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03_NAI_2000.pdf

[NAI] Normandeau Associates, Inc. 2000. "A Report on the Thermal Conditions and Fish Populations in Conowingo Pond Relative to Zero Cooling Tower Operation at the Peach Bottom Atomic Power Station (June-October 1999)." Prepared for PECO Energy Company. February 2000.

A REPORT ON THE THERMAL CONDITIONS AND FISH POPULATIONS IN CONOWINGO POND RELATIVE TO ZERO COOLING TOWER OPERATION AT THE PEACH BOTTOM ATOMIC POWER STATION (JUNE-OCTOBER 1999)

NPDES Permit No. PA009723

PREPARED FOR:
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Philadelphia, Pennsylvania 19101

PREPARED BY:
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FEBRUARY 2000

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EXECUTIVE SUMMARY

In 1996, PECO Energy sponsored a study to determine whether the number of cooling towers in operation at Peach Bottom Atomic Power Station (PBAPS) can be curtailed without adversely affecting the integrity of the balanced, indigenous fish community of Conowingo Pond. Results of that study (Normandeau Associates, 1997a), which was coordinated with agency personnel primarily from the Pennsylvania Department of Environmental Protection, Pennsylvania Fish and Boat Commission, and Maryland Department of Natural Resources, suggested that the station could be operated with zero towers without adversely affecting the balanced fish community in Conowingo Pond. As a result of that study, PECO was issued a permit amendment to operate PBAPS with no cooling towers. However, to address agency concerns of the relatively high river flow and low water temperature conditions in 1996, PECO proposed a three (3) year monitoring program (1997 through 1999) to increase the probability of observing potential effects over a wide range of flow and temperature conditions. The principal components of the monitoring program were subsequently incorporated in the permit amendment. As in 1997 and 1998, monitoring in 1999 (the third and final year of study) was conducted monthly in June-October. The investigation included two components: relative abundance and distribution of fishes as measured by a variety of gears and evaluation of thermal conditions. Sampling was conducted at selected locations that had been monitored historically. A complete set of sampling within the one week per month consisted of the following: 48 h of trap netting, one set of seine collections, trawling at transect and zone locations, electrofishing, and two thermal mapping surveys.

The ambient water temperatures (as measured at PBAPS intakes) ranged from 54.4 to 86.5°F and varied between months due to changing natural hydrological and meteorological conditions. Temperatures were highest in July, followed by August, June and September, and lowest in October. Compared to previous study years, ambient inlet temperatures in summer 1999 were higher, exceeded 80°F longer (nearly 56 consecutive days), with daily values ≥83°F on 35 days versus 3 and 13 days, respectively in 1997 and 1998.

River inflows in 1999 were lower than in the historical period (1952-1998). Record low river flows for May and June occurred in 1999, while those in July and August 1999 were the lowest for those months in the last 33 years. River flows in summer 1999 were substantially lower than those experienced in 1996, and lower than the low inflow conditions in 1997 and 1998. Overall, compared to the historical period, the fish community in Conowingo Pond experienced near-worst summer conditions in 1999.

Water temperatures at the point of discharge were mostly 19 to 20°F above the Holtwood inflow temperatures and the ambient inlet temperatures.

The heated effluent from PBAPS quickly dissipated within about 2 miles downstream of the discharge structure. The effluent affected the top 5 to 15 ft of the water column primarily along the western shoreline downstream to western and mid-pond areas at the PA/MD State Line. Except in surface and near surface waters, rise in temperatures (above the PBAPS inlet) at the State Line were generally less than 4°F. The overall pattern of vertical distribution of temperature in the water column at locations along the west shore in 1999 was similar to that observed in 1995 (also a period of low river flow and high ambient water temperature) when a minimum of three cooling towers operated.

Despite high water temperature and record low river inflow conditions in summer 1999, DO values in the vicinity of PBAPS were good and reflected seasonal, spatial, and diurnal variations observed historically.

A total of 15,328 fish representing 45 species plus one striped bass hybrid and 11 unidentified *Lepomis* spp. was collected. The most fish (5,507) were collected in June and the least (1,596) in August. The number of species collected per month was similar and ranged from 35 (July, August, and September) to 37 (June and October). Overall, spotfin shiner was the most abundant species in July, August, September, and October while gizzard shad dominated the catch in June.

As in 1997 and 1998, the 1999 fisheries data for all gears revealed that most of the monthly catch per effort (CPE's) for the common and Environmental Protection agency designated species were within or above the historic range; CPE's among species and between stations were variable, likely due to differences

in year class strength, and no thermally stressed fish were observed. Overall, zero tower operation had no discernible effect on the integrity of the balanced, indigenous fish community of Conowingo Pond.

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1.0 INTRODUCTION AND BACKGROUND

In 1996 PECO Energy sponsored a study to determine whether the number of cooling towers in operation at Peach Bottom Atomic Power Station (PBAPS) can be curtailed without adversely affecting the integrity of the balanced, indigenous fish community of Conowingo Pond. The study was coordinated with the Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), Maryland Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (USFWS), and the Susquehanna River Basin Commission (SRBC). The primary reason for initiating the study was that the existing cooling tower operations were deemed conservative. They were based on a condenser design discharge water ΔT of 20.8°F and the fishes were assumed to be in a trapped situation at PBAPS. The investigation occurred in June through October 1996 at three discrete cooling tower (zero, one, and two) operations and consisted of two components: relative abundance and distribution of fishes as measured by a variety of gears and evaluation of near-field and far-field thermal conditions. The results of the 1996 study (Normandeau Associates, 1997a) were presented and discussed with concerned resource agencies. The consulted agencies concurred with the conclusion that no meaningful differences occurred in the relative abundance, distribution or species composition in each of the three tower operating scenarios (zero, one and two towers); fish populations at zero and two tower operation were similar. The report concluded that the integrity of a balanced, indigenous fish community in Conowingo Pond can be maintained at zero tower operation.

Based on the results of the 1996 study, PECO requested that the PADEP eliminate the need for operation of any cooling towers. However, recognizing agency concerns with regards to conditions studied in 1996 (relatively high river flows and cool water temperatures), and that operational changes should not pose undue biological risks over the long term, PECO submitted a long-term monitoring plan at zero (no) cooling tower operation. This Study Plan (Normandeau Associates, 1997b), incorporated agency's comments and recommendations, provided for a three year monitoring program (1997-1999). The selected monitoring duration increased the probability of observing the potential effects of a wide range of conditions, and included contingencies in the unlikely event of unusual thermally-related fish activity. The PADEP approved and incorporated the Study Plan in an amendment for zero tower operation, in the Station's NPDES permit.

This report presents the results of thermal profiling and fish community monitoring in Conowingo Pond in June through October 1999; the final year of the three year monitoring program. Results of 1997 and 1998 monitoring were reported earlier (Normandeau Associates 1998, 1999).

2.0 METHODS

2.1 General Scheme

The basic technical approach involved sampling at selected stations in Conowingo Pond at zero cooling tower operations within one week in each month (June through October 1999). Fish sampling occurred once and thermal plume mapping twice each sampling week. All surveys were conducted at prevailing river flow and temperature conditions in the last full week of each month and were completed in 4 to 5 days.

Sampling effort was concentrated in the vicinity of PBAPS to better delineate the effects, if any, of zero tower operation on relative abundance and distribution of fishes. A similar approach, with concurrence of resource agencies, was taken in 1974-1976 to delineate the areas of fish avoidance in the vicinity of PBAPS and then again in 1993, 1995 and 1996 summer to evaluate thermal effects. The same field sampling protocols utilized during the pre-operational and post-operational periods and in 1997-1998 were used in 1999. A general description of the thermal mapping and fisheries protocols employed are provided below.

In addition to fisheries collections, reconnaissance surveys of the areas upstream and downstream of the discharge were conducted in July and August, in conjunction with weekly dissolved oxygen surveys requested by the PFBC. The surveys were conducted to document any potential fish stress as a result of zero tower operation, particularly in light of the hundreds of thousands of additional fish lifted into the Pond via operation of the fish passage facilities at Conowingo Dam.

2.2 Thermal Plume and Dissolved Oxygen (DO) Profiling

Synoptic boat based surveys were conducted twice each fisheries sampling week to delineate the spatial extent of the thermal plume. These surveys were usually conducted at the beginning and end of each sampling week; one survey was conducted in an upstream to downstream direction and the other downstream to upstream. As shown in Table 2-1 and Figure 2-1, most transects selected for this monitoring were located downstream of the PBAPS discharge. Additionally, as requested by the PFBC, two sets of DO profiles (AM and PM) were taken one day a week (July and August) at selected locations (east shore, mid-pond and west shore stations) on the Fishing Creek, Burkins Run, and Williams Tunnel transects to provide an indication of near-field diurnal variation in DO. Most AM profiles were initiated between 0600-0800 hr, while the PM profiles were conducted between 1400-1700 h.

At each transect location, water temperature and dissolved oxygen (DO) were measured at 5 ft intervals from the surface to bottom using Yellow Springs Instrumentation (YSI, Model 57 meters). The meters were calibrated/checked at each transect (the DO probes against the known solubility of oxygen in air saturated water, and the thermistors against an NIST certified traceable thermometer). Instrument operation and maintenance quality control checks were performed initially and at monthly intervals throughout the study. Measurements were recorded on standardized field forms (DO to the nearest 0.1 mg/l and water temperature to the nearest 0.2-0.3°C).

DO and water temperature measurements on each sampling date were also complemented with daily temperature and river flow data (obtained from Holtwood Dam located about 7 miles upstream of PBAPS) and daily operational data from PBAPS (power level, condenser inlet and outlet temperatures, and temperature at the discharge canal outfall to Conowingo Pond). As in the case of fish sampling, extensive monitoring of thermal conditions (via hourly measurements and boat-based surveys) occurred during the pre-operational and post-operational periods. Detailed statistical analyses of these data, establishing the magnitude of natural variations and temperature rise due to power plant discharge, are provided in Purdy and Silver (1975a,b,c,d).

2.3 Fisheries Sampling and Reconnaissance Surveys

Fishes were sampled by seine, trawl, and trap net at selected locations with emphasis on locations clustered in the vicinity of PBAPS (Tables 2-2 through 2-6; Figures 2-2 through 2-6). These locations were also sampled during the pre- and post-operational periods (1966-1973 and 1974-1987, 1993, 1995, 1996, 1997 and 1998, respectively). Similarly, electrofishing occurred at sites that had been sampled earlier.

Sampling with each gear type occurred once during the monthly sampling week. A complete sampling event consisted of the following: one set of seine collections; 48 hours of trap netting; trawl collections at Zones 405 and 408 and Transects 2, 4, and 7; and one set of electrofishing. A description of each gear type and the disposition of the catch are given below.

2.3.1 Electrofishing

Electrofishing was conducted at night at four stations (Table 2-2; Figure 2-2). Stations 161 and 190 are influenced by the thermal discharge from PBAPS. The electrofishing system consisted of a Coffelt VVP-15 variable voltage pulsator, powered by a 3.5 kW generator, and mounted in a 18 ft aluminum boat equipped with flood lights. Fishes were collected using pulsed DC current to minimize fish injury.

Data recorded for each station included weather, date, time (start and end), air and surface water temperatures, voltage, and amperage. Sampling at each location consisted of a 30 minute run and was typically completed in one pass. The boat-mounted boom shocker was maneuvered slowly through the site, as close to shore as possible. Stunned fish were netted at the bow and placed in a live well. Large stunned specimens of common carp and quillback were not netted, but were counted by the netting crew and recorded. At the end of 30 minutes, the boat was returned to the center of the station, and the catch processed. Each fish was identified to species, fork length (FL) measured to the nearest mm, and released. When a collection contained more than 10 specimens of a single species, they were measured to the nearest 10 mm FL. If a collection contained more than 50 specimens of a single species, a subsample of 50 specimens was selected for individual processing, and the remainder counted and released.

2.3.2 Seine

Seining was conducted at seven shoreline stations (Table 2-3; Figure 2-3). Station 214 is located within the PBAPS thermal plume. Data recorded at each station included weather, date, time (start and end), air and surface water temperatures, and estimated water depth. A 10 x 4 ft straight seine with ¼ inch mesh was used. The seine was deployed and moved parallel to shore for a short distance, then moved into shore to trap fish. Since size and habitat of seine stations varied, effort was made to collect a representative qualitative sample based on complete coverage of all available habitats, rather than a specific number of hauls at each station.

All specimens were identified, counted, and released near the capture site. Specimens that were too small to accurately identify in the field to the species level were only identified to the genus level. This was particularly pertinent to small sunfishes and clupeids.

2.3.3 Trap Net

Trap nets were set at four locations (Table 2-4; Figure 2-4). Station 110 is within the PBAPS thermal plume. Data recorded at each station included weather, date, time (set and retrieve), Secchi disc transparency, air temperature, water temperature at the surface, 5 ft, 10 ft, and bottom, and water depth. The trap net consisted of a 3 x 6 ft trap with a 3 x 50 ft lead of ½ inch square mesh. Trap nets were set with the lead perpendicular to the shoreline. After 24 hours the nets were retrieved, the catch removed and processed, and reset for a second 24 hour period. All specimens in each collection were identified, measured to the nearest mm FL, and released. When a collection contained more than 10 specimens of a single species, they were measured to the nearest 10 mm FL. If a collection contained more than 50 specimens of a single species, a subsample of 50 specimens was selected for individual processing, with the remainder counted and released.

2.3.4 Trawl

Trawl surveys were divided into zones and transects. Two zones (405 and 408) and three transects (2, 4, and 7) were sampled (Figures 2-5 and 2-6). Zone 405 is affected by the thermal discharge while Zone 408 is considered a control (non-affected). Each zone consisted of three near-shore and three off-shore locations, while each transect was composed of an east shore, mid-pond, and west shore station. Transect Station 371 is influenced by PBAPS discharge. A description of all stations is found in Tables 2-5 and 2-6. Data recorded during each survey included weather, date, time (start and end), Secchi disc transparency, air temperature, water temperature at the surface, 5 ft, 10 ft, and bottom, and water depth. A 16 ft semi-

balloon trawl with ¼ inch mesh liner in the cod end was used to sample the zone and transect stations. The trawl was deployed off the stern of the boat and hauled for 10 minutes in an upstream direction. A minimum of 7 minutes was required for the haul to be considered valid. After 10 minutes the trawl was retrieved, the boat was returned to the center of the station, and catch was removed from the net and processed. All specimens in each collection were identified, measured to the nearest mm fork length, and released. When a collection contained more than 10 specimens of a single species, they were measured to the nearest 10 mm FL. If a collection contained more than 50 specimens of a single species, a subsample of 50 specimens was selected for individual processing, with the remainder counted and released.

2.3.5 Reconnaissance Surveys

In conjunction with weekly DO profiling in July and August, fish reconnaissance surveys were conducted throughout Conowingo Pond, from near Holtwood Dam downstream to Conowingo Dam. These boat-based surveys were performed specifically to document occurrences of any unusual thermally related fish activity. The surveys were conducted as precautionary measures due to the co-occurrences of relatively low and warm river inflows, zero tower operation at PBAPS, and the introduction of nearly 1,200,000 fish into the Pond during spring operations at the Conowingo Dam fish passage facilities.

2.4 Data Analysis

Thermal and DO profiling, fisheries sampling, and related data were electronically processed and verified prior to analysis. For representation of average thermal conditions at transect locations during the fish sampling week each month, the profile data were pooled.

Fisheries data from each gear types were compiled and expressed as catch per unit effort (CPE) by station, and month. Seine catches were expressed as number of each species per collection, while trap net catches were expressed as number of each species captured per 24 hours. The trawl data (transects and zones) are presented as number of each species per 10 minute haul, with electrofishing data expressed as the number of fish captured per 30 minutes.

For delineating the potential effects of zero tower operation on the fish community structure, indices of diversity and similarity were calculated as had been done in earlier pre- and post-operational studies for PBAPS.

Species diversity indices (D) were calculated by the Shannon-Weaver (1948) method using the formula:

$$D = -\sum_{i=1}^{S} P_i \mathrm{Log}_2 P_i$$

where D is the species diversity index, S is the total number of species collected, and P_i is the proportion of a species in the sample. However, results are not directly comparable since the number of species vary between populations. In order to equalize all values so they are comparable, evenness values were also calculated using the formula:

$$H_{max'} = \log S$$

where S is the number of taxa.

Evenness values have a range from 0 to 1.0 with 1.0 being the maximum equality for a community.

Index of percent similarity (Whittaker and Fairbanks, 1958) was calculated to determine the similarity in species composition between stations and month. This index was calculated as follows:

$$PS_c = 100 - 0.5 \sum |a - b|$$

where PS is the percent similarity, a and b are percentages of a species at station A and B. Similarity values range from 0 (no similarity) to 100% (complete similarity). This index can be used to identify those stations that are most and least similar with respect to community structure.

Data analyses were performed utilizing SAS and Microsoft Excel software.

Table 2-1

Description of thermal mapping locations sampled in the vicinity of PBAPS, June through October 1999.

Location/ Station Number	Description	Mean Depth (ft)
	Holtwood Dam	
100	PP&L's water temperature monitor located off the upstream end of the skimmer wall (about 7 miles upstream of the PBAPS intakes)	-
	PBAPS	
001	Units 2 and 3 - condenser inlet water box temperature monitors	-
002	Units 2 and 3 - condenser outlet water box temperature monitors	-
009	Discharge canal - end of berm/outfall to Conowingo Pond	-
	Conowingo Pond	
Fishing Creek Transect (located approximately 1 mile upstream of PBAPS intake)		
101*	West shore, approximately 200 yards off Rollins Point	18
102*	Mid-pond, off the mouth of Fishing Creek	15
103*	East shore, approximately 200 yards off the mouth of Fishing Creek	5
Burkins Run Transect (located approximately 600 yards downstream of PBAPS outfall)		
201*	West shore, approximately 75 yards off the mouth of Burkins Run	13
202	About 500 yards off west shore mid-way between Stations 201 and 203	14
203*	Mid-pond off the mouth of Burkins Run	15
204	About 500 yards off the east shore mid-way between Stations 203 and 205	15
205*	East shore, approximately 75 yards off shore	5
William's Tunnel Transect (located approximately 1.2 mile downstream of PBAPS outfall)		
301*	West shore, approximately 75 yards off McClellan's Rock	23
302	About 600 yards off west shore, mid-way between Stations 301 and 303	16
303*	About 600 yards off east shore, mid-way between Stations 302 and 304	16
304*	East shore, approximately 75 yards off William's Tunnel	30
PA/MD Stateline Transect (located approximately 2 miles downstream of PBAPS outfall)		
401	West shore, approximately 75 yards off shore and 500 yards downstream of the mouth of Michael's Run	13
402	About 500 yards off west shore, mid-way between Stations 401 and 403	24
403	About 500 yards off east shore, mid-way between Stations 402 and 404	19
404	East shore, approximately 75 yards off Frazer Tunnel	40

* DO profiling (AM and PM) locations.

Table 2-2

Location of electrofishing stations sampled in Conowingo Pond, June through October 1999.

Station	Description
161	PBAPS discharge structure to approximately 500 yards downstream.
164	Southwest shoreline of Mt. Johnson Island.
165	East shoreline above Peters Creek.
190	Mouth of Michaels Run to 500 yards downstream.

Table 2-3

Location of seine stations sampled in Conowingo Pond, June through October 1999.

Station	Description
202	Southeast shore of Sicily Island.
203	West shore of Big Chestnut Island.
208	Peach Bottom Beach.
209	Broad Creek at the boat launch.
210	Conowingo Creek at the boat launch.
212	Fishing Creek at the first road bridge upstream from the mouth.
214	Beach at the mouth of Burkins Run.

Table 2-4

Location of trap net stations sampled in Conowingo Pond, June through October 1999.

Station	Description
104	100 yards directly off-shore from the PBAPS Unit 1.
107	At the mouth of Broad Creek.
108	50 yards above the mouth of Conowingo Creek.
110	Off Burkins Run (Stonewall Point).

Table 2-5

Location of Stations 451 to 456 in Trawl Zone 405 and Stations 481 to 486 in Trawl Zone 408 in Conowingo Pond sampled in June through October 1999. Trawls made at near-shore stations are indicated by odd numbers and off-shore stations by even numbers.

Station	Location
	Zone 405
451 & 452	From a point off Stonewall Point to a point at the terminus of the PBAPS Discharge Canal (as of 1970 construction). Sampling is done on the river side of the canal and not in the canal.
453 & 454	From a point approximately 50 yards upriver from the terminus of the PBAPS Discharge Canal (as of 1970 construction) to a point off the PBAPS Unit 1.
455 & 456	From a point off PBAPS Unit 1 to a point just above PBAPS Units 2 and 3.
	Zone 408
481 & 482	From a point approximately 300 yards below Peach Bottom Beach to a point off Peach Bottom Beach.
483 & 484	From a point off Peach Bottom Beach to a point off the former Ichthyological Associates dock.
485 & 486	From a point off the former Ichthyological Associates dock to a point off the mouth of Peters Creek.

Table 2-6

Location of trawl transect stations sampled in Conowingo Pond, June through October 1999.

Transect	Location
	Transect 2
321	Off PBAPS Unit 2.
322	Mid-pond between Mt. Johnson Island and PBAPS.
323	Below Mt. Johnson Island.
	Transect 4
341	Broad Creek.
342	Mid-pond off Broad Creek.
343	Wildcat Tunnel.
	Transect 7
371	Burkins Run (Stonewall Point).
372	Mid-pond between Burkins Run and the former Ichthyological Associates dock.
373	Ichthyological Associates Dock.

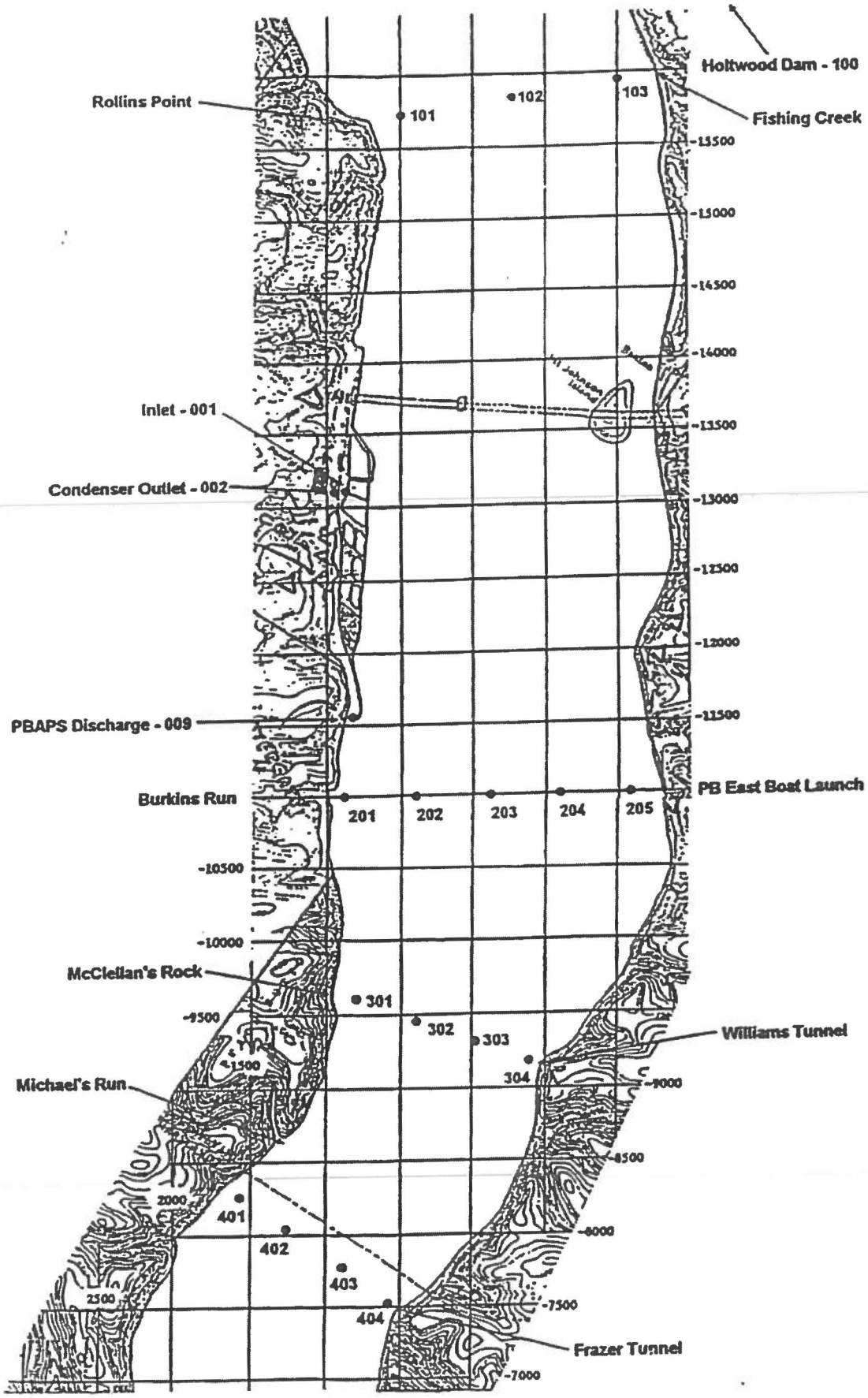


Figure 2-1

Thermal profiling locations in the vicinity of PBAPS.

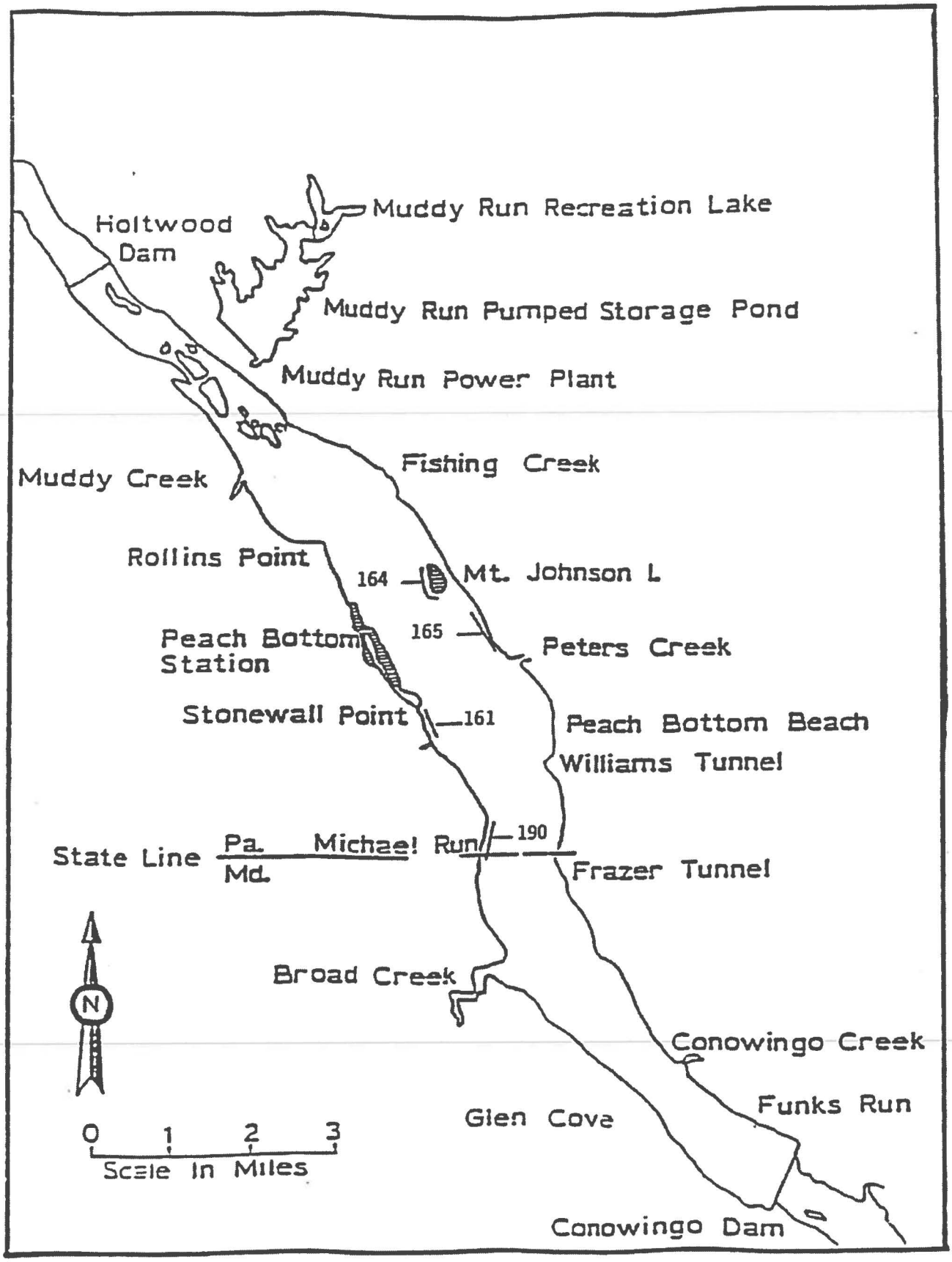


Figure 2-2 Map of Conowingo Pond showing distribution of electrofishing stations.

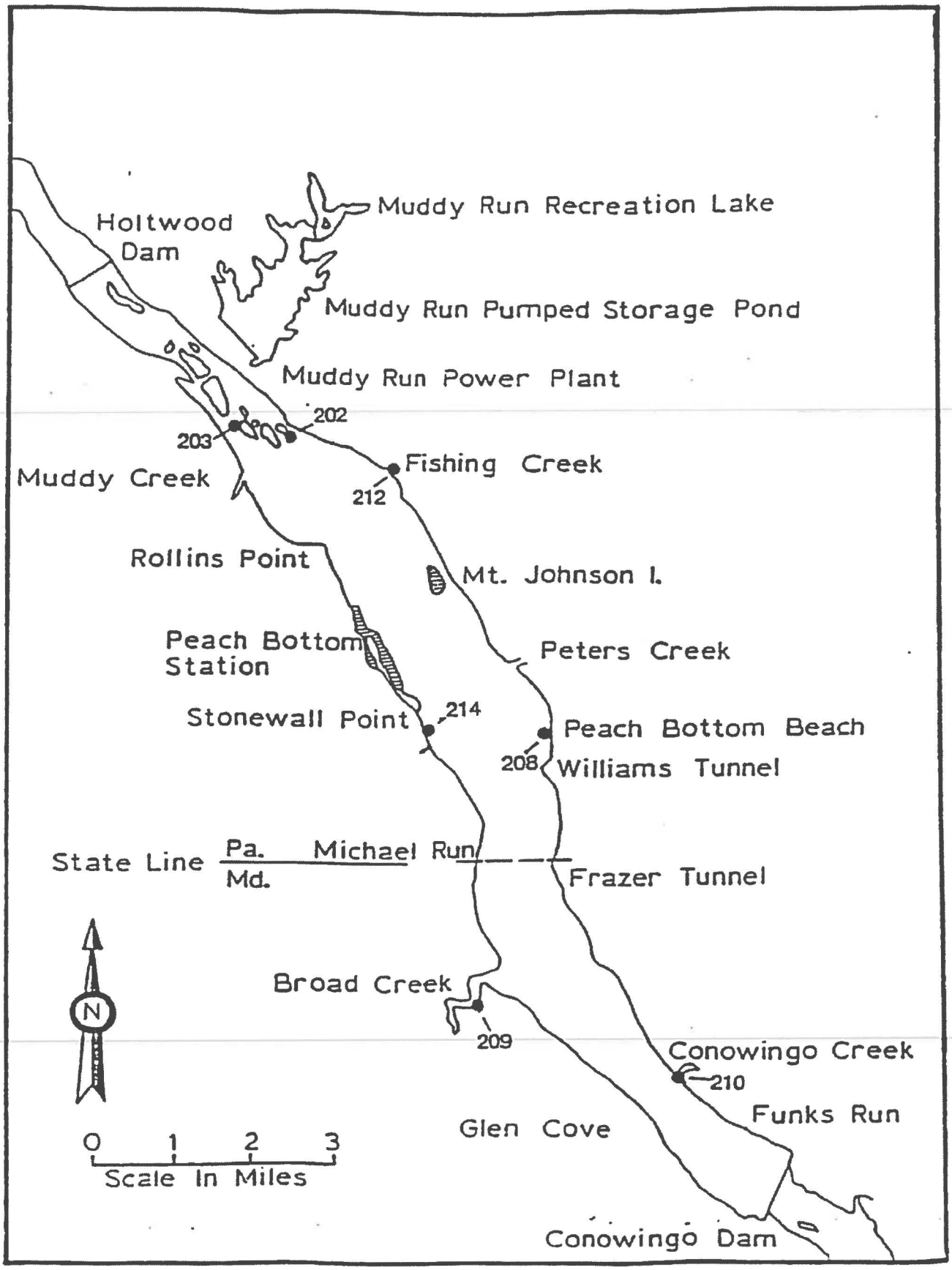


Figure 2-3 Map of Conowingo Pond showing distribution of seine stations.

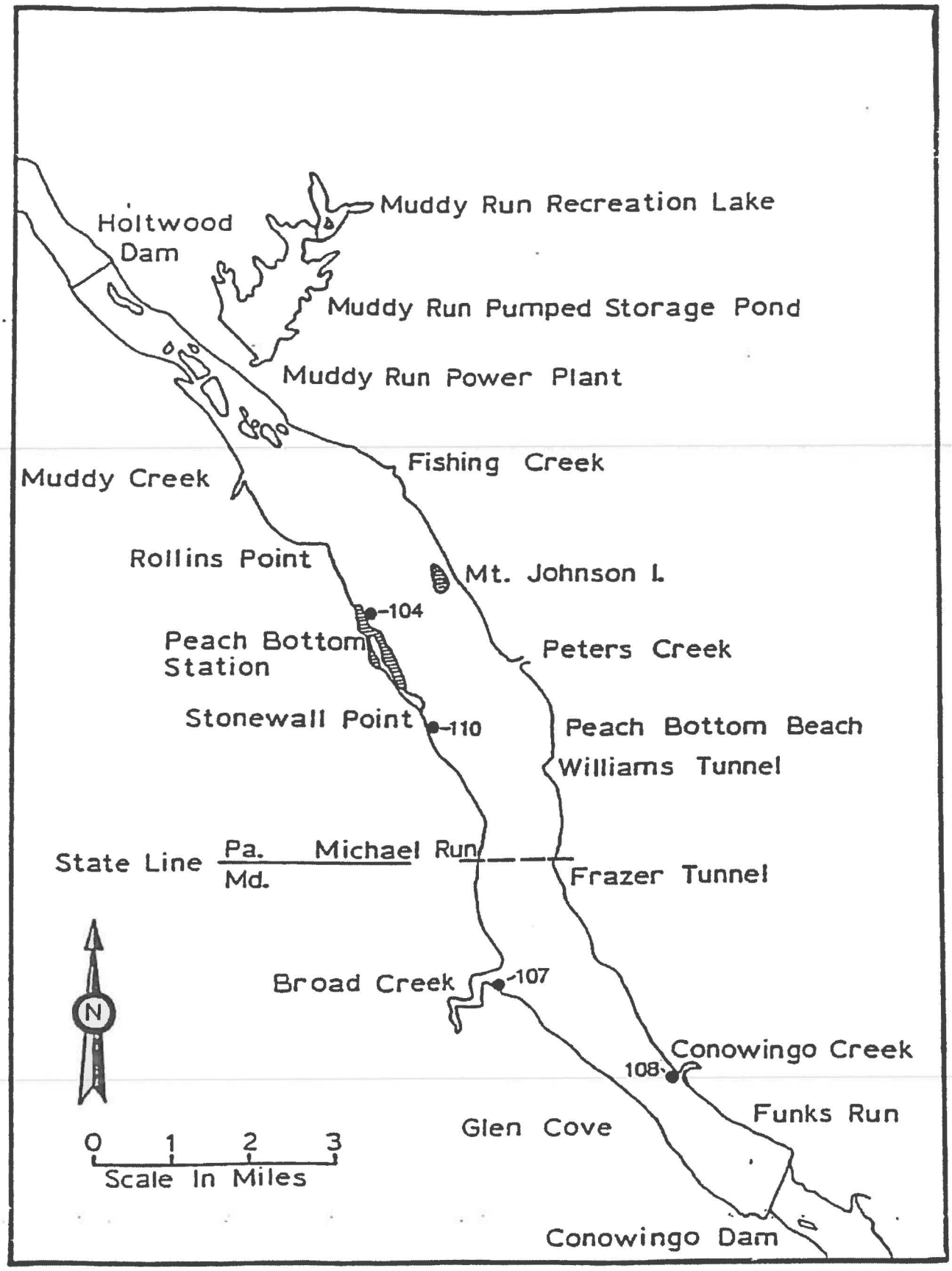


Figure 2-4 Map of Conowingo Pond showing distribution of trap net stations.

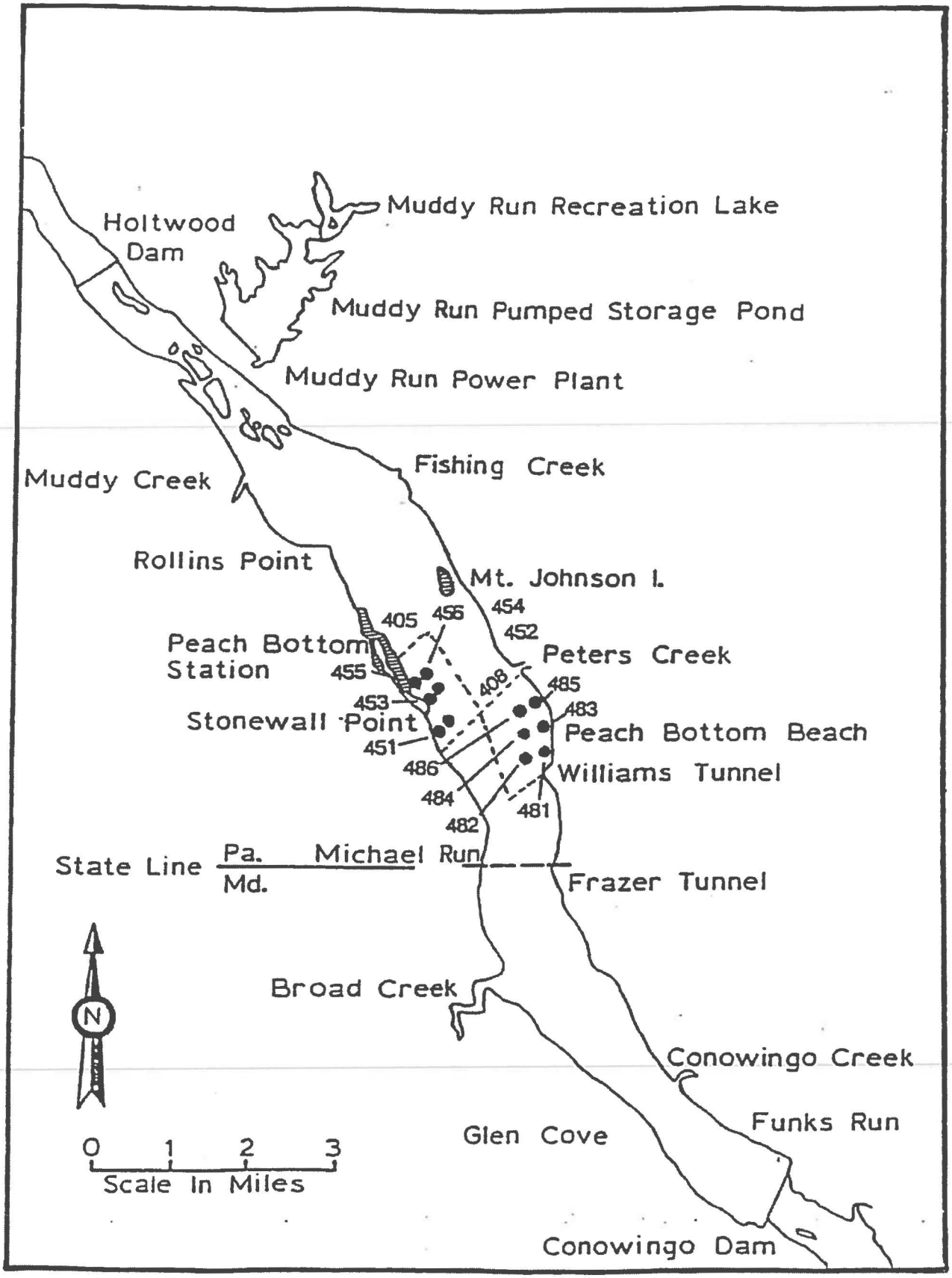


Figure 2-5 Map of Conowingo Pond showing distribution of stations in trawl zones 405 and 408.

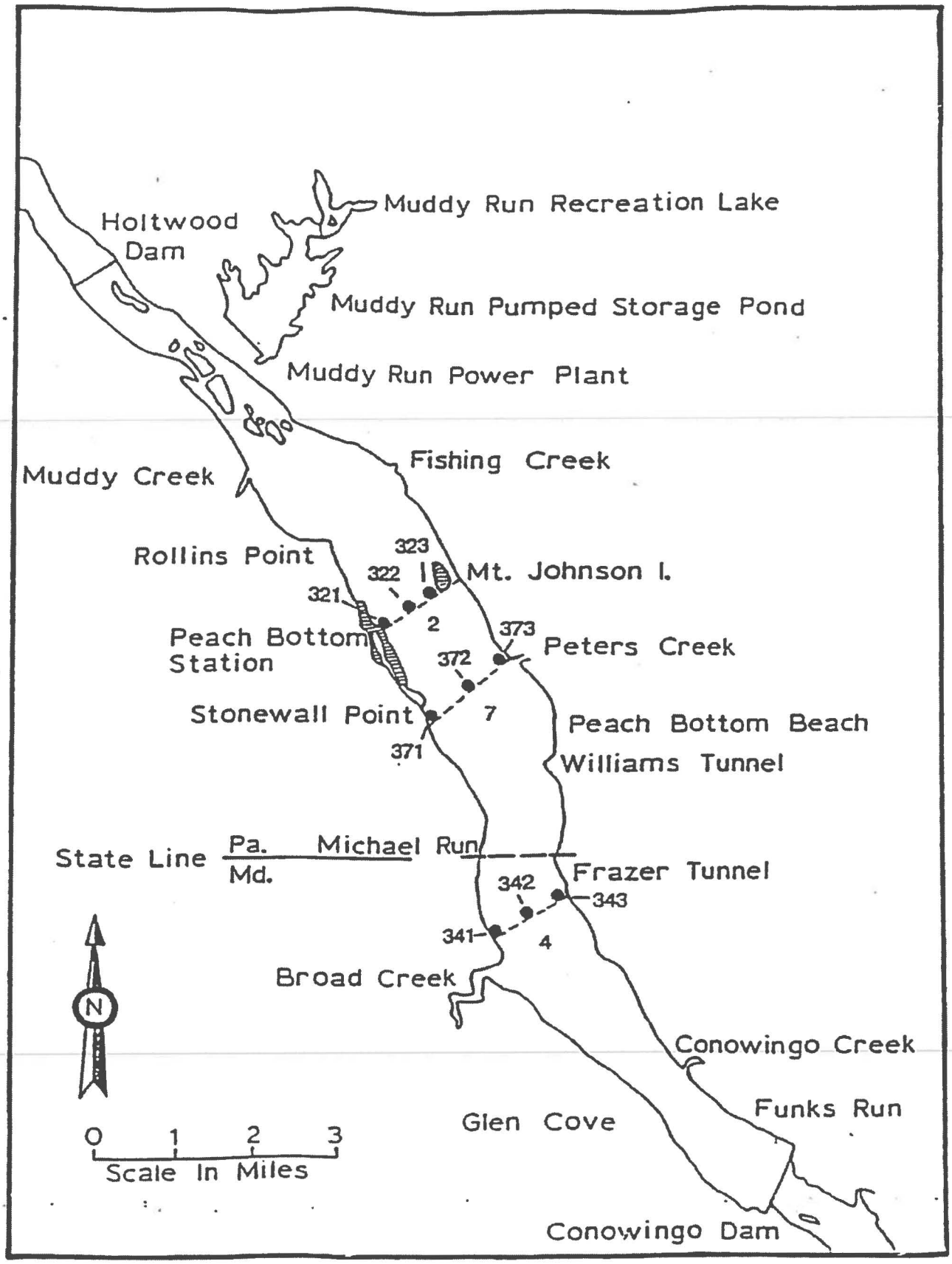


Figure 2-6 Map of Conowingo Pond showing distribution of stations in trawl transects 2, 4, and 7.

3.0 RESULTS

3.1 Study Conditions

Thermal profiling and fishery surveys were conducted at prevailing river temperatures and flows, and operational and thermal conditions at PBAPS. Table 3-1 provides a summary of the conditions experienced in each month. These conditions varied throughout the study.

3.1.1 Natural River Flow and Temperature

3.1.1.1 River Flow

During the study, average daily river flows, as measured at Holtwood Dam, ranged from 2,200 cfs (13 August) to 54,400 cfs (18 September), with the monthly mean value highest in September (26,430 cfs) and lowest in July (4,994 cfs; Table 3-1). Except in September and October, the mean river flow for each monthly survey week was ≤6,800 cfs in June-August. In September and October, the mean survey river flow was 26,780 and 10,840 cfs, respectively.

Compared to the historical flow record (1952-1998), average daily river flow in June 1999 was the lowest recorded for that month, as was that for May 1999 (Table 3-2). While not the lowest in the historical period, mean daily flows in July and August 1999 were the lowest for those months in the past 33 years, with flow for the period May-October 1999 the second lowest. Although river flows exceeded 20,000 cfs less than 25% of the time historically and in 1999; flows <10,000 cfs occurred nearly 65% in 1999 versus 42% of the time historically (Figure 3-1). The occurrence of flows <10,000 cfs in 1999 was similar to that in 1997 (the initial study year at zero tower operation) and greater than that in 1998 (the second study year). As in 1997 and 1998, river flows in 1999 were also much lower than flows in 1996 (the pilot study year for evaluating tower operation scenarios). River flows <10,000 cfs rarely occurred in 1996, with no values <7,500 cfs (Normandeau Associates, 1997a). Flow duration curves showing the historical versus 1997 to 1999 comparisons by month are provided in Appendix A.

