PRELIMINARY INVESTIGATIONS INTO THE USE OF A CONTINUOUSLY OPERATING FINE MESH TRAVELING SCREEN TO REDUCE ICHTHYOPLANKTON ENTRAINMENT AT INDIAN POINT GENERATING STATION

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Consolidated Edison Company of New York, Inc.

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ECOLOGICAL ANALYSTS INC.

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1. INTRODUCTION

The objectives of the studies described in this report were to determine the survival of striped bass (*Morone saxatilis*) early life stages impinged on a continuously operating fine mesh traveling screen (2.5-mm mesh) and to determine the effectiveness of this device in screening organisms which would otherwise be entrained.

Once-through cooling water systems used at steam electric generating stations use large amounts of water to cool the condensers. When in full operation, the two units at Indian Point* pump approximately 6,360 m^3 (1.68 million gallons) of water per minute through the condensers. Aquatic organisms are carried along with this water through the cooling water system where they may be exposed to abrupt temperature changes, changes in hydrostatic pressure, mechanical buffeting and velocity shear force.

The Consolidated Edison Company of New York (Con Edison) has been experimenting with a new screen designed to filter out entrainable ichthyoplankton. Con Edison has installed a continuously operating fine mesh traveling screen at Indian Point Unit 1 to determine its effectiveness in reducing entrainment effects on Hudson River striped bass and other species as well as enhance impingement survival.

The two basic aspects of the study were to (1) determine the collection efficiency of the screen, and (2) determine the survival of the impinged organisms. The study was conducted during June 1977, when peak concentrations of striped bass larvae are found in the Hudson River.

*Unit 1 has not operated for commercial production since 1974. Unit 2 is owned and operated by Con Edison. Unit 3 is owned by the Power Authority of the State of New York and operated by Con Edison.

2. SUMMARY

Results of this study indicate that a continuously operating fine mesh traveling screen (2.5-mm mesh) of the design tested does not effectively prevent entrainment of striped bass post-yolk-sac larvae 7-9 mm in length. Late post-yolk-sac larvae ranging in length from 10 to 18 mm (mean length, 15 mm) may be the minimum-sized larvae successfully diverted by the fine mesh traveling screen.

Initial survival of late post-yolk-sac striped bass larvae impinged on the fine mesh screen was estimated to be 68 percent at water intake velocities of 0.4 fps and screen travel rate of 10 fpm. Survival of late post-yolk-sac larvae to 96 hours after collection was 47 percent. Initial survival and survival to 96 hours of early juvenile 17 to 23 mm in length (mean length 19 mm) were 100 and 88 percent, respectively. The high surviival of impinged juveniles indicates that the fine mesh traveling screen could have significant potential to reduce entrainment impact on this life stage.

3. SITE DESCRIPTION

The Indian Point Generating Station is located on the east bank of the Hudson River, 69 river kilometers (43 mi.) north of the Battery. A detailed description of the facility and the Hudson River is given elsewhere (Con Edison 1977a).

The intake structure at Indian Point Unit 1 is of particular interest in this research. Unit 1 has not operated since 1 October 1974; thus, the intake structure provides a suitable apparatus for investigation of new designs. The intake system includes two circulating pumps, each capable of pumping 530 m^3/minute (140,000 gpm) of water. Each pump draws water from two intake forebays; thus, at full capacity, 265 m^3/minute (70,000 gpm) of water enter Forebay 11 at Unit 1. At full capacity water intake velocity is 0.9 fps at the intake forebays.

A fixed screen (9.5-mm [3/8-in.] mesh), a bar rack, and a traveling screen (9.5-mm [3.8-in.] mesh) conventionally were used to ensure that large fish, debris, and other objects were not pumped through the plant. For this study a continuously operating fine mesh (2.5-mm) traveling screen replaced the conventional traveling screen (Figure 3-1).

