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HUDSON RIVER ECOLOGICAL STUDY

IN THE AREA OF INDIAN POINT

1986 ANNUAL REPORT

Prepared for

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
4 Irving Place
New York, New York 10003

and

NEW YORK POWER AUTHORITY
123 Main Street,
White Plains, New York 10601

Jointly Financed by

Central Hudson Gas and Electric Corporation
Consolidated Edison Company of New York, Inc.
New York Power Authority
Niagara Mohawk Power Corporation
Orange and Rockland Utilities, Inc.

Prepared by

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25 Nashua Road
Bedford, New Hampshire 03102

R-1051

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TABLE OF CONTENTS

LIST OF FIGURES

PAGE

PAGE

LIST OF TABLES

PAGE

PAGE

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1.0 SUMMARY

Impingement monitoring of fish and blue crabs was conducted at the Indian Point Station in 1986, continuing sampling efforts that began in 1972. Sampling was performed at units 2 and 3 following the stratified random design first introduced during the last six months of 1981. The stratified design consisted of 110 sampling days per year, divided into four strata (seasons). A mid-January through April 1986 outage at unit 2 resulted in 4 fewer sampling days during the winter stratum than were allocated in the stratified design. At unit 3, the spring stratum fell short of the design allocation by 1 day due to a May outage. In all other cases, the number of impingement collections allocated in the stratified design was met or exceeded.

The estimated total number of fish impinged, adjusted for collection efficiency, was 736,821 fish at unit 2 and 355,145 fish at unit 3 for a combined total of 1,091,966 fish weighing an estimated 10,283 kg. Impingement abundance in previous years ranged from 850,000 to 6,470,000 (adjusted for collection efficiency). The estimated number of fish impinged per unit volume of water circulated in 1986 totaled $577/10^6 m^3$ and was at the low end of the range from past years ($496\text{-}2910/10^6 m^3$).

Screen-specific collection efficiency rates obtained from special studies at unit 2 during 1985 were applied to the 1986 data. Using screen-specific adjustments for screen 26 during the winter and summer strata and screens 21-25 during the winter stratum, and regression adjusted estimates for screens 21-25 during the summer stratam, and all screens during the spring and fall strata, the estimated annual impingement at unit 2 was 805,122 fish compared to 736,821 fish obtained solely by the regression method. Including the unit 3 regression

adjusted estimate of 355,145, the combined Indian Point impingement estimate for 1986 totaled 1,160,267 compared to 1,091,966 using the regression method.

Sixty-five (65) species of fish were recorded in impingement collections during 1986 which was within the range from past years (43-79). The oyster toadfish and white bass/striped bass hybrid were new to the species list in 1986. The three most numerous species impinged at units 2 and 3 in 1986 were, in order of abundance, the white perch, Atlantic tomcod, and bay anchovy which comprised 83% of the total estimated impingement abundance. Seasonal impingement patterns of these and other selected species were consistent with past years. Monthly impingement rates in 1986 were within the range of previous years for most species; comparatively low monthly rates were observed for blueback herring, striped bass, weakfish, and alewives, and comparatively high rates for rainbow smelt.

Blue crabs impinged at units 2 and 3 total 5,210 which was within the range of past years (348 to 12,316). The blue crab collection was characterized by a male to female ratio of 3 to 1, a survival rate of 73.8%, and a condition status of 44.0% intact crabs. Most (95%) of the blue crabs collected ranged from 70 to 179 mm with a modal carapace width of 95 mm. Blue crab reimpingement was investigated using a tag and release study. A total of 2,280 blue crabs that were impinged at units 2 and 3 were tagged and released at the unit 1 pier. A total of 205 tagged crabs were recaptured. Eleven (11) of these crabs were released and recaptured twice, one three times, and one was recaptured once at both units 2 and 3. Excluding recaptured crabs and accounting for tag loss while at large (2.2%), the total impingement count, of blue crabs in 1986 was 4,363 crabs at unit 2 and 742 crabs at unit 3 for a combined total of 5105 crabs at both units. Impingement rates (no./$10^6 m^3$) unadjusted for collection efficiency were also higher at unit 2 than unit 3. Peak rates occurred during June, July and August, and ranged from 6.5 to $15.3/10^6 m^3$ at unit 2 and from 1.3 to $4.1/10^6 m^3$ at unit 3.

NAI was requested to evaluate the mark and recapture data to see if they were appropriate for obtaining a population estimate of blue crabs in the vicinity of Indian Point. Because the mark and recapture study was designed primarily to evaluated reimpingement, several important assumptions needed to make valid population estimates could not be satisfied. Assumptions that could not be satisfied included: mortality rates of tagged and untagged crabs are the same, tagging does not effect catchability, migration is negligible in the study area, tagged blue crabs are randomly distributed among untagged blue crabs, and tagged crabs have the same probability of being impinged as crabs without tags.

The effect of formalin preservation on size measurements of abundant juvenile fishes was analyzed to determine whether tissue "shrinkage" caused by the preservative might affect comparison between entrainment (preserved) and impingement (unpreserved) measurements. Linear regression analyses were used to describe the relationships between fresh and preserved measurements and t-tests were used to evaluate each regression line.

2.0 INTRODUCTION

This report is the fifteenth in a series of annual reports entitled "Hudson River Ecological Study in the Area of Indian Point". Previous annual reports have presented the results of various studies conducted at or in the vicinity of the Station, including impingement sampling, fisheries surveys, mitigation studies and ichthyoplankton entrainment sampling (Texas Instruments, TI: 1973; 1974; 1975; 1976; 1977; 1979; 1980a; 1980b; Con Edison: 1982a; 1982b; 1983; Normandeau Associates Inc., NAI: 1984a; Martin Marrietta Environmental Systems, MMES: 1985; NAI: 1986). This report discusses the 1986 impingement data and interprets these latest study results in conjunction with the findings of previous years. Estimates are provided for the total number of fish and blue crabs impinged at each unit and for all individual species. Seasonal impingement trends at units 2 and 3 are also discussed.

With the implementation of the Settlement Agreement, the Hudson River Utilities (Consolidated Edison Company of New York, Inc., New York Power Authority, Central Hudson Gas & Electric Corporation, Orange and Rockland Utilities, Inc. and Niagara Mohawk Power Corporation) re-examined each of the programs they had been conducting to determine whether the effort allocated was sufficient. For the Indian Point impingement program, it became evident after extensive data analysis and literature review that daily collections were unnecessary to maintain acceptable levels of accuracy and precision (TI 1980b; NAI 1984b). Three potential sampling strategies were evaluated in terms of the accuracy and precision afforded by each in estimating total fish impingement at the Indian Point station. One design randomly allocated the sampling effort throughout the year. The other two designs were both stratified, one on a seasonal basis and the other based on distinct periods of high and low impingement variation at each unit (TI 1980b). The design that was ultimately selected utilized seasonal stratification and involved sampling on 110 days annually. Simulated sampling at this yearly level of intensity (30%) was found to be very accurate --i.e., the 95% confidence intervals about the simulated mean of daily impingement counts enclosed the true mean (the mean of all daily impingement counts for each unit in the 1976 through 1979 period) at units 2 and 3 more than 92% and 93% of the time, respectively (TI 1980b). Increasing the sampling intensity beyond 30% resulted in only marginal improvements in accuracy (TI 1980b).

Precision and accuracy of the reduced sampling design (110 days per year) implemented in 1981 was reevaluated after 1983 by examining the combined impingement data base from 1976-1983 (NAI 1984b). Species-specific impingement rate changes during 1981, 1982 and 1983 did not affect the precision or accuracy of impingement estimates. Similarly, mandated changes in plant operating flows have not detracted from the validity of the reduced sampling design. The inclusion of post-1979 collections in the evaluation produced a slight revision in the way in which the 110 sampling days were allocated among seasonal strata, and this revised allocation was used beginning in 1985 (NAI 1984a). Impingement monitoring during 1986 at units 2 and 3 of the Indian Point Station was conducted for the entire year on random, pre-selected days according to the stratified random sampling design. Impingement estimates were calculated as described in Appendix A.

Section 3 of this report, Materials and Methods, presents a description of the Indian Point generating station, field and laboratory methods, the 1986 sampling design, and the collection efficiency estimates and regression models used to adjust impingement counts. Section 4.0, Results and Discussion, provides estimates of the number of fish impinged during 1986, evaluates the effects of collection efficiency adjustments, presents species composition and relative abundances, describes seasonal and yearly impingement patterns, and describes blue crab impingement patterns, mark/recapture results, and population estimates. Section 5.0 presents the results of fish length, weight, and body depth regressions that were performed on fresh and preserved fish. This study was performed in order to evaluate whether tissue "shrinkage" caused by formalin preservation might affect comparison between size measurements of entrained (preserved) and impinged (unpreserved) fish. Literature citations are presented in Section 6.0. Data calculation procedures are presented in Appendix A along with Appendix Tables containing information on water quality, fish and blue crab impingement, and fish length, weight and depth measurements and regression analyses.

3.0 MATERIALS AND METHODS

Impingement collections at Indian Point units 2 and 3 were taken in four seasonal strata according to the stratified random sampling design introduced in Section 2.0. On all days when the plant operated, whether or not sampling was scheduled for impinged fish, the traveling screens were washed to remove fish, crabs, and debris. On all days when the plant operated, samples of impinged blue crabs were collected when present. The field and laboratory procedures used in collecting and processing samples are presented below, and the formulas used in the data calculations are presented in Appendix A.

3.1 THE INDIAN POINT GENERATING STATION

The Indian Point Generating Station is located on the east bank of the Hudson River, about 69 km (43 miles) above the Battery in New York City (Figure 3-1). The Station began operating with the completion of unit 1 in 1962. Unit 2, which is operated by Con Edison, and unit 3, which is operated by the New York Power Authority (NYPA), began operation in 1973 and 1976, respectively. Each unit of this nuclear plant utilizes a once-through cooling system that can entrain the early life stages of various fish species into and through the cooling system, and can impinge juvenile and older fishes on screening devices located at the opening of each water intake bay.

The combined pumping capacity of the three units for cooling purposes is 7790 m^3/minute (2,058,000 gal/min). Unit No. 1, which has two 530 m^3/min (140,000 gal/min) circulator pumps, was retired from commercial operation in October 1974. The two units currently operating each have six 530 m^3/min circulating pumps. Each unit also has service water pumps, which also withdraw river water. Unit 1 has two service pumps with a total pumping rate of 144 m^3/min

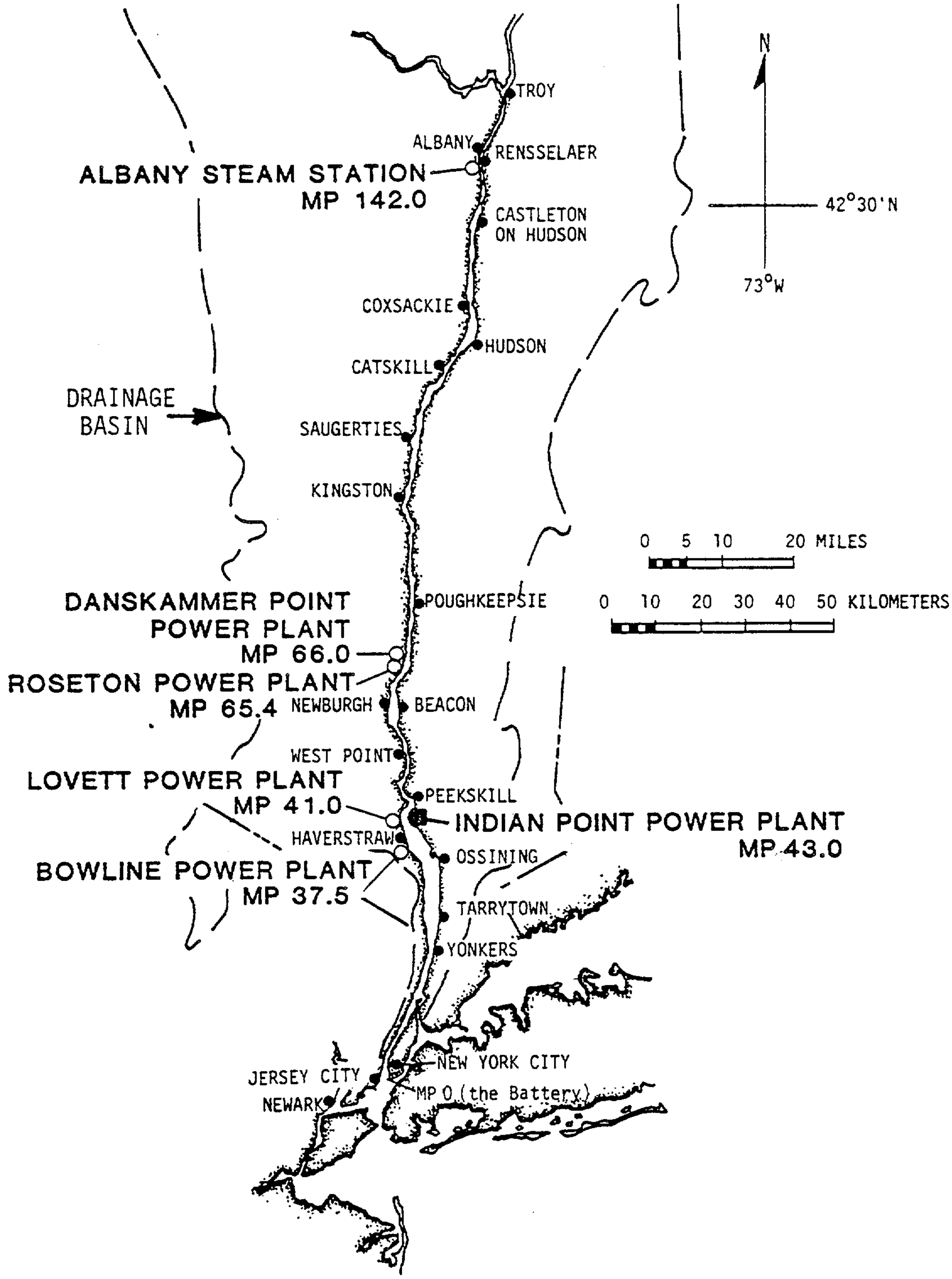


Figure 3-1. Location of Indian Point Station Relative to other Hudson River Stations.

(38,000 gal/min). Units 2 and 3 each have six service pumps with a total pumping rate of 114 m^3/min (30,000 gal/min) at each unit.

Unit 1 intakes and unit 2 intakes 21-25 have fixed intake screens at the river's edge and conventional vertical traveling screens within each intake bay (Figure 3-2). Unit 2, intake 26 has a Ristroph-modified vertical traveling screen; the fixed screen was not in place during 1986. Unit 3 has vertical traveling screens at the river's edge, but no fixed screens (Figure 3-3). Details of the plant and associated intake structures have been presented previously (Con Edison 1977, NAI 1986).

In December 1980, Con Edison, NYPA and other Hudson River utilities consented to certain restrictions in operating conditions, including the flow rates for the circulating water pumps, as part of an agreement reached with government agencies. To achieve the flow rate schedule (Table 3-1) specified by the Agreement which became effective May 14, 1981, dual speed circulating water pumps were to be installed at both Indian Point units 2 and 3 by 14 November 1984. During the interim, alternative flow rates (Table 3-2) were required to be met.

These flow rates were specified as a measure to reduce to a minimum the water withdrawal from the Hudson River to rates necessary for efficient operation of the plants. The operation of unit 2 with dual speed pumps commenced on 20 September 1984. Variable speed pumps were installed at unit 3 and were available for service in September 1985.

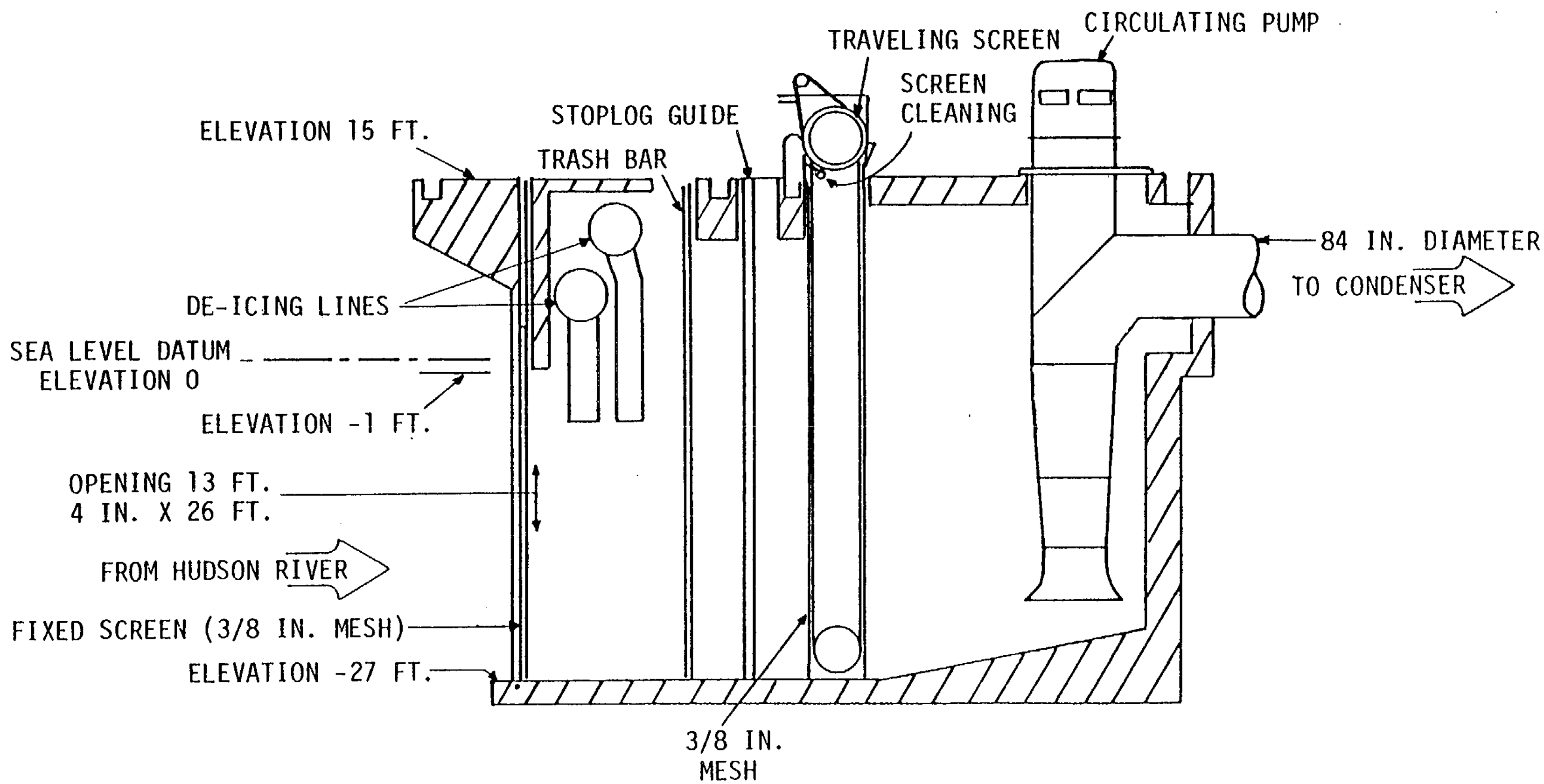


Figure 3-2. Schematic intake bay cross-section of Indian Point Unit No. 2.

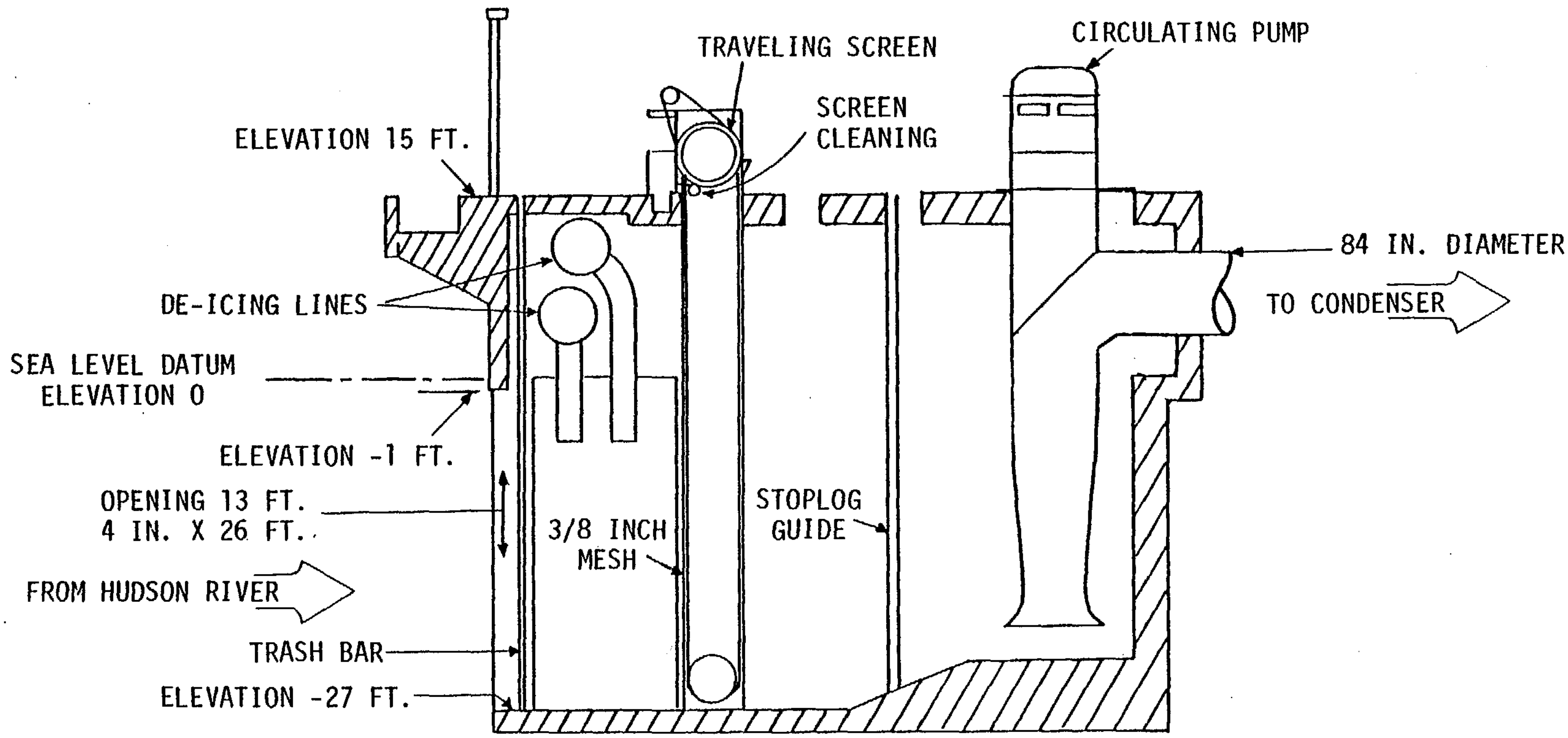


Figure 3-3. Schematic intake bay cross-section of Indian Point Unit No. 3.

TABLE 3-1. FLOW RATE SCHEDULE FOR DUAL SPEED/VARIABLE SPEED CIRCULATING WATER PUMPS AT INDIAN POINT UNITS 2 AND 3 IN EFFECT AFTER 14 NOVEMBER 1984.

