I A 1976

AN ECOLOGICAL STUDY OF THE SUSQUEHANNA RIVER IN THE VICINITY OF THE THREE MILE ISLAND NUCLEAR STATION

Annual Report For 1975

by

Wayne A. Potter, Project Leader, and Associates
Ichthyological Associates, Inc.
P.O. Box 223, Etters, Pennsylvania 17319

for

METROPOLITAN EDISON COMPANY

ICHTHYOLOGICAL ASSOCIATES, INC.
Edward C. Raney, Ph.D., Director
301 Forest Drive, Ithaca, New York 14850

February 1976

1.0 INTRODUCTION

This is the second annual postoperational report on the ecology of the York Haven Pond of the Susquehanna River in the vicinity of Three Mile Island Nuclear Station (TMINS). The study by Ichthyological Associates, Inc. was initiated in February 1974. Most data from 1974 were reported in Potter and Associates (1975). Data from 1974 not completed for the first annual report and data from January through December 1975 are herein reported. Sections are presented to meet the Environmental Technical Specifications (ETS) for TMINS, Unit 1, Appendix B. Parameters analyzed are the same as reported in Potter and Associates (1975) with the addition of surveillance for bird impaction on the natural draft cooling towers, and possible effects of salt drift on terrestrial plants near the station.

Potter, W.A. and Associates. 1975. An ecological study of the Susquehanna River in the vicinity of the Three Mile Island Nuclear Station, Annual Report for 1974. Ichthyological Associates, Inc. 468 pp.

1.1 SUMMARY

1.1.1 Impingement of Fishes

Twenty-three 24-hr surveys were done January through December 1975 at the TMINS Unit 1 Intake. A total of 476 fish of 26 species weighing 2.37 kg (5.22 lb) was impinged. Most of the fish were dead. The mean number of specimens per 24-hr survey was 20.7; mean weight was 103.0 g.

An estimated 5,556 fish weighing 37.6 kg (82.7 lb) were impinged during 1975.

More fish were impinged during 1974 (1222 specimens; 21 surveys) than in 1975 (476;23). Total biomass was higher in 1975.

1.1.2 Entrainment of Ichthyoplankton

Entrainment surveys were done semi-monthly April through October 1975. Totals of 67 larval fish, 6 juvenile fish, and zero fish eggs were collected. Percids were most common.

Larvae were taken sporadically and in numbers too low to calculate station incurred mortality.

Ichthyoplankton entrainment surveys are summarized for 1974 and 1975.

1.1.3 Entrainment of Plankton

1.1.3.1 Phytoplankton

Phytoplankton results from August through October 1974 and April through October 1975 are presented. Phytoplankton composition was similar in samples taken simultaneously at the Intake and Discharge on each date.

Eighty-nine genera of six divisions were identified in 1974 and 1975.

1.1.3.2 Zooplankton

Zooplankton results from 26-27 September through October 1974 and April through October 1975 are presented.

A total of 85 taxa of zooplankton and other invertebrates was identified in 1974. Small diel differences in composition and numbers of major zooplankton taxa were noted during late September through October. The composition and numbers of zooplankton at both the Intake and Discharge were similar on each date. Rotifers were most abundant. Cladocerans and copepods were taken in lower numbers. Mortality estimates range from 3.2 to 8.8%. Results from 1974 are summarized herein.

A total of 85 taxa of zooplankton and other invertebrates was identified in 1975. Small diel differences in composition and numbers of zooplankton were noted. The composition and density of the major zooplankton taxa at both the Intake and Discharge were similar on each date. Cladocerans, rotifers, and copepods were the most abundant zooplankton taxa accounting for 42.0, 31.5, and 25.4%, respectively, of the zooplankton. Mean values of percentage zooplankton mortality range from 0.6 to 9.6%. The percentages of zooplankton entrained by TMINS and lost to the closed cycle cooling system as condenser make-up and to other factors are estimated.

1.1.4 Fish

Fishes were sampled by seine and trapnet from March through October 1975.