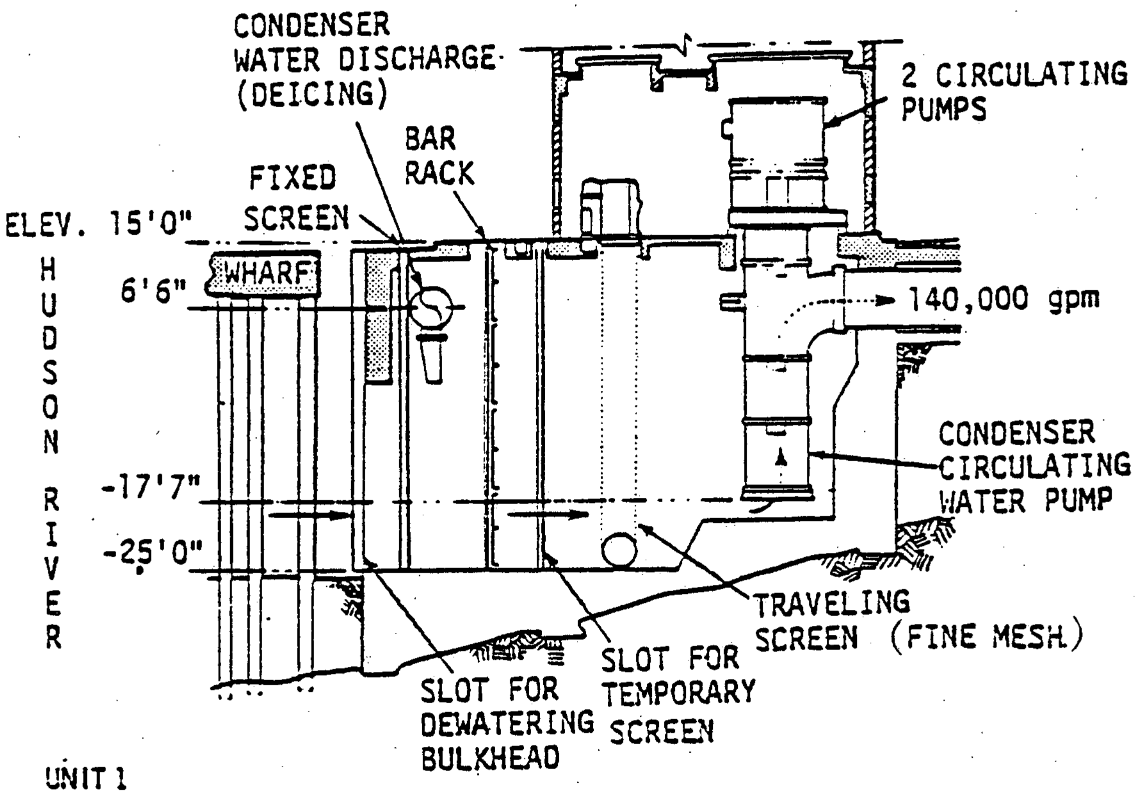

Figure 3-1. Cross-sectional view of Indian Point Generating Station Unit 1 showing location of fine mesh traveling screen. (Source: Con Edison 1977b)

4. METHODS AND MATERIALS

4.1 FINE MESH SCREEN

The conventional traveling screen was modified by removing the wire mesh panels and replacing them with 2.5-mm mesh nylon screening cloth. The screen was further modified to operate continuously at speeds from 2.5 to 20 ft per minute. Fish buckets were added which spanned the width of the screen (10 ft) to enhance survival of impinged organisms. A low-pressure wash (148 gpm at 20 psi; 182 gpm at 32 psi), located at the top rear of the screen, removed impinged organisms from the screen. Fish were washed into a fiberglass trough where an auxiliary water system maintained a water flow in the trough suitable for fish survival. A high-pressure wash, located below the fish trough, removed debris from the screen. Fish entering the trough were carried by the water flow via a sluiceway to a bypass where they returned to the river.

During all tests, circulator pump number 11 was operated at 50 percent capacity (70,000 gpm), and the traveling screen was operated at a speed of 10 ft per minute. Low-pressure screen washwater was set at 30 gpm (flow) with auxiliary water turned off. This provided approximately 2 in. of water in the trough at all times, which ensured that fish were not being washed into a dry surface. These settings were held constant throughout the study and no effort was made to optimize the operation of the screen-wash system for maximum efficiency and survival.

4.2 COLLECTION DEVICE

Fish larvae and juveniles impinged on the fine mesh traveling screen were collected by diverting the water from the sluiceway into a collection apparatus. The collection device consisted of a 505-μ mesh net in the shape of an inverted cone suspended in a cylindrical tank filled with water (Figure 4-1). The bottom (wide portion) of the conical net was fastened to a modified funnel, the neck of which exited the tank at the bottom. Tygon tubing (5 ft long, 1-1/4 in. diameter) was fastened to the neck of the funnel outside the tank. The level of water in the tank was maintained by a 3-in. drain pipe affixed with a standpipe and gate valve.

Diverted sluiceway water containing the impinged organisms entered the tank inside the conical net. No flow was allowed through the funnel and tygon tube drain during sampling, thus all water flowed through the net and out the 3-in. drain, thereby filtering out all organisms.

At the end of a sample period, the diverted flow was shut off and the tank was allowed to drain. The net was thoroughly washed down with a fine spray to remove all collected organisms. These organisms exited the tank via the Tygon tubing drain, into a collection container fastened to the opposite end. The container consisted of a 24-x-13-x-5-in. rectangular plastic box with a fastened lid which was modified with screened openings. This allowed excess water to flow from the container and further concentrated the collected organisms. The container was detached from the Tygon tubing drain and transported to the onsite laboratory.