APPROXIMATE PERIOD	APPROXIMATE FLOW (gpm/Unit)	$10^3 m^3$/min/Unit
Jan 1 - May 15	504,000	1.9
May 16 - May 22	560,000	2.1
May 23 - May 31	672,000	2.5
June 1 - June 8	731,000	2.8
June 9 - Sept 30	840,000	3.2
Oct 1 - Oct 31	731,000	2.8
Nov 1 - Dec 31	504,000	1.9

TABLE 3-2. INTERIM CIRCULATING WATER FLOW RATE SCHEDULE FOR INDIAN POINT UNITS 2 AND 3, BETWEEN 14 MAY 1981 AND 14 NOVEMBER 1984.

APPROXIMATE PERIOD	APPROXIMATE FLOW (gpm/Unit)
Jan 1 - May 1	505,000 gpm (60% Flow)
May 1 - June 1	Change: From 505,000 gpm to 840,000 gpm (100% Flow)
June 1 - Oct 1	840,000 gpm
Oct 1 - Nov 1	Change: From 840,000 gpm to 505,000 gpm (60% Flow)
Nov 1 - Dec 31	505,000 gpm

3.2 FIELD AND LABORATORY METHODS

3.2.1 Sample Design and Schedule

The stratified sampling design for impingement and water quality data collection, that was initiated in July 1981, was continued throughout 1986 at units 2 and 3. Sample days were assigned to randomly selected dates within four seasonal strata, in contrast to the daily sampling which was conducted before July 1981.

Fish and blue crab impingement samples were collected on the randomly selected sample days and analyzed. On days not selected for sample collection (non-sample days), only blue crabs were collected and analyzed; fish and debris were discarded when the traveling screens were washed. Blue crab impingement counts and biocharacteristics data were collected on all days in 1986 when blue crabs were present in impingement collections. Re-impingement of blue crabs was estimated using a mark and recapture program that utilized blue crabs >100 mm obtained from daily screen wash collections. Water quality data were collected at units 2 and 3 intakes on days when either fish or blue crabs were collected.

Allocation quotas of sampling days were met among all seasonal strata except for winter at unit 2, which was short four days due to a mid-January through April outage, and spring at unit 3, which was short 1 day due to a mid-May outage (Table 3-3). The standard procedure that was used to minimize the effect of missed collection days was to randomly replace each lost day with one from the unallocated days (i.e. not initially selected for collection) remaining within that stratum. However, due to the extended outage at unit 2 during the winter stratum, there were not enough unallocated days left in the stratum to make up the missed samples. The missed sampling day at unit 3 during spring could not be made up during the spring stratum due to constraints of timing and field logistics.

TABLE 3-3. NUMBERS OF IMPINGEMENT COLLECTION DAYS AND DAYS OF PLANT OPERATION AT INDIAN POINT UNITS 2 AND 3 DURING 1986.

UNIT	SEASONAL STRATUM	DAYS OF PLANT OPERATION[a]	DAYS OF IMPINGEMENT COLLECTIONS	DAYS ALLOCATED IN STRATIFIED DESIGN
2	Winter (Jan-Mar)	28[b]	19	23
	Spring (Apr-Jun)	73	9	8
	Summer (Jul-Sep)	92	11	11
	Fall (Oct-Dec)	92	69	68
	TOTAL	285	108	110
3	Winter (Jan-Mar)	90	35	35
	Spring (Apr-Jun)	83	19	20
	Summer (Jul-Sept)	92	31	31
	Fall (Oct-Dec)	92	26	24
	TOTAL	357	111	110

[a] A unit was considered operating on a day if any circulator pump operated for any time on that day.

[b] Partial to complete outage from mid-January through April.

Screens were washed daily, generally between 0800 and 1200 hours. Each sample day began at the time of a scheduled daily wash on one day and concluded at the time of the subsequent scheduled wash. On preselected random sampling days, fish were collected from the screen wash of unit 2 intakes 21-25 combined, unit 2 intake 26 (Ristroph screen), and unit 3 intakes 31-36 combined. On non-sample days, fish and debris were disposed of without enumeration. On occasions when sampling could not be carried out due to unit outages, abnormal screen-wash procedures, or unexpected operating conditions, an additional sampling day was randomly selected from the remaining non-sample days in the stratum (if there were any) to replace the one lost. If unscheduled screen washes or continuous washing was necessary during a sampling day because of heavy trash loading, screen malfunction, etc., then sampling was also conducted during those unscheduled washes, whenever possible, to make the date representative of the full sampling period.

The method used to calculate an estimate of the total number of fish impinged during the year (Appendix A) assumes that the volume of cooling water pumped by the plant on sample days is representative of the volume pumped for all operating days in a stratum, since each operating day is weighted equally in computing the estimate. This assumption was satisfied as shown by the close correspondence between sample and operating days in the average daily circulating volumes observed in each month at unit 2 (Table 3-4) and unit 3 (Table 3-5).

3.2.2 Sample Collection

Impingement samples were obtained from collection areas at the end of the unit 2 and 3 sluiceways and at a separate collection area for the Ristroph screen 26. Each sample effort began with a screen wash and thorough cleaning of the sluiceways and debris pits. The fixed screens at intakes 21-25 were washed manually with a hose prior to washing each traveling screen. Each fixed screen was raised and washed in 4-ft

TABLE 3-4. COMPARISON OF SAMPLING DATES, AVERAGE DAILY SAMPLING VOLUMES, OPERATING DATES AND AVERAGE DAILY OPERATING VOLUMES AT INDIAN POINT UNIT 2 BY MONTH DURING 1986.

MONTH	SAMPLING DATES	AVERAGE DAILY SAMPLING VOLUME ($10^6 m^3$)	STANDARD DEVIATION	OPERATING DATES	AVERAGE DAILY OPERATING VOLUME ($10^6 m^3$)[a]	STANDARD DEVIATION
January	2,7,9,10,11 12,13,14,15	2.36	1.21	1-14	2.74	0.25
February	-[b]	-		-	-	-
March	20,21,22,23,24, 25,26,27,28,31	0.76	0.02	17-28 30-31	0.90	0.26
April	-	-		1-12 29-30	0.85	0.09
May	3,31	2.01	1.62	2-6 8-31	1.93	0.98
June	17,24,26,27,28 29,30	3.89	1.41	1-30	3.91	1.24
July	14,21,22	4.46	0.09	1-31	4.51	0.32
August	6,24,29	4.17	0.44	1-31	4.60	0.13
September	9,11,14,18,23	5.19	3.05	1-30	4.64	0.10
October	2,5,6,7,8,10, 12,13,15,17, 19-25,27-29,31	3.46	0.58	1-31	3.84	0.54
November	1,3-6,8,10,11, 14-21,23,26-30	2.69	0.60	1-30	2.71	0.25
December	1-5,7-13,15-19, 21-24,26-30	2.68	0.18	1-31	2.77	0.13

[a] Includes service water, except days when no circulating pump operated

[b] Partial to complete outage from mid-January through April

TABLE 3-5. COMPARISON OF SAMPLING DATES, AVERAGE DAILY SAMPLING VOLUMES, OPERATING DATES, AND DAILY OPERATING VOLUMES AT INDIAN POINT UNIT 3 BY MONTH DURING 1986.

MONTH	SAMPLING DATES	AVERAGE DAILY SAMPLING VOLUME ($10^6 m^3$)	STANDARD DEVIATION	OPERATING DATES	AVERAGE DAILY OPERATING VOLUME ($10^6 m^3$)[a]	STANDARD DEVIATION
January	2,4,9-10,14-16, 22,25,28-30	2.16	0.17	1-31	2.40	0.01
February	1,2,6,7,9,12, 14,17	2.35	1.14	1-28	2.39	0.02
March	3,5,6,8,10,11, 15,17,19,20, 22,23,25,27,30	2.55	0.61	1-31	2.67	0.15
April	2,5,8,11,16, 17,20,22,25, 29	2.41	0.43	1-30	2.59	0.49
May	3,24	1.50	1.53	1-6 15-31	1.83	1.01
June	9,13,17,21-23, 30	3.02	1.28	1-30	3.50	0.46
July	4,8,11,12,14, 16,18,19,21, 22,26	1.30	1.28	1-31	1.52	1.31
August	6,8,10,11,15, 17,20,24,29	0.70	0.05	1-31	0.79	0.06
September	1,2,9,11,14,18, 23,25,27,29,30	4.19	1.93	1-30	4.06	0.77
October	2,6,7,10,20, 22,24,29,31	3.88	0.19	1-31	4.05	0.11
November	1,3,4,6,16, 21,29	2.85	0.31	1-30	2.85	0.02
December	4,5,10-13,15, 20,21,30	2.61	0.16	1-31	2.76	0.09

[a]Includes service water, except days when no circulating pump operated

increments until the entire screen broke water and all impinged material passed into the intake forebay to be removed from the condenser cooling water by the conventional vertical traveling screens. Unit 2 intake 26 (Ristroph modified screen) and all of the unit 3 intakes were equipped only with traveling screens in 1986 so that there were no fixed screens to be washed before washing each traveling screen. Each sample ended with the start of the next scheduled screen wash usually on the following day. If unscheduled washes occurred before the end time of the sample day, the fish, crabs, and debris were sorted, retained and added to the contents of the scheduled wash that completed that sample day.

On sample days, all fish and blue crabs washed from the intake screens of the unit(s) being sampled were taken to the laboratory for processing. On non-sample days, only blue crabs were kept for processing. Temperature ($^{\circ}C$) and conductivity (micro-siemens/cm) were measured at the intake of units 2 and 3 at 0.3 m (1 foot) below the water surface on days when fish or blue crabs were collected, as close as was practical to the time of flood or high tide (Tables A-1 and A-2). Plant operating data were recorded for each day that fish or blue crabs were collected: time of screenwash, screenwash order, head loss at each screen, and operating condition of each screen.

3.2.3 Sample Processing

Fish were identified and enumerated by four general size classes for each species, based on total length in millimeters:

Length Class 1 = up to Division 1,
Length Class 2 = Division 1 + 1 mm up to Division 2,
Length Class 3 = Division 2 + 1 mm up to 250 mm, and
Length Class 4 = 251 mm and larger.

The Division 1 and 2 cutoffs used to define the length groups represent the upper length limits of young-of-the-year and yearling age classes, respectively. Values for the division cutoffs were determined from length-frequency data obtained from the impingement collections and supplemented when necessary by aging selected specimens by scale analysis. These values were periodically updated throughout the year (usually every two weeks) to allow for growth.

Subsamples were taken for any species, except Atlantic tomcod during January through March and during December, if the total number of fish in Length Class 1 or 2 exceeded 100. In those cases, 100 fish were randomly selected within the length class and weighed. The total count for that species in the subsampled length class was estimated as 100 multiplied by the ratio of the total weight of the length class to the subsample weight. Total counts (sum of four length classes) for each species are summarized by month in Tables A-3 through A-5 and by seasonal stratum in Tables A-6 through A-8. For each species, weights were recorded to the nearest gram for Length Class 1, Length Class 2, and total of all four length classes (Tables A-9 through A-11).

The effect of formalin preservation on size measurements of juvenile fishes was analyzed to determine whether tissue "shrinkage" caused by the preservative might affect comparison between entrainment (preserved) and impingement (unpreserved) measurements. Body depth, length, and weight data were collected on fresh and preserved Length Class 1 bay anchovy, Atlantic tomcod, and weakfish from late March through August 15. Each species was divided into 8 or 10 length increments, and up to 20 individuals were measured for body depth (nearest mm), total length (nearest mm), and weight (nearest gram) from each increment as they became available in impingement collections. Only Atlantic tomcod and weakfish occurred in sufficient numbers for the analysis. Each specimen was then tagged and stored in a 10% formalin solution for a minimum of four weeks. After the four week period each fish was identified by its tag number and remeasured for depth, length, and weight.

Blue crabs were examined for total count (Table A-12) and total weight, and the following data were recorded for each specimen: carapace width to the nearest millimeter (Table A-13), weight (nearest 0.1 g), survival (alive or dead), condition (intact or missing body parts), and sex. If more than 50 blue crabs were present in a sample, then a subsample of fifty whole blue crabs were randomly selected and weighed. The total number of blue crabs in the sample was estimated as 50 multiplied by the ratio of total weight of the blue crabs in the sample to the subsample weight. In case of subsampling, sex, alive-dead status, and condition were determined only for the 50 crabs in the subsample. After processing, all alive crabs were returned to the river away from the intake structure.

To estimate re-impingement of blue crabs at each unit, a maximum of 50 alive blue crabs greater than 100 mm carapace width were randomly selected for tagging from each units daily collection. Crabs larger than 100 mm were used because of their lower rate of molting compared to smaller crabs and consequently an anticipated higher rate of tag retention. Tags (Floy FD 67 Dennison Anchor Tag) were inserted in each crab in the slit between the carapace and the abdominal "key" located on the posterior region of the crab. Crabs were marked with consecutively numbered tags specific for each release cohort (i.e., crabs from screens 21-25, 26 and 31-36) and released at the unit 1 pier located between units 2 and 3. Impinged crabs greater than 100 mm carapace width were inspected for evidence of tagging recaptures on both sample and non-sample days. Recaptured crabs were remeasured for carapace width and weight, and the crabs sex, condition and alive/dead status were recorded. Studies were conducted to evaluate tag retention in blue crabs by obtaining, tagging, and holding for up to 53 days healthy specimens of each 50 mm carapace-width length group (101-150 mm, 151-200 mm, and 201 mm and above) in aquaria located in the impingement laboratory. Crabs were fed daily using dead fish from the impingement collections and inspected at 24-hour intervals for alive/dead status, condition, and tag retention. Upon test termination the remaining alive, tagged crabs were released to the river at the unit 1 pier.

Any shortnose or Atlantic sturgeon collected were measured (total length in mm), weighed, and the data were entered in a Sturgeon Log. Alive sturgeon were returned to the river. All yearling and older striped bass, white perch, and Atlantic tomcod, and young-of-the-year tomcod after the first day of marking in December, were examined for finclips, tags, or tag wounds. Any suspected recaptures were preserved in 10% formalin for later verification. All young-of-the-year, yearling and older striped bass were checked for hatchery-administered (magnetic) tags on both sampling and non-sampling days.

Water quality data were collected on scheduled sample days and days when blue crabs were collected. Water temperature and conductivity were measured *in situ* with a YSI model 33 SCT Meter at a depth of one foot below the surface. The water quality sample for unit 2 was taken off the gangway in front of Screen No. 2. The sample for unit 3 was taken at the south side of the unit 1 pier. Temperature was measured to the nearest 0.5°C and conductivity to the nearest 10 scale units (2.5%).

Quality control (QC) checks were performed on fish identifications, counts, weights, crab measurements, and examinations of suspected recaptures. The selection of samples for QC checks followed Military Standard 1235 (Single and Multiple Level Continuous Sampling Procedures), which assured that 90% or more of the data were within specified tolerance limits. Data were recorded on standard data coding forms developed for this study. Calibration checks of the conductivity and temperature measurement systems were performed using standard KCl solution and NBS traceable field thermometers obtained from NAI's standards laboratory. Calibrations were performed prior to each collection of conductivity/temperature data.

3.3 COLLECTION EFFICIENCY

While collections from the intake screens at Indian Point provide an indication of seasonal and yearly impingement patterns, they do not account for 100% of the fish impinged. Some impinged fish may be lost prior to collection because of 1) scavenging by crabs, fish, and birds, 2) river currents and wave action, or 3) the screenwash collection procedures. Deterioration and disintegration of impinged fish on the screens can also contribute to these losses.

Extensive collection efficiency studies were performed at Indian Point from 1977-1980 and in 1982 (Con Edison 1983). The observed values of collection efficiency in those studies, as summarized by Con Edison (1983), were used to develop the following regression models:

$$E_2 = -0.00871\ T_2 + 0.51858 \qquad \text{(Equation 1)}$$
$$E_3 = -0.00792\ T_3 + 0.71640 \qquad \text{(Equation 2)}$$

where E_2 and E_3 = collection efficiency at units 2 and 3, respectively, and
T_2 and T_3 = intake water temperature (^{o}C) at units 2 and 3, respectively.

Although individual observations of collection efficiency were highly variable at all temperatures, the above relationships were found to be statistically significant (efficiency decreased significantly with increasing temperature), and therefore useful for estimating actual impingement rates from impingement collections (Con Edison 1983).

During the Ristroph Screen Special Studies (1 January through 19 April 1985; Con Edison 1985) and the Ristroph Screen Survival Studies (16 July through 31 December; unpublished), collection efficiency studies were conducted at the intake screens at unit 2 (Con Edison 1985). These data were used to qualitatively evaluate the effectiveness of applying regression equations derived from historical data (Equations 1 and 2) to adjust impingement rates during periods when empirical collection efficiency data was available. Screen-specific collection efficiency values for winter and summer strata were determined as follows:

- Winter, fixed screens 21-25; stratum mean collection efficiency = 50.2%,
- Winter, fixed screen 26; stratum mean collection efficiency = 50.2%,
- Winter, Ristroph screen 26; stratum mean collection efficiency = 70.8%,
- Summer, fixed screens 21-25; monthly mean collection efficiency = 5.0% for July, 2.8% for August, and 2.8% for September, and
- Summer, screen 26; monthly mean collection efficiency = 18.7% for Ristroph screen in July (estimated based on August value) 18.7% for Ristroph screen in August, and 29.6% for Ristroph screen in September.

4.0 RESULTS AND DISCUSSION

4.1 ESTIMATED NUMBERS OF FISH IMPINGED DURING 1986

A combined total of 231,059 fish were collected at Indian Point units 2 and 3 in 1986 (Table A-5). When adjusted for collection efficiency using the regression equations (Equations 1 and 2) and scaled to the number of operational days, the estimated total number impinged was 736,821 fish at unit 2, and 355,145 at unit 3 (Tables 4-1 and 4-2) for a combined total of 1,091,966 fish weighing an estimated 10,283 kg (Table A-11). The levels of precision (standard errors) were 12.2 and 8.5 percent of the total estimates for unit 2 and unit 3, respectively. The level of precision for unit 2 (12.2%) was less precise than the levels projected for unit 2 by TI (9.5%, 1980b) and NAI (7.8%, 1984b) for the stratified random design. This appeared to be the result of having higher variance at unit 2 during summer 1986 which required more samples than had been allocated in the stratified design, thus providing a less precise estimate of the number of fish impinged (Table 4-3). The level of precision at unit 3 (8.5%) was within the range of precision levels for unit 3 (8.2%: TI 1980b and 7.7%: NAI 1984b).

The total number of fish impinged by units 2 and 3 combined in 1986, estimated at 1.09 million (Tables 4-1 and 4-2), was within the range of other yearly estimates in the 1976-1984 historical data base (range 0.85-6.47 million; Table 4-4) and was nearly the same as last year's estimate of 1.08 million. The volume of water circulated through Indian Point Station during 1986, 1892 x $10^6 m^3$, was well within the range of values from previous years (Table 4-4) and included an outage at unit 2 during mid-January through April.

Total estimated impingement abundance at unit 2 was highest during the fall stratum followed by summer, winter, and spring (Table 4-1). This ranking, especially the comparatively low impingement abundance during winter, was influenced by the mid-January through April

TABLE 4-1
ESTIMATED NUMBER OF FISH IMPINGED AT INDIAN POINT UNIT 2 DURING 1986
BY TAXON AND SEASONAL STRATUM
(ADJUSTED FOR COLLECTION EFFICIENCY)

COMMON NAME	WINTER	SPRING	SUMMER	FALL	1986 TOTAL	STANDARD ERROR	COEFFICIENT OF VARIATION
ALEWIFE	6	560	1286	173	2026	287	14.1
AMERICAN EEL	157	711	836	497	2202	390	17.7
AMERICAN SHAD	6	942	4259	1216	6423	1725	26.8
ATHERINID UNID.	0	0	26	0	26	23	89.8
ATLANTIC CROAKER	0	26	0	4	30	24	82.0
ATLANTIC MENHADEN	0	5149	1169	53	6370	1514	23.8
ATLANTIC NEEDLEFISH	0	0	30	0	30	27	89.8
ATLANTIC SILVERSIDE	6	0	0	29	35	5	15.4
ATLANTIC STURGEON	0	0	28	3	31	25	81.3
ATLANTIC TOMCOD	93	21129	92126	4030	117378	59354	50.6
BANDED KILLIFISH	180	103	138	3107	3527	503	14.2
BAY ANCHOVY	0	27814	52688	4992	85495	13536	15.8
BLACK CRAPPIE	6	0	0	9	15	3	23.1
BLACK SEA BASS	0	0	0	10	10	3	28.4
BLUEBACK HERRING	12	1289	733	5185	7219	749	10.4
BLUEFISH	9	513	3507	15	4044	1841	45.5
BLUEGILL	27	219	399	683	1328	267	20.1
BROWN BULLHEAD	27	51	82	55	215	51	23.6
BUTTERFISH	0	0	136	0	136	56	41.1
CARP	18	0	0	44	62	9	14.6
CLUPEID UNID.	0	322	0	22	344	253	73.7
CREVALLE JACK	0	0	0	77	77	14	18.3
FOURSPINE STICKLEBACK	0	80	0	119	199	79	39.5
GIZZARD SHAD	1548	0	0	225	1773	281	15.9
GOLDEN SHINER	38	25	0	5	68	27	40.2
GOLDFISH	15	0	0	12	27	5	19.2
GRAY SNAPPER	0	0	0	4	4	2	50.0
HICKORY SHAD	0	0	26	0	26	24	89.8
HOGCHOKER	1196	9139	32021	8096	50452	12443	24.7
LARGEMOUTH BASS	3	27	0	40	69	26	37.3
LOGPERCH	0	0	0	70	70	35	50.0
LOOKDOWN	0	0	26	18	44	24	54.5
MUMMICHOG	6	0	0	0	6	2	39.0
NAKED GOBY	6	0	0	81	87	9	10.5
NORTHERN PIKE	3	0	0	0	3	2	56.7
NORTHERN PIPEFISH	0	19	30	22	72	33	46.1
OYSTER TOADFISH	0	0	0	3	3	2	50.0
PUMPKINSEED	271	51	109	2557	2989	345	11.5
RAINBOW SMELT	466	5626	3708	1080	10879	2416	22.2
REDBREAST SUNFISH	0	0	102	215	317	105	33.0
ROUGH SILVERSIDE	0	0	26	0	26	23	89.8
SEA LAMPREY	6	0	27	5	39	25	63.8
SILVER LAMPREY	0	0	0	3	3	2	50.0
SPOTTAIL SHINER	126	0	0	465	591	59	10.0
STRIPED BASS	2259	458	4288	1412	8417	1443	17.1
STRIPED MULLET	6	0	0	0	6	2	39.0
STRIPED SEAROBIN	0	0	0	3	3	2	50.0
SUMMER FLOUNDER	0	3109	1174	121	4404	899	20.4
TESSELLATED DARTER	3	0	0	153	156	18	11.8

(CONTINUED)

TABLE 4-1. (CONTINUED)

COMMON NAME	WINTER	SPRING	SUMMER	FALL	1986 TOTAL	STANDARD ERROR	COEFFICIENT OF VARIATION
THREESPINE STICKLEBACK	25	0	0	0	25	9	36.0
TIDEWATER SILVERSIDE	0	0	27	15	42	25	58.2
WEAKFISH	0	0	6230	361	6592	2429	36.8
WHITE CATFISH	446	102	321	1530	2399	203	8.4
WHITE PERCH	143528	9357	35293	221426	409605	41703	10.2
WINTER FLOUNDER	3	0	26	3	32	24	73.9
YELLOW PERCH	59	0	0	310	369	84	22.8
TOTAL ALL TAXA	150561	86820	240880	258561	736821	90035	12.2