3.1.1.2 River Temperature

Average daily river inflow temperatures, as measured at Holtwood Dam (Table 3-1), ranged from 53.2°F (31 October) to 85.9°F (8 July). Mean inflow temperatures were ≥80°F for the survey conducted in July (84.4°F), 74.9°F in June, 78.8°F in August, 65.6°F in September and 53.9°F in October. On a monthly basis, mean values were highest in July followed by August, June and September, and lowest in October.

Compared to the historical June-October record (1956-1998), average daily inflow temperatures in 1999 were slightly lower (Figure 3-2). In both periods, inflow temperatures exceeded 80°F nearly 32% of the time, while the occurrence of temperatures in the range of 65 to 80°F was higher in 1999, and higher historically for temperatures >85°F. Compared to 1997 and 1998, inflow temperatures were slightly cooler in 1999.

Because water temperature and river flow are important influencing variables, an analysis of their joint occurrence was performed to provide a perspective on conditions that fishes experienced historically, in 1999, and in 1997-1998. Table 3-3 provides the results of this analysis for the entire period of June through October. Appendix A shows the same analyses for each month.

Historically, although water temperatures ≥80°F occurred 35% of the time in June-October, they coincided with river flows <10,000 cfs nearly 21% of the time (Table 3-3). In 1999, the occurrence of water temperatures ≥80°F was less (32% of the time), but jointly occurred with river flows <10,000 cfs nearly 32% of the time. In contrast, these temperature and flow conditions jointly occurred less than 5% of the time in 1996 (Normandeau Associates, 1997a). In addition, the overall occurrence (and joint occurrence with flows <10,000 cfs) of water temperatures ≥80°F in June-October 1999 was greater than that which occurred in 1997, 1998, and in 1995 (the most recent period of high temperatures and near historic low river flows when cooling towers were in operation at PBAPS). In 1995, water temperatures ≥80°F occurred jointly with flows <10,000 cfs about 29% of the time (Normandeau Associates, 1997a).

3.1.2 PBAPS Operational and Thermal Conditions

3.1.2.1 Power Output

The average daily power output ranged from 0 to 200% (the sum of both units) during the study period (Table 3-1). The station was operated at the maximum level of power achievable based on available fuel supplies.

Figure 3-3 shows the weekly average power output in June-October 1999. Overall, maximum output (near 200%) declined in summer to near 150% in late September due to fuel depletion during the Unit 3 end of cycle coast down. . Except in early October when both units were shutdown, Unit 2 remained operational at 100% power during the Unit 3 refuel outage (30 September to 29 October). Full load (>195%) was restored by 1 November.

End of cycle coast down of one unit is an annual operational occurrence in spring to summer. As a result, the total power output of the station is less than the maximal 200% (Table 3-4).

3.1.2.2 Inlet (Intake) Temperatures

During the study, the daily average temperature at the PBAPS inlet ranged from 54.4°F (27 and 28 October) to 86.5°F (1 August) (Table 3-1). Overall, daily inlet temperatures were highest in July (79.7-86.3°F, with values >80°F on 30 of the 31 days) followed by August (76.6-86.5°F, with values >80°F on 21 days), and June (72.6-81.6°F, with values >80°F on 4 days) and lowest in October (54.4-66.9°F). Except for one day (2 July), inlet temperatures exceeded 80°F for a 56 consecutive day period (27 June-21 August). In July-August 1999 inlet temperatures ≥83°F occurred on 35 days compared to 3 and 13 days in 1997 and 1998, respectively (Normandeau 1998, 1999).

Compared to corresponding river inflow temperatures measured at Holtwood Dam, inlet temperatures followed a similar pattern, but were generally higher (1 to 4°F) in June to August, with differences less than 1°F in September and October (Figure 3-4).

3.1.2.3 Condenser Outlet and Discharge Temperatures

Condenser outlet temperatures reflect the warmest water available for discharge at PBAPS, the magnitude of which is dependent on the inlet water temperature and power output/heat loads. Excluding early October when both units were shutdown, daily condenser outlet water temperatures ranged from 68.3 to 107.2°F, with survey and monthly mean values highest in July, followed by August, June and September, and lowest in October (Table 3-1). Corresponding average daily condenser ΔT's were 12.3 to 24.0°F based on the number of units and circulating water pumps in operation. The ΔT's in late September and late October (Figure 3-3) were 4-6°F higher than normal due to the removal from service (for preventative maintenance) of one of the three Unit 3 main condenser circulating cooling water pumps. Following the shutdown of Unit 3, mean condenser ΔT's in October were 17-20°F when Unit 2 operated at 100% power and three circulating water pumps (which represents half the total condenser outflow volume when both units are operating). Compared to 1993-1998, the decline in condenser ΔT's and power levels (when the units operated with six pumps) in 1999 was less than that observed in 1993-1998 (Table 3-4). The power levels and subsequent condenser ΔT's remained higher in 1999 as coast down started later and condenser cooling (heat transfer) was not as efficient due the warm ambient (inlet) cooling water temperatures (83-87°F) in July-August.

Water temperatures at the end of the discharge canal (outfall) represent the warmest water discharged to Conowingo Pond, the magnitude of which is dependent on the station power output/heat load and the number of circulating water pumps operating. In 1999, the daily average temperature of water discharged to Conowingo Pond ranged from 66.7 to 106.5°F (Table 3-1).[1] Except for some minor

[1] As is evident in Table 3-1, some mean and/or range values given for the PBAPS discharge temperatures differ slightly from the corresponding condenser outlet value. These differences are attributed primarily to the measurement process for each location. Average daily condenser outlet temperatures reflect the mean of hourly measurements recorded to the nearest 0.1°F via multiple thermistors placed at the outlet side of unit condensers, while the discharge temperature is the average of six readings per day (each taken at 4 hr intervals and recorded to the nearest 1°F).

differences, the average daily discharge temperature generally approximated the average condenser outlet temperature throughout most of the study period (Figure 3-5). A summary of observed discharge ΔT's (canal outfall temperature minus the inlet temperature) is provided in Figure 3-6. Except in September and late October when only 5 circulating water pumps were in operation at power, discharge ΔT's generally were less than the predicted design ΔT of 20.8°F.

3.2 Thermal and Dissolved Oxygen Conditions in Conowingo Pond

3.2.1 Thermal Conditions

Thermal profiling was conducted on 11 weeks in June through October 1999 to evaluate the areas in Conowingo Pond affected by the thermal discharge. The number of locations profiled on each transect included three for Fishing Creek, five for Burkins Run, and four each at Williams Tunnel and the PA/MD State Line (Table 2-1; Figure 2-1). However, for brevity, only data from three locations on each transect downstream of the discharge are utilized in subsequent presentation and discussion. The locations selected were considered representative of thermal conditions observed across each transect: western area of Conowingo Pond, mid-pond, and eastern area. Respectively, the selected locations include Stations 201, 203, and 205 on the Burkins Run transect, Stations 301, 303, and 304 on the Williams Tunnel transect, and Stations 402, 403, and 404 on the PA/MD State Line transect. On the latter transect, Station 402 was considered more representative of thermal, flow, and depth conditions along the west shore than Station 401. Station 401 was shallower and slightly cooler, perhaps influenced by inflow from Michael's Run (located approximately 500 yds upstream).

The magnitude of the effect of the thermal discharge was evaluated by examining the differences in absolute temperature, or ΔT's (temperature at location/depth minus the corresponding PBAPS inlet temperature).

Table 3-5 provides these differences by locations and depths for selected weeks in June through October 1999. Overall, the influence of the heated discharge from PBAPS, which dissipated rapidly within the two miles downstream to the State Line, was most evident at the West location on the Burkins Run transect, followed by the West and Mid-pond location on the Williams Tunnel transect. In addition, the heated effluent was limited to the top 5 to 15 ft of the water column, with the warmest water at the surface, at affected locations. Except at the West location on the Burkins Run transect, temperature differences between depths greater than 5 to 15 ft usually were within 2 to 4°F of that at the inlet. The highest temperatures in the water column occurred at the Burkins Run West surface location (ΔT's varied from 7.5 to 13.9°F), with ΔT's at the bottom typically 2 to 4°F less than those at the surface. Compared to the PBAPS inlet values, surface values at locations across the State Line transect were 2.1 to 7.1°F higher, with ΔT's in most weeks ≤4°F. The differences in ΔT's among other locations and depths on transects downstream of the PBAPS discharge as well as the locations on the upstream transect (Fishing Creek), generally were <3°F.

Table 3-6 provides a general comparison of profile water temperatures measured at common locations (west shore) downstream of the PBAPS in August and September in 1995 (when a minimum of three towers operated and when high water temperatures coincided with low river flows) and in 1999 (zero tower operation). In August, daily river flows most often were <6000 cfs and daily intake temperatures >81°F in both years. In September 1995, daily temperatures were higher and daily inflows lower than observed in 1999. The prevailing river flows in August 1999 were the lowest experienced in August in the past 33 years, whereas those in 1995 were the second lowest. In August, discharge temperatures were higher at zero tower operation (1999) versus multiple tower operation (1995). However, the general effect of the higher discharge temperature on the vertical distribution of temperature at locations downstream of the discharge was not as readily apparent. Overall, at zero tower operation (1999) temperature profiles at downstream locations (particularly at Williams Tunnel and the State Line locations) were similar to those under multiple tower operations (1995). Although the mean discharge temperature in September was the same in both years, water temperatures at locations downstream of the discharge were lower in 1999 due to the higher and cooler inflow conditions.

3.2.2 Dissolved Oxygen (DO) Conditions

DO profiling was conducted in conjunction with thermal surveys, and in July through August included two sets of profiles (AM and PM) on a weekly basis at west, mid-pond, and east locations on three transects (Fishing Creek, Burkins Run, and Williams Tunnel) as requested by the PFBC. The locations used in subsequent presentation are the same as those selected above for thermal profiling. As appropriate, corresponding values at depth from locations on a given transect were pooled to represent DO conditions and trends observed during the study period.

Figure 3-7 summarizes weekly DO (surface and bottom) conditions. Overall, DO varied seasonally and was higher at the surface than at the bottom, trends commonly observed in the historical period (RMC, 1985) and in temperate waters. In most weeks, surface DO values were >7 mg/l, differences between transects usually were <1 mg/l, and DO was not consistently higher or lower at any given transect (Table 3-7). However, corresponding bottom DO values were lower in June-August, particularly at the deeper water stations along the east shore on Williams Tunnel and the State Line transects. During this period, mean bottom DO was <5 mg/l, while values exceeded 5 mg/l at other times. At the Fishing Creek transect (located upstream of PBAPS) and Burkins Run transect (located just downstream of the PBAPS discharge) DO values in bottom waters remained >5 mg/l throughout the study period. Overall, bottom DO was consistently higher at the Burkins Run and Fishing Creek transects, and lowest at the State Line transect.

Although mean bottom DO was usually lower than corresponding surface values (Table 3-7), the magnitude of difference in most weeks was <2 mg/l at the Fishing Creek Transect, <1 mg/l Burkins Run Transect, while differences exceeded 3 mg/l at the Williams Tunnel and State Line transects. The weekly mean value for each of these transects reflected the contribution of the low bottom DO in the deeper waters primarily along the eastern shore (Station 304 on the Williams Tunnel transect and 404 on the State Line transect). Overall, DO in bottom and near bottom waters at theses locations in summer 1999 generally was lower than conditions observed in 1997 and 1998 (Normandeau 1998,1999). The lower DO conditions in 1999 were attributed to the extended period of record low inflows in May-August.

3.2.3 Diurnal Variations in DO

In July through August the weekly survey included two sets of profiles (AM and PM) at selected locations on the Fishing Creek, Burkins Run and the Williams Tunnel transects to evaluate diurnal variations. These profiles were taken to evaluate the potential near-field effects of zero tower operation on diurnal variations in DO. Figure 3-8 provides a comparison of the AM and PM mean DO values at the surface and bottom on sampled transects. Throughout the period, surface PM values were higher than corresponding AM values at transects located downstream of the PBAPS discharge (Burkins Run and Williams Tunnel), while the same occurred in most sampled weeks at the upstream Fishing Creek transect. Generally, the difference between surface AM and PM values was within 1 to 3 mg/l, with slightly higher values at transects located downstream of the PBAPS discharge. During most survey weeks, diurnal variation in DO was also evident in bottom waters. However, the difference between AM and PM values at the bottom was usually less than that observed in surface waters.

Overall, under the warm water temperature and record low river flow conditions experienced in summer 1999, DO conditions in the study area were good and reflected seasonal, spatial, and diurnal variations observed under similar flow and temperature conditions historically (RMC, 1985).

Table 3-1

Summary of the mean and range of daily plant power output, temperature conditions, and river flows and temperatures (measured at Holtwood Dam) during thermal and fish population surveys conducted at zero tower operations at PBAPS, June-October 1999.

	June	July	August	September	October
Survey Period (Week of)	20 Jun	25 Jul	22 Aug	19 Sep	24 Oct
Power Output (%)[1]					
Survey Mean	200	199	190	180	129
Survey Range	199-200	198-200	183-193	179-181	102-184
Monthly Mean	197	198	193	172	92
Monthly Range	168-200	169-200	165-199	80-189	0-196
Inlet Temperature (°F)					
Survey Mean	76.3	85.1	79.1	65.2	54.5
Survey Range	74.7-78.0	84.7-86.3	78.7-79.5	64.6-66.1	54.4-54.8
Monthly Mean	77.2	83.6	82	71.7	59.4
Monthly Range	72.6-81.6	79.7-86.3	76.6-86.5	64.6-79.3	54.4-66.9
Condenser Outlet Temperature (°F)					
Survey Mean	96.7	105.7	98.6	87.9	71.2
Survey Range	95.1-98.4	105.2-107.2	98.2-99.1	87.1-89.5	68.3-76.7
Monthly Mean	97.6	104.2	102.2	91.1	74.5
Monthly Range	93.4-102.2	100.1-107.2	96.1-107.0	79.3-98.5	65.1-81.0
Discharge (Outfall) Temperature (°F)					
Survey Mean	96.3	104.9	98.1	87.8	70.9
Survey Range	94.7-97.8	104.3-106.5	97.8-98.5	86.5-89.0	68.5-75.7
Monthly Mean	96.9	103	101.6	91.1	74.7
Monthly Range	93.2-101.0	98.7-106.5	96.3-105.8	81.2-97.6	66.7-80.8
Actual ΔT (°F)[2]					
Survey Mean	20.4	20.6	19.5	22.7[4]	16.6
Survey Range	20.4-20.5	20.5-20.9	19.0-19.8	22.0-24.0[4]	13.6-22.1[4]
Monthly Mean	20.5	20.6	20.2	19.4	15.0
Monthly Range	18.9-21.8	19.7-20.9	19.0-21.1	12.3-24.0[4]	0.2-23.3[4]
Design ΔT (°F)[3]	20.8	20.8	20.8	20.8	20.8
River Flow (cfs)					
Survey Mean	6,160	3,720	6,800	26,780	10,840
Survey Range	5,000-7,400	3,600-3,900	5,400-10,100	21,900-30,300	10,100-11,800
Monthly Mean	7,010	4,994	5,158	19,687	19,329
Monthly Range	4,400-11,600	3,400-7,500	2,200-15,200	3,700-54,400	8,900-42,100
River Temperature (°F)					
Survey Mean	74.9	84.4	78.8	65.6	53.9
Survey Range	74.5-75.1	84.3-84.7	78.2-79.4	64.6-66.5	53.6-54.5
Monthly Mean	76.6	82.7	80.8	71.6	59
Monthly Range	72.9-79.3	78.0-85.9	76.3-84.5	64.4-78.9	53.2-67.4

1 The total station percent power output (Unit 2 & Unit 3). Maximum station output is 200% when both units operate at 100% power. The values in June through September reflect the maximum output achievable due to end of cycle coast down for Unit 3. Unit 3 was shutdown for refueling on 30 September and restored to near 100% power load in late October.

2 Actual ΔT (condenser outlet temperature minus inlet temperature) measured during the study.

3 Design condenser ΔT criteria for both units operating at 100% power with six circulating water pumps.

4 One Unit 3 circulating pump was out of service; a total of only 5 pumps were operational for 11 days at the end of September, and 7 days in late October. This resulted in a ΔT that was 4-6°F higher than what would have occurred with all pumps operating.

Table 3-2

Monthly mean river flow and water temperature at Holtwood Dam, May-October 1952-1998, and in 1995, 1996, 1997, 1998, and 1999.

Period	May	June	July	August	September	October	May-October
				Flow (cfs)			
1995 *	22,752	20,223	15,545	5,745	3,703	23,997	15,364
1996	82,229	28,833	26,368	15,942	39,813	52,487	41,017
1997	30,968	24,710	8,794	7,613	7,897	7,068	14,489
1998	75,255	26,430	22,184	7,019	4,843	7,461	23,955
1999	19,939 **	7,010 **	4,994	5,158	19,867	19,329	12,708 **
1952-1998	49,239	29,935	16,940	12,042	13,331	18,766	23,504
				Water Temperature (°C)			
1995 *	65.3	76.1	80.6	84.3	76.8	64.6	74.6
1996	61.6	77.0	79.3	81.3	72.6	59.3	71.8
1997	62.8	75.8	83.4	80.9	74.4	63.2	73.4
1998	65.6	74.5	80.0	81.3	76.7	65.6	74.0
1999	67.8	76.6	82.7	80.8	71.6	59.0	73.1
1952-1998	63.8	74.9	81.1	80.9	75.0	62.5	73.0

* 1995 is the most recent period of high water temperatures and near record low river flows when cooling towers were in operation at PBAPS.

** Mean daily river flows in May and June 1999 set a new record low for those months, while the flows for July and August 1999 were the lowest in the last 33 years.

Table 3-3

Joint occurrence of daily water temperature and river flow at Holtwood Dam, June-October 1956-1998, 1997, 1998, and 1999.

Daily Average River Flow (cfs)	Daily Average Temperature (°F) 40-49 No.	40-49 Pct.	50-59 No.	50-59 Pct.	60-69 No.	60-69 Pct.	70-79 No.	70-79 Pct.	80-85 No.	80-85 Pct.	>85 No.	>85 Pct.	Total No.	Total Pct.
						1956-1998								
< 2,500	.	.	.	.	8	0.12	11	0.17	10	0.16	9	0.14	38	0.59
2,500-4,999	.	.	22	0.34	102	1.59	219	3.42	277	4.33	108	1.69	728	11.37
5,000-7,499	.	.	59	0.92	170	2.65	283	4.42	334	5.22	138	2.15	984	15.37
7,500-9,999	.	.	35	0.55	151	2.36	267	4.17	361	5.64	71	1.11	885	13.82
10,000-14,999	.	.	67	1.05	174	2.72	481	7.51	479	7.48	41	0.64	1,242	19.39
15,000-19,999	.	.	49	0.77	116	1.81	461	7.20	228	3.56	7	0.11	861	13.44
20,000-29,999	1	0.02	42	0.66	124	1.94	483	7.54	138	2.15	1	0.02	789	12.32
30,000-39,999	.	.	19	0.30	71	1.11	227	3.54	42	0.66	.	.	359	5.61
40,000-50,000	2	0.03	27	0.42	34	0.53	103	1.61	13	0.20	.	.	179	2.80
> 50,000	20	0.31	74	1.16	119	1.86	118	1.84	8	0.12	.	.	339	5.29
Total	*23*	*0.36*	*394*	*6.15*	*1.069*	*16.69*	*2.653*	*41.43*	*1.890*	*29.51*	*375*	*5.86*	*6.404*	*100.00*
						1997								
< 2,500	.	.	.	.	.	.	.	.	.	.	.	.	0	.
2,500-4,999	.	.	.	.	1	0.65	.	.	6	3.92	.	.	7	4.58
5,000-7,499	.	.	7	4.58	17	11.11	16	10.46	15	9.80	5	3.27	60	39.22
7,500-9,999	.	.	.	.	4	2.61	11	7.19	14	9.15	2	1.31	31	20.26
10,000-14,999	.	.	.	.	5	3.27	6	3.92	16	10.46	1	0.65	28	18.30
15,000-19,999	.	.	.	.	.	.	10	6.54	3	1.96	.	.	13	8.50
20,000-29,999	.	.	.	.	3	1.96	4	2.61	.	.	.	.	7	4.58
30,000-39,999	.	.	.	.	3	1.96	.	.	.	.	.	.	3	1.96
40,000-50,000	.	.	.	.	2	1.31	.	.	.	.	.	.	2	1.31
> 50,000	.	.	.	.	2	1.31	.	.	.	.	.	.	2	1.31
Total	*0*	.	*7*	*4.58*	*37*	*24.18*	*47*	*30.72*	*54*	*35.29*	*8*	*5.23*	*153*	*100.00*
						1998								
< 2,500	.	.	.	.	.	.	.	.	.	.	.	.	0	.
2,500-4,999	.	.	.	.	.	.	22	14.38	2	1.31	.	.	24	15.69
5,000-7,499	.	.	3	1.96	8	5.23	7	4.58	22	14.38	2	1.31	42	27.45
7,500-9,999	.	.	.	.	9	5.88	2	1.31	13	8.50	.	.	24	15.69
10,000-14,999	.	.	.	.	5	3.27	.	.	10	6.54	.	.	15	9.80
15,000-19,999	.	.	.	.	5	3.27	4	2.61	1	0.65	.	.	10	6.54
20,000-29,999	.	.	.	.	2	1.31	11	7.19	6	3.92	.	.	19	12.42
30,000-39,999	.	.	.	.	2	1.31	10	6.54	3	1.96	.	.	15	9.80
40,000-50,000	.	.	.	.	.	.	2	1.31	2	1.31	.	.	4	2.61
> 50,000	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Total	*0*	.	*3*	*1.96*	*31*	*20.26*	*58*	*37.91*	*59*	*38.56*	*2*	*1.31*	*153*	*100.00*
						1999								
< 2,500	.	.	.	.	.	.	.	.	3	1.96	.	.	3	1.96
2,500-4,999	.	.	.	.	.	.	12	7.84	28	18.30	.	.	40	26.14
5,000-7,499	.	.	.	.	.	.	27	17.65	15	9.80	1	0.65	43	28.10
7,500-9,999	.	.	1	0.65	.	.	9	5.88	2	1.31	.	.	12	7.84
10,000-14,999	.	.	10	6.54	.	.	6	3.92	.	.	.	.	16	10.46
15,000-19,999	.	.	5	3.27	8	5.23	2	1.31	.	.	.	.	15	9.80
20,000-29,999	.	.	1	0.65	12	7.84	1	0.65	.	.	.	.	14	9.15
30,000-39,999	.	.	.	.	4	2.61	1	0.65	.	.	.	.	5	3.27
40,000-50,000	.	.	.	.	2	1.31	.	.	.	.	.	.	2	1.31
> 50,000	.	.	.	.	2	1.31	1	0.65	.	.	.	.	3	1.96
Total	*0*	.	*17*	*11.11*	*28*	*18.30*	*59*	*38.56*	*48*	*31.37*	*1*	*0.65*	*153*	*100.00*

Table 3-4

Comparison of average monthly measured versus model-predicted condenser ΔT at the Peach Bottom Atomic Power Station with both units operating at maximum power achievable (and six circulating water pumps), Spring to Fall 1993-1998, and 1999. N represents the number of days.

Month	N	Total Power Output (%)	Condenser ΔT (°F) Predicted	Observed	Difference
			1993-1998		
April	41	195	20.8	19.4	1.4
May	129	189	20.8	18.8	2.0
June	173	184	20.8	17.9	2.9
July	168	178	20.8	17.4	3.4
August	159	170	20.8	16.7	4.1
September	74	163	20.8	16.0	4.8
October	30	190	20.8	18.7	2.1
			1999		
April	4	200	20.8	20.7	0.1
May	31	200	20.8	21.1	-0.3
June	30	197	20.8	20.5	0.3
July	31	198	20.8	20.6	0.2
August	31	193	20.8	20.2	0.5
September [a]	19	177	20.8	18.4	2.4
October [b]	--	--	20.8	--	--

a Due to the operational loss of one Unit 3 circulating water pump, only 5 pumps were operational on 11 days in late September.

b Unit 3 was in outage from 30 September until restored to near 100% power in late October. During the Unit 3 outage, Unit 2 operated at 100% power on 16 days; condenser ΔT's were 12.3 to 15.7°F on those days..

Table 3-5

Selected weekly thermal profile conditions (expressed as ΔT = temperature at location/depth minus the corrsesponding PBAPS Inlet temperature) at locations sampled in Conowingo Pond, June-October 1999. (For transect locations W = western area; M = mid-pond; and E = eastern area)

		Week of																				
		20 June*			11 July			25 July*			8 August			22 August*			19 September*			24 October*		
	Depth	W	M	E	W	M	E	W	M	E	W	M	E	W	M	E	W	M	E	W	M	E
Holtwood Dam	-	-1.4	-	-	-0.8	-	-	-0.4	-	-	-2.1	-	-	-0.1	-	-	-0.1	-	-	-2.2	-	-
Fishing Creek	0	-2.1	-1.1	-0.4	-2.9	-1.5	-0.6	-1.6	0.0	1.3	-2.3	0.4	-0.3	-2.5	-1.6	-2.0	-0.5	-0.3	-0.1	-1.0	-0.6	-0.6
	5	-2.9	-1.3	-	-2.9	-1.5	-0.6	-2.1	-0.3	-	-2.3	0.4	-	-2.4	-1.6	-	-0.5	-0.4	-	-1.5	-1.1	-0.8
	10	-3.4	-	-	-2.9	-	-1.0	-2.0	-2.1	-	-2.3	0.4	-	-2.5	-	-	-0.5	-	-	-1.6	-1.1	-
	15	-3.6	-	-	-2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Bottom	-3.6	-3.3	-4.0	-2.9	-1.9	-1.0	-2.1	-2.3	0.4	-2.3	-0.7	-0.7	-2.5	-2.3	-4.1	-0.6	-0.4	-0.6	-1.6	-1.1	-0.8
*PBAPS Inlet***	-	76.2	-	-	82.1	-	-	84.9	-	-	82.9	-	-	79.0	-	-	65.8	-	-	54.6	-	-
PBAPS Discharge	-	19.8	-	-	19.7	-	-	19.6	-	-	19.6	-	-	19.1	-	-	23.1	-	-	14.7	-	-
Burkins Run	0	11.9	4.5	4.4	11.1	3.9	1.7	11.9	4.5	3.3	13.9	6.7	6.5	9.5	0.5	1.6	12.6	0.6	0.6	7.5	0.4	-0.4
	5	10.4	2.1	-	10.2	3.5	-	11.9	4.2	-	13.0	5.3	-	8.8	0.2	-	10.5	0.6	-	7.3	0.3	-
	10	9.3	1.0	-	8.9	-1.1	-	10.4	-	-	-	0.4	-	-	-	-	-	-	-	6.5	0.0	-
	15	-	-1.2	-	-	-	-	-	-	-	-	-0.5	-	-	-	-	-	-	-	-	-	-
	Bottom	9.0	-1.2	3.5	7.9	-2.4	1.7	9.2	1.6	2.0	12.1	-0.5	4.7	8.1	-1.8	1.4	4.0	-0.2	0.3	6.3	0.0	-0.7
Williams Tunnel	0	8.1	6.7	5.8	8.8	4.3	3.9	9.6	6.5	4.7	9.4	8.3	6.7	8.3	6.1	5.9	8.9	4.1	1.1	5.5	1.6	1.3
	5	6.9	6.3	5.8	6.6	4.3	3.9	8.3	6.3	4.7	7.6	7.1	6.5	7.0	5.4	5.7	2.7	0.8	0.7	1.5	1.1	1.2
	10	5.7	4.6	5.1	2.6	3.5	2.5	5.8	4.6	4.2	5.1	4.9	4.9	5.7	4.6	4.8	1.0	-0.1	0.1	0.7	0.8	1.2
	15	4.0	-	4.0	-	-	2.1	3.8	-	2.9	-	-	2.2	2.8	-	2.3	0.2	-	-0.1	0.7	0.8	0.9
	20	0.7	-	1.4	-	-	-	-	-	-0.7	-	-	1.3	2.0	-	-	-	-	-	-	-	0.8
	25	-	-	-	-	-	-	-	-	-1.7	-	-	0.4	-	-	-	-	-	-	-	-	0.8
	Bottom	0.0	-0.5	-0.4	1.7	2.5	-1.9	2.0	2.1	-2.7	3.1	0.9	-0.1	0.7	1.4	0.3	0.2	-0.2	-0.3	0.7	0.8	0.6
PA/MD State Line	0	3.9	4.0	4.2	3.5	2.1	2.1	5.6	4.6	4.8	7.1	4.0	4.0	5.3	4.3	4.0	5.8	5.6	4.2	4.2	3.8	2.3
	5	3.6	3.7	3.7	2.1	2.1	2.1	5.1	4.6	4.8	4.0	3.8	3.6	4.3	4.3	4.0	3.1	3.7	3.6	4.1	3.5	2.3
	10	3.6	3.5	3.6	2.1	2.1	1.9	4.7	4.4	4.2	3.5	3.3	3.3	4.2	4.3	3.9	1.3	1.8	2.7	3.7	3.1	2.3
	15	3.6	-	2.5	1.9	-	1.7	4.5	-	3.7	3.1	3.1	2.7	4.2	-	3.7	0.7	-	2.4	3.3	2.6	2.3
	20	2.2	-	0.2	-	-	1.7	-	-	2.9	2.9	-	2.7	2.5	-	3.3	0.3	-	1.3	3.3	-	1.9
	25	0.3	-	-0.6	-	-	1.6	-	-	1.1	-	-	2.2	-	-	2.2	-	-	0.9	-	-	1.8
	30	-	-	-1.5	-	-	-1.1	-	-	-0.5	-	-	1.7	-	-	1.2	-	-	0.6	-	-	1.6
	35	-	-	-1.5	-	-	-1.3	-	-	-0.9	-	-	1.3	-	-	-	-	-	-	-	-	1.6
	40	-	-	-	-	-	-1.3	-	-	-2.3	-	-	1.1	-	-	-	-	-	-	-	-	1.5
	Bottom	0.3	2.6	-1.8	1.4	1.9	-1.3	2.4	1.8	-0.3	0.4	3.1	0.9	1.6	3.7	0.4	0.1	1.1	0.0	3.1	2.3	1.5

* Fish sampling survey week

** The absolute temperatures (°F) measured at the PBAPS Inlet (included for reference).

Table 3-6

Comparison of the mean (and range) profile water temperatures (F) at western sampling stations on transects located downstream of the PBAPS discharge in August and September, 1995 and 1999.

		August *				September *			
		1995 **		1999 ***		1995 **		1999 ***	
	Depth	Mean	Range	Mean	Range	Mean	Range	Mean	Range
PBAPS Discharge		90.3	88.5-90.8	100.8	97.8-104.2	88.9	85.7-91.0	88.9	88.8-89.0
Burkins Run (201)	0	87.3	84.2-92.3	93.1	85.6-98.2	84.8	82.4-87.8	78.4	77.0-79.7
	5	87.1	84.2-92.3	91.9	84.2-96.8	84.7	82.4-86.9	76.3	75.6-77.0
	10	87.8	85.1-92.3	--	--	85.1	83.3-86.9	70.0	68.0-72.0
	15	87.4	85.1-91.4	--	--	84.2	83.3-86.0	--	--
	Bottom	86.6	84.2-89.6	90.6	82.8-95.0	84.5	82.4-86.9	69.8	68.0-71.6
Williams Tunnel (301)	0	88.7	87.8-89.6	90.5	86.4-95.9	--	--	74.7	73.8-75.6
	5	87.8	87.8-87.8	89.4	86.0-95.0	--	--	68.5	67.1-69.8
	10	86.9	86.0-87.8	87.4	83.8-91.0	--	--	66.8	66.2-67.5
	15	86.9	86.9-86.9	85.2	81.5-89.6	--	--	66.0	65.8-66.2
	Bottom	86.0	86.0-86.0	83.6	78.8-88.2	--	--	66.0	65.8-66.2
State Line (402)	0	83.5	82.4-86.0	86.9	84.2-90.0	81.7	78.8-84.2	71.6	69.8-73.4
	5	83.6	82.4-86.0	85.9	82.4-89.6	81.1	78.8-82.4	68.9	67.1-70.7
	10	--	--	85.7	82.2-89.6	--	--	67.1	66.2-68.0
	15	--	--	85.5	82.2-89.2	--	--	66.5	65.8-67.1
	Bottom	83.5	82.4-86.0	83.7	80.6-87.8	81.3	78.8-83.3	65.9	65.8-66.0

* In 1995, profiles were taken daily from 25-31 August and 1-12 September when PBAPS operated a minimum of 3 cooling towers. In 1999, profiles were taken on 5 days in August and 2 days in September during zero tower operation.

** In August and September 1995, daily river inflows were <6000 cfs on most days, with inlet temperatures typically >81°F in August and >75°F in September.

*** In 1999, daily inflows were <5000 cfs on most days in August, but >10,000 cfs in September. Inlet temperatures typically were >81°F in August and >68°F in September.

Table 3-7

Selected weekly DO profiles at transect locations (W = western area; M = mid-pond; and E = eastern area) in Conowingo Pond, June-October 1999.

		Week of																				
		20 June*			11 July			25 July*			8 August			22 August*			19 September*			24 October*		
	Depth	W	M	E	W	M	E	W	M	E	W	M	E	W	M	E	W	M	E	W	M	E
Fishing Creek	0	8.6	8.8	9.4	6.0	7.3	8.4	8.0	8.0	7.4	6.8	8.2	8.2	6.6	6.9	7.2	8.7	8.2	8.1	10.1	10.0	10.0
	5	7.0	8.6	-	5.9	7.3	8.4	7.0	7.9	-	6.9	8.2	-	6.5	6.9	-	8.6	8.2	-	10.0	9.9	10.0
	10	6.6	7.7	-	5.9	7.1	8.2	6.7	7.7	-	6.9	7.9	-	6.4	-	-	8.5	8.2	-	10.0	9.9	-
	15	6.3	-	-	5.8	-	-	-	-	-	6.9	-	-	6.4	-	-	-	-	-	10.0	-	-
	Bottom	6.0	5.1	10.2	5.7	7.1	8.1	6.2	5.6	7.3	6.9	6.6	8.1	6.4	5.8	7.1	8.5	8.2	8.1	10.0	10.0	9.9
Burkins Run	0	7.6	8.3	8.3	7.1	7.1	6.9	7.1	6.4	7.1	8.0	7.5	8.6	7.2	7.1	7.3	8.2	8.2	8.1	9.9	9.8	10.1
	5	7.7	6.5	-	7.1	7.0	-	7.2	6.1	-	8.0	6.9	-	7.1	6.8	-	8.2	8.2	-	9.9	9.7	-
	10	7.8	-	-	7.1	6.4	-	-	-	-	-	7.0	-	-	-	-	8.0	8.3	-	9.9	9.7	-
	15	-	-	-	-	-	-	-	-	-	-	7.3	-	-	-	-	-	-	-	-	-	-
	Bottom	7.9	5.1	6.8	7.1	6.1	6.9	7.1	5.3	6.0	8.0	7.1	6.6	7.0	6.0	6.4	8.0	7.8	8.0	9.9	9.7	10.1
Williams Tunnel	0	7.1	7.2	7.4	7.1	6.8	6.9	6.8	6.9	7.1	9.0	8.4	9.0	7.1	7.2	7.2	8.4	8.5	8.6	9.8	9.7	9.8
	5	6.8	7.0	7.3	6.8	6.7	6.8	6.6	6.8	6.8	8.6	8.0	8.8	6.8	6.9	7.1	8.4	8.5	8.6	9.7	9.7	9.8
	10	6.1	6.9	7.1	6.0	6.5	6.6	6.3	6.1	5.9	7.8	8.0	8.1	6.7	6.9	6.9	8.4	8.3	8.6	9.6	9.6	9.7
	15	5.8	5.1	6.4	-	-	6.2	4.7	-	3.6	-	-	4.5	6.5	-	6.7	8.5	-	8.6	9.6	9.5	9.7
	20	-	-	4.8	-	-	5.6	-	-	2.7	-	-	5.4	-	-	-	-	-	8.5	-	-	9.6
	25	-	-	1.0	-	-	4.6	-	-	2.2	-	-	5.0	-	-	-	-	-	8.5	-	-	9.6
	Bottom	3.4	4.0	3.5	4.5	5.9	3.7	2.9	3.2	1.2	6.1	5.0	4.1	5.4	5.3	5.5	8.0	8.2	8.3	9.7	9.5	9.5
PA/MD State Line	0	8.7	8.3	7.7	7.0	6.7	6.6	7.2	6.6	7.0	9.4	8.6	8.7	7.4	7.2	7.2	8.5	8.7	8.7	9.4	9.6	9.5
	5	8.5	8.2	7.7	6.7	6.6	6.5	6.9	6.1	6.8	8.0	8.5	8.6	7.3	7.2	7.1	8.4	8.6	8.6	9.4	9.6	9.5
	10	8.0	8.5	7.4	6.6	6.6	6.3	6.4	5.9	6.1	8.0	7.9	7.6	7.2	7.0	7.0	8.3	8.4	8.6	9.4	9.5	9.5
	15	7.7	6.5	5.8	6.4	-	6.1	6.2	-	5.5	7.0	6.9	6.4	7.2	6.4	6.6	8.5	8.1	8.6	9.3	9.5	9.5
	20	5.3	-	4.0	-	-	6.1	-	-	3.3	4.0	-	3.9	-	-	6.1	-	-	8.5	9.2	-	9.4
	25	-	-	2.9	-	-	6.1	-	-	1.6	-	-	3.1	-	-	6.0	-	-	8.5	-	-	9.4
	30	-	-	2.4	-	-	4.4	-	-	1.6	-	-	3.5	-	-	5.5	-	-	8.4	-	-	9.4
	35	-	-	2.2	-	-	4.3	-	-	0.6	-	-	3.9	-	-	-	-	-	8.5	-	-	9.3
	40		-	2.0	-	-	4.1	-	-	0.1	-	-	4.0	-	-	-	-	-	8.3	-	-	9.3
	Bottom	2.5	5.8	1.9	5.4	6.4	3.9	3.2	4.4	1.4	3.5	6.8	3.9	5.3	5.5	4.3	8.3	8.0	8.2	9.2	9.5	9.3

* Fish sampling survey week

Figure 3-1.
Duration curve of daily average river temperatures (F) at Holtwood Dam,
in June - October 1952 to 1998 (historical) and in 1997,1998, 1999.

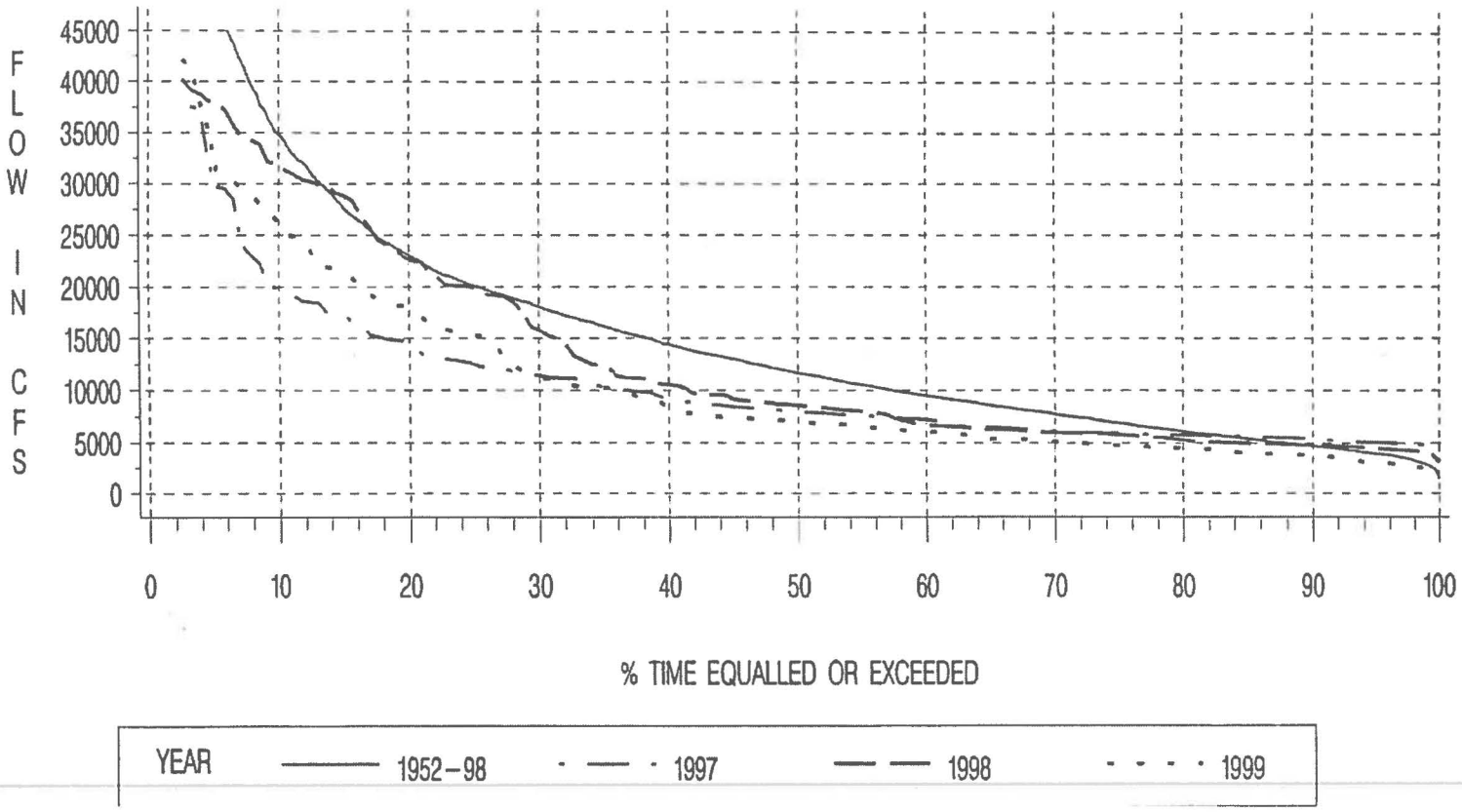
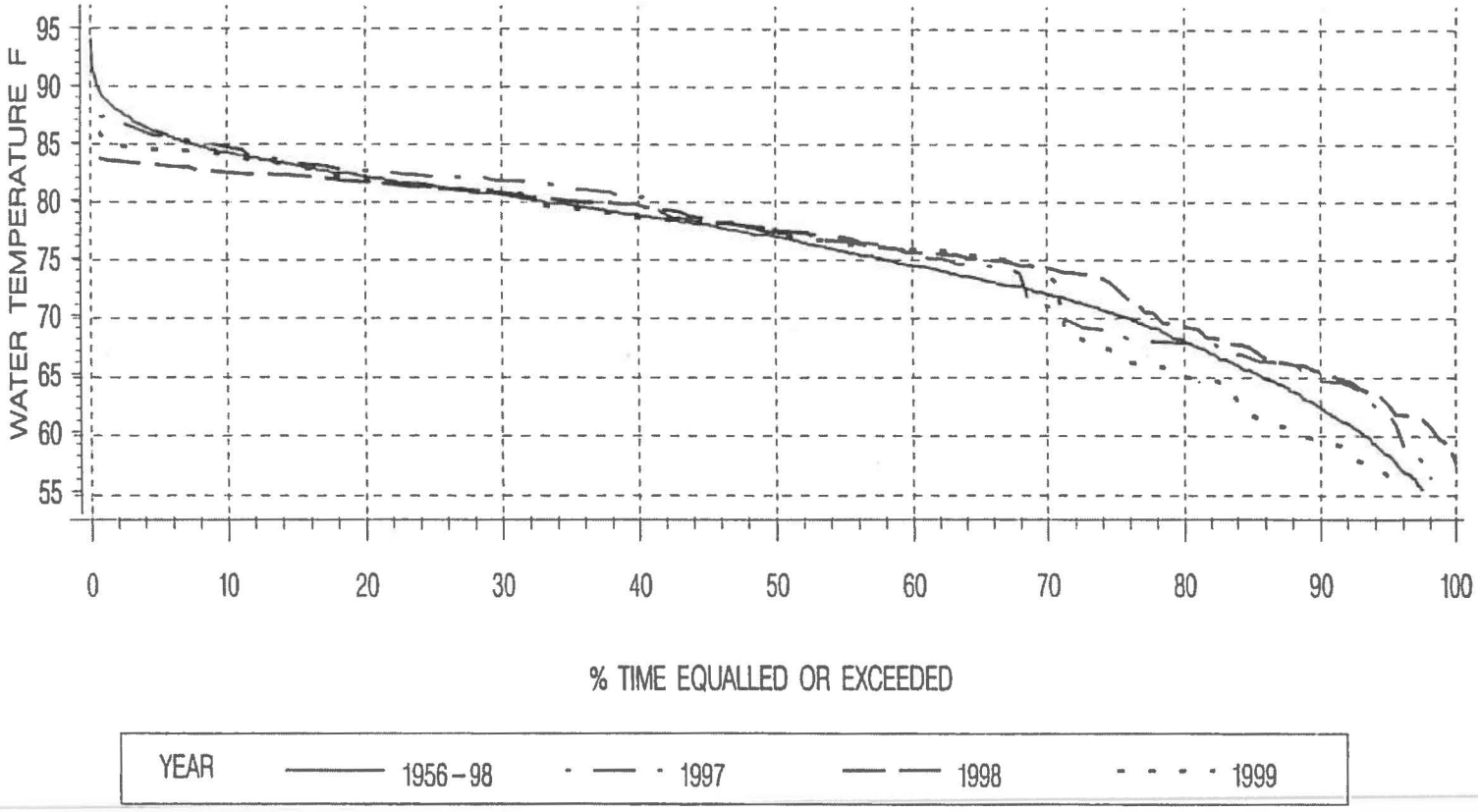


Figure 3-2.
Duration curve of daily average river temperatures (°F) at Holtwood Dam, in June - October 1956 to 1998 (historical) and in 1997,1998, 1999.