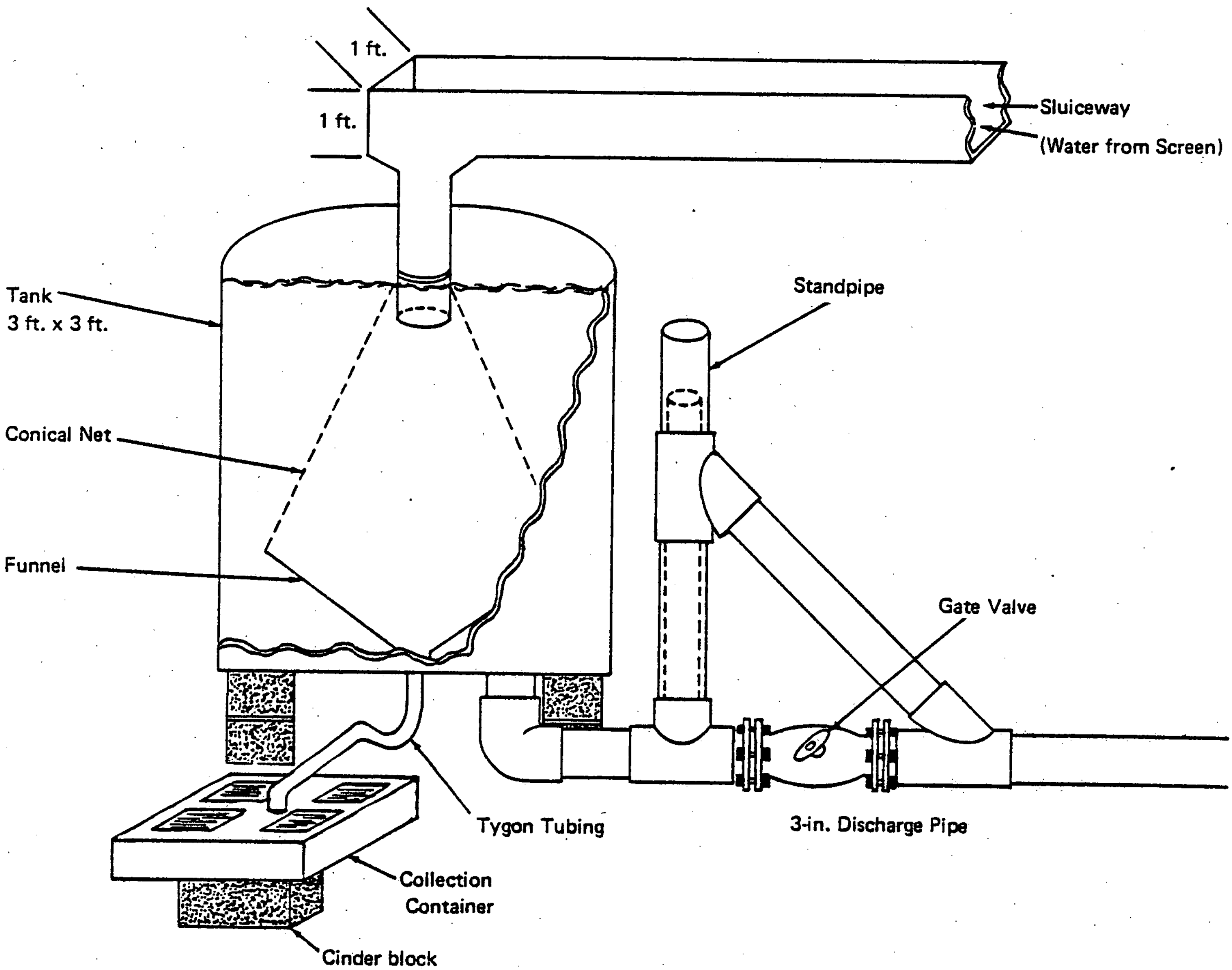

Figure 4-1. Collection device used for fine mesh traveling screen studies at Indian Point.

4.3 COLLECTION EFFICIENCY

To determine the collection efficiency of the fine mesh screen, a known number of striped bass post-yolk-sac larvae, obtained from the Texas Instruments (TI) hatchery, were released in front of the continuously operating traveling screen into Forebay 11 at Unit 1. The screen washwater was diverted for 10 minutes after the release, and the numbers of larvae collected were enumerated. Observations of the screen were made before and after the screen wash to determine the effectiveness of the wash.

Collection efficiency experiments were conducted on 7 June 1977, using two groups of approximately 5,000 and one group of approximately 10,000 post-yolk-sac larvae 14 days of age (mean length 7 mm). A second efficiency test was conducted on 14 June 1977 using an estimated 78,750 post-yolk-sac larvae 21 days old (mean length 9 mm).

To determine if larvae were being lost in the sluiceway and/or the collection device, a control group of 25 hatchery post-yolk-sac larvae (21 days old, mean length 9 mm) were introduced into the trough directly behind the traveling screen. The screen washwater was diverted for 10 minutes and larvae were enumerated. In addition, small particles (approximately 5 mm diameter) of styrofoam were released with the larvae and were observed en route through the entire system.

4.4 IMPINGEMENT SURVIVAL

The second aspect of the study, to determine survival of impinged larvae, was conducted using wild Hudson River larvae. Collections of screen washwater were made during periods when the river density of striped bass larvae were known to be high, based on other ongoing studies (entrainment viability) (Ecological Analysts 1977). Several collections of various durations were made of screen washwater between the hours of 2020 and 2140 on 16 and 21 June 1977. The object of these collections was to obtain a suitable number of organisms for survival determination. After collection, fish larvae and juveniles were transported to the onsite laboratory and sorted immediately. Organisms were classified as to condition and held for latent effects observations. Larval and juvenile fish were classified as live, stunned, or dead, based upon the following criteria:

- Live: - swimming vigorously, no orientation problems
- Stunned: - swimming abnormally, struggling, swimming on side
- Dead: - no vital life signs, no body or opercular movement, no response to gentle probing.

Live and stunned fish were carefully transferred to separate holding containers (0.95-liter jar containing filtered, ambient river water) with a large-bore glass pipette.

A maximum of five larvae were placed in each holding container, which was aerated and maintained in an ambient water trough. Dead specimens were preserved for later identification.

Live and stunned organisms from the initial sort were retained and examined at 3, 6, 12, 24, 48, 72, and 96 hours after sample collection.

Any dead organisms were removed from the holding jars and preserved in vials. All organisms remaining alive after 96 hours were also preserved and placed in vials.

After completion of latent effects observations all vials were delivered to the Middletown ichthyoplankton laboratory where the species and life stage identifications were made.

Control larvae and juveniles were also subjected to stresses associated with the collection, handling, and holding processes of the experiments. Striped bass larvae and juveniles to be used as controls were collected from the Hudson River in front of the intake at Indian Point Unit 2, using a pump/larval table. The "larval table" was modified from the original design described by McGroddy and Wyman (1977). Alive fish collected in this manner were held in the onsite latent effects laboratory for 48 hours before being used as controls. Handling and holding procedures in the laboratory during this period were identical to procedures used for test organisms.

