other life-stage density above 1 organism per 100 m^3 was alewife eggs in the mid-July sample (2.0 organisms per 100 m^3). All remaining species and life-stage combinations were collected at well below 1 organism per 100 m^3.

3.1.3 Monthly Variation

To examine seasonal trends, month-specific densities were calculated for each taxa and life stage collected during ichthyoplankton sampling using the density calculation methodology described above, but aggregating the data by month of year (Table 4). Total ichthyoplankton density was highest in June (26.48 per 100 m^3) and was the largely the result of yellow perch yolk-sac larvae with a mean monthly density of 23.39. The next highest month was July (1.65 per 100 m^3) and consisted primarily of alewife eggs with a mean monthly density of 1.08. The two lowest months for density were May and September when no larvae or eggs were collected in the ichthyoplankton samples (Table 4).

3.1.4 Diel Variation

Examination of diel trends indicates that density of most species and life stages was highest during nighttime hours (Table 5). For example, alewife eggs and larvae were almost exclusively collected from 2200 to 0559 hours. Yellow perch larvae were collected during each of the twelve 2-hour intervals examined, but were most abundant between 2200 and 0159 hours.

3.1.5 Size Distribution

Average, minimum (min) and maximum (max) length of larvae collected in ichthyoplankton samples are contained in Table 6. Length measurements were collected from four species: alewife, banded killifish, white sucker and yellow perch. Individual lengths ranged from a 4.2 mm alewife yolk-sac larvae collected in June to a 20 mm banded killifish post-yolk-sac larvae collected in August. Yellow perch were measured in the greatest number yet the range of lengths observed was relatively narrow (i.e., 5.0 to 9.2 mm) compared to, for example, alewife (i.e., 4.2 to 16.7 mm).

3.2 Entrainment Monitoring

3.2.1 Catch Composition

A total of ten taxa, including 32 eggs, 29 larvae and 13 juveniles, was collected in the ten entrainment sampling events conducted at AES Greenidge during 2006 (Table 7 and Figure 13). Similar to the ichthyoplankton collections, the majority of organisms were collected in June and July samples. There were exceptions, however, with significant catches of white sucker larvae when sampling started in late April and in early May. An unidentified post-yolk-sac larva and a bullhead species juvenile were collected in early August and mid-September, respectively.

3.2.2 Entrainment Sample Event Densities

Alewife eggs were collected in the highest density of any species and life stage combination in entrainment samples, with all individuals occurring during June (2.3 per 100 m^3; Table 8 and Figures 14 through 24). Also present in July were banded killifish juveniles (1.0 per 100 m^3), white sucker post-yolk-sac larvae in April and May (0.3 and 0.9 per 100 m^3, respectively), and

unidentified eggs in July (0.6 per 100 m^3). All other collections were typically well below 0.3 per 100 m^3.

3.2.3 Monthly Variation

To examine seasonal trends in entrainment, month-specific densities were calculated for each taxa and life stage using the density calculation methodology described above, but aggregating the data by month of year (Table 9). Total entrainment density was highest in June (1.47 per 100 m^3) and was the largely the result of alewife eggs with a mean monthly density of 1.12. The next highest month was July (1.22 per 100 m^3) and consisted primarily of banded killifish juveniles with a mean monthly density of 0.49. The two lowest months for entrainment density were August and September (both months with a total of 0.10 per 100 m^3).

3.2.4 Diel Variation

The diel distribution of organism densities was less pronounced in entrainment samples than in ichthyoplankton samples (Table 10). While a number of relatively high densities were recorded during the 2200 to 2359 sampling period, the remaining periods exhibited a mostly random abundance distribution pattern.

3.2.5 Size Distribution

Average, mean, min and max lengths of larvae collected in entrainment samples are contained in Table 11. Length measurements were collected from five taxa: white sucker, darters, yellow perch, banded killifish and carp. Individual lengths ranged from a 4.3 mm *Etheostoma* spp. yolk-sac larvae collected in June to a 25.3 mm carp juvenile collected in July. Fewer individuals were measured from entrainment samples (22) than in ichthyoplankton samples (476) consistent with the total number of organisms collected in each gear.

3.2.6 Annual Entrainment Estimate

A total of more than 591,000 early lifestage fish were estimated to have been entrained at AES Greenidge during April through September, 2006 (Table 12). Of the total, 165,852 (28%) individuals are attributable to the flow from the now retired Unit 3 while 425,848 (72%) are attributable to Unit 4 (Table 13 and 14). The total combined Units estimate, which accounts for

the total cooling water intake flows (i.e., Unit 3 and Unit 4 cooling water intake volumes), is comprised of approximately 236,000 eggs, 28,000 yolk-sac larvae, 164,000 post-yolk-sac larvae, 53,000 unidentified-life stage (YS/PYS) larvae, and 111,000 juveniles. Total entrainment peaked in June (216,000 organisms) and July (206,000). Alewife eggs and post-yolk-sac white sucker larvae were entrained in the greatest number with a total of 165,000 and 99,000, respectively. Other species and life stages contributing to entrainment were juvenile (82,000) and post-yolk-sac (25,000) banded killifish, and unidentified eggs (57,000). All other species and life stages contributed less than 17,000 individuals, or less than 3%, to the estimated total entrainment.

4.0 SUMMARY OF FINDINGS

The fish communities observed in the ichthyoplankton (offshore tows, 30-foot water depth) and entrainment (14- to 15-foot water depth) samples collected at AES Greenidge during 2006 differed considerably despite the overlap of sample collections in time. For example, twice as many taxa were collected in entrainment samples (10) compared to ichthyoplankton samples (5), juveniles comprised 18% of the total collected in entrainment samples while no juveniles were collected in ichthyoplankton samples and, finally, yellow perch larvae comprised 95% of the total larvae collected in ichthyoplankton samples and just 3% in entrainment samples. These differences are likely due to a number of factors, including species-specific habitat preferences and differences in sampling methodologies.

The abundance of juveniles in entrainment samples relative to ichthyoplankton samples is likely a result of sampling gear differences between the two surveys. Juveniles may have been able to avoid the towed gear more easily than the pump sampler in the turbulent intake canal. Habitat preferences likely explain some of the difference in catch composition as well. Tows with the ichthyoplankton net were conducted near lake-bottom at the 30-foot depth contour while the Unit 3 intake pipes draw water near the bottom at the 14 to 15-ft depth contour. Yellow perch have a documented tendency to move offshore as larvae to search for food (zooplankton) and reduced predation (MDDNR 2007). This life history strategy likely contributed to the high proportion of yellow perch larvae in the ichthyoplankton samples relative to entrainment given the different habitats sampled in the two surveys.

Entrainment at AES Greenidge was last studied during 1976 and 1977 (NYSEG 1977). The entrainment of larval fish was studied once in March 1976, twice monthly from April through September and once a month from October through February 1977. Two samples were collected during each sampling period (one during daylight and one during darkness). Over the course of the study, a total of 252 larval fish representing four taxa was collected during entrainment sampling. Total annual entrainment of 23.3 million larval fish was estimated, 22.3 million of which were estimated to be rainbow smelt entrained during May 1976. Carp had the largest estimated entrainment (625,000) of the remaining species. The entrainment estimate generated from the 2006 survey amounts to 592,000 eggs, larvae and juvenile. The larval estimate of 245,000 is considerably lower than the late 1970s estimate which accounted for larvae only. Entrainment species composition also has changed with no rainbow smelt collected in the current study. Today, entrainment appears to be comprised primarily of alewife, banded killifish and white sucker. Carp made up a relatively small 16,500 of the 2006 estimate.

The large difference in total number entrained between the late-1970s and current studies appears to be the result of at least two compounding factors: 1) the collection of an abundance of rainbow smelt in May 1976 with no comparably large catches in the current study, and 2) the number of units in operation at AES Greenidge in the 1970's relative to today. The 1976-1977 study estimated annual entrainment losses by multiplying the average density measured in monthly samples (totaling approximately 50-100 m^3 of water sampled) times the total monthly station flow and summing the losses calculated for each month. This framework produced losses of 22.3 million rainbow smelt, or 94% of the total annual estimated number entrained, based on the collection of 237 rainbow smelt larvae in the May samples. The current study sampled larger volumes of water on each day sampled (10 samples totally approximately 1,000 m^3 amounting to 1,000-2,000 m^3 sampled per month) and thus was less subject to extreme high catches that might have appeared in individual samples. For example, the density of rainbow smelt collected in May 1976 sampling (33.2 per 100 m^3, based on 100 m^3 of water) was more than a magnitude higher than the highest average sample event density measured during the 2006 entrainment study (i.e., 2.3 per 100 m^3, alewife eggs in June 2006 based on approximately 2,000 m^3). The difference in total annual number of organisms entrained at AES Greenidge between the former and current studies is also due to the number of units in operations. In the 1970's, Units 1

through 4 were all in operation while in the current study only Units 3 and 4 operated. It is also worth noting the former study collected entrainment samples in the discharge canal, and thus sampled water from all three intake locations, whereas the current study collected samples in the Unit 3 intake canal only.

5.0 LITERATURE CITED

Henningson, Durham & Richardson Architecture and Engineering, P.C. In Association with HDR Engineering, Inc. (HDR). 2010. AES Greenidge Generating Station Impingement and Entrainment Characterization Study. April 29, 2010.

Appendix I. AES Greenidge Generating Station 2006 Ichthyoplankton and Entrainment Studies.

Appendix II. AES Greenidge Generating Station 2006-2007 Impingement Study.

Appendix III. AES Greenidge Generating Station 2006-2007 Finfish Community and Waterbody Studies.

Maryland Department of Natural Resources (MDDNR). 2007. Yellow Perch. http://www.dnr.state.md.us/fisheries/education/yellowperch/yperch.html. May 2007.

New York State Electric & Gas Corporation (NYSEG). 1977. Environmental Assessment of Impingement and Entrainment, Greenidge Station. August 1977.

6.0 TABLES

Table 1 – Life Staging Criteria Used in the Laboratory Identification of AES Greenidge Generating Station Ichthyoplankton and Entrainment Samples

Life Staging Criteria	
Egg	The embryonic development stage from spawning until hatching. Eggs are counted only if they have been fertilized and were viable when collected.
Yolk-Sac Larva (YS)	The transition stage from hatching through the development of a complete, functional digestive system (regardless of the degree of yolk and/or oil globule detention).
Post Yolk-Sac Larva (PYS)	The transition stage from development of a complete, functional digestive system to transformation to juvenile form (regardless of the degree of yolk and/or oil globule retention).
YS/PYS	Some larvae may be too damaged to place into one of the two larval life stages described above, YS or PYS. These larvae will be placed into this life stage category.
Juvenile (JUV)	The stage from completed transformation to Age 1. A juvenile has a full complement of adult fin rays and other adult characteristics.

Table 2 - Species of Fish Represented by Eggs (E), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

Common Name	Scientific Name	Sample Date									
		04/26/2006	05/4/2006	05/16/2006	06/06/2006	06/20/2006	07/12/2006	07/25/2006	08/08/2006	08/22/2006	09/12/2006
Alewife	*Alosa pseudoharengus*					E, YS, PYS	E, YS, PYS	E, PYS			
Banded Killifish	*Fundulus diaphanus*								PYS		
Carps and Minnows	Cyprinidae spp.					YS					
Perches	Percidae spp.						YS/PYS				
White Sucker	*Catostomus commersonii*	PYS									
Yellow Perch	*Perca flavescens*				YS,PYS,YS/PYS	YS,PYS,YS/PYS	PYS				
Unidentified	Unidentified					YS/PYS					

Table 3 - Density (Number per 100 m^3) of Eggs (Egg), Yolk-sac larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

Common Name	Scientific Name	LifeStage	Ichthyoplankton Density (organimsms per 100 m^3)*									
			04/26/2006	05/04/2006	05/16/2006	06/06/2006	06/20/2006	07/12/2006	07/25/2006	08/08/2006	08/22/2006	09/12/2006
Alewife	*Alosa pseudoharengus*	Egg					0.090	1.992	0.091			
		YS					0.090	0.249				
		PYS					0.359	0.415	0.273			
Banded Killifish	*Fundulus diaphanus*	PYS								0.077		
Carps and Minnows	Cyprinidae spp.	YS					0.807					
Perches	Percidae spp.	YS/PYS						0.083				
White Sucker	*Catostomus commersonii*	PYS	0.154									
Yellow Perch	*Perca flavescens*	YS				36.792	8.787					
		PYS				2.058	1.704	0.083				
		YS/PYS				0.329	0.717					
Unidentified	Unidentified	YS/PYS					0.090					

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0.154 39.179 12.644 2.822 0.364 .077

2.173 (3.9%) 55.24

Table 4 - Mean Monthly Density (Number per 100 m^3) of Eggs (Egg), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

Common Name	Scientific Name	Ichthyoplankton Density (organisms per 100 m^3)*							Average
		Life Stage	Apr	May	June	Jul	Aug	Sept	
Alewife	*Alosa pseudoharengus*	Egg			0.04	1.08			**0.19**
		YS			0.04	0.13			**0.03**
		PYS			0.17	0.35			**0.09**
		YS/PYS							
Banded Killifish	*Fundulus diaphanus*	Egg							
		YS							
		PYS					0.04		**0.01**
		YS/PYS							
Carps and Minnow	Cyprinidae spp.	Egg							
		YS			0.39				**0.06**
		PYS							
		YS/PYS							
Perches	Percidae spp.	Egg							
		YS							
		PYS							
		YS/PYS				0.04			**0.01**
Unidentified	Unidentified	Egg							
		YS							
		PYS							
		YS/PYS			0.04				**0.01**
White Sucker	*Catostomus commersonii*	Egg							
		YS							
		PYS	0.15						**0.03**
		YS/PYS							
Yellow Perch	*Perca flavescens*	Egg							
		YS			23.39				**3.90**
		PYS			1.89	0.04			**0.32**
		YS/PYS			0.51				**0.09**
Total Density		**Egg**			**0.04**	**1.08**			**0.19**
		YS			**23.82**	**0.13**			**3.99**
		PYS	**0.15**		**2.06**	**0.39**	**0.04**		**0.44**
		YS/PYS			**0.56**	**0.04**			**0.10**
		ALL	**0.15**		**26.48**	**1.65**	**0.04**		**4.72**

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Table 5 - Diel Trends in Density (Number per 100 m^3) of Eggs (Egg), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

Common Name	Scientific Name	LifeStage	Average Density (Number per 100 m^3) per Hour Interval*											
			0	2	4	6	8	10	12	14	16	18	20	22
Alewife	*Alosa pseudoharengus*	Egg	2.1114	0.2012	0.1154									
		YS	0.0918	0.2012										0.0902
		PYS	0.2754	0.4024	0.1154				0.0913					0.2706
Banded Killifish	*Fundulus diaphanus*	PYS		0.1006										
Carps and Minnows	Cyprinidae spp.	YS	0.2754	0.3018					0.0913					0.1804
Perches	Percidae spp.	YS/PYS		0.1006										
White Sucker	*Catostomus commersonii*	PYS			0.1154			0.0755						
Yellow Perch	*Perca flavescens*	YS	10.3733	5.6333	0.1154	2.9511	2.1272	4.4518	4.1081	1.2017	3.5582	1.6927	0.1875	14.8836
		PYS	0.4590	0.6036	0.1154	1.1477		0.2264	0.6390	0.6009	0.4808	0.3385		0.3608
		YS/PYS					0.0925		0.1826		0.1923			0.6314
Unidentified	Unidentified	YS/PYS												0.0902
Total			**13.586**	**7.545**	**0.577**	**4.099**	**2.220**	**4.754**	**5.112**	**1.803**	**4.231**	**2.031**	**0.187**	**16.507**

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Table 6 - Minimum, Mean and Maximum Length (mm) of Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

Common Name	Scientific Name	LifeStage	Month	Length (mm)			Number Measured
				Min	Average	Max	
Alewife	*Alosa pseudoharengus*	YS	June	4.2	4.2	4.2	1
		PYS	June	5.6	6.3	7.1	4
		YS	July	4.8	4.9	5.0	2
		PYS	July	5.3	10.9	16.7	7
Banded Killifish	*Fundulus diaphanus*	PYS	August	20.0	20.0	20.0	1
White Sucker	*Catostomus commersonii*	PYS	April	13.9	14.3	14.6	2
Yellow Perch	*Perca flavescens*	YS	June	5.0	6.1	7.1	413
		PYS	June	6.2	7.3	9.2	42
		YS/PYS	June	5.8	6.7	8.1	3
		PYS	July	7.4	7.4	7.4	1

Table 7 - Species of Fish Represented by Eggs (E), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	Sample Date									
		04/26/2006	05/04/2006	05/16/2006	06/06/2006	06/20/2006	07/12/2006	07/25/2006	08/09/2006	08/22/2006	09/12/2006
Alewife	*Alosa pseudoharengus*					E					
Banded Killifish	*Fundulus diaphanus*						PYS	PYS, JUV			
Brook silverside	*Labidesthes sicculus*					E					
Bullhead Species	*Ameiurus* spp.										JUV
Carp	*Cyprinus carpio*							JUV			
Carps and Minnows	Cyprinidae spp.					E, YS	PYS				
Darters	Etheostoma spp.					YS					
Suckers	Catostomidae spp.	YS/PYS									
Unidentified	Unidentified				E		E, YS/PYS		PYS		
White Sucker	*Catostomus commersonii*	PYS	YS,PYS,YS/PYS								
Yellow Perch	*Perca flavescens*					PYS					