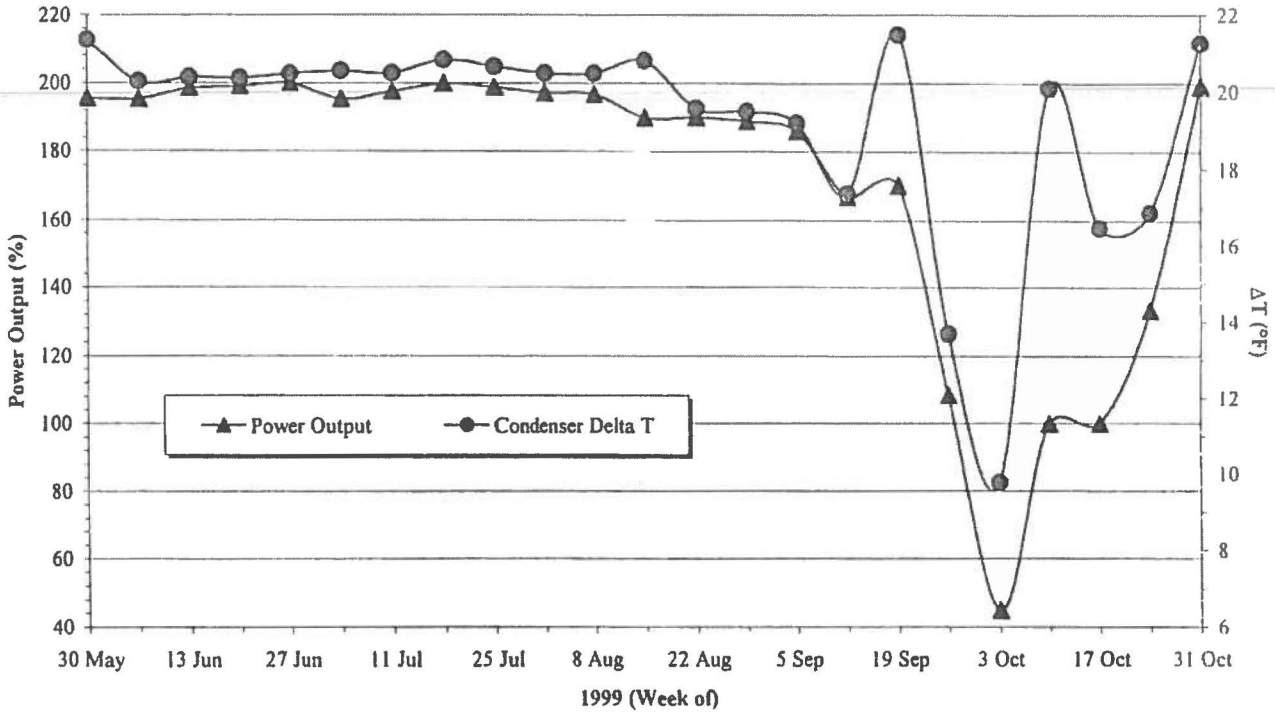


Figure 3-3

Weekly mean percent (%) power output and condenser ΔT (°F) at PBAPS, June-October 1999.

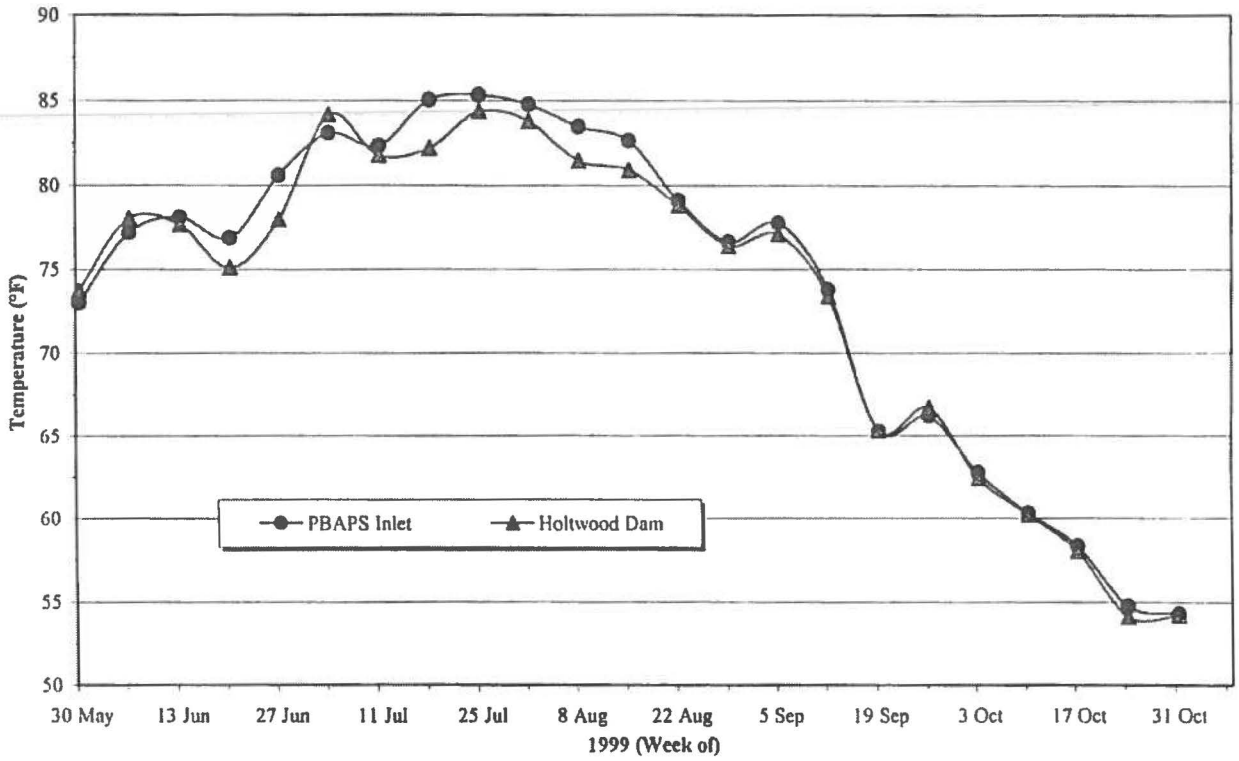


Figure 3-4

Weekly mean temperatures (°F) at Holtwood Dam and PBAPS inlet, June-October 1999.

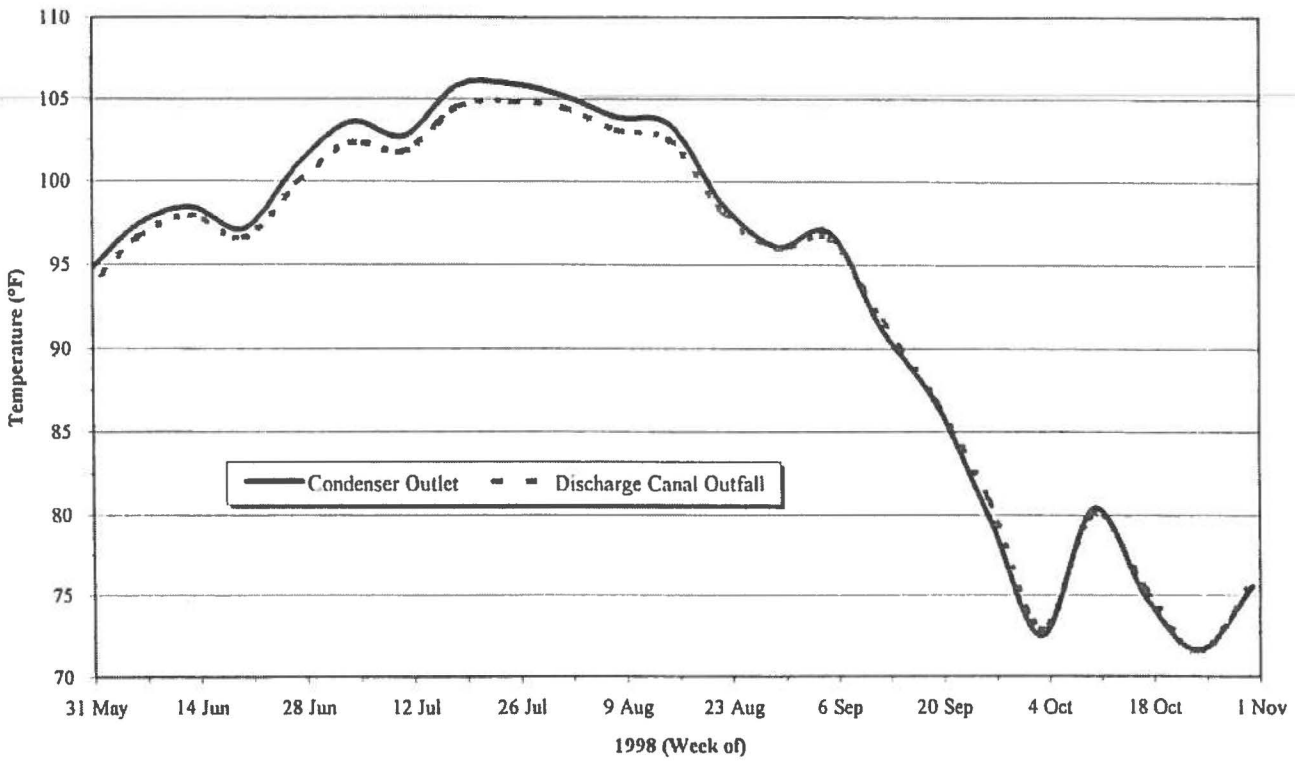


Figure 3-5

Average daily condenser outlet and canal outfall temperatures (°F) at PBAPS, June-October 1999.

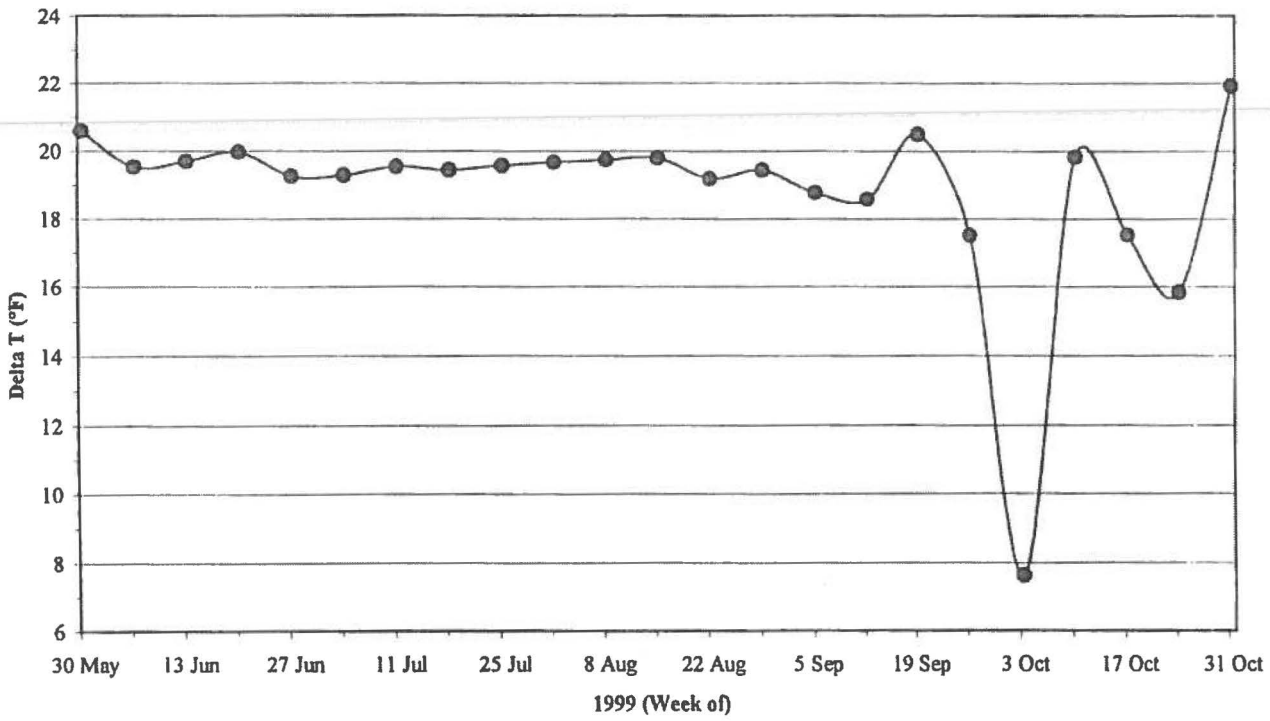
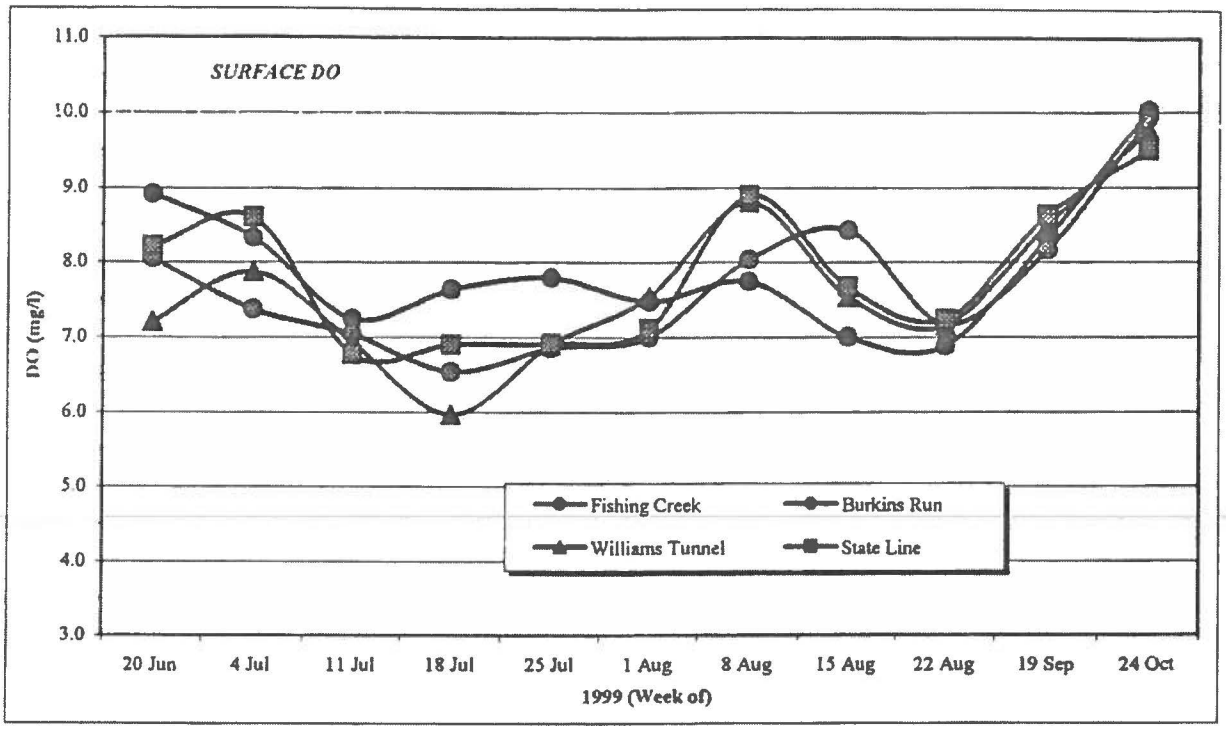


Figure 3-6

Weekly mean canal outfall ΔT (outfall °F minus inlet °F) at PBAPS, June-October 1999.



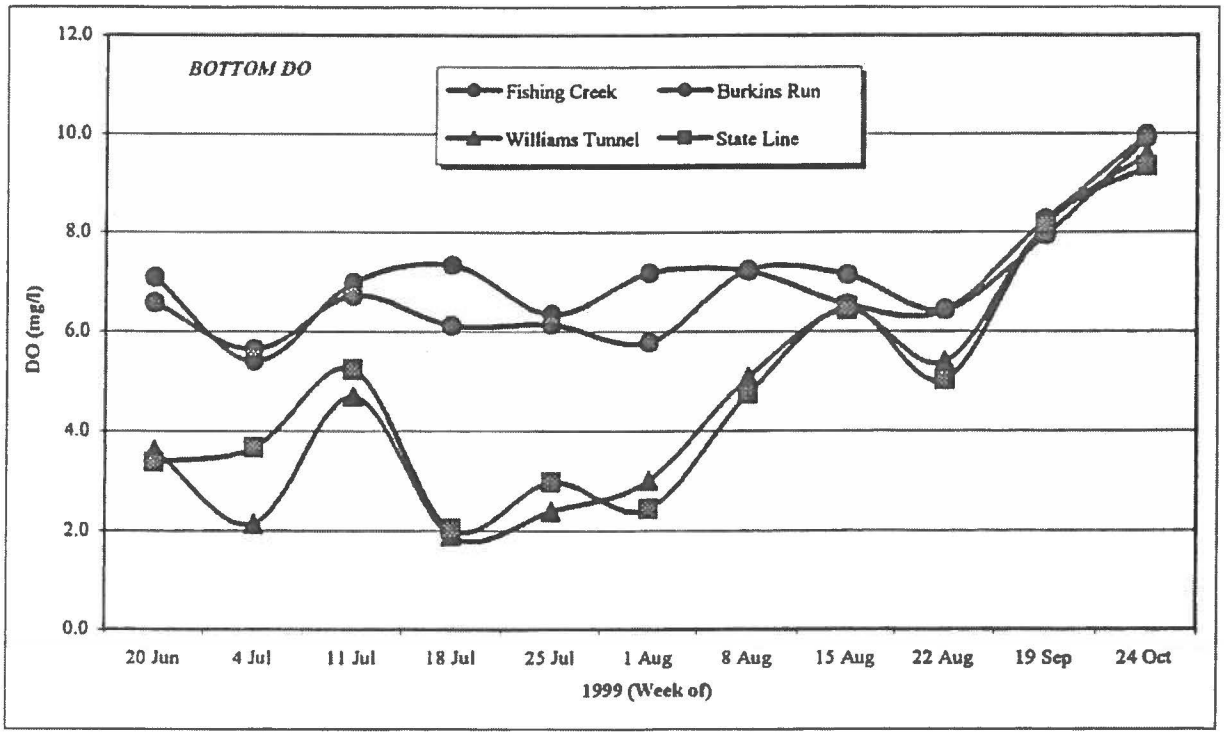


Figure 3-7

Weekly mean surface and bottom DO at transects sampled in the vicinity of PBAPS, June-October 1999.

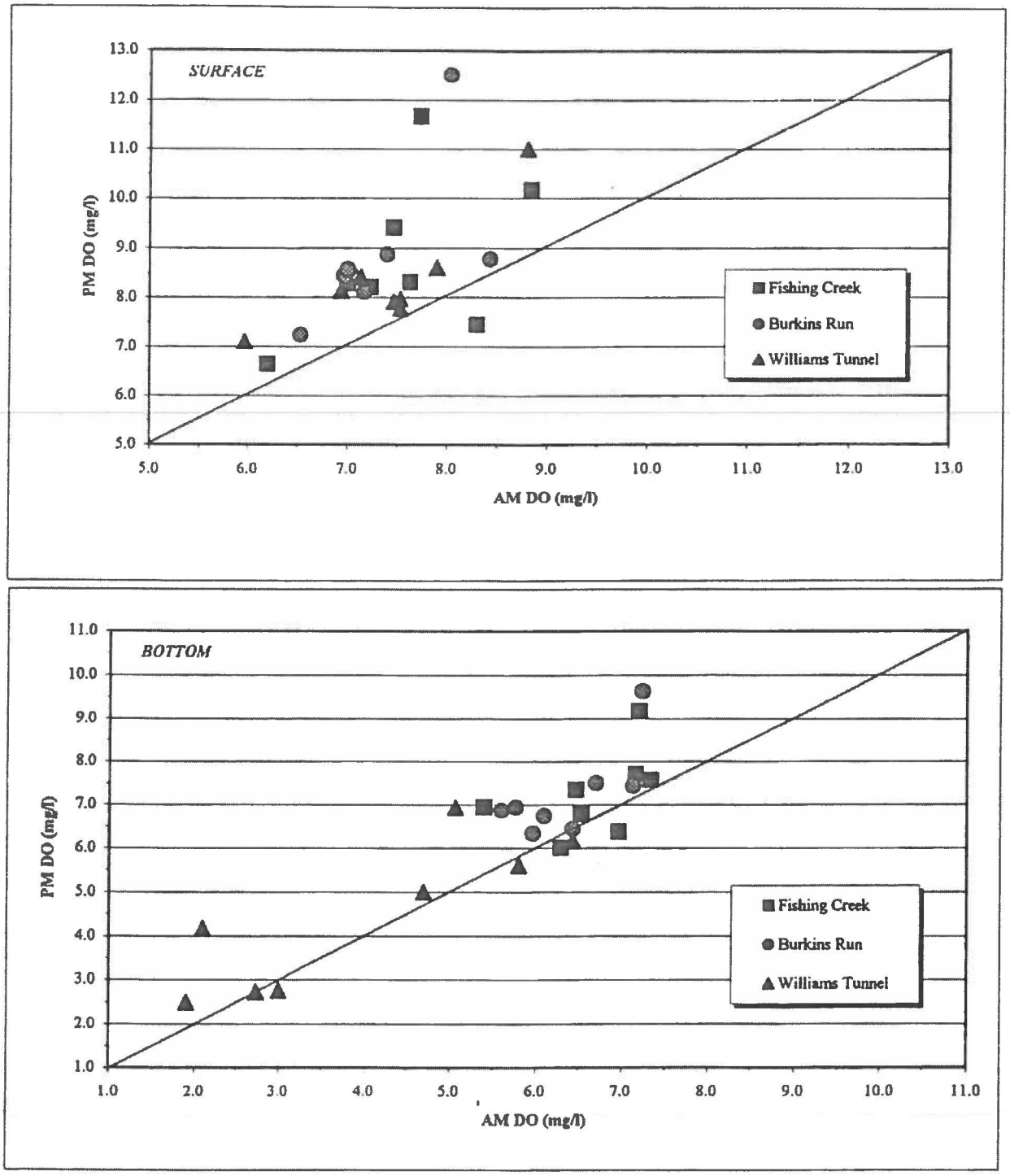


Figure 3-8

Comparison of AM versus PM DO (mg/l) at the surface and bottom at transects sampled in the vicinity of PBAPS in July through August 1999. Solid line represents line of equality.

3.3 Fisheries (Overall)

Sampling occurred on five occasions in June through October at zero cooling tower operation. A list of scientific and common names of species collected is found in Table 3-8.

A total of 15,328 fish representing 45 species plus one striped bass hybrid and 11 unidentified *Lepomis* spp. was collected (Table 3-9). Spotfin shiner, gizzard shad, channel catfish, bluegill, tessellated darter, bluntnose minnow, and smallmouth bass comprised 84% of the 1999 catch.

June accounted for the most fish (5,507) collected in a single month, while the least (1,596) was collected in August (Table 3-9). In 1998, July accounted for the fewest fish collected (3,525) while August accounted for the most fish (5,309). Number of species observed per month was similar and ranged from 35 (July, August, and September) to 37 (June and October). Spotfin shiner was the most abundant species in July, August, September, and October while gizzard shad dominated the catch in June.

3.3.1 Electrofishing

A total of 3,520 fish representing 26 species was collected (Table 3-10). Bluegill, smallmouth bass, gizzard shad, green sunfish, and largemouth bass comprised nearly 82% of the catch; all other species individually made up less than 4% of the total. Number of species between months varied and ranged from 13 (July) to 21 (September). The catch increased steadily from June, peaking in September, and declined in October.

The most common species collected during each month were similar. These were bluegill, smallmouth bass, gizzard shad and green sunfish. The species with the highest overall catch per effort (CPE) value was bluegill (49.35) while CPE values for smallmouth bass (31.40) and gizzard shad (30.60) were similar (Table 3-11).

Species CPE varied by month (Table 3-11). Bluegill, smallmouth bass, gizzard shad, and green sunfish ranked in the top five during all sample periods while spotfin shiner ranked among the top five in two of the five sample periods. The only other species that ranked in the top five was comely shiner during the August sample period. The highest CPE (345.25) for all species combined occurred in September and the lowest CPE (89.25) in June.

Overall, the number of species collected at each station varied slightly (Table 3-12). At stations 161 and 190 (both located within the influence of the thermal plume), 19 and 17 species were collected at each location, respectively. Stations 164 and 165 (outside the influence of the thermal plume) contributed 19 and 22 species, respectively. Generally, CPE values for bluegill were highest and nearly identical at stations 165 and 190 with gizzard shad having the highest CPE value for any species at station 164. Smallmouth bass had the highest CPE value at station 161.

Comparison of monthly CPE's for the 1997-1999 sampling effort and the historical data for common and important representative species are shown in Table 3-13. Little historical data were available for the period June through September; however, 76 of the 105 calculated monthly CPE's were within or above the range observed historically. White crappie CPE values for July through October were lower than the historical range, possibly due to variations in year class strength from year to year. Strong populations of gizzard shad, now bolstered by introductions from the Conowingo Dam East fish lift, may be outcompeting white crappie for available food during critical juvenile stages. High fluctuations in year class strength of white crappie have been observed historically. Smallmouth bass CPE values for June, July, August, and September were higher than those observed historically, while CPE values for largemouth bass were generally similar or above those values recorded historically.

3.3.2 Seine

A total of 6,714 fish representing 31 species plus eleven unidentified Lepomis spp. was collected (Table 3-14). Spotfin shiner, bluntnose minnow, and tessellated darter dominated the catch. These three species comprised over 81% of the total catch by seine; all other species individually made up less than 2.2% of the total. The lowest number of species collected (19) occurred in September while the highest number of species (25) occurred in June. The largest number of fish collected by seine (1,686) occurred in

September, whereas the lowest number collected (815) occurred in August. Spotfin shiner dominated the catch during all five sampling events. The number of species and specimens collected was variable over the sampling period. This was largely a factor of the mobility and growth of young fish.

The highest overall monthly CPE occurred in September (240.86) while the lowest value occurred in August (116.44; Table 3-15). Spotfin shiner was the most common species collected with a mean monthly CPE of 119.17. Bluntnose minnow and tessellated darter ranked second and third, respectively.

The number of species collected varied by station (Table 3-16). The most species (25) were collected at station 212 while the fewest (8) were collected at station 209. The total number of species collected was 31 plus eleven unidentified Lepomis spp. Spotfin shiner, bluntnose minnow, and tessellated darter were the most common species in the catch.

All monthly CPE values were within or above the historical range from 1997 to 1999 (Table 3-20). During the three year study, bluntnose minnow had CPE values higher than the existing range on six occasions while spottail shiner, largemouth bass, and tessellated darter had values greater than the existing range on at least three occasions. CPE values for smallmouth bass and pumpkinseed were each higher during one of the sample periods.

Diversity and evenness values by month are presented in Table 3-17. The values range from 0.370 (September) to 0.819 (June), similar to what was observed previously. Calculated diversity values were low due to the dominance of a few species, mainly spotfin shiner.

Percent similarity values between stations are found in Table 3-18. Variation in PS_C values was evident between stations. Station 212 appeared to be the least similar to the others, possibly due to habitat differences, since this station is located in Fishing Creek, unlike the others which are located within Conowingo Pond.

Percent similarity values between months are found in Table 3-19. The similarity in catch was high (>77%) between August, September, and October. Values for June were relatively low as compared to other months whereas July values were similar for each monthly comparison except for September.

3.3.3 Trap Net

A total of 656 fish representing 21 species was collected (Table 3-21). Five species comprised over 77% of the catch. They were white crappie, channel catfish, bluegill, gizzard shad, and common carp. Number of species collected ranged from 10 in June to 17 in September.

Overall catch per effort values ranged from 4.70 in June to 31.81 in September (Table 3-22). White crappie ranked first with a mean CPE of 3.65. Channel catfish and bluegill ranked second and third with mean CPE values of 2.77 and 2.57, respectively. By month, white crappie had the highest CPE values in September and October while bluegill, gizzard shad, and channel catfish were dominant in June, July, and August, respectively.

The number of species collected at each station was variable (Table 3-23). Number of species ranged from 11 collected at station 108 to 17 at station 110 which is located within the influence of the thermal plume. Gizzard shad and channel catfish were the dominant species collected at station 110 while white crappie dominated collections at stations 104, 107, and 108. Eight species were collected at all four stations. These were white crappie, channel catfish, bluegill, gizzard shad, common carp, green sunfish, largemouth bass, and pumpkinseed.

Most of the common and important representative species have monthly CPE values within the historical range from 1997 to 1999 (Table 3-24). Twenty-four of the 135 sample periods (17.8%) had CPE values less than the historical range. Monthly CPE values were generally lower for brown bullhead, channel catfish, pumpkinseed, and white crappie from July through September, while CPE values for bluegill, gizzard shad, smallmouth bass, largemouth bass, and walleye were consistently within the historical range during most sampling events.

3.3.4 Trawl Zones

3.3.4.1 Zone 405

A total of 741fish representing 15 species was collected in 1999 (Table 3-25). Channel catfish was the dominant species and accounted for more than 75% of the total catch. Channel catfish along with tessellated darter comprised nearly 92% of the catch. The remaining 13 species were collected in low numbers, infrequently, and represented slightly more than 8% of the total catch.

By month, the highest overall CPE value occurred in June (67.25) with lower values observed from July through October (Table 3-26). The lowest value (6.74) occurred in August, possibly due to the severe drought conditions the region experienced this summer. Except for tessellated darter in July, channel catfish had the highest CPE values of any species during each monthly sampling event.

The number of species collected per station varied and ranged from four at station 452 to 9 at station 455 (Table 3-27). Except for station 456, where tessellated darter dominated the catch, channel catfish was dominant at all other stations.

Monthly catch per effort values for the commonly collected species were within or greater than the range of the historical data from 1997 to 1999 (Table 3-28). The CPE values for tessellated darter were generally higher than the existing range from June through September with some higher CPE values for channel catfish, largemouth bass, and spottail shiner observed during July and August sampling periods.

3.3.4.2 Zone 408

A total of 840 fish of 14 species was collected (Table 3-29). Five species comprised 91% of the catch. They were gizzard shad, channel catfish, tessellated darter, bluntnose minnow, and bluegill. Gizzard shad dominated the catch in June with channel catfish dominant during July and August. Channel catfish, pumpkinseed, and bluegill were collected during each sampling event, whereas gizzard shad and tessellated darter were present in four of the five collections.

Overall monthly CPE values varied and ranged from 2.50 in September to 114.28 in June (Table 3-30). Strong numbers of gizzard shad and tessellated darters collected in June accounted for the higher CPE value observed. Catch per effort values were relatively strong in June but drastically decreased from July through October. Catch per effort values of certain species varied by station (Table 3-31). Gizzard shad, channel catfish, bluegill, and tessellated darter were present at all six stations whereas pumpkinseed and largemouth bass were collected at five of the six stations.

The relative abundance of all commonly collected species except for white crappie was generally within or above the historic range of monthly CPE values from 1997 to 1999 (Table 3-32). During the 3-year study period, monthly CPE values higher than the historic range were usually observed during June or July for bluegill, gizzard shad, smallmouth and largemouth bass, tessellated darter, and spottail shiner.

3.3.5 Trawl Transects

At trawl transect stations, a total of 2,857 fish representing 19 species was collected (Table 3-33). Three species, gizzard shad, channel catfish, and tessellated darter comprised more than 94% of the catch. Only one other species individually, bluegill, made up more than 1% of the catch. The remaining species were collected in low numbers and infrequently.

The number of species collected by month was similar and ranged from 8 in August to 13 in June (Table 3-34). The highest overall CPE (270.80) occurred in June with the lowest value (5.76) observed in October. Gizzard shad had the highest mean CPE overall and dominated the catch in June while channel catfish had the highest CPE values in July, August, and September. Bluegill had the highest CPE value in October.

The number of species collected at each station was generally similar (Table 3-35). Number of species ranged from four (Station 371) to 11 (Stations 343 and 373). Catch per effort values at each station were variable. Station 371 had the lowest CPE of any station. This was probably due to high current velocity precluding full utilization of the area by young-of the year fishes, which typically dominate trawl

catches. Channel catfish dominated the catch at stations 321, 342, 372, and 373 with gizzard shad most abundant at stations 323 and 341. Tessellated darter had the highest CPE values for stations 322 and 343.

The CPE of all commonly collected species (except for white crappie during four sampling events and one event each for channel catfish and spottail shiner) were within or above their historic range of values from 1997 to 1999 (Table 3-36). CPE values higher than historical values were observed often during the 3-year study for largemouth bass, tessellated darter, smallmouth bass, and gizzard shad.

3.3.6 Reconnaissance Surveys

Weekly fish reconnaissance surveys were conducted throughout Conowingo Pond in June through August, with three additional surveys conducted in August at river inflows <3,000 cfs. These boat-based surveys were performed to document occurrences of any unusual thermally related fish activity, particularly with the introduction of nearly 1,200,000 fish (including 950,000 gizzard shad) into the pond via spring fish passage operations at Conowingo Dam. These surveys revealed no unusual fish activity; no thermally stressed fish were observed. However, a total of 410 dead fish (comprised primarily of gizzard shad, followed by American shad, channel catfish and carp) was observed throughout the Pond. Nearly 60% of the dead fish (primarily gizzard shad, channel catfish, carp, and American shad) were observed in the four weeks surveyed in June. All were in various stages of decomposition, and mortality probably was due to post-spawning stress. During the low flow surveys in August, no dead fish were observed in the PBAPS discharge or downstream areas. Fish activity throughout this area in mid-July through August included predator species feeding on large schools of gizzard shad.

Table 3-8

Scientific and common names of fishes collected in Conowingo Pond, June-October 1999.

Clupeidae	**Herrings**	*Ictaluridae, continued*	**Bullhead catfishes, continued**
Alosa sapidissima	American shad	*Ameiurus natalis*	Yellow bullhead
Dorosoma cepedianum	Gizzard shad	*Ameiurus nebulosus*	Brown bullhead
		Ictalurus punctatus	Channel catfish
Cyprinidae	**Carps and minnows**		
Campostoma anomalum	Central stoneroller	*Cyprinodontidae*	**Killifishes**
Clinostomus funduloides	Rosyside dace	*Fundulus diaphanus*	Banded killifish
Cyprinus carpio	Common carp		
Notropis buccatus	Silverjaw minnow	*Percichthyidae*	**Temperate basses**
Exoglossum maxillingua	Cutlips minnow	*Morone americana*	White perch
Notemigonus crysoleucas	Golden shiner	*M saxatilis x M chrysops*	Striped bass x white bas
Notropis amoenus	Comely shiner		
Luxilus cornutus	Common shiner	*Centrarchidae*	**Sunfishes**
Notropis hudsonius	Spottail shiner	*Ambloplites rupestris*	Rock bass
Notropis procne	Swallowtail shiner	*Lepomis sp*	Lepomis sp
Notropis rubellus	Rosyface shiner	*Lepomis auritus*	Redbreast sunfish
Cyprinella spiloptera	Spotfin shiner	*Lepomis cyanellus*	Green sunfish
Notropis volucellus	Mimic shiner	*Lepomis gibbosus*	Pumpkinseed
Pimephales notatus	Bluntnose minnow	*Lepomis macrochirus*	Bluegill
Rhinichthys atratulus	Blacknose dace	*Micropterus dolomieu*	Smallmouth bass
Rhinichthys cataractae	Longnose dace	*Micropterus salmoides*	Largemouth bass
Semotilus atromaculatus	Creek chub	*Pomoxis annularis*	White crappie
Semotilus corporalis	Fallfish	*Pomoxis nigromaculatus*	Black crappie
Catostomidae	**Suckers**	*Percidae*	**Perches**
Carpiodes cyprinus	Quillback	*Etheostoma blennioides*	Greenside darter
Catostomus commersoni	White sucker	*Etheostoma olmstedi*	Tessellated darter
Hypentelium nigricans	Northern hogsucker	*Perca flavescens*	Yellow perch
Moxostoma macrolepidotum	Shorthead redhorse	*Percina caprodes*	Logperch
		Percina peltata	Shield darter
Ictaluridae	**Bullhead catfishes**	*Stizostedion vitreum*	Walleye
Ameiurus catus	White catfish		

Table 3-9

Number and percent composition of fishes collected by all gear types per month in Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
American shad	0	0.00	0	0.00	0	0.00	0	0.00	1	0.05	1	0.01
Gizzard shad	2,188	39.73	283	11.76	260	16.29	166	4.56	122	5.59	3,019	19.70
Central stoneroller	2	0.04	0	0.00	0	0.00	0	0.00	0	0.00	2	0.01
Rosyside dace	8	0.15	6	0.25	13	0.81	32	0.88	8	0.37	67	0.44
Common carp	21	0.38	20	0.83	11	0.69	46	1.26	49	2.25	147	0.96
Cutlips minnow	1	0.02	4	0.17	1	0.06	0	0.00	1	0.05	7	0.05
Golden shiner	0	0.00	1	0.04	12	0.75	2	0.05	0	0.00	15	0.10
Comely shiner	15	0.27	13	0.54	63	3.95	14	0.38	43	1.97	148	0.97
Common shiner	21	0.38	14	0.58	10	0.63	7	0.19	3	0.14	55	0.36
Spottail shiner	15	0.27	37	1.54	0	0.00	7	0.19	20	0.92	79	0.52
Swallowtail shiner	2	0.04	3	0.12	2	0.13	0	0.00	0	0.00	7	0.05
Rosyface shiner	0	0.00	4	0.17	1	0.06	1	0.03	0	0.00	6	0.04
Spotfin shiner	647	11.75	794	33.00	558	34.96	1,427	39.22	882	40.44	4,308	28.11
Bluntnose minnow	325	5.90	402	16.71	41	2.57	35	0.96	82	3.76	885	5.77
Blacknose dace	9	0.16	0	0.00	3	0.19	8	0.22	3	0.14	23	0.15
Longnose dace	1	0.02	5	0.21	1	0.06	1	0.03	1	0.05	9	0.06
Creek chub	15	0.27	16	0.67	6	0.38	10	0.27	0	0.00	47	0.31
Fallfish	3	0.05	0	0.00	0	0.00	0	0.00	0	0.00	3	0.02
Silverjaw minnow	0	0.00	0	0.00	2	0.13	0	0.00	0	0.00	2	0.01
Mimic shiner	5	0.09	44	1.83	1	0.06	3	0.08	33	1.51	86	0.56
Quillback	54	0.98	9	0.37	8	0.50	6	0.16	7	0.32	84	0.55
White sucker	73	1.33	42	1.75	11	0.69	2	0.05	14	0.64	142	0.93
Northern hogsucker	0	0.00	0	0.00	0	0.00	0	0.00	4	0.18	4	0.03
Shorthead redhorse	8	0.15	9	0.37	5	0.31	5	0.14	14	0.64	41	0.27
White catfish	3	0.05	2	0.08	0	0.00	1	0.03	1	0.05	7	0.05
Yellow bullhead	2	0.04	1	0.04	2	0.13	5	0.14	4	0.18	14	0.09
Brown bullhead	4	0.07	2	0.08	6	0.38	16	0.44	1	0.05	29	0.19
Channel catfish	731	13.27	175	7.27	190	11.90	313	8.60	110	5.04	1,519	9.91
Banded killifish	1	0.02	1	0.04	0	0.00	0	0.00	1	0.05	3	0.02
White perch	0	0.00	0	0.00	1	0.06	7	0.19	1	0.05	9	0.06
Rock bass	4	0.07	8	0.33	8	0.50	25	0.69	33	1.51	78	0.51
Redbreast sunfish	11	0.20	0	0.00	1	0.06	2	0.05	2	0.09	16	0.10
Green sunfish	46	0.84	71	2.95	33	2.07	148	4.07	100	4.59	398	2.60
Pumpkinseed	21	0.38	23	0.96	30	1.88	73	2.01	37	1.70	184	1.20
Bluegill	130	2.36	118	4.90	138	8.65	669	18.39	313	14.35	1,368	8.92
Smallmouth bass	156	2.83	95	3.95	83	5.20	277	7.61	108	4.95	719	4.69
Largemouth bass	101	1.83	38	1.58	43	2.69	203	5.58	99	4.54	484	3.16
White crappie	5	0.09	13	0.54	13	0.81	87	2.39	36	1.65	154	1.00
Black crappie	0	0.00	0	0.00	0	0.00	1	0.03	1	0.05	2	0.01
Lepomis sp*	11	0.20	0	0.00	0	0.00	0	0.00	0	0.00	11	0.07
Tessellated darter	850	15.43	134	5.57	21	1.32	27	0.74	26	1.19	1,058	6.90
Yellow perch	2	0.04	1	0.04	0	0.00	1	0.03	4	0.18	8	0.05
Logperch	14	0.25	16	0.67	16	1.00	7	0.19	2	0.09	55	0.36
Shield darter	1	0.02	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01
Walleye	0	0.00	1	0.04	1	0.06	3	0.08	14	0.64	19	0.12
Striped bass hybrid*	0	0.00	0	0.00	0	0.00	1	0.03	0	0.00	1	0.01
Greenside darter	1	0.02	1	0.04	1	0.06	0	0.00	1	0.05	4	0.03
Overall	*5,507*	*100*	*2,406*	*100*	*1,596*	*100*	*3,638*	*100*	*2,181*	*100*	*15,328*	*100*
Number of species	*37*		*35*		*35*		*35*		*37*		*45*	

* Not counted as separate species.

Table 3-10

Number and percent composition of fishes collected by DC electrofisher per month in Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Gizzard shad	29	8.12	184	43.09	173	32.34	105	7.60	121	14.76	612	17.39
Common carp	1	0.28	7	1.64	5	0.93	11	0.80	27	3.29	51	1.45
Golden shiner	0	0.00	1	0.23	12	2.24	1	0.07	0	0.00	14	0.40
Comely shiner	14	3.92	1	0.23	49	9.16	14	1.01	43	5.24	121	3.44
Spottail shiner	1	0.28	0	0.00	0	0.00	2	0.14	1	0.12	4	0.11
Spotfin shiner	50	14.01	23	5.39	17	3.18	27	1.96	19	2.32	136	3.86
Bluntnose minnow	0	0.00	0	0.00	1	0.19	0	0.00	0	0.00	1	0.03
Quillback	0	0.00	0	0.00	8	1.50	2	0.14	7	0.85	17	0.48
White sucker	0	0.00	0	0.00	0	0.00	0	0.00	14	1.71	14	0.40
Shorthead redhorse	5	1.40	4	0.94	5	0.93	4	0.29	10	1.22	28	0.80
White catfish	0	0.00	0	0.00	0	0.00	1	0.07	0	0.00	1	0.03
Yellow bullhead	1	0.28	0	0.00	2	0.37	0	0.00	4	0.49	7	0.20
Brown bullhead	0	0.00	0	0.00	0	0.00	1	0.07	0	0.00	1	0.03
Channel catfish	27	7.56	17	3.98	26	4.86	18	1.30	23	2.80	111	3.15
Rock bass	3	0.84	8	1.87	6	1.12	18	1.30	16	1.95	51	1.45
Redbreast sunfish	11	3.08	0	0.00	1	0.19	2	0.14	1	0.12	15	0.43
Green sunfish	45	12.61	46	10.77	31	5.79	140	10.14	100	12.20	362	10.28
Pumpkinseed	1	0.28	0	0.00	5	0.93	38	2.75	7	0.85	51	1.45
Bluegill	48	13.45	36	8.43	117	21.87	555	40.19	231	28.17	987	28.04
Smallmouth bass	118	33.05	84	19.67	65	12.15	261	18.90	100	12.20	628	17.84
Largemouth bass	1	0.28	15	3.51	10	1.87	176	12.74	82	10.00	284	8.07
White crappie	0	0.00	0	0.00	0	0.00	2	0.14	2	0.24	4	0.11
Black crappie	0	0.00	0	0.00	0	0.00	1	0.07	0	0.00	1	0.03
Tessellated darter	1	0.28	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03
Logperch	1	0.28	1	0.23	2	0.37	1	0.07	0	0.00	5	0.14
Walleye	0	0.00	0	0.00	0	0.00	0	0.00	12	1.46	12	0.34
Striped bass hybrid*	0	0.00	0	0.00	0	0.00	1	0.07	0	0.00	1	0.03
Overall	*357*	*100.00*	*427*	*100.00*	*535*	*100.00*	*1,381*	*100.00*	*820*	*100.00*	*3,520*	*100.00*
Number of species	*17*		*13*		*18*		*21*		*19*		*26*	

* Not counted as separate species.

Table 3-11

Monthly catch per effort (number per 30 min) for fishes collected by a DC electrofisher in Conowingo Pond, June-October 1999.

	June	July	August	September	October	Mean
Gizzard shad	7.25	46.00	43.25	26.25	30.25	30.60
Common carp	0.25	1.75	1.25	2.75	6.75	2.55
Golden shiner	0.00	0.25	3.00	0.25	0.00	0.70
Comely shiner	3.50	0.25	12.25	3.50	10.75	6.05
Spottail shiner	0.25	0.00	0.00	0.50	0.25	0.20
Spotfin shiner	12.50	5.75	4.25	6.75	4.75	6.80
Bluntnose minnow	0.00	0.00	0.25	0.00	0.00	0.05
Quillback	0.00	0.00	2.00	0.50	1.75	0.85
White sucker	0.00	0.00	0.00	0.00	3.50	0.70
Northern hogsucker	0.00	0.00	0.00	0.00	0.00	0.00
Shorthead redhorse	1.25	1.00	1.25	1.00	2.50	1.40
White catfish	0.00	0.00	0.00	0.25	0.00	0.05
Yellow bullhead	0.25	0.00	0.50	0.00	1.00	0.35
Brown bullhead	0.00	0.00	0.00	0.25	0.00	0.05
Channel catfish	6.75	4.25	6.50	4.50	5.75	5.55
Rock bass	0.75	2.00	1.50	4.50	4.00	2.55
Redbreast sunfish	2.75	0.00	0.25	0.50	0.25	0.75
Green sunfish	11.25	11.50	7.75	35.00	25.00	18.10
Pumpkinseed	0.25	0.00	1.25	9.50	1.75	2.55
Bluegill	12.00	9.00	29.25	138.75	57.75	49.35
Smallmouth bass	29.50	21.00	16.25	65.25	25.00	31.40
Largemouth bass	0.25	3.75	2.50	44.00	20.50	14.20
White crappie	0.00	0.00	0.00	0.50	0.50	0.20
Black crappie	0.00	0.00	0.00	0.25	0.00	0.05
Tessellated darter	0.25	0.00	0.00	0.00	0.00	0.05
Logperch	0.25	0.25	0.50	0.25	0.00	0.25
Walleye	0.00	0.00	0.00	0.00	3.00	0.60
Striped bass hybrid*	0.00	0.00	0.00	0.25	0.00	0.05
Overall	*89.25*	*106.75*	*133.75*	*345.25*	*205.00*	*176.00*
Number of species	*17*	*13*	*18*	*21*	*19*	*26*

* Not counted as separate species.