4.5 DATA ANALYSIS

Survival of striped bass impinged on the traveling screen was calculated in a manner identical to entrainment survival. Proportion surviving was calculated as the ratio of organisms found alive to the total number collected:

$$P_T = \frac{\text{number alive (live + stunned)}}{\text{total number}}$$

where

P_T = total proportion surviving.

Live organisms were grouped with stunned in the analysis, as the alternative of including them in the dead category would be inappropriate.

The survival of test organisms is the product of the conditional probability of surviving impingement and the sampling process. Assuming there is no interaction between the two stresses,

$$P_T = P_I \times P_S$$

where

P_I = probability of surviving impingement
P_S = probability of surviving sampling apparatus.

The survival of the control organisms is used as an estimate of P_S and proportion surviving impingement can be determined by:

$$P_I = \frac{P_T}{P_S}$$

or expressed as percent survival:

$$S_I = \frac{P_T}{P_S} \times 100$$

where

S_I = impingement survival.

Significant differences between proportions surviving of experimental and control larvae were tested using a z test for comparisons between two proportions at $\alpha = 0.05$ (Ostle and Mensing 1977:pp. 133-134). Confidence intervals on proportion surviving were determined according to Ostle and Mensing (1977:pp. 100-101).

5. RESULTS

5.1 COLLECTION EFFICIENCY

Collection efficiency experiments using 14-day-old post-yolk-sac hatchery striped bass larvae indicated that larvae of this age (mean length of 7 mm) were not impinged on the traveling screen (Table 5-1). Following release of two groups of approximately 5,000 and one group of approximately 10,000 post-yolk-sac hatchery larvae directly into Forebay 11 at Unit 1, only 34 dead larvae were recovered in the three 10-minute samples (3 of these were wild clupeid larvae). Most of the styrofoam released along with the larvae as an indication of collection efficiency was observed in the collection apparatus within 3 minutes after release. Of the 25 control larvae released directly into the sluiceway behind the traveling screen, 23 were recovered in the collection container, indicating high recovery by the sampling gear after larvae enter the sluiceway.

Experiments using 21-day-old post-yolk-sac hatchery striped bass larvae (mean length 9 mm) indicated low collection efficiency by the fine mesh screen for this size group. A total of 3,229 larvae (approximately 4 percent of the initial number released) were recovered from a 10-minute collection of screen washwater following a release of approximately 78,750 larvae directly in front of the screen (Table 5-1). The number of larvae recovered were enumerated directly and consisted of 3 alive, 3 stunned, and 3,223 dead. The number of larvae released in front of the screen was estimated using a subsampling procedure. Of the total larvae released, it was estimated by subsampling that 80 percent were dead and 20 percent were alive at the time of release. The larvae were apparently stressed at the time of release due to handling and holding, and these data should not be used for survival estimates. However, these data were used to indicate collection efficiency.

5.2 SURVIVAL ESTIMATES

The total organisms collected for impingement survival analysis are shown in Table 5-2. A total of 119 wild striped bass (*Morone saxatilis*) were collected during the study for survival estimates. Of the striped bass collected, 103 were late post-yolk-sac (length range 10 to 18 mm, mean 15 mm) and 16 were classified as juveniles (length range 17 to 23 mm, mean 19 mm). In addition, several other species were collected, the majority being Atlantic tomcod (*Microgadus tomcod*) juveniles. The tomcod averaged 59 mm in length. Only a subsample of the larger juveniles was retained for survival observations.

5.2.1 Proportion Surviving Impingement and Collection

Initial and 96-hour survivals of each species collected by the fine mesh traveling screen are shown in Table 5-3. Initial and 96-hour survivals of late post-yolk-sac striped bass larvae were 68 and 47 percent, respectively. Initial and 96-hour striped bass juvenile survivals were 100 and 88 percent, respectively. These estimates indicate survival after experiencing

TABLE 5-1 RESULTS OF FINE MESH TRAVELING SCREEN COLLECTION EFFICIENCY FOR RELEASE ON 7 AND 14 JUNE 1977

Release No.	Number Released	Mean Length (mm)	Number Recovered Live	Stunned	Dead	Total
1	5,000	7	0	0	15[a]	15
2	5,000	7	0	0	3	3
3	10,000	7	0	0	16	16
4	25[b]	7	15	0	8	23
5	78,750[c]	9	3	3	3,223	3,229

(a) Not all *Morone*.
(b) Controls, released in sluiceway.
(c) 64,260 dead, 14,490 live.

TABLE 5-2 TOTAL NUMBERS AND MEAN LENGTHS OF EACH TAXON AND LIFE STAGE COLLECTED FOR SURVIVAL DETERMINATIONS AT THE FINE MESH TRAVELING SCREEN, JUNE 1977

Taxon	Post-Yolk-Sac Larvae Number Collected	Post-Yolk-Sac Larvae Mean Length (mm)	Juveniles Number Collected	Juveniles Mean Length (mm)
Striped bass (*Morone saxatilis*)	103	15	16	19
White perch (*Morone americana*)	7	15	1	--
Unidentified *Morone* (*Morone* spp.)	9	--	1	--
Bay anchovy (*Anchoa mitchilli*)	1	--	7	64
Herring (Clupeidae)	2	--	3	21
Atlantic tomcod (*Microgadus tomcod*)	0	--	39	59
Bluefish (*Pomatomus saltatrix*)	0	--	3	63
Rainbow smelt (*Osmerus mordax*)	0	--	6	35

Note: Dashes indicate no length recorded.