Table 8 - Density (Number per 100 m^3) of Eggs (Egg), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) collected in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	LifeStage	Sample Event Density (Number per 100 m^3)*									
			04/26/2006	05/04/2006	05/16/2006	06/06/2006	06/20/2006	07/12/2006	07/25/2006	08/08/2006	08/22/2006	09/12/2006
Alewife	*Alosa pseudoharengus*	Egg					2.2466					
Banded Killifish	*Fundulus diaphanus*	PYS						0.1955	0.0971			
		JUV							0.9706			
Brook silverside	*Labidesthes sicculus*	Egg					0.0977					
Bullhead Species	*Ameiurus* spp.	JUV										0.0966
Carp	*Cyprinus carpio*	JUV							0.1941			
Carps and Minnows	Cyprinidae spp.	Egg					0.0977					
		YS					0.0977					
		PYS						0.1955				
Darters	Etheostoma spp.	YS					0.1954					
Suckers	Catostomidae spp.	YS/PYS	0.2138									
White Sucker	*Catostomus commersonii*	YS		0.0976								
		PYS	0.3207	0.8780								
		YS/PYS		0.0976								
Yellow Perch	*Perca flavescens*	PYS					0.0977					
Unidentified	Unidentified	Egg				0.0976		0.5864				
		PYS								0.1955		
		YS/PYS						0.1955				

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2.2466 (30.9%)

0.5345 1.0732 .0976 2.8328 1.1729 1.2618 0.1955 .0966 7.2649

Table 9 - Mean Monthly Density (Number per 100 m^3) of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	Life Stage	Entrainment Density (organisms per 100m^3)*						Average
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			1.12				**0.19**
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				0.15			**0.02**
		YS/PYS							
		JUV				0.49			**0.08**
Brook silverside	*Labidesthes sicculus*	EGG			0.05				**0.01**
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						0.10	**0.02**
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				0.10			**0.02**
Carps and Minnows	Cyprinidae spp.	EGG			0.05				**0.01**
		YS			0.05				**0.01**
		PYS				0.10			**0.02**
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			0.10				**0.02**
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	0.20						**0.03**
		JUV							
Unidentified	Unidentified	EGG			0.05	0.29			**0.06**
		YS							
		PYS					0.10		**0.02**
		YS/PYS				0.10			**0.02**
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		0.05					**0.01**
		PYS	0.29	0.44					**0.12**
		YS/PYS		0.05					**0.01**
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			0.05				**0.01**
		YS/PYS							
		JUV							
Total Entrainment Density		**EGG**			**1.27**	**0.29**			**0.26**
		YS		**0.05**	**0.15**				**0.03**
		PYS	**0.29**	**0.44**	**0.05**	**0.24**	**0.10**		**0.19**
		YS/PYS	**0.20**	**0.05**		**0.10**			**0.06**
		JUV				**0.58**		**0.10**	**0.11**
		ALL	**0.49**	**0.54**	**1.47**	**1.22**	**0.10**	**0.10**	**0.65**

*blank cells have a value of zero

Table 10 - Diel Trends in Density (Number per 100 m^3) of Eggs (Egg), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	Life Stage	Average Entrainment Density (Number per 100 m^3) per Hour Interval*											
			0	2	4	6	8	10	12	14	16	18	20	22
Alewife	*Alosa pseudoharengus*	Egg	0.3879	0.2921	0.2925	0.2444		0.1222		0.3261	0.2171			0.6914
Banded Killifish	*Fundulus diaphanus*	PYS				0.1222					0.1085			0.1383
		JUV	0.0970	0.1947										0.9680
Brook silverside	*Labidesthes sicculus*	Egg										0.1080		
Bullhead Species	*Ameiurus* spp.	JUV												0.1383
Carp	*Cyprinus carpio*	JUV												0.2766
Carps and Minnows	Cyprinidae spp.	Egg			0.0975									
		YS												0.1383
		PYS	0.1939											
Darters	Etheostoma spp.	YS												0.2766
Suckers	Catostomidae spp.	YS/PYS			0.1950									
White Sucker	*Catostomus commersonii*	YS	0.0970											
		PYS			0.4876	0.4889	0.6201					0.1080		
		YS/PYS	0.0970											
Yellow Perch	*Perca flavescens*	PYS								0.1087				
Unidentified	Unidentified	Egg				0.1222		0.4888		0.1087			0.1626	
		PYS		0.0974							0.1085			
		YS/PYS							0.0977		0.1085			
Total Entrainment Density			**0.8727**	**0.5841**	**1.0727**	**0.9777**	**0.6201**	**0.6110**	**0.0977**	**0.5435**	**0.5427**	**0.2160**	**0.1626**	**2.6274**

*blank cells have a value of zero

Table 11 - Minimum, Mean and Maximum Length (mm) of Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

Common Name	Scientific Name	LifeStage	Month	Length (mm)			Number Measured
				Min	Mean	Max	
White Sucker	*Catostomus commersonii*	PYS	April	13.5	13.7	13.9	3
		YS	May	13.7	13.7	13.7	1
		PYS	May	13.7	14.0	14.4	2
		YS/PYS	May	13.8	13.8	13.8	1
Darters	Etheostoma spp.	YS	June	4.3	4.8	5.3	2
Yellow Perch	*Perca flavescens*	PYS	June	6.7	6.7	6.7	1
Banded Killifish	*Fundulus diaphanus*	PYS	July	7.7	8.9	11.0	3
		JUV	July	14.3	16.1	20.3	8
Carp	*Cyprinus carpio*	JUV	July	25.3	25.3	25.3	1

Table 12 - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Entrained at AES Greenidge Generating Station during 2006

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est.	Lower	Upper
			Apr	May	Jun	Jul	Aug	Sep	Entrained	95% C.I.	95% C.I.
Alewife	*Alosa pseudoharengus*	EGG			165,400				165,400	61,300	269,600
		YS									
		PYS									
		YS/PYS									
		JUV									
Banded Killifish	*Fundulus diaphanus*	EGG									
		YS									
		PYS				24,700			24,700		51,500
		YS/PYS									
		JUV				81,900			81,900		199,300
Brook silverside	*Labidesthes sicculus*	EGG			7,200				7,200		21,400
		YS									
		PYS									
		YS/PYS									
		JUV									
Bullhead Species	*Ameiurus* spp.	EGG									
		YS									
		PYS									
		YS/PYS									
		JUV						13,000	13,000		38,700
Carp	*Cyprinus carpio*	EGG									
		YS									
		PYS									
		YS/PYS									
		JUV				16,500			16,500		49,200
Carps and Minnows	Cyprinidae spp.	EGG			7,200				7,200		21,500
		YS			7,200				7,200		21,500
		PYS				16,500			16,500		49,200
		YS/PYS									
		JUV									
Darters	Etheostoma spp.	EGG									
		YS			14,400				14,400		42,900
		PYS									
		YS/PYS									
		JUV									
Suckers	Catostomidae spp.	EGG									
		YS									
		PYS									
		YS/PYS	30,000						30,000		89,400
		JUV									
Unidentified	Unidentified	EGG			7,200	49,400			56,600		125,600
		YS									
		PYS					16,600		16,600		39,400
		YS/PYS				16,500			16,500		39,000
		JUV									
White Sucker	*Catostomus commersoni*	EGG									
		YS		6,000					6,000		17,800
		PYS	45,000	53,800					98,800	1,200	196,400
		YS/PYS		6,000					6,000		17,800
		JUV									
Yellow Perch	*Perca flavescens*	EGG									
		YS									
		PYS			7,200				7,200		21,500
		YS/PYS									
		JUV									
Estimated Total Entrainment		**EGG**			**187,000**	**49,400**			**236,400**	**61,300**	**438,100**
		YS		**6,000**	**21,600**				**27,600**		**82,200**
		PYS	**45,000**	**53,800**	**7,200**	**41,200**	**16,600**		**163,800**	**1,200**	**358,000**
		YS/PYS	**30,000**	**6,000**		**16,500**			**52,500**		**146,200**
		JUV				**98,400**		**13,000**	**111,400**		**287,200**
		ALL	**75,000**	**65,800**	**215,800**	**205,500**	**16,600**	**13,000**	**591,700**	**62,500**	**1,311,700**

*blank cells have a value of zero

Table 13 - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Entrained at AES Greenidge Generating Station Unit 3 during 2006

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est. Entrained
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			47,209				47,209
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				8,176			8,176
		YS/PYS							
		JUV				27,109			27,109
Brook silverside	*Labidesthes sicculus*	EGG			2,055				2,055
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						2,512	2,512
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				5,462			5,462
Carps and Minnows	Cyprinidae spp.	EGG			2,055				2,055
		YS			2,055				2,055
		PYS				5,462			5,462
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			4,110				4,110
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	8,463						8,463
		JUV							
Unidentified	Unidentified	EGG			2,055	16,351			18,406
		YS							
		PYS					5,444		5,444
		YS/PYS				5,462			5,462
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		649					649
		PYS	12,695	5,823					18,518
		YS/PYS		649					649
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			2,055				2,055
		YS/PYS							
		JUV							
Estimated Total Entrainment		**EGG**			**53,374**	**16,351**			**69,726**
		YS		**649**	**6,165**				**6,815**
		PYS	**12,695**	**5,823**	**2,055**	**13,637**	**5,444**		**39,655**
		YS/PYS	**8,463**	**649**		**5,462**			**14,574**
		JUV				**32,570**		**2,512**	**35,083**
		ALL	**21,159**	**7,122**	**61,595**	**68,021**	**5,444**	**2,512**	**165,852**

*blank cells have a value of zero

Table 14 - Estimated Number of Eggs (EGG), Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), Unidentified-lifestage Larvae (YS/PYS), and Juveniles (JUV) Entrained at AES Greenidge Generating Station Unit 4 during 2006

Common Name	Scientific Name	Life Stage	Estimated Entrainment*						Total Est. Entrained
			Apr	May	Jun	Jul	Aug	Sep	
Alewife	*Alosa pseudoharengus*	EGG			118,191				**118,191**
		YS							
		PYS							
		YS/PYS							
		JUV							
Banded Killifish	*Fundulus diaphanus*	EGG							
		YS							
		PYS				16,524			**16,524**
		YS/PYS							
		JUV				54,791			**54,791**
Brook silverside	*Labidesthes sicculus*	EGG			5,145				**5,145**
		YS							
		PYS							
		YS/PYS							
		JUV							
Bullhead Species	*Ameiurus* spp.	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV						10,488	**10,488**
Carp	*Cyprinus carpio*	EGG							
		YS							
		PYS							
		YS/PYS							
		JUV				11,038			**11,038**
Carps and Minnows	Cyprinidae spp.	EGG			5,145				**5,145**
		YS			5,145				**5,145**
		PYS				11,038			**11,038**
		YS/PYS							
		JUV							
Darters	Etheostoma spp.	EGG							
		YS			10,290				**10,290**
		PYS							
		YS/PYS							
		JUV							
Suckers	Catostomidae spp.	EGG							
		YS							
		PYS							
		YS/PYS	21,537						**21,537**
		JUV							
Unidentified	Unidentified	EGG			5,145	33,049			**38,194**
		YS							
		PYS					11,156		**11,156**
		YS/PYS				11,038			**11,038**
		JUV							
White Sucker	*Catostomus commersoni*	EGG							
		YS		5,351					**5,351**
		PYS	32,305	47,977					**80,282**
		YS/PYS		5,351					**5,351**
		JUV							
Yellow Perch	*Perca flavescens*	EGG							
		YS							
		PYS			5,145				**5,145**
		YS/PYS							
		JUV							
Estimated Total Entrainment		**EGG**			**133,626**	**33,049**			**166,674**
		YS		**5,351**	**15,435**				**20,785**
		PYS	**32,305**	**47,977**	**5,145**	**27,563**	**11,156**		**124,145**
		YS/PYS	**21,537**	**5,351**		**11,038**			**37,926**
		JUV				**65,830**		**10,488**	**76,317**
		ALL	**53,841**	**58,678**	**154,205**	**137,479**	**11,156**	**10,488**	**425,848**

*blank cells have a value of zero

7.0 FIGURES

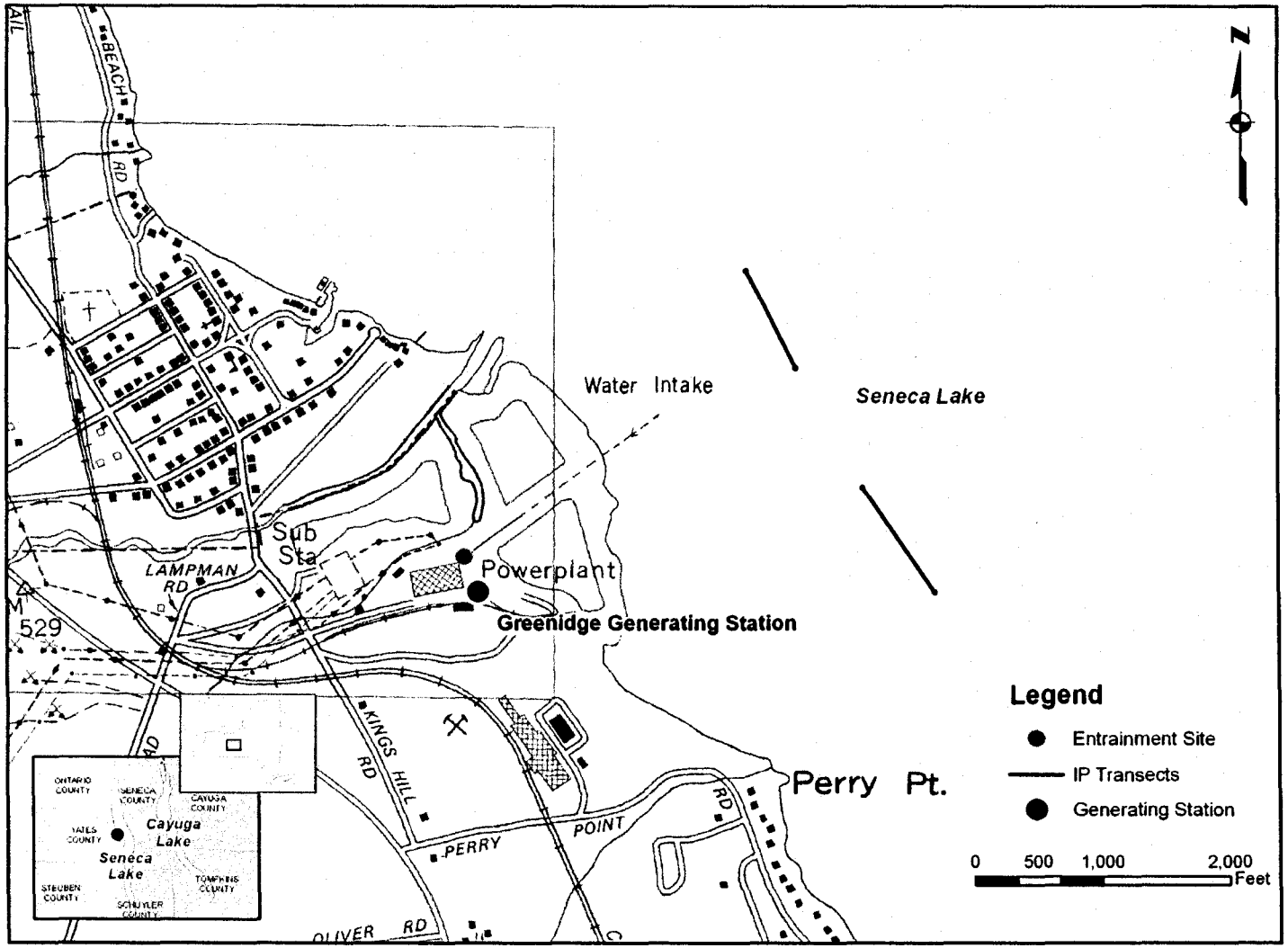

Figure 1 - Ichthyoplankton and Entrainment Sampling Locations for AES Greenidge Generating Station 2006 Sampling

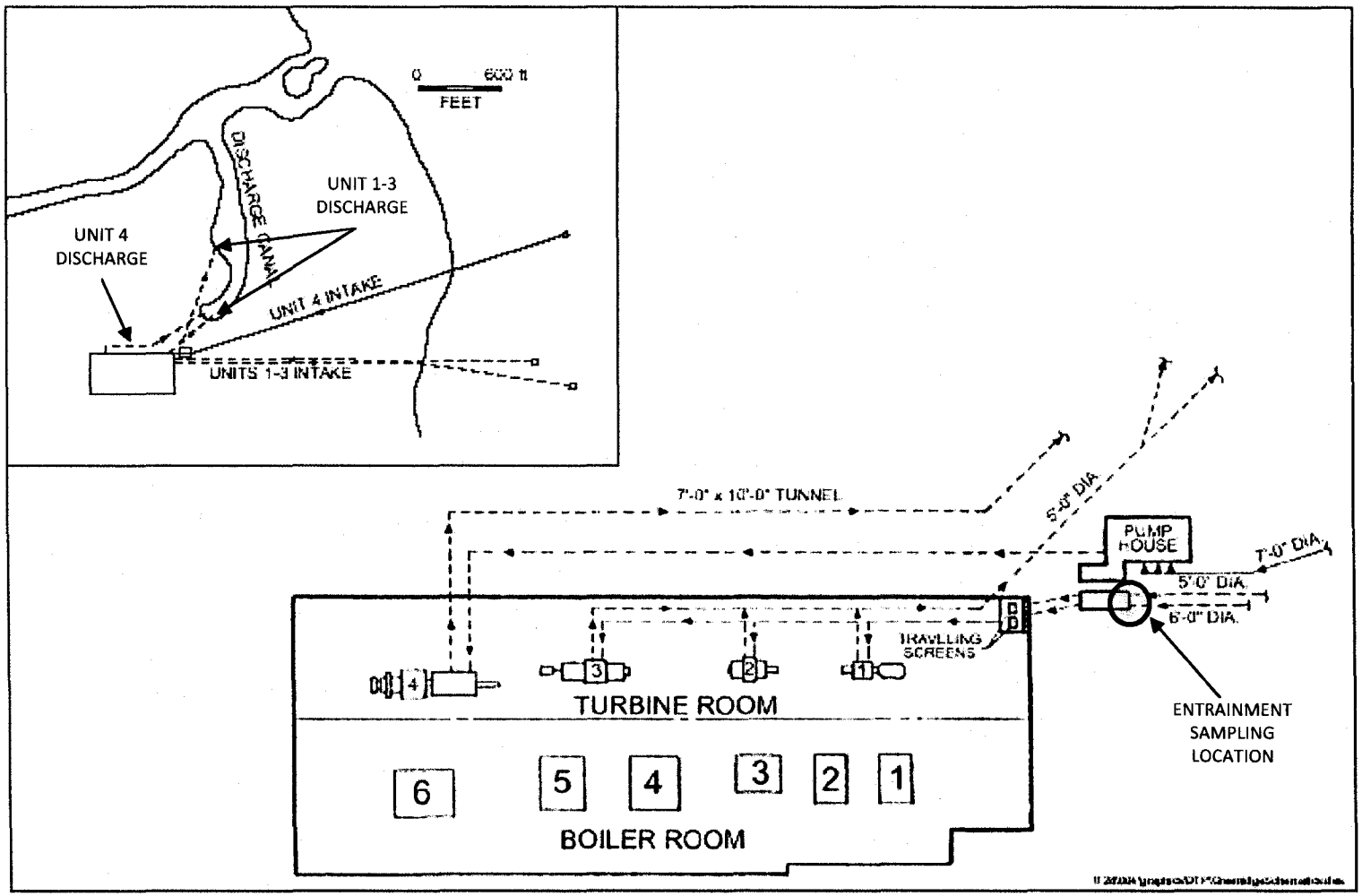

Figure 2 – Routing of Cooling Water Flow through AES Greenidge Generating Station and 2006 and 2007 Entrainment Sampling Location