STANDARD ERROR-----------STANDARD ERROR OF 1986 TOTAL
COEFFICIENT OF VARIATION-STANDARD ERROR/1986 TOTAL *100

TABLE 4-2
ESTIMATED NUMBER OF FISH IMPINGED AT INDIAN POINT UNIT 3 DURING 1986
BY TAXON AND SEASONAL STRATUM
(ADJUSTED FOR COLLECTION EFFICIENCY)

COMMON NAME	WINTER	SPRING	SUMMER	FALL	1986 TOTAL	STANDARD ERROR	COEFFICIENT OF VARIATION
ALEWIFE	158	653	303	302	1416	212	15.0
AMERICAN EEL	284	173	39	78	575	62	10.7
AMERICAN SHAD	15	222	950	3716	4904	1273	26.0
ATLANTIC CROAKER	4	17	0	0	20	15	73.3
ATLANTIC MENHADEN	0	1729	1445	123	3296	889	27.0
ATLANTIC NEEDLEFISH	0	0	6	0	6	5	81.4
ATLANTIC SILVERSIDE	4	0	5	18	27	10	36.8
ATLANTIC STURGEON	4	0	0	0	4	3	78.2
ATLANTIC TOMCOD	528	8039	2373	2662	13602	3181	23.4
BANDED KILLIFISH	101	31	5	132	269	48	17.9
BAY ANCHOVY	0	9307	3727	3631	16665	3639	21.8
BLACK CRAPPIE	41	0	0	5	46	12	25.4
BLUEBACK HERRING	22	1777	314	8527	10640	2228	20.9
BLUEFISH	0	1001	508	6	1515	425	28.0
BLUEGILL	71	22	0	139	232	46	20.0
BROWN BULLHEAD	37	30	11	21	100	19	19.4
BUTTERFISH	0	0	55	32	87	29	33.5
CARP	48	0	0	16	64	16	24.5
CLUPEID UNID.	0	24	0	0	24	21	87.8
CREVALLE JACK	0	0	17	83	100	28	28.1
FOURSPINE STICKLEBACK	0	7	0	0	7	6	87.8
GIZZARD SHAD	7413	0	0	322	7735	2235	28.9
GOLDEN SHINER	96	34	0	0	130	29	22.6
GOLDFISH	48	8	0	5	61	14	22.6
HICKORY SHAD	0	0	6	0	6	5	81.4
HOGCHOKER	1006	3834	15075	2961	22875	6236	27.3
LARGEMOUTH BASS	15	0	0	5	20	7	35.2
LOOKDOWN	0	0	0	12	12	7	58.7
MOONFISH	0	0	0	6	6	5	84.7
MUMMICHOG	4	8	0	0	12	8	64.6
NORTHERN PIPEFISH	0	34	6	6	46	20	44.5
NORTHERN SEAROBIN	0	7	0	0	7	6	87.8
PUMPKINSEED	839	100	22	221	1182	124	10.5
RAINBOW SMELT	445	2067	69	195	2776	1001	36.0
RED HAKE	41	69	0	0	109	52	47.9
REDBREAST SUNFISH	0	0	5	6	12	7	59.1
SEA LAMPREY	4	0	0	0	4	3	78.2
SEAHORSE	0	7	0	0	7	6	87.8
SMALLMOUTH BASS	0	0	0	17	17	10	60.9
SPOTTAIL SHINER	496	20	0	147	663	102	15.4
SPOTTED HAKE	0	0	12	0	12	7	56.6
STRIPED BASS	1590	132	174	410	2305	323	14.0
STRIPED MULLET	4	0	0	0	4	3	78.2
STRIPED SEAROBIN	0	0	0	6	6	5	84.7
SUMMER FLOUNDER	0	106	153	57	316	66	20.9
TAUTOG	0	8	0	0	8	7	87.8
THREESPINE STICKLEBACK	111	7	0	0	118	33	27.6
TIDEWATER SILVERSIDE	0	16	0	12	28	12	43.0
WEAKFISH	0	0	1575	227	1802	581	32.2

(CONTINUED)

TABLE 4-2. (CONTINUED)

COMMON NAME	WINTER	SPRING	SUMMER	FALL	1986 TOTAL	STANDARD ERROR	COEFFICIENT OF VARIATION
WHITE BASS X STRIPED BASS *	4	0	0	0	4	3	78.2
WHITE CATFISH	626	77	40	336	1078	120	11.1
WHITE PERCH	185528	32653	1611	40194	259986	26294	10.1
WHITE SUCKER	4	0	0	0	4	3	78.2
WINTER FLOUNDER	11	0	0	0	11	5	43.8
YELLOW PERCH	93	84	0	10	187	49	26.4
TOTAL ALL TAXA	199689	62303	28506	64647	355145	30014	8.5

STANDARD ERROR-----------STANDARD ERROR OF 1986 TOTAL
COEFFICIENT OF VARIATION-STANDARD ERROR/1986 TOTAL *100
* WHITE BASS X STRIPED BASS HYBRID VERIFIED BY THE NEW YORK STATE DEC

TABLE 4-3. ESTIMATED MEAN DAILY NUMBER OF FISH IMPINGED IN EACH SEASONAL STRATUM AT INDIAN POINT UNITS 2 AND 3 DURING 1986.

UNIT	SEASONAL STRATUM	NUMBER OF SAMPLING DAYS	DAYS ALLOCATED IN STRATIFIED DESIGN	MEAN DAILY ESTIMATE[a]	STANDARD DEVIATION
2	Winter (Jan-Mar)	19	23	5,377.2	7312.3
	Spring (Apr-Jun)	9	8	1,189.3	910.0
	Summer (Jul-Sep)	11	11	2,618.3	3022.0
	Fall (Oct-Dec)	69	68	2,810.5	5586.5
	1986 Total	108	110	2,585.3[b]	
3	Winter (Jan-Mar)	35	35	2,218.8	1926.6
	Spring (Apr-Jun)	19	20	760.6	826.0
	Summer (Jul-Sep)	31	31	309.8	679.8
	Fall (Oct-Dec)	26	24	702.7	659.0
	1986 Total	111	110	994.8[b]	

[a] Adjusted for collection efficiency

[b] Stratified mean daily estimate

TABLE 4-4. TOTAL VOLUME CIRCULATED AT INDIAN POINT UNITS 2 AND 3 COMBINED, ESTIMATED NUMBER OF FISH IMPINGED, IMPINGEMENT RATE, AND NUMBER OF SPECIES COLLECTED DURING 1976 THROUGH 1986.

	VOLUME ($10^6 m^3$)[a]	ESTIMATED NO. IMPINGED (10^6)[b]	IMPINGEMENT RATE (No./$10^6 m^3$)	NO. SPECIES COLLECTED
1976	1329	1.63	1190	58
1977	2159	6.47	2910	72
1978	2030	3.91	1870	72
1979	1935	4.48	2230	74
1980	1822	3.21	1710	76
1981	1617	4.57	2830	72
1982	1273	1.60	1260	43
1983	1286	0.85	661	49
1984	1710	0.85	496	56
1985	1977	1.08	556	79
1986	1892	1.09	577	65

[a] Including service water

[b] Adjusted for collection efficiency

outage at unit 2. Impingement abundance expressed as a mean daily impingement rate for each seasonal strata demonstrated instead that the highest daily impingement rates at unit 2 occurred during winter followed by fall, summer, and spring (Table 4-3). At unit 3, total estimated impingement abundance was also highest during winter followed by fall, spring and summer (Table 4-2). Mean daily impingement rates at unit 3 demonstrated that the winter stratum contained the highest daily impingement rates followed by the spring and fall strata, and lastly the summer stratum (Table 4-3).

The precision of estimated total impingement for individual fish species at units 2 and 3 varied greatly (8-90%). As expected, most species with high coefficients of variation (> 70%) occurred infrequently in the Indian Point area (moonfish, striped mullet, Atlantic croaker, seahorse, Atlantic needlefish, tautog, searobins, hickory shad, Atlantic sturgeon) or were common in the area but only subject to minimal impingement (fourspine stickleback and mummichogs). Conversely, many fish species with a relatively high degree of precision (coefficients of variation <20%) for impingement abundance estimates were impinged in relatively uniform numbers among the four seasonal strata or in high but relatively uniform numbers among the days within one or two seasonal strata (American eel, banded killifish, brown bullhead, pumpkinseed, spottail shiner, striped bass, white perch, white catfish, alewife, bay anchovy, blueback herring). A number of species also occurred periodically and in low numbers but had relatively precise estimates of impingement (Atlantic silversides, carp, crevalle jack, gizzard shad, goldfish, naked goby, tessellated darter). For these species, the high precision levels were the result of impingement occurring at unit 2 during the fall stratum, and to a less extent winter stratum, which had very large allocations of sampling dates. This effect was not as apparent at unit 3 where allocation of sampling dates was more uniform among strata.

4.2 EFFECTS OF COLLECTION EFFICIENCY ADJUSTMENTS

The combined effects of application of the unit 2 and unit 3 collection efficiency regression equations (Equations 1 and 2) can be seen by comparing the increase in seasonal impingement rates before and after adjustment (Figure 4-1; Tables 4-1, 4-2, A-6, A-7, A-8). As in 1985, impingement rates adjusted for collection efficiency using the temperature regression equation were approximately double the unadjusted rates during winter months and approximately three times unadjusted rates during summer. The higher summer adjustment reflected lower summertime collection efficiency. Operation of unit 2 intake 26 during 1986 without a fixed screen (Ristroph screen only) may have reduced the accuracy of the regression-adjusted total impingement estimates. The high collection efficiency of the Ristroph screen compared to the fixed screen and relatively high proportion of unit 2 fish impinged at intake 26 (Con Edison 1985) would result in impingement estimates derived from the historical regression equation being higher than for estimates made with the fixed screen in place.

Collection efficiency data obtained during the Ristroph Screen Special Studies and Ristroph Survival Studies at unit 2 in 1985 permit empirical estimation of collection efficiency during the winter and summer strata. These data were used to calculate adjusted total impingement estimates in the winter and summer strata for comparison with unadjusted estimates and adjusted estimates derived from the regression equations (Table 4-5). As described above, regression adjustment for collection efficiency approximately doubled (2.0) unadjusted total impingement estimates during the winter stratum and approximately tripled (3.4) total estimates during the summer stratum. Screen specific adjustments also increased unadjusted total impingement estimates during the winter stratum by nearly two times (1.8) but increased estimates during the summer stratum by over 12 times. The disproportionate increase in adjusted total impingement estimates during the summer stratum at unit 2 reflected low collection efficiency due to

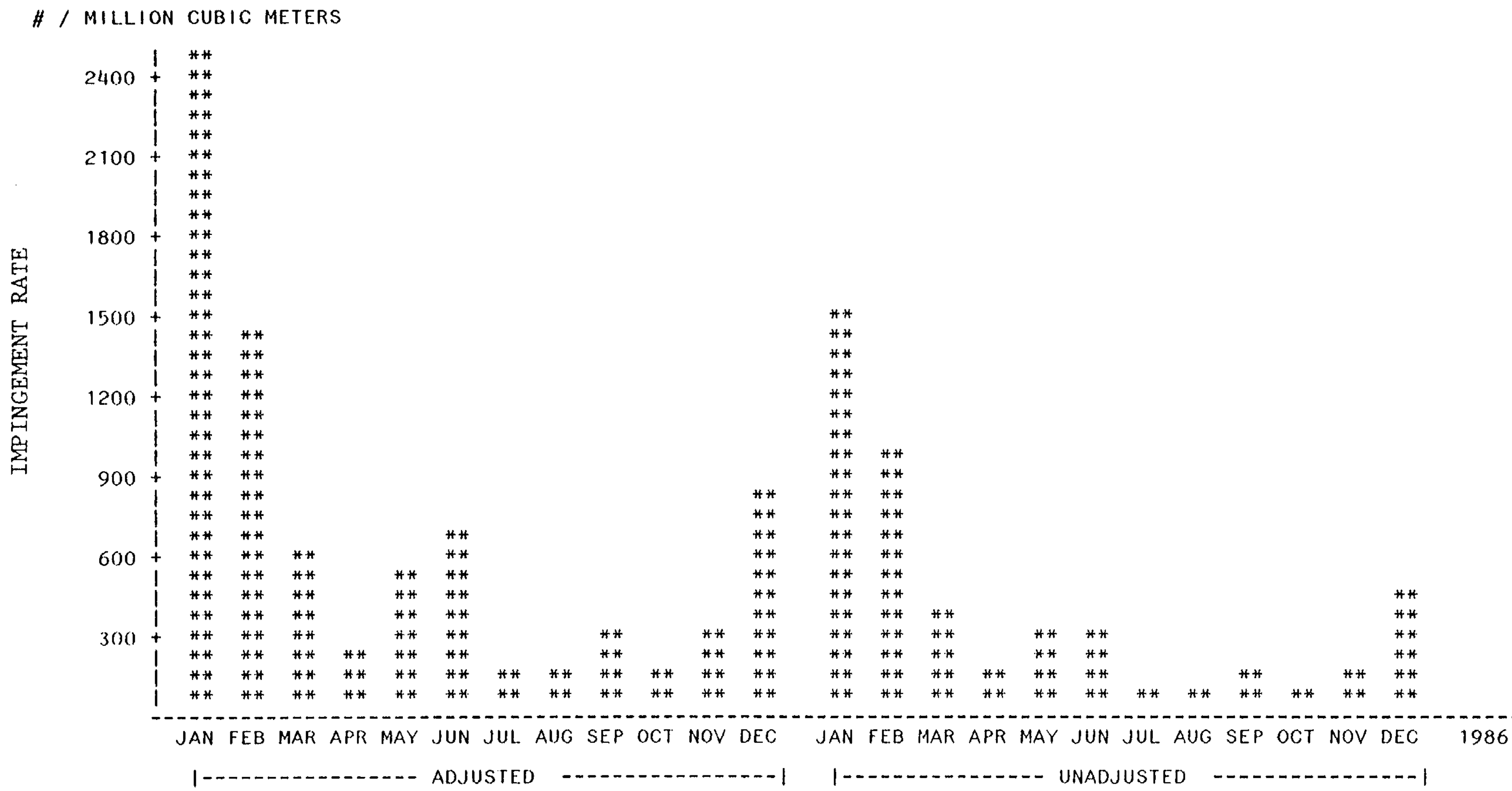


FIGURE 4-1. COMPARISON OF IMPINGEMENT RATES FOR ALL TAXA AT INDIAN POINT UNITS 2 AND 3 COMBINED IN 1986, ADJUSTED AND UNADJUSTED FOR COLLECTION EFFICIENCY.

TABLE 4-5. EFFECT OF REGRESSION OR SCREEN-SPECIFIC COLLECTION EFFICIENCY ADJUSTMENTS ON UNADJUSTED TOTAL COUNTS OF FISH IMPINGED AT INDIAN POINT UNIT 2 DURING THE 1986 WINTER AND SUMMER STRATA.

		COLLECTION EFFICIENCY ADJUSTMENT		
SEASONAL STRATUM	SCREEN	UNADJUSTED[1]	REGRESSION[2]	SCREEN-SPECIFIC[3]
Winter	26	25,092	50,372	35,441
(Jan-Mar)	21-25	49,907	100,189	99,418
	Combined	74,999	150,561	134,859
Summer	26	51,604	172,778	256,780
(Jul-Sep)	21-25	20,340	68,102	641,934
	Combined	71,944	240,880	898,714

[1]Unadjusted total number of fish impinged at unit 2, screens 21-25 and 26 in the winter or summer stratum, scaled from the number of days sampled to the total number of days in the stratum.

[2]Total number of fish impinged at unit 2, screens 21-25 and 26 in the winter or summer stratum, adjusted for collection efficiency using the temperature regression equation 1.

[3]Total number of fish impinged at unit 2, screens 21-25 and 26 in the winter or summer stratum, empirically adjusted for screen-specific collection efficiency.

blue crab scavenging and perhaps other losses such as deterioration and disintergration of the impinged fish.

Because 1985 was an exceptional year in terms of blue crab impingement and consequently predation, screen-specific adjustments derived from the 1985 collection efficiency data may over estimate impingement abundance during other years. This over estimate would be expected to be larger for screens 21-25 where the effect of blue crab predation on dead fish impinged on the fixed screens is greater than predation on the mostly live fish collected by the continuously rotating Ristroph screen (screen 26). Thus, screen-specific adjustments during summer when blue crabs are most abundant may be less accurate for screens 21-25 than for screen 26. Consequently, the annual impingement at unit 2 may be estimated using screen-specific adjusted estimates for screen 26 during the winter and summer strata and screens 21-25 during the winter stratum, and using regression adjusted total estimates for screens 21-25 during summer strata and all screens during the spring and fall strata. Using this collection efficiency adjustment procedure, the annual impingement at unit 2 totaled 805,122 fish compared to 736,821 fish by the regression method. The annual impingement at unit 3 estimated by the regression method totaled 355,145 for a combined station total of 1,160,267 and 1,091,966 using the screen-specific and regression methods, respectively.

4.3 WATER QUALITY

Daily intake water temperature averaged for both units rose from a seasonal low in mid-February of 0.0°C to a high of 30°C in mid-July and subsequently declined to 2.6°C by the end of December (Table A-1). Daily intake conductivity fluctuated during the year in a characteristic seasonal pattern (Table A-2). Lowest conductivity levels were recorded during spring when values consistently ranged from 130-1000 µS/cm with occasional pulses of 1000 to 9000 µS/cm recorded.

Conductivity was at its highest during summer and fall with values of 1000-9000 µS/cm consistently detected. During mid-November through December, conductivity once again dropped to levels below 1000 µS/cm.

4.4 SPECIES COMPOSITION AND RELATIVE ABUNDANCE

Fish collected in impingement samples during 1986 totaled 231,059 and comprised 65 species for unit 2 and 3 combined (Table 4-6). Among these species, 20 were primarily freshwater inhabitants, 18 were primarily marine species tolerant of moderate freshwater influences, and 27 were euryhaline species tolerant at one time or another of a wide range of salinity conditions. The number of species caught in 1986 (65) was well within the range of the previous ten years (43-79 species). In addition, two species were never reported at Indian Point before, and are new to the species list compiled for the Indian Point Impingement Program: oyster toadfish (*Opsanus tau*) and white bass/striped bass hybrid. A single oyster toadfish was collected at unit 2 in November. Oyster toadfish are common in coastal shoal waters from Cuba to Cape Cod (Bigelow and Schroeder, 1953) and may occur in the Hudson River at Indian Point as strays from Long Island Sound or New York Harbor. In the Potomac River estuary, oyster toadfish have been reported in fresh water but are most abundant in waters with salinities greater than 7 ppt (Lippson *et al.* 1980).

The white bass/striped bass hybrid was collected on March 3, 1986 at unit 3. Identification of this fish as a hybrid was verified by the New York State Department of Environmental Conservation (NYSDEC). The hybrid was a Length Class 4 gravid female weighing 670 grams. A hybrid was also reported in a beach seine collection obtained by the NYSDEC in 1985. The origin of white bass/striped bass hybrids in the Hudson River is speculative. The NYSDEC has no record of hybrid white bass/striped bass stocking in the Hudson River Water Drainage Basin. Stocking of hybrids has been reported in the Delaware Drainage Basin and

TABLE 4-6. SPECIES COLLECTED IN IMPINGEMENT SAMPLING AT INDIAN POINT UNITS 2 AND 3 IN 1986.

COMMON NAME[a]	SCIENTIFIC NAME[a]	SALINITY PREFERENCE[b]
Alewife	*Alosa pseudoharengus*	e
American eel	*Anguilla rostrata*	e
American shad	*Alosa sapidissima*	e
Atherinid unid.		e
Atlantic croaker	*Micropogonias undulatus*	e
Atlantic menhaden	*Brevoortia tyrannus*	m
Atlantic needlefish	*Strongylura marina*	e
Atlantic silverside	*Menidia menidia*	e
Atlantic sturgeon	*Acipenser oxyrhynchus*	e
Atlantic tomcod	*Microgadus tomcod*	e
Banded killifish	*Fundulus diaphanus*	f
Bay anchovy	*Anchoa mitchilli*	e
Black crappie	*Pomoxis nigromaculatus*	f
Black sea bass	*Centropristis striata*	m
Blueback herring	*Alosa aestivalis*	e
Bluefish	*Pomatomus saltatrix*	m
Bluegill	*Lepomis macrochirus*	f
Brown bullhead	*Ictalurus nebulosus*	f
Butterfish	*Peprilus triacanthus*	m
Common carp	*Cyprinus carpio*	f
Clupeid unid.		e
Crevalle jack	*Caranx hippos*	e

TABLE 4-6. (Continued)

COMMON NAME[a]	SCIENTIFIC NAME[a]	SALINITY PREFERENCE[b]
Fourspine stickleback	*Apeltes quadracus*	e
Gizzard shad	*Dorosoma cepedianum*	f
Golden shiner	*Notemigonus crysoleucas*	f
Goldfish	*Carassius auratus*	f
Gray snapper	*Lutjanus griseus*	m
Hickory shad	*Alosa mediocris*	e
Hogchoker	*Trinectes maculatus*	e
Largemouth bass	*Micropterus salmoides*	f
Logperch	*Percina caprodes*	f
Lookdown	*Selene vomer*	e
Moonfish	*Selene setapinnis*	m
Mummichog	*Fundulus heteroclitus*	e
Naked goby	*Gobiosoma bosci*	e
Northern pike	*Esox lucius*	f
Northern pipefish	*Syngnathus fuscus*	e
Northern searobin	*Prionotus carolinus*	m
Oyster toadfish	*Opsanus tau*	m
Pumpkinseed	*Lepomis gibbosus*	f
Rainbow smelt	*Osmerus mordax*	e
Red hake	*Urophycis chuss*	m
Redbreast sunfish	*Lepomis auritus*	f
Rock gunnel	*Pholis gunnellus*	m
Rough silverside	*Membras martinica*	e

TABLE 4-6. (Continued)

COMMON NAME[a]	SCIENTIFIC NAME[a]	SALINITY PREFERENCE[b]
Sea lamprey	*Petromyzon marinus*	m
Seahorse	*Hippocampus* sp.	e
Silver lamprey	*Ichthyomyson unicuspis*	f
Smallmouth bass	*Micropterus dolomieu*	f
Spottail shiner	*Notropis hudsonius*	f
Spotted hake	*Urophycis regia*	m
Striped bass	*Morone saxatilis*	e
Striped mullet	*Mugil cephalus*	e
Striped searobin	*Prionotus evolans*	m
Summer flounder	*Paralichthys dentatus*	m
Tautog	*Tautoga onitis*	m
Tesselated darter	*Etheostoma olmstedi*	f
Threespine stikleback	*Gasterosteus aculeatus*	e
Tidewater silverside	*Menidia peninsulae*	e
Weakfish	*Cynoscion regalis*	m
White bass x Striped bass[c]	*Morone chrysops x M. saxatilis*	e
White catfish	*Ictalurus catus*	f
White perch	*Morone americana*	e
Winter flounder	*Pseudopleuronectes americanus*	m
Yellow perch	*Perca flavescens*	f

[a] Names recognized by the American Fisheries Society (Robins, et al. 1980)

[b] m = marine, e = euryhaline, f = freshwater

[c] White bass x striped bass hybrid verified by the New York State DEC

strays may conceivably find their way to the Hudson River by way of the coast. White bass have fairly recently been introduced into the Hudson River, from the Great Lakes by way of the Barge Canal (Smith 1985) and therefore, natural hybridization is also a possibility.