Table 3-12

Catch per effort (number per 30 min) for fishes collected by a DC electrofisher at stations in Conowingo Pond, June-October 1999.

	Station				
	161**	164	165	190**	Mean
Gizzard shad	16.60	68.80	11.60	25.40	30.60
Common carp	5.80	1.40	0.80	2.20	2.55
Golden shiner	0.00	0.00	0.20	2.60	0.70
Comely shiner	1.20	6.60	5.60	10.80	6.05
Spottail shiner	0.20	0.20	0.20	0.20	0.20
Spotfin shiner	2.20	7.80	11.20	6.00	6.80
Bluntnose minnow	0.00	0.00	0.20	0.00	0.05
Quillback	2.00	0.00	0.40	1.00	0.85
White sucker	2.00	0.20	0.60	0.00	0.70
Shorthead redhorse	2.60	1.60	0.40	1.00	1.40
White catfish	0.00	0.20	0.00	0.00	0.05
Yellow bullhead	0.40	0.80	0.20	0.00	0.35
Brown bullhead	0.20	0.00	0.00	0.00	0.05
Channel catfish	11.20	2.40	4.00	4.60	5.55
Rock bass	0.60	3.20	6.40	0.00	2.55
Redbreast sunfish	0.20	1.20	0.20	1.40	0.75
Green sunfish	9.80	14.20	26.60	21.80	18.10
Pumpkinseed	0.20	4.40	5.40	0.20	2.55
Bluegill	39.80	44.00	57.00	56.60	49.35
Smallmouth bass	47.00	28.60	33.60	16.40	31.40
Largemouth bass	36.00	8.80	7.60	4.40	14.20
White crappie	0.00	0.20	0.60	0.00	0.20
Black crappie	0.00	0.00	0.20	0.00	0.05
Tessellated darter	0.00	0.00	0.00	0.20	0.05
Logperch	0.00	0.20	0.80	0.00	0.25
Walleye	1.60	0.00	0.00	0.80	0.60
Striped bass hybrid*	0.20	0.00	0.00	0.00	0.05
Overall	*179.80*	*194.80*	*173.80*	*155.60*	*176.00*
Number of species	*19*	*19*	*22*	*17*	*26*

* Not counted as separate species.

** Located within the influence of PBAPS thermal effluent.

Table 3-13

Comparison of the monthly catch per effort (number per 30 minutes) for the common and Environmental Protection Agency designated, representative, important species collected at electrofishing stations in Conowingo Pond in June-October. "-"-designates a period when no effort was expended. Underlined CPEs are greater than historical values and italicized are less than historical values.

	June		July		August		September		October	
	N*	Range	N*	Range	N*	Range	N*	Range	N*	Range
					White crappie					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	0.00-1.18	3	0.92-1.50	4	1.00-3.07	2	3.0-3.58	8	1.25-33.00
1997		0.25		*0.25*		*0.25*		*1.25*		*0.75*
1998		0.25		*0.00*		*0.00*		*0.25*		*0.00*
1999		0.00		*0.00*		*0.00*		*0.50*		*0.50*
					Channel catfish					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	6.86-50.95	3	9.30-25.05	4	14.67-56.00	2	16.54-23.17	8	6.25-72.25
1997		*6.00*		10.75		56.25		26.75		12.75
1998		*5.50*		13.75		19.50		23.25		23.25
1999		*6.75*		*4.25*		*6.50*		*4.50*		*5.75*
					Bluegill					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	6.33-11.09	3	7.50-10.38	4	15.80-42.00	2	20.00-33.09	8	22.62-136.25
1997		*4.50*		*6.05*		20.75		37.00		*13.25*
1998		*6.00*		10.00		22.00		62.75		25.75
1999		12.00		9.00		29.25		138.75		57.75
					Gizzard shad					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	0.38-6.42	3	0.00-129.60	4	8.0-111.17	2	2.06-29.08	8	1.00-101.37
1997		1.50		46.50		11.50		34.25		34.50
1998		2.50		9.25		11.00		10.25		17.75
1999		7.25		46.00		43.25		26.25		30.25
					Smallmouth bass					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	9.80-15.67	3	13.0-15.17	4	12.67-20.58	2	18.43-19.67	8	12.88-64.75
1997		13.75		17.00		40.25		30.50		14.25
1998		17.75		19.75		32.00		38.75		25.50
1999		29.50		21.00		16.25		65.25		25.00
					Largemouth bass					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	0.43-2.42	3	0.30-1.67	4	0.60-3.83	2	3.69-9.17	8	1.04-98.75
1997		1.50		3.50		7.25		*3.50*		27.25
1998		3.75		1.50		2.25		*2.00*		13.50
1999		*0.25*		3.75		2.50		44.00		20.50
					Walleye					
Pre-operational	-	-	-	-	-	-	-	-	-	-
Post-operational	3	0.00-0.25	3	0.00-1.20	4	0.08-0.33	2	0.00-2.83	8	0.00-7.12
1997		0.00		0.00		*0.00*		0.00		0.75
1998		0.00		0.00		*0.00*		0.00		1.00
1999		0.00		0.00		*0.00*		0.00		3.00

* N= the number of years in the historical period (pre- or post-operational) that sampling occurred in a given month.

Table 3-14

Number and percent composition of fishes collected by 10 x 4 ft seine per month in Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Gizzard shad	0	0.00	0	0.00	79	9.69	43	2.55	1	0.09	123	1.83
Central stoneroller	2	0.12	0	0.00	0	0.00	0	0.00	0	0.00	2	0.03
Rosyside dace	8	0.49	6	0.40	13	1.60	32	1.90	8	0.74	67	1.00
Common carp	0	0.00	0	0.00	0	0.00	0	0.00	1	0.09	1	0.01
Cutlips minnow	1	0.06	4	0.27	1	0.12	0	0.00	1	0.09	7	0.10
Comely shiner	1	0.06	12	0.81	14	1.72	0	0.00	0	0.00	27	0.40
Common shiner	21	1.28	14	0.94	10	1.23	7	0.42	3	0.28	55	0.82
Spottail shiner	1	0.06	35	2.36	0	0.00	2	0.12	17	1.57	55	0.82
Swallowtail shiner	2	0.12	3	0.20	2	0.25	0	0.00	0	0.00	7	0.10
Rosyface shiner	0	0.00	4	0.27	1	0.12	1	0.06	0	0.00	6	0.09
Spotfin shiner	597	36.31	770	51.89	541	66.38	1,400	83.04	863	79.54	4,171	62.12
Bluntnose minnow	254	15.45	401	27.02	40	4.91	35	2.08	82	7.56	812	12.09
Blacknose dace	9	0.55	0	0.00	3	0.37	8	0.47	3	0.28	23	0.34
Longnose dace	1	0.06	5	0.34	1	0.12	1	0.06	1	0.09	9	0.13
Creek chub	15	0.91	16	1.08	6	0.74	10	0.59	0	0.00	47	0.70
Fallfish	3	0.18	0	0.00	0	0.00	0	0.00	0	0.00	3	0.04
Silverjaw minnow	0	0.00	0	0.00	2	0.25	0	0.00	0	0.00	2	0.03
Mimic shiner	5	0.30	44	2.96	1	0.12	3	0.18	33	3.04	86	1.28
Quillback	54	3.28	8	0.54	0	0.00	0	0.00	0	0.00	62	0.92
White sucker	73	4.44	42	2.83	11	1.35	2	0.12	0	0.00	128	1.91
Northern hogsucker	0	0.00	0	0.00	0	0.00	0	0.00	4	0.37	4	0.06
Banded killifish	1	0.06	1	0.07	0	0.00	0	0.00	1	0.09	3	0.04
Green sunfish	0	0.00	0	0.00	1	0.12	4	0.24	0	0.00	5	0.07
Pumpkinseed	11	0.67	13	0.88	14	1.72	30	1.78	19	1.75	87	1.30
Bluegill	34	2.07	10	0.67	4	0.49	69	4.09	27	2.49	144	2.14
Smallmouth bass	25	1.52	9	0.61	16	1.96	15	0.89	8	0.74	73	1.09
Largemouth bass	85	5.17	9	0.61	24	2.94	12	0.71	7	0.65	137	2.04
Lepomis sp*	11	0.67	0	0.00	0	0.00	0	0.00	0	0.00	11	0.16
Tessellated darter	415	25.24	62	4.18	16	1.96	6	0.36	3	0.28	502	7.48
Logperch	13	0.79	15	1.01	14	1.72	6	0.36	2	0.18	50	0.74
Shield darter	1	0.06	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01
Greenside darter	1	0.06	1	0.07	1	0.12	0	0.00	1	0.09	4	0.06
Overall	*1,644*	*100.00*	*1,484*	*100.00*	*815*	*100.00*	*1,686*	*100.00*	*1,085*	*100.00*	*6,714*	*100.00*
Number of species	*25*		*22*		*23*		*19*		*20*		*31*	

* Not counted as separate species.

Table 3-15

Monthly catch per effort (number per collection) for fishes collected by a 10 x 4 ft seine in Conowingo Pond, June-October 1999.

	June	July	August	September	October	Mean
Gizzard shad	0.00	0.00	11.29	6.14	0.14	3.51
Central stoneroller	0.29	0.00	0.00	0.00	0.00	0.06
Rosyside dace	1.14	0.86	1.86	4.57	1.14	1.91
Common carp	0.00	0.00	0.00	0.00	0.14	0.03
Cutlips minnow	0.14	0.57	0.14	0.00	0.14	0.20
Comely shiner	0.14	1.71	2.00	0.00	0.00	0.77
Common shiner	3.00	2.00	1.43	1.00	0.43	1.57
Spottail shiner	0.14	5.00	0.00	0.29	2.43	1.57
Swallowtail shiner	0.29	0.43	0.29	0.00	0.00	0.20
Rosyface shiner	0.00	0.57	0.14	0.14	0.00	0.17
Spotfin shiner	85.29	110.00	77.29	200.00	123.29	119.17
Bluntnose minnow	36.29	57.29	5.71	5.00	11.71	23.20
Blacknose dace	1.29	0.00	0.43	1.14	0.43	0.66
Longnose dace	0.14	0.71	0.14	0.14	0.14	0.26
Creek chub	2.14	2.29	0.86	1.43	0.00	1.34
Fallfish	0.43	0.00	0.00	0.00	0.00	0.09
Silverjaw minnow	0.00	0.00	0.29	0.00	0.00	0.06
Mimic shiner	0.71	6.29	0.14	0.43	4.71	2.46
Quillback	7.71	1.14	0.00	0.00	0.00	1.77
White sucker	10.43	6.00	1.57	0.29	0.00	3.66
Northern hogsucker	0.00	0.00	0.00	0.00	0.57	0.11
Banded killifish	0.14	0.14	0.00	0.00	0.14	0.09
Green sunfish	0.00	0.00	0.14	0.57	0.00	0.14
Pumpkinseed	1.57	1.86	2.00	4.29	2.71	2.49
Bluegill	4.86	1.43	0.57	9.86	3.86	4.11
Smallmouth bass	3.57	1.29	2.29	2.14	1.14	2.09
Largemouth bass	12.14	1.29	3.43	1.71	1.00	3.91
Lepomis sp*	1.57	0.00	0.00	0.00	0.00	0.31
Tessellated darter	59.29	8.86	2.29	0.86	0.43	14.34
Logperch	1.86	2.14	2.00	0.86	0.29	1.43
Shield darter	0.14	0.00	0.00	0.00	0.00	0.03
Greenside darter	0.14	0.14	0.14	0.00	0.14	0.11
Overall	*234.85*	*212.01*	*116.44*	*240.86*	*154.98*	*191.82*
Number of species	*25*	*22*	*23*	*19*	*20*	*31*

* Not counted as separate species.

Table 3-16

Catch per effort (number per collection) for fishes collected by a 10 x 4 ft seine at stations in Conowingo Pond, June-October 1999.

	Station							
	202	203	208	209	210	212	214*	Mean
Gizzard shad	0.80	0.00	0.00	0.00	0.00	23.60	0.20	3.51
Central stoneroller	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.06
Rosyside dace	0.00	0.00	0.00	0.00	0.00	13.40	0.00	1.91
Common carp	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.03
Cutlips minnow	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.20
Comely shiner	2.80	0.00	1.40	0.00	0.00	1.20	0.00	0.77
Common shiner	0.00	0.00	0.00	0.00	0.00	10.80	0.20	1.57
Spottail shiner	2.00	3.00	0.00	0.00	0.00	5.80	0.20	1.57
Swallowtail shiner	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.20
Rosyface shiner	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.17
Spotfin shiner	170.40	115.20	64.40	48.80	184.80	209.60	41.00	119.17
Bluntnose minnow	33.20	9.00	23.00	14.60	2.00	71.00	9.60	23.20
Blacknose dace	0.00	0.00	0.00	0.00	0.00	4.60	0.00	0.66
Longnose dace	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.26
Creek chub	0.00	0.00	0.00	0.20	0.00	9.20	0.00	1.34
Fallfish	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.09
Silverjaw minnow	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.06
Mimic shiner	7.60	8.20	0.20	0.00	0.00	1.20	0.00	2.46
Quillback	0.00	12.40	0.00	0.00	0.00	0.00	0.00	1.77
White sucker	0.00	0.00	0.00	0.00	0.00	25.60	0.00	3.66
Northern hogsucker	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.11
Banded killifish	0.00	0.00	0.20	0.00	0.00	0.00	0.40	0.09
Green sunfish	0.00	0.00	0.00	0.00	0.20	0.80	0.00	0.14
Pumpkinseed	0.00	0.20	0.40	5.80	3.20	6.60	1.20	2.49
Bluegill	0.00	0.60	0.00	4.60	2.20	10.80	10.60	4.11
Smallmouth bass	2.40	3.20	4.00	0.00	1.60	2.60	0.80	2.09
Largemouth bass	1.60	0.00	0.60	20.20	1.20	3.60	0.20	3.91
Lepomis sp**	0.00	0.40	1.20	0.20	0.40	0.00	0.00	0.31
Tessellated darter	27.40	8.20	5.80	4.80	0.20	54.00	0.00	14.34
Logperch	0.00	2.80	0.00	0.20	0.40	6.60	0.00	1.43
Shield darter	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Greenside darter	0.00	0.60	0.00	0.00	0.20	0.00	0.00	0.11
Overall	*248.40*	*163.80*	*101.20*	*99.40*	*196.40*	*468.20*	*65.40*	*191.82*
Number of species	*10*	*11*	*9*	*8*	*10*	*25*	*12*	*31*

* Located within the influence of PBAPS thermal effluent.

** Not counted as separate species.

Table 3-17

Diversity and evenness values for fishes taken by seine per month in Conowingo Pond, June-October 1999.

Month	Diversity	Evenness
June	0.819	0.579
July	0.677	0.505
August	0.631	0.464
September	0.370	0.290
October	0.407	0.312

Table 3-18

Index of percent similarity of species composition between seine stations during zero tower operation in Conowingo Pond, June-October 1999.

	Station						
Station	202	203	208	209	210	212	214
202	100.00	83.93	85.62	67.93	71.14	72.00	77.94
203		100.00	76.66	60.31	73.26	59.22	70.20
208			100.00	69.80	66.76	67.66	79.49
209				100.00	53.98	69.17	70.54
210					100.00	49.89	67.58
212						100.00	64.94
214							100.00

Table 3-19

Index of percent similarlity of species composition per month in Conowingo Pond, June-October 1999.

	June	July	August	September	October
June	100.00	65.71	54.26	45.83	50.10
July		100.00	67.35	59.38	68.20
August			100.00	78.98	77.12
September				100.00	89.44
October					100.00

Table 3-20

Comparison of the monthly catch per effort (number per collection) for the common and Environmental Protection Agency designated, representative, important species collected at seine stations in Conowingo Pond in June-October. "-"-designates a period when no effort was expended. Underlined CPEs are greater than historical values and italcized are less than historical values.

	June		July		August		September		October	
	N*	Range	N*	Range	N*	Range	N*	Range	N*	Range
					White crappie					
Pre-operational	7	0-4.70	8	0-14.00	8	0-7.60	8	0-1.40	8	0-2.11
Post-operational	7	0-0.05	7	0-0.05	7	0	7	0-1.79	8	0-1.21
1997		0.00		0.00		0.00		0.00		0.00
1998		0.00		0.00		0.00		0.00		0.00
1999		0.00		0.00		0.00		0.00		0.00
					Channel catfish					
Pre-operational	5	0-1.60	8	0-0.31	8	0-0.60	8	0-0.90	8	0-0.18
Post-operational	7	0-0.08	7	0	7	0-0.07	7	0-0.57	8	0-0.43
1997		0.00		0.00		0.00		0.00		0.00
1998		0.00		0.29		0.14		0.00		0.29
1999		0.00		0.00		0.00		0.00		0.00
					Bluegill					
Pre-operational	7	0-2.06	8	0.42-62.46	8	0.62-103.05	8	0.45-62.80	8	0.75-50.71
Post-operational	7	0-2.00	7	0.36-5.71	7	0.21-3.21	7	0.14-28.38	8	0.07-39.36
1997		0.00		1.00		1.43		0.71		4.71
1998		7.57		6.00		7.00		16.14		12.71
1999		4.86		1.43		0.57		9.86		3.86
					Smallmouth bass					
Pre-operational	6	0-7.62	8	0-2.10	8	0-0.46	8	0-0.19	8	0-0.33
Post-operational	7	0-0.90	7	0.07-3.48	7	0-1.52	7	0-3.90	8	0-2.00
1997		1.14		1.14		0.57		0.43		0.00
1998		3.86		2.57		0.43		0.14		0.86
1999		3.57		1.29		2.29		2.14		1.14
					Largemouth bass					
Pre-operational	7	0-3.06	8	0.14-6.82	8	0-1.20	8	0-0.67	8	0-0.28
Post-operational	7	0.08-3.00	7	1.00-14.00	7	0.07-1.38	7	0-2.52	8	0.14-1.79
1997		10.29		3.14		1.00		0.71		0.00
1998		2.43		0.29		0.00		0.29		0.86
1999		12.14		1.29		3.43		1.71		1.00
					Spotfin shiner					
Pre-operational	7	11.50-85.43	8	2.11-79.92	8	19.17-100.95	8	26.53-124.10	8	27.42-134.74
Post-operational	7	27.62-79.92	7	9.64-60.21	7	17.58-105.71	7	20.91-213.29	8	22.31-284.43
1997		42.14		101.71		96.29		70.71		87.14
1998		28.86		44.14		214.14		176.86		262.57
1999		85.29		110.00		77.29		200.00		123.29
					Bluntnose minnow					
Pre-operational	7	0.35-1.30	8	0-8.15	8	0.08-47.00	8	0.20-11.40	8	0.43-6.55
Post-operational	7	0.30-6.33	7	0.86-7.43	7	0.23-8.79	7	0.09-20.48	8	0.71-62.50
1997		0.71		6.86		48.29		15.71		51.29
1998		13.86		1.43		84.00		36.86		31.57
1999		36.29		57.29		5.71		5.00		11.71
					Pumpkinseed					
Pre-operational	7	0-1.78	8	0.51-6.08	8	0.21-17.75	8	0.14-37.60	8	0-9.71
Post-operational	7	0-1.62	7	0.22-4.00	7	1.20-4.00	7	0.57-10.90	8	0-5.57
1997		0.71		1.43		1.86		1.14		1.57
1998		3.86		1.29		4.00		6.57		3.57
1999		1.57		1.86		2.00		4.29		2.71
					Spottail shiner					
Pre-operational	7	0.04-2.57	8	0-5.39	8	0-6.65	8	0-5.89	8	0-20.42
Post-operational	7	0.31-7.25	7	0.11-12.13	7	0-3.56	7	0-1.33	8	0-4.17
1997		9.71		27.00		5.71		3.57		1.57
1998		74.43		0.57		11.14		5.86		2.43
1999		0.14		5.00		0.00		0 29		2.43
					Tesselated darter					
Pre-operational	7	0-8 00	8	0-7.45	8	0-1.83	8	0-2.50	8	0-2.43
Post-operational	7	0.29-5.54	7	0.63-21.50	7	0.50-5.87	7	0.14-8.71	8	0.17-7.36
1997		31.14		54.00		5.29		2.00		1.29
1998		7.71		10.14		4.71		3.71		1.43
1999		59.29		8.86		2.29		0.86		0.43

* N= the number of years in the historical period (pre- or post-operational) that sampling occurred in a given month.

Table 3-21

Number and percent composition of fishes collected by trap net per month in Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Gizzard shad	0	0.00	92	47.92	6	8.45	1	0.39	0	0.00	99	15.09
Common carp	4	10.53	4	2.08	3	4.23	22	8.66	14	13.86	47	7.16
Golden shiner	0	0.00	0	0.00	0	0.00	1	0.39	0	0.00	1	0.15
Spotfin shiner	0	0.00	1	0.52	0	0.00	0	0.00	0	0.00	1	0.15
Quillback	0	0.00	0	0.00	0	0.00	3	1.18	0	0.00	3	0.46
Shorthead redhorse	2	5.26	3	1.56	0	0.00	1	0.39	3	2.97	9	1.37
White catfish	2	5.26	0	0.00	0	0.00	0	0.00	0	0.00	2	0.30
Yellow bullhead	1	2.63	1	0.52	0	0.00	3	1.18	0	0.00	5	0.76
Brown bullhead	0	0.00	1	0.52	2	2.82	13	5.12	1	0.99	17	2.59
Channel catfish	7	18.42	17	8.85	24	33.80	54	21.26	9	8.91	111	16.92
White perch	0	0.00	0	0.00	1	1.41	7	2.76	0	0.00	8	1.22
Rock bass	0	0.00	0	0.00	2	2.82	5	1.97	17	16.83	24	3.66
Redbreast sunfish	0	0.00	0	0.00	0	0.00	0	0.00	1	0.99	1	0.15
Green sunfish	1	2.63	25	13.02	1	1.41	4	1.57	0	0.00	31	4.73
Pumpkinseed	4	10.53	5	2.60	4	5.63	1	0.39	2	1.98	16	2.44
Bluegill	13	34.21	27	14.06	14	19.72	36	14.17	15	14.85	105	16.01
Smallmouth bass	0	0.00	0	0.00	0	0.00	1	0.39	0	0.00	1	0.15
Largemouth bass	1	2.63	3	1.56	1	1.41	15	5.91	2	1.98	22	3.35
White crappie	3	7.89	13	6.77	13	18.31	85	33.46	34	33.66	148	22.56
Black crappie	0	0.00	0	0.00	0	0.00	0	0.00	1	0.99	1	0.15
Walleye	0	0.00	0	0.00	0	0.00	2	0.79	2	1.98	4	0.61
Overall	*38*	*100.00*	*192*	*100.00*	*71*	*100.00*	*254*	*100.00*	*101*	*100.00*	*656*	*100.00*
Number of species	*10*		*12*		*11*		*17*		*12*		*21*	

Table 3-22

Monthly catch per effort (number per 24 h) for fishes collected by trap net at stations in Conowingo Pond, June-October 1999.

	June	July	August	September	October	Mean
Gizzard shad	0.00	11.32	0.76	0.13	0.00	2.44
Common carp	0.48	0.45	0.37	2.78	1.69	1.15
Golden shiner	0.00	0.00	0.00	0.13	0.00	0.03
Spotfin shiner	0.00	0.13	0.00	0.00	0.00	0.03
Quillback	0.00	0.00	0.00	0.37	0.00	0.07
Shorthead redhorse	0.24	0.37	0.00	0.12	0.36	0.22
White catfish	0.25	0.00	0.00	0.00	0.00	0.05
Yellow bullhead	0.13	0.13	0.00	0.38	0.00	0.13
Brown bullhead	0.00	0.13	0.25	1.61	0.12	0.42
Channel catfish	0.89	2.07	3.01	6.79	1.11	2.77
White perch	0.00	0.00	0.12	0.90	0.00	0.20
Rock bass	0.00	0.00	0.25	0.64	2.15	0.61
Redbreast sunfish	0.00	0.00	0.00	0.00	0.13	0.03
Green sunfish	0.12	3.10	0.12	0.50	0.00	0.77
Pumpkinseed	0.51	0.58	0.49	0.12	0.25	0.39
Bluegill	1.57	3.14	1.77	4.50	1.86	2.57
Smallmouth bass	0.00	0.00	0.00	0.13	0.00	0.03
Largemouth bass	0.14	0.37	0.13	1.93	0.25	0.56
White crappie	0.37	1.59	1.62	10.53	4.14	3.65
Black crappie	0.00	0.00	0.00	0.00	0.11	0.02
Walleye	0.00	0.00	0.00	0.25	0.24	0.10
Overall	*4.70*	*23.38*	*8.89*	*31.81*	*12.41*	*16.24*
Number of species	*10*	*12*	*11*	*17*	*12*	*21*

Table 3-23

Catch per effort (number per 24 h) for fishes collected by trap net at stations in Conowingo Pond, June-October 1999.

	Station				
	104	107	108	110*	Mean
Gizzard shad	0.10	0.10	0.20	9.36	2.44
Common carp	0.10	0.49	0.61	3.42	1.15
Golden shiner	0.00	0.00	0.00	0.10	0.03
Spotfin shiner	0.00	0.00	0.00	0.10	0.03
Quillback	0.00	0.29	0.00	0.00	0.07
Shorthead redhorse	0.00	0.48	0.20	0.19	0.22
White catfish	0.20	0.00	0.00	0.00	0.05
Yellow bullhead	0.00	0.00	0.30	0.21	0.13
Brown bullhead	0.20	0.19	1.30	0.00	0.42
Channel catfish	0.67	0.57	0.80	9.07	2.77
White perch	0.00	0.09	0.00	0.72	0.20
Rock bass	2.02	0.00	0.00	0.41	0.61
Redbreast sunfish	0.10	0.00	0.00	0.00	0.03
Green sunfish	0.30	0.39	0.30	2.08	0.77
Pumpkinseed	0.68	0.20	0.19	0.49	0.39
Bluegill	2.63	1.63	2.17	3.83	2.57
Smallmouth bass	0.00	0.00	0.00	0.10	0.03
Largemouth bass	0.31	0.19	0.31	1.44	0.56
White crappie	3.12	3.93	6.31	1.23	3.65
Black crappie	0.00	0.00	0.00	0.09	0.02
Walleye	0.10	0.00	0.00	0.29	0.10
Overall	*10.53*	*8.55*	*12.69*	*33.13*	*16.24*
Number of species	*13*	*12*	*11*	*17*	*21*

* Located within influence of PBAPS thermal effluent.

Table 3-24

Comparison of the monthly catch per effort (number per 24 h) for the common and Environmental Protection Agency designated, representative, important species collected at trap net stations in Conowingo Pond in June-October. "-"-designates a period when no effort was expended. Underlined CPEs are greater than historical values and italicized are less than historical values.

	June		July		August		September		October	
	N*	Range	N*	Range	N*	Range	N*	Range	N*	Range
					White crappie					
Pre-operational	7	29.82-144.41	7	17.08-87.09	7	9.41-75.11	7	10.67-63.54	8	7.24-114.21
Post-operational	15	0.52-34.74	7	1.01-17.46	7	1.11-23.31	7	5.35-34.81	16	1.13-27.19
1997		0.65		1.38		3.37		*1.70*		3.64
1998		1.96		*1.00*		1.61		*0.86*		2.65
1999		*0.37*		1.59		1.62		10.53		4.14
					Channel catfish					
Pre-operational	7	2.37-12.66	7	1.67-65.55	7	1.53-13.38	7	1.37-14.71	8	0.92-19.93
Post-operational	15	0.00-135.67	7	2.61-21.71	7	4.70-21.77	7	2.60-16.24	16	0.11-62.98
1997		3.36		*0.75*		1.87		*0.75*		0.75
1998		0.78		*0.25*		*1.49*		*1.08*		1.62
1999		0.89		*2.07*		3.01		6.79		1.11
					Bluegill					
Pre-operational	7	0.55-8.16	7	2.49-10.54	7	1.10-9.98	7	2.75-5.72	8	0.50-7.80
Post-operational	15	0-6.00	7	1.02-3.36	7	1.34-11.65	7	1.51-7.00	16	0.31-13.06
1997		3.47		*0.92*		2.83		2.60		2.24
1998		0.52		4.76		4.56		5.99		2.24
1999		1.57		3.14		1.77		4.50		1.86
					Gizzard shad					
Pre-operational	1	0.08	2	0.06-0.14	2	0	2	0.04-0.13	2	0.02-0.04
Post-operational	15	0-0.52	7	0-1.68	7	0.06-0.57	7	0-0.64	16	0-102.66
1997		0.00		0.00		0.12		0.00		0.25
1998		0.00		0.00		0.00		0.13		0.25
1999		0.00		11.32		0.76		0.13		0.00
					Smallmouth bass					
Pre-operational	--	--	4	0-0.06	4	0-0.02	4	0	4	0-0.02
Post-operational	15	0	7	0-0.18	7	0-0.07	7	0	16	0
1997		0.00		0.00		0.00		0.00		0.00
1998		0.00		0.00		0.00		0.00		0.00
1999		0.00		0.00		0.00		0.13		0.00
					Largemouth bass					
Pre-operational	4	0-0.08	6	0-0.05	6	0-0.15	6	0-0.08	7	0-0.12
Post-operational	15	0-0.29	7	0-0.30	7	0-0.12	7	0-0.12	16	0-0.77
1997		0.25		0.12		0.12		0.00		0.00
1998		0.00		0.25		0.00		0.00		0.00
1999		0.14		0.37		0.13		1.93		0.25
					Walleye					
Pre-operational	6	0-0.29	6	0-0.18	6	0-0.04	6	0-0.04	7	0-0.08
Post-operational	15	0-0.52	7	0-0.07	7	0-0.05	7	0-0.24	16	0-0.39
1997		0.00		0.00		0.00		0.00		0.00
1998		0.00		0.00		0.00		0.00		0.13
1999		0.00		0.00		0.00		0.25		0.24
					Brown bullhead					
Pre-operational	7	0.88-5.38	7	0.65-3.98	7	0.58-2.21	7	0.15-3.02	8	0.33-2.63
Post-operational	15	0-12.16	7	0.27-0.55	7	0.46-1.78	7	0.34-2.00	16	0-4.99
1997		0.12		*0.00*		*0.00*		*0.00*		0.12
1998		0.40		*0.12*		*0.00*		*0.00*		0.13
1999		0.00		*0.13*		*0.25*		1.61		0.12
					Pumpkinseed					
Pre-operational	7	0.53-7.31	7	1.40-11.32	7	0.86-3.12	7	1.26-6.46	8	1.23-10.34
Post-operational	15	0-9.29	7	0.30-4.53	7	0.41-2.70	7	0.38-4.00	16	0-41.25
1997		0.89		*0.12*		0.74		*0.12*		1.09
1998		0.26		*0.13*		*0.26*		0.74		0.50
1999		0.51		0.58		0.49		*0.12*		0.25

* N= the number of years in the historical period (pre- or post-operational) that sampling occurred in a given month.

Table 3-25

Number and percent composition of fishes collected by a 16 ft semi-balloon trawl per month in trawl zone 405, Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Gizzard shad	3	0.77	0	0.00	0	0.00	8	6.72	0	0.00	11	1.48
Common carp	4	1.02	3	2.78	2	5.00	8	6.72	5	6.02	22	2.97
Spottail shiner	0	0.00	1	0.93	0	0.00	0	0.00	0	0.00	1	0.13
Bluntnose minnow	0	0.00	1	0.93	0	0.00	0	0.00	0	0.00	1	0.13
Shorthead redhorse	1	0.26	1	0.93	0	0.00	0	0.00	0	0.00	2	0.27
White catfish	1	0.26	1	0.93	0	0.00	0	0.00	0	0.00	2	0.27
Yellow bullhead	0	0.00	0	0.00	0	0.00	1	0.84	0	0.00	1	0.13
Brown bullhead	1	0.26	1	0.93	0	0.00	1	0.84	0	0.00	3	0.40
Channel catfish	325	83.12	36	33.33	34	85.00	92	77.31	71	85.54	558	75.30
Rock bass	1	0.26	0	0.00	0	0.00	2	1.68	0	0.00	3	0.40
Bluegill	0	0.00	6	5.56	0	0.00	1	0.84	3	3.61	10	1.35
Largemouth bass	0	0.00	1	0.93	1	2.50	0	0.00	0	0.00	2	0.27
Tessellated darter	55	14.07	55	50.93	3	7.50	5	4.20	4	4.82	122	16.46
Yellow perch	0	0.00	1	0.93	0	0.00	0	0.00	0	0.00	1	0.13
Walleye	0	0.00	1	0.93	0	0.00	1	0.84	0	0.00	2	0.27
Overall	*391*	*100.00*	*108*	*100.00*	*40*	*100.00*	*119*	*100.00*	*83*	*100.00*	*741*	*100.00*
Number of species	*8*		*12*		*4*		*9*		*4*		*15*	

Table 3-26

Monthly catch per effort (number per 10 min haul) for fishes collected by a 16 ft semi-balloon trawl in trawl zone 405, Conowingo Pond, June-October 1999.

	June	July	August	September	October	Mean
Gizzard shad	0.57	0.00	0.00	1.33	0.00	0.38
Common carp	0.67	0.50	0.33	1.40	0.83	0.75
Spottail shiner	0.00	0.21	0.00	0.00	0.00	0.04
Bluntnose minnow	0.00	0.21	0.00	0.00	0.00	0.04
Shorthead redhorse	0.17	0.21	0.00	0.00	0.00	0.08
White catfish	0.17	0.21	0.00	0.00	0.00	0.08
Yellow bullhead	0.00	0.00	0.00	0.24	0.00	0.05
Brown bullhead	0.17	0.21	0.00	0.17	0.00	0.11
Channel catfish	54.88	6.67	5.67	15.33	11.83	18.88
Rock bass	0.17	0.00	0.00	0.33	0.00	0.10
Bluegill	0.00	1.17	0.00	0.24	0.50	0.38
Largemouth bass	0.00	0.21	0.24	0.00	0.00	0.09
Tessellated darter	10.45	10.04	0.50	0.83	0.67	4.50
Yellow perch	0.00	0.17	0.00	0.00	0.00	0.03
Walleye	0.00	0.21	0.00	0.24	0.00	0.09
Overall	*67.25*	*20.02*	*6.74*	*20.11*	*13.83*	*25.60*
Number of species	*8*	*12*	*4*	*9*	*4*	*15*

Table 3-27

Catch per effort (number per 10 min haul) for fishes collected by 16 ft semi-balloon trawl in trawl zone 405, Conowingo Pond, June-October 1999.

	Station						
	451*	452	453	454	455	456	Mean
Gizzard shad	0.00	0.80	0.40	0.80	0.00	0.29	0.38
Common carp	0.29	0.00	1.00	2.00	0.80	0.40	0.75
Spottail shiner *	0.00	0.00	0.00	0.00	0.25	0.00	0.04
Bluntnose minnow	0.00	0.00	0.25	0.00	0.00	0.00	0.04
Shorthead redhorse	0.00	0.00	0.25	0.00	0.20	0.00	0.08
White catfish	0.00	0.00	0.00	0.00	0.45	0.00	0.08
Yellow bullhead	0.29	0.00	0.00	0.00	0.00	0.00	0.05
Brown bullhead	0.00	0.20	0.00	0.20	0.25	0.00	0.11
Channel catfish	1.40	40.60	16.70	11.80	35.10	7.66	18.88
Rock bass	0.00	0.00	0.00	0.00	0.20	0.40	0.10
Bluegill	0.29	0.00	1.20	0.80	0.00	0.00	0.38
Largemouth bass	0.29	0.00	0.00	0.00	0.25	0.00	0.09
Tessellated darter	0.00	1.20	3.30	7.60	3.95	10.94	4.50
Yellow perch	0.00	0.00	0.00	0.20	0.00	0.00	0.03
Walleye	0.29	0.00	0.25	0.00	0.00	0.00	0.09
Overall	*2.85*	*42.80*	*23.35*	*23.40*	*41.45*	*19.69*	*25.60*
Number of species	*6*	*4*	*8*	*7*	*9*	*5*	*15*

* Locates within influence of PBAPS thermal effluent.

Table 3-28

Comparison of the monthly catch per effort (number per 10 min haul) for the common and Environmental Protection Agency designated, representative, important species collected at trawl zone 405 in Conowingo Pond in June-October. "-"-designates a period when no effort was expended. Underlined CPEs are greater than historical values and italicized are less than historical values.

	June		July		August		September		October	
	N*	Range	N*	Range	N*	Range	N*	Range	N*	Range
					White crappie					
Pre-operational	7	0.04-41.00	8	0.00-63.33	8	0.58-84.25	7	0.21-145.88	7	0.31-418.40
Post-operational	6	0.00-0.09	15	0.00-0.70	15	0.00-4.23	15	0.00-1.90	16	0.00-2.59
1997		0.17		0.33		0.00		0.00		0.00
1998		0.00		0.00		0.21		0.33		0.17
1999		0.00		0.00		0.00		0.00		0.00
					Channel catfish					
Pre-operational	7	0.88-294.24	8	0.00-156.33	8	1.80-138.67	7	2.00-278.88	7	6.57-933.80
Post-operational	6	9.70-117.36	15	1.25-88.83	15	0.00-180.26	15	0.14-220.15	16	2.79-201.02
1997		244.94		163.17		183.33		63.00		31.33
1998		130.96		92.00		168.25		112.38		102.88
1999		54.88		6.67		5.67		15.33		11.83
					Bluegill					
Pre-operational	6	0.06-2.75	8	0.00-22.55	8	0.00-18.13	7	0.08-21.33	7	0.00-17.75
Post-operational	6	0	15	0.00-0.33	15	0.00-5.51	15	0.00-6.25	16	0.00-2.40
1997		0.00		13.00		1.90		2.00		1.50
1998		0.17		0.00		0.17		0.00		0.67
1999		0.00		1.17		0.00		0.24		0.50
					Gizzard shad					
Pre-operational	--	--	2	0	2	0.00-0.04	2	0.00-0.50	2	0
Post-operational	6	0.00-0.14	15	0.00-15.88	15	0.00-4.83	15	0.00-6.43	16	0.00-165.92
1997		0.00		3.17		0.24		0.00		0.40
1998		0.00		0.00		0.33		0.33		0.00
1999		0.57		0.00		0.00		1.33		0.00
					Smallmouth bass					
Pre-operational	2	0.13-0.33	3	0.00-0.50	3	0.00-0.38	2	0.04-0.13	2	0
Post-operational	6	0.00-0.20	15	0.00-0.09	15	0.00-0.17	15	0.00-0.15	16	0.00-0.20
1997		0.00		0.00		0.00		0.00		0.00
1998		0.00		0.00		0.00		0.00		0.00
1999		0.00		0.00		0.00		0.00		0.00
					Largemouth bass					
Pre-operational	5	0.00-0.13	3	0.00-0.11	3	0.00-0.13	2	0.00-0.63	2	0.00-0.04
Post-operational	6	0	15	0	15	0.00-0.05	15	0.00-0.17	16	0.00-0.17
1997		0.00		0.17		0.33		0.00		0.17
1998		0.00		0.00		0.00		0.00		0.00
1999		0.00		0.21		0.24		0.00		0.00
					Walleye					
Pre-operational	6	0.00-0.12	5	0.00-0.11	5	0.00-0.16	4	0.00-0.16	4	0.00-0.16
Post-operational	6	0.00-0.10	15	0.00-0.25	15	0.00-0.11	15	0.00-0.29	16	0.00-0.12
1997		0.00		0.00		0.00		0.00		0.00
1998		0.00		0.00		0.38		0.00		0.00
1999		0.00		0.21		0.00		0.24		0.00
					Pumpkinseed					
Pre-operational	6	0.24-2.33	8	0.00-7.92	8	0.00-9.94	7	0.04-14.33	7	0.14-6.95
Post-operational	6	0.00-0.33	14	0.00-1.80	14	0.00-1.75	14	0.00-5.95	16	0.00-3.65
1997		0.00		0.00		0.00		0.33		0.00
1998		0.00		0.00		0.00		0.00		0.00
1999		0.00		0.00		0.00		0.00		0.00
					Tesselated darter					
Pre-operational	7	0.00-1.25	8	0.00-7.42	8	0.04-6.00	7	0.00-5.54	7	0.00-4.43
Post-operational	6	0.67-4.00	14	0.67-30.60	14	0.25-16.29	14	0.13-7.70	16	0.50-15.17
1997		18.85		33.17		29.10		18.33		9.83
1998		8.50		10.33		8.68		9.33		2.00
1999		10.45		10.04		0.50		0.83		0.67
					Spottail shiner					
Pre-operational	7	0.00-2.29	8	0.00-3.00	8	0.00-3.25	7	0.00-5.33	7	0.00-19.00
Post-operational	6	0.00-0.67	14	0.00-6.27	14	0.00-4.50	14	0.00-2.57	16	0.00-3.83
1997		0.17		0.83		1.50		0.00		0.00
1998		0.33		7.67		11.74		1.04		0.00
1999		0.00		0.21		0.00		0.00		0.00

* N= the number of years in the historical period (pre- or post-operational) that sampling occurred in a given month.

Table 3-29

Number and percent composition of fishes collected by a 16 ft semi-balloon trawl per month in trawl zone 408, Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Gizzard shad	401	59.14	5	7.81	1	2.33	2	13.33	0	0.00	409	48.69
Common carp	2	0.29	3	4.69	0	0.00	1	6.67	1	2.50	7	0.83
Spottail shiner	2	0.29	1	1.56	0	0.00	0	0.00	1	2.50	4	0.48
Bluntnose minnow	64	9.44	0	0.00	0	0.00	0	0.00	0	0.00	64	7.62
White catfish	0	0.00	0	0.00	0	0.00	0	0.00	1	2.50	1	0.12
Yellow bullhead	0	0.00	0	0.00	0	0.00	1	6.67	0	0.00	1	0.12
Brown bullhead	2	0.29	0	0.00	0	0.00	0	0.00	0	0.00	2	0.24
Channel catfish	61	9.00	24	37.50	30	69.77	3	20.00	1	2.50	119	14.17
Pumpkinseed	3	0.44	5	7.81	5	11.63	3	20.00	7	17.50	23	2.74
Bluegill	25	3.69	10	15.63	2	4.65	5	33.33	17	42.50	59	7.02
Smallmouth bass	9	1.33	1	1.56	2	4.65	0	0.00	0	0.00	12	1.43
Largemouth bass	10	1.47	9	14.06	1	2.33	0	0.00	4	10.00	24	2.86
Tessellated darter	99	14.60	6	9.38	2	4.65	0	0.00	7	17.50	114	13.57
Yellow perch	0	0.00	0	0.00	0	0.00	0	0.00	1	2.50	1	0.12
Overall	*678*	*100.00*	*64*	*100.00*	*43*	*100.00*	*15*	*100.00*	*40*	*100.00*	*840*	*100.00*
Number of species	*11*		*9*		*7*		*6*		*9*		*14*	

Table 3-30

Monthly catch per effort (number per 10 min haul) for fishes collected by a 16 ft semi-balloon trawl in trawl zone 408, Conowingo Pond, June-October 1999.

	June	July	August	September	October	Mean
Gizzard shad	67.40	0.88	0.17	0.33	0.00	13.76
Common carp	0.40	0.50	0.00	0.17	0.17	0.25
Spottail shiner	0.33	0.21	0.00	0.00	0.17	0.14
Bluntnose minnow	10.67	0.00	0.00	0.00	0.00	2.13
White catfish	0.00	0.00	0.00	0.00	0.17	0.03
Yellow bullhead	0.00	0.00	0.00	0.17	0.00	0.03
Brown bullhead	0.33	0.00	0.00	0.00	0.00	0.07
Channel catfish	10.24	4.00	5.00	0.50	0.17	3.98
Pumpkinseed	0.50	0.83	0.83	0.50	1.17	0.77
Bluegill	4.24	1.83	0.33	0.83	2.83	2.01
Smallmouth bass	1.50	0.17	0.33	0.00	0.00	0.40
Largemouth bass	1.67	1.50	0.17	0.00	0.67	0.80
White crappie	0.00	0.00	0.00	0.00	0.00	0.00
Tessellated darter	17.00	1.00	0.33	0.00	1.17	3.90
Yellow perch	0.00	0.00	0.00	0.00	0.17	0.03
Overall	*114.28*	*10.92*	*7.16*	*2.50*	*6.69*	*28.30*
Number of species	*11*	*9*	*7*	*6*	*9*	*14*

Table 3-31

Catch per effort (number per 10 min haul) for fishes collected by 16 ft semi-balloon trawl in trawl zone 408, Conowingo Pond, June-October 1999.

	Station						
	481	482	483	484	485	486	Mean
Gizzard shad	0.25	13.20	0.40	19.40	47.00	2.29	13.76
Common carp	0.00	0.40	0.20	0.20	0.00	0.69	0.25
Spottail shiner	0.45	0.00	0.40	0.00	0.00	0.00	0.14
Bluntnose minnow	0.00	0.00	0.60	0.60	11.60	0.00	2.13
White catfish	0.00	0.20	0.00	0.00	0.00	0.00	0.03
Yellow bullhead	0.00	0.20	0.00	0.00	0.00	0.00	0.03
Brown bullhead	0.00	0.20	0.00	0.20	0.00	0.00	0.07
Channel catfish	3.60	12.40	5.00	1.80	0.20	0.89	3.98
Pumpkinseed	0.20	2.20	1.80	0.20	0.20	0.00	0.77
Bluegill	1.20	4.40	2.00	2.20	1.80	0.49	2.01
Smallmouth bass	0.40	0.00	0.20	0.40	1.40	0.00	0.40
Largemouth bass	0.00	0.80	0.60	1.80	1.40	0.20	0.80
Tessellated darter	2.80	3.20	1.00	13.20	1.00	2.20	3.90
Yellow perch	0.00	0.20	0.00	0.00	0.00	0.00	0.03
Overall	*8.90*	*37.40*	*12.20*	*40.00*	*64.60*	*6.76*	*28.30*
Number of species	*7*	*11*	*10*	*10*	*8*	*6*	*14*

Table 3-32

Comparison of the monthly catch per effort (number per 10 min haul) for the common and Environmental Protection Agency designated, representative, important species collected at trawl zone 468 in Conowingo Pond in June-October. "-"-designates a period when no effort was expended. Underlined CPEs are greater than historical values and italicized are less than historical values.