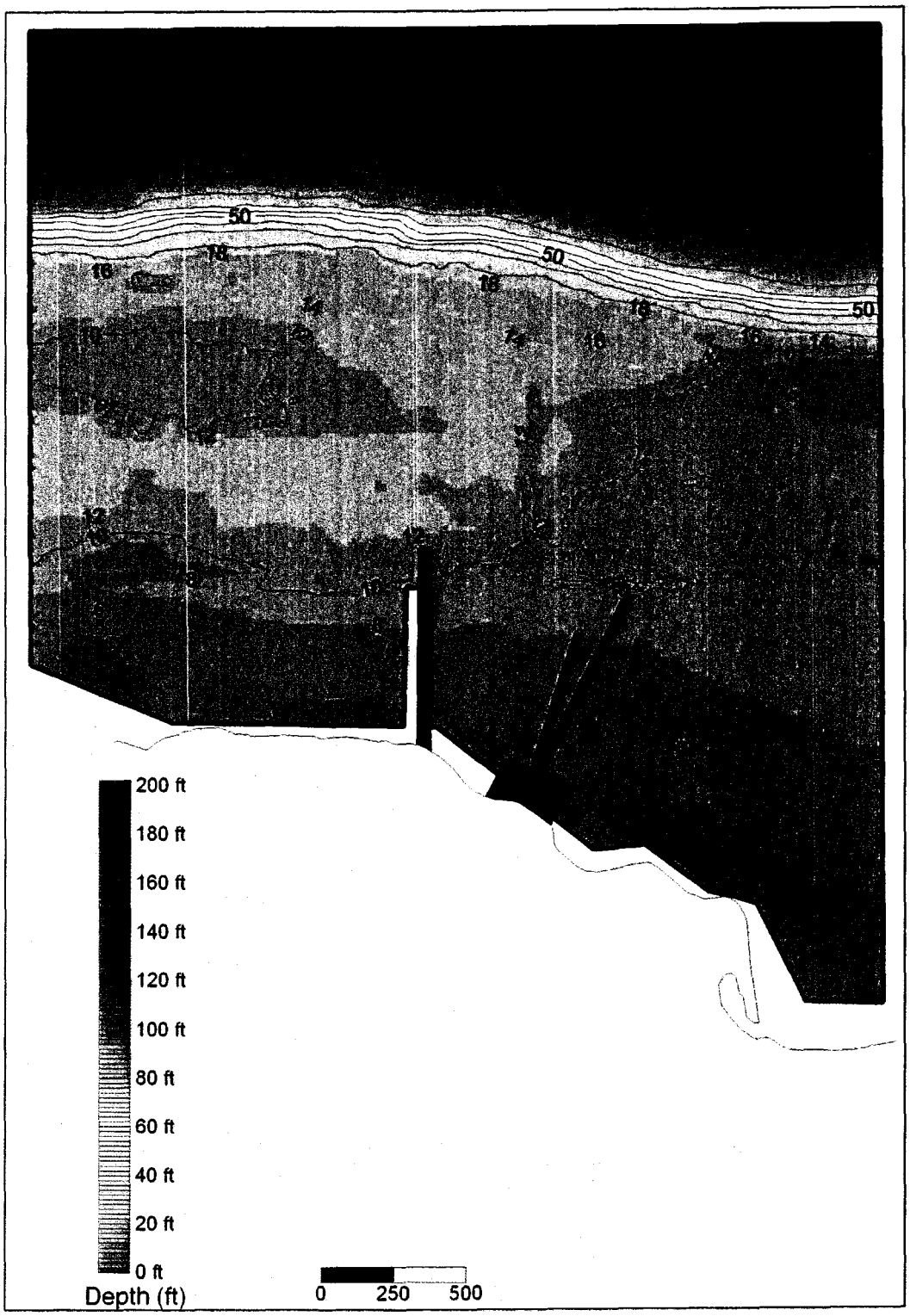

Figure 3 - Bathymetry of Seneca Lake in the Vicinity of AES Greenidge Generating Station Based on 2007 Sampling (Note: average lake surface elevation associated with the hydrographic survey [444.9 ft NGVD29] was very near the 1956-2007 average lake level [444.8 ft NGVD29])

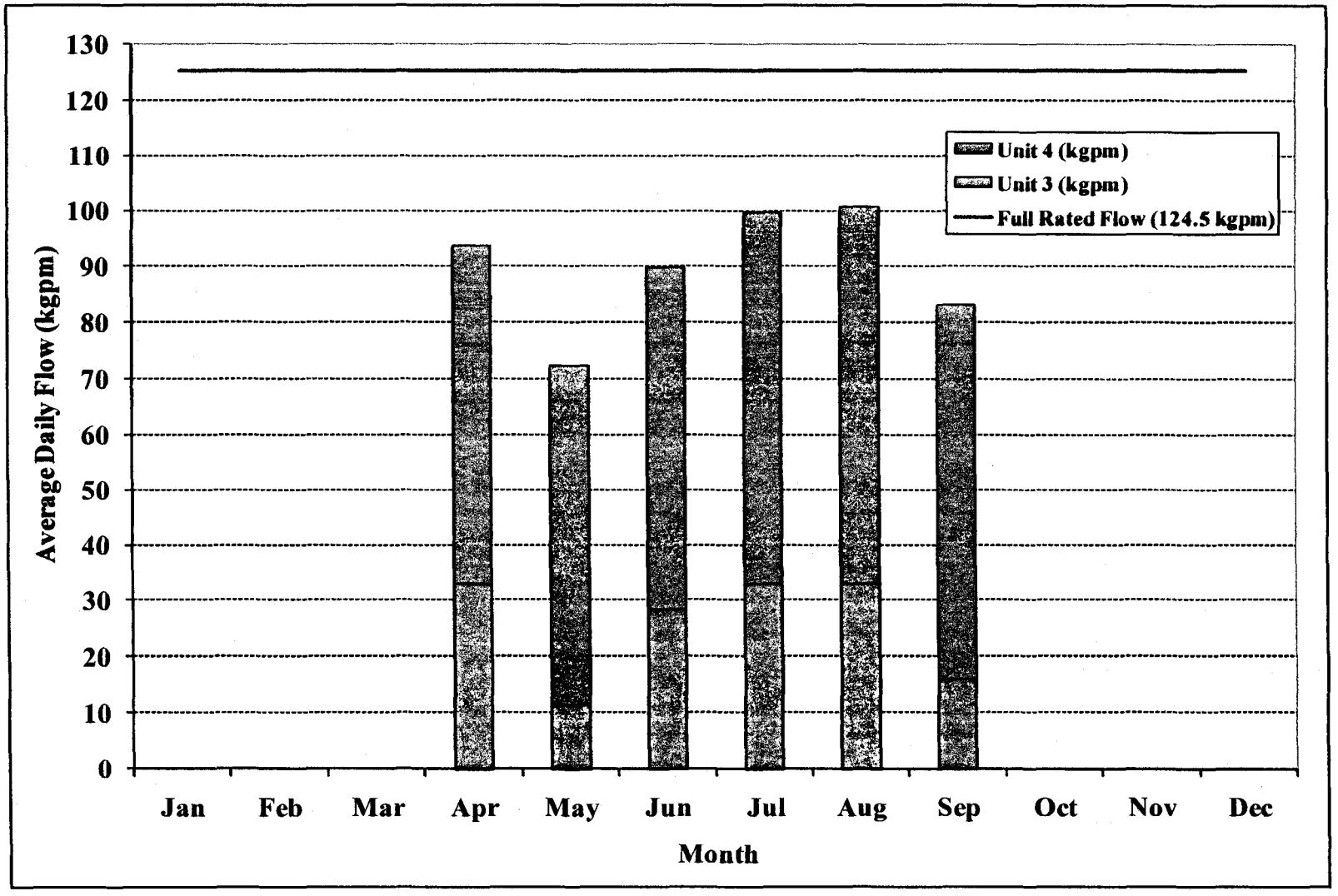

Figure 4 - AES Greenidge Generating Station Actual Average Daily Cooling Water Flow (thousand gallons per minute [kgpm]) for the Entrainment Study (April through September 2006)

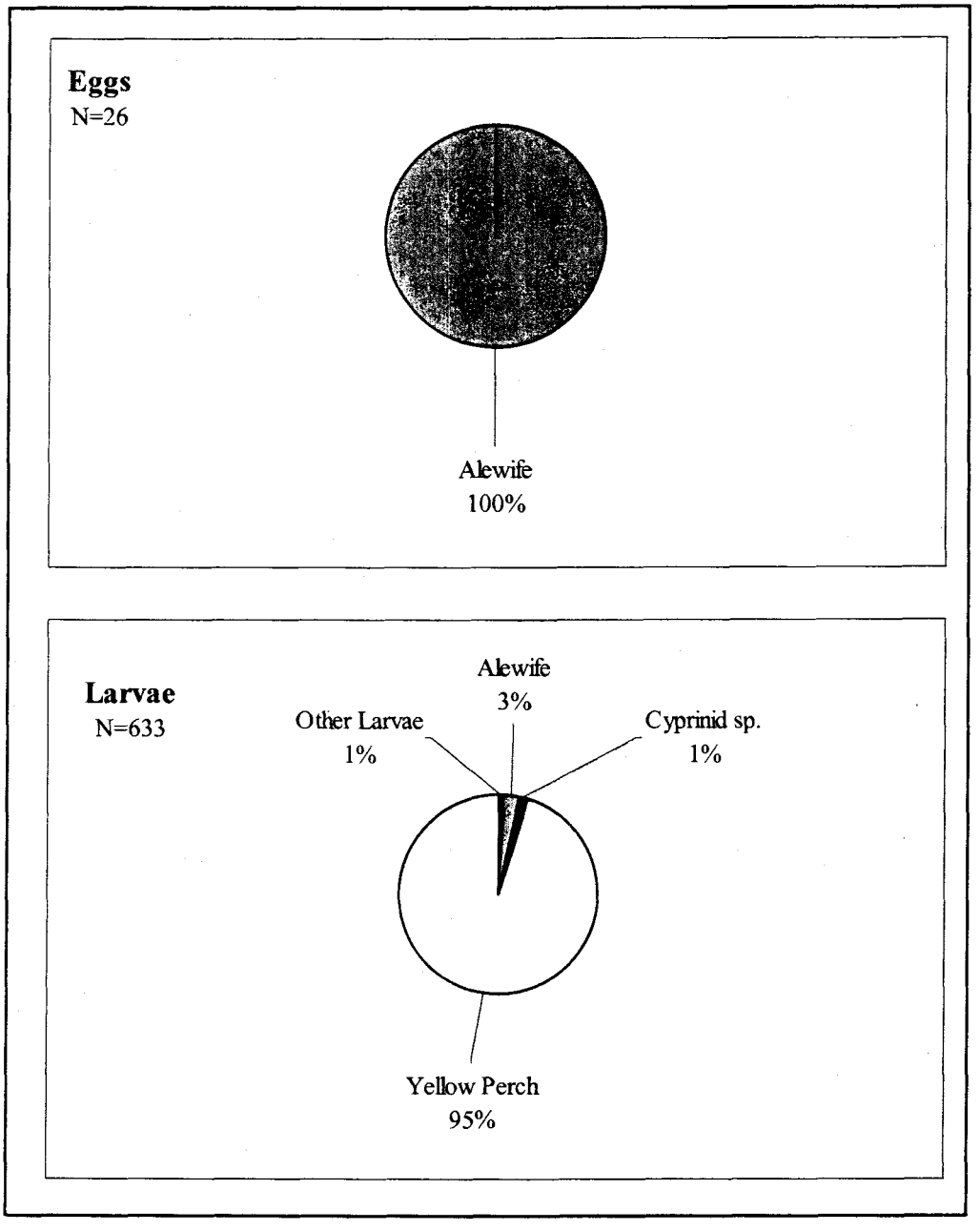

Figure 5 - Percent Contribution of Fish Eggs and Larvae taken in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

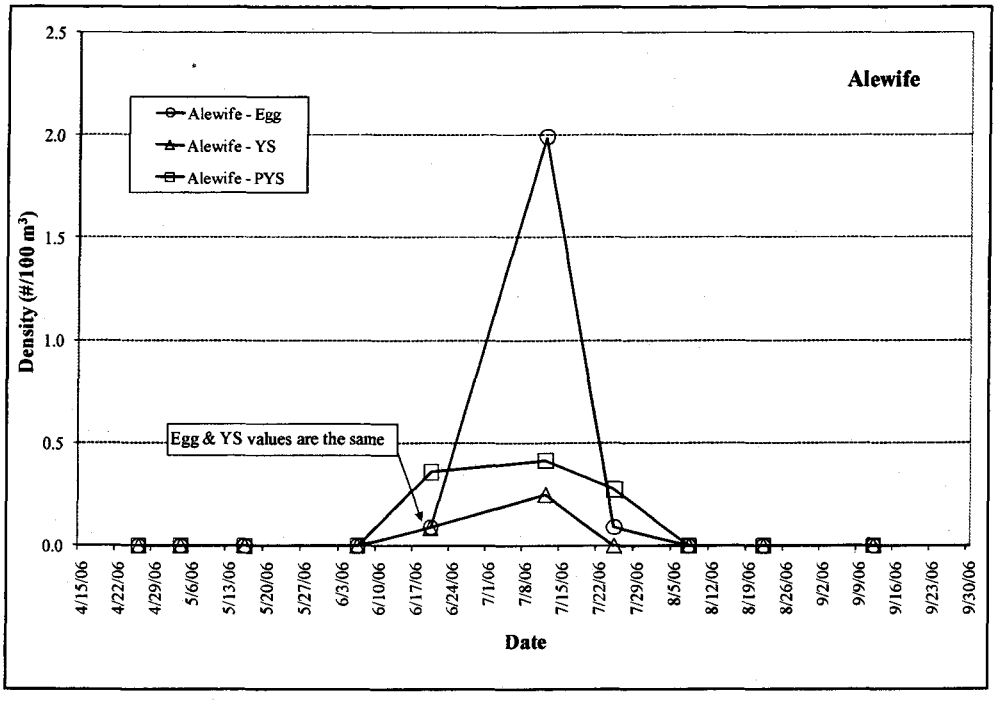

Figure 6 - Density (Number per 100 m^3) of Alewife Eggs (Egg), yolk-sac Larvae (YS) and Post-yolk-sac Larvae (PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

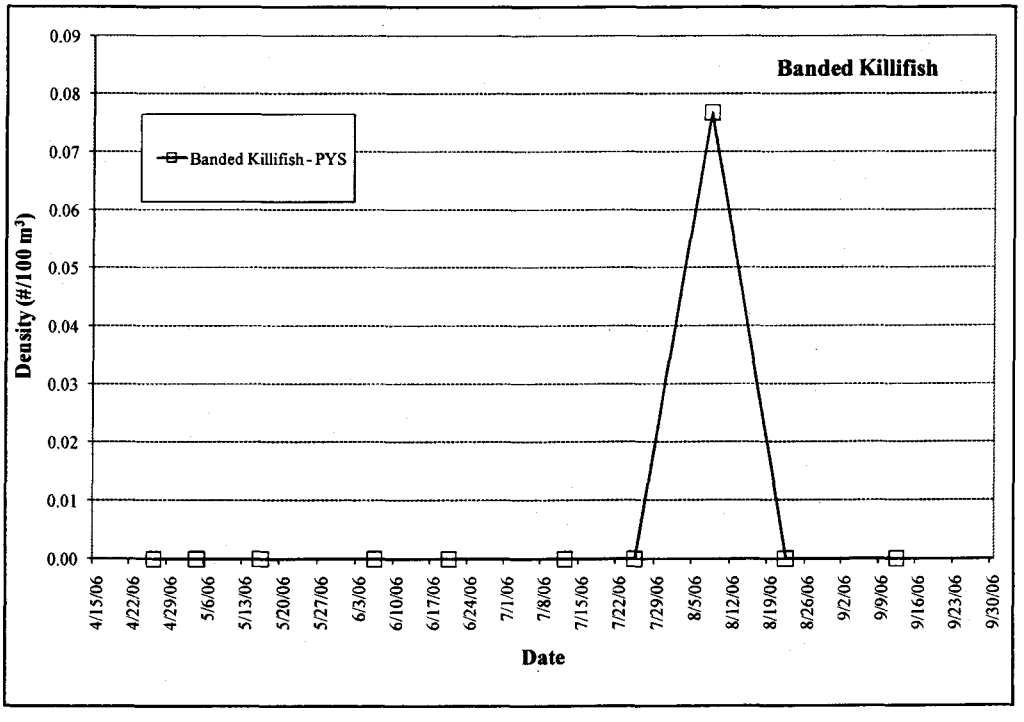

Figure 7 - Density (Number per 100 m^3) of Banded Killifish Post-yolk-sac Larvae (PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