TABLE 5-3 INITIAL AND 96-HOUR SURVIVAL OF EACH TAXON AND LIFE STAGE COLLECTED AT THE FINE MESH TRAVELING SCREEN AT INDIAN POINT, JUNE 1977

	Post-Yolk-Sac Larvae			Juveniles		
	Sample	Proportion Alive[a]		Sample	Proportion Alive	
Species	Size	Initial	96-hr	Size	Initial	96-hr
Striped bass	103	0.68 (0.58, 0.77)	0.47 (0.37, 0.57)	16	1.00	0.88 (0.62, 0.99)
White perch	7	0.43 (0.12, 0.82)	0.14 (0.01, 0.67)	1	1.00	0.00
Bay anchovy	1	0.00	0.00	7	0.86 (0.48, 1.00)	0.00
Bluefish	0	--	--	3	0.67 (0.09, 0.99)	0.00
Tomcod	0	--	--	39	1.00	0.67 (0.51, 0.81)
Rainbow smelt	0	--	--	6	1.00	0.17 (0.00, 0.64)
Herring	2	0.00	0.00	3	0.33 (0.01, 0.91)	0.00
Controls						
Striped bass	15	1.00	0.80 (0.52, 0.96)	25	1.00	0.96 (0.80, 1.00)
White perch	6	1.00	0.83 (0.36, 1.00)	10	1.00	1.00

(a) Proportion alive calculated using live plus stunned organisms (numbers in parentheses indicate 95 percent confidence interval; from Ostle and Mensing 1977).

impingement, collection, handling, and holding. Initial and 96-hour survivals of 15 control striped bass larvae were 100 and 80 percent, respectively (Table 5-3). Initial and 96-hour survivals of 25 control striped bass juveniles were 100 and 96 percent, respectively. These estimates indicate percent surviving after experiencing collection, handling, and holding.

Latent survivals of experimental and control groups of striped bass larvae are shown in Figure 5-1. Although the experimental larvae appeared to die off more rapidly than controls in the beginning, no significant difference ($\alpha = 0.05$) in proportion surviving occurs at 96 hours. Of the 17 stunned larvae in the experimental group, all died within the first 24 hours (Appendix A). Latent survival of striped bass juveniles was similar for experimental and control groups throughout the observation period (Figure 5-2).

Numbers of fish initially classified as live, stunned, or dead, and those live and stunned surviving for periods up to 96 hours, are given in Appendix A. These data can be used to determine proportion surviving at any time period after collection. Initial proportion surviving of any species can be calculated as live plus stunned, divided by the total collected for that species. Survival at any time after collection can be calculated for live, stunned, or live plus stunned, as desired.

5.2.2 Estimates of Impingement Survival

The effects of impingement alone on striped bass survival were estimated using control and experimental results. Control survival was calculated based on those fish subjected to collection and handling alone. Experimental survival was calculated based on fish subjected to impingement and associated effects of the traveling screen plus collection and handling effects.

Impingement survival estimates for striped bass larvae were made using both initial and 12-hour survival data. Estimates were made at both time intervals since the proportion of larvae surviving both initially and for periods up to 48 hours were significantly lower ($\alpha = 0.05$) for the experimental group than for the controls. The reasons for choosing the 12-hour data are given in the discussion. Survival of impinged striped bass larvae was estimated to be 68 percent using initial data, and 60 percent using proportion surviving 12 hours after collection. Survival of impinged striped bass juveniles was estimated using initial data since latent survival was similar for control and experimental groups. Survival of impinged striped bass juveniles was estimated to be 100 percent.