4.0 ENTRAINMENT OF PLANKTON

The ETS Appendix B, Section 4.1.1C required semi-monthly 24-hr sampling for plankton from April through October. Samples were taken at 4-hr intervals at both the TMINS Intake and Discharge.

4.1 PHYTOPLANKTON

4.1.1 METHODS AUGUST THROUGH OCTOBER 1974

Phytoplankton samples were taken at the surface from in front of the trash rake unit in the Unit 1 Intake and from the Flow and Radiation Monitor Pit near the Discharge. One liter samples were collected at 4-hr intervals with a bucket. All samples were preserved and stained with 10% Lugol's solution.

Samples were concentrated after three weeks settling time to between 0.1 and 0.2 l volumes by siphoning off the supernatant. Phytoplankton enumerations were made with a Palmer-Maloney cell at 200X magnification. Subsample size was 0.1 ml and the volume searched was 0.005 ml to 0.1 ml depending upon the phytoplankton density. Taxa were identified to genus or species at 400X or 1000X magnification. Counts were made in terms of "units" a method modified by Ichthyological Associates (1972) from Tucker (1948). With the exception of the Bacillariophyta (each cell in a chain was counted), one cell, colony, or 10 cell filament was equivalent to one "unit" (Table 4.1-1). Many phyto-flagellates were unidentifiable in the preserved samples; these taxa were lumped and listed separately in the tables.

The densities of each plankton division for each 24 hr period at the

Intake and Discharge were compared using the formula (Simpson et al. 1960):

$$t = \bar{d}/\sqrt{s^2/n}$$

where: $\bar{d}$ = mean difference between densities of a plankton division

s^2 = variance

n = number of paired observations.

4.1.2 RESULTS AUGUST THROUGH OCTOBER 1974

A total of 152 phytoplankton samples was collected during thirteen 24-hr entrainment studies in 1974. Analysis was completed on 82 samples taken on 25-26 April, 9-10 and 23-24 May, 6-7 and 20-21 June, 11-12 and 25-26 July and was reported in Potter and Associates (1975). The data and analysis for the remaining 70 samples collected on 15-16 and 29-30 August, 12-13 and 26-27 September, and 10-11 and 24-25 October are herein reported. Two samples were not taken at 1600 and 0800 hr on 10-11 October due to la[illegible] of access to the intake sampling site.

Eighty-nine genera belonging to six divisions of phytoplankton were identified in 1974 (Table 4.1-2). The Chlorophyta (green algae) were represented by 43 genera and the Bacillariophyta (diatoms) by 26 genera. Nine genera of the Cyanophyta (blue-green algae), 4 genera of Pyrrophyta (dinoflagellates), and three genera each of the Euglenophyta (euglenoids) and Chrysophyta (yellow-green algae) were identified. Common genera such as *Pediastrum* and *Scenedesmus* were represented by more than one species.

Data on phytoplankton abundance and composition in samples taken during each study are presented in Tables 4.1-3 through 4.1-8. Mean density and relative abundance of each phytoplankton division for each 24-hr period are given in Table 4.1-9.

Phytoplankton composition was similar in samples taken simultaneou at the Intake and Discharge on each date. Although apparent differences were sometimes observed, phytoplankton density was not generally different at either site over an entire 24-hour period. Paired t-tests, calculated for each plankton division, indicated that apparent differences in abundance were not significant ($P = 0.05$), except on 15-16 August when slightly lower numbers and on 12-13 September, when slightly higher numbers of Chlorophyta were found in the Discharge.

The composition and relative abundance of the phytoplankton varied from month to month. Only data from the Intake are discussed because of the above mentioned similarity of composition. Mean phytoplankton densities were higher in August than in September and October (Table 4.1-10). Taxa belonging to the Chlorophyta comprised 47% to 48% and those belonging to the Bacillariophyta 23% to 25% of the phytoplankton populations found on 15-16 and 29-30 August. *Ankistrodesmus falcatus*, *Golendinia radiata*, *Scenedesmus quadricauda* (all Chlorophyta), *Cyclotella* spp. and *Tabellaria fenestrata* (both Bacillariophyta) were the most abundant members of a diverse population.