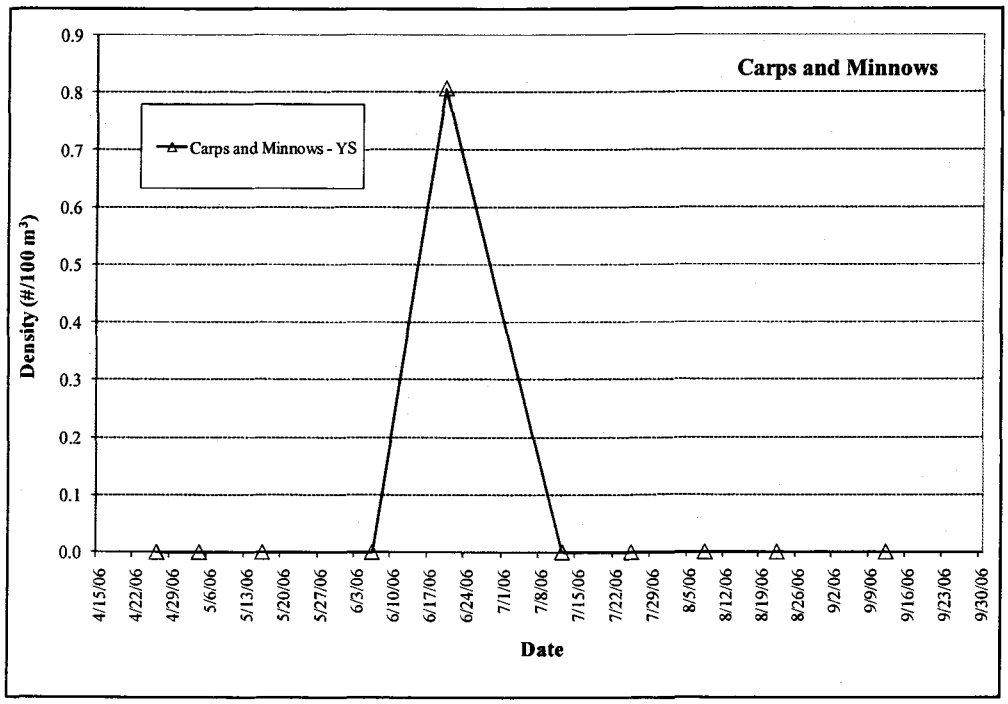

Figure 8 - Density (Number per 100 m^3) of Carps and Minnows Yolk-sac Larvae (YS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

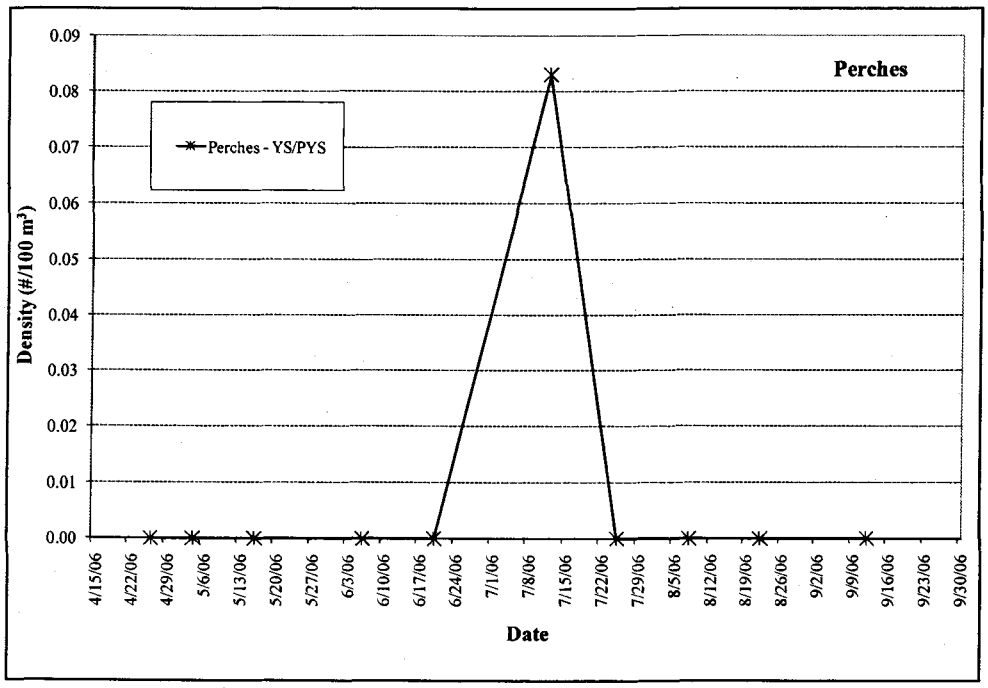

Figure 9 - Density (Number per 100 m^3) of Perches Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

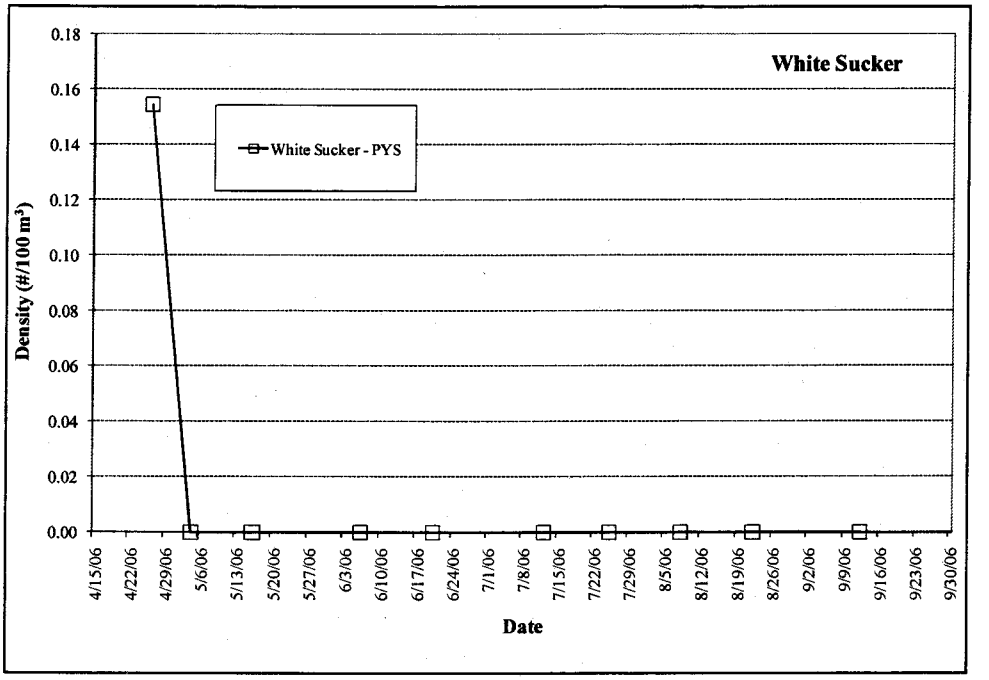

Figure 10 - Density (Number per 100 m^3) of White Sucker Post-yolk-sac Larvae (PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

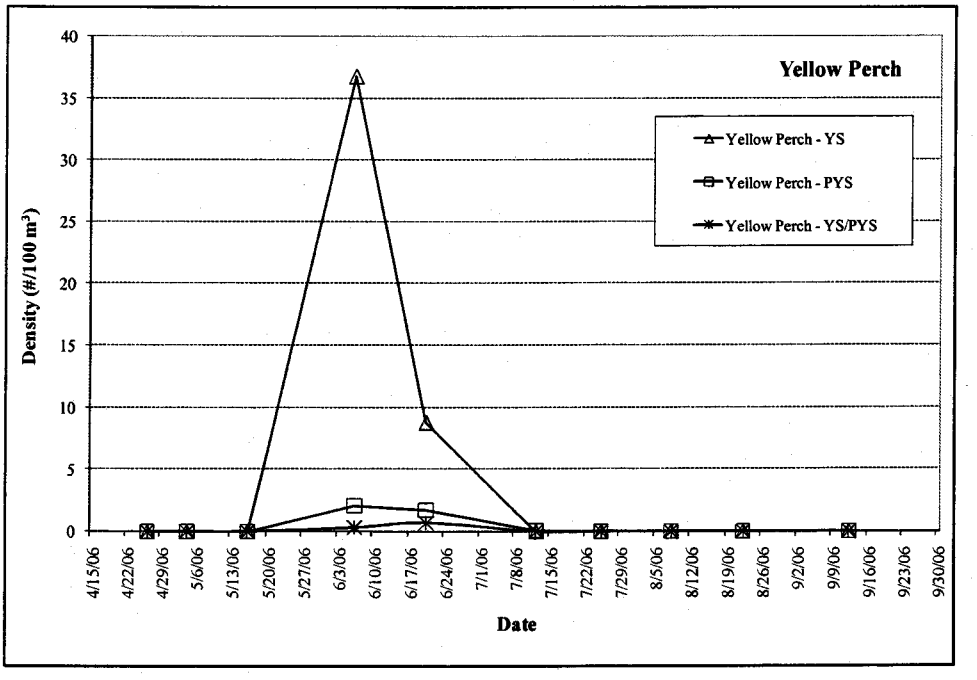

Figure 11 - Density (Number per 100 m^3) of Yellow Perch Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS), and Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

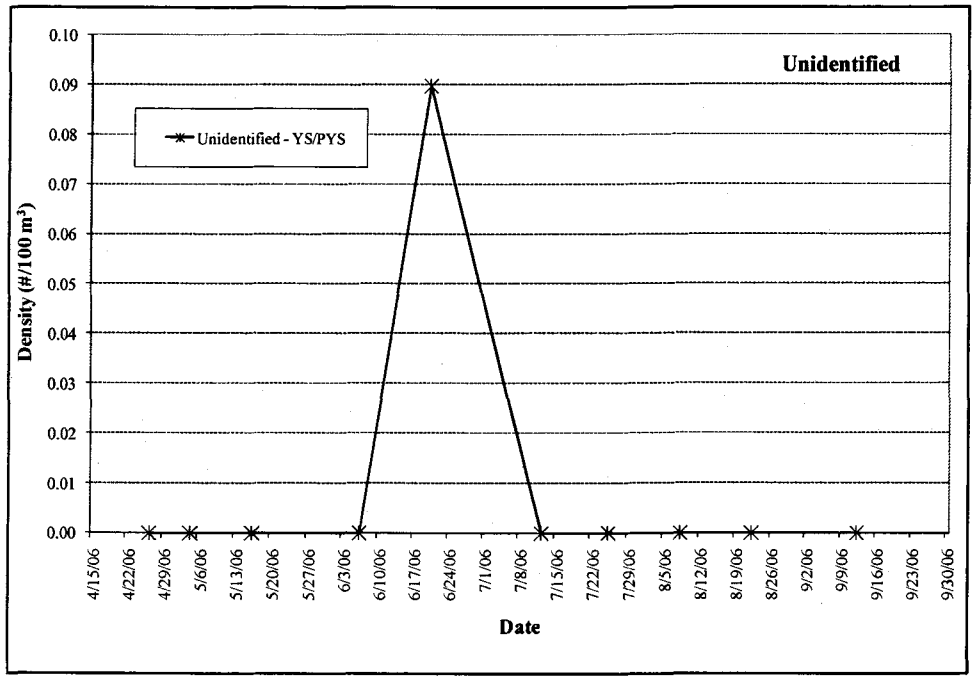

Figure 12 - Density (Number per 100 m^3) of Unidentified Species Unidentified-lifestage Larvae (YS/PYS) Collected in AES Greenidge Generating Station Ichthyoplankton Samples, 2006

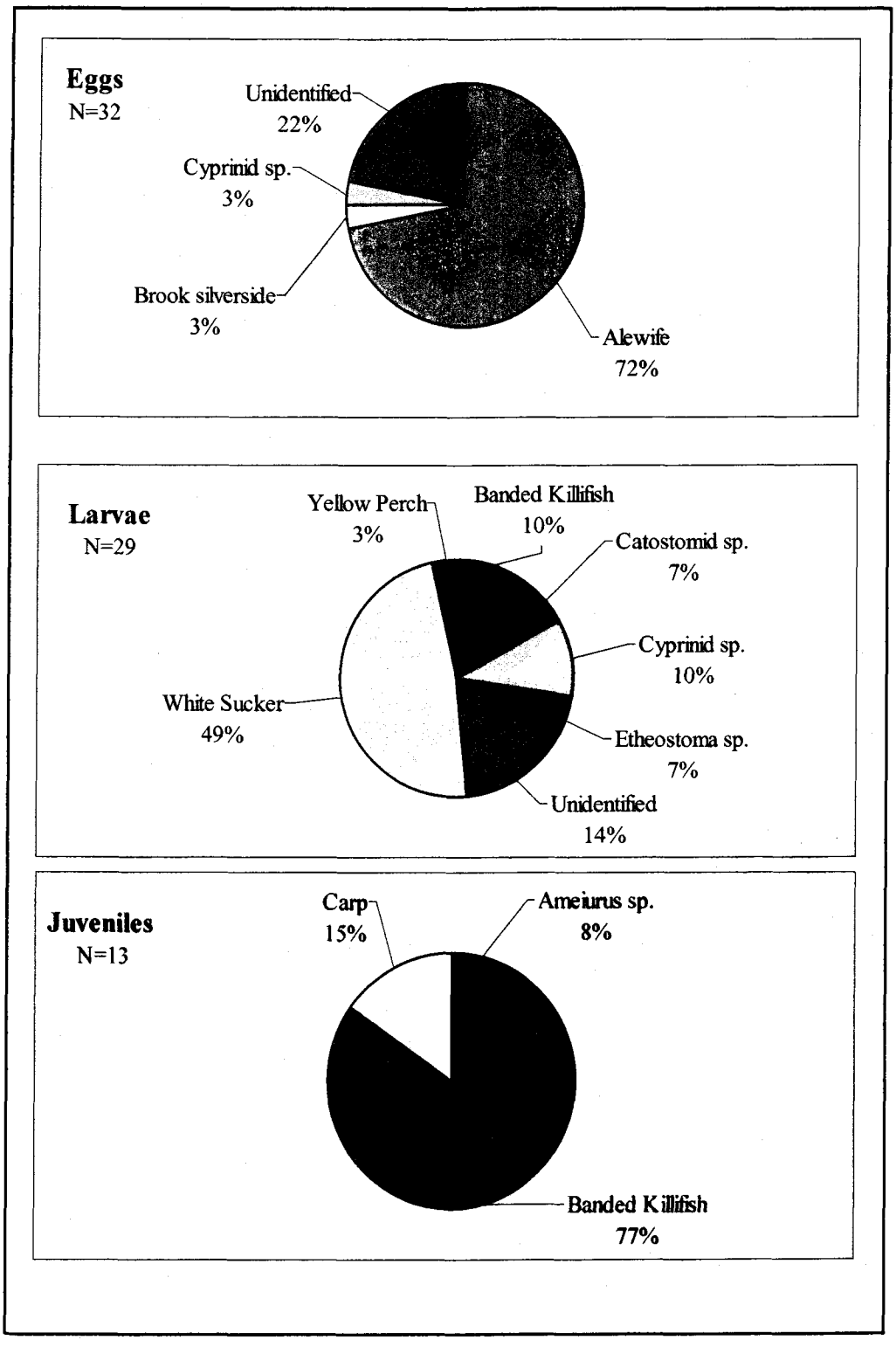

Figure 13 - Percent Contribution of Fish Eggs, Larvae and Juvenile taken in AES Greenidge Generating Station Entrainment Samples, 2006

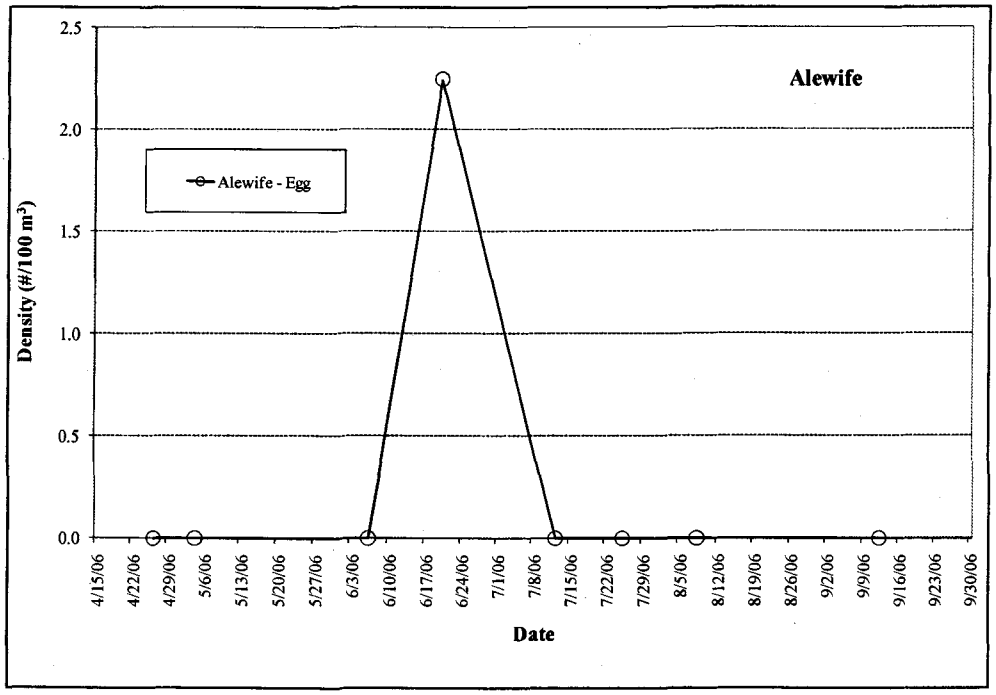

Figure 14 - Density (Number per 100 m^3) of Alewife Eggs Collected in AES Greenidge Generating Station Entrainment Samples, 2006