The three numerically dominate species impinged at Indian Point units 2 and 3 in 1986 were white perch, Atlantic tomcod, and bay anchovy (Table 4-7). Collectively, these fishes comprised nearly 83% of the total estimated impingement abundance at the Indian Point Station in 1986 and were among the top ten species impinged in previous monitoring programs. White perch were by far the most dominant species, as in previous years, accounting for 61.3% of the number of fish impinged (Table 4-7). Unit 2 impingement collections accounted for 61% of the total white perch abundance, 84% of the total bay anchovy abundance and 90% of the total tomcod abundance.

The schedule of plant operation at unit 3 did not appear to greatly influence estimates of species composition or yearly impingement abundance since unit 3 operated most of the year. Unit 2 however, had an extended outage from mid-January through April during which little or no circulating water was sampled (Table 4-8). This outage coincided with peak mean daily impingement rates (Table 4-3), thus substantially lowering impingement abundance estimates for the winter stratum and to a lesser extend the spring stratum. The outage resulted in less impingement of winter and spring seasonally abundant fishes at unit 2 such as white perch, striped bass, white catfish, rainbow smelt and spottail shiner than if the plant had been operating during mid-January through April.

4.5 SEASONAL AND YEARLY IMPINGEMENT PATTERNS

Seasonal trends were examined using mean monthly impingement rates (daily count of a taxon adjusted for collection efficiency divided by the daily volume pumped, averaged over each month). Due to an

TABLE 4-7. ESTIMATED NUMBER IMPINGED AT INDIAN POINT IN 1986 AND TOTAL PERCENT COMPOSITION OF THE TWELVE MOST ABUNDANT SPECIES[a] AND ALL SPECIES COMBINED.

SPECIES	UNIT 2		UNIT 3		BOTH UNITS		
	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	CUM. PERCENT
White perch	409,605	55.6	259,986	73.2	669,591	61.3	61.3
Atlantic tomcod	117,378	15.9	13,602	3.8	130,980	12.0	73.3
Bay anchovy	85,495	11.6	16,665	4.7	102,160	9.4	82.7
Hogchoker	50,452	6.8	22,875	6.4	73,327	6.7	89.4
Blueback herring	7,219	1.0	10,640	3.0	17,859	1.6	91.0
Rainbow smelt	10,879	1.5	2,776	0.8	13,655	1.3	92.3
American shad	6,423	0.9	4.904	1.4	11,327	1.0	93.3
Striped bass	8,417	1.1	2,305	0.6	10,722	1.0	94.3
Atlantic menhaden	6,370	0.9	3,296	0.9	9,666	0.9	95.2
Gizzard shad	1,773	0.2	7,735	2.2	9,508	0.9	96.1
Weakfish	6,592	0.9	1,802	0.5	8,394	0.8	96.9
Bluefish	4,044	0.5	1,515	0.4	5,559	0.5	97.4
All species combined	736,821		355,145		1,091,966		

[a]Includes all species comprising over 0.5% of the total at the two units combined, and includes 10 of the 14 selected species.

TABLE 4-8. CIRCULATING WATER VOLUME PUMPED ($10^6 m^3$) IN ASSOCIATION WITH IMPINGEMENT SAMPLING AT INDIAN POINT IN 1986.

MONTH	UNIT 2	UNIT 3	UNITS 2 AND 3
Jan	21.3	25.9	47.2
Feb	[a]	18.8	18.8
Mar	7.6	38.2	45.8
Apr	[a]	24.1	24.1
May	4.0	3.0	7.0
Jun	27.2	21.1	48.3
Jul	13.4	14.3	27.7
Aug	12.5	6.3	18.8
Sep	26.0	46.1	72.1
Oct	72.7	34.9	107.6
Nov	59.1	19.9	79.0
Dec	69.6	26.1	95.7
Total	313.4	278.9	592.10

[a] No sampling due to unit shutdown

extended outage at unit 2 from mid-January through April, impingement rates were not available for unit 2 for February and April, and March rates corresponded to small sampling and operating volumes (Table 3-4). Seasonal patterns and rates for 1986 were compared to the 1982-1985 data which were based on the same stratified sampling design used in the 1986 program.

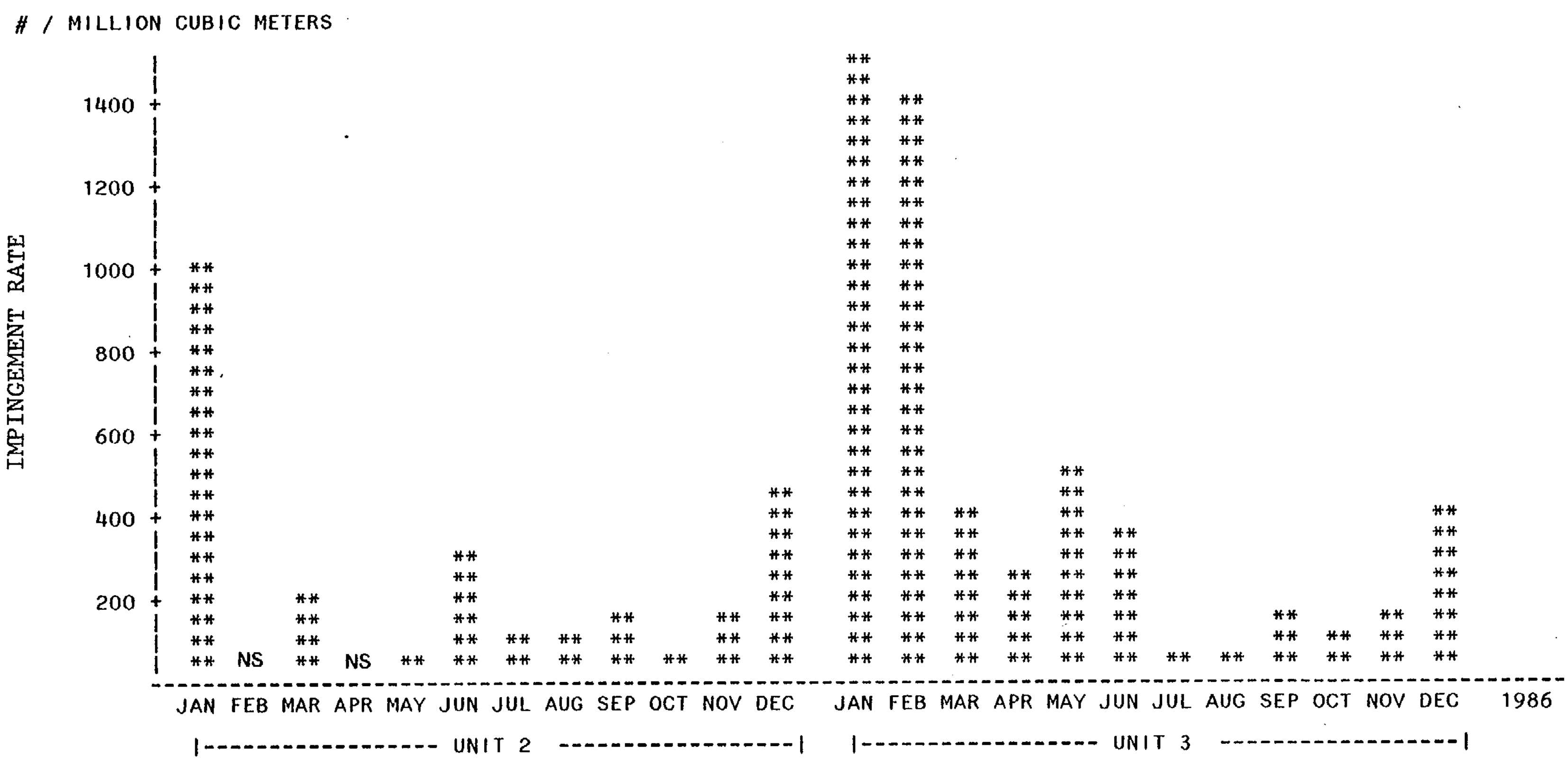
Impingement patterns in 1986 were similar between units 2 and 3. Both units exhibited maximum impingement rates in the winter stratum with small pulses during spring and fall (Figure 4-2). Impingement rates were highest during January and February at unit 3, and during January at unit 2 (no February or April sampling at unit 2). High winter impingement rates were due primarily to a large influx of yearling white perch in January and February. Similar peaks were observed during the winter stratum in previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986). As in previous years, young-of-the-year white perch were also numerous in impingement collections during December. The small pulse in impingement rate during the spring stratum of 1986 consisted primarily of Atlantic tomcod and bay anchovy.

Fifteen species were previously selected for more detailed examination of impingement patterns, based on abundance in impingement collections, designation as representative important species by the U.S. Environmental Protection Agency, and current or potential importance to commercial or sport fisheries (TI, 1980b):

White perch	Rainbow smelt	White catfish
Atlantic tomcod	American shad	Alewife
Bay anchovy	Striped bass	Spottail shiner
Hogchoker	Weakfish	Atlantic sturgeon
Blueback herring	Bluefish	Shortnose sturgeon

The monthly impingement rates for 13 of the above species are presented in order of abundance in Figures 4-3 through 4-15 and discussed below. Young-of-the-year fish (Y) are distinguished from yearling and older fish (O) on each figure. No shortnose sturgeon were impinged and only 7 Atlantic sturgeon were impinged in 1986.

ALL TAXA



NS = NOT SAMPLED

FIGURE 4-2. MONTHLY ADJUSTED IMPINGEMENT RATES FOR ALL TAXA COMBINED AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

WHITE PERCH

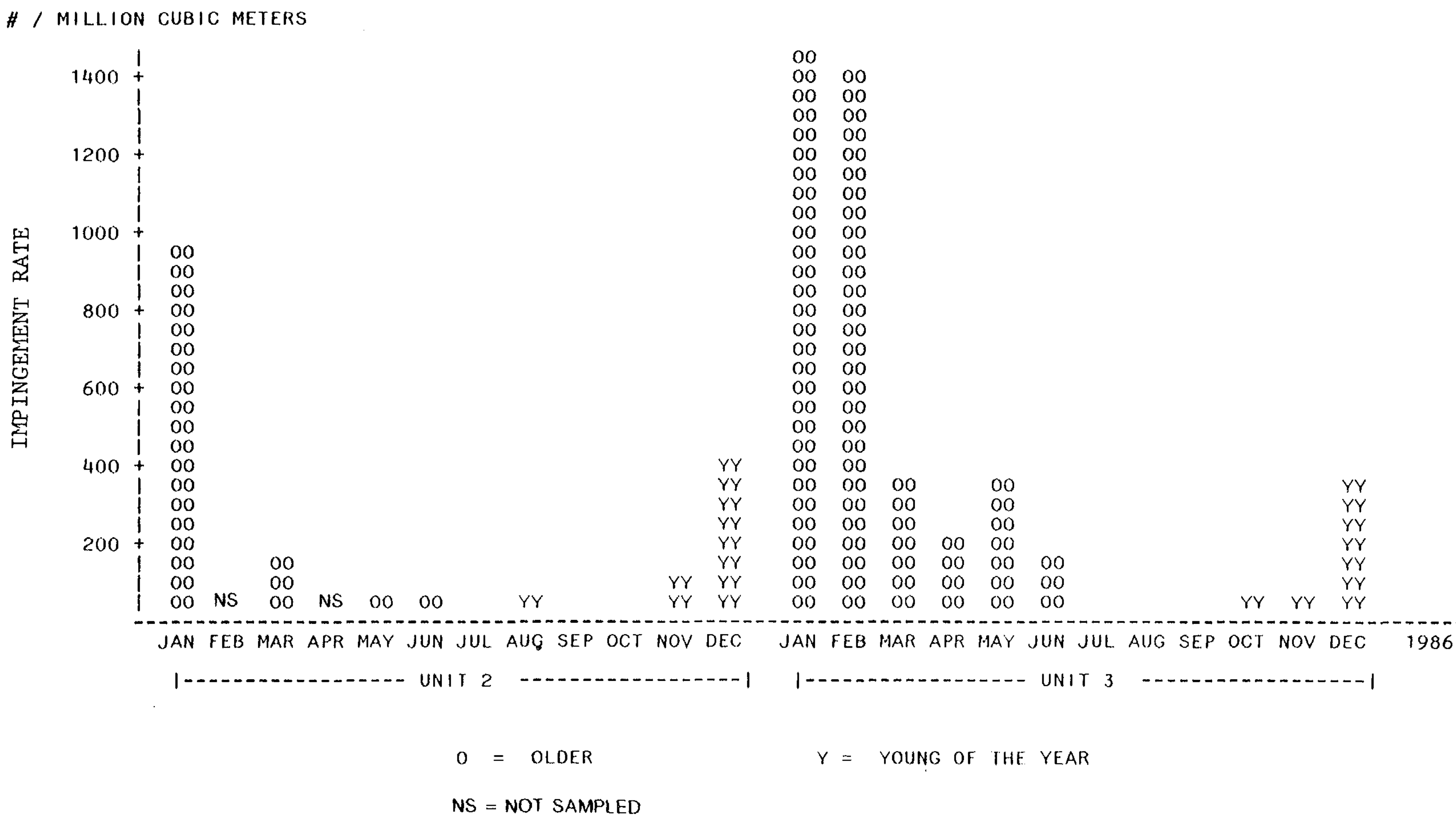


FIGURE 4-3. MONTHLY ADJUSTED IMPINGEMENT RATES FOR WHITE PERCH AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY

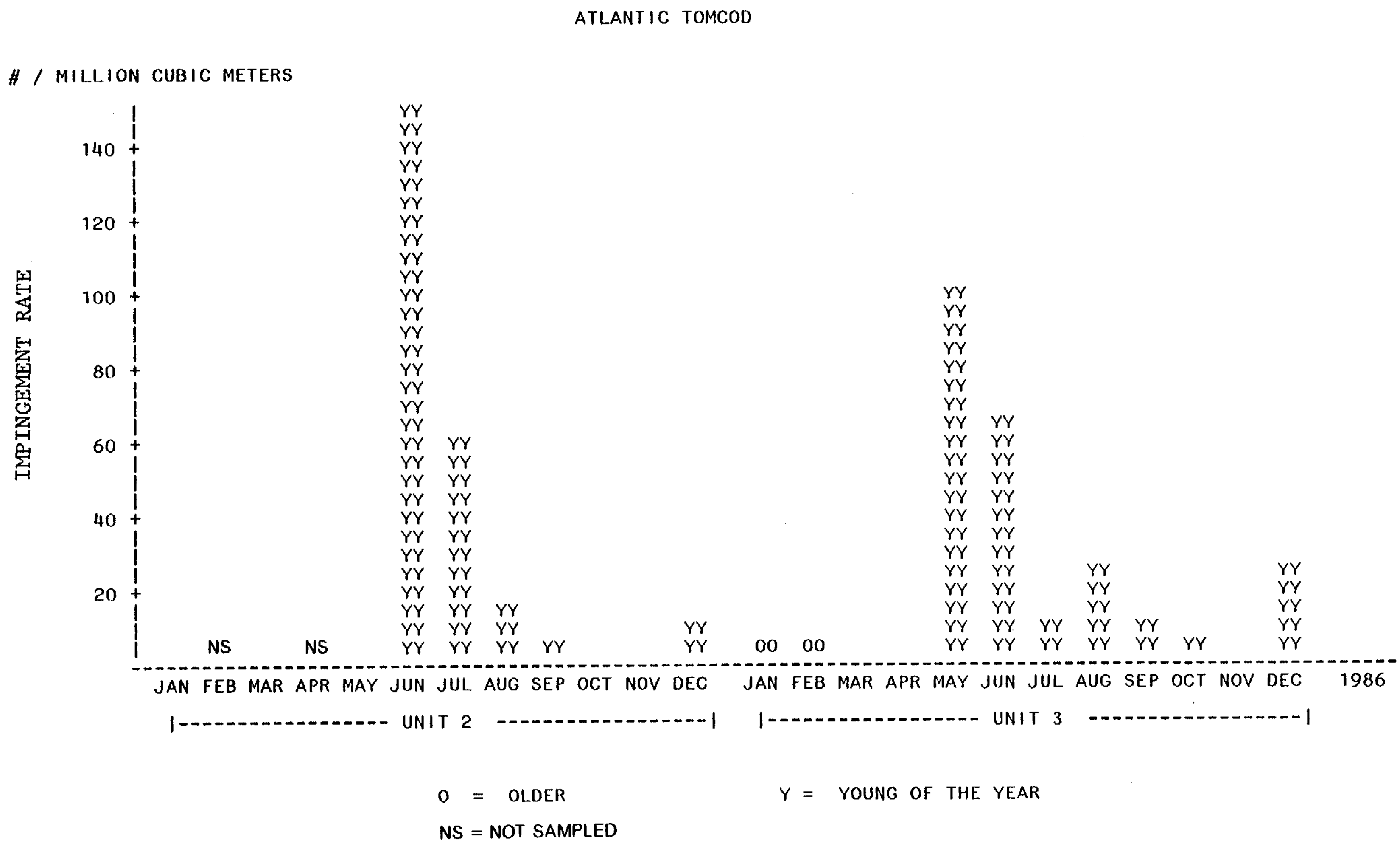
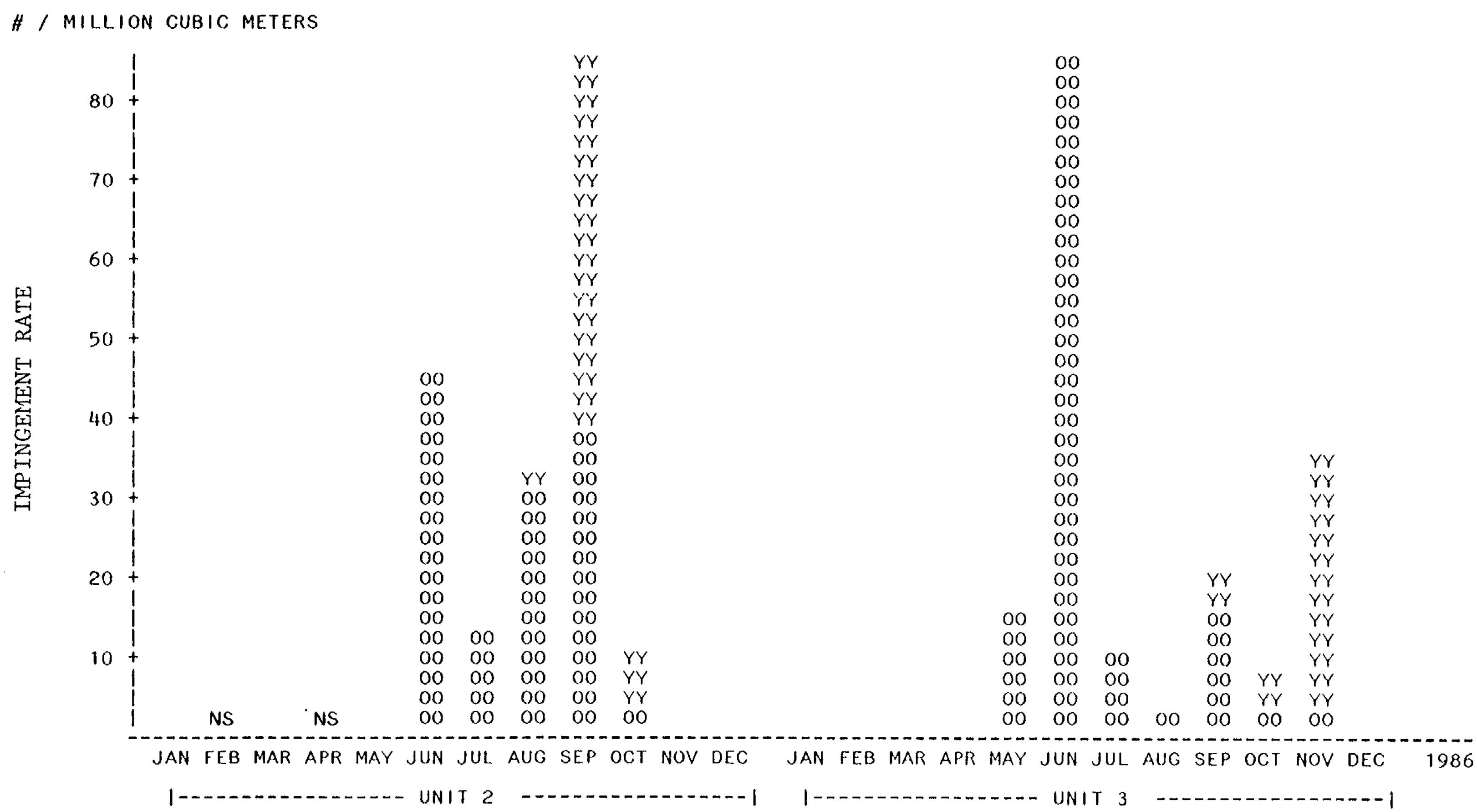


FIGURE 4-4. MONTHLY ADJUSTED IMPINGEMENT RATES FOR ATLANTIC TOMCOD AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