	June		July		August		September		October	
	N*	Range	N*	Range	N*	Range	N*	Range	N*	Range
					White crappie					
Pre-operational	7	2.96-59.39	8	5.92-569.88	8	1.83-216.36	6	2.00-343.00	7	0.00-95.54
Post-operational	7	0.22-10.97	15	0.18-9.45	15	0.33-50.78	15	0.17-37.04	16	0.33-32.76
1997		*0.00*		*0.00*		*0.00*		*0.00*		*0.00*
1998		0.33		3.83		*0.00*		*0.00*		0.33
1999		*0.00*		*0.00*		*0.00*		*0.00*		0.00
					Channel catfish					
Pre-operational	7	5.67-113.88	8	3.60-144.25	8	0.00-226.17	6	0.00-139.25	7	2.31-13.44
Post-operational	7	3.22-26.17	15	0.67-55.25	15	0.42-49.81	15	1.45-41.96	16	0.17-95.57
1997		6.83		10.00		63.33		21.17		6.00
1998		7.00		2.50		2.83		1.67		0.17
1999		10.24		4.00		5.00		0.50		0.17
					Bluegill					
Pre-operational	6	0.04-7.25	8	0.04-42.50	8	0.83-243.41	6	0.00-22.16	7	0.29-22.54
Post-operational	7	0.00-0.49	15	0.00-38.09	15	1.25-32.00	15	1.17-35.37	16	0.09-19.33
1997		0.67		53.17		4.67		3.50		3.67
1998		3.83		103.83		7.17		3.33		5.83
1999		4.24		1.83		*0.33*		0.83		2.83
					Gizzard shad					
Pre-operational	--	--	2	0	2	0.33-12.46	2	0.58-10.58	2	0.03-0.08
Post-operational	7	0.00-32.33	15	0.10-673.00	15	0.14-22.17	15	0.08-66.97	16	0.00-173.73
1997		0.00		1.17		0.33		0.67		7.33
1998		75.17		0.00		0.17		4.00		0.00
1999		67.40		0.88		0.17		0.33		0.00
					Smallmouth bass					
Pre-operational	2	0.08-0.42	3	0.00-0.38	3	0.00-0.17	3	0.00-0.17	3	0.00-0.08
Post-operational	7	0.00-2.84	15	0.00-2.73	15	0.00-1.92	15	0.00-0.62	16	0.00-0.32
1997		1.17		1.00		0.33		0.17		0.17
1998		4.50		1.00		0.17		0.00		0.00
1999		1.50		0.17		0.33		0.00		0.00
					Largemouth bass					
Pre-operational	5	0.00-0.42	7	0.00-0.75	7	0.00-1.33	6	0.00-0.25	6	0.00-2.50
Post-operational	7	0.00-1.33	15	0.00-2.18	15	0.00-0.63	15	0.00-1.33	16	0.00-0.67
1997		0.17		10.00		1.67		1.00		0.17
1998		0.67		0.50		0.00		0.17		0.00
1999		1.67		1.50		0.17		0.00		0.67
					Walleye					
Pre-operational	3	0.00-0.08	6	0.00-0.08	6	0.00-0.08	5	0.00-0.08	5	0.00-0.08
Post-operational	7	0.00-0.24	15	0.00-0.09	15	0.00-0.13	15	0.00-0.09	16	0.00-0.45
1997		0.00		0.00		0.00		0.00		0.17
1998		0.00		0.00		0.00		0.00		0.00
1999		0.00		0.00		0.00		0.00		0.00
					Pumpkinseed					
Pre-operational	7	0.08-7.00	8	0.17-7.88	8	0.58-26.16	6	0.00-13.25	7	0.83-12.12
Post-operational	7	0.67-2.82	15	0.35-8.61	15	0.90-13.28	15	0.61-19.70	16	0.27-5.33
1997		1.50		0.50		2.50		2.33		3.00
1998		1.33		1.50		3.33		3.67		2.33
1999		0.50		0.83		0.83		0.50		1.17
					Tesselated darter					
Pre-operational	7	0.00-0.96	8	0.00-4.04	8	0.02-2.67	6	0.00-3.71	7	0.33-3.83
Post-operational	7	0.13-4.46	15	0.56-40.27	15	0.00-19.36	15	0.00-17.50	16	0.00-11.58
1997		36.50		221.17		6.17		3.83		3.33
1998		26.17		10.67		1.00		0.67		0.50
1999		17.00		1.00		0.33		0.00		1.17
					Spottail shiner					
Pre-operational	7	0.00-1.89	8	0.00-1.75	8	0.00-13.08	6	0.00-5.66	7	0.00-7.33
Post-operational	7	0.00-4.00	15	0.00-32.64	15	0.39-31.89	15	0.20-19.50	16	0.00-21.33
1997		1.17		0.17		0.00		0.00		0.33
1998		93.67		18.17		0.17		0.17		0.00
1999		0.33		0.21		0.00		0.00		0.17

* N= the number of years in the historical period (pre- or post-operational) that sampling occurred in a given month.

Table 3-33

Number and percent composition of fishes collected by 16 ft semi-balloon trawl per month at trawl transects in Conowingo Pond, June-October 1999.

	June		July		August		September		October		Overall	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
American shad	0	0.00	0	0.00	0	0.00	0	0.00	1	1.92	1	0.04
Gizzard shad	1,755	73.16	2	1.53	1	1.09	7	3.83	0	0.00	1,765	61.78
Common carp	10	0.42	3	2.29	1	1.09	4	2.19	1	1.92	19	0.67
Spottail shiner	11	0.46	0	0.00	0	0.00	3	1.64	1	1.92	15	0.53
Bluntnose minnow	7	0.29	0	0.00	0	0.00	0	0.00	0	0.00	7	0.25
Quillback	0	0.00	1	0.76	0	0.00	1	0.55	0	0.00	2	0.07
Shorthead redhorse	0	0.00	1	0.76	0	0.00	0	0.00	1	1.92	2	0.07
White catfish	0	0.00	1	0.76	0	0.00	0	0.00	0	0.00	1	0.04
Brown bullhead	1	0.04	0	0.00	4	4.35	1	0.55	0	0.00	6	0.21
Channel catfish	311	12.96	81	61.83	76	82.61	146	79.78	6	11.54	620	21.70
White perch	0	0.00	0	0.00	0	0.00	0	0.00	1	1.92	1	0.04
Pumpkinseed	2	0.08	0	0.00	2	2.17	1	0.55	2	3.85	7	0.25
Bluegill	10	0.42	29	22.14	1	1.09	3	1.64	20	38.46	63	2.21
Smallmouth bass	4	0.17	1	0.76	0	0.00	0	0.00	0	0.00	5	0.18
Largemouth bass	4	0.17	1	0.76	6	6.52	0	0.00	4	7.69	15	0.53
White crappie	2	0.08	0	0.00	0	0.00	0	0.00	0	0.00	2	0.07
Tessellated darter	280	11.67	11	8.40	0	0.00	16	8.74	12	23.08	319	11.17
Yellow perch	2	0.08	0	0.00	0	0.00	1	0.55	3	5.77	6	0.21
Walleye	0	0.00	0	0.00	1	1.09	0	0.00	0	0.00	1	0.04
Overall	*2,399*	*100.00*	*131*	*100.00*	*92*	*100.00*	*183*	*100.00*	*52*	*100.00*	*2,857*	*100.00*
Number of species	*13*		*10*		*8*		*10*		*11*		*19*	

Table 3-34

Monthly catch per effort (number per 10 min haul) for fishes collected by 16 ft semi-balloon trawl at trawl transects in Conowingo Pond, June-October 1999.

	June	July	August	September	October	Mean
American shad	0.00	0.00	0.00	0.00	0.11	0.02
Gizzard shad	195.00	0.22	0.12	0.78	0.00	39.22
Common carp	1.14	0.33	0.14	0.44	0.11	0.43
Spottail shiner	1.25	0.00	0.00	0.33	0.11	0.34
Bluntnose minnow	0.78	0.00	0.00	0.00	0.00	0.16
Quillback	0.00	0.11	0.00	0.11	0.00	0.04
Shorthead redhorse	0.00	0.11	0.00	0.00	0.11	0.04
White catfish	0.00	0.11	0.00	0.00	0.00	0.02
Brown bullhead	0.11	0.00	0.44	0.11	0.00	0.13
Channel catfish	35.03	9.00	9.14	16.22	0.67	14.01
White perch	0.00	0.00	0.00	0.00	0.11	0.02
Pumpkinseed	0.22	0.00	0.22	0.11	0.22	0.16
Bluegill	1.11	3.22	0.11	0.33	2.22	1.40
Smallmouth bass	0.44	0.11	0.00	0.00	0.00	0.11
Largemouth bass	0.44	0.11	0.71	0.00	0.44	0.34
White crappie	0.22	0.00	0.00	0.00	0.00	0.04
Tessellated darter	34.81	1.22	0.00	1.78	1.33	7.83
Yellow perch	0.25	0.00	0.00	0.11	0.33	0.14
Walleye	0.00	0.00	0.12	0.00	0.00	0.02
Overall	*270.80*	*14.54*	*11.00*	*20.32*	*5.76*	*64.47*
Number of species	*13*	*10*	*8*	*10*	*11*	*19*

Table 3-35

Catch per effort (number per 10 min haul) for fishes collected by 16 ft semi-balloon trawl at stations on trawl transects in Conowingo Pond, June-October 1999.

	Station									
	321	322	323	341	342	343	371	372	373	Mean
American shad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.02
Gizzard shad	0.00	0.42	30.20	310.20	0.20	9.40	0.00	0.00	2.60	39.22
Common carp	0.45	0.25	0.60	0.60	0.40	1.00	0.00	0.60	0.00	0.43
Spottail shiner	0.20	0.25	1.40	0.00	0.00	0.40	0.00	0.20	0.60	0.34
Bluntnose minnow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.16
Quillback	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.04
Shorthead redhorse	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.04
White catfish	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.02
Brown bullhead	0.00	0.00	0.00	0.60	0.40	0.20	0.00	0.00	0.00	0.13
Channel catfish	8.45	20.45	6.40	23.00	17.00	1.20	4.60	34.00	11.00	14.01
White perch	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.02
Pumpkinseed	0.00	0.00	0.40	0.20	0.00	0.20	0.00	0.00	0.60	0.16
Bluegill	0.60	0.60	0.60	3.60	0.20	5.40	0.40	0.20	1.00	1.40
Smallmouth bass	0.00	0.00	0.40	0.00	0.00	0.00	0.20	0.00	0.40	0.11
Largemouth bass	0.25	0.42	0.40	0.60	0.20	0.20	0.00	0.00	1.00	0.34
White crappie	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.04
Tessellated darter	6.20	34.05	6.40	5.80	1.00	14.60	0.20	0.40	1.80	7.83
Yellow perch	0.20	0.45	0.40	0.00	0.00	0.20	0.00	0.00	0.00	0.14
Walleye	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Overall	*16.55*	*57.31*	*47.20*	*345.00*	*19.40*	*33.20*	*5.40*	*35.60*	*20.80*	*64.47*
Number of species	*8*	*10*	*10*	*10*	*7*	*11*	*4*	*6*	*11*	*19*

Table 3-36

Comparison of the monthly catch per effort (number per 10 min haul) for the common and Environmental Protection Agency designated, representative, important species collected at trawl transects stations in Conowingo Pond in June-October. "-"-designates a period when no effort was expended. Underlined CPEs are greater than historical values and italicized are less than historical values.

	June		July		August		September		October	
	N*	Range	N*	Range	N*	Range	N*	Range	N*	Range
					White crappie					
Pre-operational	7	0.15-25.59	7	0.76-269.54	7	1.28-89.46	7	1.14-102.31	7	1.10-66.46
Post-operational	7	0-5.33	7	0.20-7.38	7	0.31-4.47	7	0-6.46	8	0.20-2.12
1997		0.11		2.78		0.67		0.22		0.22
1998		0.44		*0.00*		0.33		0.11		0.89
1999		0.22		*0.00*		*0.00*		0.00		*0.00*
					Channel catfish					
Pre-operational	7	4.85-120.38	7	11.75-134.27	7	9.0-141.14	7	4.68-495.08	7	9.48-48.70
Post-operational	7	3.43-59.35	7	6.44-84.50	7	0.80-166.29	7	7.25-185.54	8	2.80-133.28
1997		45.20		90.89		94.44		52.78		15.83
1998		36.78		77.58		61.87		23.33		7.11
1999		35.03		9.00		9.14		16.22		*0.67*
					Bluegill					
Pre-operational	6	0.05-1.77	7	0.02-17.19	7	0-65.07	7	0.54-18.77	7	0-35.54
Post-operational	7	0-0.09	7	0-3.31	7	0.30-11.08	7	0.25-13.92	8	0-9.63
1997		1.00		54.87		24.44		7.56		8.11
1998		0.78		11.14		2.25		3.44		2.00
1999		1.11		3.22		0.11		0.33		2.22
					Gizzard shad					
Pre-operational	--	--	2	0.00-0.19	2	0.07-1.00	2	0.00-0.38	2	0.00-0.12
Post-operational	7	0.00-8.09	7	0.08-12.58	7	0.18-2.70	7	0.00-6.25	8	0.00-2.27
1997		0.00		3.32		0.44		2.00		3.61
1998		46.33		0.14		4.65		0.22		0.56
1999		195.00		0.22		0.12		0.78		0.00
					Smallmouth bass					
Pre-operational	4	0.02-0.42	3	0.00-0.42	3	0.00-0.04	3	0.00-0.33	3	0
Post-operational	7	0	7	0.00-1.50	7	0.00-0.45	7	0.00-0.23	8	0.00-0.31
1997		0.44		0.94		0.11		0.33		0.11
1998		1.56		0.00		0.00		0.00		0.00
1999		0.44		0.11		0.00		0.00		0.00
					Largemouth bass					
Pre-operational	2	0.03	6	0.00-0.15	6	0.00-0.08	6	0.00-0.04	6	0.00-0.10
Post-operational	7	0.00-0.15	7	0.00-0.25	7	0.00-0.09	7	0.00-0.07	8	0.00-0.07
1997		0.12		0.38		0.44		0.67		0.00
1998		0.00		0.00		0.28		0.11		0.00
1999		0.44		0.11		0.71		0.00		0.44
					Walleye					
Pre-operational	5	0.02-0.14	6	0.00-0.12	6	0.00-0.04	6	0.00-0.17	6	0.00-0.04
Post-operational	7	0.00-0.36	7	0.00-0.04	7	0.00-0.18	7	0.00-0.06	8	0.00-0.19
1997		0.00		0.00		0.00		0.11		0.00
1998		0.11		0.00		0.00		0.00		0.00
1999		0.00		0.00		0.12		0.00		0.00
					Tesselated darter					
Pre-operational	6	0.00-0.69	7	0.00-0.64	7	0.04-1.78	7	0.12-8.67	7	0.23-3.78
Post-operational	7	0.00-15.50	7	0.50-58.33	7	0.00-12.25	7	0.00-11.50	8	0.45-4.80
1997		50.55		33.48		26.44		14.33		13.89
1998		22.78		12.75		5.89		5.56		0.89
1999		34.81		1.22		0.00		1.78		1.33
					Pumpkinseed					
Pre-operational	7	0.00-1.77	7	0.00-5.62	7	0.00-7.75	7	0.08-5.23	7	0.00-4.23
Post-operational	7	0.08-1.25	7	0.00-1.44	7	0.40-3.20	7	0.50-7.45	8	0.00-4.33
1997		0.47		2.38		0.56		0.33		1.19
1998		0.89		1.50		0.22		2.89		1.89
1999		0.22		0.00		0.22		0.11		0.22
					Spottail shiner					
Pre-operational	6	0.00-1.38	7	0.03-2.60	7	0.00-11.27	7	0.04-23.23	7	0.00-4.26
Post-operational	7	0.00-5.92	7	0.17-7.00	7	0.00-32.71	7	0.00-6.73	8	0.00-9.60
1997		1.23		0.56		0.00		0.11		0.25
1998		2.00		16.11		2.69		1.56		2.89
1999		1.25		*0.00*		0.00		0.33		0.11

* N= the number of years in the historical period (pre- or post-operational) that sampling occurred in a given month.

4.0 SUMMARY AND CONCLUSIONS

Monthly surveys were completed in June-October 1999, as prescribed in PECO's Study Plan and approved by the PADEP, to monitor the operation of zero cooling towers on fishes and thermal conditions in Conowingo Pond. The same sampling protocols utilized during PBAPS pre- and post-operational studies and in 1996 to 1998 were employed in 1999.

Compared to the historical record (1952-1998), river flows and inflow water temperatures in 1999 were lower. Specifically, river flows in summer 1999 were substantially lower than those observed in 1996, 1997, and 1998. During the long-term monitoring period of 1996 to 1999 a wide range of hydrological conditions were observed; for example, in 1996 hydrological conditions were deemed above normal characterized by higher river flows and lower temperatures, whereas the 1999 period was characterized by lower river flows and higher temperatures. Thus, the fish community in Conowingo Pond presumably were exposed to near-worst summer temperature conditions in 1999 compared to summers of 1996 to 1998.

PBAPS generally operated at the maximum power level achievable (<200%) in late summer, due to the end of cycle coast down (an annual occurrence in spring through summer) of Unit 3. Following the Unit 3 refueling outage, total power output was restored to near 200% (in early November).

Inlet temperatures at PBAPS mirrored the pattern of variation in inflow temperatures, but were consistently 1 to 4°F higher than corresponding values at Holtwood Dam during the summer. Inlet temperatures in summer 1999 were higher for a longer period than in 1997 and 1998.

Discharge ΔT's were mostly 19 to 20°F above the Holtwood inflow temperatures or ambient inlet temperatures. Both are less than the designed criterion of 20.8°F

Under the existing river flow and temperature conditions surveyed, the heated effluent quickly dissipated within 2 miles downstream of the PBAPS discharge. The heated discharge was primarily limited to the top 5 to 15 ft of the water column along the western shore at the Burkins Run transect and west to mid-pond areas at the Williams Tunnel and PA/MD State Line transects. The West location at Burkins Run, being nearest the discharge outlet, displayed the highest temperatures in the water column, with surface values 7.5 to 13.9°F higher than corresponding values at the PBAPS inlet. Although differences in profile ΔT values were noted among other locations and depths on transects downstream of the PBAPS discharge and at the transect upstream (Fishing Creek), the differences generally were <3°F. Similar variations were also observed between Holtwood Dam and the PBAPS inlet temperatures. Profile temperatures and patterns observed at downstream locations in summer 1999 (zero tower operation) were most similar to those observed under low flow conditions in 1995 when a minimum of three towers operated.

DO conditions in the vicinity of PBAPS in 1999 were similar to seasonal, spatial, and diurnal variations observed historically.

In determining whether or not zero tower operation affects the relative abundance, distribution, and species composition in Conowingo Pond, the following were evident in 1999: most of the monthly CPE's for the commonly collected species were within or above the historic range; CPE's among species and between stations were variable likely due to differences in year class strength; and no thermally stressed fish were observed. Overall, zero tower operation in 1999 had no discernible effect on the integrity of the balanced, indigenous fish community of Conowingo Pond. This conclusion also extends to some 1.2 million additional fish (as part of the ongoing American shad restoration program) that were introduced into Conowingo Pond via the East fish lift downstream of Conowingo Dam.

Findings of no obvious adverse effects of zero tower operation on fish relative abundance are not surprising and indeed are consistent with results reported in the literature (Bennett and Gibbons 1974; Coutant 1972, 1974; Raney *et al.* 1973; Romberg *et al.* 1943; PECO 1975; Stauffer *et al.* 1975; Thorpe and Gibbons 1977). A major contributing factor for this conclusion is the fish behavioral response (preference or avoidance) to thermal discharge which assures continued propagation of balanced, indigenous, community. Conowingo Pond fishes are no exception in that regard; they are not trapped and thus they freely exercise their preference/avoidance behavior relative to PBAPS discharge. Because the

configuration and size of the PBAPS thermal plume and its associated temperature profiles vary with the prevailing hydrological conditions fishes are not consistently exposed to a specific temperature rise for a long time. The temperature regime created as a result of zero tower operation was within the tolerance limits of fishes; no direct mortality or stress was observed. The observations made during the monitoring in 1995 to 1999 are consistent with the laboratory-predicted responses of Conowingo fishes.

Fishes can and will follow a temperature gradient. They normally follow this gradient to or toward their preferred temperature. The behavior of a given species often depends on the magnitude of change of temperature to which it may be exposed. It may be attracted to a higher or lower temperature, or it may avoid higher or lower temperature, or it may not react.

The preference and avoidance behavior of fishes is an important factor which govern their distribution in relationship to heated discharges. Lethal temperatures are avoided by motile aquatic organisms. Thus, fishes generally avoid the hotter part of plumes. Observations at power stations discharging relatively large volumes of heated water into rivers and lakes confirm the absence or rarity of thermal fish kills or serious biological damage. Upper temperature tolerance limits are not applicable unless fishes are trapped and have no escape routes; fishes at PBAPS are not trapped. Even in a trapped situation, fishes can withstand a sudden temperature change of 20°F, depending upon the acclimation temperature.

The fish community in Conowingo Pond shows great seasonal and annual fluctuations in abundance under natural conditions, adapted to living over a wide range of temperatures within its own balance. This is well corroborated from the observations that the relative abundance of common fishes in Conowingo was within the historical range both during the complete shutdown of PBAPS in 1987 to 1989 and with full operation without cooling towers in 1996 to 1999. Based on these observations, a fair conclusion can be made that the propagation of a balanced, indigenous fish community in Conowingo Pond can be expected without operation of cooling towers at PBAPS.

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APPENDIX A

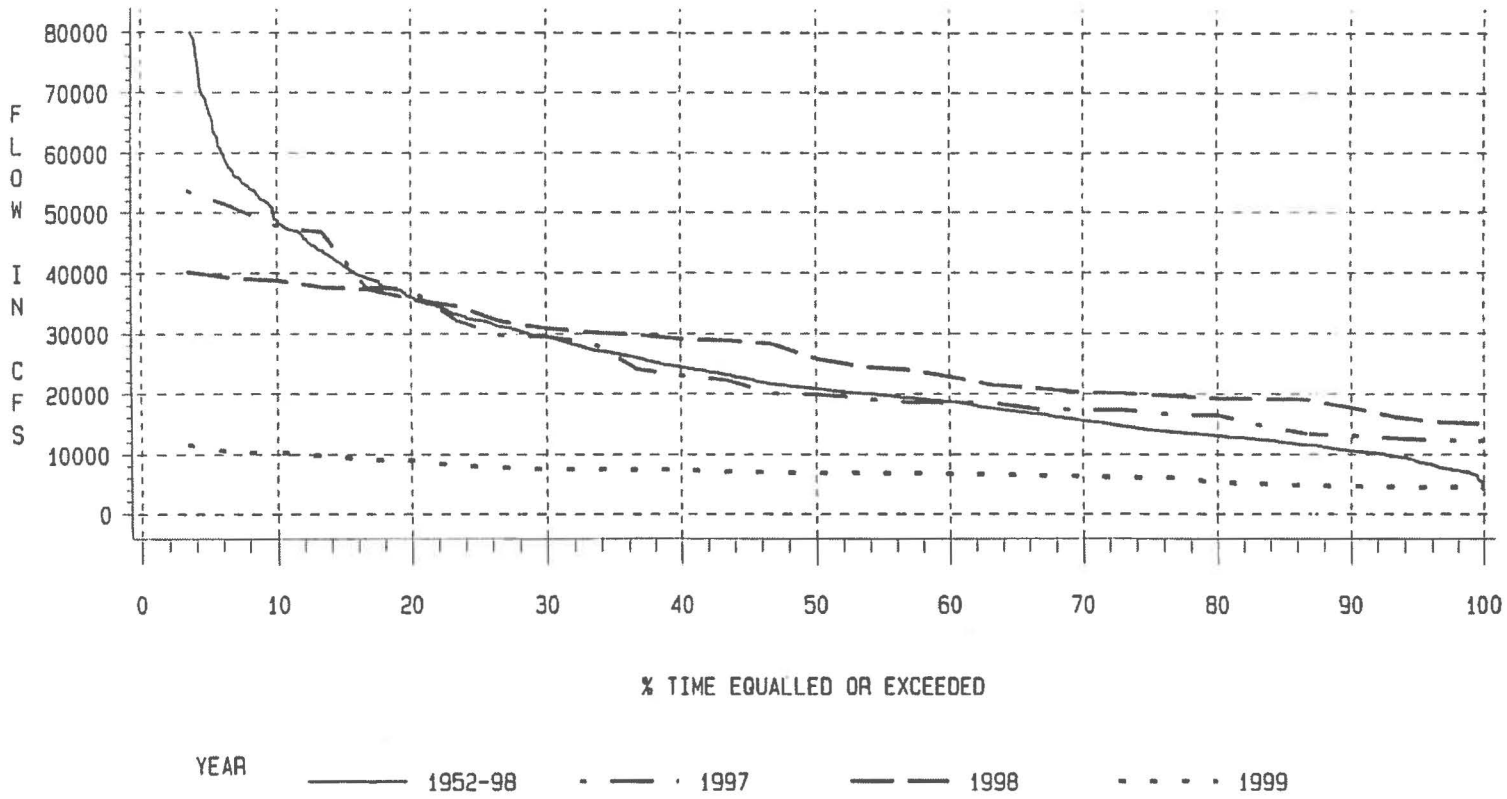
MONTHLY FLOW DURATION CURVES
JUNE-OCTOBER
HISTORICAL (1952-1998) VERSUS 1997, 1998, AND 1999

AND

JOINT OCCURRENCE OF DAILY WATER TEMPERATURE AND RIVER FLOW
JUNE-OCTOBER
HISTORICAL (1956-1998), 1997, 1998, AND 1999

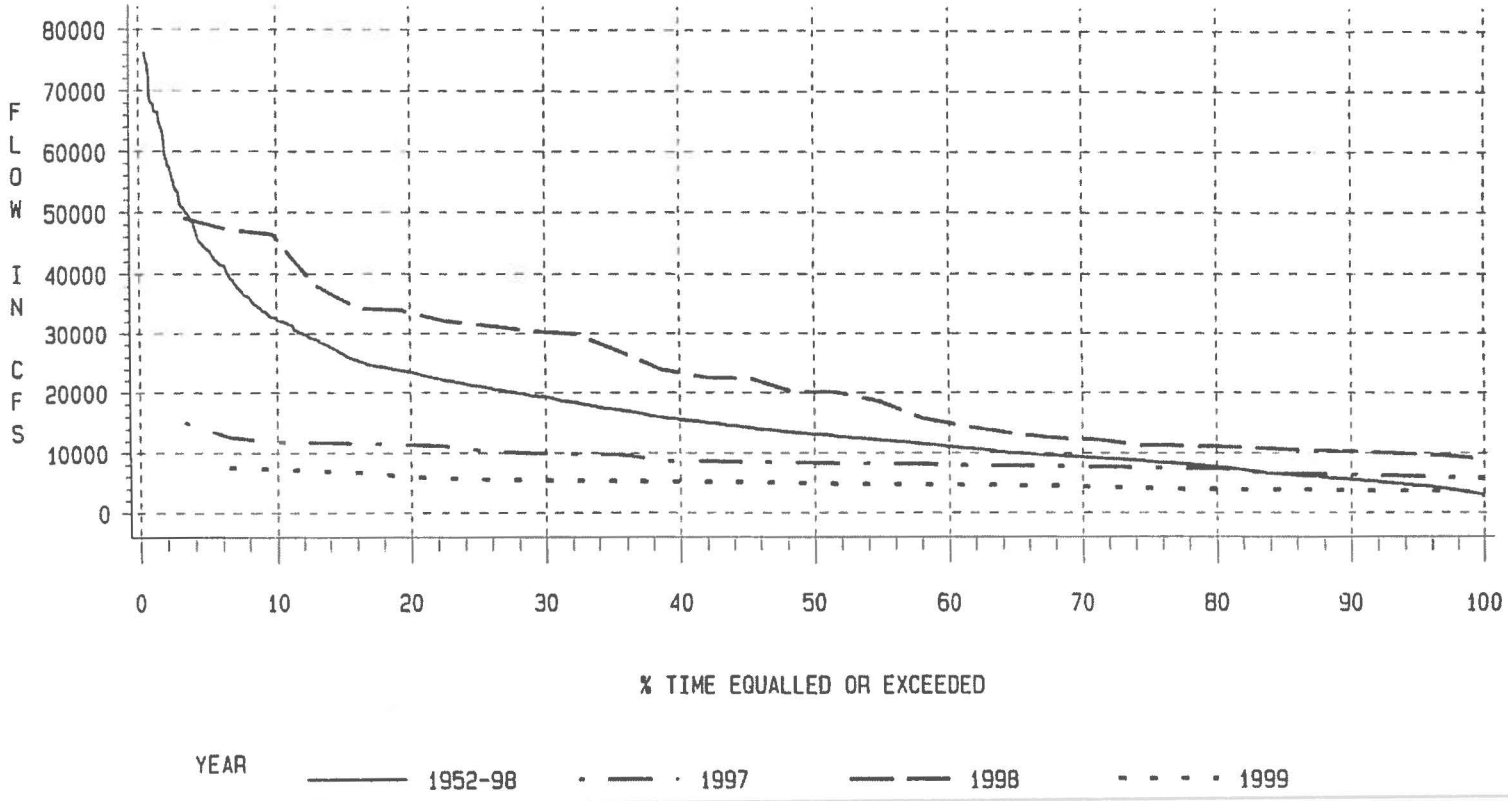
Duration curve of average daily river flows at Holtwood Dam,
1952 to 1997 (historical), 1997, 1998 and 1999.

MONTH=JUNE



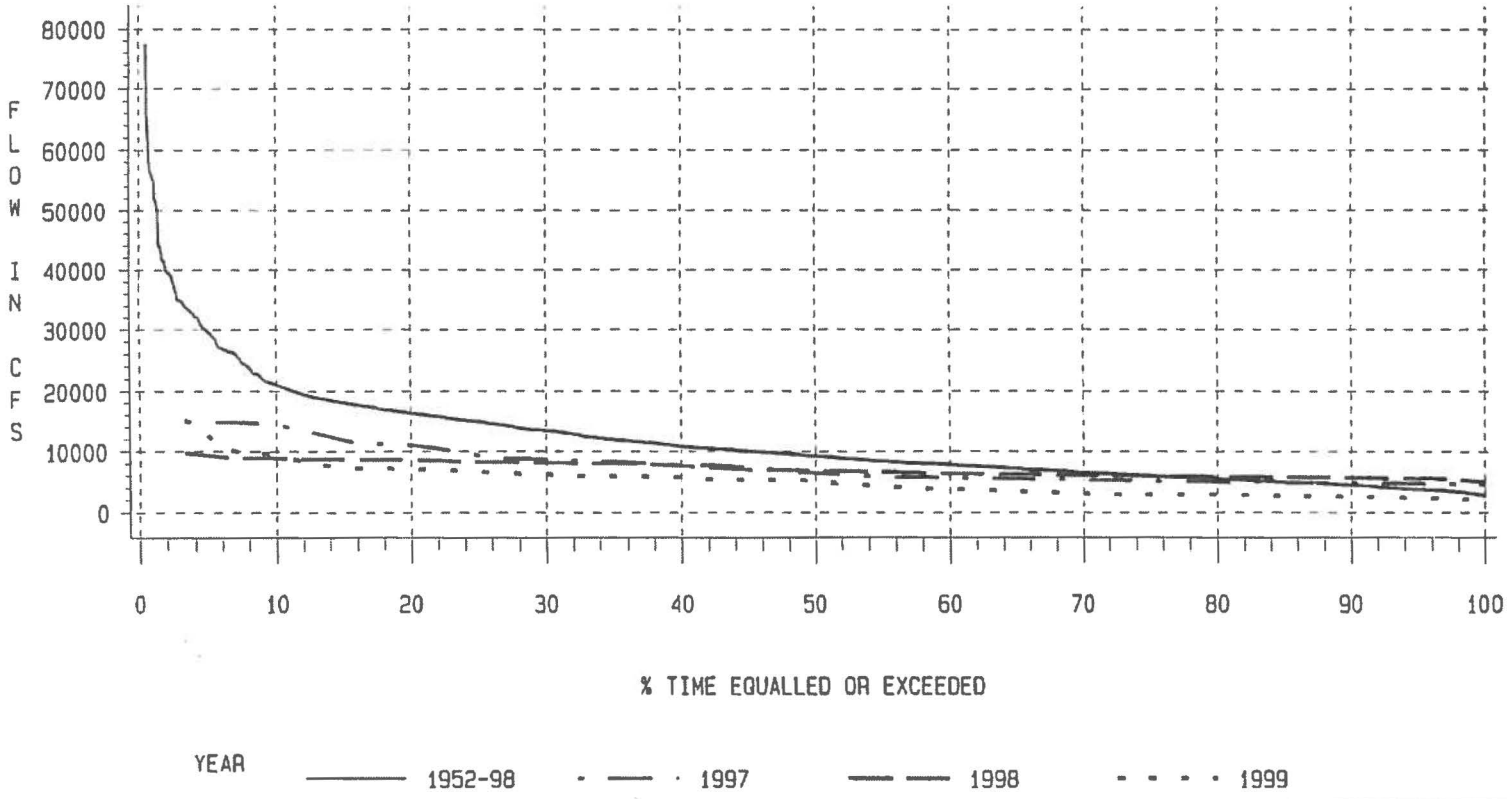
Duration curve of average daily river flows at Holtwood Dam,
1952 to 1997 (historical), 1997, 1998 and 1999.

MONTH=JULY



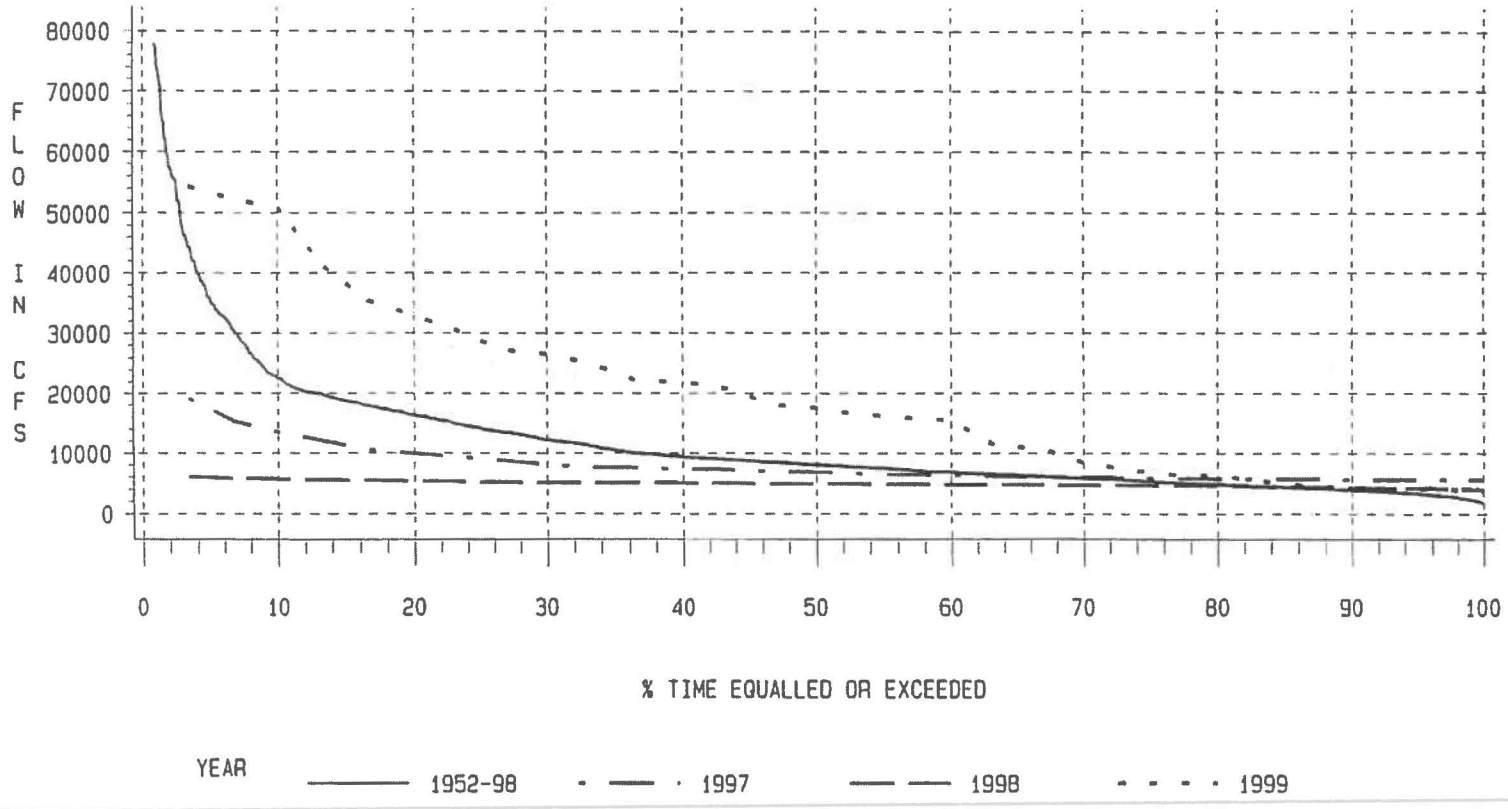
Duration curve of average daily river flows at Holtwood Dam,
1952 to 1997 (historical), 1997, 1998 and 1999.

MONTH=AUGUST



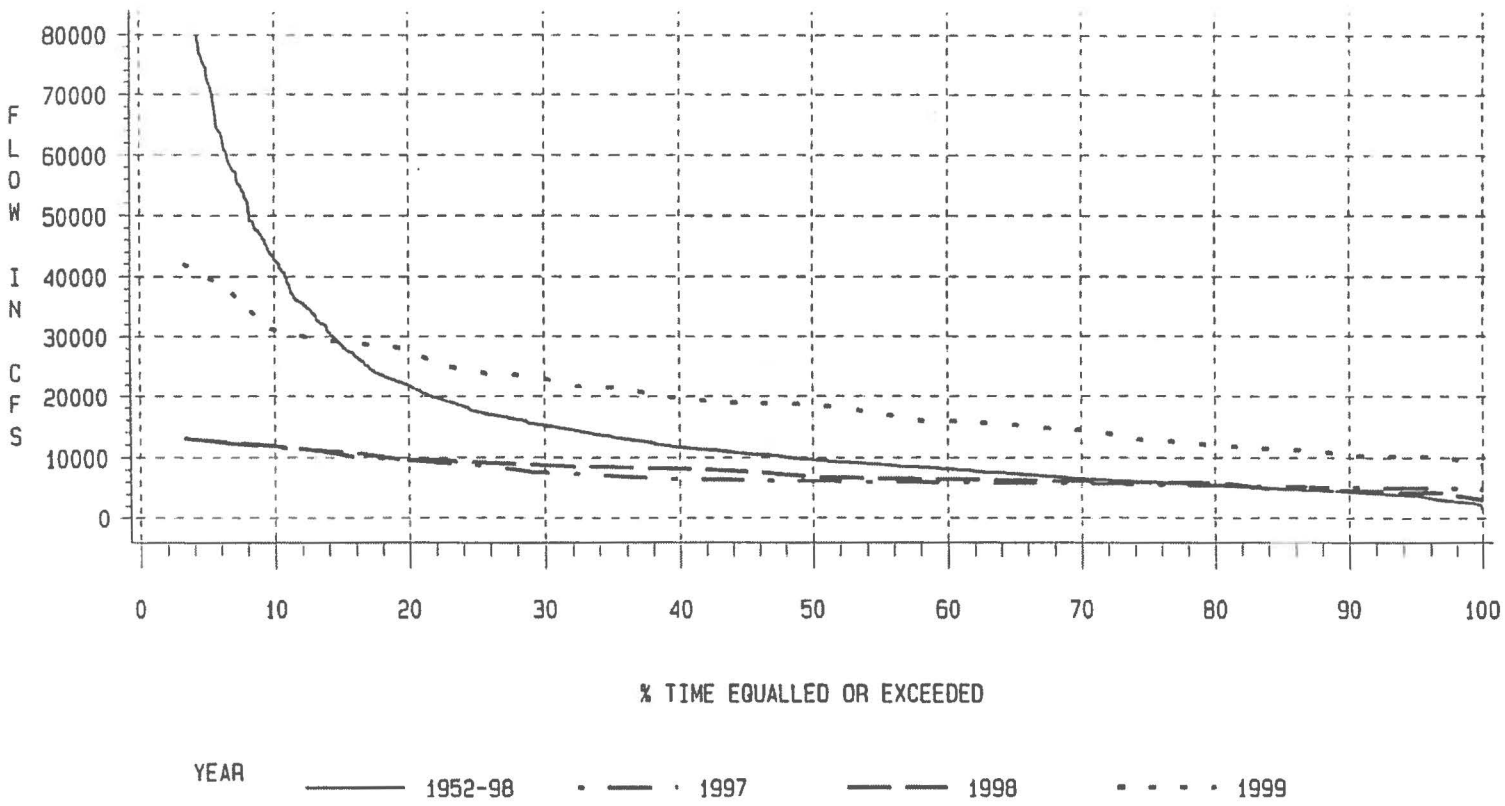
Duration curve of average daily river flows at Holtwood Dam,
1952 to 1997 (historical), 1997, 1998 and 1999.

MONTH=SEPTEMBER



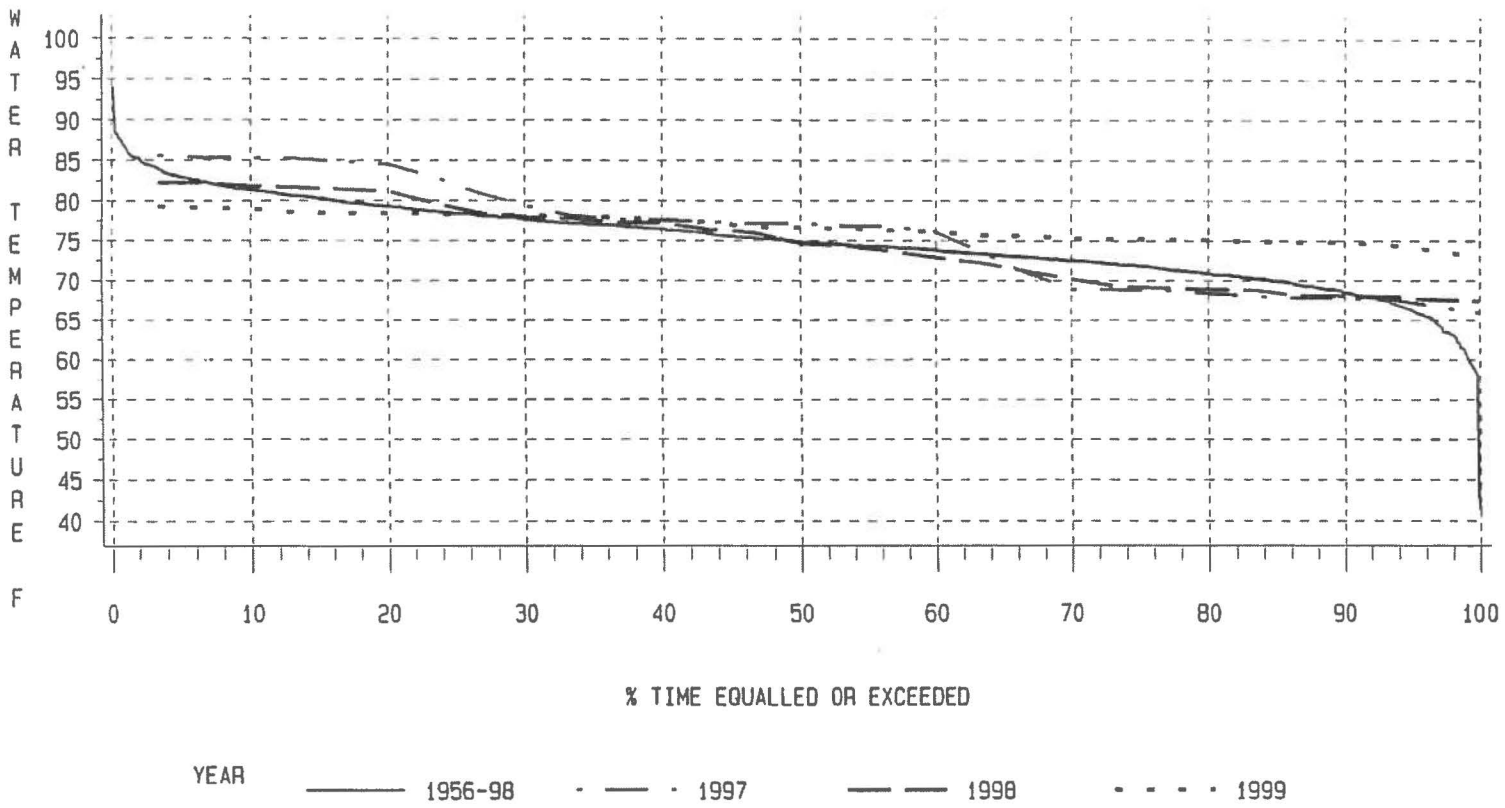
Duration curve of average daily river flows at Holtwood Dam,
1952 to 1997 (historical), 1997, 1998 and 1999.

MONTH=OCTOBER



Duration curve of average daily river temperatures (°F) at Holtwood Dam, 1956 to 1997 (historical), 1997, 1998 and 1999.

MONTH=JUNE



Duration curve of average daily river temperatures (°F) at Holtwood Dam, 1956 to 1997 (historical), 1997, 1998 and 1999.