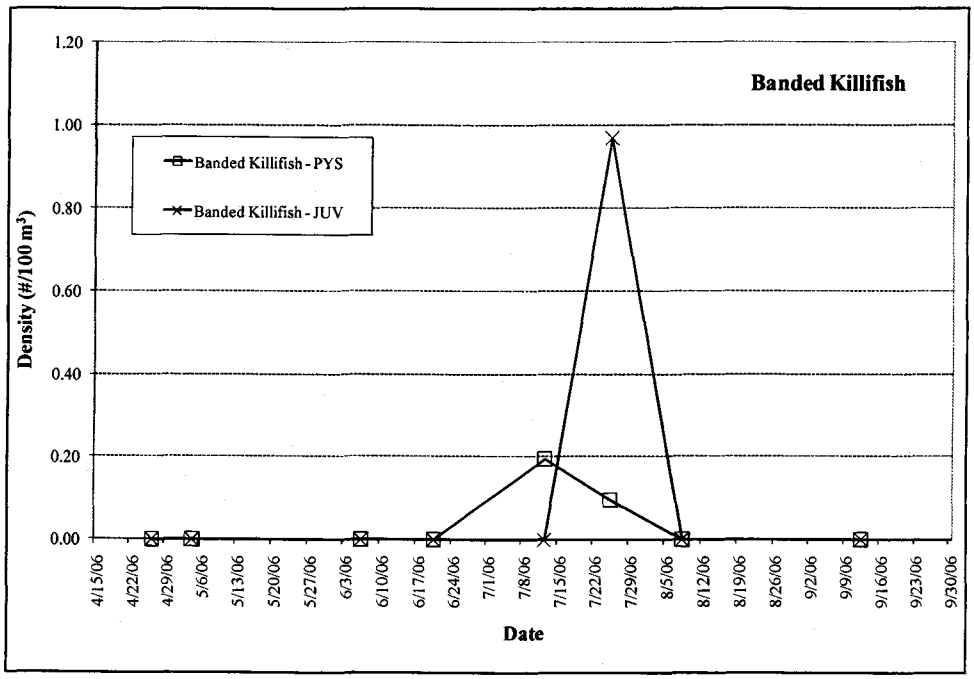

Figure 15 - Density (Number per 100 m^3) of Banded Killifish Post-yolk-sac Larvae (PYS) and Juveniles (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

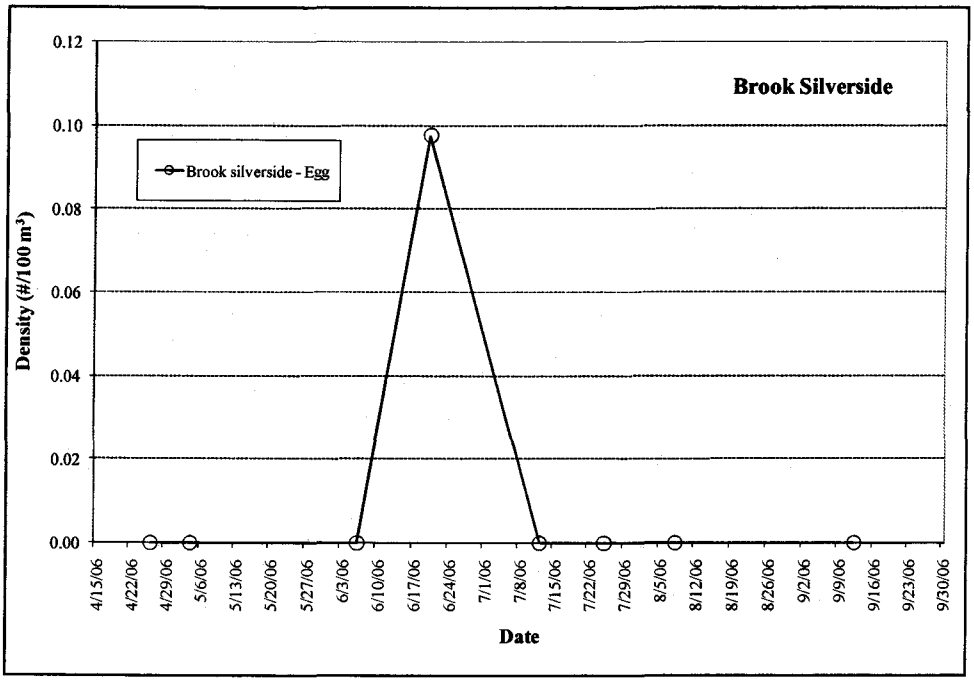

Figure 16 - Density (Number per 100 m^3) of Brook Silverside Eggs (Egg) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

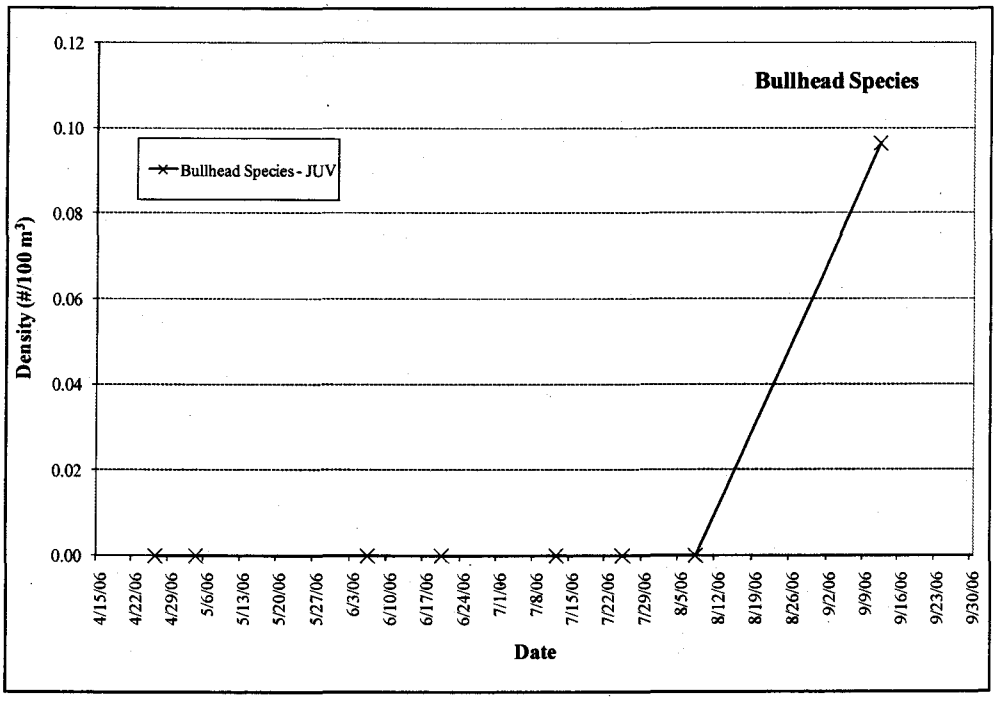

Figure 17 - Density (Number per 100 m^3) of Bullhead Species Juveniles (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

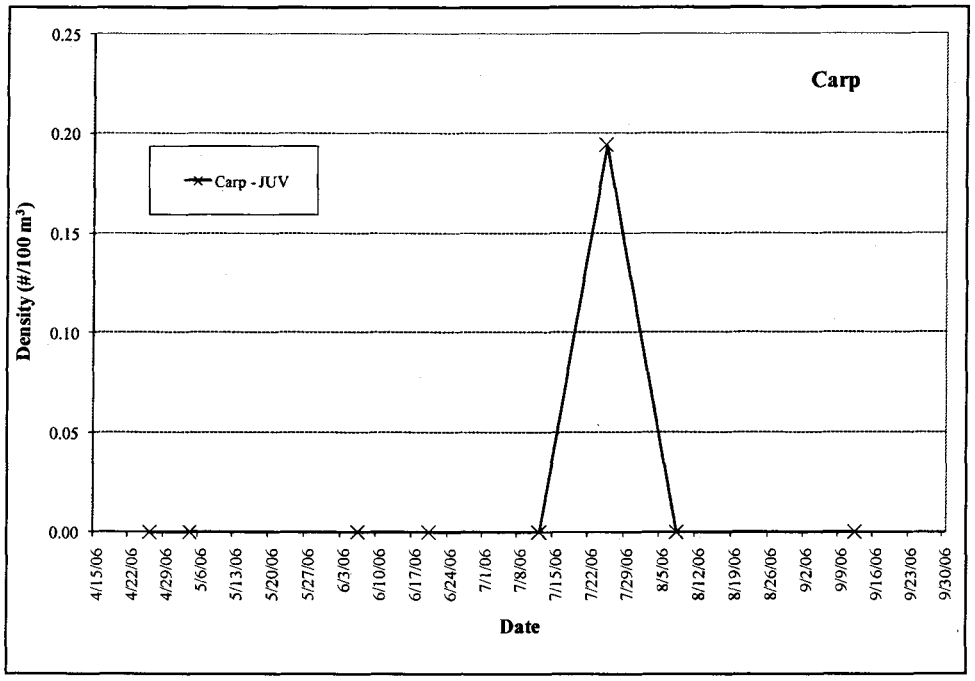

Figure 18 - Density (Number per 100 m^3) of Carp Juveniles (JUV) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

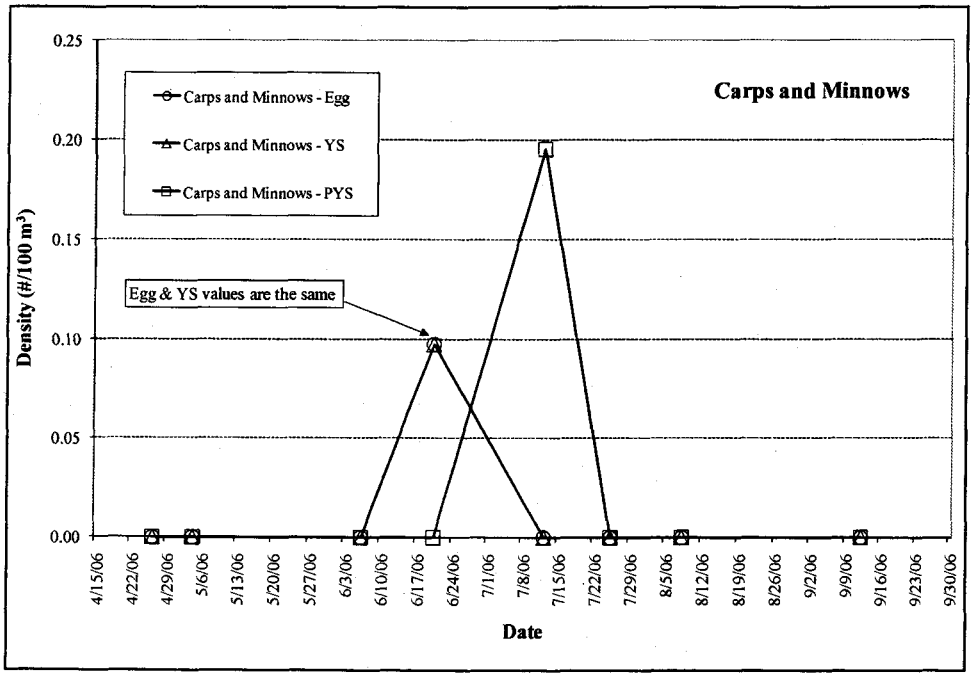

Figure 19 - Density (Number per 100 m^3) of Carps and Minnows Eggs (Egg), Yolk-sac Larvae (YS) and Post-yolk-sac Larvae (PYS) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

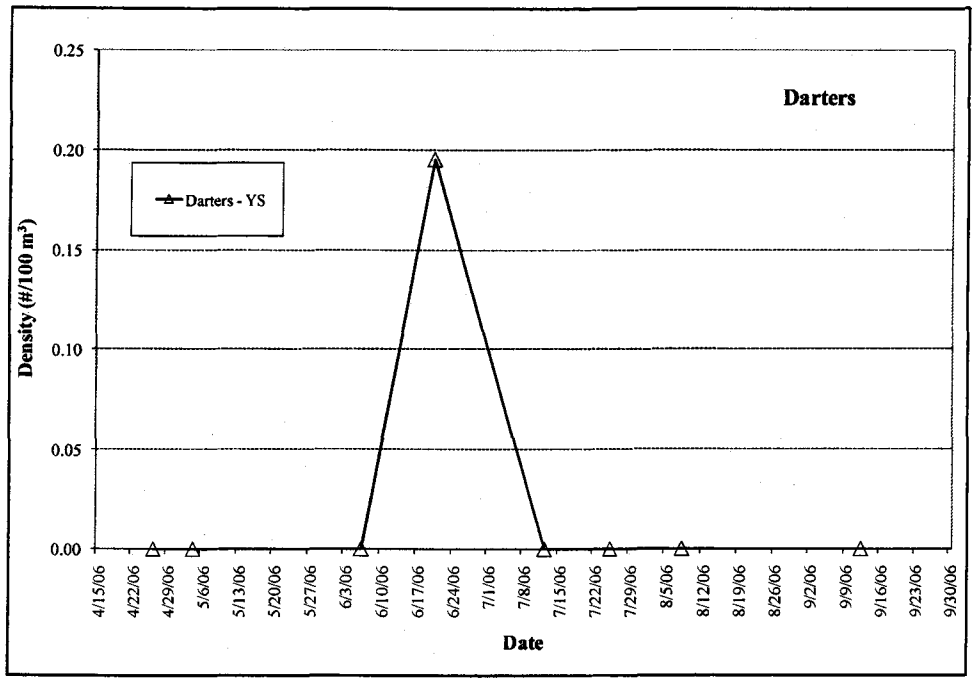

Figure 20 - Density (Number per 100 m^3) of Darters Yolk-sac Larvae (YS) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

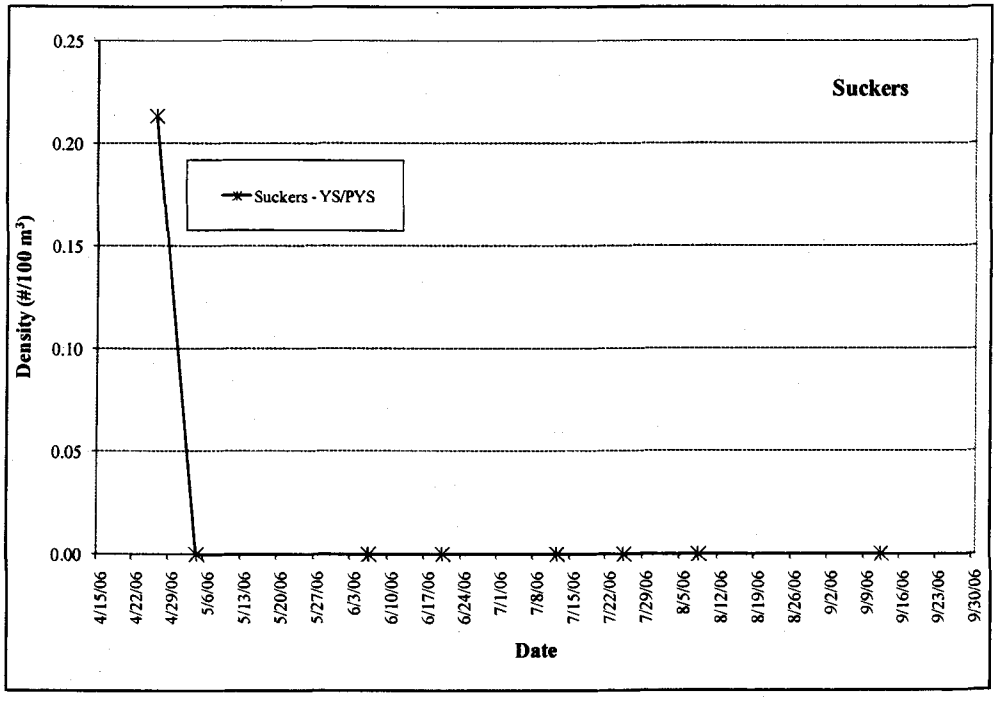

Figure 21 - Density (Number per 100 m^3) of Suckers Unidentified-lifestage (YS/PYS) Larvae Collected in AES Greenidge Generating Station Entrainment Samples, 2006