BAY ANCHOVY



O = OLDER Y = YOUNG OF THE YEAR

NS = NOT SAMPLED

FIGURE 4-5. MONTHLY ADJUSTED IMPINGEMENT RATES FOR BAY ANCHOVY AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

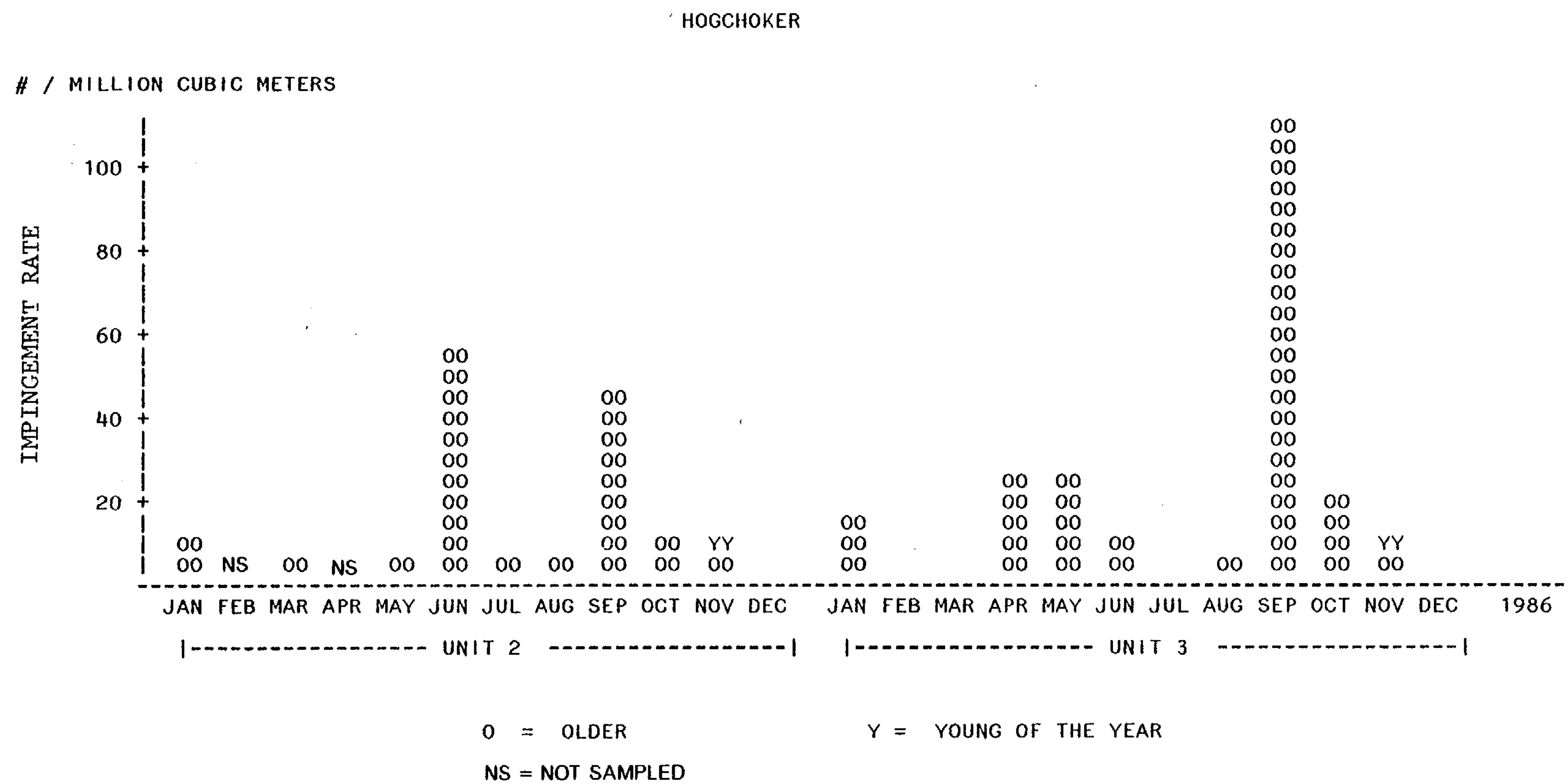


FIGURE 4-6. MONTHLY ADJUSTED IMPINGEMENT RATES FOR HOGCHOKER AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

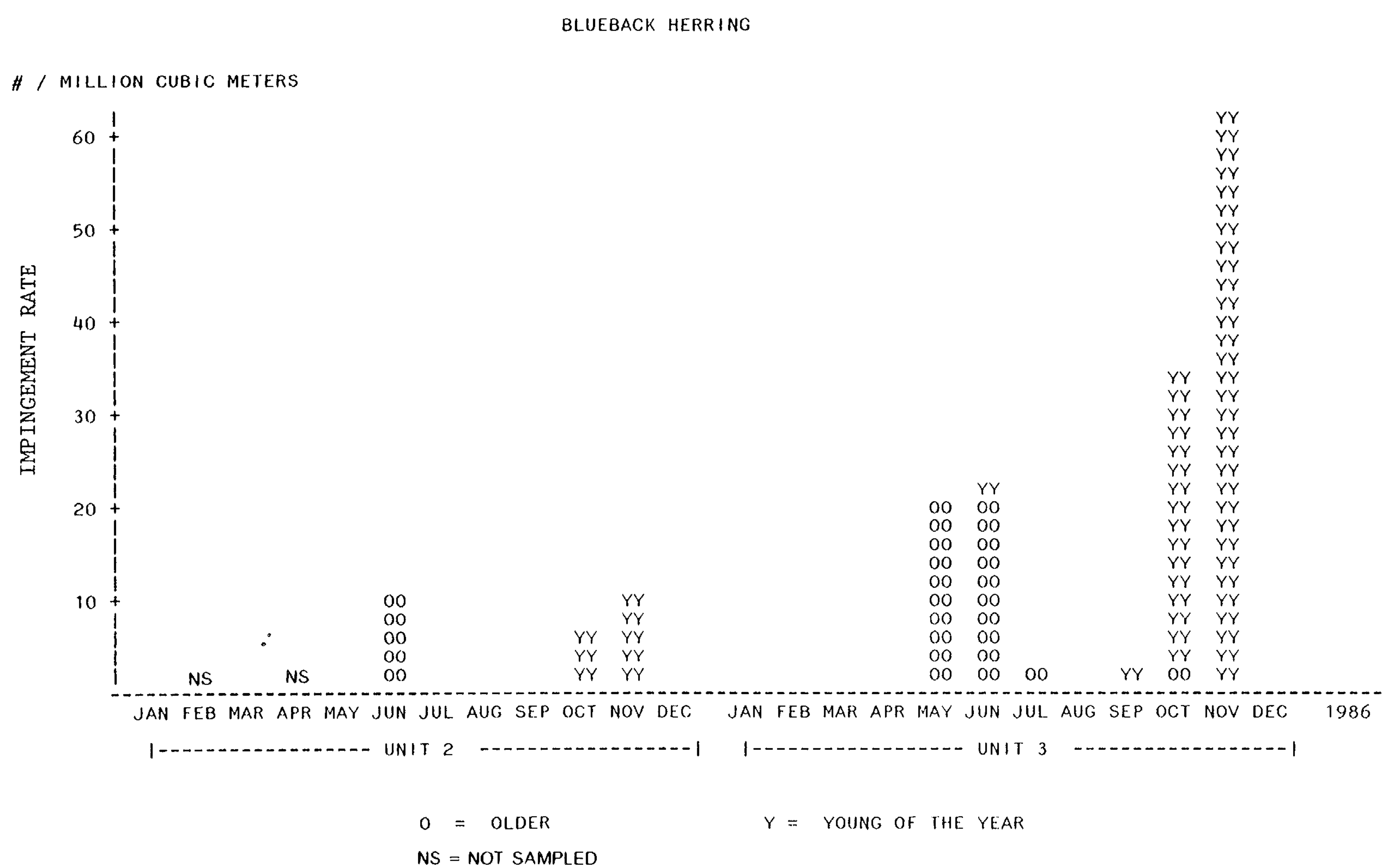


FIGURE 4-7. MONTHLY ADJUSTED IMPINGEMENT RATES FOR BLUEBACK HERRING AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

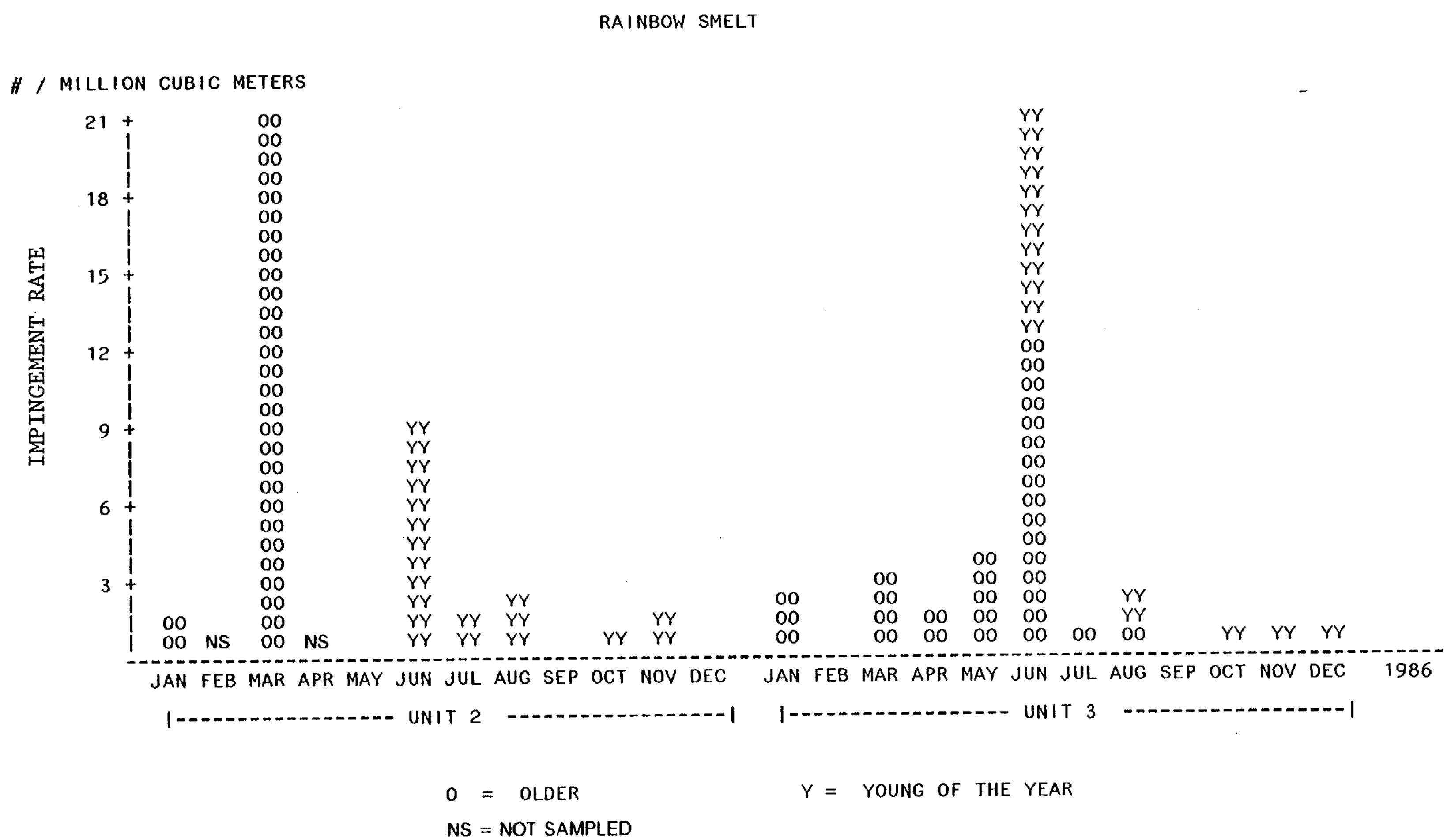


FIGURE 4-8. MONTHLY ADJUSTED IMPINGEMENT RATES FOR RAINBOW SMELT AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

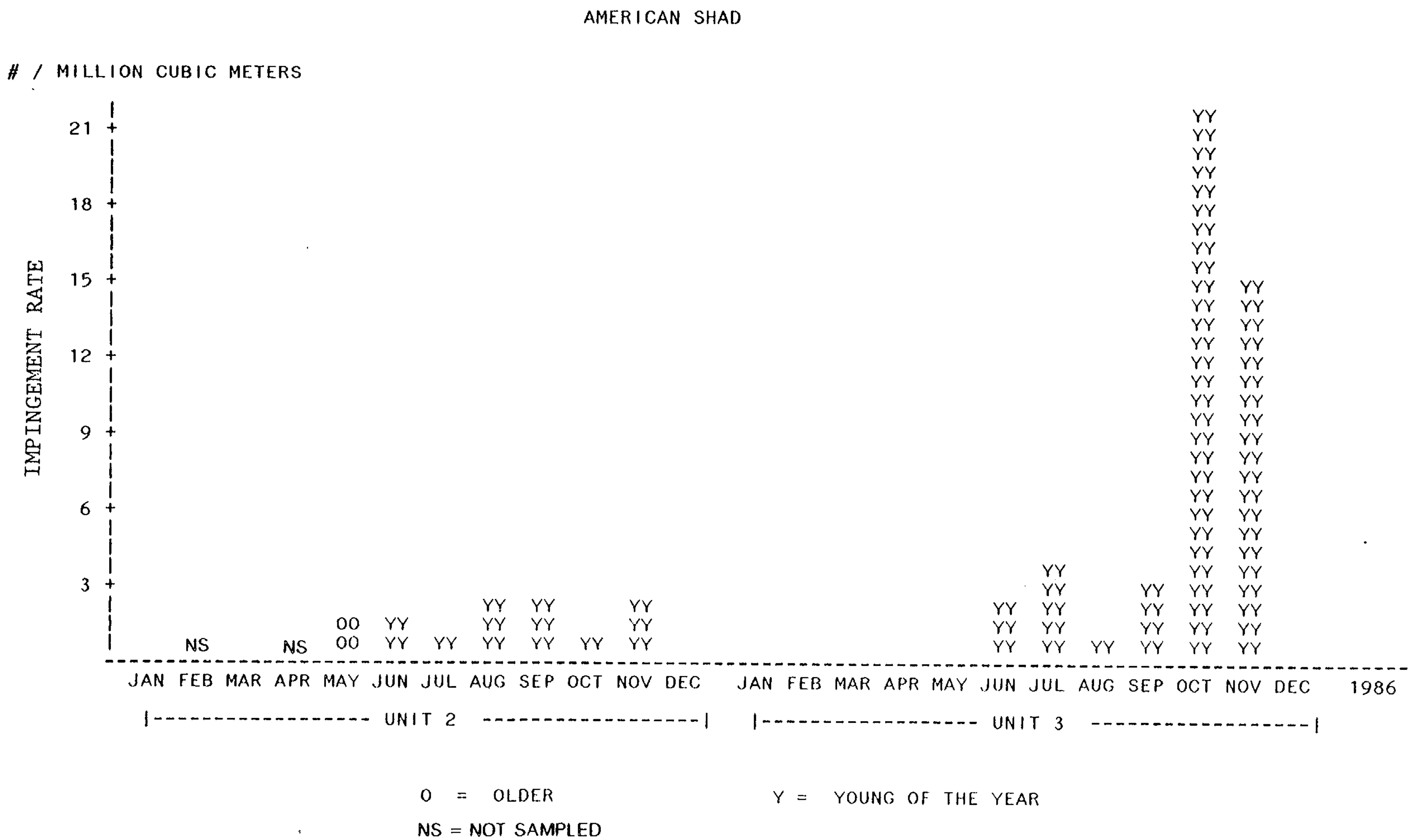
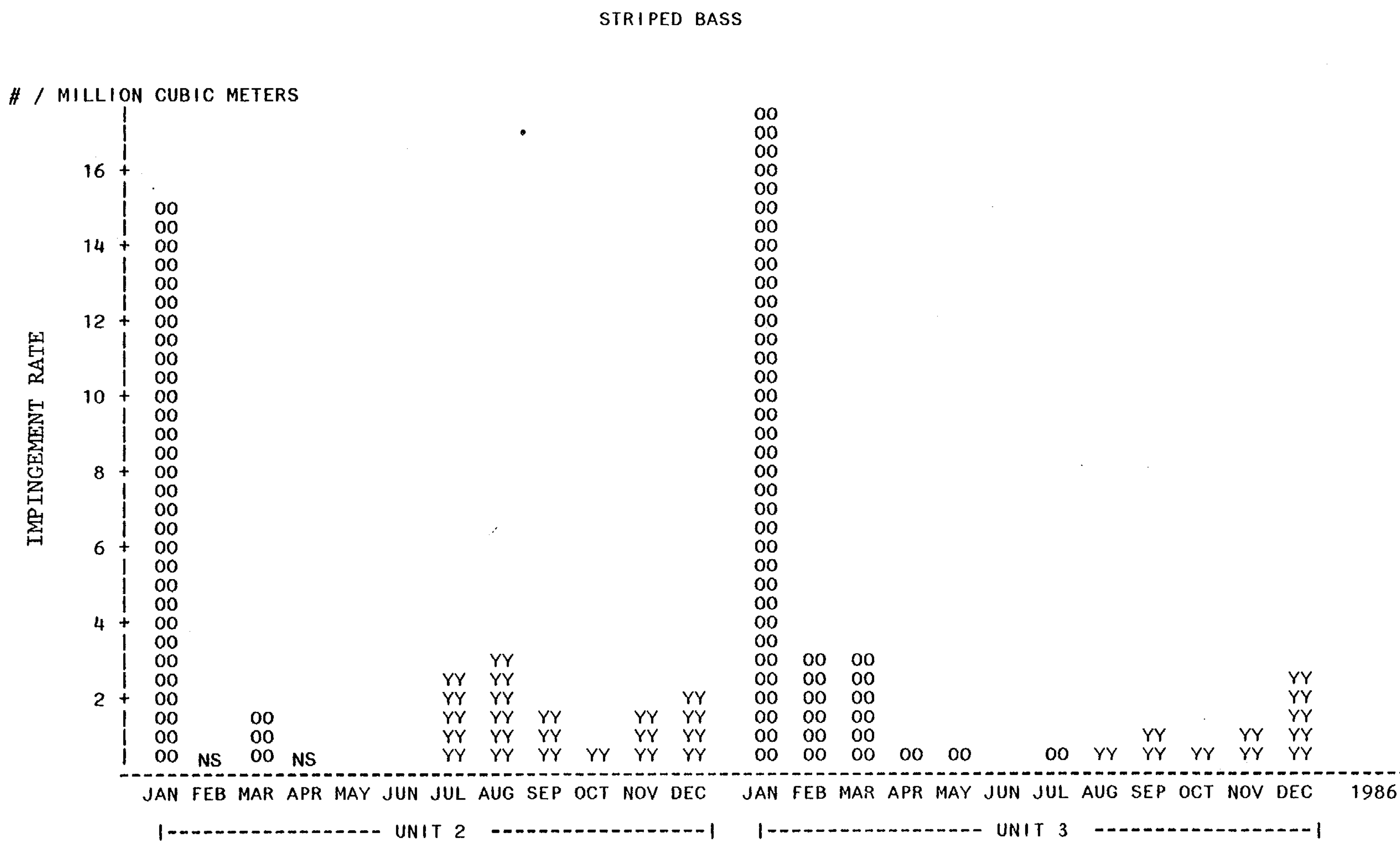


FIGURE 4- 9. MONTHLY ADJUSTED IMPINGEMENT RATES FOR AMERICAN SHAD AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.