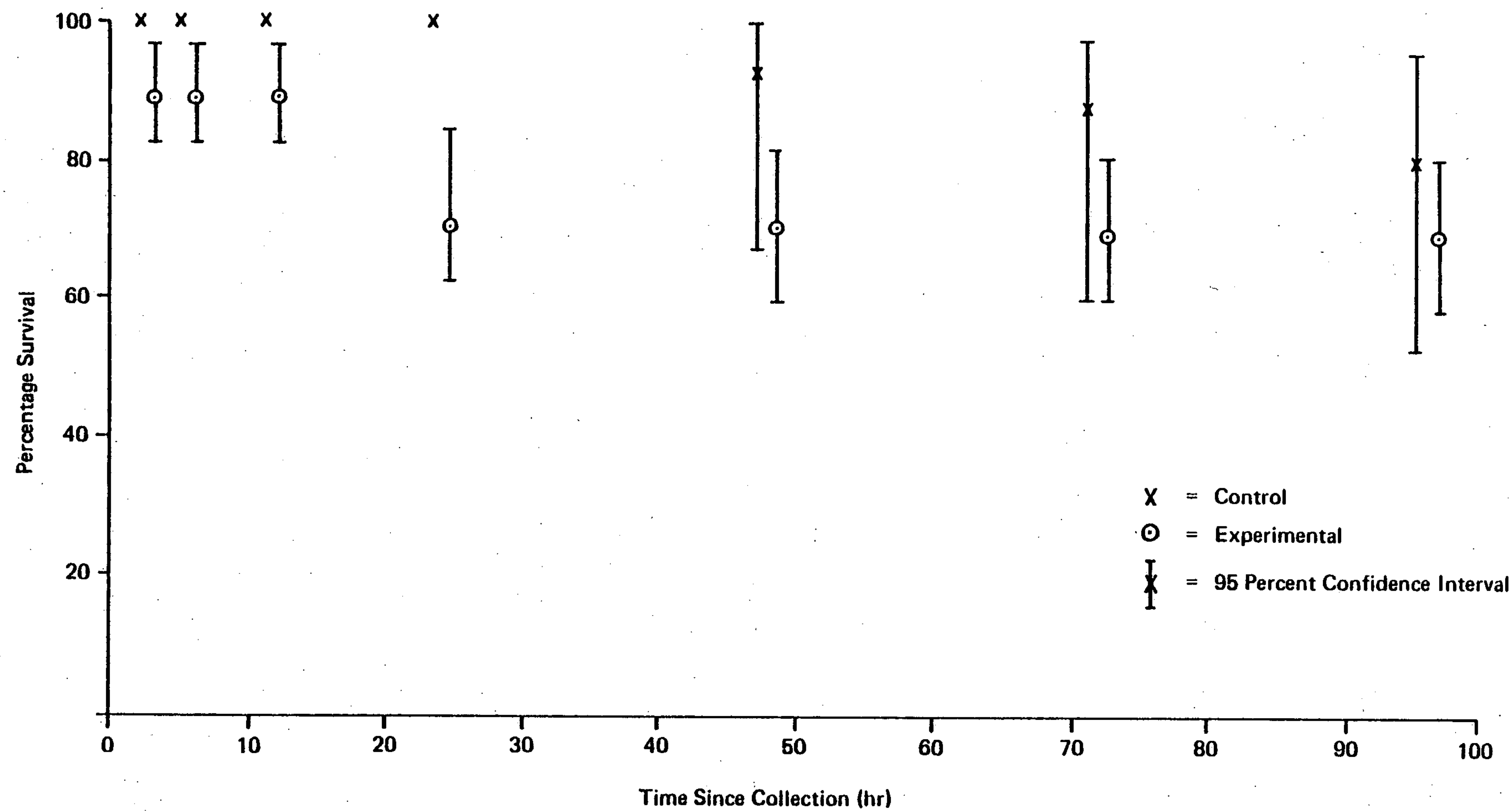

Figure 5-1. Latent survival of striped bass larvae collected at the fine mesh traveling screen at Indian Point, June 1977.

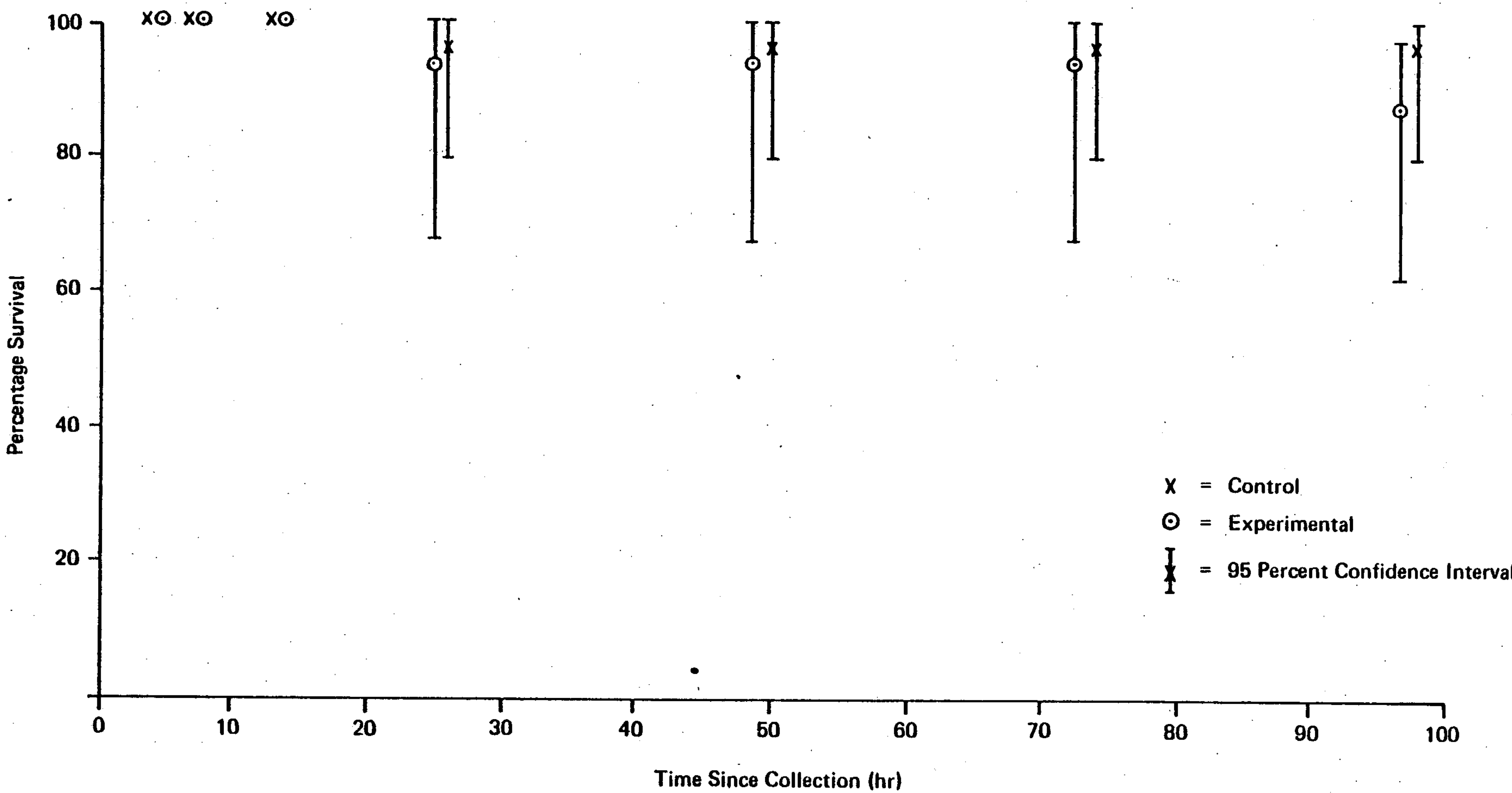

Figure 5-2. Latent survival of striped bass juveniles collected at the fine mesh traveling screen at Indian Point, June 1977.