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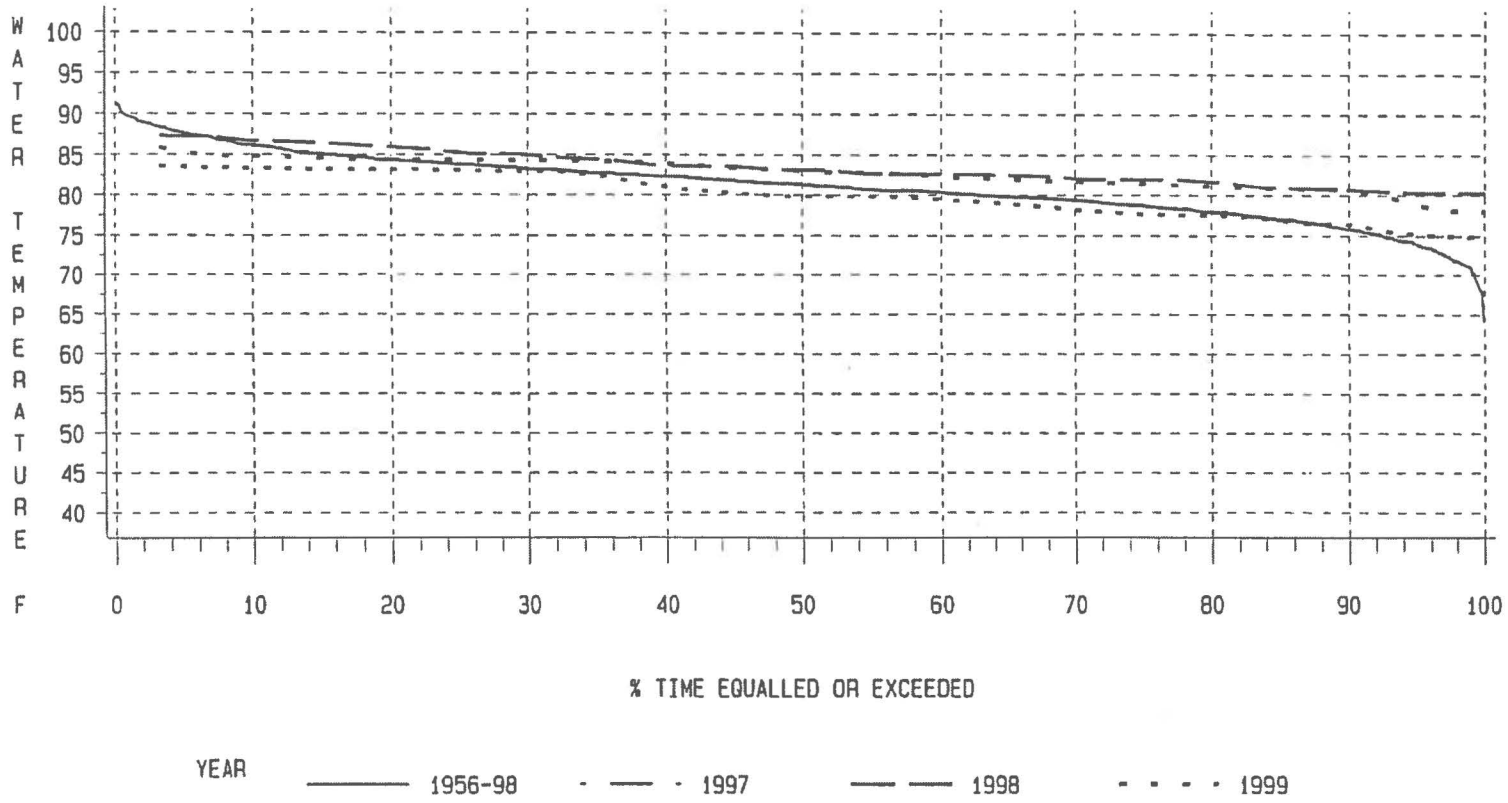

Duration curve of average daily river temperatures (°F) at Holtwood Dam, 1956 to 1997 (historical), 1997, 1998 and 1999.

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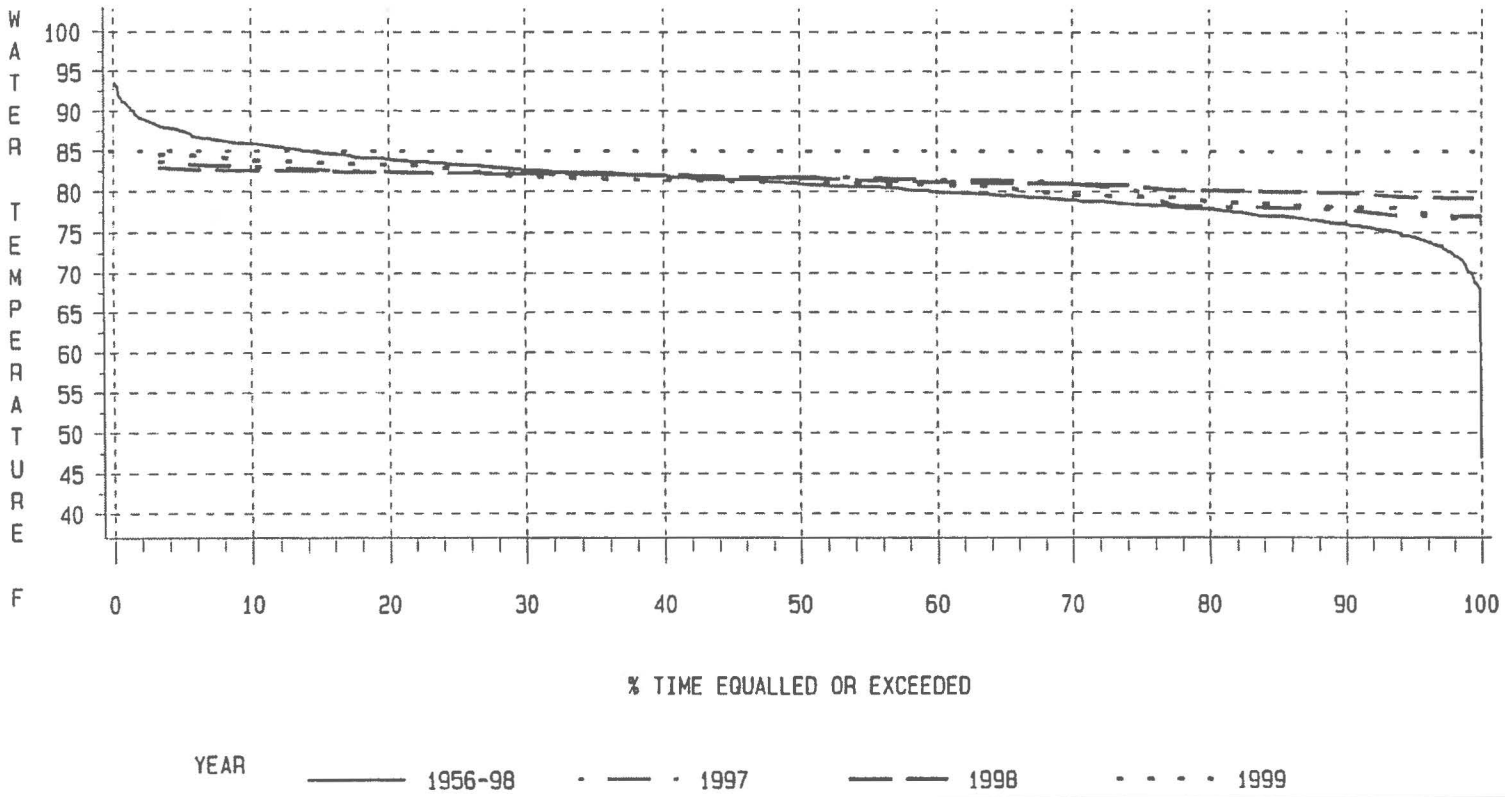

Duration curve of average daily river temperatures (°F) at Holtwood Dam, 1956 to 1997 (historical), 1997, 1998 and 1999.

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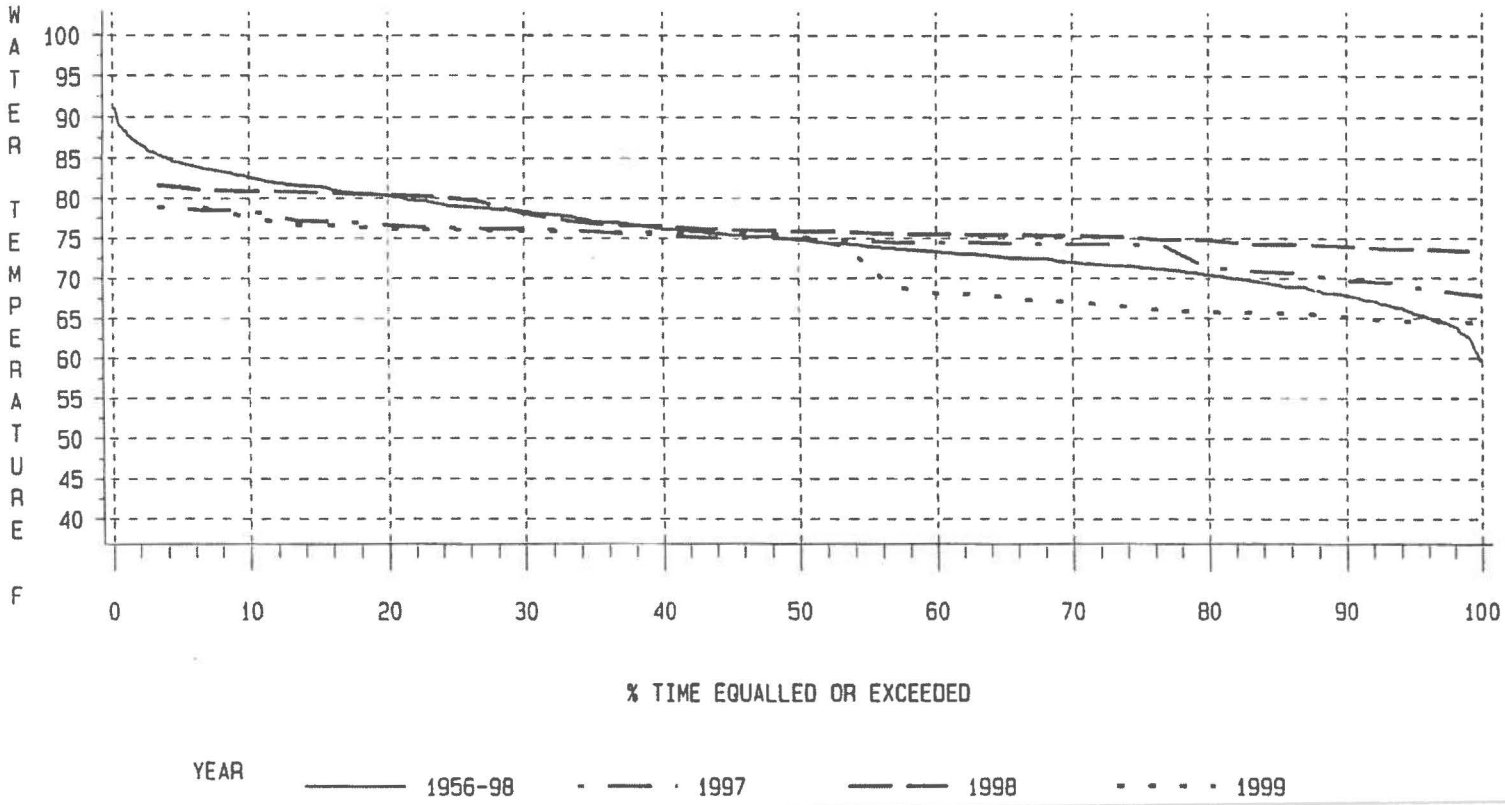

Duration curve of average daily river temperatures (°F) at Holtwood Dam, 1956 to 1997 (historical), 1997, 1998 and 1999.

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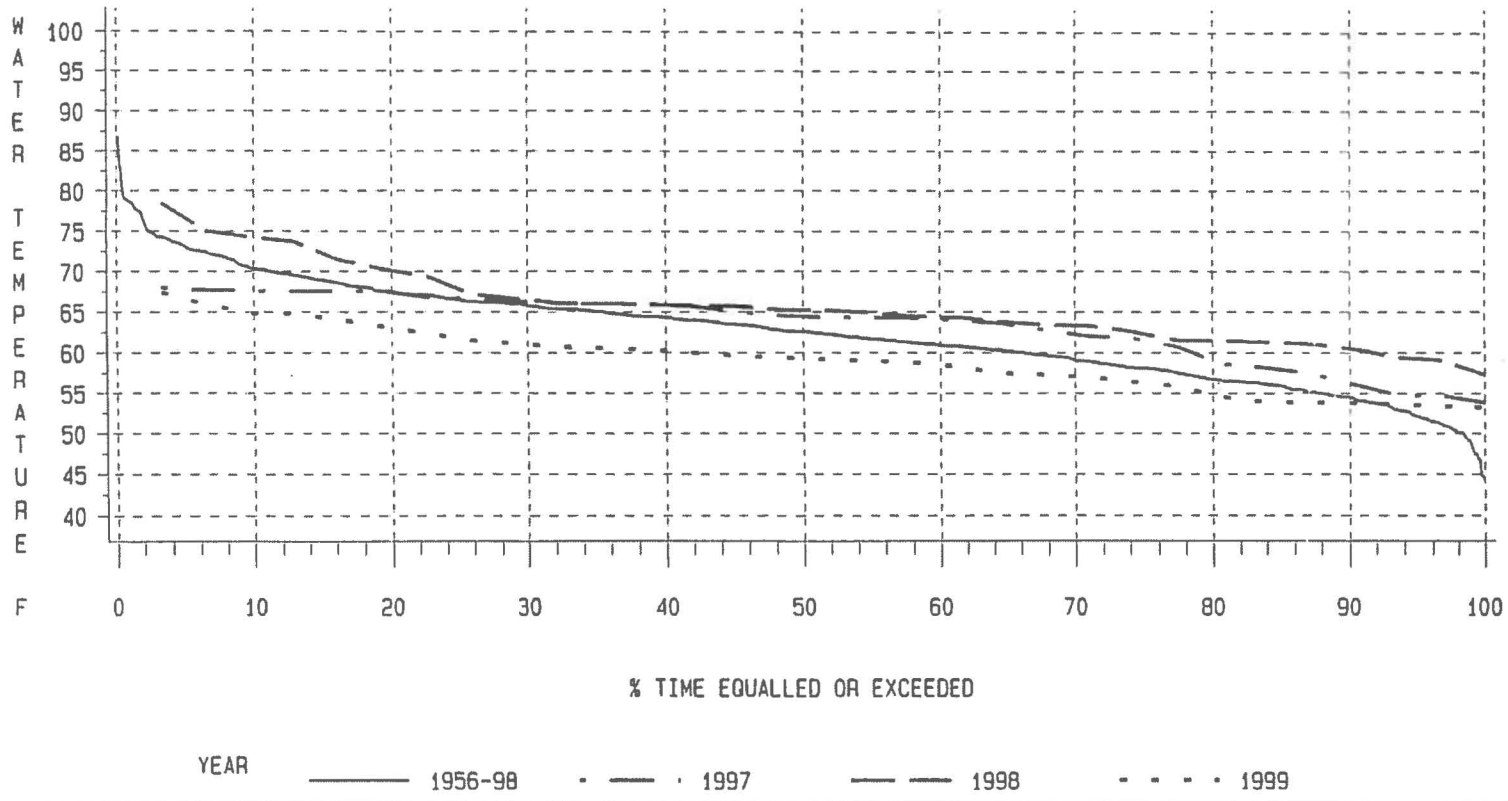

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, 1956 - 1998.

..... MONTH=JUNE .....

	HOLTWOOD DAILY AVG TEMPERATURE												TOTAL	
	40-49		50-59		60-69		70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW														
2,500-4,999	.	.	.	.	.	.	.	.	1	0.08	.	.	1	0.08
5,000-7,499	.	.	.	.	.	.	21	1.65	17	1.34	4	0.31	42	3.30
7,500-9,999	.	.	.	.	.	.	20	1.57	38	2.99	1	0.08	59	4.64
10,000-14,999	.	.	.	.	10	0.79	157	12.35	82	6.45	13	1.02	262	20.61
15,000-19,999	.	.	.	.	9	0.71	200	15.74	26	2.05	.	.	235	18.49
20,000-29,999	.	.	1	0.08	37	2.91	246	19.35	29	2.28	.	.	313	24.63
30,000-39,999	.	.	.	.	26	2.05	119	9.36	17	1.34	.	.	162	12.75
40,000-49,999	1	0.08	.	.	21	1.65	50	3.93	3	0.24	.	.	75	5.90
50,000 PLUS	1	0.08	6	0.47	58	4.56	55	4.33	2	0.16	.	.	122	9.60
TOTAL	2	0.16	7	0.55	161	12.67	868	68.29	215	16.92	18	1.42	1271	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, 1956 - 1998.

MONTH=JULY

	HOLTWOOD DAILY AVG TEMPERATURE								TOTAL	
	60-69		70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW										
2,500-4,999	.	.	.	.	54	4.18	45	3.48	99	7.66
5,000-7,499	.	.	10	0.77	92	7.12	56	4.33	158	12.22
7,500-9,999	.	.	20	1.55	128	9.90	39	3.02	187	14.46
10,000-14,999	.	.	57	4.41	216	16.86	16	1.24	291	22.51
15,000-19,999	.	.	65	5.03	117	9.05	4	0.31	186	14.39
20,000-29,999	.	.	117	9.05	86	6.65	1	0.08	204	15.78
30,000-39,999	.	.	58	4.49	18	1.39	.	.	76	5.88
40,000-49,999	.	.	37	2.86	7	0.54	.	.	44	3.40
50,000 PLUS	9	0.70	37	2.86	2	0.15	.	.	48	3.71
TOTAL	9	0.70	401	31.01	722	55.84	161	12.45	1293	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, 1956 - 1998.

MONTH=AUGUST

	HOLTWOOD DAILY AVG TEMPERATURE										TOTAL	
	40-49		60-69		70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW												
2,500-4,999	.	.	.	.	12	0.91	125	9.43	54	4.08	191	14.42
5,000-7,499	.	.	.	.	53	4.00	171	12.91	67	5.08	291	21.96
7,500-9,999	.	.	1	0.08	44	3.32	146	11.02	24	1.81	215	16.23
10,000-14,999	.	.	.	.	113	8.53	156	11.77	9	0.68	278	20.98
15,000-19,999	.	.	.	.	112	8.45	77	5.81	2	0.15	191	14.42
20,000-29,999	1	0.08	.	.	75	5.66	16	1.21	.	.	92	6.94
30,000-39,999	.	.	.	.	33	2.49	7	0.53	.	.	40	3.02
40,000-49,999	.	.	.	.	7	0.53	1	0.08	.	.	8	0.60
50,000 PLUS	.	.	6	0.45	13	0.98	.	.	.	.	19	1.43
TOTAL	1	0.08	7	0.53	462	34.87	699	52.75	156	11.77	1325	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, 1956 - 1998.

MONTH=SEPTEMBER

	HOLTWOOD DAILY AVG TEMPERATURE								TOTAL	
	60-69		70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW										
0-2,500	.	.	6	0.48	10	0.80	9	0.72	25	2.00
2,500-4,999	6	0.48	153	12.25	93	7.45	8	0.64	260	20.82
5,000-7,499	28	2.24	176	14.09	53	4.24	11	0.88	268	21.46
7,500-9,999	12	0.96	155	12.41	49	3.92	7	0.56	223	17.85
10,000-14,999	14	1.12	134	10.73	23	1.84	3	0.24	174	13.93
15,000-19,999	49	3.92	73	5.84	8	0.64	1	0.08	131	10.49
20,000-29,999	37	2.96	36	2.88	7	0.56	.	.	80	6.41
30,000-39,999	22	1.76	12	0.96	.	.	.	.	34	2.72
40,000-49,999	6	0.48	8	0.64	2	0.16	.	.	16	1.28
50,000 PLUS	26	2.08	8	0.64	4	0.32	.	.	38	3.04
TOTAL	200	16.01	761	60.93	249	19.94	39	3.12	1249	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, 1956 - 1998.

MONTH=OCTOBER

	HOLTWOOD DAILY AVG TEMPERATURE												TOTAL	
	40-49		50-59		60-69		70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW														
0-2,500	.	.	.	.	8	0.63	5	0.39	.	.	.	.	13	1.03
2,500-4,999	.	.	22	1.74	96	7.58	54	4.27	4	0.32	1	0.08	177	13.98
5,000-7,499	.	.	59	4.66	142	11.22	23	1.82	1	0.08	.	.	225	17.77
7,500-9,999	.	.	35	2.76	138	10.90	28	2.21	.	.	.	.	201	15.88
10,000-14,999	.	.	67	5.29	150	11.85	20	1.58	.	.	.	.	237	18.72
15,000-19,999	.	.	49	3.87	58	4.58	11	0.87	.	.	.	.	118	9.32
20,000-29,999	.	.	41	3.24	50	3.95	9	0.71	.	.	.	.	100	7.90
30,000-39,999	.	.	19	1.50	23	1.82	5	0.39	.	.	.	.	47	3.71
40,000-49,999	1	0.08	27	2.13	7	0.55	1	0.08	.	.	.	.	36	2.84
50,000 PLUS	19	1.50	68	5.37	20	1.58	5	0.39	.	.	.	.	112	8.85
TOTAL	20	1.58	387	30.57	692	54.66	161	12.72	5	0.39	1	0.08	1266	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1997

---------- MONTH=JUNE ----------

	HOLTWOOD DAILY AVG TEMPERATURE								TOTAL	
	60-69		70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW										
10,000-14,999	.	.	.	.	5	16.67	1	3.33	6	20.00
15,000-19,999	.	.	8	26.67	2	6.67	.	.	10	33.33
20,000-29,999	3	10.00	4	13.33	.	.	.	.	7	23.33
30,000-39,999	3	10.00	.	.	.	.	.	.	3	10.00
40,000-49,999	2	6.67	.	.	.	.	.	.	2	6.67
50,000 PLUS	2	6.67	.	.	.	.	.	.	2	6.67
TOTAL	10	33.33	12	40.00	7	23.33	1	3.33	30	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1997

MONTH=JULY

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
5,000-7,499	3	9.68	5	16.13	8	25.81
7,500-9,999	13	41.94	2	6.45	15	48.39
10,000-14,999	7	22.58	.	.	7	22.58
15,000-19,999	1	3.23	.	.	1	3.23
TOTAL	24	77.42	7	22.58	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1997

MONTH=AUGUST

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	70-79		80-85			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
2,500-4,999	.	.	6	19.35	6	19.35
5,000-7,499	.	.	12	38.71	12	38.71
7,500-9,999	5	16.13	1	3.23	6	19.35
10,000-14,999	3	9.68	4	12.90	7	22.58
TOTAL	8	25.81	23	74.19	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1997

MONTH=SEPTEMBER

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	60-69		70-79			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
5,000-7,499	3	10.00	16	53.33	19	63.33
7,500-9,999	.	.	6	20.00	6	20.00
10,000-14,999	.	.	3	10.00	3	10.00
15,000-19,999	.	.	2	6.67	2	6.67
TOTAL	3	10.00	27	90.00	30	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1997

MONTH=OCTOBER

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	50-59		60-69			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
2,500-4,999	.	.	1	3.23	1	3.23
5,000-7,499	7	22.58	14	45.16	21	67.74
7,500-9,999	.	.	4	12.90	4	12.90
10,000-14,999	.	.	5	16.13	5	16.13
TOTAL	7	22.58	24	77.42	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1998

---------- MONTH=JUNE ----------

	HOLTWOOD DAILY AVG TEMPERATURE						TOTAL	
	60-69		70-79		80-85			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW								
15,000-19,999	5	16.67	3	10.00	.	.	8	26.67
20,000-29,999	2	6.67	5	16.67	5	16.67	12	40.00
30,000-39,999	2	6.67	5	16.67	2	6.67	9	30.00
40,000-49,999	.	.	1	3.33	.	.	1	3.33
TOTAL	9	30.00	14	46.67	7	23.33	30	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1998

---------- MONTH=JULY ----------

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	70-79		80-85			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
7,500-9,999	.	.	3	9.68	3	9.68
10,000-14,999	.	.	10	32.26	10	32.26
15,000-19,999	1	3.23	1	3.23	2	6.45
20,000-29,999	6	19.35	1	3.23	7	22.58
30,000-39,999	5	16.13	1	3.23	6	19.35
40,000-49,999	1	3.23	2	6.45	3	9.68
TOTAL	13	41.94	18	58.06	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1998

MONTH=AUGUST

	HOLTWOOD DAILY AVG TEMPERATURE						TOTAL	
	70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW								
5,000-7,499	1	3.23	16	51.61	2	6.45	19	61.29
7,500-9,999	2	6.45	10	32.26	.	.	12	38.71
TOTAL	3	9.68	26	83.87	2	6.45	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1998

MONTH=SEPTEMBER

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	70-79		80-85			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
2,500-4,999	16	53.33	2	6.67	18	60.00
5,000-7,499	6	20.00	6	20.00	12	40.00
TOTAL	22	73.33	8	26.67	30	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1998

MONTH=OCTOBER

	HOLTWOOD DAILY AVG TEMPERATURE						TOTAL	
	50-59		60-69		70-79			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW								
2,500-4,999	.	.	.	.	6	19.35	6	19.35
5,000-7,499	3	9.68	8	25.81	.	.	11	35.48
7,500-9,999	.	.	9	29.03	.	.	9	29.03
10,000-14,999	.	.	5	16.13	.	.	5	16.13
TOTAL	3	9.68	22	70.97	6	19.35	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1999

---------- MONTH=JUNE ----------

	HOLTWOOD DAILY AVG TEMPERATURE			
	70-79		TOTAL	
	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW				
2,500-4,999	5	16.67	5	16.67
5,000-7,499	16	53.33	16	53.33
7,500-9,999	6	20.00	6	20.00
10,000-14,999	3	10.00	3	10.00
TOTAL	30	100.00	30	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1999

---------- MONTH=JULY ----------

	HOLTWOOD DAILY AVG TEMPERATURE						TOTAL	
	70-79		80-85		86 AND GREATER			
	N	PCTN	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW								
2,500-4,999	1	3.23	15	48.39	.	.	16	51.61
5,000-7,499	1	3.23	11	35:48	1	3.23	13	41.94
7,500-9,999	1	3.23	1	3.23	.	.	2	6.45
TOTAL	3	9.68	27	87.10	1	3.23	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1999

MONTH=AUGUST

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	70-79		80-85			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
0-2,500	.	.	3	9.68	3	9.68
2,500-4,999	.	.	13	41.94	13	41.94
5,000-7,499	7	22.58	4	12.90	11	35.48
7,500-9,999	1	3.23	1	3.23	2	6.45
10,000-14,999	1	3.23	.	.	1	3.23
15,000-19,999	1	3.23	.	.	1	3.23
TOTAL	10	32.26	21	67.74	31	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1999

---------- MONTH=SEPTEMBER ----------

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	60-69		70-79			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
2,500-4,999	.	.	6	20.00	6	20.00
5,000-7,499	.	.	3	10.00	3	10.00
7,500-9,999	.	.	1	3.33	1	3.33
10,000-14,999	.	.	2	6.67	2	6.67
15,000-19,999	4	13.33	1	3.33	5	16.67
20,000-29,999	5	16.67	1	3.33	6	20.00
30,000-39,999	2	6.67	1	3.33	3	10.00
40,000-49,999	1	3.33	.	.	1	3.33
50,000 PLUS	2	6.67	1	3.33	3	10.00
TOTAL	14	46.67	16	53.33	30	100.00

JOINT OCCURRENCE OF DAILY HOLTWOOD FLOWS AND TEMPERATURES, JUNE - OCTOBER, 1999

---------- MONTH=OCTOBER ----------

	HOLTWOOD DAILY AVG TEMPERATURE				TOTAL	
	50-59		60-69			
	N	PCTN	N	PCTN	N	PCTN
HOLTWOOD DAILY AVG FLOW						
7,500-9,999	1	3.23	.	.	1	3.23
10,000-14,999	10	32.26	.	.	10	32.26
15,000-19,999	5	16.13	4	12.90	9	29.03
20,000-29,999	1	3.23	7	22.58	8	25.81
30,000-39,999	.	.	2	6.45	2	6.45
40,000-49,999	.	.	1	3.23	1	3.23
TOTAL	17	54.84	14	45.16	31	100.00

ENCLOSURE 4

04_NAI_2010a.pdf

[NAI] Normandeau Associates, Inc. 2010a. "Data Report on Intake Screen Sampling at Peach Bottom Atomic Power Station in 2010." Prepared for Peach Bottom Atomic Power Station. December 2010.

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2010

December 2010

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2010

Prepared for

PEACH BOTTOM ATOMIC POWER STATION
Delta, Pennsylvania 17314

Prepared by

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Normandeau Associates' Project Number 20316 .003

December 2010

1.0 INTRODUCTION

Exelon's Peach Bottom Atomic Power Station (PBAPS) contracted Normandeau Associates, Inc. to conduct intake screen sampling during fall 2010. The data collection objective is two-fold: it fulfills Exelon's obligation to support the Susquehanna River's American shad restoration program as stated in the 2010 annual work plan and it provides juvenile American shad specimens to the Pennsylvania Fish and Boat Commission (PFBC) for otolith analysis, which compares the overall contribution of hatchery and wild fish.

2.0 METHODS

Intake screen sampling was scheduled three days per week, (Monday, Wednesday, and Friday), with a two-person crew, from 25 October to 10 December, 2010. Nineteen of the 20 scheduled sampling events were conducted during the outmigration period. Sampling did not occur on 3 December, 2010 due to high river flows and constant automatic operation of the intake screens which prevented sampling due to lack of available bins that could be set aside for inspection. Normandeau personnel contacted PFBC personnel throughout the study period to keep them updated on collection/sampling activities.

Peach Bottom control room personnel were contacted before and after each sampling event. The intake screens were operated on an as needed basis during the sample period. Peach Bottom personnel hoisted the bins out of the screen house to facilitate sampling and ensure the safety of the work crew. All fish observed in the bins (both Units 2 and 3) were identified and counted (if possible). In 2010, subsampling of certain species, (gizzard shad), due to large numbers or heavy debris loads occurred infrequently. Juvenile American shad that were suitable for analysis, (head and body intact), were counted, measured (total length in mm), and preserved (frozen) prior to delivery to PFBC personnel.

3.0 RESULTS

A total of 14,692 fish of 25 taxa, including crayfish, was collected; 5,726 from Unit 2 and 8,977 from Unit 3 (Table 1). Gizzard shad, (7,791), comprised 53%, while bluegill, (5,533), accounted for 37% of the total fish collected. Other species common in the remaining 10% of the collections were channel catfish, (602), alewife, (510), and green sunfish, (70).

A total of 11 juvenile American shad were collected (Table 2); 6 collected at Unit 2 and 5 collected at Unit 3. Juvenile shad were collected throughout the sampling period with shad collected from Unit 2 on 29 October, 03, 15, and 19 November, and from Unit 3 on 01, 08, 10, 22 November, and 01 December.

4.0 SUMMARY

Intake screen sampling was conducted during the juvenile American shad outmigration period in Conowingo Pond. A total of 11 juvenile American shad were provided to the PFBC for otolith analysis and stock determination from the intake screen sampling. In addition to these 11 juvenile shad, only 7 additional shad, (2 from Conowingo strainer sampling, 4 from haul seining efforts upriver, and 1 while electrofishing in Lake Aldred) were collected during the fall outmigration period in 2010. A total of 510 alewife was also collected, and are believed to be a residualized population present in Conowingo pond as no alewife were observed passing through the Conowingo East fish lift in 2010. No blueback herring were collected during the 2010 sampling at Peach Bottom.

Table 1

Number of fish collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 25 October to 10 December 2010.

Species	Unit 2	Unit 3	Total
American shad	6	5	**11**
Alewife	137	373	**510**
Blueback herring	0	0	**0**
Gizzard shad	2,849	4,942	**7,791**
Carp	0	2	**2**
Comely shiner	11	9	**20**
Spottail shiner	3	7	**10**
Spotfin shiner	5	5	**10**
Bluntnose minnow	2	3	**5**
Quillback	0	2	**2**
Shorthead redhorse	1	6	**7**
Channel catfish	137	465	**602**
Flathead catfish	2	3	**5**
White sucker	0	1	**1**
Rock bass	12	30	**42**
Green sunfish	20	50	**70**
White Perch	1	0	**1**
Bluegill	2,513	3,020	**5,533**
Largemouth bass	2	0	**2**
White crappie	3	18	**21**
Black crappie	0	3	**3**
Tessellated darter	10	22	**32**
Walleye	1	0	**1**
Yellow perch	0	2	**2**
Logperch	2	5	**7**
Crayfish	9	4	**13**
TOTAL	***5,726***	***8,977***	***14,692***

Table 2

Number of juvenile American shad collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 25 October to 10 December, 2010.

Date	Unit 2	Unit 3	Total
29 Oct	1	0	**1**
01 Nov	0	1	**1**
03 Nov	2	0	**2**
08 Nov	0	1	**1**
10 Nov	0	1	**1**
15 Nov	2	0	**2**
19 Nov	1	0	**1**
22 Nov	0	1	**1**
01 Dec	0	1	**1**
TOTAL	***6***	***5***	***11***

ENCLOSURE 5

05_NAI_2011a.pdf

[NAI] Normandeau Associates, Inc. 2011a. "Data Report or Intake Screen Sampling at Peach Bottom Atomic Power Station in 2011." Prepared for Peach Bottom Atomic Power Station. December 2011.

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2011

December 2011

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2011

Prepared for

PEACH BOTTOM ATOMIC POWER STATION
Delta, Pennsylvania 17314

Prepared by

NORMANDEAU ASSOCIATES, INC.
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Normandeau Associates' Project Number 20316 .003

December 2011

1.0 INTRODUCTION

Exelon's Peach Bottom Atomic Power Station (PBAPS) contracted Normandeau Associates, Inc. to conduct intake screen sampling during fall 2011. The data collection objective is two-fold: it fulfills Exelon's obligation to support the Susquehanna River's American shad restoration program as stated in the 2011 annual work plan and it provides juvenile American shad specimens to the Pennsylvania Fish and Boat Commission (PFBC) for otolith analysis, which compares the overall contribution of hatchery and wild fish.

2.0 METHODS

Intake screen sampling was originally scheduled three days per week, (Monday, Wednesday, and Friday), with a two-person crew, from 24 October to 2 December, 2011. Nine of the 17 scheduled sampling events were cancelled due to maintenance activities at the outer screen house during the juvenile American shad outgration period. Normandeau personnel contacted PFBC personnel throughout the study period to keep them updated on collection/sampling activities.

Peach Bottom control room personnel were contacted before and after each sampling event. The intake screens were operated on an as needed basis during the sample period. Peach Bottom personnel hoisted the bins out of the screen house to facilitate sampling and ensure the safety of the work crew. All fish observed in the bins (both Units 2 and 3) were identified and counted (if possible). In 2011, subsampling of certain species, (gizzard shad), due to large numbers or heavy debris loads did not occur. Juvenile American shad that were suitable for analysis, (head and body intact), were counted, measured (total length in mm), and preserved (frozen) prior to delivery to PFBC personnel.

3.0 RESULTS

A total of 5,738 fish of 23 taxa was collected; 2,591 from Unit 2 and 3,147 from Unit 3 (Table 1). Gizzard shad (3,111) and bluegill (2,411) comprised 96% of the total while all other species combined accounted for 4% of the total fish collected. Other species common in the collections were channel catfish (69), and comely shiner (37).

No juvenile American shad were collected at Peach Bottom in 2011, (Table 2).

4.0 SUMMARY

Intake screen sampling was conducted during a portion of the juvenile American shad outmigration period in Conowingo Pond. The 2011 outmigration period may have occurred earlier due to heavy rainfall events in September from the remnants of Hurricane Irene and Tropical storm Lee. The extremely high river flows that occurred due to these rain events may have forced juvenile American shad to leave the Susquehanna River prematurely in 2011. No juvenile American shad were collected or provided to the PFBC from sampling activities at the PBAPS in 2011.

Table 1

Number of fish collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 2 November to 2 December 2011.

Species	Unit 2	Unit 3	Total
Alewife	9	16	**25**
American shad	0	0	**0**
Gizzard shad	1,117	1,994	**3,111**
Gold fish	0	1	**1**
Comely shiner	15	22	**37**
Spottail shiner	1	0	**1**
Spotfin shiner	8	5	**13**
Fathead minnow	0	1	**1**
Golden shiner	2	1	**3**
Shorthead redhorse	0	3	**3**
Channel catfish	28	41	**69**
Flathead catfish	8	5	**13**
Tiger muskie	0	1	**1**
Rock bass	1	5	**6**
Green sunfish	1	2	**3**
Pumpkinseed	0	1	**1**
Bluegill	1,394	1,017	**2,411**
Redbreast sunfish	2	4	**6**
Largemouth bass	2	10	**12**
White crappie	2	12	**14**
Black crappie	0	2	**2**
Tessellated darter	1	0	**1**
Yellow perch	0	3	**3**
Logperch	0	1	**1**
TOTAL	***2,591***	***3,147***	***5,738***

Table 2

Number of juvenile American shad collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 2 November to 2 December, 2011.

Date	Unit 2	Unit 3	Total
2 November - 2 December	0	0	**0**
TOTAL	***0***	***0***	***0***

ENCLOSURE 6

06_NAI_2012a.pdf

[NAI] Normandeau Associates, Inc. 2012a. "Data Report or Intake Screen Sampling at Peach Bottom Atomic Power Station in 2012." Prepared for Peach Bottom Atomic Power Station. December 2012.

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2012

December 2012

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Prepared for

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December 2012

1.0 INTRODUCTION

Exelon's Peach Bottom Atomic Power Station (PBAPS) contracted Normandeau Associates, Inc. to conduct intake screen sampling during fall 2012. The data collection objective is two-fold: it fulfills Exelon's obligation to support the Susquehanna River's American shad restoration program as stated in the 2012 annual work plan and it provides juvenile American shad specimens to the Pennsylvania Fish and Boat Commission (PFBC) for otolith analysis, which compares the overall contribution of hatchery and wild fish.

2.0 METHODS

Intake screen sampling was originally scheduled three days per week, (Monday, Wednesday, and Friday), with a two-person crew, from 29 October to 7 December, 2012. Two of the 17 scheduled sampling events (29 and 31 October) were cancelled due to poor/unsafe weather conditions resulting from Hurricane Sandy. Maintenance activities at the outer screen house on 7 November resulted in cancellation of sampling for that day. During the juvenile American shad outmigration period, Normandeau personnel communicated with PFBC to keep them updated on collection/sampling activities.

Peach Bottom control room personnel were contacted before and after each sampling event. The intake screens were operated on an as needed basis during the sample period. Peach Bottom personnel hoisted the bins out of the screen house to facilitate sampling and ensure the safety of the work crew. All fish observed in the bins (both Units 2 and 3) were identified and counted (if possible). In 2012, subsampling of certain species, (gizzard shad and bluegill), occurred when large numbers of fish or heavy debris loads were present in the sampling bins. Juvenile American shad that were suitable for analysis, (head and body intact), were counted, measured (total length in mm), and preserved (frozen) prior to delivery to PFBC personnel.

3.0 RESULTS

A total of 108,004 fish of 29 taxa was collected; 23,588 from Unit 2 and 84,416 from Unit 3 (Table 1). Gizzard shad (78,528) and bluegill (28,147) comprised nearly 99% of the total while all other species combined accounted for 1% of the total fish collected. Other species common in the collections were alewife (683), channel catfish (129), and green sunfish (101).

A total of 29 juvenile American shad (Unit 2 = 10; Unit 3 = 19) were collected at Peach Bottom in 2012, (Table 2).

4.0 SUMMARY

Intake screen sampling was conducted during the peak of the juvenile American shad outmigration period in Conowingo Pond. The 2012 outmigration period may have been influenced by the occurrence of Hurricane Sandy in late October, 2012 as collection of 28 of the 29 juvenile American shad at Peach Bottom occurred on 2 and 5 November. The increase to river flow that occurred from this rain event may have triggered the outmigration of juvenile American shad to occur in a relatively narrow time period in 2012. Twenty-nine juvenile American shad were collected and provided to the PFBC from sampling activities at the PBAPS in 2012.

Table 1

Number of fish collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 2 November to 7 December 2012.

Species	Unit 2	Unit 3	Total
Alewife	427	256	**683**
American shad	10	19	**29**
Gizzard shad	16,399	62,129	**78,528**
Carp	4	28	**32**
Quillback	1	3	**4**
White sucker	0	1	**1**
Comely shiner	21	33	**54**
Spottail shiner	6	15	**21**
Spotfin shiner	4	21	**25**
Bluntnose minnow	1	2	**3**
Golden shiner	0	3	**3**
Fallfish	0	4	**4**
Banded killifish	0	1	**1**
Shorthead redhorse	1	1	**2**
Channel catfish	66	63	**129**
Flathead catfish	15	23	**38**
White perch	4	3	**7**
Rock bass	4	13	**17**
Green sunfish	8	93	**101**
Pumpkinseed	7	45	**52**
Bluegill	6,580	21,567	**28,147**
Smallmouth bass	2	5	**7**
Largemouth bass	4	30	**34**
White crappie	0	11	**11**
Black crappie	0	2	**2**
Tessellated darter	16	14	**30**
Yellow perch	2	7	**9**
Walleye	0	1	**1**
Logperch	6	23	**29**
TOTAL	***23,588***	***84,416***	**108,004**

Table 2

Number of juvenile American shad collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 2 November to 7 December, 2012.

Date	Unit 2	Unit 3	Total
02 Nov	9	17	**26**
05 Nov	0	2	**2**
19 Nov	1	0	**1**
TOTAL	***10***	***19***	***29***

ENCLOSURE 7

07_NAI_2013a.pdf

[NAI] Normandeau Associates, Inc. 2013a. "Data Report or Intake Screen Sampling at Peach Bottom Atomic Power Station in 2013." Prepared for Peach Bottom Atomic Power Station. December 2013.

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2013

December 2013

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2013

Prepared for

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December 2013

1.0 INTRODUCTION

Normandeau Associates, Inc. (Normandeau) was contracted by Exelon Corporation to conduct intake screen sampling at their Peach Bottom Atomic Power Station (PBAPS) during fall 2013. The study objective was two-fold: it fulfills Exelon's obligation to support the Susquehanna River's American shad restoration program as stated in the 2013 annual work plan, and it provides juvenile American shad specimens to the Pennsylvania Fish and Boat Commission (PFBC) for otolith analysis, which compares the overall contribution of hatchery and wild fish to the population.

2.0 METHODS

Intake screen sampling was scheduled to occur three days per week, (Monday, Wednesday, and Friday), with a two-person crew, from 4 November to 6 December 2013 (except for Friday, 29 November). A total of 14 sampling events was conducted at the outer screen house during the juvenile American shad outmigration period. Normandeau personnel contacted PFBC personnel throughout the study period to keep them updated on collection/sampling activities.

Peach Bottom control room personnel were contacted before and after each sampling event. The intake screens were operated on an as needed basis during the sample period, and for a minimum of 30 minutes prior to each trash bin being pulled from the collection pit and the contents available for sampling. Peach Bottom personnel hoisted the trash bins out of the screen house to facilitate sampling and ensure the safety of the work crew. All fish observed in the trash bins (both Units 2 and 3) were identified and counted (if possible). In 2013, sub-sampling of certain species, (gizzard shad), was necessary due to large numbers or heavy debris loads which occurred infrequently throughout the study period. Juvenile American shad that were suitable for analysis, (head and body intact), were counted, measured (nearest mm total length), and preserved (frozen) prior to delivery to PFBC personnel.

3.0 RESULTS

A total of 20,062 fish of 25 taxa was collected; 10,058 from Unit 2 and 10,004 from Unit 3 (Table 1). Gizzard shad (13,989) and bluegill (5,693) comprised 98% of the total, while all other species combined accounted for 2% of the total fish collected. Other species common in the collections were channel catfish (154), carp (55) and American shad (49).

A total of 49 American shad was collected during the fall 2013 sampling at the PBAPS. American shad were collected on 12 of the 14 scheduled sampling events; American shad were not collected on December 4 and 6 (Table 2). All juvenile American shad collected were provided to the PFBC for otolith analysis.

4.0 SUMMARY

Intake screen sampling was conducted during the main portion of the juvenile American shad outmigration period in Conowingo Pond. No sampling occurred in October 2013 due to a refueling outage at the PBAPS. At this time, it is uncertain when these juvenile shad may have moved downstream into Conowingo Pond. A weekly haul seine project conducted by Normandeau for the PFBC in the vicinity of City Island (Harrisburg, PA) and Columbia, PA from mid-July through October 2013 resulted in one juvenile American shad collected at Columbia on 12 August 2013. Relatively stable river flows occurred throughout the sampling period with no discernible freshets which would move fish downstream. The 49 American shad collected in 2013 was nearly double that collected in 2012. A total of 49 juvenile American shad was collected and provided to the PFBC from sampling activities at the PBAPS in 2013.

Table 1

Number of fish collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 4 November to 6 December 2013.

Species	Unit 2	Unit 3	Total
American eel	0	3	**3**
American shad	21	28	**49**
Gizzard shad	7,152	6,837	**13,989**
Carp	27	28	**55**
Golden shiner	1	0	**1**
Comely shiner	13	12	**25**
Spottail shiner	1	1	**2**
Spotfin shiner	0	2	**2**
Bluntnose minnow	3	0	**3**
Shorthead redhorse	1	0	**1**
Channel catfish	125	29	**154**
Flathead catfish	7	5	**12**
Banded killifish	7	3	**10**
White perch	1	0	**1**
Rock bass	1	2	**3**
Redbreast sunfish	0	1	**1**
Green sunfish	12	9	**21**
Bluegill	2,669	3,024	**5,693**
Smallmouth bass	1	0	**1**
Largemouth bass	9	11	**20**
White crappie	0	3	**3**
Black crappie	5	4	**9**
Tessellated darter	1	1	**2**
Logperch	1	0	**1**
Greenside darter	0	1	**1**
TOTAL	***10,058***	***10,004***	***20,062***

Table 2

Number of juvenile American shad collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 4 November to 6 December, 2013.