O = OLDER Y = YOUNG OF THE YEAR

NS = NOT SAMPLED

FIGURE 4-10. MONTHLY ADJUSTED IMPINGEMENT RATES FOR STRIPED BASS AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

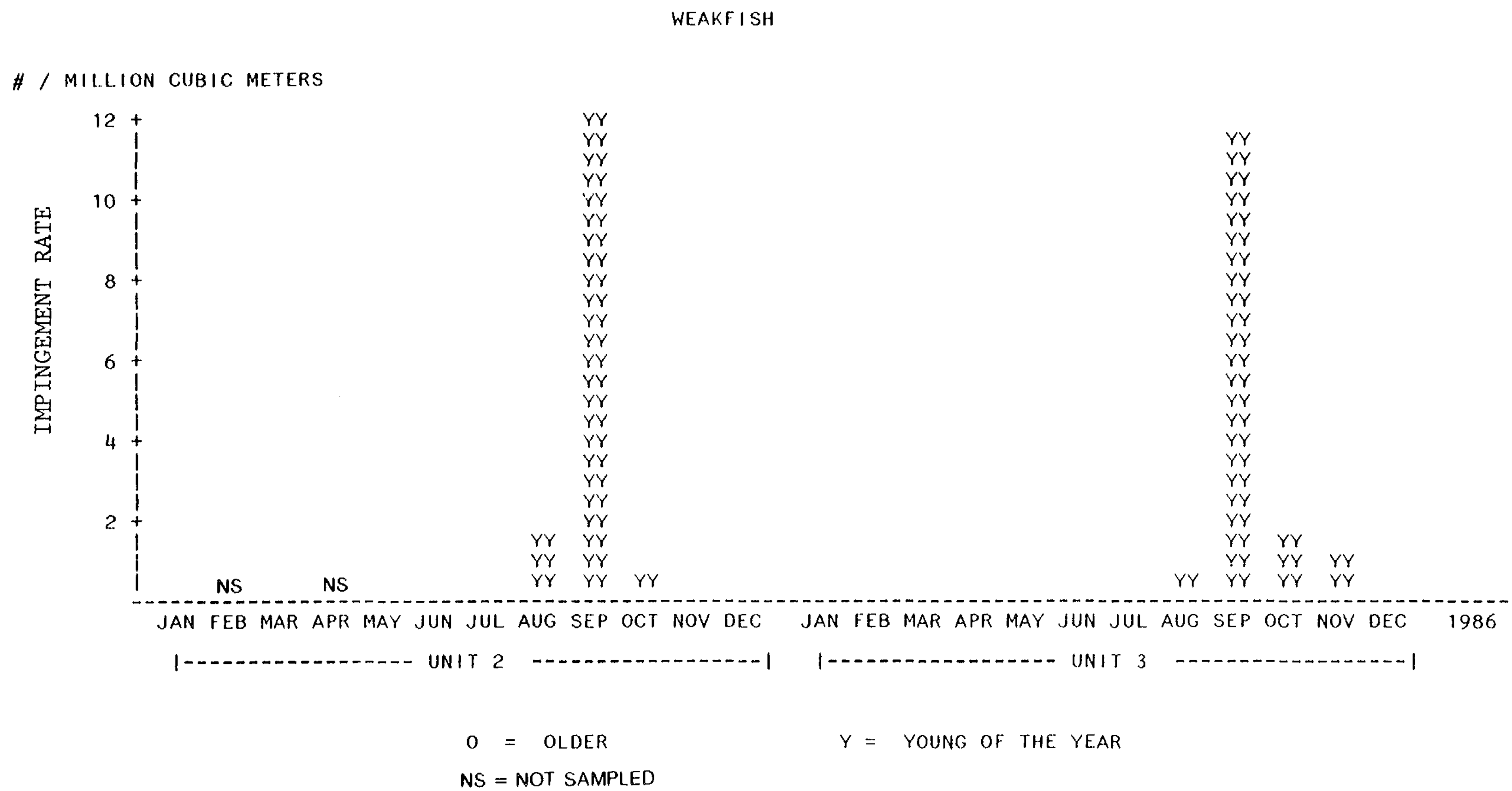


FIGURE 4-11. MONTHLY ADJUSTED IMPINGEMENT RATES FOR WEAKFISH AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

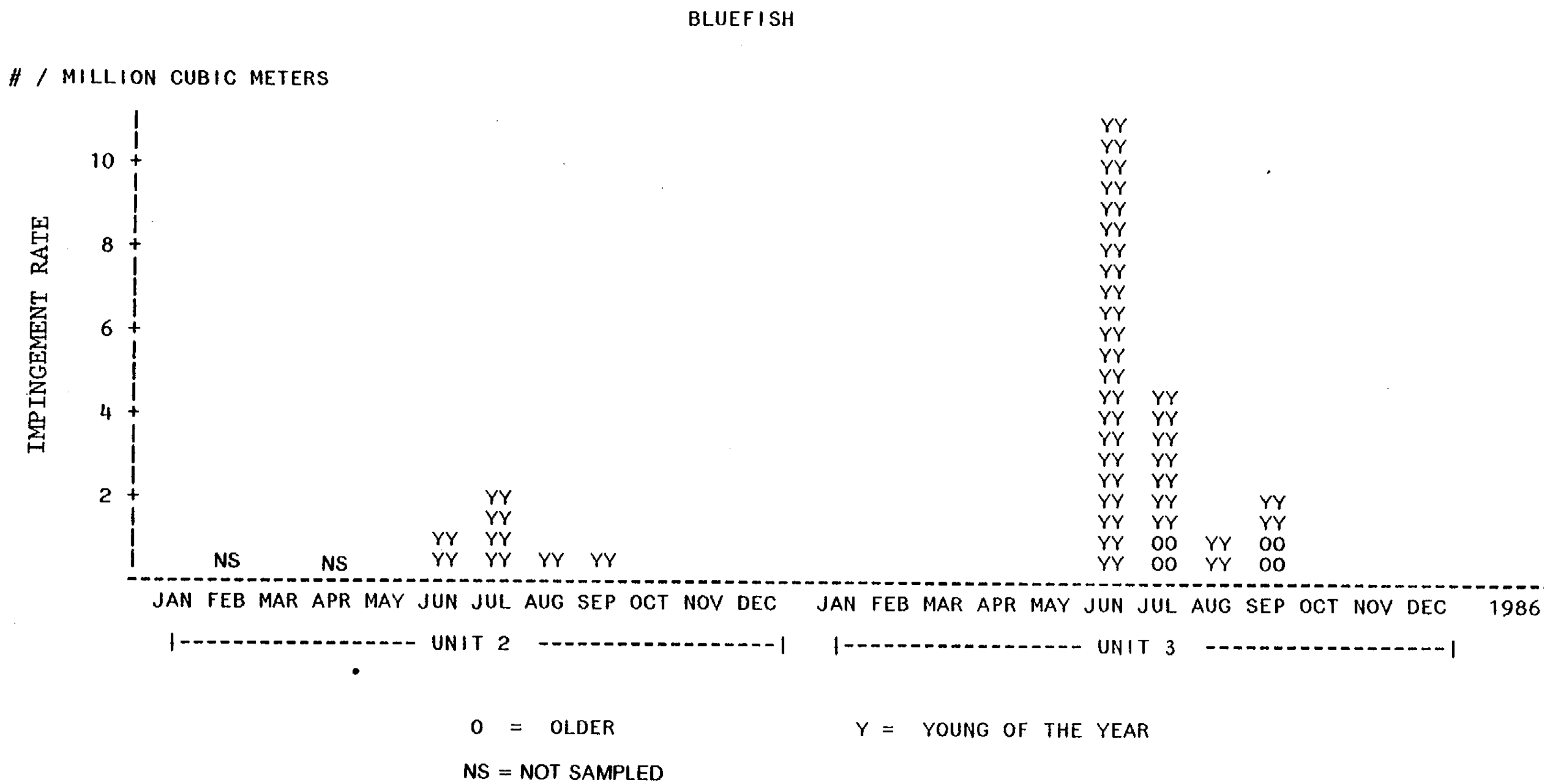


FIGURE 4-12. MONTHLY ADJUSTED IMPINGEMENT RATES FOR BLUEFISH AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

WHITE CATFISH

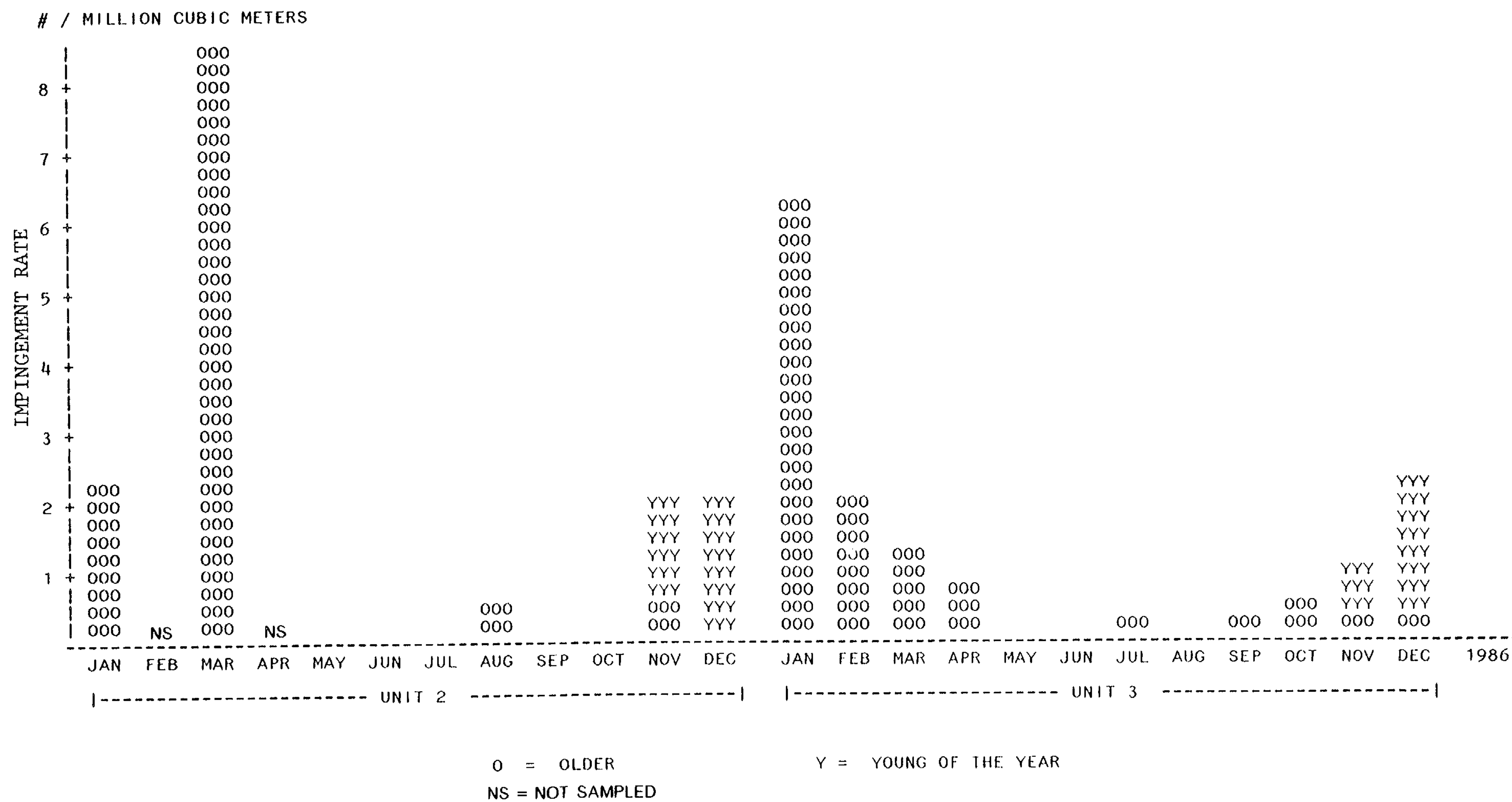


FIGURE 4-13. MONTHLY ADJUSTED IMPINGEMENT RATES FOR WHITE CATFISH AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

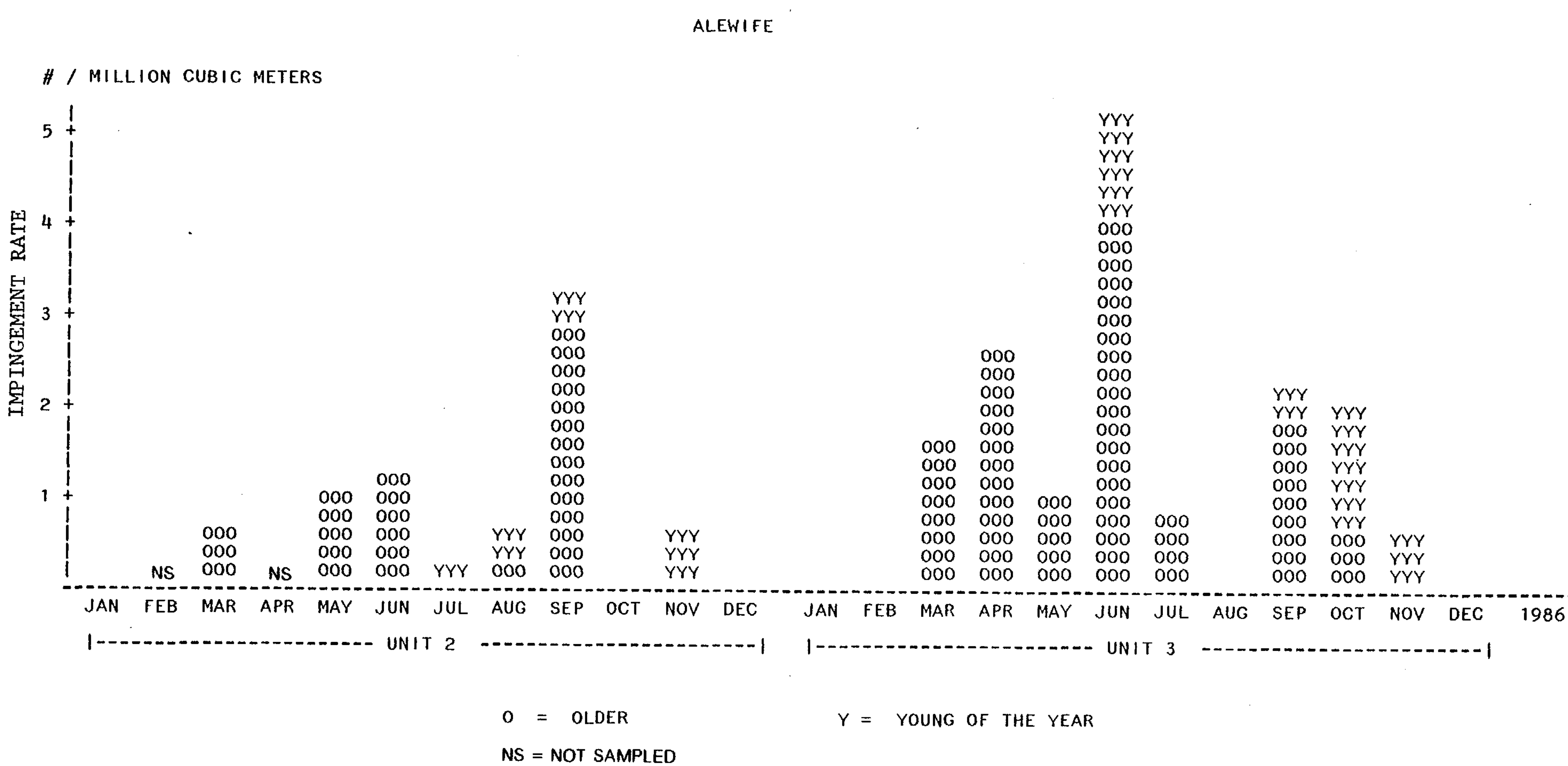


FIGURE 4-14. MONTHLY ADJUSTED IMPINGEMENT RATES FOR ALEWIFE AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

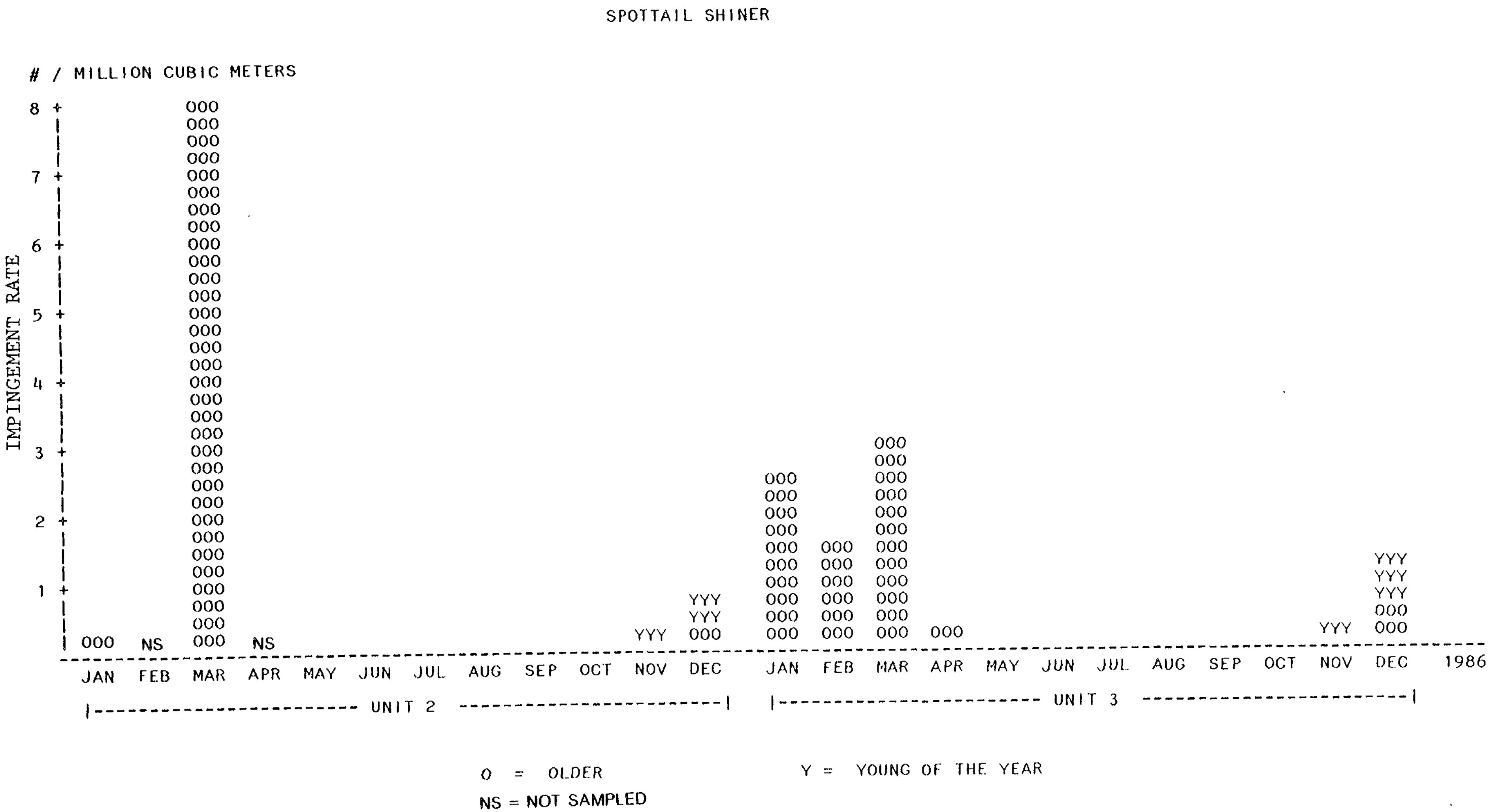


FIGURE 4-15. MONTHLY ADJUSTED IMPINGEMENT RATES FOR SPOTTAIL SHINER AT INDIAN POINT UNITS 2 AND 3 IN 1986, ADJUSTED FOR COLLECTION EFFICIENCY.

White perch were the most numerous fish impinged in 1986 (Table 4-7, Figure 4-3). Impingement rates were highest during winter at both units 2 and 3, and collections consisted mostly of yearling fish. Impingement rates decreased in the spring stratum and were minimal in the summer stratum. Impingement rates increased again in the fall stratum as young-of-the-year white perch became abundant during December. This seasonal pattern and the magnitude of monthly impingement rates were consistent with patterns and rates presented in previous years' reports (Con Edison 1983; MMES 1985; NAI 1984a, 1986).

Atlantic tomcod yearling and older fish were impinged during the winter stratum in low numbers (Figure 4-4). Young-of-the-year fish were considerably more abundant in impingement collections and occurred in highest numbers during May, June, and July, and subsequently declined in abundance during late summer and fall. This pattern was similar to patterns of tomcod impingement observed in previous years and is consistent with the described life history of the tomcod in which older fish spawn in shoal areas in the winter and young-of-the-year fish are first large enough to be impinged by late spring and early summer (TI 1980a). Peak monthly impingement rates for 1986 were within the range of peak rates recorded in previous years (Con Edison 1983; MMES 1984; NAI 1984a, 1986).

Bay anchovies were impinged from May through November with yearling and older fish most numerous during June through September and young-of-the-year fish most numerous during September through November (Figure 4-5). Bay anchovies spawn in the high salinity waters of the lower estuary primarily from June through August (NAI 1985). The yearling and older fish that were impinged beginning in May probably represent a portion of the bay anchovy population that utilize the Indian Point region as a feeding ground prior to spawning (NAI 1985). The young-of-the-year fish impinged from September through November most likely represent the dispersion of early life stages upstream into the lower salinity waters of the lower and middle estuary that are the bay anchovy's nursery grounds. Peak monthly impingement rates and the seasonal pattern of impingement during 1986 were comparable to most previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986).

Hogchokers were impinged during most months in 1986 with peak impingement rates during June and September (Figure 4-6). Yearling and older fish comprised the majority of the total hogchoker impingement abundance with young-of-the-year recorded only in November. The seasonal pattern of hogchoker impingement differed from previous years in that the May peak observed in previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986) was not observed in 1986. Variations in seasonal abundance patterns, as observed with hogchokers in 1986, may be a result of annual variation in salt front position.

Blueback herring were impinged primarily during May and June, and October and November (Figure 4-7). The spring peak consisted primarily of yearling and older fish, and the larger fall peak consisted of young-of-the-year. Previous years impingement data showed similar results with maximum impingement rates of young-of-the-year blueback herring having occurred in the fall (Con Edison 1983; MMES 1985; NAI 1984a, 1986). Yearling and older fish migrate upriver during spring to spawn in the fresh water areas of the river above Catskill and are subject to impingement by Indian Point and other cooling water intakes which they pass on route. During fall, as young-of-the-year fish migrate down river toward high salinity waters, they too become vulnerable to impingement by these same cooling water intakes. Peak monthly impingement rates in 1986 (up to $61/10^6m^3$) were at the low end of the range of peak monthly rates recorded from 1982 through 1985 (up to 38 to $620/10^6m^3$, annually).

Rainbow smelt were impinged throughout the year at Indian Point except for February and September (Figure 4-8). Yearling and older fish were impinged from January through August with peak rates during March. Young-of-the-year fish were impinged from June through

December with peak impingement rates during June. Impingement patterns have been variable for this species in previous years with maximum impingement rates occurring in several different months (NAI 1984a). Peak monthly impingement rates in 1986 (up to $21/10^6 m^3$) were higher than peak monthly rates observed in past years (up to 4 to $16/10^6 m^3$).

American shad yearling and older were impinged during May in low numbers. Young-of-the-year fish were impinged from June through November with peak numbers in October and November (Figure 4-9). Fall peaks were also recorded in 1984 and 1985, while in 1982 and 1983 peak impingement rates occurred during summer (Con Edison 1983; MMES 1985; NAI 1984a, 1986). American shad spawn in the fresh water of the upper estuary, and shad eggs and larvae are concentrated in this region (NAI 1985). Transformation of the American shad post yolk-sac larvae to the juvenile stage begins around late June at about 25°C and juveniles subsequently become much more dispersed throughout the estuary. During fall as water temperatures drop, young-of-the-year shad actively emigrate from the estuary. The summer peaks observed in 1982 and 1983 may have been due to an earlier down stream dispersion of young-of-the-year fish during those years than subsequent years and perhaps a faster growth rate resulting in early impingement. The fall peaks in 1984, 1985, and 1986 reflected passage of fish through the Indian Point area during their outward migration from the estuary. Peak monthly impingement rates in 1986 were within the range of peak monthly rates presented in previous reports (Con Edison 1983; MMES 1985; NAI 1984a, 1986).

Striped bass exhibited a similar impingement pattern to white perch, however, impingement rates were much lower (Figure 4-10). Striped bass impingement rates were highest in January when yearling and older fish predominated. A large population of yearling and older striped bass presumably overwinter in the deep waters of the lower estuary, such as that in the Indian Point area, and thus are more vulnerable to impingement at Indian Point during winter (TI 1980c). Impingement abundance of yearling and older striped bass subsequently declined through early summer. Young-of-the-year striped bass were impinged from July through December. This seasonal pattern of impingement was similar to the seasonal patterns described for previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986). Peak monthly impingement rates in 1986 (up to $16/10^6 m^3$) were at the low end of the range of peak monthly rates observed in previous years (up to 19 to $600/10^6 m^3$).

Weakfish were impinged at units 2 and 3 in 1986 only as young-of-the-year fish (Figure 4-11). Impingement occurred from August through November with the peak impingement rate during September. Weakfish spawn at the mouths of estuaries and the juveniles subsequently move upstream to utilize the low salinity water of the estuary as a nursery area (NAI 1985). Peak monthly impingement rates in 1986 (up to $12/10^6 m^3$) were lower than the extremely high peak impingement rates in 1983 (approximately $1500/10^6 m^3$ in August at unit 2) and were more consistent with the peak monthly rates observed in other years (up to 41 to $210/10^6 m^3$).

Bluefish were impinged at Indian Point from June through September (Figure 4-12). Yearling and older fish were impinged only at unit 3 in July and September. Young-of-the-year bluefish were impinged from June through September with peak impingement during June. Monthly impingement rates at Indian Point in 1986 were within the range presented in previous reports (Con Edison 1983; MMES 1985; NAI 1984a, 1986).

White catfish impingement was greatest during the winter and fall strata, as in past years (Figure 4-13). Yearling and older white catfish predominated during the winter stratum and young-of-the-year catfish during the fall stratum. Adult white catfish overwinter in deep water areas of the lower Hudson River such as Indian Point and during spring move upstream into the low salinity and shallow water regions of the middle and upper estuary to spawn (TI 1981). Spawning occurs during spring in waters with salinities below 2 ppt (Perry and Avault 1968) and young-of-the-year fish are first present beginning around July and continuing through December with peak densities upstream of Indian Point (NAI 1985). Monthly adjusted impingement rates in 1986 were within the range observed in previous years.

Alewives were impinged from March through November (Figure 4-14). Yearling and older fish were recorded primarily from March through September and young-of-the-year from June through November. This was similar to previous years and corresponded with the generalized life history of the alewife in which spawning adults migrate upriver in the spring past Indian Point to spawn in fresh water, and both adults and young-of-the-year fish migrate downriver past Indian Point to the ocean in the fall (NAI 1985). Peak monthly impingement rates (up to $5/10^6 m^3$) were at the low end of the range of peak monthly rates observed in past years (up to $7\text{-}36/10^6 m^3$, annually).

Spottail shiners were impinged largely during the winter and fall strata (Figure 4-15). The majority of the spottail shiners impinged were yearling and older fish that were probably overwintering in deeper water areas such as Indian Point (NAI 1985). The young-of-the-year fish impinged during fall were presumably the product of the spring and early summer spawning in the upper estuary. The seasonal pattern and magnitudes of monthly impingement rates were consistent with previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986).

A total of 7 Atlantic sturgeon were impinged at Indian Point during 1986 (Table 4-9). No shortnose sturgeon were impinged at either unit in 1986. Three Atlantic sturgeon were impinged during the winter stratum, two during the spring stratum, and two during the fall stratum. The fish ranged in total length from 427 to 788 mm and in weight from 274 to 1795 gm. Of the 7 fish impinged, 3 were collected alive (43% survival) and released back to the river.

TABLE 4-9. ATLANTIC STURGEON IMPINGED AT INDIAN POINT UNIT 2 AND UNIT 3 ON BOTH SAMPLE AND NON-SAMPLE DAYS DURING 1986.

1986 DATE	UNIT	SAMPLE	LENGTH (mmTL)	WEIGHT (grams)	CONDITION
14 Feb	3	3018	663	775	Dead
28 Feb	3	--[a]	427	274	Alive[b]
13 Mar	3	--	788	1795	Dead
21 Apr	--[c]	--	455	454	Dead
6 Jul	2[d]	2076	466	380	Alive
30 Nov	3	--	445	409	Dead
5 Dec	2	2349	474	525	Alive

[a] Indicates sturgeon were collected on a non-sample day

[b] Alive fish were released to the river away from intake screens

[c] Unit was not recorded for this fish collected on a non-sample day

[d] Screen 26.