6. DISCUSSION

The results of this study indicate that a continuously operating fine mesh traveling screen (2.5-mm mesh) does not efficiently prevent entrainment of striped bass post-yolk-sac larvae 7-9 mm in length. Very few early post-yolk-sac hatchery larvae (7-9 mm in length) were impinged when released directly in front of the screen. Based on collections of wild river larvae, late post-yolk-sac larvae ranging in length from 10 to 18 mm (mean length 15 mm) may be the minimum size larvae successfully excluded by the fine mesh traveling screen. The length frequency distribution of striped bass larvae collected from the fine mesh traveling screen is shown in Figure 6-1. Also shown is the length frequency distribution of 116 striped bass larvae that were collected by pumps during other studies in the same time period at Indian Point Units 2 and 3 intakes. In the sample collected from the fine mesh screen 60 percent of the larvae were over 15 mm in length. However, in the sample collected by the pumps only 17 percent of the larvae were over 15 mm in length. Assuming that the length-frequency distributions of the larvae collected by the pumps represent the length distribution of larvae in the river at the time of the study, then this size distribution shift indicates that the fine mesh traveling screen selectively diverts larger larvae (over 15 mm) but allows entrainment of most smaller larvae (less than 15 mm).

Impingement survival estimates of late post-yolk-sac striped bass larvae ranged from 60 to 68 percent depending on method of calculation. If latent survival were similar for both control and experimental larvae, initial proportion surviving could be used to determine impingement effects (68 percent survival). However, as Figure 5-1 indicates, latent effects observations for late post-yolk-sac larvae show significantly ($\alpha = 0.05$) lower survival of experimental larvae as compared to controls up to 48 hours after collection. No significant differences ($\alpha = 0.05$) were found at 72 and 96 hours after collection. Figure 5-1 shows that the survival rate of experimental larvae was about constant from 3 to 12 hours after collection. The decline in survival of experimental larvae between 12 and 24 hours was probably not attributable to impingement effects alone since latent survival of controls also declined to the same level in the later portion of the holding period. Thus, survival of experimental larvae just prior to this unexplainable decline (at 12 hours) was selected as the best lower estimate of impingement survival (60 percent).

The results of this study indicate a potential for high survival (100 percent) of early striped bass juveniles (19 mm in length) impinged on the fine mesh traveling screen. However, all survival estimates were made on larvae and juveniles successfully washed from the screen by the low-pressure wash. The possibility exists that some fish may have been impinged in such a way ("gilled") that they were not washed from the screen by the fine screen wash. Such impinged fish would then encounter the high-pressure wash and probably would not survive; however, observations of the screen after the fine wash showed no remaining impinged fish.