In September, the Bacillariophyta and the Chlorophyta were equally dominant, each representing about 38% of the total population. *Cyclotella* spp. and *Ankistrodesmus falcatus* were the most abundant taxa.

The Bacillariophyta, especially *Cyclotella* spp., *Melosira* spp. and *Navicula* spp. accounted for 48% to 72% of the total population on 10-11 and 24-25 October. *Ankistrodesmus falcatus* was the most abundant member of the Chlorophyta (19% to 25%).

4.1.2.1 SUMMARY 1974

Phytoplankton composition and abundance were generally similar a the Intake and Discharge during all 24-hr studies (Table 4.1-10).

The Bacillariophyta, particularly Cyclotella and Melosira, were abundant in May, and were common throughout the year. Asterionella w dominant in April, Navicula in April and October, Synedra from April July and Tabellaria in August. Increasing numbers of Chlorophyta wer found in the late spring and summer; Ankistrodesmus, Scenedesmus, Dictyosphaerium, Micractinium, and Golenkinia were most abundant. Th Cyanophyta, especially Oscillatoria and Anacystis were at their seaso maximum in July; the phyto-flagellates peaked in August.

4.1.3 METHODS 1975

Methods were as stated in Section 4.1.1 except that Discharge sa were taken at the mouth of the discharge pipe at the river.

4.1.4 RESULTS 1975

A total of 166 phytoplankton samples was collected during fourte 24-hr entrainment studies in 1975. Discharge samples were not taken a 1600 and at 2000 hr on 21 April due to a sampling mistake.

Ninety-five genera belonging to six divisions of phytoplankton we identified in 1974 and 1975 (Table 4.1-11). The Chlorophyta were repr sented by 49 genera and the Bacillariophyta by 27 genera. Nine genera Cyanophyta, 4 genera of Chrysophyta and 3 genera each of the Euglenoph and Pyrrophyta were observed. Common genera such as Pediastrum and Scenedesmus were represented by more than one species.

Data on phytoplankton abundance and composition in samples taken during each study are presented in Tables 4.1-12 to 4.1-25. Mean dens [illegible] abundance of each phytoplankton division for each 24-hr [illegible] given in Table 4.1-26.

[illegible] species composition of the phytoplankton was similar in samples [illegible] the Intake and Discharge during each 4-hr sampling period. [illegible] apparent differences were sometimes observed, phytoplankton [illegible] were not generally higher or lower at either site over an [illegible]-hr period. Paired t-tests calculated for each plankton division [illegible] that differences with few exceptions in the abundance were not [illegible]ficant (P = 0.05). On 16 June the Chlorophyta were more abundant and [illegible] August the Cyanophyta were slightly less abundant in the Discharge. [illegible] number of phyto-flagellates was significantly lower in the Discharge [illegible] July.

In the following discussion of seasonal distribution, only data from the Intake are used. In April and May taxa belonging to the Bacillario-phyta, particularly Cyclotella spp., Melosira spp., Synedra spp., and Asterionella formosa, accounted for approximately 59% to 88% of the total phytoplankton population (Table 4.1-26). The mean density of diatoms increased from 88,700 cells/liter on 7-8 April to 7,350,500 cells/liter on 27-28 May.

In June the three most abundant phytoplankton divisions were the Bacillariophyta (27% to 52% of the population), the Chlorophyta (30% to 45%) and the Cyanophyta (less than 5%). Prevalent species included Cyclotella spp., Synedra spp., and Nitzschia spp. (all diatoms), and Ankistrodesmus falcatus, Actinastrum hantzschii, Dictyosphaerium pulchellum, and Scenedesmus spp. (all green algae). Phyto-flagellates were also common (15% to 23%).