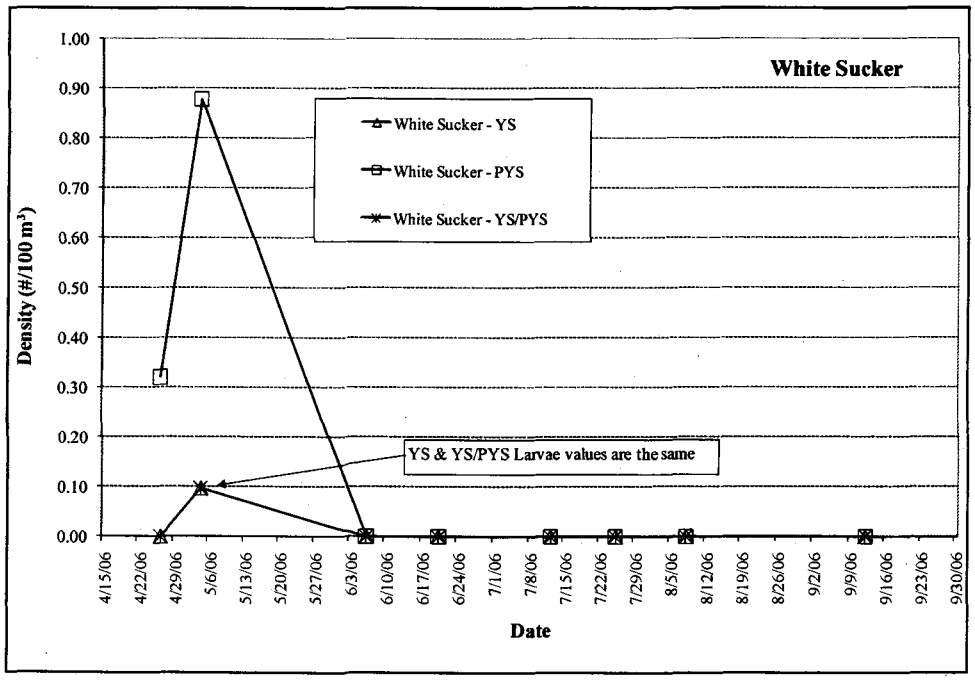

Figure 22 - Density (Number per 100 m^3) of White Sucker Yolk-sac Larvae (YS), Post-yolk-sac Larvae (PYS) and Unidentified-lifestage (YS/PYS) Larvae Collected in AES Greenidge Generating Station Entrainment Samples, 2006

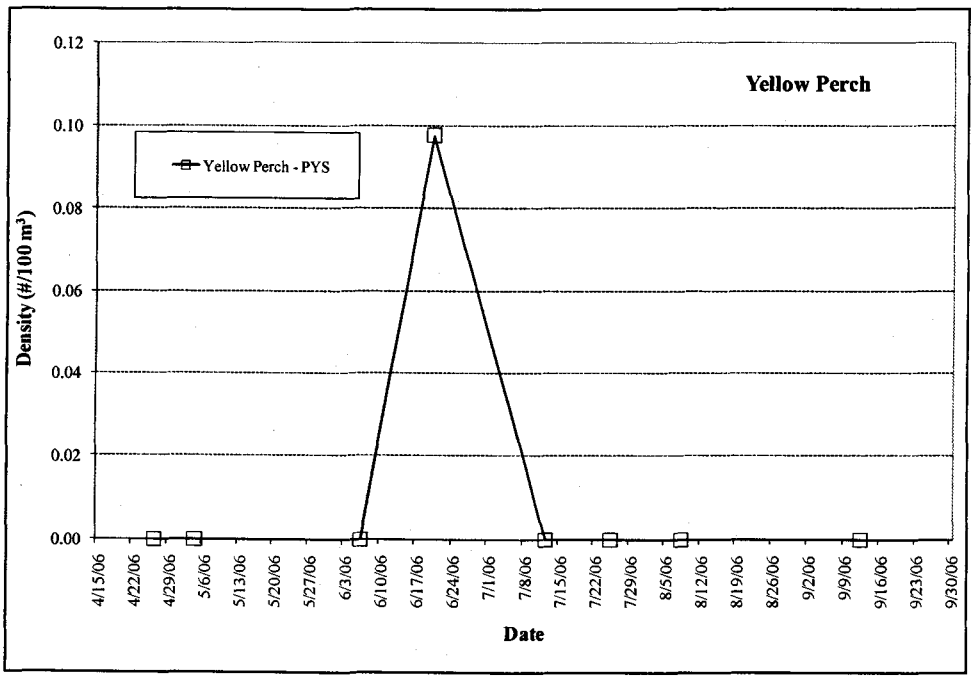

Figure 23 - Density (Number per 100 m^3) of Yellow Perch Post-yolk-sac Larvae (PYS) Collected in AES Greenidge Generating Station Entrainment Samples, 2006

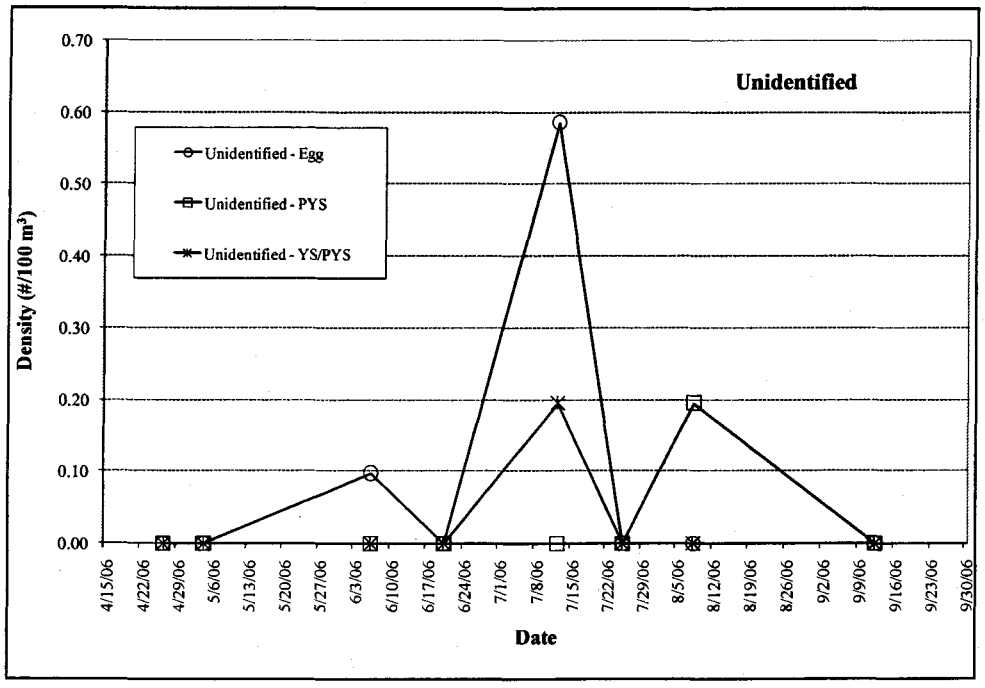

Figure 24 - Density (Number per 100 m^3) of Unidentified Eggs (Egg), Post-yolk-sac Larvae (PYS) and Unidentified-lifestage (YS/PYS) Larvae Collected in AES Greenidge Generating Station Entrainment Samples, 2006

Appendix A

Ichthyoplankton Collection Data

Date	Start Time	Common Name	Life Stage	Number Collected	Mean Length (mm)	Sample Vol (m^3)	Transect
26-Apr-06	11:01:00 AM	White Sucker	PYS	1	13.9	1,296	S
27-Apr-06	5:42:00 AM	White Sucker	PYS	1	14.6	1,296	N
06-Jun-06	9:36:00 AM	Yellow Perch	YS	21	6.4	1,215	N
06-Jun-06	10:05:00 AM	Yellow Perch	YS	7	6.2	1,215	S
06-Jun-06	11:38:00 AM	Yellow Perch	PYS	1	7.2	1,215	N
06-Jun-06	11:38:00 AM	Yellow Perch	YS	21	6.3	1,215	N
06-Jun-06	11:55:00 AM	Yellow Perch	PYS	2	7.3	1,215	S
06-Jun-06	11:55:00 AM	Yellow Perch	YS	27	6.4	1,215	S
06-Jun-06	1:39:00 PM	Yellow Perch	PYS	2	7.3	1,215	N
06-Jun-06	1:39:00 PM	Yellow Perch	YS/PYS	2		1,215	N
06-Jun-06	1:39:00 PM	Yellow Perch	YS	20	6.3	1,215	N
06-Jun-06	1:59:00 PM	Yellow Perch	PYS	3	6.7	1,215	S
06-Jun-06	1:59:00 PM	Yellow Perch	YS	21	6.2	1,215	S
06-Jun-06	4:06:00 PM	Yellow Perch	YS	7	6.1	1,215	N
06-Jun-06	4:24:00 PM	Yellow Perch	PYS	2	7.0	1,215	S
06-Jun-06	4:24:00 PM	Yellow Perch	YS	24	6.2	1,215	S
06-Jun-06	7:08:00 PM	Yellow Perch	YS	10	6.0	1,215	N
06-Jun-06	7:26:00 PM	Yellow Perch	PYS	1	7.2	1,215	S
06-Jun-06	7:26:00 PM	Yellow Perch	YS	10	6.1	1,215	S
06-Jun-06	8:43:00 PM	Yellow Perch	YS	1	6.5	1,215	N
06-Jun-06	9:10:00 PM	Yellow Perch	YS	2	6.8	1,215	S
06-Jun-06	10:51:00 PM	Yellow Perch	PYS	1	6.6	1,215	N
06-Jun-06	10:51:00 PM	Yellow Perch	YS	68	6.1	1,215	N
06-Jun-06	11:16:00 PM	Yellow Perch	PYS	1	7.1	1,215	S
06-Jun-06	11:16:00 PM	Yellow Perch	YS/PYS	2		1,215	S
06-Jun-06	11:16:00 PM	Yellow Perch	YS	64	6.1	1,215	S
07-Jun-06	1:21:00 AM	Yellow Perch	PYS	2	7.0	1,215	N
07-Jun-06	1:21:00 AM	Yellow Perch	YS	40	6.2	1,215	N
07-Jun-06	1:42:00 AM	Yellow Perch	YS	44	5.9	1,215	S
07-Jun-06	3:40:00 AM	Yellow Perch	PYS	2	6.5	1,215	N
07-Jun-06	3:40:00 AM	Yellow Perch	YS	26	6.1	1,215	N
07-Jun-06	3:58:00 AM	Yellow Perch	PYS	1	6.7	1,215	S
07-Jun-06	3:58:00 AM	Yellow Perch	YS	17	6.0	1,215	S
07-Jun-06	6:12:00 AM	Yellow Perch	PYS	4	7.4	1,215	N
07-Jun-06	6:12:00 AM	Yellow Perch	YS	11	6.4	1,215	N
07-Jun-06	6:30:00 AM	Yellow Perch	PYS	3	7.2	1,215	S
07-Jun-06	6:30:00 AM	Yellow Perch	YS	7	6.3	1,215	S
20-Jun-06	8:44:00 AM	Yellow Perch	YS	1	6.0	1,115	N
20-Jun-06	9:05:00 AM	Yellow Perch	YS/PYS	1		1,115	S
20-Jun-06	9:05:00 AM	Yellow Perch	YS	1	5.6	1,115	S
20-Jun-06	11:30:00 AM	Yellow Perch	YS	1	5.9	1,115	N
20-Jun-06	11:45:00 AM	Yellow Perch	YS	3	5.5	1,115	S
20-Jun-06	1:09:00 PM	Carps and Minnows	YS	1		1,115	N
20-Jun-06	1:09:00 PM	Yellow Perch	YS	2	5.8	1,115	N
20-Jun-06	1:28:00 PM	Yellow Perch	PYS	1	6.6	1,115	S
20-Jun-06	1:28:00 PM	Yellow Perch	YS	2	5.5	1,115	S
20-Jun-06	3:52:00 PM	Yellow Perch	PYS	3	7.4	1,115	N
20-Jun-06	3:52:00 PM	Yellow Perch	YS	6	5.8	1,115	N

Date	Start Time	Common Name	Life Stage	Number Collected	Mean Length (mm)	Sample Vol (m^3)	Transect
20-Jun-06	4:08:00 PM	Yellow Perch	YS/PYS	1	8.1	1,115	S
20-Jun-06	4:08:00 PM	Yellow Perch	YS	2	6.3	1,115	S
20-Jun-06	5:46:00 PM	Yellow Perch	PYS	3	8.1	1,115	N
20-Jun-06	5:46:00 PM	Yellow Perch	YS/PYS	1	5.8	1,115	N
20-Jun-06	5:46:00 PM	Yellow Perch	YS	4	6.3	1,115	N
20-Jun-06	6:01:00 PM	Yellow Perch	PYS	3	7.9	1,115	S
20-Jun-06	10:26:00 PM	Alewife	PYS	2	6.3	1,115	N
20-Jun-06	10:26:00 PM	Alewife	YS	1	4.2	1,115	N
20-Jun-06	10:26:00 PM	Carps and Minnows	YS	1		1,115	N
20-Jun-06	10:26:00 PM	Yellow Perch	PYS	2	6.5	1,115	N
20-Jun-06	10:26:00 PM	Yellow Perch	YS/PYS	1	6.1	1,115	N
20-Jun-06	10:26:00 PM	Yellow Perch	YS	32	5.8	1,115	N
20-Jun-06	10:53:00 PM	Carps and Minnows	YS	1		1,115	S
20-Jun-06	10:53:00 PM	Unidentified	YS/PYS	1		1,115	S
20-Jun-06	10:53:00 PM	Yellow Perch	YS/PYS	4		1,115	S
20-Jun-06	10:53:00 PM	Yellow Perch	YS	1	6.6	1,115	S
21-Jun-06	12:36:00 AM	Alewife	Egg	1		1,115	N
21-Jun-06	12:36:00 AM	Carps and Minnows	YS	1		1,115	N
21-Jun-06	12:36:00 AM	Yellow Perch	PYS	1	9.1	1,115	N
21-Jun-06	12:36:00 AM	Yellow Perch	YS	15	6.1	1,115	N
21-Jun-06	12:59:00 AM	Alewife	PYS	1	5.7	1,115	S
21-Jun-06	12:59:00 AM	Carps and Minnows	YS	2		1,115	S
21-Jun-06	12:59:00 AM	Yellow Perch	PYS	2	8.8	1,115	S
21-Jun-06	12:59:00 AM	Yellow Perch	YS	14	5.9	1,115	S
21-Jun-06	3:24:00 AM	Carps and Minnows	YS	1		1,115	N
21-Jun-06	3:24:00 AM	Yellow Perch	PYS	1	8.7	1,115	N
21-Jun-06	3:24:00 AM	Yellow Perch	YS	8	5.9	1,115	N
21-Jun-06	3:44:00 AM	Alewife	PYS	1	7.0	1,115	S
21-Jun-06	3:44:00 AM	Carps and Minnows	YS	2		1,115	S
21-Jun-06	3:44:00 AM	Yellow Perch	PYS	2	6.8	1,115	S
21-Jun-06	3:44:00 AM	Yellow Perch	YS	5	6.4	1,115	S
21-Jun-06	5:19:00 AM	Yellow Perch	YS	1	6.2	1,115	N
21-Jun-06	5:40:00 AM	Yellow Perch	PYS	1	7.0	1,115	S
12-Jul-06	1:34:40 PM	Alewife	PYS	1	6.1	1,205	S
12-Jul-06	1:34:40 PM	Yellow Perch	PYS	1	7.4	1,205	S
12-Jul-06	10:11:00 PM	Alewife	PYS	1		1,205	S
13-Jul-06	12:45:00 AM	Alewife	PYS	1	9.2	1,205	N
13-Jul-06	12:45:00 AM	Alewife	YS	1		1,205	N
13-Jul-06	1:02:00 AM	Alewife	Egg	22		1,205	S
13-Jul-06	1:02:00 AM	Alewife	PYS	1	7.9	1,205	S
13-Jul-06	3:20:00 AM	Alewife	Egg	2		1,205	N
13-Jul-06	3:20:00 AM	Alewife	YS	2	4.9	1,205	N
13-Jul-06	3:35:00 AM	Perches	YS/PYS	1		1,205	S
13-Jul-06	5:43:00 AM	Alewife	PYS	1	5.3	1,205	S
26-Jul-06	2:04:00 AM	Alewife	PYS	1	15.3	1,101	S
26-Jul-06	3:54:00 AM	Alewife	PYS	2	16.2	1,101	S
26-Jul-06	5:37:00 AM	Alewife	Egg	1		1,101	S
09-Aug-06	3:32:00 AM	Banded Killifish	PYS	1	20.0	1,300	N

(YS) = Yolk-sac larvae
(PYS) = Post-yolk-sac larvae
(YS/PYS) = Unidentified-life stage larvae