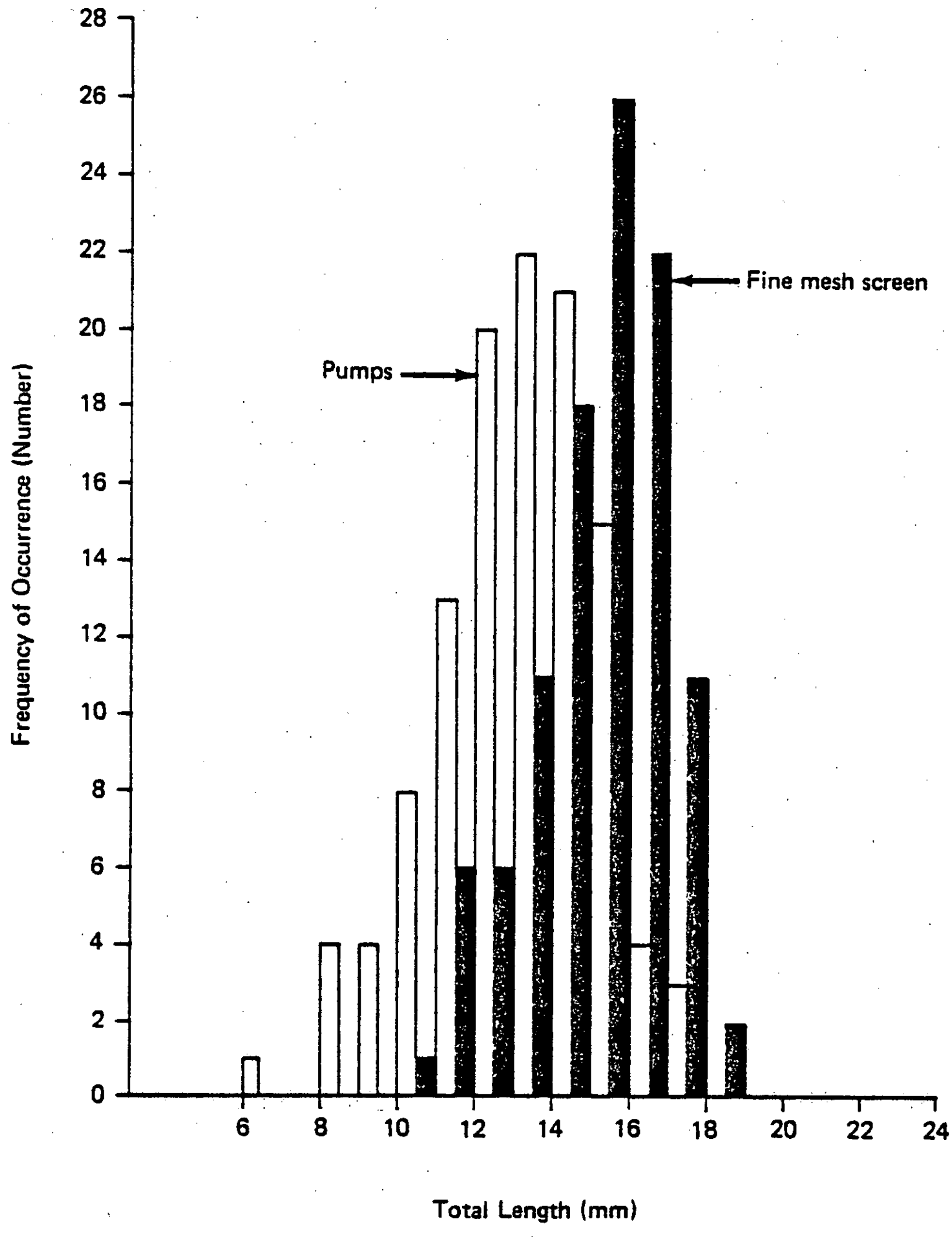

Figure 6-1. Length - frequency of striped bass larvae impinged on a fine mesh traveling screen compared to those collected by pumps (16 June 1977 through 21 June 1977).

No problems were encountered with debris during the fine mesh traveling screen studies. However, circulator pump 11 was only operating at 50 percent capacity. Since only half the flow of this pump enters Forebay 11, only 132 m^3 (35,000 gallons) per minute were flowing through the screen. Intake water velocity at this flow was 0.4 fps. No tests were conducted at full pump capacity, which would create an intake water velocity of 0.9 fps.

The usefulness of a fine mesh traveling screen to prevent entrainment loss should be determined by comparing mortality associated with entrainment to that of impingement on the fine mesh screen. The results of this study indicate a potential for 100 percent survival of impinged striped bass juveniles. If this is an accurate estimate of impingement survival, the fine mesh screen design may provide a means of reducing entrainment impact.

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APPENDIX A

RAW DATA

Table A-1 gives numbers of each species and life stage collected during this study. Numbers surviving are shown separately for live and stunned organisms throughout the latent effects observations period. Thus, proportion surviving at any time interval can be calculated using live, stunned, or live plus stunned organisms. Table A-2 gives the same information for control groups of striped bass and white perch.

TABLE A-1 NUMBERS OF FISH LARVAE AND JUVENILES SURVIVING TO 96 HOURS AFTER IMPINGEMENT ON A CONTINUOUSLY OPERATING FINE MESH TRAVELING SCREEN INCLUDING EFFECTS ASSOCIATED WITH SAMPLE COLLECTION AND HANDLING

Species Name	Initial			3-hr		6-hr		12-hr		24-hr		48-hr		72-hr		96-hr	
	L[a]	S[b]	D[c]	L	S	L	S	L	S	L	S	L	S	L	S	L	S
Larvae																	
Morone saxatilis	53	17	33	52	10	52	10	52	10	51	0	49	0	49	0	48	0
Morone americana	3	0	4	2	0	2	0	2	0	2	0	1	0	1	0	1	0
Morone species	1	4	4	1	4	1	4	1	4	0	1	0	0	0	0	0	0
Clupeidae (family)	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anchoa mitchilli	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juvenile																	
Morone saxatilis	16	0	0	16	0	16	0	16	0	15	0	15	0	15	0	14	0
Morone americana	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
Morone species	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0
Anchoa mitchilli	5	1	1	5	1	5	1	5	1	0	0	0	0	0	0	0	0
Pomatomus saltatrix	2	0	1	2	0	2	0	2	0	0	0	0	0	0	0	0	0
Microgadus tomcod	38	1	0	38	1	38	1	38	1	38	1	38	1	38	1	26	1
Osmerus mordax	2	4	0	2	3	2	3	2	3	1	1	1	0	1	0	1	0
Clupeidae (family)	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(a) L indicates live.
(b) S indicates stunned.
(c) D indicates dead.

TABLE A-2 NUMBERS OF CONTROL LARVAE AND JUVENILES SURVIVING TO 96 HOURS AFTER EXPERIENCING ONLY SAMPLE COLLECTION AND HANDLING EFFECTS

Species Name	Initial			3-hr		6-hr		12-hr		24-hr		48-hr		72-hr		96-hr	
	L[a]	S[b]	D[c]	L	S	L	S	L	S	L	S	L	S	L	S	L	S
Larvae																	
Morone saxatilis	15	0	0	15	0	15	0	15	0	15	0	14	0	13	0	12	0
Morone americana	5	1	0	5	1	5	1	5	1	5	0	5	0	5	0	5	0
Juvenile																	
Morone saxatilis	23	2	0	23	2	23	2	23	2	23	1	23	1	23	1	23	1
Morone americana	10	0	0	10	0	10	0	10	0	10	0	10	0	10	0	10	0

(a) L indicates live.
(b) S indicates stunned.
(c) D indicates dead.

Note: 60 organisms released, 56 recovered.