Bacillariophyta were abundant (67% to 72% of the population) in July. Mean diatom densities were higher (13,114,999 cells/liter) on 7-8 July than at any other time; Tabellaria fenestrata was dominant. Phyto-flagellates were common (15% to 16%).

In August and September the Chlorophyta, primarily Golendinea radiata, Scenedesmus spp. and Ankistrodesmus falcatus, represented 42% to 63% of the population. The Bacillariophyta, particularly Cyclotella spp. and Stephanodiscus spp., were less numerous (3% to 34%). Phyto-flagellates represented 17% to 22% of the population.

Mean phytoplankton densities were lower in October than in August and September. Diatoms such as Cyclotella spp. and Melosira spp. were the most common taxa (61% to 64% of the population). Phyto-flagellates were also common (23%).

As of this writing the ETS requirements for entrainment studies concerning phytoplankton are fulfilled. No further studies appear necessary therefore analyses of phytoplankton entrainment in relation to TMINS have been terminated.

Ichthyological Associates. 1972. An ecological study of the North Branch Susquehanna River in the vicinity of Berwick, Pennsylvania. Pennsylvania Power and Light Company, Allentown, PA. 232 pp.

Potter, W.A., and Associates. 1975. An ecological study of the Susquehanna River in the vicinity of the Three Mile Island Nuclear Station. Metropolitan Edison Company, Reading, Pennsylvania. 468 pp.

Tucker, A. 1948. The phytoplankton of the Bay Quinte. Trans. Amer. Microsc. Soc. 67:365-383.

4.2 ZOOPLANKTON

4.2.1 METHODS SEPTEMBER AND OCTOBER 1974

Methods were as described in Potter and Associates (1975).

4.2.2 RESULTS SEPTEMBER AND OCTOBER 1974

Analysis of samples taken from 25-26 April through 12-13 September 1974 was completed and reported in Potter and Associates (1975). Analysis was completed for samples taken on 26-27 September, 10-11 and 24-25 October; the results are herein reported.

A total of 85 taxa of zooplankton and other invertebrates was identified in 1974 (Table 4.2-1). Data on the abundance and composition of zooplankton taken on each date are presented in Tables 4.2-2 through 4.2-7.

Small diel differences in the composition and density of major zooplankton taxa were noted (Tables 4.2-8 through 4.2-10).

The composition and density of zooplankton at the Intake and Discharge were similar on each date (Tables 4.2-11 through 4.2-13). Seasonal fluctuations are described using data taken at the Intake.

Rotifers were the most abundant taxon and accounted for 90.8 to 97.2% of the zooplankton. *Brachionus quadridentatus* and *B. calyciflorus* were the most common species.

Cladocerans and copepods were taken in low numbers and accounted for 1.2 to 4.8% of the zooplankton. Cyclopoid copepodids and nauplii (immature stages) were the most common copepods. No single cladoceran species was common.

Mortality estimates were made for all samples (Tables 4.2-14 through 4.2-16); mean values for each entrainment study were 8.8% (26-27 September), 3.2% (10-11 October), and 3.8% (24-25 October).

4.2.3 SUMMARY 1974

Zooplankton composition and abundance were generally similar at the Intake and Discharge during each 24-hr study, April through October 1974. Diel differences were small.

Rotifers were the most abundant taxon during all entrainment studies except 15-16 August (Table 4.2-13). *Brachionus quadridentatus* and *B. calyciflorus* were the most common species.

Cladocerans and copepods, common throughout the year, were collected in greatest numbers in late July and August. *Bosmina longirostris* was the most common cladoceran collected. *Cyclops vernalis*, cyclopoid copepodid, and nauplii were the most common copepods.

Estimates of zooplankton mortality were made for eight of thirteen 24-hr studies. Mean values for percentage zooplankton mortality ranged from -1.2 to 8.8% with the grand mean for 1974 of 2.4%.