4.6 BLUE CRAB IMPINGEMENT

4.6.1 Blue Crab Impingement Daily Collections

Blue crabs were impinged at Indian Point during 1986 from January through March and May through November (Table 4-10). A total of 5205 crabs were collected, with a total weight of 601 kg. This number of crabs was within the range of numbers impinged at Indian Point since blue crab impingement monitoring began in 1983 (821 in 1983, 348 in 1984, 12,316 in 1985). Monthly impingement rates (no./$10^6 m^3$) unadjusted for collection efficiency were calculated to facilitate comparison of blue crab impingement between units 2 and 3 (Table 4-11). During the period May through November when most crabs were collected, impingement rates were notably higher at unit 2 than unit 3. Peak rates occurred during June, July and August, and ranged from 6.5 to 15.3/$10^6 m^3$ at unit 2 and from 1.3 to 4.1/$10^6 m^3$ at unit 3.

As anticipated, few blue crabs were impinged during the first four months of 1986 (Table 4-10). Impingement abundance and total weight first began to increase in May, peaked during August, and subsequently declined to zero by December. Blue crabs undergo extensive seasonal migrations related to mating and spawning (Lippson *et al*. 1980; Williams 1965) and the pattern of impingement abundance at Indian Point probably reflects this migration. Mature male and female crabs migrate into shallow and low salinity water during spring and early summer months to mate. Juvenile crabs hatched during the previous years spawning also move upstream and into the shallows. During fall as temperatures cool, females move down river to the higher salinity waters (20-32 ppt) to spawn (Lippson *et al*. 1980), while males remain upriver in the low-salinity waters throughout the year (Williams 1965). Females can spawn 2 to 9 months after mating but most often wait until the following spring. By late fall and winter, the male and juvenile crabs in the upriver regions move offshore into deeper water where they burrow into the bottom and become inactive.

TABLE 4-10. TOTAL NUMBERS AND WEIGHTS OF BLUE CRABS IMPINGED EACH MONTH AT INDIAN POINT DURING JANUARY - DECEMBER 1986.

		JAN	FEB	MAR	APR[a]	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC[a]	TOTAL
COUNT	UNIT 2	1	0	1	0	8	150	1313	2016	809	116	16	0	4430
	UNIT 3	0	2	0	0	5	58	62	28	531	85	4	0	775
	TOTAL	1	2	1	0	13	208	1375	2044	1340	201	20	0	5205
WEIGHT (g)	UNIT 2	52	0	11	0	606	17025	106867	227347	127862	15695	1195	0	496660
	UNIT 3	0	69	0	0	644	5694	3833	2599	78886	12265	465	0	104455
	TOTAL	52	69	11	0	1250	22719	110700	229946	206748	27960	1660	0	601115

[a] No Blue crabs were impinged in April or December 1986.

TABLE 4-11. MONTHLY BLUE CRAB IMPINGEMENT RATES (MEAN COUNT PER $10^6 m^3$) AT INDIAN POINT UNITS 2 AND 3 IN 1986, UNADJUSTED FOR COLLECTION EFFICIENCY.

MONTH	UNIT 2	UNIT 3
JAN	0.0173	0.0000
FEB	NS	0.0312
MAR	0.0911	0.0000
APR	NS	0.0000
MAY	0.1099	0.0553
JUN	1.6591	0.7436
JUL	10.3920	2.5682
AUG	15.2656	1.2733
SEP	6.4838	4.0629
OCT	1.0781	0.7000
NOV	0.3298	0.0480
DEC	0.0000	0.0000

Blue crab males accounted for approximately 77% of the blue crabs impinged at the Indian Point Station in 1986 (Tables 4-12, A-12, and A-14). A ratio of 3 males to 1 female is fairly typical of blue crab populations in low salinity areas like Indian Point (Williams 1965), since mature females enter these areas only to mate and subsequently return to high salinity waters in the lower estuary to spawn, while males remain in the low salinity waters after mating for the remainder of their lives. The percentage composition of males was relatively constant each month with males most dominant in June (91.8%) and least dominant in September (70.9%; Table 4-12). The increased number and proportion of female crabs in August and September may reflect the period during which mating occurs.

Sizes of blue crabs (carapace width) are presented in Appendix Table A-13 by month and 10-mm size class. Ninety-five percent of the blue crabs collected in impingement samples ranged from 70 mm to 179 mm with a modal size of 95 mm (12.8 percent of the total crabs measured). Blue crabs impinged at units 2 and 3 increased in modal carapace width from 95 mm in July to 155 mm in September. No increase in modal carapace width was observed in October, and by November, carapace width of the few crabs collected ranged from 30 to 189 mm with no distinct size mode.

Survival averaged 73.8% for crabs subsampled for survival (Table 4-12). This was similar to the average survival rates observed in 1983 and 1985 (72%; NAI 1984a and 1986) and was within the range of monthly rates observed in 1984 (47-100%; MMES 1985). Survival increased from a low of approximately 62% in May to 85% in July, subsequently dropped to 65% in September, and leveled off at 75% in October and November. This pattern was different from past years in which survival appeared to be influenced by water and air temperatures with lowest survival rates during summer and highest rates during spring and fall.

Blue crab condition followed the same pattern as survival. The highest proportion of intact crabs occurred in July (58.4%) and the

TABLE 4-12. MONTHLY COUNTS BY SEX, SURVIVAL, AND CONDITION OF BLUE CRABS IMPINGED AT INDIAN POINT DURING JANUARY THROUGH DECEMBER 1986.

	MONTH												
	JAN	FEB	MAR	APR[a]	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC[a]	TOTAL
Sex:													
Male	0	2	1	0	11	191	1120	1569	950	152	16	0	4012
Female	1	0	0	0	2	16	254	472	388	49	4	0	1186
Undetermined	0	0	0	0	0	1	1	3	2	0	0	0	7
Total	1	2	1	0	13	208	1375	2044	1340	201	20	0	5205
Survival:													
Alive	1	2	0	0	8	134	1167	1488	874	151	15	0	3840
Dead	0	0	1	0	5	74	208	556	461	50	5	0	1365
Total	1	2	1	0	13	208	1375	2044	1340	201	20	0	5205
Condition:													
Intact	1	2	1	0	6	94	803	919	378	79	8	0	2291
Missing Parts	0	0	0	0	7	114	572	1125	962	122	12	0	2914
Total	1	2	1	0	13	208	1375	2044	1340	201	20	0	5205

[a] No blue crabs were impinged in April or December 1986.

lowest proportion in September (28.2%; Figure 4-11). Overall, the proportion of intact crabs at units 2 and 3 averaged 44.0%.

Decreasing survival and condition from the highs in July to the lows in September corresponded to an increasing size frequency of crabs from a low in July (75% at 70-120 mm) to a high in September (68% at 120-170 mm; Table A-13). Similarly, in 1985 peak survival and condition which occurred in June corresponded with a population comprised largely of juveniles (73% at 20-80 mm) while the low survival and condition which occurred in July and August corresponded to a population consisting of larger crabs (87% at 80-160 mm; NAI 1986). These trends suggest that larger crabs may be subject to greater environmental or impingement related stresses than juvenile crabs and therefore lower impingement survival rates, however, the actual relationship between size and survival/condition status is not readily apparent..

4.6.2 Blue Crab Impingement Mark and Recapture Studies

A total of 2,280 blue crabs that were impinged at units 2 and 3, were tagged and released at the unit 1 pier located between units 2 and 3 from June through November. A total of 205 tagged crabs were recaptured during the period June through November (Table A-15); 11 crabs were released and recaptured twice, and 1 crab three times (Table 4-13). In addition, one crab was recaptured once at unit 2 and once at unit 3. Accounting for double and triple recaptures, the number of unique recaptures (i.e., each crab that was impinged one or more times) totaled 44 at unit 2 and 150 at unit 3 (Table 4-13). Nearly 40% of the crabs marked and released were recaptured within the first day after release (Table 4-14) and nearly 90% were recaptured within the first week. The recapture rate was slightly faster at unit 3 than at unit 2, since 76% of the recaptured crabs were caught at unit 2 within 6 days, while more than 90% of the crabs were recaptured within 6 days at unit 3 (Table 4-14).

TABLE 4-13. ADJUSTMENT OF BLUE CRAB IMPINGEMENT DATA AT UNITS 2 AND 3 BASED ON RELEASE/RECAPTURE DATA AND 6-DAY TAG LOSS DATA.

UNIT	IMPINGE-MENT COUNT	NUMBER MARKED AND RELEASED	TOTAL NUMBER RECORDED RECAPTURES(a)	UNIQUE NUMBER RECAPTURED 2 TIMES(b)	UNIQUE NUMBER RECAPTURED 3 TIMES(c)	ADJUSTED UNIQUE RE-CAPTURES(d)	ADJUSTED FOR 6-DAY TAG LOSS(e)	PERCENT REIMPINGE-MENT(f)	IMPINGEMENT COUNT EXCLUDING RECAPTURES(g)
2	4,430	1979	46	2	0	44	45	2.0	4,363.16
3	775	301	159	7	1	150	153	6.7	741.6
2 & 3	5,205	2,280*	205	10**	1	-	-	-	5,104.8

*All crabs were released at the unit 1 pier.
**One crab was recaptured once at unit 2 and once at unit 3.

Note:
d = a - (b+2C)
e = d + 2.2%, Table 4-14.
f = e ÷ 2280
g = dead impingement count + [alive impingement count × (1-f)]

TABLE 4-14. DAYS AT LARGE, NUMBER AND CUMULATIVE PERCENT OF TAGGED BLUE CRABS RECAPTURED AT THE INDIAN POINT STATION IN 1986.

DAYS AT LARGE	UNIT 2 NUMBER RECAP-TURED	UNIT 2 CUMU-LATIVE %	UNIT 3 NUMBER RECAP-TURED	UNIT 3 CUMU-LATIVE %	UNIT 2 & 3 NUMBER RECAP-TURED	UNIT 2 & 3 CUMU-LATIVE %
0		0.0	2	1.3	2	1.0
1	16	34.8	61	40.6	77	39.3
2	5	45.7	33	61.9	38	58.2
3	6	58.7	24	77.4	30	73.1
4	2	63.0	13	85.8	15	80.6
5	4	71.7	5	89.0	9	85.1
6	2	76.1	2	90.3	4	87.1
7		76.1	4	92.9	4	89.1
8	2	80.4	2	94.2	4	91.0
9	2	84.8	2	95.5	4	93.0
10		84.8	2	96.8	1	93.5
12	1	87.0	2	98.1	3	95.0
13		87.0	1	98.7	1	95.5
14	1	89.1		98.7	1	96.0
15	1	91.3		98.7	1	96.5
20		91.3	1	99.4	1	97.0
22	2	95.7		99.4	2	98.0
25	1	97.8		99.4	1	98.5
27	1	100.0		99.4	1	99.0
33			1	100.0	1	100.0
TOTAL	46		155		201	

Note:

Four crabs were recaptured with incomplete or illegible tags, and consequently, release date and days at large are unknown.

To obtain an estimate of the percent reimpingement of blue crabs released to the river using mark and recapture data, it is necessary to have some estimate of tag loss among the crabs used in the study. Tag loss was estimated in 1986 by a laboratory tag retention study. Crabs held in aquaria retained tags through the molting process, and only four crabs shed their tags out of the 121 crabs originally tagged and held (Table 4-15). Percent tag loss increased from 0.9% within the first day to 13.8% for crabs held 25 days (Table 4-15). Since most crabs tagged and released were recaptured within the first 6 days after release (76.1% at unit 2, 90.3% at unit 3; Table 4-14) a 6-day tag loss estimate of 2.2% was applied to the recapture counts to adjust for tag loss. A time-weighted tag loss rate was not calculated since there were only 4 crabs with missing tags in the tag loss study, and only 1 crab lost a tag in each time interval (Table 4-15). Percent reimpingement, therefore, adjusted for number of unique recaptures and 6-day tag loss was 2.0% at unit 2 and 6.7% at unit 3 (Table 4-13). Using the adjusted percent reimpingement estimates, the total impingement count of blue crabs in 1986, excluding recaptures, was 4,363 crabs at unit 2 and 741 crabs at unit 3 for a total of 5,105 blue crabs at both units combined (Table 4-13). Reimpingement accounted for only 1.9% of blue crabs impinged at Indian Point in 1986.

The influence that reimpinged blue crabs had on estimates of impingement survival and condition status was evaluated by comparing data sets that included and excluded tagged, recaptured crabs (Table A-12 through A-18). Impingement survival of marked and recaptured blue crabs (51.8% males and 39.7% females; Table A-16) was lower than impingement survival for impinged blue crabs excluding recaptures (76.2% males and 70.6% females; Table A-18). The proportion of intact blue crabs was also lower among the group of marked and recaptured crabs (21.9% males and 7.4% females; Table A-16) than for the group of impinged blue crabs excluding recaptures (46.8% males and 39.5% females; Table A-18). The reduced survival and condition status of recaptured crabs is attributable to the additional mechanical and physiological stresses exerted on crabs impinged and handled more than once.

TABLE 4-15. RESULTS OF THE BLUE CRAB TAG RETENTION STUDY, 1986 INDIAN POINT IMPINGEMENT PROGRAM.

DAYS OBSERVED	NUMBER CRABS MISSING TAGS	CUMULATIVE NUMBER MISSING TAGS	NUMBER ALIVE AND RETAINING TAGS	TAG LOSS (%)
0	0	0	121	0.0
1	1	1	113	0.9
6	1	2	91	2.2
13	1	3	67	4.3
25	1	4	25	13.8

Impingement survival and condition status or recaptured blue crabs lowered the overall survival rate and condition status of total impinged crabs. This was most notable at unit 3 where total impingement counts were low and recapture rates were high. For unit 3, the proportion of alive and intact blue crabs increased by an average of 3.8% and 6.2% (sexes combined), respectively, when data for recaptured blue crabs were excluded from the analysis (Tables A-14 and A-18). Recaptured crabs had almost no influence on survival and condition status of crabs at unit 2 where total impingement counts were high and recapture rates were low (Tables A-14 and A-18). For unit 2, the proportion of alive and intact blue crabs increased by 0.0% and 0.2% (sexes combined), respectively. For both units combined, the proportion of alive and intact crabs increased by 1.1%, each, when recaptured crabs were excluded from the analysis.

4.6.3 Blue Crab Nearfield Population Estimate

The blue crab tagging program, was designed primarily to estimate blue crab reimpingement, however, the data could also be used to estimate the blue crab population size in the vicinity of the Indian Point Station using a mark-recapture estimator, if the data satisfied the assumptions of the estimator. The Schumacher-Eschmeyer regression technique, the Schnabel method, and the modified Schnabel method were first examined because they are simple, closed population, multiple census estimators which permit tagging and recapture efforts to occur concurrently and under certain circumstances may be used for migratory populations.

Assumptions which must be satisfied to estimate the blue crab population in the vicinity of Indian Point units 2 and 3 using the Schumacher-Eschmeyer method or any of the above methods (Cormack 1968; Ricker 1975; MMES 1986) were:

1) tagged blue crabs suffer the same mortality as untagged blue crabs,

2) tagging does not affect blue crab catchability,

3) tagged blue crabs do not lose their marks,

4) all tags are recognized and reported,

5) natural tagging does not occur or is recognizable,

6) immigration and/or emigration is negligible in the study area i.e., the population is closed, and

7) tagged blue crabs are randomly distributed among untagged blue crabs or the distribution of fishing effort is proportional to the abundance of blue crabs.

With regard to assumption 1, no quantitative information is available to compare mortality rates for tagged blue crabs with untagged blue crabs. Both the tag retention study and the recapture study did not provide control data needed to distinguish mortality due to tagging from mortality due to holding or multiple impingement. However, it is reasonable to assume that tagged crabs had a higher mortality rate than untagged crabs. Reimpinged, tagged crabs had a higher morality rate and fewer of these crabs were intact when compared with untagged, impinged crabs (Section 4.6.2). While most of the mortality and physical damage of reimpinged, tagged crabs was probably due to the impingement process, the fact that reimpinged, tagged crabs suffered higher mortality and a smaller percentage were intact may indicate the tagging process puts these crabs at a physiological disadvantage and makes them more vulnerable to physical damage and mortality. To fully evaluate tagging mortality, it would be necessary to hold both tagged and untagged crabs in aquaria under similar conditions.

Assumption 2, that tagging does not affect blue crab catchability, may have been violated. There is evidence (further discussed in the evaluation of assumption 7) that tagged crabs may have behaved differently from untagged crabs, particularly in the late summer-early fall period. This may be due to the release location of impinged crabs at the unit 1 pier between units 2 and 3, which apparently exposes these crabs to reimpingement at unit 3 as they disperse predominantly in a downriver direction.

The assumption that blue crabs do not lose their tags (Assumption 3) was evaluated in a laboratory holding experiment. As described in Section 4.6.2, a 6-day, blue crab tag shedding rate of 2.2% would be applied to any population estimate.

Assumption 4, the recognition and reporting of tags, was addressed by the Standard Operating Procedures and QA/QC procedures reviewed by Con Edison (NAI 1987). Since this program provided marking and recapture efforts, non-reporting of tags did not occur. The high visibility of the tags is attested to by the return of at least one blue crab tag by a recreational fisherman to the Hudson River Foundation as part of the 1985-86 Hudson River Striped Bass Tag Return Program (J. Waldman, pers. comm. 1987).

Assumption 5 was satisfied because the marking technique, insertion of an external tag, could not be imitated by natural conditions.

Immigration and emigration (Assumption 6) was substantial over the five month period that blue crabs were common in impingement collections at Indian Point units 2 and 3. Blue crabs are migratory in the Hudson River (see Section 4.6.1) and move into shallow, low salinity waters during the spring and early summer. As water temperatures cool in the fall, females crabs return to high salinity waters while males remain in the low salinity waters. This migration may be reflected in Table 4-16 and Figure 4-16 where recapture proportions (R/C) are variable but generally increased over the six month period. Recapture

TABLE 4-16. RECAPTURE OF TAGGED BLUE CRABS CROSS-CLASSIFIED BY RELEASE AND RECAPTURE MONTH FOR BLUE CRABS TAGGED AT INDIAN POINT NUCLEAR GENERATING STATION UNITS 2 AND 3, 22 JUNE THROUGH THE WEEK OF 23 NOVEMBER 1986.

RELEASE MONTH	NUMBER MARKED (M)	STA-TISTIC	JUNE C = 52	JULY C = 644	AUGUST C = 1223	SEPTEMBER C = 787	OCTOBER C = 173	NOVEMBER C = 9	TOTAL 2888
JUNE	7	R	1						1
		R/M	0.1429						0.1429
		R/C	0.0192						
JULY	492	R		8	6				14
		R/M		0.0163	0.0122				0.0285
		R/C		0.0124	0.0049				
AUGUST	921	R			22	3			25
		R/M			0.0239	0.0033			0.0271
		R/C			0.0180	0.0038			
SEPTEMBER	714	R				141	7		148
		R/M				0.1975	0.0098		0.2073
		R/C				0.1792	0.0405		
OCTOBER	139	R					20	2	22
		R/M					0.1439	0.0144	0.1583
		R/C					0.1156	0.2222	
NOVEMBER	7	R						0	0
		R/M						0.0000	0.0000
		R/C						0.0000	
TOTAL	2280	R	1	8	28	144	27	2	210
		R/C	0.0192	0.0124	0.0229	0.1830	0.1561	0.2222	0.0727

LEGEND:
R = number of blue crabs recaptured
M = number of blue crabs ≥ 100 mm TL marked and released
C = number of blue crabs ≥ 100 mm TL caught and examined for tags
R/M = recapture rate
R/C = recapture proportion

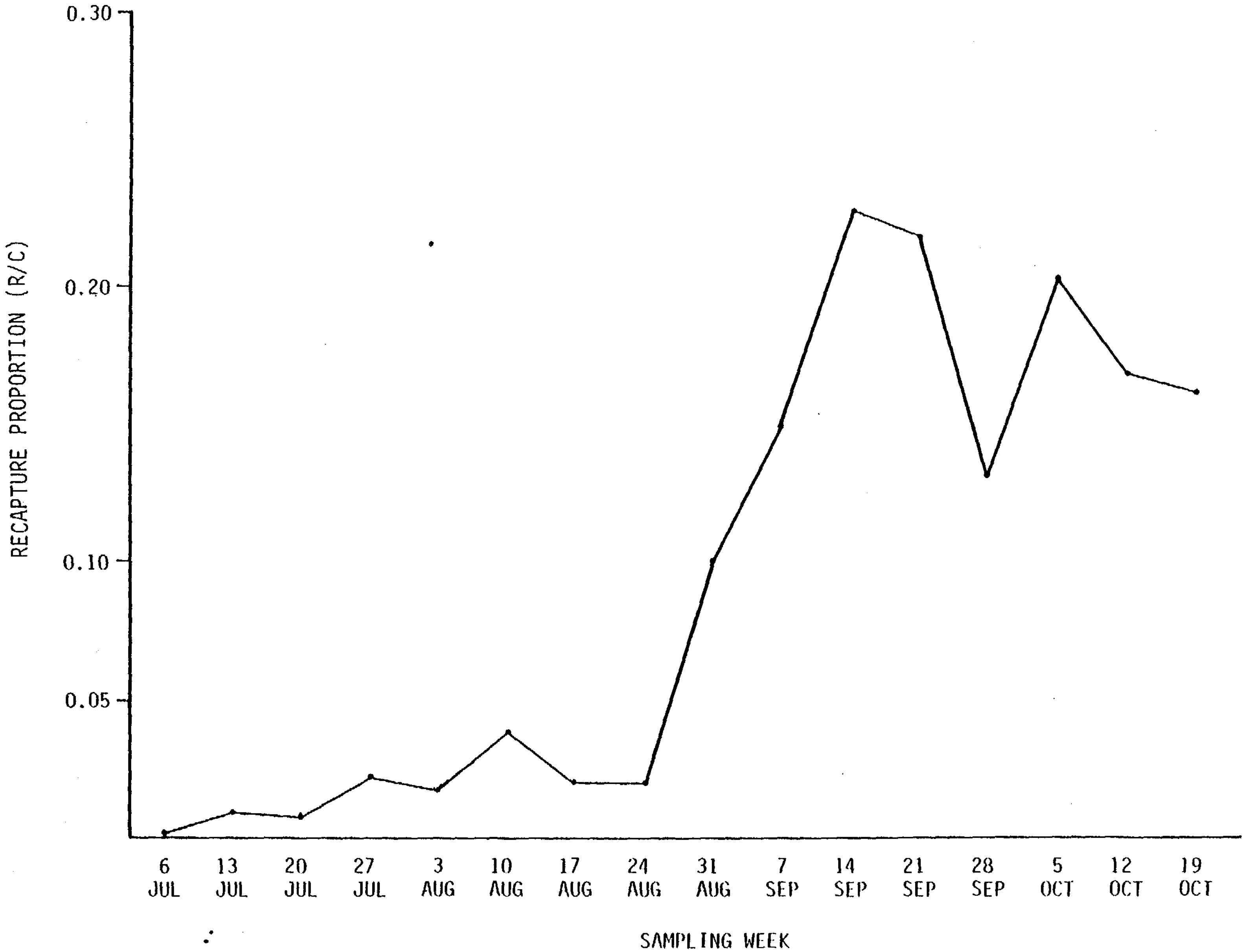


Figure 4-16. Weekly recapture proportions (R/C) for blue crabs marked and released from Indian Point Units 2 and

proportions (R/C) are the ratio of the sum of all previously tagged and released blue crabs that were recaptured in week i to the number of crabs that were caught and examined for tags in week i. A trend of increasing recapture proportions with time may indicate 1) a decreasing number of crabs were caught and examined for tags (i.e., the denominator C decreases relative to the numerator R), 2) an increase in the number of recaptured crabs due to their accumulation in the nearfield area (i.e., the numerator R increases relative to the denominator C), or 3) the number of recaptured crabs increases and the catch of blue crabs decreases (i.e., the numerator R increases and the denominator C decreases). Crab impingement counts generally decreased from early August through November at unit 2, however counts at unit 3 increased in September from relatively low numbers during the early summer and late fall (Table 4-17). The number of blue crabs recaptured at unit 3 also increased during September and recaptured crabs contributed nearly half (49%) of the blue crabs impinged at unit 3 during that month. The disproportionate increase in the number of blue crabs recaptured at unit 3 during September coupled with the decrease in impingement of blue crabs at unit 2 during late August and September resulted in the overall increase in weekly recapture proportions when counts from both units were combined (Figure 4-16). It is also possible that tagged crabs are not emigrating at the same rate as the untagged population which contributed to the increased number of blue crabs recaptured at unit 3 in late August through early October. In the summer (June-early August), blue crabs may be migrating through the Indian Point Station nearfield area. Tagged crabs would mingle with untagged, migratory crabs keeping the overall recapture proportion low. Relatively few tagged crabs appeared to remain in the Indian Point nearfield area beyond 6 days (Table 4-13) which further suggests tagged crabs are migrating out of the study area. The increase in recapture proportions during late August through early October suggests the migration rate of tagged blue crabs has slowed, exposing proportionally more tagged crabs to impingement. Higher recapture proportions for unit 3 during the fall also suggests that the predominant direction of migration may be

TABLE 4-17. NUMBER OF BLUE CRABS RECAPTURED (R), CAUGHT AND EXAMINED FOR TAGS (C), AND RECAPTURE PROPORTIONS (R/C) BY RECAPTURE WEEK FOR BLUE CRABS TAGGED AT INDIAN POINT NUCLEAR GENERATING STATION UNITS 2 AND 3, 22 JUNE THROUGH THE WEEK OF 23 NOVEMBER 1986.