Appendix B

Entrainment Collection Data

Start Date	Start Time	Common Name	Life Stage	Number Collected	Mean Length (mm)	Sample Vol (m^3)
26-Apr-06	9:50:00 AM	White Sucker	PYS	2	13.7	935.6
26-Apr-06	7:35:00 PM	White Sucker	PYS	1	13.7	935.6
27-Apr-06	5:30:00 AM	Suckers	YS/PYS	2		935.6
05-May-06	1:00:00 AM	White Sucker	YS	1	13.7	1025.1
05-May-06	1:00:00 AM	White Sucker	YS/PYS	1	13.8	1025.1
05-May-06	5:34:00 AM	White Sucker	PYS	5	14.4	1025.1
05-May-06	7:57:00 AM	White Sucker	PYS	4	13.7	1025.1
06-Jun-06	8:16:00 PM	Unidentified	EGG	1		1024.1
20-Jun-06	7:52:00 AM	Alewife	EGG	2		1023.8
20-Jun-06	10:22:00 AM	Alewife	EGG	1		1023.8
20-Jun-06	2:55:00 PM	Alewife	EGG	3		1023.8
20-Jun-06	2:55:00 PM	Yellow Perch	PYS	1	6.7	1023.8
20-Jun-06	5:20:00 PM	Alewife	EGG	2		1023.8
20-Jun-06	7:40:00 PM	Brook silverside	EGG	1		1023.8
20-Jun-06	10:05:00 PM	Alewife	EGG	5		1023.8
20-Jun-06	10:05:00 PM	Carps and Minnows	YS	1		1023.8
20-Jun-06	10:05:00 PM	Darters	YS	2	4.8	1023.8
21-Jun-06	12:25:00 AM	Alewife	EGG	4		1023.8
21-Jun-06	2:58:00 AM	Alewife	EGG	3		1023.8
21-Jun-06	5:10:00 AM	Alewife	EGG	3		1023.8
21-Jun-06	5:10:00 AM	Carps and Minnows	EGG	1		1023.8
12-Jul-06	7:40:00 AM	Banded Killifish	PYS	1	8.0	1023.2
12-Jul-06	7:40:00 AM	Unidentified	EGG	1		1023.2
12-Jul-06	10:00:00 AM	Unidentified	EGG	4		1023.2
12-Jul-06	12:25:00 PM	Unidentified	YS/PYS	1		1023.2
12-Jul-06	2:47:00 PM	Unidentified	EGG	1		1023.2
12-Jul-06	5:10:00 PM	Banded Killifish	PYS	1	7.7	1023.2
12-Jul-06	5:10:00 PM	Unidentified	YS/PYS	1		1023.2
13-Jul-06	12:20:00 AM	Carps and Minnows	PYS	2		1023.2
25-Jul-06	10:05:00 PM	Banded Killifish	PYS	1	11.0	1030.3
25-Jul-06	10:05:00 PM	Banded Killifish	JUV	7	16.7	1030.3
25-Jul-06	10:05:00 PM	Carp	JUV	2	25.3	1030.3
26-Jul-06	12:25:00 AM	Banded Killifish	JUV	1	14.4	1030.3
26-Jul-06	2:50:00 AM	Banded Killifish	JUV	2	15.5	1030.3
08-Aug-06	5:08:00 PM	Unidentified	PYS	1		1023.0
09-Aug-06	2:30:00 AM	Unidentified	PYS	1		1023.0
12-Sep-06	10:02:00 PM	Ameiurus spp.	JUV	1		1035.3

(YS) = Yolk-sac larvae
(PYS) = Post-yolk-sac larvae
(YS/PYS) = Unidentified-life stage larvae
(JUV) = Juvenile

Appendix C

Ichthyoplankton Water Quality Data

Date	Time	Station Depth (ft)	Surface Temp (°C)	Mid-depth Temp (°C)	Bottom Temp (°C)	Surface DO (ppm)	Mid-depth DO (ppm)	Bottom DO (ppm)	Surface Cond. (µS/cm)	Mid-depth Cond. (µS/cm)	Bottom Cond. (µS/cm)	Transect
26-Apr-06	10:22:00 AM	30	6.5	6.2	6	12.5	12.7	12.8	690	697	700	N
26-Apr-06	11:01:00 AM	36	6.6	6	6	12.5	12.8	12.8	690	709	705	S
26-Apr-06	12:40:00 PM	30	6.9	6	5.9	12.8	13	13	708	715	712	N
26-Apr-06	1:02:00 PM	35	6.5	5.8	5.9	12.7	12.8	12.8	705	713	710	S
26-Apr-06	3:12:00 PM	29	7.2	6.2	5.8	13	13	12.9	701	710	709	N
26-Apr-06	3:33:00 PM	32	7.1	5.8	5.8	13	13	12.9	694	712	710	S
26-Apr-06	5:43:00 PM	30	6.1	5.8	5.8	12.8	12.8	12.8	713	712	714	N
26-Apr-06	6:19:00 PM	30	6.9	5.8	5.8	12.9	12.9	12.8	698	710	709	S
26-Apr-06	7:50:00 PM	31	6.3	5.9	5.7	13	13	12.9	711	713	712	N
26-Apr-06	8:13:00 PM	32	6.4	5.8	5.7	13.1	13	12.8	712	714	711	S
26-Apr-06	10:30:00 PM	35	7.1	5.9	6	12.8	12.8	12.8	712	715	711	N
26-Apr-06	11:00:00 PM	35	7.1	5.9	6	12.8	12.8	12.8	712	715	711	S
27-Apr-06	12:42:00 AM	30	6.9	6.1	6.1	12.6	12.7	12.7	712	714	710	N
27-Apr-06	1:10:00 AM	35	6.9	6.1	6.1	12.6	12.7	12.7	712	714	710	S
27-Apr-06	3:18:00 AM	35	6.7	6.1	6	12.4	12.8	12.8	708	710	706	N
27-Apr-06	3:40:00 AM	30	6	6.1	6	12.7	12.7	12.8	712	709	707	S
27-Apr-06	5:42:00 AM	35	6.3	5.8	5.5	12.5	12.6	12.6	710	710	708	N
27-Apr-06	6:05:00 AM	30	6.2	6	5.9	12.5	12.7	12.6	709	709	706	S
27-Apr-06	8:00:00 AM	60	7	5.8	5.8	12.2	12.6	12.5	702	709	707	N
27-Apr-06	8:21:00 AM	29	7.2	5.8	5.7	12.5	12.7	12.5	704	707	706	S
4-May-06	11:47:00 AM	30	10.6	8.4	7.8	12.8	13.2	13.2	680	684	684	N
4-May-06	12:07:00 PM	30	9.9	8.3	8	13	13.3	13.1	681	683	684	S
4-May-06	12:59:00 PM	31	10.3	8.1	7.8	12.8	13.3	13.4	680	682	684	N
4-May-06	1:19:00 PM	31	10.2	8.2	7.9	12.8	13.2	13.2	680	683	683	S
4-May-06	5:05:00 PM	31	11.9	7.9	7	13	13.4	13.5	684	693	684	N
4-May-06	5:28:00 PM	33	11.2	8.1	6.7	13	13.4	12.5	679	684	685	S
4-May-06	5:55:00 PM	28	12.7	7.8	7.1	13.1	13.4	13.2	671	684	684	N
4-May-06	6:18:00 PM	32	11.3	8.1	7.6	13	13.4	12.8	686	692	692	S
4-May-06	8:59:00 PM	29	11	8.1	7.8	13	13.3	13.2	682	692	693	N
4-May-06	9:17:00 PM	31	10.3	8.2	8.1	12.8	13.3	13.3	684	683	683	S
4-May-06	11:25:00 PM	45	11	8.1	6.9	12.7	13.3	13	678	683	686	N
4-May-06	11:55:00 PM	26	11.3	8.7	7.9	12.3	12.9	12.7	677	681	683	S
5-May-06	1:30:00 AM	35	10.6	9.8	7.6	12.7	13	13.1	676	679	684	N
5-May-06	2:13:00 AM	27	9.6	9.6	8.6	12.8	13	13	680	680	682	S
5-May-06	4:03:00 AM	35	9.9	8.5	5.3	12.8	12.5	12.7	679	683	690	N
5-May-06	4:48:00 AM	27	9.8	9.8	6.6	12.6	12.8	13	679	680	686	S

Date	Time	Station Depth (ft)	Surface Temp (°C)	Mid-depth Temp (°C)	Bottom Temp (°C)	Surface DO (ppm)	Mid-depth DO (ppm)	Bottom DO (ppm)	Surface Cond. (µS/cm)	Mid-depth Cond. (µS/cm)	Bottom Cond. (µS/cm)	Transect
5-May-06	5:55:00 AM	31	11.2	10	5.5	12.5	12.8	12.5	672	678	689	N
5-May-06	6:14:00 AM	27	9.7	9.6	7.2	12.6	12.5	12.8	679	680	684	S
5-May-06	8:17:00 AM	40	10.3	7.5	6.4	12.5	13	12.7	676	683	686	N
5-May-06	8:41:00 AM	27	9.8	7.9	6.2	12.7	13	12.8	678	682	684	S
16-May-06	10:07:00 AM	29	10.4	9.7	8.8	13	13.5	14	676	676	677	N
16-May-06	10:28:00 AM	30	9.4	9	8.6	13.7	13.9	13.9	677	676	677	S
16-May-06	11:43:00 AM	31	9.1	8.8	8.3	13.7	13.9	13.9	678	678	679	S
16-May-06	11:24:00 AM	30	10.4	8.7	8.1	13.1	13.9	13.7	675	679	680	N
16-May-06	2:37:00 PM	29	11.5	8.6	8.4	12.9	14	13.9	675	678	679	N
16-May-06	2:57:00 PM	32	9.9	9	8.4	13.7	13.8	13.8	677	678	679	S
16-May-06	4:27:00 PM	30	12.4	8.6	8.3	13	13.8	13.6	677	687	687	N
16-May-06	4:44:00 PM	31	11.7	8.5	8	13	13.9	13.7	681	687	688	S
16-May-06	6:07:00 PM	30	11.4	8.8	7.9	13.2	14.1	13.8	674	687	691	N
16-May-06	6:24:00 PM	31	9.9	8.8	8.5	13.7	13.9	13.8	677	678	679	S
16-May-06	8:53:00 PM	32	11	9.3	8.4	14.2	14.7	14.5	689	689	688	N
16-May-06	9:14:00 PM	34	10.1	9.1	7.7	14.4	14.8	14.4	692	692	692	S
16-May-06	11:21:00 PM	35	10.3	8.9	8.4	14.5	14.2	14.4	687	693	691	N
16-May-06	11:43:00 PM	35	10	8.7	8.2	14.3	14.7	13.8	693	692	692	S
17-May-06	1:23:00 AM	28	10.7	9.7	8.6	14.3	14.5	14.5	686	692	690	N
17-May-06	1:42:00 AM	34	10.4	8.8	8.3	14.7	14.8	14.6	693	693	690	S
17-May-06	4:06:00 AM	28	10.1	8.7	8.5	14.4	14.5	14.4	690	692	692	N
17-May-06	4:26:00 AM	37	10.4	8.4	8	14.1	14.8	14.4	692	693	693	S
17-May-06	6:11:00 AM	30	10.1	9.8	8.4	14.4	14.5	14.6	690	692	692	N
17-May-06	6:29:00 AM	33	10.1	8.4	8.2	14.2	14.8	14.6	694	693	692	S
6-Jun-06	9:36:00 AM	29	15.1	13.6	11.3	11.1	11.7	11.3	682	681	684	N
6-Jun-06	10:05:00 AM	30	15.2	12.6	10.8	11.2	11.6	11.7	680	682	681	S
6-Jun-06	11:38:00 AM	30	15.5	11.7	11	11.4	11.9	11.7	674	675	681	N
6-Jun-06	11:55:00 AM	31	16	12.6	11.6	11.4	11.9	11.7	674	675	680	S
6-Jun-06	1:39:00 PM	29	16.7	12.7	11.7	10.8	11.7	11.7	684	680	679	N
6-Jun-06	1:59:00 PM	31	16.2	10.3	9.8	11.1	12.3	11.7	673	675	681	S
6-Jun-06	4:06:00 PM	30	17.2	14.8	10.8	11.7	12.2	11.9	671	670	678	N
6-Jun-06	4:24:00 PM	29	15.4	12.4	10.7	11.5	11.6	11.7	673	674	680	S
6-Jun-06	7:08:00 PM	30	16	13.5	11.4	10.8	11.2	11.5	684	686	682	N
6-Jun-06	7:26:00 PM	31	15.6	14.8	9.4	10.9	11	11.5	684	684	686	S
6-Jun-06	8:43:00 PM	35	18.3	13.9	9.3	11.5	13	13.4	663	667	685	N
6-Jun-06	9:10:00 PM	30	17.9	11.4	8.4	12.3	13.4	13.7	675	684	697	S
6-Jun-06	10:51:00 PM	37	17.4	11.9	9.1	11.4	12.9	13.3	690	694	702	N

Date	Time	Station Depth (ft)	Surface Temp (°C)	Mid-depth Temp (°C)	Bottom Temp (°C)	Surface DO (ppm)	Mid-depth DO (ppm)	Bottom DO (ppm)	Surface Cond. (µS/cm)	Mid-depth Cond. (µS/cm)	Bottom Cond. (µS/cm)	Transect
6-Jun-06	11:16:00 PM	30	15.4	12.3	8.7	12.1	13	13.4	689	695	708	S
7-Jun-06	1:21:00 AM	33	17.1	11.9	9.5	11.6	13	13.3	689	697	706	N
7-Jun-06	1:42:00 AM	29	15.1	11.7	9	12	13	13.3	695	699	708	S
7-Jun-06	3:40:00 AM	30	16.7	12.1	11.4	11.6	12.8	12.8	691	697	701	N
7-Jun-06	3:58:00 AM	29	15.3	11.5	11.2	11.7	12.9	12.9	695	698	702	S
7-Jun-06	6:12:00 AM	28	15.2	12.1	12	11.8	12.8	12.6	693	698	699	N
7-Jun-06	6:30:00 AM	30	15.3	11.7	11.3	11.6	12.8	12.8	695	700	703	S
20-Jun-06	8:44:00 AM	31	16.8	15.9	14.6	11.1	10.9	11	672	675	679	N
20-Jun-06	9:05:00 AM	31	16.3	15.8	14.8	11.1	11.1	10.6	672	674	676	S
20-Jun-06	11:30:00 AM	30	18.2	16.1	14.9	11.3	11.5	11.2	664	670	674	N
20-Jun-06	11:45:00 AM	31	17	15.9	15	11.3	11.2	10.9	667	672	674	S
20-Jun-06	1:09:00 PM	31	17	15.9	14.6	11.7	11.6	11.5	667	671	674	N
20-Jun-06	1:28:00 PM	30	16.9	15.8	15	10.6	10.7	10.7	670	671	674	S
20-Jun-06	3:52:00 PM	30	17.5	16.9	16.6	11	11	10.9	672	674	675	N
20-Jun-06	4:08:00 PM	31	17.7	17.3	16.5	10.9	10.7	10.7	671	673	673	S
20-Jun-06	5:46:00 PM	31	17.7	17.4	16.7	10.4	10.2	10.4	674	672	676	N
20-Jun-06	6:01:00 PM	31	17.9	17.8	17.8	10.2	10.2	10.2	672	672	674	S
20-Jun-06	10:26:00 PM	35	18.6	17.8	17.6	12.6	12.8	12.3	663	665	666	N
20-Jun-06	10:53:00 PM	35	17.8	17.7	17.5	12.4	12.5	12.2	664	665	666	S
21-Jun-06	12:36:00 AM	35	18	15.7	14.2	12.4	13.2	12.5	664	669	674	N
21-Jun-06	12:59:00 AM	30	17.9	17.7	15.7	12.8	12.8	13.2	665	665	670	S
21-Jun-06	3:24:00 AM	38	17.9	17.7	16.1	12.6	12.5	12.2	665	665	669	N
21-Jun-06	3:44:00 AM	36	18	17.8	15.5	12.6	12.5	12.5	665	665	672	S
21-Jun-06	5:19:00 AM	38	18.9	17.5	14.4	11.7	12.8	13.1	661	667	674	N
21-Jun-06	5:40:00 AM	35	17.9	17.7	16.1	12.5	12.7	12.7	664	665	669	S
12-Jul-06	9:06:30 AM	30	22.1	20.5	16.4	10	9.7	10	664	670	674	N
12-Jul-06	9:27:50 AM	30	22	20.6	16.6	11.2	9.8	10	678	671	668	S
12-Jul-06	10:12:20 AM	30	21.7	20.4	17.3	10	9.8	10.4	603	614	661	N
12-Jul-06	10:35:30 AM	30	21.1	20.6	18	9.9	9.9	10	627	670	676	S
12-Jul-06	1:11:50 PM	30	21.7	20.6	18.7	10	10.4	9.7	670	670	680	N
12-Jul-06	1:34:40 PM	30	20.8	20	17.8	10.2	10	10.3	672	674	677	S
12-Jul-06	3:54:00 PM	30	22.4	20.4	19.5	9.9	10.2	10.5	664	667	664	N
12-Jul-06	4:14:25 PM	30	20.6	19.6	18.4	10.3	10.3	10.6	668	667	668	S
12-Jul-06	6:48:30 PM	30	21.9	19.4	18.9	10.1	10.2	10.2	646	667	667	N
12-Jul-06	7:06:45 PM	30	22	19.9	19	10.1	10.3	10.2	658	666	670	S
12-Jul-06	8:55:00 PM	30	21.6	20.1	17.6	9.8	9.8	10.3	613	645	651	N
12-Jul-06	9:16:00 PM	30	21.5	21.1	18.6	9.8	10	9.8	622	639	650	S