4.2.4 METHODS 1975

Replicate (2) samples were taken semi-monthly at 4-hr intervals for 24 hr, April through October. Additional samples (3 to 4) were taken at 1200 hr at both the Intake and Discharge from 7-8 April through 23-24 June. Samples were taken by pump (modified from 1974) as described in Section 3.0. The pump was fitted with a No. 20 (0.08 mm) mesh net. Sample size was either 0.38 m^3 (100 gal) or 0.76 m^3 (200 gal) dependent upon observed zooplankton densities.

A live count technique similar to that described in Potter and Associates (1975) was utilized for estimating percentage zooplankton mortality due to entrainment. Samples were concentrated immediately after collection. Two 1 ml subsamples were withdrawn using a Hensen-Stemple pipet. Each subsample was placed on a Sedgewick-Rafter mounting cell and sorted for numbers of dead zooplankton; these were limited to abundant or prominent (size) rotifers (Brachionus spp. and Euchlanis sp.), and all cladocerans and copepods. Mortality estimates were not possible during all entrainment studies because of low zooplankton densities or large amounts of suspended solids in the water.

The percentage of dead organisms per cubic meter was calculated from the ratio of the number of dead organisms per cubic meter and the total number of organisms per cubic meter; total numbers were determined from quantitative analysis of the samples. The mortality of zooplankton was derived by subtracting the percentage of dead organisms at the Intake (mortality due to sampling; all organisms were assumed alive when collected) from the percentage of dead organisms at the Discharge.

The percentage influent used as condenser make-up (C) was calculated using the following formula:

$$C = \left[(I - E) + b - m\right] 100/I$$

where: I = Influent (m^3/min) calculated using the number of pumps and their rated discharge (A.E.C. 1971)

E = Effluent (m^3/min) recorded by TMINS

b = 7.6 m^3/min; estimated blowdown (A.E.C. 1971)

m = 1.5 m^3/min; maximum evaporative loss at the mechanical draft cooling tower (A.E.C. 1971)

The percentage of entrained zooplankton lost (Z) was equated with the condensor make-up (C = Z) with the assumption that 100% of the zooplankton in the water used as condenser make-up was lost in the closed cycle cooling system.

The total entrained zooplankton lost (N) was calculated using the formula:

$$N = (I)(D_I) - (E)(D_E)$$

where: D_I = Zooplankton density at the Intake

D_E = Zooplankton density at the Discharge

For quantitative analysis, four one ml subsamples from each collection were analyzed (April through 3-4 September). One ml subsamples were taken and analyzed until 200 organisms of one taxon were counted or up to a total of four one ml subsamples were withdrawn (22-23 September through October).

For discussion densities were quantified as low (less than 1000/m^3), moderate (1,000 to 20,000/m^3), and high (greater than 20,000/m^3).

[illegible] RESULTS 1975

[illegible] total of 85 taxa of zooplankton and other invertebrates was [illegible]d (Table 4.2-17). Data on the abundance and composition of [illegible]on during each 24-hr study are presented in Tables 4.2-18 [illegible] 2-45.

[illegible] diel differences in the composition and density of major zooplankton taxa were noted (Tables 4.2-46 through 4.2-59).

[illegible] composition and density of the major taxa at the Intake and [illegible] were similar on each date (Table 4.2-60). Because of these similarities, seasonal variations were discussed in respect to only Intake collections.

Cladocerans, rotifers, and copepods were the most abundant zooplankton accounting for 42.0, 31.5, and 25.4%, respectively, of the zooplankton.

Cladocerans were taken in low numbers in April through June; during July and early August numbers increased, reaching a peak ($134,807/m^3$) on 11-12 August when cladocerans comprised 55.1% of the zooplankton (Table 4.2-60). Numbers were high through August and September; low numbers were found in October.

<u>Bosmina longirostris</u> accounted for 88.8% of the cladocerans. Numbers were low in April through early July; they increased to a peak ($125,222/m^3$) on 11-12 August (Table 4.2-61). <u>Daphnia</u> spp. and <u>Diaphanosoma</u> spp. followed in abundance.