Date	Unit 2	Unit 3	Total
04 Nov	1	0	**1**
06 Nov	6	10	**16**
08 Nov	1	1	**2**
11 Nov	0	2	**2**
13 Nov	1	2	**3**
15 Nov	2	0	**2**
18 Nov	0	1	**1**
20 Nov	2	4	**6**
22 Nov	1	0	**1**
25 Nov	4	3	**7**
27 Nov	3	3	**6**
02 Dec	0	2	**2**
TOTAL	***21***	***28***	***49***

ENCLOSURE 8

08_NAI_2013b_REDACTED.pdf

[NAI] Normandeau Associates, Inc. 2013b. "Peach Bottom Atomic Power Station Entrainment Characterization Study 2012." Prepared for Exelon Generation. February 2013.

PEACH BOTTOM ATOMIC POWER STATION ENTRAINMENT CHARACTERIZATION STUDY 2012

REDACTED VERSION

January 2019

Prepared for:

Exelon Generation.

By: Normandeau Associates, Inc.

February 2013

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Appendix A. Work Plan for an Entrainment Characterization Study at Peach Bottom Atomic Power Station

Appendix B. Scientific and common names of fishes collected in Conowingo Pond.

INTRODUCTION

This report presents the results of an entrainment characterization study conducted by Normandeau Associates, Inc. at the Peach Bottom Atomic Power Station (PBAPS). The entrainment characterization study was completed based on a work plan that was reviewed and accepted by the Pennsylvania Department of Environmental Protection (PA DEP). The primary objective of the entrainment study was to identify and quantify the densities of the ichthyoplankton (fish eggs and larvae) entrained through the PBAPS.

Peach Bottom Atomic Power Station currently operates under NPDES Permit No. PA 0009733 which was issued November 30, 2010 with an effective date of January 1, 2011. The permit contains a requirement for an entrainment characterization study to be conducted over at least one fish spawning season as described in the permit within Part C. section II.D.1 as follows:

1. *Within 90 days of permit issuance, The Permittee shall submit a Work Plan to conduct entrainment sampling (see Section 2 below) of the non-contact cooling water inner intake structure at the Peach Bottom Atomic Power Station ("Facility"). The Permittee shall respond to the Department's comments on the Work Plan within 30 days of receipt. Startup of the sampling program shall occur at the beginning of the next fish spawning season following receipt of written Department approval of the Work Plan, or an alternate schedule approved by the Department, in writing.*
2. *The Work Plan shall include a detailed proposal for the following entrainment sampling of fish eggs and larvae.*
    a) *Entrainment data collections shall occur for a period of at least one fish spawning season, approximately March through September, at a sampling frequency sufficient to characterize the entrainment occurring.*
    b) *Voucher specimens of two (or one if only one is available) Chesapeake logperch (Percina bimaculata) and federal and state threatened, endangered and candidate fish species collected shall be retained and catalogued. The Department along with the appropriate state and federal authorities shall be notified within 24-hours if any federal or state threatened, endangered, or candidate fish species are identified.*
    c) *Entrainment data collection shall be performed by qualified consultants and/or trained professionals with the skills and knowledge appropriate for producing valid samples and evaluations under a formal QA/QC plan.*

The Station

PBAPS is located in York County, Pennsylvania, on the west shore of Conowingo Reservoir (Pond), approximately 3 miles upstream from the Pennsylvania-Maryland border (Figure 1). PBAPS is a two-unit nuclear-fueled power generating facility with a nominal generating capacity of 2,304 megawatts electrical (MWe). The Station operates

as a base-load facility with both units normally generating at full capacity. Unit 2 began commercial operation in June 1974 and Unit 3 entered commercial service in December 1974. Conowingo Pond was formed in 1928 with the construction of Conowingo Hydroelectric Station.

Cooling Water System

PBAPS utilizes a once-through cooling system to remove waste heat from the station's condensers. The cooling water for both units is withdrawn from the Pond through an outer intake structure located on the shoreline of Conowingo Pond, through two 3-acre intake ponds (one serving each unit), and then through an inner intake structure as shown in Figure 2. Conowingo Pond refers to the portion of the Susquehanna River impounded by the Conowingo Dam; the boundaries of the Pond extend from the base of Holtwood Dam downstream to Conowingo Dam.

The outer intake is approximately 480 ft long with a fixed vertical trash rack on the face of the intake followed by a set of 24 vertical traveling screens which have 3/8-inch mesh openings. The trash rack consists of 0.25-inch by 3-inch steel bars spaced 3.5 inches on center and is designed to prevent large debris and ice from entering the intake. The trash rack is cleaned periodically per a preventative maintenance program.

After passing through the outer intake, the cooling water flows through the intake ponds to the inner intake. Fish live and grow in the ponds and can enter the ponds through the outer screens when they are small, by being carried over the screens if they are not removed during the screen cleaning process, and through the cross-tie gate from the discharge canal in winter. During cold weather and on an as-needed basis, a cross-tie gate between the discharge basin and the intake ponds is opened to re-circulate some of the heated discharge water.

At the inner intake, water enters the pumphouse through eight screen bays. Two bays are devoted to service water flows and six convey water to the circulating water pumps. Water flowing to the circulating water pumps is screened by 3/8-inch mesh dual-flow, or dual-entry single-exit, traveling screens. Approximately 47 ft downstream from the screens, there are six circulating water pumps, three per unit, each with a capacity of about 361 MGD (250,880 gpm) for a facility total of 2,168 MGD (3,360 cfs). The water travels from the circulating water pumps and then passes through the condensers and is discharged into a common basin (Figure 2). From the common basin the discharge flows down a 4,700-ft long canal to the Conowingo Pond.

METHODS

Sampling Location and Frequency

Entrainment sampling was conducted at the circulating water discharge outfall for Units 2 and 3, not at the inner circulating water intake structure as stated in the NPDES permit.

Exelon had serious plant safety concerns regarding maintaining the integrity of the nuclear plant's water supply and would not allow the sampling equipment to be installed within the inner intake structure. As discussed in EPRI (2005), sampling in the power plant discharge actually has advantages over sampling at the intake, such as:

- Certainty that all organisms collected were actually entrained and
- Turbulence reduces potential bias resulting from non-random vertical distribution of entrained organisms.

The sampling frequency of the entrainment characterization study was based on guidance provided by the Electric Power Research Institute (EPRI) in *Entrainment Abundance Monitoring Technical Support Document* (EPRI 2005) and based on similar PA DEP-approved entrainment studies conducted recently by Normandeau Associates, Inc. (Normandeau) at other generating stations in Pennsylvania (Normandeau 2008a, 2008b).

Entrainment sampling was performed over one 24-hour sampling event each week from March through September 2012. The weekly sampling event was scheduled for approximately the same day each week to ensure regular spacing of the events. If either planned or unanticipated events interfered with this schedule, the sampling interval was adjusted one or more days. If the circulating water pumps of both Unit 2 and Unit 3 were not operable for an extended period (i.e., for several days during a week), the sampling was not completed. As long as one unit was operating, the sampling was completed. Sampling was performed by trained personnel from Normandeau operating under an approved sampling protocol.

Sample Collection Method

The samples were collected with a 3-inch electric pump that obtained the sample water through a 3-inch diameter pipe positioned vertically in the discharge basin as close as feasible to the discharge structure outfall. The pump was located on the bank of the discharge basin with the suction line leading to the sampling pipe which was attached to a rock-filled structure at the discharge outfall (Figure 3). Samples were obtained from mid-depth in the water column through a 90-degree elbow or "T" facing into the discharge current.

Total target volume of each pumped sample was approximately 100 cubic meters (28,000 gallons). The suction line conveyed the sample water to the sampling pump and then through a calibrated in-line flow meter. The electric pump had a pumping rate of approximately 150 gallons per minute as measured by the in-line flow meter. This flow rate was approximately 0.6 cubic meters per minute. Thus, a total of approximately 3 hours of pumping was completed to obtain a single sample of approximately 100 m^3. One sample was collected every 6 hours for each weekly 24-hour sampling event. From the pump the sample was discharged through a 4-inch pipe into a plankton net constructed of 500-micron mesh and suspended in a large tank of water. The velocity of water exiting the hose was thereby reduced greatly before encountering the mesh of the net. The lower velocity reduced potential damage to the eggs and larval fish specimens.

The 500-micron mesh net is fine enough to capture the eggs and larvae of all fishes likely to be encountered at PBAPS. The contents of the plankton net were rinsed down from the outside with ambient water and carefully transferred to sample containers. The samples were immediately preserved with 10 percent buffered formalin, labeled (both inside and out) and sent to Normandeau's laboratory for analysis.

The sample was acceptable if all of the following conditions were met:

- A minimum sample volume of approximately 100 m^3 was collected, unless this volume was impractical to achieve due to clogging, pumping problems, etc.,
- The net was not torn,
- The flowmeter was not physically damaged,
- None of the ichthyoplankton sample was lost or spilled during the net rinse down and sample transfer steps.

For each sample the following information was recorded:

- Volume of water filtered,
- Intake water temperature, dissolved oxygen, and pH at the start of each sample,
- Date and time of the day at the start and end of each sample,
- Identification of the circulating water and other major pumps in operation at the start and end of each 24-hour sampling event,
- Names of the sample collectors, and
- Any deviations from the sampling protocol, unusual conditions, or other pertinent observations.

Mechanical issues occurred with the entrainment collection system from April 5 to May 2. Specifically, part of the entrainment collection system piping which was attached to the rock-filled structure (stand pipe) was damaged during the study period. The turbulent flows created from the Unit 2 and 3 discharge cracked the stand pipe and resulted in complete loss of suction and rendered the collection system inoperable. This resulted in the need to complete alternative sampling while a new stand pipe was being fabricated and installed. Alternative entrainment sampling was completed to ensure a complete data record during the course of the study period. The alternative sampling method was completed by suspending a 1-m diameter plankton net from the road bridge at the head of the discharge canal (Figure 3). The net was lowered approximately 2-4 feet below the water surface into the discharge canal and a sample was collected. A General Oceanics Mechanical Flowmeter was mounted in the mouth of the net and used to record the volume of water sampled. The alternative method yielded four samples; two collections during the day and two at night. Each sample was collected over an approximately 20-minute period with a target sample volume of 100 m^3.

Sample Processing and Taxonomy

All samples were processed in entirety for ichthyoplankton (eggs and larvae), juvenile, and adult fish. Samples were sorted under magnification to ensure that all organisms were removed.

The specimens were removed from the samples, identified to the lowest taxonomic category practicable (generally species), and counted. Larvae and juveniles were categorized by lifestage into prolarvae (yolk-sac larvae), postlarvae (post yolk-sac larvae), young-of-the-year (YOY), yearling or older, and unknown. The unknown life stage indicated that the larvae were damaged or the life stage could not be determined. The unknown life stage larvae were either prolarvae or postlarvae. The separation of these two life stages can be difficult if the specimens are damaged. For each sample a maximum of 20 individuals for each species and life stage category was measured for total length to the nearest 0.1 mm (nearest 1.0 mm for juvenile fish).

All ichthyoplankton specimens were retained for the duration of the study. If any Federal or Pennsylvania endangered, threatened, or candidate fish species were collected, the appropriate Federal and state authorities were to be notified within 24 hours of making a confirmed identification of any of these important species. Specimens of the genus *Percina* were to be retained for transfer to the PA DEP at a later date.

In situ water quality measurements were collected from the PBAPS discharge canal. A calibrated YSI Sonde was used to determine water temperature, pH, and dissolved oxygen prior to and after the collection of each entrainment sample. In addition, water temperature monitoring at the PBAPS outer intake structure was completed concurrently for another study (Normandeau 2013). Water temperature was recorded using an Onset HOBO Pro v2 water temperature data logger which recorded water temperature every 15 minutes. Discharge records for Holtwood Hydroelectric Facility were also included to characterize flows entering Conowingo Pond. Holtwood Dam is located approximately 6 miles upstream from the PBAPS intake.

Fish entrainment density was calculated for each week of sampling. These estimates were based upon the mean density of each taxon which was calculated from the density observed in each of the four entrainment samples collected during each week. Density was calculated by dividing the actual number of each taxon in a sample by the volume of water filtered through the sampling net. Mean density for each week was determined by summing the density of each taxon in the four samples and dividing by four. Estimated density for each taxon was also determined for the entire study period. This overall density was determined by summing the density of each taxon observed in a sample and dividing by the total number of samples collected.

Quality Assurance and Control

Entrainment sampling was performed by trained individuals from Normandeau working under a standard operating procedure and quality assurance plan developed for the entrainment study. Field instruments were calibrated prior to each sampling event

according to the manufacturer's specifications. Laboratory processing and identification were performed by Normandeau's trained technicians and experienced taxonomists, respectively, operating under a formal QA/QC plan.

RESULTS

Water Quality and River Discharge

Daily mean water temperature measured at the PBAPS intake during the entrainment sampling program ranged from 12.1 to 30.7 °C (Figure 4). Water temperature during the start of the study was cool, actually decreasing slightly during the end of March. During April water temperature increased gradually and then cooled slightly toward the end of the month. From May onward water temperatures gradually increased reaching the highest temperatures in mid-July. Temperatures gradually decreased from mid-July to the end of the study period. Water temperatures were coolest in March and April and warmest during July.

Susquehanna River discharge data was available from the Holtwood Hydroelectric Facility. River discharge during the entrainment sampling period ranged from 5,900 to 107,300 cubic feet per second (cfs) with mean flow of 24,945 cfs. Flows were highest during March and May to mid-June, then relatively low throughout the end of the study period (Figure 5). The highest daily mean discharge of 107,300 cfs was recorded on May 17.

Entrainment Sample Water Quality

Measurements of water temperature, dissolved oxygen (DO), and pH were recorded for the PBAPS discharge outfall during the course of the entrainment sampling program. Water temperature in the discharge ranged from 20.7 to 41.1 °C with mean of 32.4 °C. Temperatures in the discharge canal followed a similar trend to that of the ambient Pond temperatures measured at the PBAPS intake structure (Figure 4). Water pH during the study ranged from 7.1 to 8.9 with mean of 8.1. Dissolved oxygen in the discharge water ranged from 5.0 to 13.6 milligrams per liter (mg/l) with mean of 8.3 mg/l.

Entrainment of Ichthyoplankton

A total of 112 entrainment samples were collected from March 8 to September 27, 2012 over the 30-week sampling period. Samples collected with the 3-inch pump accounted for 88 of the collected entrainment samples. Four samples were collected during each 24-hr sampling event each week. The first sample each week was collected between 06:00-12:00hrs with subsequent samples collected approximately 6 hours later, between 12:00-18:00hrs, 18:00-00:00hrs, and 00:00-06:00hrs. Water volumes for these samples ranged from 102 to 130 m^3 with mean of 106 m^3.

Twenty-four samples were collected using the alternative sampling method. Most of the alternative method samples were collected from April 5 to May 2 with two samples collected in June and four samples collected in August. Four 20-minute samples were

collected during each 24-hr sampling event. The first two samples were collected between 06:00-12:00 hrs and the remaining two samples were collected between 18:00-00:00 hrs. Water volumes for the alternative samples ranged from 57 to 193 m^3 with mean of 123 m^3. For both collection methods a total of 6,562,430 gallons (24,841m^3) of water was sampled during the entire study period.

Ten species were represented by the 1,529 fish eggs and larvae collected in the 112 samples (Table 1). Gizzard shad (76.0%) was the most numerically abundant taxon. Other common species include tessellated darter (7.8%), banded darter (1.2%), and channel catfish (0.7%). A total of 12.2% of the larval fishes that were collected were not identifiable because of damage to the larvae as a result of being transported through the PBAPS cooling water system or through the entrainment sampling system.

Most of the 1,440 larval fish collected were yolk-sac larvae, post yolk-sac larvae, or unknown (either yolk-sac or post yolk-sac larvae) life stage (Table 2). A majority (50.0%) of the entrained fishes were unknown life stage (either yolk-sac or post-yolk sac larvae). Yolk-sac larvae and post yolk-sac larvae were also abundant, comprising 22.2 and 22.0% of all individuals, respectively. A total of 74 fish eggs were collected which accounted for 4.8% of entrained organisms. Only 13 YOY and two yearling and older fishes were collected.

Temporal variation in fish entrainment was evident with a majority of the fish being collected from April 18 to July 27 (Figure 6). Only one fish was collected in March (spottail shiner) and only three fish were collected during August and September. The largest entrainment sample collections occurred on April 25 and May 30 when 375 and 350 fish were collected, respectively. Most fish were collected during nighttime hours with 36% collected between 18:00-00:00 hrs (Table 3).

Of the entrained fish, 284 were measured for total length. A majority of these were gizzard shad, tessellated darter, and banded darter (Table 4). Mean length for entrained fish was 6.5 mm (standard deviation of 3.4 mm). Most of the entrained fish ranged in total length from 3 to 9 mm (Figure 4). The overall length range for entrained fish was between 3 mm (gizzard shad) and 128 mm (American eel) (Table 4).

Description of Entrainment of Common Species

Banded darter

A total of 19 banded darter was collected in entrainment samples. All collected individuals were either yolk-sac or post yolk-sac larvae. Banded darter was collected from April 19 to August 1, with most of the individuals being collected in May 8. Mean entrainment density of banded darter over the study period was 1.59/1000m^3 with maximum density of 21.9 occurring in week 10. Mean total length of banded darter was 7.6 mm with range between 6 and 10 mm.

Channel catfish

A total of 11 channel catfish was collected in the entrainment samples. Eight YOY and three post yolk-sac larvae were collected from June 14 to July 6. Entrainment density of channel catfish for the sample period was 0.92/1000m^3 with a maximum density of 14.7/1000m3 during week 16. Mean total length of channel catfish was 15.5 mm and ranged between 14.5 and 17 mm.

Gizzard shad

Gizzard shad was the most abundant fish in entrainment samples with a total of 1,162 individuals collected. Most of the identifiable life stages of gizzard shad were either post yolk-sac (206) or yolk-sac (285) larvae. The unknown life stage (600), which includes both yolk-sac and post yolk-sac larvae, accounted for most of the gizzard shad. A total of 71 gizzard shad eggs was collected. Gizzard shad was collected from April 19 to July 18 in 23 of the 30 sample weeks (Figure 9). The largest single collection event (four samples) occurred on April 25, when a total of 362 individuals was collected. The mean entrainment density of gizzard shad over the sample period was 92.22/1000m^3 with maximum entrainment density of 1327.7/1000m^3 in week 13 (Tables 7 and 8). Total length of gizzard shad larvae ranged from 3.0 to 18 mm with mean length of 5.3 mm.

Sunfishes

A total of six sunfishes were collected in entrainment samples. All six sunfishes were post yolk-sac larvae and were collected from April 25 to May 2. This group represents the genus *Lepomis* and includes green sunfish, bluegill, and pumpkinseed. Larvae of these species are not distinguishable from each other at this life stage. Entrainment density of *Lepomis* spp. was 0.48/1000m^3 for the study period with maximum density of 11.5/1000m^3 recorded during week 8. Mean total length of this group was 5.0 m with length range between 4.5 and 6 mm.

Tessellated darter

Tessellated darter was the second most abundant fish collected in entrainment samples with a total of 119 individuals collected. Most tessellated darter were either yolk-sac (44) or post yolk-sac (49) larvae. This species was collected from April 19 to May 30 (Figure

8). Entrainment density of tessellated darter was 10.1/1000m^3 with maximum density of 185.9/1000m^3 occurring in week 11 (Table 7). Mean total length of this group was 7.0 mm with length range between 5 and 17 mm.

DISCUSSION AND CONCLUSIONS

The results of the 2012 entrainment characterization study were consistent with the expected results based on the known fish species composition in Conowingo Pond and historic entrainment and ichthyoplankton studies in Conowingo Pond in the vicinity of PBAPS. The highest rates of entrainment occurred during the spawning season for the abundant species in Conowingo Pond which extended from April to July. Few fishes were entrained during March, August or September.

Recent fish surveys have been completed in Conowingo Pond as a part of a 316(a) Demonstration Study (Normandeau 2011, 2012b). During these field surveys in 2010 and 2011 a total of 43 fish species and 38,145 individuals was collected (Table 5). The dominant species observed were gizzard shad (42.4%), channel catfish (19.5%), spotfin and comely shiners (14.7%), and bluegill (6.6%). The proportion of several of the species observed during these recent field surveys was also reflected in the rates of entrainment of these species observed in the PBAPS outfall discharge. However, many of the abundant species based on recent field surveys were absent from the entrainment samples. Much of a given fish species likelihood of being entrained is related to species-specific life history traits and their preferred spawning locations within a waterbody. Other important factors that affect rates of entrainment include the type of waterbody (lentic, lotic, or tidal), location of the cooling water intake structure within the waterbody, design of the cooling water intake, and intake approach velocities of the water entering the cooling water system.

Many of the fish species that occur within Conowingo Pond are nest builders that lay adhesive and demersal eggs. Species with these traits include the family Centrarchidae (bluegill, largemouth and smallmouth bass, and green sunfish), Ictaluridae (catfishes), and several darter (*Etheostoma* spp.) species. These attributes can significantly reduce the likelihood of larval fishes or eggs being entrained and subsequently being transported through the PBAPS cooling water system. Species without these life history traits are more likely to be entrained. These species are broadcast spawners, lay semi-adhesive eggs that may not be demersal. Some of these species include common carp, gizzard shad, some native minnow species, and white sucker.

Spawning locations in relation to the PBAPS intake structure are also important in determining rates of entrained fishes. Spawning habitats for most of the nest building species are limited in the immediate vicinity of the PBAPS intake structure. Most of the spawning locations with the highest densities of ichthyoplankton have been previously determined to occur in areas other than those in close proximity to the PBAPS intake structure (Ichthyological Associates 1976, Anjard 1977). Therefore, the eggs and larvae of these species are not likely to be in close proximity of the PBAPS intake structure and to be entrained. Eggs and larvae of nest-building species are more likely to be entrained

during high flow events or floods that transport eggs or larvae from spawning locations into the water column and subsequently through the cooling water system. Generalist, broadcast spawners that occur in Conowingo Pond tend to spawn over submerged vegetation, woody debris, or other structures. These species include gizzard shad, quillback, and common carp. Primary spawning areas of gizzard shad have been previously determined to include areas in the immediate vicinity of the PBAPS intake structure and downstream near the mouth of Broad Creek (Ichthyological Associates 1976). Gizzard shad eggs are more likely to be entrained because spawning occurs in close proximity to the intake structure.

Gizzard shad were introduced to Conowingo Pond in 1972 during transport of American shad in the Conowingo Dam fish lifts. The fish lifts are designed to transport adult American shad upstream of the Dam during their migratory spawning runs. The numbers of gizzard shad adults that are transported into Conowingo Pond have increased over recent years. During 2012 a total of 1.2 million adult gizzard shad were introduced into Conowingo Pond from the Conowingo Dam fish lift (Normandeau 2012a). The introduction of these adult gizzard shad during spring of 2012 coincided with the highest entrainment collections of gizzard shad eggs and larvae. Large numbers of adult gizzard shad were observed during a concurrent field study that was being conducted in the vicinity of PBAPS during the spring of 2012. Many of entrained gizzard shad eggs and larvae were likely spawned by the recently introduced gizzard shad completing their migratory spawning runs upriver.

Spawning Attributes of Selected Species

Gizzard shad

Gizzard shad spawn from March to August, usually between April and June in temperate latitudes (Miller 1960). Spawning usually occurs at near surface depths (0.3 to 1.6m), but sometimes as deep as 15 m, and sometimes over vegetation or debris (Jones et al. 1978, Miller 1960, Wang and Kernehan 1979). Spawning groups swim near the surface and roll about as a mass, ejecting eggs and sperm (Miller 1960). Eggs are demersal and adhere to algae, rocks, and other objects (Miller 1960). Fecundity (total number of mature eggs in the ovary prior to spawning) is 22,400 to 543,000 eggs per female (Schneider 1969).

Channel catfish

Channel catfish usually spawn in secluded, semi-darkened nests under rocks, in log jams, in holes, and in other types of cavities (Harlan and Speaker 1956). Nests are constructed in these sheltered areas by both sexes (Clemens and Sneed 1957). They spawn in late spring or early summer when water temperatures reach 24 °C. Females produce from 3,000 to 4,000 eggs per pound of body weight (Clemens and Sneed 1957). Hatching occurs in five to ten days at 26 to 28 °C (Jones et al. 1978). The male cares for the eggs (Clemens and Sneed 1957).

Banded darter

Spawning appears to take place between 20 and 25 °C (Page 1983, Erickson and Mahan 1982). Banded darters have adhesive eggs which they attach to filamentous algae and aquatic plants (ODNR website). Spawning occurs in riffles of depths less than 60 cm and this darter typically attaches its eggs to vegetation (Pflieger 1975). Fecundity is 80-262 mature ova (Erickson 1977).

White Sucker

The typical spawning habitat is riffles with largely gravel bottoms in large creeks to large rivers (Jenkins and Burkhead 1993). Fecundity is 20,000 to 139,000 ova (Scott and Crossman 1973). The fertilized eggs adhere to the gravel in riffles or drift downstream where they adhere to the substrate in areas with water of slow velocity (Geen et al. 1966).

Tessellated darter

In the northern areas, tessellated darters spawn in May or early June and presumably the southern populations spawn earlier. The male chooses a spawning site and guards the site throughout the spawning period. Typically, the adhesive eggs are deposited under an overhanging rock or log or other obstruction but they may spawn on top of flat rocks also (Schmidt 1980). Tsai (1972) reported that fecundity ranged from 54-668 with larger females containing the greater numbers of eggs. A female may not necessarily lay all the eggs she contains, however.

The social behavior of the tessellated darter is apparently unique among fishes in that males regularly clean and defend eggs which they did not fertilize (Constantz 1979). Large, behaviorally dominant males defend the few rocks in the stream which are suitable for spawning. After fertilizing eggs deposited by the female at one rock, dominant males often move to other rocks which appear to offer more uncovered spawning surface, apparently because these rocks are preferred by spawning females. Subordinate males occupy newly-vacated rocks and clean the remaining uncovered surface, incidentally cleaning the dominant male's eggs.

Centrarchidae

The spawning behavior of all of the centrarchids (*Lepomis, Pomoxis, Ambloplites,* and *Micropterus*) is remarkably similar (Cooper 1983). Males prepare a nest over clean hard substrates, spawn singly with one or more females in the nest, and then drive away all other fishes and other large invaders. The adhesive eggs in the nests are aerated by swimming motions of the male, and the eggs and young are guarded against predators.

Native minnow species

Notropis, Luxilus, Cyprinella and *Pimephales* are the four genera that comprise the vast majority of the native minnow species that inhabit Conowingo Pond. According to Jenkins and Burkhead (1993), *Notropis* and *Luxilus* are relatively primitive broadcast spawners and *Cyprinella* and *Pimephales* are egg-attachers. Members of the genus *Notropis* typically spawn in shallow runs or riffles, either on unmodified gravel substrate or over minnow nests, sucker redds, or nests of other species (Pflieger 1975, R. J. Miller 1964). Egg counts of the saffron shiner (*Notropis rubricroceus*) were 445-1,174 (Outten

1958). Egg counts of the emerald shiner (*Notropis atherinoides*) were 888-5,443 (Heufelder and Fuiman 1982).

Species in the genus *Luxilus* commonly or exclusively are associates of gravel nest-building minnows; some species dig rudimentary spawning pits (Jenkins and Burkhead 1994). Some striped shiners (*Luxilus chrysocephalus*) produced more than 1,000 eggs (Jenkins and Burkhead 1993).

Cyprinella species such as spotfinshiner (*Cyprinella spiloptera*) typically deposit eggs in crevices in loose bark on trees or stumps or other "artificial" substrates, and are often fractional spawners, producing up to 3,600 to 7,000 eggs in total per year (Jenkins and Burkhead 1993).

Spawning of *Pimephales* typically occurs between late May and September. Spawning takes place in pool shallows beneath stones or debris. When natural cavities are lacking, sometimes the male burrows through the silt to create a space beneath an object (Parker 1964). The eggs are usually deposited in the cavities in a single layer, rarely in clumps (Jenkins and Burkhead 1993). Females of this genus, like *Cyprinella*, are fractional spawners (Jenkins and Burkhead 1993). Males defend the nest.

Comparison to previous entrainment study at PBAPS

The most recent historical entrainment study was performed by Anjard (1977) who collected weekly ichthyoplankton samples at three locations (both intake ponds and discharge canal) at PBAPS from May through July in 1975-1976. Collections were taken by towing a plankton net from a boat for 10-minute intervals. A total of seven eggs larvae of 20 species were collected in entrainment samples over the 2-year period. The most common were larvae of the gizzard shad, common carp, quillback, channel catfish, and tessellated darter. The gizzard shad, common carp, and quillback made up over 80% of the collected larvae while larvae of the sunfishes, smallmouth bass, white crappie, and walleye comprised 2%. The mean density of larvae in the 1975 and 1976 spawning seasons was 131.6/1000m^3 of which 60.0/1000m^3 (44%) were gizzard shad (Table 6). Entrainment varied over the 3-month sampling period. The highest densities of the commonly entrained fish larvae occurred between the last week in May and the first week in July. From May through early June larvae of the common carp and quillback were abundant, while from mid-June until mid-July the gizzard shad and channel catfish predominated. The larvae of sunfishes were entrained in June and July, shield darter and tessellated darter in June. The species composition, densities, and seasonal occurrence of entrained fish larvae were similar to those observed in Conowingo Pond adjacent to the Peach Bottom intakes (Anjard 1975 and 1976).

Estimated entrainment density of all fishes was slightly lower (122.6/1000m^3) in 2012 compared to 1975-1976 (average = 131.6/1000m^3) (Tables 6 and 8). A total of 10 taxa were entrained in 2012 compared to the 20 taxa collected during the historic entrainment study. Gizzard shad had the highest entrainment densities during 2012 (92.2/1000m^3) and during the historic study (60/1000m^3). No quillback were collected in 2012 compared to mean of 26.6/1000m^3 in the historic study. Common carp entrainment

density was also lower in 2012 (0.13/1000m^3) compared to historic study (22/1000m^3). Other species that were collected during both entrainment studies with similar entrainment densities included tessellated darter, channel catfish, spottail shiner, white sucker, and sunfishes (Tables 6 and 8). In general entrainment rates were lower for most species in 2012 compared to the historic study. Part of the differences in entrainment rates may be related to the locations that the samples were collected from in the two entrainment studies. Samples collected during 2012 were collected from the PBAPS discharge outfall where most specimens likely were entrained through the PBAPS cooling system. The samples collected in 1975-1976 were collected from the intake ponds (each 3-acres in size) and a portion of the fishes collected were not likely to be entrained, but rather may have been living within the intake ponds and never been subject to entrainment through the PBAPS cooling system.

Species of Special Concern

No state or federally listed endangered or threatened species were collected in the entrainment samples. However, two species of concern, Chesapeake logperch and American eel, occur within Conowingo Pond and a brief discussion of these species follows.

The Chesapeake logperch (*Percina bimaculata*) was recently listed as a threatened species in Pennsylvania and is also currently listed as threatened in the state of Maryland. This species has been recently collected in Conowingo Pond (Table 6). The Chesapeake logperch range includes the lower Susquehanna River and several tributaries including Fishing Creek, Muddy Creek, Peters Creek, Michael Run, and Octoraro Creek. This species only occurs in approximately 30 combined stream and river miles within Pennsylvania. No Chesapeake logperch were collected during entrainment sampling in 2012.

A single juvenile American eel (*Anguilla rostrata*) was collected in an entrainment sample on September 27. Few American eels are present within Conowingo Pond and none were collected during recent fish surveys in Conowingo Pond (Table 6). The American eel population is in apparent decline and is considered a species of concern. In 2011 the U.S. Fish and Wildlife Service initiated a new status review for the American eel as a result of a 90-day finding on the Council for Endangered Species Act Reliability's petition to list the American eel as threatened under the authority of the Endangered Species Act.

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FIGURES

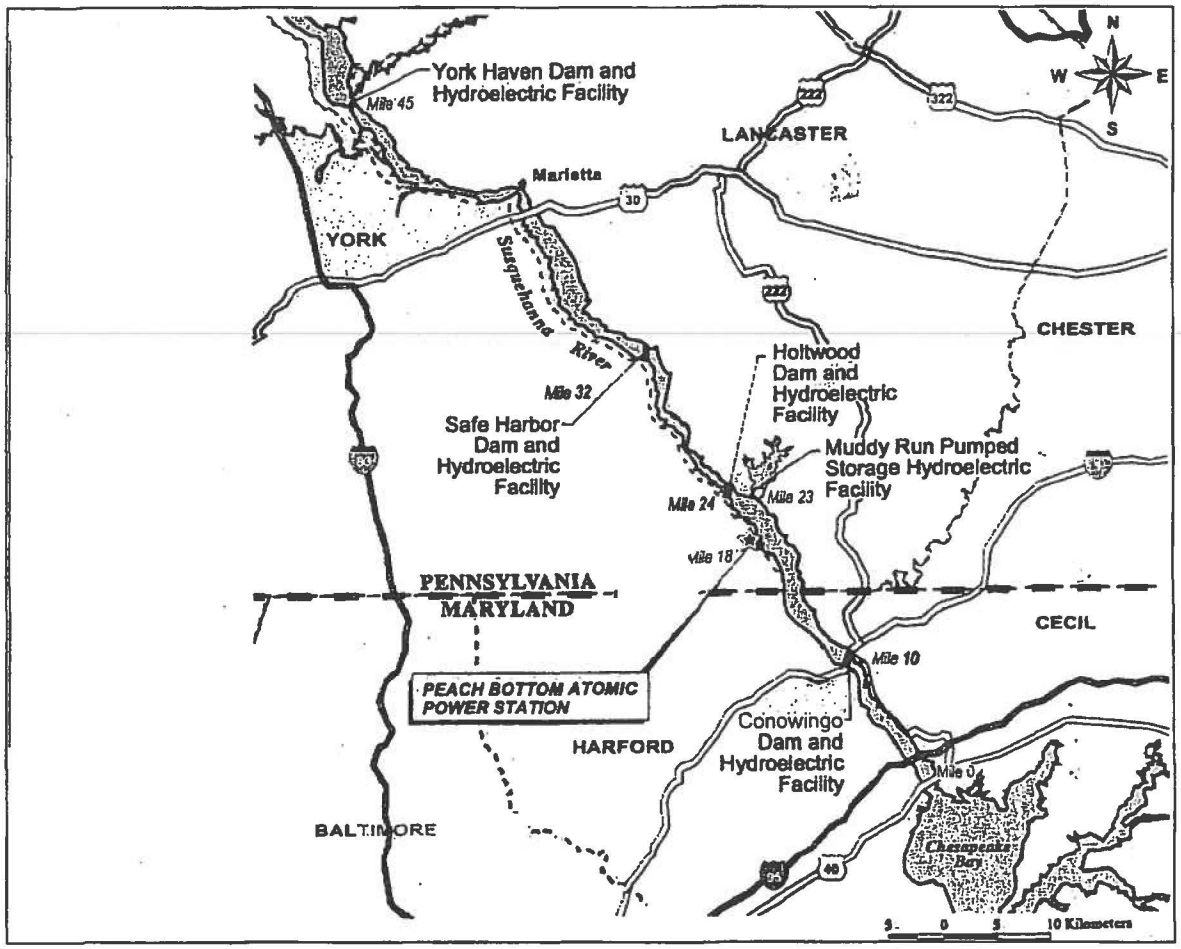

Figure 1. Map of Conowingo Reservoir showing locations of Peach Bottom Atomic Power Station and other power plants.

REDACTED
Pennsylvania Open Records Law

Figure 2. Peach Bottom Atomic Power Station cooling water intakes and discharge structures.

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Figure 3. Entrainment characterization study sampling locations at PBAPS during 2012.

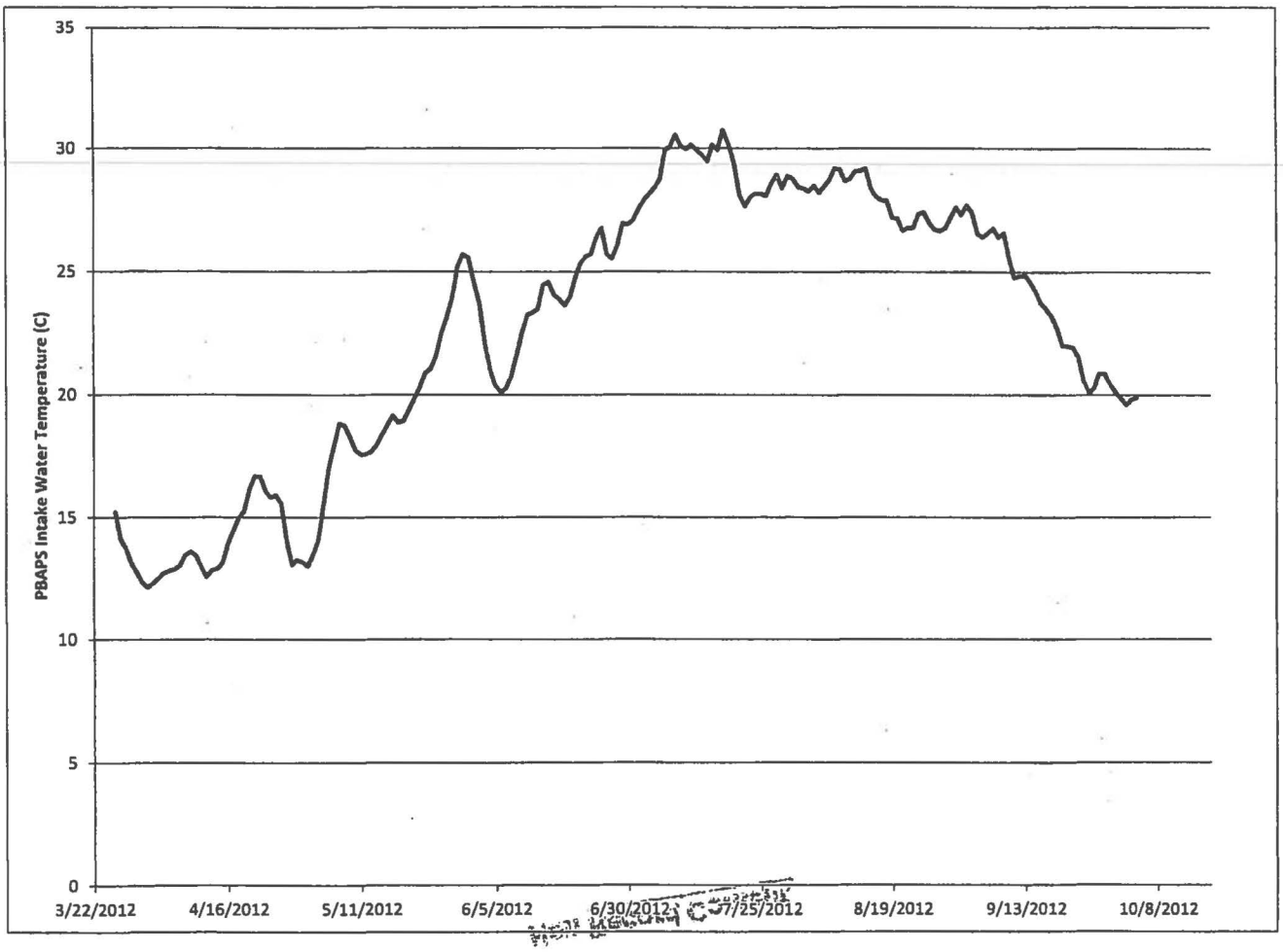

Figure 4. Water temperature measured at the PBAPS outer intake screens , March to October 2012.

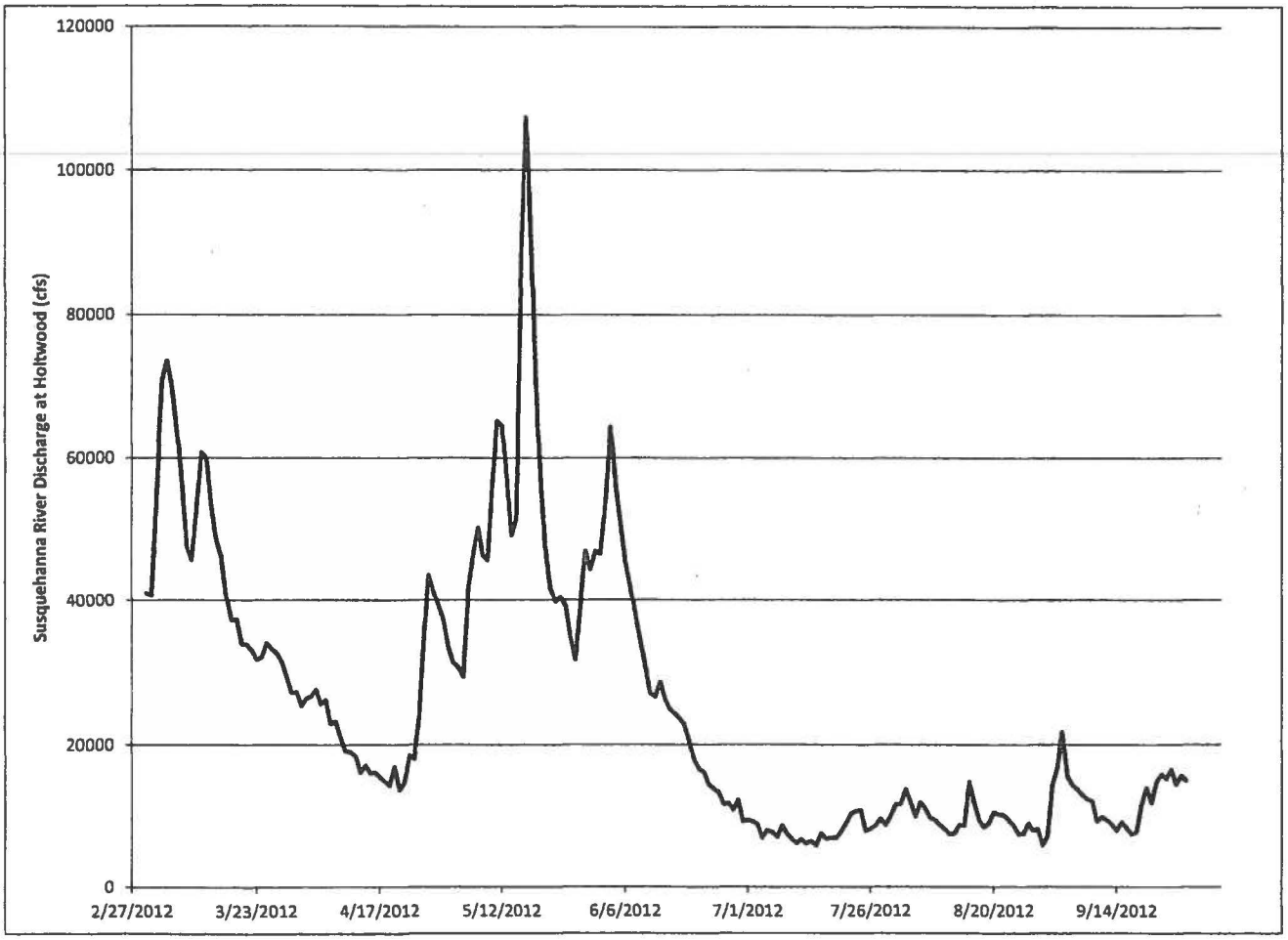

Figure 5. Susquehanna River discharge measured at Holtwood Hydroelectric Facility, March to September 2012.

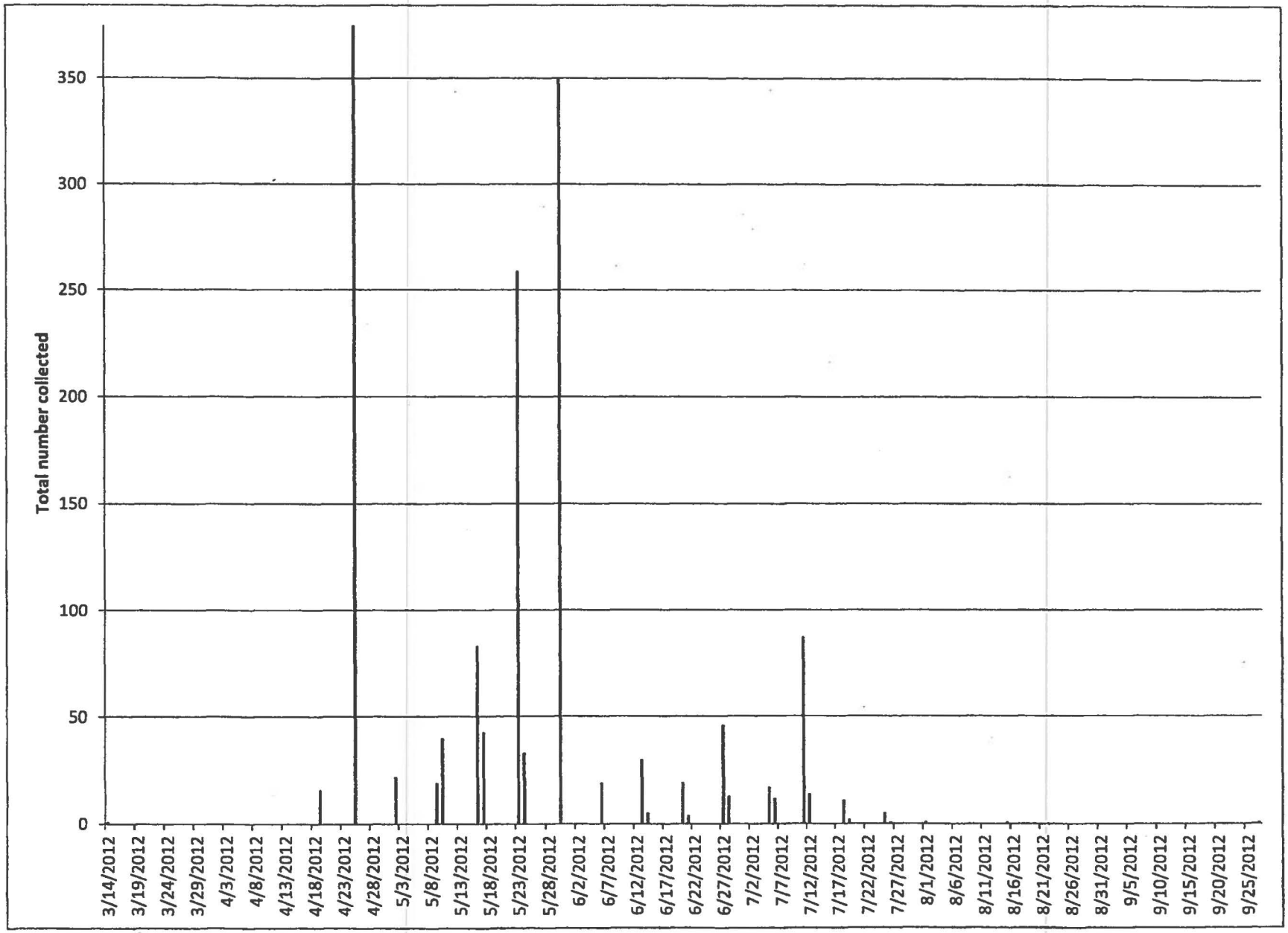

Figure 6. Total number of fish collected in entrainment samples at PBAPS, March 8 to September 27 2012.