Date	Time	Station Depth (ft)	Surface Temp (°C)	Mid-depth Temp (°C)	Bottom Temp (°C)	Surface DO (ppm)	Mid-depth DO (ppm)	Bottom DO (ppm)	Surface Cond. (µS/cm)	Mid-depth Cond. (µS/cm)	Bottom Cond. (µS/cm)	Transect
12-Jul-06	9:55:00 PM	29	21.6	21.1	20.6	9.8	10	9.6	620	639	642	N
12-Jul-06	10:11:00 PM	32	21.8	21	18.8	9.5	10	10.1	627	641	648	S
13-Jul-06	12:45:00 AM	31	21.7	20.8	19.8	9.5	9.7	9.8	608	643	648	N
13-Jul-06	1:02:00 AM	28	21.5	21.4	19.9	9.5	9.6	10	641	645	647	S
13-Jul-06	3:20:00 AM	30	21.5	21.4	21.2	9.2	9.4	9.4	610	643	638	N
13-Jul-06	3:35:00 AM	31	21.3	21.1	20.3	9.3	9.6	9.8	626	634	644	S
13-Jul-06	5:43:00 AM	32	22	21.5	21.3	8.7	9.1	9	593	626	631	N
13-Jul-06	5:58:00 AM	28	21.7	21.6	21.4	8.9	9	9.1	596	616	629	S
25-Jul-06	9:15:00 AM	30	23.6	21	18.6	10.2	9.9	10.1	663	671	671	N
25-Jul-06	9:43:00 AM	30	23	22.2	19	10.3	10.4	9.8	666	669	671	S
25-Jul-06	10:40:00 AM	30	23.9	22.3	18.8	10.2	10.4	10.1	661	666	670	N
25-Jul-06	11:00:00 AM	30	23.1	21.3	18.5	10.5	10.4	9.9	665	666	662	S
25-Jul-06	1:21:00 PM	30	24.5	22.3	19.5	10.5	10.7	9.6	653	661	661	N
25-Jul-06	1:42:00 PM	30	23.8	21.6	18.4	10.5	10.8	9.6	660	664	661	S
25-Jul-06	4:03:00 PM	30	25.8	22.2	18.9	10	10.5	9.9	661	664	661	N
25-Jul-06	4:21:00 PM	30	24.3	21.8	19	10.8	10.8	9.9	658	666	664	S
25-Jul-06	7:17:00 PM	30	24.4	21	20.1	10.4	10.3	10.2	664	666	667	N
25-Jul-06	7:36:00 PM	30	22.8	20	18.6	10.5	10.2	10	666	667	669	S
25-Jul-06	8:36:00 PM	30	26.4	21.1	20.3	10.1	10.9	10.8	671	635	676	N
25-Jul-06	8:59:00 PM	31	23	21.5	19.9	11.1	10.9	10.8	673	672	674	S
25-Jul-06	10:24:00 PM	35	23.8	22.9	21.3	11.4	10.9	10.5	664	675	674	N
25-Jul-06	10:46:00 PM	30	22.9	22.4	20.9	11	11.1	10.6	672	673	676	S
26-Jul-06	1:43:00 AM	35	25.1	22.5	22.1	10.4	11	10.4	664	674	674	N
26-Jul-06	2:04:00 AM	30	23.6	22.4	21.9	11.1	10.7	10.9	665	672	674	S
26-Jul-06	3:38:00 AM	30	24	22.6	22.4	11.7	11	10.8	655	673	673	N
26-Jul-06	3:54:00 AM	30	23	22.6	22.1	11.1	11	10.8	669	676	674	S
26-Jul-06	5:18:00 AM	30	24	22.8	22.7	10.2	10.8	10.3	671	673	675	N
26-Jul-06	5:37:00 AM	30	22.8	22.4	22.1	10.9	10.7	10.7	670	672	675	S
8-Aug-06	9:08:00 AM	30	24	23.9	25.9	9	9.2	8.3	663	663	666	N
8-Aug-06	9:30:00 AM	30	24	24	24.2	9.1	9.1	8.2	662	662	662	S
8-Aug-06	10:16:00 AM	30	24.2	24.2	24.1	8.8	8.9	8.2	660	661	662	N
8-Aug-06	10:33:00 AM	30	24.4	24.4	24.4	8.5	8.5	8.2	656	657	657	S
8-Aug-06	1:45:00 PM	30	24.9	24.8	24.4	8.1	8.2	8	653	656	658	N
8-Aug-06	2:02:00 PM	30	25.2	24.8	24.7	8.1	8.1	8	655	655	656	S
8-Aug-06	3:57:00 PM	30	25.6	25.2	25.2	8.1	8.1	8.1	648	653	652	N
8-Aug-06	4:15:00 PM	30	25.4	25.2	25.2	8.1	8.1	8	651	653	654	S
8-Aug-06	6:05:00 PM	30	25.2	25	25	8	7.9	8	652	657	657	N

Date	Time	Station Depth (ft)	Surface Temp (°C)	Mid-depth Temp (°C)	Bottom Temp (°C)	Surface DO (ppm)	Mid-depth DO (ppm)	Bottom DO (ppm)	Surface Cond. (µS/cm)	Mid-depth Cond. (µS/cm)	Bottom Cond. (µS/cm)	Transect
8-Aug-06	6:21:00 PM	30	25	25	24.9	7.9	8	7.9	658	657	659	S
8-Aug-06	8:10:00 PM	29	24.7	24.6	24.4	9.3	9.3	9.1	662	663	663	N
8-Aug-06	8:29:00 PM	32	24.8	24.8	24.5	9.1	9.2	9.1	663	664	666	S
8-Aug-06	9:56:00 PM	32	24.7	24.6	24.5	9	9	9.1	663	666	666	N
8-Aug-06	10:17:00 PM	31	24.9	24.7	24.3	9.4	9.3	9	660	664	670	S
9-Aug-06	12:41:00 AM	34	24.6	24.4	24.2	9	9	9	665	668	669	N
9-Aug-06	1:02:00 AM	32	24.7	24.6	24.3	8.8	8.9	8.8	663	665	669	S
9-Aug-06	3:32:00 AM	30	24.5	23.4	10.6	8.8	8.8	10.6	666	682	690	N
9-Aug-06	3:54:00 AM	30	24.6	24.5	24.4	8.6	8.6	8.5	665	665	669	S
9-Aug-06	6:00:00 AM	33	24.5	24.4	23.5	8.8	8.4	8.4	664	669	670	N
9-Aug-06	6:16:00 AM	33	24.5	24.4	24.2	8.8	8.6	8.5	664	665	672	S
22-Aug-06	9:08:00 AM	30	23.4	23.2	23.1	8.3	8.3	7.1	657	658	660	N
22-Aug-06	9:39:00 AM	30	23.3	23.2	23.2	8.3	8.2	8	660	659	658	S
22-Aug-06	10:33:00 AM	30	23.5	23.3	23.4	8.3	7.6	7.6	659	660	658	N
22-Aug-06	11:03:00 AM	30	23.4	23.2	23.2	8.3	8.4	7.8	660	658	659	S
22-Aug-06	1:01:00 PM	30	26.1	23.5	23.3	9.4	7.6	7.2	655	660	658	N
22-Aug-06	1:26:00 PM	30	24.1	23.4	23.4	8.3	7.5	7.5	659	659	658	S
22-Aug-06	4:22:00 PM	30	25.2	23.4	23.5	9.6	8.5	8.1	654	656	655	N
22-Aug-06	4:40:00 PM	30	24	23.3	23.1	9	8.6	7.9	654	656	656	S
22-Aug-06	6:31:00 PM	30	23.9	23.4	23.4	8.7	8.7	8.3	661	660	660	N
22-Aug-06	6:51:00 PM	30	23.8	23.3	23.1	8.8	8.5	8.2	661	660	660	S
22-Aug-06	7:51:00 PM	30	23.8	23.6	23.5	8.7	8.9	8.8	660	660	661	N
22-Aug-06	8:10:00 PM	30	23.7	23.6	23.4	8.8	8.7	8.6	660	660	660	S
22-Aug-06	10:09:00 PM	35	26	23.5	23.5	10.1	8.8	8.7	656	667	668	N
22-Aug-06	10:32:00 PM	30	24	23.5	23.4	10.7	9	8.7	660	666	668	S
23-Aug-06	12:34:00 AM	30	24.4	23.5	23.4	8.9	8.9	8.6	662	666	666	N
23-Aug-06	12:53:00 AM	30	23.4	23.4	23.2	8.9	8.9	8.5	665	665	667	S
23-Aug-06	3:12:00 AM	30	24	23.3	23.1	8.4	8.8	8.5	663	666	668	N
23-Aug-06	3:31:00 AM	30	23.4	23.3	22.8	8.7	8.7	8.2	665	665	669	S
23-Aug-06	5:32:00 AM	30	23.9	23.1	22.6	8.2	8.8	8.4	661	661	670	N
23-Aug-06	5:48:00 AM	30	23.2	23.1	22.6	8.7	8.7	8.3	666	667	668	S
12-Sep-06	8:44:00 AM	30	19.8	19.7	19.4	9.8	10	9.9	457	628	656	N
12-Sep-06	9:10:00 AM	30	19.6	19.6	19.5	10.2	10.2	10.2	637	637	640	S
12-Sep-06	10:18:00 AM	30	19.8	19.8	19.8	10.2	10.2	9.9	638	644	648	N
12-Sep-06	10:38:00 AM	30	19.7	19.7	19.6	10.3	10.2	10	635	636	648	S
12-Sep-06	1:04:00 PM	30	19.8	19.7	19.6	10.7	10.4	10.3	629	642	654	N
12-Sep-06	1:26:00 PM	30	19.7	19.6	19.5	10.4	10.2	10.2	645	650	657	S

Date	Time	Station Depth (ft)	Surface Temp (°C)	Mid-depth Temp (°C)	Bottom Temp (°C)	Surface DO (ppm)	Mid-depth DO (ppm)	Bottom DO (ppm)	Surface Cond. (µS/cm)	Mid-depth Cond. (µS/cm)	Bottom Cond. (µS/cm)	Transect
12-Sep-06	4:15:00 PM	30	19.6	19.2	18.8	10.8	10.3	10	628	650	660	N
12-Sep-06	4:35:00 PM	30	19.5	19.5	18.7	10.3	10.3	9.8	652	653	661	S
12-Sep-06	6:21:00 PM	30	19.4	19.4	18.4	10.5	10.3	9.7	645	652	662	N
12-Sep-06	6:40:00 PM	30	19.5	19.5	19	10.2	10.2	10	681	651	660	S
12-Sep-06	8:51:00 PM	30	20.8	18.7	17.7	9.5	8.4	7.9	473	656	661	N
12-Sep-06	9:18:00 PM	30	16.4	18	17.4	8.8	8.4	7.9	646	655	661	S
12-Sep-06	10:44:00 PM	30	20	18.5	17.8	9.3	8.5	7.9	520	655	658	N
12-Sep-06	11:06:00 PM	30	19.2	19	17.1	8.8	8.8	8.1	618	650	663	S
13-Sep-06	1:33:00 AM	30	19.6	18.7	18.6	8.9	8.6	8.4	513	650	651	N
13-Sep-06	1:52:00 AM	30	18.8	18.4	17.2	8.7	8.6	8.8	651	655	664	S
13-Sep-06	6:06:00 AM	30	19.2	17.1	16.9	8.5	7.9	7.8	475	655	662	N
13-Sep-06	6:26:00 AM	30	18.5	18.5	17.6	8.5	8.5	8.2	607	611	618	S

Appendix D

Entrainment Water Quality Data

Date	Time	Stratum	DO (ppm)	Temperature (°C)	Conductivity (µS/cm)
26-Apr-06	11:00:00 AM	Mid	11.9	6.8	674
26-Apr-06	1:13:00 PM	Mid	12.1	8	666
26-Apr-06	3:50:00 PM	Mid	11.7	8.2	678
26-Apr-06	5:55:00 PM	Mid	12.3	8.1	683
26-Apr-06	8:36:00 PM	Mid	12	8	674
26-Apr-06	10:50:00 PM	Mid	12.8	7.4	683
27-Apr-06	1:05:00 AM	Mid	12.7	6.9	691
27-Apr-06	3:40:00 AM	Mid	12.8	6.4	695
27-Apr-06	6:10:00 AM	Mid	12.7	6.4	696
27-Apr-06	8:30:00 AM	Mid	12.7	6.4	695
4-May-06	11:17:00 AM	Mid	12.3	13.5	750
4-May-06	1:46:00 PM	Mid	11.9	14.1	760
4-May-06	4:03:00 PM	Mid	12.6	11.1	780
4-May-06	6:33:00 PM	Mid	12.5	10.6	784
4-May-06	9:18:00 PM	Mid	12.9	9.9	782
4-May-06	11:45:00 PM	Mid	12.9	10.8	N/A
5-May-06	2:05:00 AM	Mid	12.1	10.6	689
5-May-06	4:04:00 AM	Mid	11.7	10.6	687
5-May-06	6:17:00 AM	Mid	11.8	10.2	689
5-May-06	8:42:00 AM	Mid	11.8	10.4	686
16-May-06	9:17:00 AM	Mid	11.8	11	704
16-May-06	11:44:00 AM	Mid	11.7	11.3	702
16-May-06	2:05:00 PM	Mid	11.8	11.3	700
16-May-06	5:05:00 PM	Mid	12.1	10.6	701
16-May-06	6:50:00 PM	Mid	13.4	9.9	703
16-May-06	9:16:00 PM	Mid	13.6	9.6	692
16-May-06	11:38:00 PM	Mid	13.5	9.5	696
17-May-06	1:56:00 AM	Mid	13.1	10	699
17-May-06	4:13:00 AM	Mid	12.8	10.3	699
17-May-06	6:40:00 AM	Mid	12.9	10.3	699
6-Jun-06	9:12:00 AM	Mid	10.6	13.7	780
6-Jun-06	11:32:00 AM	Mid	10.7	14.5	737
6-Jun-06	1:57:00 PM	Mid	11.2	15	678
6-Jun-06	4:32:00 PM	Mid	11.4	14.9	694
6-Jun-06	6:52:00 PM	Mid	11.1	15.9	735
6-Jun-06	9:02:00 PM	Mid	11.1	14.9	758
6-Jun-06	11:20:00 PM	Mid	10.7	15.4	802
7-Jun-06	1:45:00 AM	Mid	10.8	15.2	813
7-Jun-06	4:05:00 AM	Mid	10.7	14.3	837
7-Jun-06	6:10:00 AM	Mid	10.7	14	848
20-Jun-06	8:40:00 AM	Mid	11.3	16.2	690
20-Jun-06	11:10:00 AM	Mid	11.2	16.7	670
20-Jun-06	1:30:00 PM	Mid	11.9	17.3	686
20-Jun-06	3:45:00 PM	Mid	11.9	17.7	686
20-Jun-06	6:10:00 PM	Mid	11.5	17.7	689
20-Jun-06	8:30:00 PM	Mid	11.5	17.8	695
20-Jun-06	10:54:00 PM	Mid	11.2	17.9	692

Date	Time	Stratum	DO (ppm)	Temperature (°C)	Conductivity (µS/cm)
21-Jun-06	4:08:00 AM	Mid	11.1	17.7	699
21-Jun-06	6:18:00 AM	Mid	10.9	17.3	697
12-Jul-06	8:30:00 AM	Mid	9.2	23.1	647
12-Jul-06	10:50:00 AM	Mid	9.2	23.1	643
12-Jul-06	1:15:00 PM	Mid	9.1	23.3	641
12-Jul-06	3:35:00 PM	Mid	9.1	23.9	642
12-Jul-06	5:50:00 PM	Mid	9.1	23.2	645
12-Jul-06	9:04:00 PM	Mid	8.97	22.2	650
12-Jul-06	10:41:00 PM	Mid	8.82	22.2	670
13-Jul-06	1:09:00 AM	Mid	8.55	22.7	628
13-Jul-06	3:53:00 AM	Mid	8.16	22.9	640
13-Jul-06	6:06:00 AM	Mid	8.37	22.4	639
25-Jul-06	8:27:00 AM	Mid	8	24.7	657
25-Jul-06	11:03:00 AM	Mid	8.3	25.6	641
25-Jul-06	1:15:00 PM	Mid	8.5	26.4	639
25-Jul-06	3:53:00 PM	Mid	9	26.4	642
25-Jul-06	6:16:00 PM	Mid	9	25.2	649
25-Jul-06	8:40:00 PM	Mid	9	24.5	642
25-Jul-06	11:05:00 PM	Mid	8.36	24.2	647
26-Jul-06	1:26:00 AM	Mid	8.16	24.2	646
26-Jul-06	4:02:00 AM	Mid	6.85	24.3	651
26-Jul-06	6:10:00 AM	Mid	7.42	23.9	654
8-Aug-06	8:15:00 AM	Mid	7.7	25.2	652
8-Aug-06	10:35:00 AM	Mid	7.4	26.5	646
8-Aug-06	1:00:00 PM	Mid	7.7	27.5	635
8-Aug-06	3:45:00 PM	Mid	8.2	27.7	626
8-Aug-06	5:50:00 PM	Mid	8.3	27.5	646
8-Aug-06	8:20:00 PM	Mid	7.7	26.6	648
8-Aug-06	10:45:00 PM	Mid	7.8	25.5	650
9-Aug-06	1:05:00 AM	Mid	7.9	24.8	653
9-Aug-06	3:30:00 AM	Mid	7.6	24.5	651
9-Aug-06	5:50:00 AM	Mid	7.4	24.1	653
22-Aug-06	8:20:00 AM	Mid	8.6	23.9	646
22-Aug-06	10:55:00 AM	Mid	9.2	24.6	637
22-Aug-06	1:10:00 PM	Mid	9.3	25.4	640
22-Aug-06	3:50:00 PM	Mid	9.8	26.2	625
22-Aug-06	6:10:00 PM	Mid	10	25.4	639
22-Aug-06	8:10:00 PM	Mid	9.8	25.5	643
22-Aug-06	11:02:00 PM	Mid	8.2	25.2	646
23-Aug-06	1:51:00 AM	Mid	8.2	24.6	645
23-Aug-06	4:10:00 AM	Mid	8.7	23.6	645
23-Aug-06	6:37:00 AM	Mid	7.5	23.7	649
12-Sep-06	8:50:00 AM	Mid	10.3	20.1	446
12-Sep-06	11:09:00 AM	Mid	9.3	20.7	449
12-Sep-06	1:34:00 PM	Mid	9.5	20.6	465
12-Sep-06	4:28:00 PM	Mid	10.2	20.2	470
12-Sep-06	6:27:00 PM	Mid	9.1	20	479
12-Sep-06	8:45:00 PM	Mid	9.5	19.8	480
12-Sep-06	10:50:00 PM	Mid	9.1	19.5	500

Date	Time	Stratum	DO (ppm)	Temperature (°C)	Conductivity (µS/cm)
13-Sep-06	1:15:00 AM	Mid	9.1	19.3	504
13-Sep-06	3:30:00 AM	Mid	7.3	19.1	508
13-Sep-06	5:50:00 AM	Mid	7.4	19	511