Numbers of rotifers were low in April through 16-17 June; they increased to a peak ($50,148/m^3$) on 25-26 August (Table 4.2-60). Numbers decreased in early September and increased to $98,048/m^3$ in late September. Rotifers accounted for 86.4% of the zooplankton on 22-23 September. Low numbers were taken in October.

<u>Brachionus calyciflorus</u> comprised 42.7% of the rotifers. Numbers were low through 7-8 July (Table 4.2-61). Successively higher peaks were observed on 21-22 July ($2,955/m^3$), 25-26 August ($24,143/m^3$), and 22-23 September ($59,550/m^3$). Numbers were low between the peaks. None was collected in October. <u>B</u>. <u>angularis</u> (11.4%) was taken in greatest numbers on 25-26 August. <u>B</u>. <u>budapestinensis</u> (8.0%) and <u>B</u>. <u>caudatus</u> (7.9%) were most common in September. Unidentified rotifers (6.3%) were taken in low to moderate numbers throughout the year.

nk-

kton.

ng

Copepods were taken in low numbers in April through 7-8 July, moderate numbers in late July and peak numbers (97,835/m^3) on 11-12 August (Table 4.2-60). Numbers declined in late August through October.

Cyclopoid copepodids and nauplii (immature stages) were the most abundant copepods and accounted for 49.6 and 37.0% of the copepods. Peak numbers of the immature stages and Cyclops vernalis were taken on 11-12 August (Table 4.2-61).

Nematodes, tardigrades, oligochaetes, ostracods, and insects were collected in low numbers throughout the year. Ciliophorans were taken in low numbers at the Intake; they were more common at the Discharge (Table 4.2-62).

The percentages of zooplankton mortality varied during each 24-hr study (Tables 4.2-63 through 4.2-67); mean values were 3.6% (7-8 July), 2.6% (11-12 August), 0.6% (25-26 August), 0.7% (3-4 September), and 9.6% (22-23 September) with the grand mean of 3.4% for 1975.

:e

The percentages of rotifers and cladocerans entrained by TMINS and lost to the closed cycle cooling system as condenser make-up and to other factors were variable during periods of low zooplankton densities (Table 4.2-68). The percentage of rotifers lost was less than expected if 100% is lost in the condenser make-up. Percentages lost for cladocerans showed little or no correlation with the percentage of cladocerans in the condenser make-up. The percentages of copepods lost to the closed cycle cooling system were similar to the percentages of influent used as condenser make-up.

ie

:re

During periods of higher zooplankton densities the percentage of cladocerans and copepods lost within TMINS was in all instances higher than the percentage of influent used as make-up. Values for rotifers remained variable.

4.2.6 DISCUSSION

We examined only the effects of TMINS on entrained zooplankton populations. From this we could not determine the effect of entrainment loss on the remaining river populations. If we assume random distribution of zooplankton in the river the amount of zooplankton lost from the river system amounts to less than one percent of the river zooplankton populations during most river flow conditions. Zooplankton densities and composition may be very different in any one section of river because of selective elimination and because the majority of zooplankton in the river comes from backwaters and ponds which adjoin the river (Hynes 1971). Thus, the loss of zooplankton may be greater than one percent of the river populations.

The ETS requirements concerning entrainment of zooplankton were completed as of this writing; studies therefore have been terminated.

Anonymous. 1971. Environmental Report, Operating License Stage, Three Mile Island Nuclear Station Unit 1 and Unit 2. Metropolitan Edison Company, Jersey Central Power and Light Company. pp 3.4-1 through 3.5-4.

Hynes, H.B.N. 1970. The Ecology of Running Waters. University of Toronto Press, Toronto, Canada. 555 pp.

Potter, W.A. and Associates. 1975. An Ecological Study of the Susquehanna River in the vicinity of Three Mile Island Nuclear Station, Annual Report for 1974. Ichthyological Associates, Inc. 468 pp.

THIS IS THE

LAST

PAGE