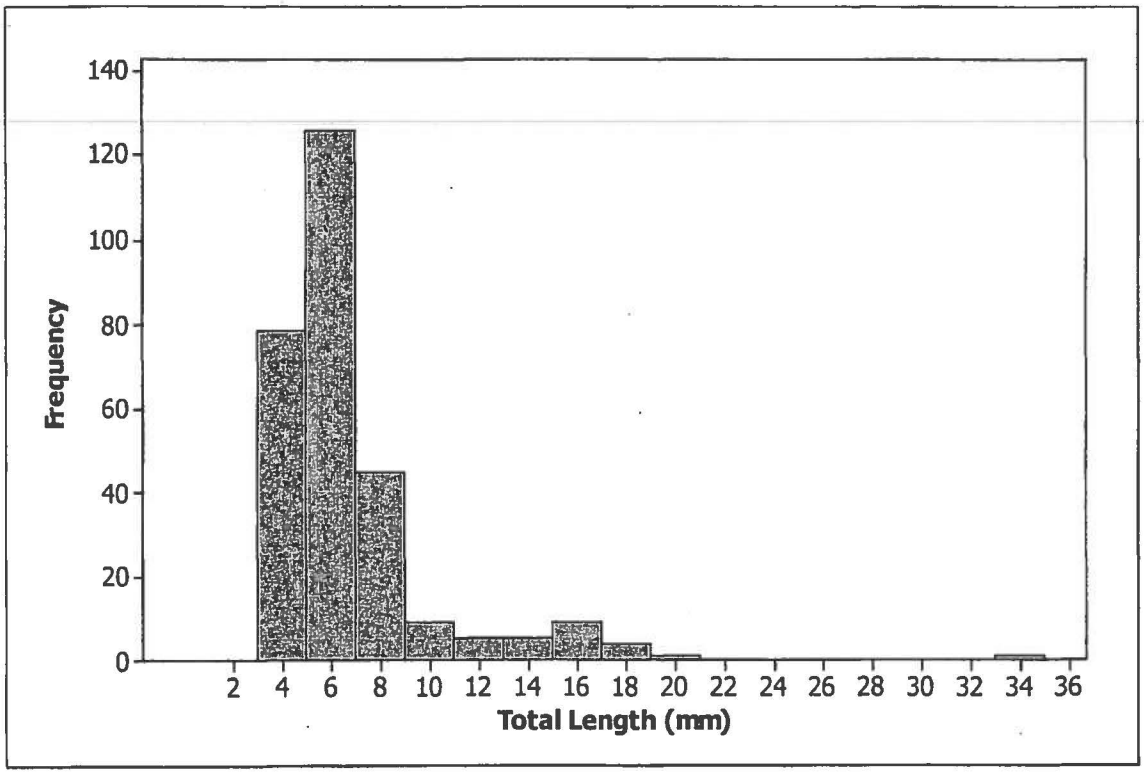

Figure 7. Length-frequency distribution of fishes collected in entrainment samples at PBAPS, March 8 to September 27 2012. Excludes one American eel (TL=128 mm)

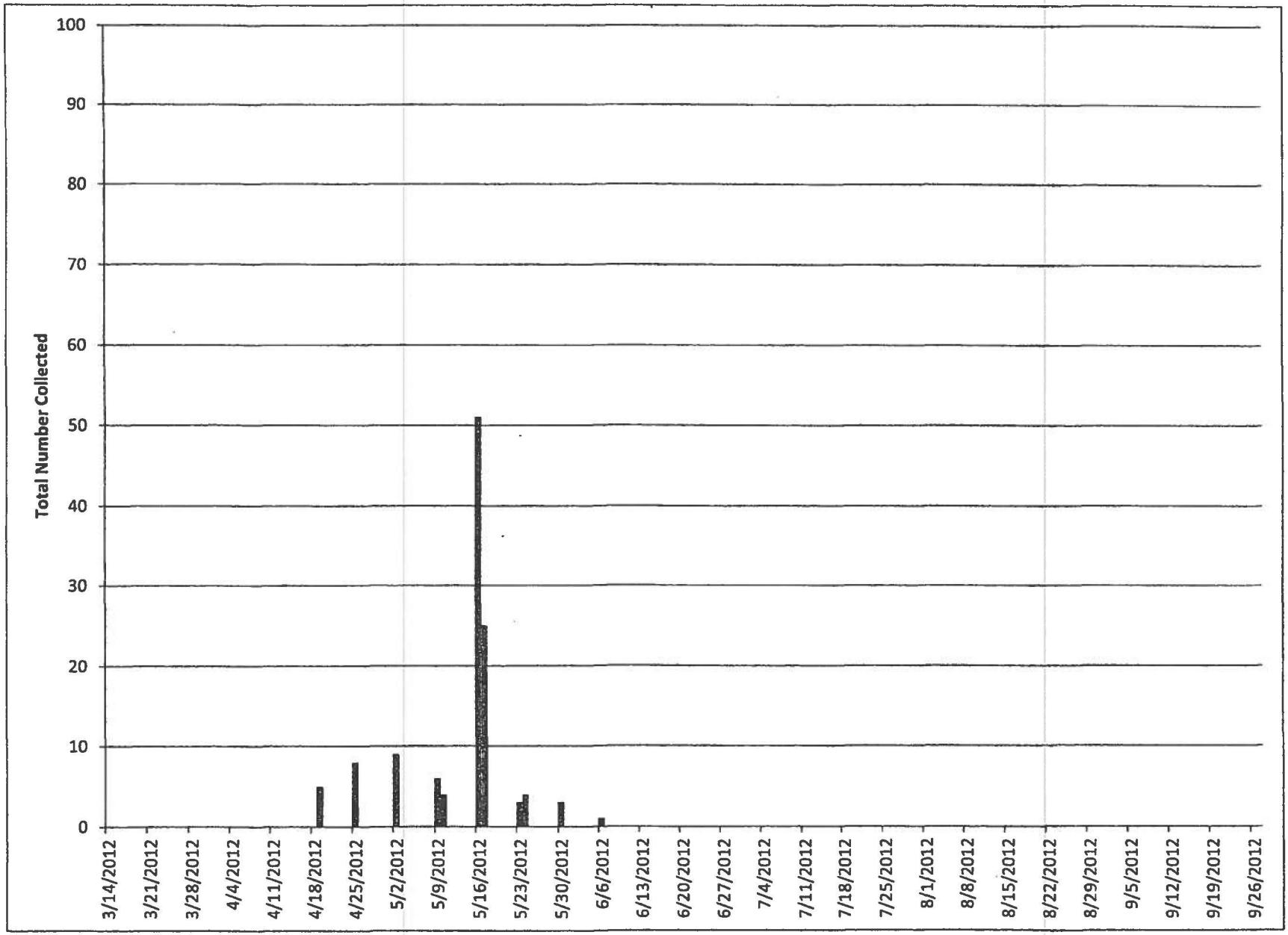

Figure 8. Number of tessellated darter collected in each entrainment sample through time at the PBAPS discharge structure outfall during 2012.

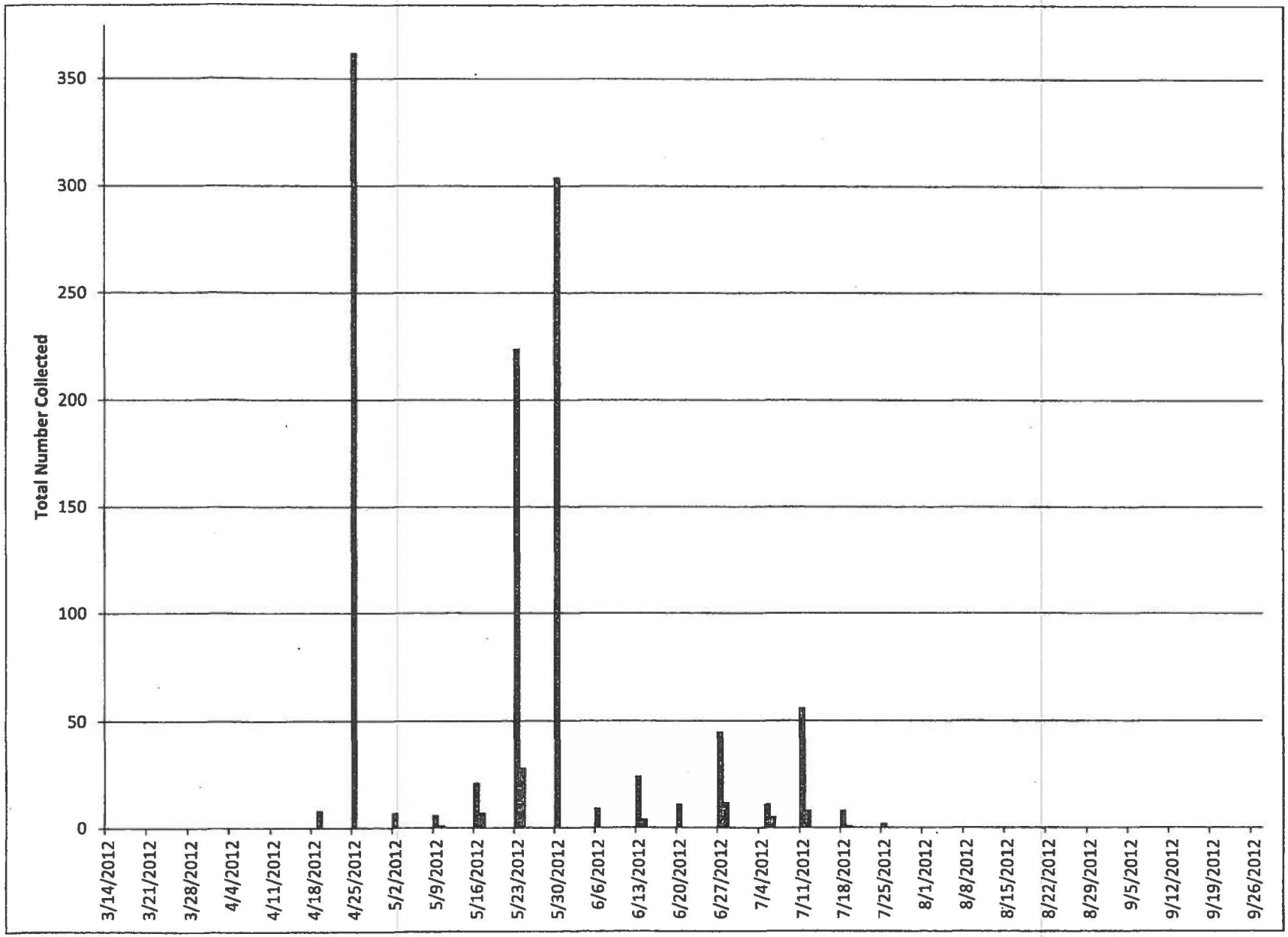

Figure 9. Number of gizzard shad collected in each entrainment sample through time at the PBAPS discharge structure outfall during 2012.

Table 1. Total number and percent composition of fish collected in entrainment samples at the PBAPS discharge structure outfall, March 8 to September 27 2012.

Common Name	Scientific Name	Total Number	Percent Composition
American eel	Anguilla rostrata	1	0.1
Banded darter	*Etheostoma zonale*	19	1.2
Carp and minnow family	Cyprinidae	5	0.3
Channel catfish	*Ictalurus punctatus*	11	0.7
Common carp	*Cyprinus carpio*	2	0.1
Darter species	*Etheostoma spp.*	9	0.6
Gizzard shad	*Dorosoma cepedianum*	1162	76.0
greenside darter	*Etheostoma blennioides*	1	0.1
Sunfishes	*Lepomis spp.*	6	0.4
Spottail shiner	*Notropis hudsonius*	2	0.1
Sucker family	Catostomidae	1	0.1
Sunfish family	Centrarchidae	1	0.1
Tessellated darter	*Etheostoma olmstedi*	119	7.8
unidentified fish		187	12.2
White sucker	*Catostomus commersoni*	3	0.2
Total		1,529	

Table 2. Total number of each taxon and life stage collected in entrainment samples at the PBAPS discharge structure outfall, March 8 to September 27 2012.

	Life Stage						
Taxon	Unknown	Egg	Yolk-sac larvae	Post yolk-sac larvae	YOY	Yearling and older	Total
American eel						1	1
Banded darter	1		8	10			19
Cyprinidae				5			5
Channel catfish				3	8		11
Common carp		1	1				2
Etheostoma species	7			2			9
Gizzard shad	600	71	285	206			1,162
greenside darter				1			1
Lepomis species				6			6
Spottail shiner					1	1	2
Catostomidae			1				1
Centrarchidae				1			1
Tessellated darter	22		44	49	4		119
unidentified fish	134	2		51			187
White sucker	1			2			3
Total Number	765	74	339	336	13	2	1,529
Percent Composition	50.0	4.8	22.2	22.0	0.9	0.1	

Table 3. Number of each taxon collected in entrainment samples during each time interval at PBAPS, March 8 to September 27 2012.

	Time Period (hours)			
Taxon	06:00-12:00	12:00-18:00	18:00-00:00	00:00-06:00
American eel	0	0	0	1
Banded darter	5	2	4	8
Cyprinidae	0	0	4	1
Channel catfish	0	1	3	7
Common carp	1	0	1	0
Etheostoma species	1	4	2	2
Gizzard shad	176	352	395	239
Greenside darter	1	0	0	0
Lepomis species	3	0	3	0
Spottail shiner	0	0	2	0
Catostomidae	1	0	0	0
Centrarchidae	0	0	1	0
Tessellated darter	9	8	69	33
White sucker	0	1	2	0
Total Icthyoplankton	197	368	486	291
Percent Composition	15	27	36	22
Total Number of Samples	32	26	33	21

Table 4. Descriptive statistics for total length of fishes collected in entrainment samples from PBAPS discharge structure outfall, March 8 to September 27 2012.

	Total Length (mm)			
Taxon	Mean	Minimum	Maximum	Number Measured
American eel	128	128	128	1
Banded darter	7.6	6	10	12
Cyprinidae	7.3	5	13	5
Channel catfish	15.5	14.5	17	10
Common carp	5.0	5	5	1
Gizzard shad	5.3	3	18	156
Greenside darter	6.5	6.5	6.5	1
Lepomis species	5.0	4.5	6	5
Spottail shiner	27.5	20	35	2
Catostomidae	8.0	8	8	1
Centrarchidae	6.5	6.5	6.5	1
Tessellated darter	7.0	5	17	88
White sucker	8.3	8	8.5	2
Total				284

Table 5. Total number and percent composition of fishes collected in Conowingo Pond using electrofisher, seine, and trawl during 2010 and 2011.

Species	Total Number	Percent Composition
Alewife	1	<0.1
American shad	1	<0.1
Banded darter	5	<0.1
Banded killifish	273	0.7
Black crappie	5	<0.1
Bluegill	2,515	6.6
Bluntnose minnow	676	1.8
Channel catfish	7,432	19.5
Comely shiner	2,611	6.8
Common carp	320	0.8
Common shiner	7	<0.1
Creek chub	4	<0.1
Eastern mosquitofish	1	<0.1
Fallfish	36	0.1
Flathead catfish	60	0.2
Gizzard shad	16,170	42.4
Golden shiner	32	0.1
Green sunfish	1,507	4.0
Greenside darter	19	<0.1
Hybrid Striped bass	9	<0.1
Largemouth bass	169	0.4
Logperch	142	0.4
Mimic shiner	25	0.1
Northern hogsucker	41	0.1
Pumpkinseed	13	<0.1
Quillback	102	0.3
Rainbow smelt	1	<0.1
Redbreast sunfish	9	<0.1
River chub	1	<0.1
Rock bass	507	1.3
Shield darter	32	0.1
Shorthead redhorse	145	0.4
Smallmouth bass	553	1.4
Spotfin shiner	3,003	7.9
Spottail shiner	1,131	3.0
Striped bass	1	<0.1
Swallowtail shiner	9	<0.1
Tessellated darter	313	0.8
Walleye	176	0.5
White crappie	20	0.1
White perch	40	0.1
White sucker	13	<0.1
Yellow perch	15	<0.1
Total Number	38,145	
Total Species	43	

Table 6. Mean densities of larval fishes collected with a towed plankton net within the PBAPS intake ponds during 1975 and 1976.

	Density(number/1000m^3)		
Taxon	1975	1976	Mean
Common carp	6.9	35.3	22
Channel catfish	4. 7	4.1	4.4
Comely shiner	0.1	0.1	0.1
Creek chub	0	0.1	-
Gizzard shad	34.8	78.6	60
Golden shiner	0	0.1	-
Logperch	0.1	0	-
Quillback	27.6	25.7	26.6
Redbreast sunfish	0.1	0	-
Rock bass	0.1	0	0.1
Shield darter	5.3	1.6	3.3
Smallmouth bass	0.4	0	0.2
Spotfin shiner	0.1	0.1	0.1
Spottail shiner	0.1	0.1	0.1
Sunfishes	1.5	1.4	1.5
Tessellated darter	5.8	8.7	7.3
Unidentifiable fish	0.5	8.1	4.6
Unidentified minnows	3.3	0.6	1.9
Unidentified suckers	0.1	0	0.1
Walleye	0.7	0.3	0.6
White crappie	0.3	0.6	0.5
White sucker	0.3	0.7	0.5
Yellow bullhead	0	0.1	0.1
Total	92.7	166.2	131.6

Table 7. Mean density of each taxon collected during weekly entrainment sample collections at PBAPS discharge outfall, March 8 to September 27 2012.

Sample Week	Taxon	Mean Density (number/1000m^3)[1]
2	Spottail shiner	2.4
7	Banded darter	5.0
7	Cyprinidae	3.0
7	Gizzard shad	15.5
7	Tessellated darter	15.2
8	Gizzard shad	822.5
8	Lepomis species	11.5
8	Tessellated darter	17.6
9	Banded darter	2.9
9	Common carp	3.4
9	Gizzard shad	10.6
9	Lepomis species	1.5
9	Catostomidae	1.5
9	Tessellated darter	15.9
10	Banded darter	21.9
10	Gizzard shad	17.0
10	Tessellated darter	24.4
10	Unidentified Fish	80.7
11	Etheostoma species	12.2
11	Gizzard shad	68.5
11	Tessellated darter	185.9
11	Unidentified Fish	36.7
11	White sucker	4.9
12	Banded darter	3.8
12	Etheostoma species	2.2
12	Gizzard shad	531.6
12	Centrarchidae	1.9
12	Tessellated darter	13.7
12	Unidentified Fish	61.4
13	Etheostoma species	8.7
13	Gizzard shad	1,327.7
13	Tessellated darter	13.1
13	Unidentified Fish	174.7
13	White sucker	4.4

Table 7. Continued.

Sample Week	Taxon	Mean Density (number/1000m^3)[1]
14	Cyprinidae	5.5
14	Etheostoma species	2.2
14	Gizzard shad	19.0
14	greenside darter	2.2
14	Tessellated darter	2.2
14	Unidentified Fish	7.7
15	Banded darter	4.2
15	Cyprinidae	2.1
15	Channel catfish	2.0
15	Gizzard shad	53.6
15	Unidentified Fish	10.4
16	Channel catfish	14.7
16	Gizzard shad	24.1
16	Unidentified Fish	14.2
17	Channel catfish	2.4
17	Gizzard shad	139.2
17	Unidentified Fish	2.4
18	Banded darter	2.4
18	Channel catfish	2.3
18	Gizzard shad	36.3
18	Unidentified Fish	25.0
19	Gizzard shad	153.6
19	Unidentified Fish	88.7
20	Channel catfish	2.3
20	Gizzard shad	21.9
20	Unidentified Fish	7.3
21	Channel catfish	2.4
21	Gizzard shad	4.9
21	Unidentified Fish	7.3
22	Banded darter	4.4
24	Spottail shiner	2.4
30	American eel	2.4

[1] Average density of taxon in the four samples collected each week

Table 8. Mean density of each taxon in entrainment sample collections at PBAPS discharge outfall, March 5 to September 27 2012.

Taxon	Mean Density (number/1000m^3)[1]
American eel	0.08
Banded darter	1.59
Cyprinidae	0.37
Channel catfish	0.92
Common carp	0.13
Etheostoma species	0.74
Gizzard shad	92.22
Greenside darter	0.08
Lepomis species	0.48
Spottail shiner	0.18
Catostomidae	0.05
Centrarchidae	0.08
Tessellated darter	10.06
Unidentified Fish	15.32
White sucker	0.26
Total	122.58

[1] Mean density determined by averaging density for each sample collected during the study period

WORK PLAN FOR AN ENTRAINMENT CHARACTERIZATION STUDY AT PEACH BOTTOM ATOMIC POWER STATION

Prepared for:

Exelon Nuclear

By: Normandeau Associates, Inc.

Revision 1, July 2012

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Figure 1. Map of Conowingo Reservoir showing locations of Peach Bottom Atomic Power Station and other power plants.

Figure 2. Peach Bottom Atomic Power Station intake structures and discharge.

Record of Revisions

Revision	Date	Pages/Sections Changed	Brief Description
000	February 2011	All	Initial release
001	July 2012	Page 4	Collection pump size changed to 3-inch with corresponding pump rate at approximately 150 gpm. Total pumping time for one sample adjusted to 180 minutes (3hrs).

INTRODUCTION

Peach Bottom Atomic Power Station (PBAPS) operates under NPDES Permit No. PA 0009733 which was issued November 30, 2010 with an effective date of January 1, 2011. The permit contains a requirement for an entrainment characterization study to be conducted over at least one fish spawning season as described in the permit within Part C. section II.D.1 as follows:

Entrainment Characterization Study

1. *Within 90 days of permit issuance, The Permittee shall submit a Work Plan to conduct entrainment sampling (see Section 2 below) of the non-contact cooling water inner intake structure at the Peach Bottom Atomic Power Station ("Facility"). The Permittee shall respond to the Department's comments on the Work Plan within 30 days of receipt. Startup of the sampling program shall occur at the beginning of the next fish spawning season following receipt of written Department approval of the Work Plan, or an alternate schedule approved by the Department, in writing.*
2. *The Work Plan shall include a detailed proposal for the following entrainment sampling of fish eggs and larvae.*
    a) *Entrainment data collections shall occur for a period of at least one fish spawning season, approximately March through September, at a sampling frequency sufficient to characterize the entrainment occurring.*
    b) *Voucher specimens of two (or one if only one is available) Chesapeake logperch (Percina bimaculata) and federal and state threatened, endangered and candidate fish species collected shall be retained and catalogued. The Department along with the appropriate state and federal authorities shall be notified within 24-hours if any federal or state threatened, endangered, or candidate fish species are identified.*
    c) *Entrainment data collection shall be performed by qualified consultants and/or trained professionals with the skills and knowledge appropriate for producing valid samples and evaluations under a formal QA/QC plan.*

This document is the Work Plan for the required entrainment characterization study. It describes the proposed study to be performed in response to the permit requirement.

The Station

PBAPS is located in York County, Pennsylvania, on the west shore of Conowingo Reservoir (Pond), approximately 3 miles upstream from the Pennsylvania-Maryland border (Figure 1). PBAPS is a two-unit nuclear-fueled power generating facility with a nominal generating capacity of 2,304 megawatts electrical (MWe). The Station operates as a base-load facility with both units normally generating at full capacity. Unit 2 began commercial operation in June 1974 and Unit 3 entered commercial service in December 1974. Conowingo Pond was formed in 1928 with the construction of Conowingo Hydroelectric Station.

Cooling Water System

PBAPS utilizes a once-through cooling system to remove waste heat from the station's condensers. The cooling water for both units is withdrawn from the Pond through an outer intake structure located on the shoreline of Conowingo Pond, through two 3-acre intake ponds (one serving each unit), and then through an inner intake structure as shown in Figure 2.

The outer intake is approximately 480 ft long with a fixed vertical trash rack on the face of the intake followed by a set of 24 vertical traveling screens which have 3/8-inch mesh openings. The trash rack consists of 0.25-inch by 3-inch steel bars spaced 3.5 inches on center and is designed to prevent large debris and ice from entering the intake. The trash rack is cleaned periodically per a preventative maintenance program.

After passing through the outer intake, the cooling water flows through the intake ponds to the inner intake. Fish live and grow in the ponds and can enter the ponds through the outer screens when they are small, by being carried over the screens if they are not removed during the screen cleaning process, and through the cross-tie gate from the discharge canal in winter. During cold weather and on an as-needed basis, a cross-tie

gate between the discharge basin and the intake ponds is opened to re-circulate some of the heated discharge water.

At the inner intake, water enters the pumphouse through eight screen bays. Two are devoted to service water flows and six convey water to the circulating water pumps. Water flowing to the circulating water pumps is screened by 3/8-inch mesh dual-flow, or dual-entry single-exit, traveling screens before being pumped through the condensers. The heated water is then discharged to a discharge basin as shown in Figure 2.

ENTRAINMENT CHARACTERIZATION STUDY

Objective

The primary objective of the entrainment study is to identify and quantify the densities of the ichthyoplankton (fish eggs and larvae) entrained through the PBAPS.

Sampling Frequency and Location

The sampling frequency of the entrainment characterization study is based on guidance provided by the Electric Power Research Institute (EPRI) in *Entrainment Abundance Monitoring Technical Support Document* (EPRI 2005) and based on similar PA DEP-approved entrainment studies conducted recently by Normandeau Associates, Inc. (Normandeau) at other generating stations in Pennsylvania. Entrainment sampling is proposed to be performed over one 24-hour sampling event each week from March through September 2012.

Entrainment sampling is proposed to be conducted at the circulating water discharge outfall for Units 2 and 3, not at the inner circulating water intake structure as stated in the NPDES permit. Exelon has serious plant safety concerns regarding maintaining the integrity of the nuclear plant's water supply and will not allow the sampling equipment to be installed within the inner intake structure. As discussed in EPRI (2005), sampling in the power plant discharge actually has advantages over sampling at the intake, such as:

- Certainty that all organisms collected were actually entrained and

- Turbulence reduces potential bias resulting from non-random distribution of entrained organisms.

The weekly sampling events will be scheduled for approximately the same day each week to assure regular spacing of the events. If either planned or unanticipated events interfere with this schedule, an adjustment of one or more days may be necessary. If the circulating water pumps of both Unit 2 and Unit 3 are not operable for an extended period (i.e., for several days during a week), the sampling will not take place that week. As long as one unit is operating, the sampling will take place. Sampling will be performed by trained personnel from Normandeau Associates, Inc. operating under an approved sampling protocol.

Sample Collection Method

The samples will be collected with a 3-inch pump that obtains the sample water through a 3-inch diameter pipe positioned vertically in the discharge basin as close as feasible to the discharge structure. The pump is to be located on the bank of the discharge basin with the suction line leading to the sampling pipe which will be attached a small pontoon work boat just off the rock-filled structure at the discharge outfall (Figure 2). Samples will be obtained from mid-depth in the water column through a 90 degree elbow or "T" facing into the current.

Total target volume of each pumped sample is approximately 100 cubic meters. The suction line will convey the sample water to the sampling pump and then through a calibrated in-line flow meter. The electric pump will have a pumping rate of approximately 150 gallons per minute as shown on the in-line flow meter. This flow rate is approximately 0.6 cubic meters per minute. Thus, it takes a total of approximately 180 minutes or approximately 3 hours of pumping to obtain a single sample of approximately 100 cubic meters. One sample will be collected every 6 hours for each weekly 24-hour sampling event. From the pump the sample is discharged through a 4-inch pipe into a plankton net constructed of 500-micron mesh and suspended in a large tank of water. The velocity of water exiting the hose is thereby reduced greatly reduced before encountering the mesh of the net. The lower velocity reduces potential damage to the eggs and larval fish specimens.

The 500-micron mesh net is fine enough to capture the eggs and larvae of all fishes likely to be encountered at PBAPS. The contents of the plankton net will be rinsed down from the outside with ambient water and carefully transferred to sample containers. The samples will be immediately preserved with 10 percent buffered formalin, labeled (both inside and out) and sent to Normandeau's laboratory for analysis.

The sample is acceptable if all of the following conditions have been met:

- A minimum sample volume of 100 m^3 was collected, unless this volume is impractical to achieve due to clogging, pumping problems, etc.,
- The net was not torn,
- The flowmeter was not physically damaged,
- The pumping apparatus was deployed at the appropriate depth, and
- None of the ichthyoplankton sample was lost or spilled during the net rinse down and sample transfer steps.

For each sample the following information will be recorded:

- Volume of water filtered,
- Intake water temperature, dissolved oxygen, and pH at the start of each sample,
- Date and time of the day at the start and end of each sample,
- Identification of the circulating water and other major pumps in operation at the start and end of each 24-hour sampling event,
- Names of the sample collectors, and
- Any deviations from the sampling protocol, unusual conditions, or other pertinent observations.

Sample Processing and Taxonomy

In general, the entire sample will be processed for ichthyoplankton (eggs and larvae) and early juvenile fish. In samples where fish eggs, larvae or juveniles are numerous, the sample may be subsampled using a plankton splitter so that the fraction of the sample analyzed reaches a quota of at least 200 organisms (all species and life stages combined). Samples will be sorted under magnification to ensure that all organisms are removed. Some samples may be difficult to split at the sort stage (e.g., samples heavy in detritus). If the number of organisms warrants it, these samples will be split after sorting but prior to identification.

The organisms will be removed from the samples, identified to the lowest taxonomic category practicable (generally species), and counted. Larvae will be categorized by lifestage into prolarvae (yolk-sac larvae), and postlarvae (post yolk-sac larvae). For each sample a maximum of 20 individuals for each species and life stage category will be measured for total length to the nearest 0.1 mm (nearest 1.0 mm for juvenile fish).

All ichthyoplankton specimens will be retained for the duration of the study. If any Federal or Pennsylvania endangered, threatened, or candidate fish species are collected, the appropriate Federal and state authorities will be notified within 24 hours of making a confirmed identification of any of these important species. Specimens of the genus *Percina* will be retained for transfer to the PA DEP at a later date.

Data Analysis and Reporting

All identified organisms will be enumerated and the density of collected organisms (by lifestage) will be calculated by relating the number observed to the volume of water comprising the sample. Evaluation will be made of species' occurrences over diel and longer time periods over the spawning season. Descriptions of species composition and abundance will be provided. A final report will describe the methods and results of the entrainment study.

Schedule

Sampling will begin during the week of March 4, 2012 and continue once weekly through September 2012. The report for the entrainment characterization study will be submitted to the PA DEP by March 1, 2013.

Quality Assurance and Control

Entrainment sampling will be performed by trained individuals from Normandeau working under a standard operating procedure and quality assurance plan developed for the entrainment study. Field instruments will be calibrated prior to each sampling event according to the manufacturer's specifications. Laboratory processing and identification shall be performed by Normandeau's trained technicians and experienced taxonomists, respectively, operating under a formal QA/QC plan.

REFERENCES

EPRI. 2005. *Entrainment Abundance Monitoring Technical Support Document.* Electric Power Research Institute Report No. 1011280. Palo Alto, CA.

Appendix B. Scientific and common names of fishes collected in Conowingo Pond.

Clupeidae	**Herrings**	***Belonidae***	**Needlefishes**
Dorosoma cepedianum	Gizzard shad	*Strongylura marina*	Atlantic needlefish
Cyprinidae	**Carps and minnows**	***Cyprinodontidae***	**Killifishes**
Clinostomus funduloides	Rosyside dace	*Fundulus diaphanus*	Banded killifish
Cyprinella spiloptera	Spotfin shiner		
Cyprinus carpio	Common carp	***Percichthyidae***	**Temperate basses**
Exoglossum maxillingua	Cutlips minnow	*Morone americana*	White perch
Luxilus cornutus	Common shiner	*Morone saxatilis*	Striped bass
Nocomis micropogon	River chub		
Notemigonus crysoleucas	Golden shiner	***Centrarchidae***	**Sunfishes**
Notropis amoenus	Comely shiner	*Ambloplites rupestris*	Rock bass
Notropis hudsonius	Spottail shiner	*Lepomis auritus*	Redbreast sunfish
Notropis procne	Swallowtail shiner	*Lepomis cyanellus*	Green sunfish
Notropis rubellus	Rosyface shiner	*Lepomis gibbosus*	Pumpkinseed
Notropis volucellus	Mimic shiner	*Lepomis macrochirus*	Bluegill
Pimephales notatus	Bluntnose minnow	*Micropterus dolomieu*	Smallmouth bass
Semotilus atromaculatus	Creek chub	*Micropterus salmoides*	Largemouth bass
Semotilus corporalis	Fallfish	*Pomoxis annularis*	White crappie
		Pomoxis nigromaculatus	Black crappie
Catostomidae	**Suckers**		
Carpiodes cyprinus	Quillback	***Percidae***	**Perches**
Catostomus commersoni	White sucker	*Etheostoma blennioides*	Greenside darter
Hypentelium nigricans	Northern hog sucker	*Etheostoma olmstedi*	Tessellated darter
Moxostoma macrolepidotum	Shorthead redhorse	*Etheostoma zonale*	Banded darter
		Perca flavescens	Yellow perch
Ictaluridae	**Bullhead catfishes**	*Percina bimaculata*	Chesapeake logperch
Ictalurus punctatus	Channel catfish	*Stizostedion vitreum*	Walleye
Pylodictis olivaris	Flathead catfish		

Attachment 2
Example Verification Completion Form
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Verification Documentation

Correspondence/Letter number: 13-27 Origination Date: 3/25/13

Agency/External Stakeholder: PA DEP Submittal Due Date: 3/4/13

Recipient of Correspondence: JULIAN MAZERO, PGADS PERMIT ENGINEER FOR PA DEP
(name and title if known)

Purpose of Submittal: 2012 ENTRAINMENT CHARACTERIZATION STUDY REPORT

Originating Office: ☐ Cantera ☐ Kennett Square ☒ Site PEACH BOTTOM
(specify)

Preparer: B. LEES (NORMANDEAU) (print) J. Bergin FOR BRYAN LEES (sign) 3/4/13 (date)

Peer Reviewer: J. BROTZMAN (print) J. Bergin (sign) 3/4/13 (date)

Certified Mail Return Receipt Requested: ☐ Yes ☒ No FED EX TRACKING

Approvals (check box if applicable)

	Applicable	Date Review Needed	Signature of Reviewer	Date of Review
Site Departments				
Chemistry S. O'DANIEL	☒	3/5/13	Stephen O'Daniel	3/11/13
Operations	☐			
Engineering	☐			
Regulatory Assurance	☐			
Other: _____ (specify)	☐			
Corporate				
SME/FAM	☐			
Site Management				
Plant Manager	☐		☐ Report Signed and Approved	
Site Vice President	☐			

Attach additional page for comments.

ENCLOSURE 9

09_NAI_2014a.pdf

[NAI] Normandeau Associates, Inc. 2014a. "Data Report or Intake Screen Sampling at Peach Bottom Atomic Power Station in 2014." Prepared for Peach Bottom Atomic Power Station. December 2014.

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2014

December 2014

DATA REPORT ON INTAKE SCREEN SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2014

Prepared for

PEACH BOTTOM ATOMIC POWER STATION
Delta, Pennsylvania 17314

Prepared by

NORMANDEAU ASSOCIATES, INC.
1921 River Road
Drumore, Pennsylvania 17518

Normandeau Associates' Project Number 23444.002

December 2014

1.0 INTRODUCTION

Normandeau Associates, Inc. (Normandeau) was contracted by Exelon Corporation to conduct intake screen sampling at their Peach Bottom Atomic Power Station (PBAPS) during fall 2014. The study objective was two-fold: it fulfills Exelon's obligation to support the Susquehanna River's American shad restoration program as stated in the 2014 annual work plan, and it provides juvenile American shad specimens to the Pennsylvania Fish and Boat Commission (PFBC) for otolith analysis, which compares the overall contribution of hatchery and wild fish to the population.

2.0 METHODS

Due to an extended unit shut down for maintenance and refueling, scheduled for mid-October through mid-December, intake screen sampling was scheduled to occur three days per week, (Monday, Wednesday, and Friday), with a two-person crew, from 1 to 17 October, 2014. A total of 8 sampling events was conducted at the outer screen house during this portion of the juvenile American shad outmigration period. Normandeau personnel contacted PFBC personnel throughout the study period to keep them updated on collection/sampling activities.

Peach Bottom control room personnel were contacted before and after each sampling event. The intake screens were operated on an as needed basis during the sample period, and for a minimum of 30 minutes prior to each trash bin being pulled from the collection pit and the contents available for sampling. Peach Bottom personnel hoisted the trash bins out of the screen house to facilitate sampling and ensure the safety of the work crew. All fish observed in the trash bins (both Units 2 and 3) were identified and counted (if possible). In 2014, sub-sampling of certain species, (gizzard shad), was not necessary as large numbers of fish or heavy debris loads occurred infrequently throughout the abbreviated study period. Juvenile American shad that were suitable for analysis, (head and body intact), were counted, measured (nearest mm total length), and preserved (frozen) prior to delivery to PFBC personnel.

3.0 RESULTS

A total of 8,496 fish of 17 taxa was collected; 4,699 from Unit 2 and 3,797 from Unit 3 (Table 1). Gizzard shad (7,634), channel catfish (395), and bluegill (371) comprised nearly 99% of the total, while all other species combined accounted for 1.1% of the total fish collected. Other species common in the collections were white perch (16) and comely shiner (16).

No juvenile American shad were collected at PBAPS or provided to the PFBC for analysis during this sampling period (Table 2).

4.0 SUMMARY

Intake screen sampling was conducted during the early portion of the juvenile American shad outmigration period in Conowingo Pond. No sampling occurred after October 17, 2014 due to a refueling outage at the PBAPS. At this time, it is uncertain when these juvenile shad moved downstream into Conowingo Pond. A weekly haul seine project conducted by Normandeau for the PFBC, in the vicinity of City Island (Harrisburg, PA) and Columbia, PA, from mid-July through October 2014, resulted in the collection of 31 juvenile American shad (24 from City Island; 7 from Columbia). Relatively low, stable river flows occurred throughout the sampling period with no discernible freshets which would move fish downstream. The river water temperature during the 2014 study ranged from 63.5° F to 75.4° F which is relatively warm and may not have triggered the urge for juvenile American shad to begin their downstream migration. No juvenile American shad were collected or provided to the PFBC from sampling activities at the PBAPS in 2014.

Table 1

Number of fish collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 1 to 17 October 2014.

Species	Unit 2	Unit 3	Total
Alewife (residualized)	2	5	**7**
Gizzard shad	4,257	3,377	**7,634**
Common carp	4	4	**8**
Comely shiner	9	7	**16**
Spottail shiner	4	0	**4**
Channel catfish	238	157	**395**
Flathead catfish	7	5	**12**
White perch	7	9	**16**
Rock bass	0	3	**3**
Green sunfish	0	3	**3**
Pumpkinseed	1	0	**1**
Bluegill	155	216	**371**
Smallmouth bass	2	2	**4**
Largemouth bass	1	2	**3**
White crappie	6	4	**10**
Tessellated darter	5	1	**6**
Logperch	1	2	**3**
TOTAL	***4,699***	***3,797***	***8,496***

Table 2

Number of juvenile American shad collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 1 to 17 October, 2014.

Date	Unit 2	Unit 3	Total
01 Oct	0	0	**0**
03 Oct	0	0	**0**
06 Oct	0	0	**0**
08 Oct	0	0	**0**
10 Oct	0	0	**0**
13 Oct	0	0	**0**
15 Oct	0	0	**0**
17 Oct	0	0	**0**
TOTAL	***0***	***0***	***0***

ENCLOSURE 10

10_NAI_2015a.pdf

[NAI] Normandeau Associates, Inc. 2015a. "Data Report or Intake Screen Sampling at Peach Bottom Atomic Power Station in 2015." Prepared for Peach Bottom Atomic Power Station. December 2015.

DATA REPORT ON AMERICAN SHAD SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2015

December 2015

DATA REPORT ON AMERICAN SHAD SAMPLING AT PEACH BOTTOM ATOMIC POWER STATION IN 2015

Prepared for

PEACH BOTTOM ATOMIC POWER STATION
Delta, Pennsylvania 17314

Prepared by

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Normandeau Associates' Project Number 23444.002

December 2015

1.0 INTRODUCTION

Normandeau Associates, Inc. (Normandeau) was contracted by Exelon Corporation to conduct sampling for juvenile American Shad at the outer intake screens at Peach Bottom Atomic Power Station (PBAPS) during November 2015. The study objective was two-fold: it fulfills Exelon's obligation to support the Susquehanna River's American shad restoration program as stated in the 2015 annual work plan, and it provides juvenile American shad specimens to the Pennsylvania Fish and Boat Commission (PFBC) for otolith analysis, which compares the overall contribution of hatchery and wild fish to the population.

2.0 METHODS

After fall refueling outage activities were completed, outer intake screen sampling was performed three days per week, (Monday, Wednesday, and Friday), with a two-person crew, from 2 to 25 November, 2015. A total of 11sampling events were conducted at the outer screen house during this portion of the juvenile American shad outmigration period. Normandeau personnel contacted PFBC personnel throughout the study period to keep them updated on collection/sampling activities.

Peach Bottom control room personnel were contacted before and after each sampling event. The outer intake screens were operated on an as needed basis during the sample period, and prior to each trash bin being pulled from the collection pit and the contents available for sampling. Peach Bottom personnel hoisted the trash bins out of the screen house to facilitate sampling and ensure the safety of the work crew. All fish observed in the trash bins (both Units 2 and 3) were identified and counted (if possible). In 2015, sub-sampling of certain species, (gizzard shad), was not necessary as large numbers of fish or heavy debris loads occurred infrequently throughout the study period. Juvenile American shad that were suitable for analysis, (head and body intact), were counted, measured (nearest mm total length), and preserved (frozen) prior to delivery to PFBC personnel.

3.0 RESULTS

A total of 33,410 fish of 29 taxa was collected; 12,625 from Unit 2 and 20,785 from Unit 3 (Table 1). Gizzard shad (25,585), bluegill (5,986), and white perch (1,014) comprised nearly 98% of the total, while all other species combined accounted for about 2% of the total fish collected. Other species common in the collections were channel catfish (290) and green sunfish (112).

A total of 62 American shad was collected at PBAPS and provided to the PFBC for analysis during this sampling period (Table 2).

4.0 SUMMARY

Outer intake screen sampling was conducted during the November portion of the historical juvenile American shad outmigration period (October/November) in Conowingo Pond. No sampling occurred prior to November 2, 2015 due to a refueling outage at the PBAPS. At this time, it is uncertain when these juvenile shad collected at the PBAPS moved downstream into Conowingo Pond since the weekly haul seine project conducted by Normandeau for the PFBC, in the vicinity of Columbia, PA, from mid-September through mid-November 2015, did not result in the collection of any juvenile American shad. Relatively low, stable river flows occurred throughout the sampling period with no discernible freshets which would move fish downstream. The river water temperature during the 2015 study ranged from 45.9° F to 56.9° F, conducive for triggering outmigration behavior of juvenile American shad. A total of 62 juvenile American shad were collected and provided to the PFBC from sampling activities at the PBAPS in 2015. For reference, a total of 49 and 0 juvenile American shad were collected and provided to the PFBC from sampling activities at the PBAPS in 2013 and 2014, respectively.

Table 1

Number of fish collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 2 to 25 November 2015.

Species	Unit 2	Unit 3	Total
American eel	1	3	**4**
American shad	29	33	**62**
Alewife (residualized)	1	4	**5**
Alosa sp. (decapitated)	1	0	**1**
Gizzard shad	9,755	15,830	**25,585**
Common carp	9	42	**51**
Golden shiner	4	3	**7**
Comely shiner	64	22	**86**
Spottail shiner	0	2	**2**
Spotfin shiner	1	2	**3**
Quillback	1	0	**1**
Shorthead redhorse	1	3	**4**
Channel catfish	150	140	**290**
Flathead catfish	3	12	**15**
Banded killifish	13	17	**30**
White perch	242	772	**1,014**
Striped bass	2	2	**4**
Rock bass	4	12	**16**
Green sunfish	29	83	**112**
Pumpkinseed	2	2	**4**
Bluegill	2,286	3,700	**5,986**
Smallmouth bass	1	18	**19**
Largemouth bass	5	29	**34**
White crappie	5	14	**19**
Black crappie	2	13	**15**
Tessellated darter	6	7	**13**
Yellow Perch	2	12	**14**
Ch. Logperch	5	6	**11**
Walleye	0	2	**2**
Greenside darter	1	0	**1**
TOTAL	***12,625***	***20,785***	***33,410***

Table 2

Number of juvenile American shad collected during intake screen sampling by unit at Peach Bottom Atomic Power Station, 2 to 25 November, 2015.

Date	Unit 2	Unit 3	Total
02 Nov	7	0	**7**
04 Nov	1	13	**14**
06 Nov	4	1	**5**
09 Nov	6	2	**8**
11 Nov	3	2	**5**
13 Nov	0	1	**1**
16 Nov	0	1	**1**
18 Nov	0	1	**1**
20 Nov	0	4	**4**
23 Nov	6	5	**11**
25 Nov	2	3	**5**
TOTAL	***29***	***33***	***62***