RECAPTURE WEEK	UNIT 2			UNIT 3		
	R	C	R/C	R	C	R/C
22 JUN	0	43	0.0000	1	9	0.1111
29 JUN	0	29	0.0000	0	4	0.0000
06 JUL	0	57	0.0000	0	0	0.0000
13 JUL	1	87	0.0115	0	2	0.0000
20 JUL	1	194	0.0052	0	5	0.0000
27 JUL	3	253	0.0119	3	13	0.2308
3 AUG	6	378	0.0159	0	2	0.0000
10 AUG	8	259	0.0309	2	3	0.6667
17 AUG	7	379	0.0186	1	3	0.3333
24 AUG	1	196	0.0051	3	3	1.0000
31 AUG	5	103	0.0485	7	10	0.7000
7 SEP	1	120	0.0083	25	57	0.4386
14 SEP	3	169	0.0176	59	117	0.5043
21 SEP	2	125	0.0160	42	86	0.4883
28 SEP	7	64	0.1094	4	12	0.3333
5 OCT	0	23	0.0000	7	17	0.4118
12 OCT	1	7	0.0435	2	11	0.1818
19 OCT	1	11	0.0909	4	20	0.2000
26 OCT	0	3	0.0000	1	5	0.2000
2 NOV	0	2	0.0000	2	2	1.0000
9 NOV	0	3	0.0000	0	1	0.0000
16 NOV	0	0	0.0000	0	0	0.0000
23 NOV	0	1	0.0000	0	0	0.0000
ALL WEEKS	47	2506	0.0196	163*	382	0.4372

downriver at that time, which agrees with migratory pattern described in Section 4.6.1. For these reasons, assumption 6 may be violated and a population estimate is not possible for the period blue crabs were abundant in the vicinity of Indian Point Station.

Assumption 7, that tagged blue crabs are randomly distributed among untagged crabs, or that the distribution of fishing effort is proportional to the abundance of blue crabs, also appears to be violated. Tagged blue crabs do not appear to be randomly distributed among the total crab population in the vicinity of Indian Point units 2 and 3, but were generally more abundant in the impingement collections at unit 3 (Table 4-17). The total number of recaptured crabs and recapture proportions (R/C) were greater at unit 3 although the number of crabs caught was greater at unit 2 (Table 4-17). Unit 3, therefore, recaptured a greater proportion of tagged crabs than would be expected if tagged crabs were randomly mixed with untagged crabs. Additionally, fishing effort is most likely independent of blue crab abundance, and is probably directly related to the duration of operation of the cooling water intake screens units 2 and 3.

Sexual differences in the migratory patterns of blue crabs in the Hudson River, and the apparent non-random mixing of tagged crabs with the rest of the blue crab population in the vicinity of Indian Point units 2 and 3 invalidate the use of closed population mark-recapture techniques to estimate population size. It may be possible in subsequent years to develop an estimate of blue crab populations based on a period of time during which the blue crab population may appear closed. The only equivalent relative index of blue crab population is the number of crabs impinged at units 2 and 3. However this index is highly dependent on plant operation and would be greatly affected by outages during periods of high blue crab abundance. For a mark-recapture population index to be useful, it should be for the same period of time each year and would provide a relative estimate of the blue crab population that would be independent of plant operation.

The use of "open" population estimators may overcome the difficulty in making a population estimate that the migratory life style of the blue crab imposes. An "open" population estimator such as the Jolly-Seber, Manly-Parr, and Parker methods can be used on a population that is undergoing either emigration or immigration (MMES 1986). However, these methods require that all crabs have the same probability of being reimpinged, or marked crabs are randomly distributed in the total population. Since these assumptions appear to be violated, it does not appear that "open" population estimators can be used to estimate crab populations at Indian Point units 2 and 3.

5.0 ANALYSIS OF FRESH VS PRESERVED SIZE MEASUREMENTS

The effect of formalin preservation on size measurements of abundant juvenile fishes was analyzed to determine whether tissue "shrinkage" caused by the preservative might affect comparison between entrainment (preserved) and impingement (unpreserved) measurements. Length, weight and body depth were measured on 121 Atlantic tomcod and 19 weakfish immediately following collections and at least 30 days after initial preservation in 10% formalin. Linear regression analysis was used to describe the relationship between paired fresh and preserved measurements of fish length, weight, and body depth data (Appendix Table A-20 and Figures 5-1 through 5-6). In every case the linear model showed a highly significant (0.0001 significance level) positive correlation ($r^2 = 0.67\text{-}1.00$) between the independent variable (fresh) and response variable (preserved). This correlation was notably stronger for Atlantic tomcod measurements ($r^2 = 0.92\text{-}1.00$) than for weakfish measurements ($r^2 = 0.67\text{-}0.99$).

Figures 5-1 through 5-6 show the correspondence between the regression line ($Y = a + b(X)$; where a = intercept and b = slope) and a reference plot of fresh equals preserved measurements ($Y = X$; intercept = 0, slope = 1). A t-test was performed for each relationship of fresh and preserved measurements to determine if the regression line established by the regression model differed significantly ($\alpha = 0.05$) from the reference line in intercept and slope. Regression lines for preserved and fresh length measurements of Atlantic tomcod and all preserved and fresh size measurements for weakfish did not differ significantly from the reference line (Table 5-1). Thus for these species and size parameters, preservation in 10% formalin did not significantly affect the size measurements after 30 days.

For preserved and fresh depth measurements of Atlantic tomcod, the regression line was found to vary significantly from the reference line in both its intercept and slope (Table 5-1 and Figure 5-1). The

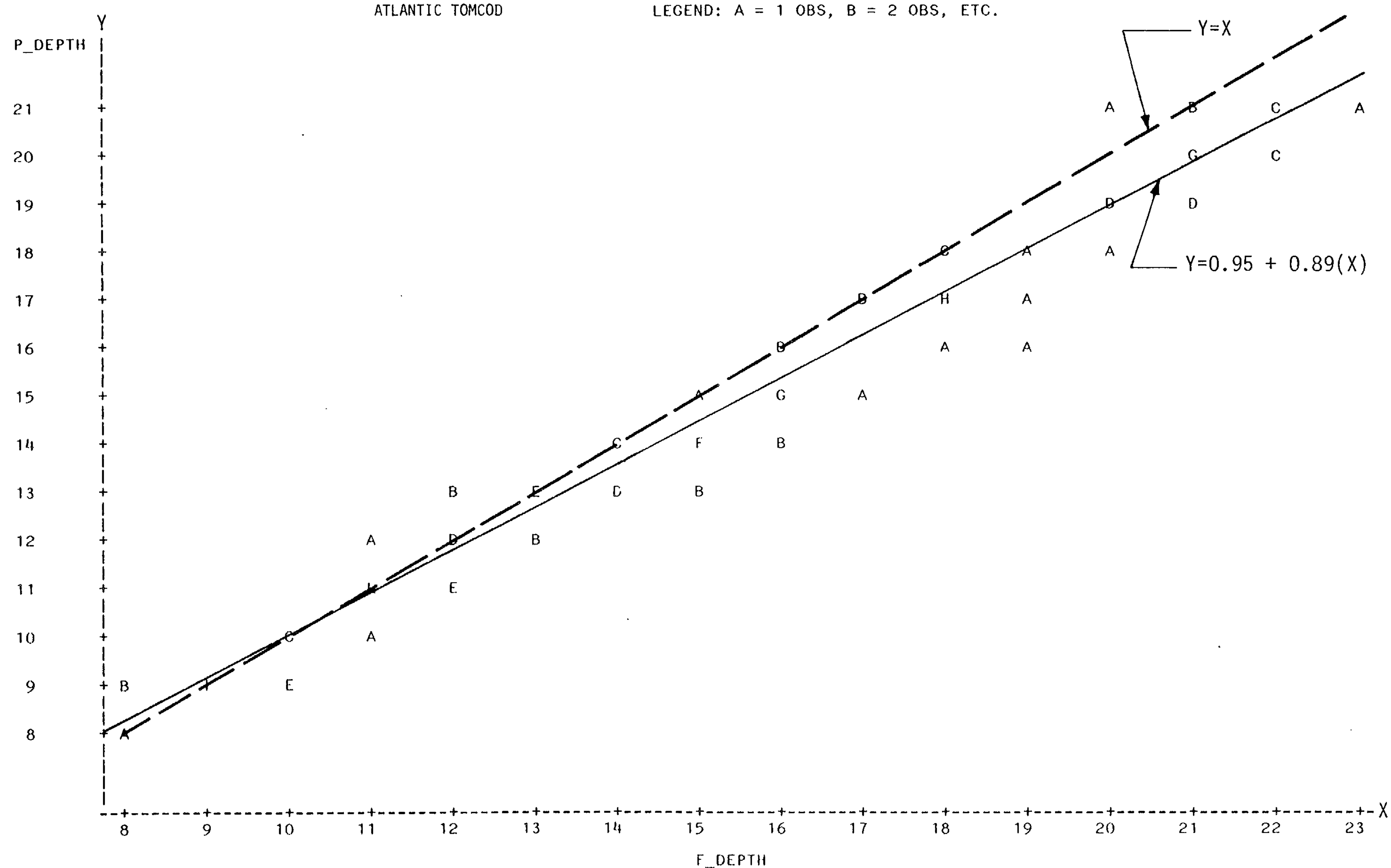


Figure 5-1. Preserved body depth (mm) as a function of fresh body depth (mm) for Atlantic tomcod obtained from the 1986 Indian Point Station Impingement Program.

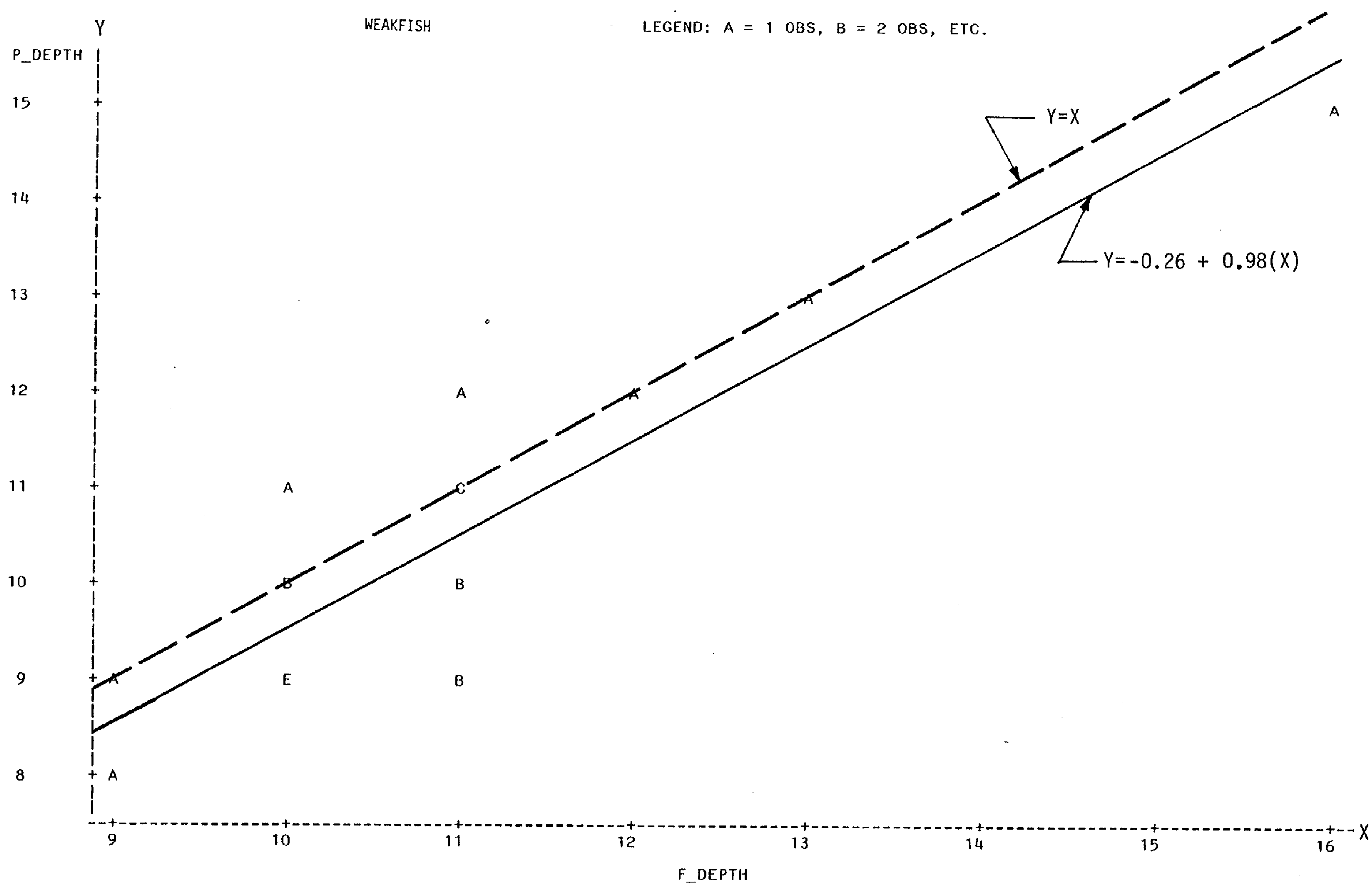


Figure 5-2. Preserved body depth (mm) as a function of fresh body depth (mm) for weakfish obtained from the 1986 Indian Point Station Impingement Program.

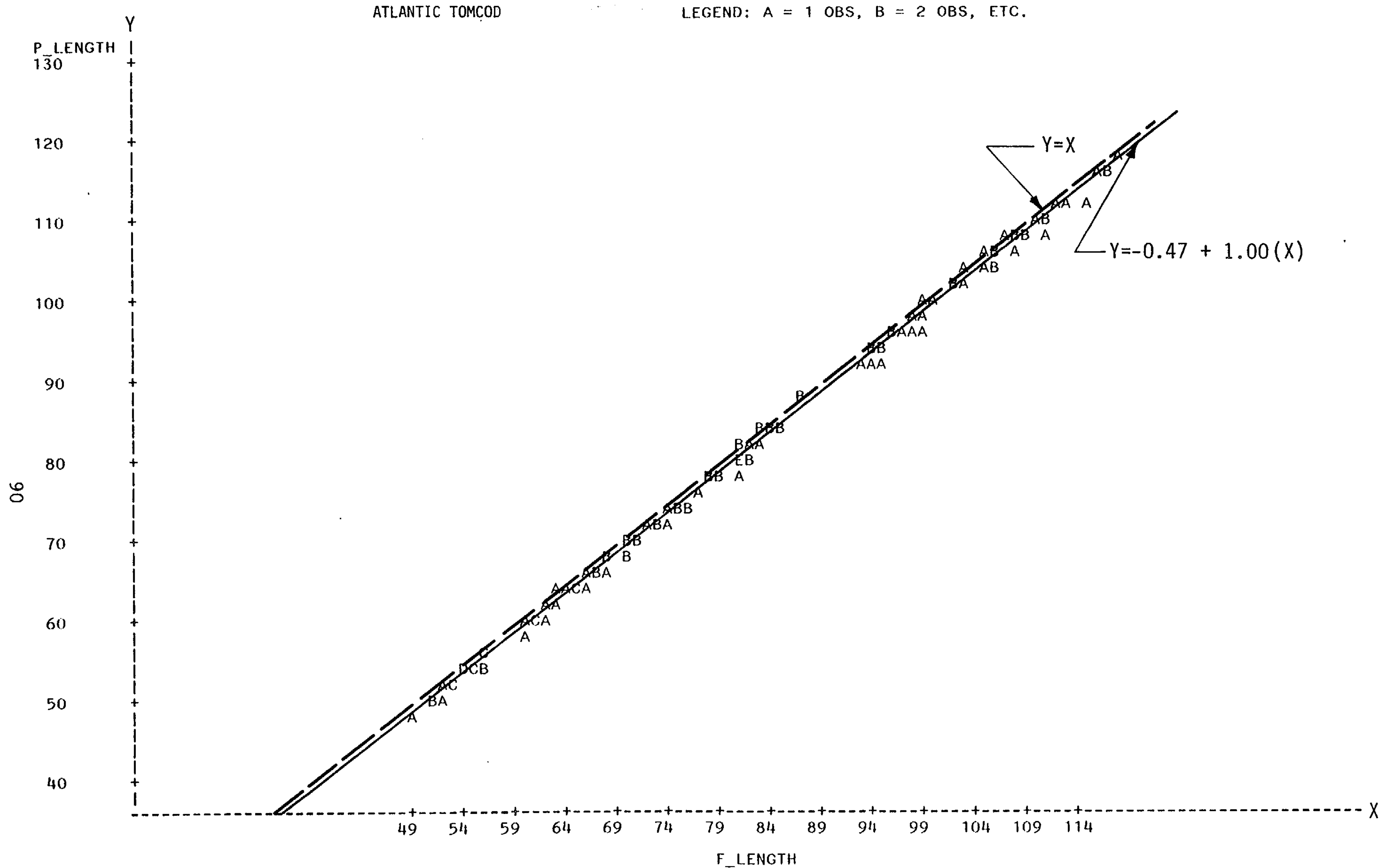


Figure 5-3. Preserved length (mm) as a function of fresh length (mm) for Atlantic tomcod obtained from the 1986 Indian Point Station Impingement Program.

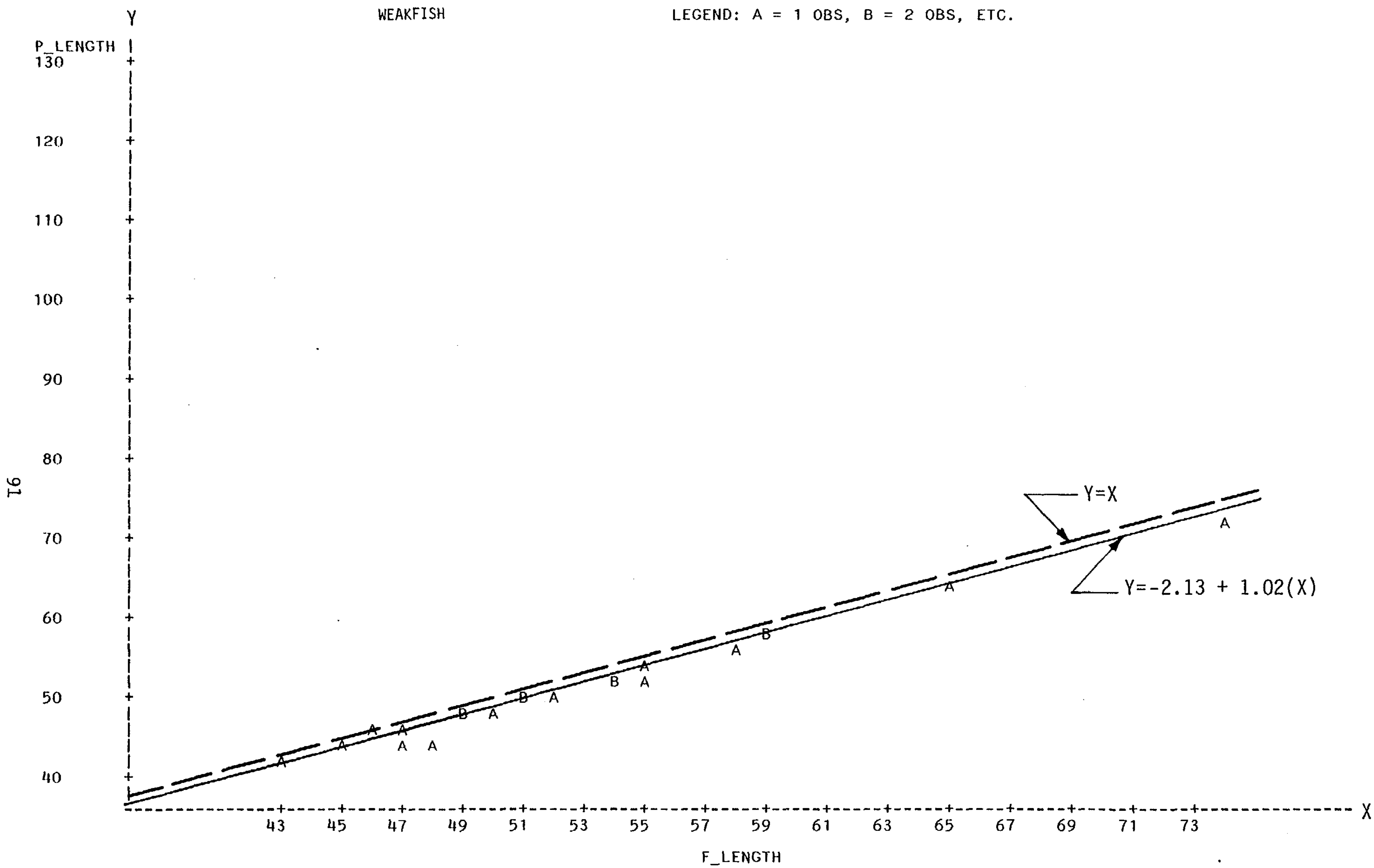


Figure 5-4. Preserved length (mm) as a function of fresh length (mm) for weakfish obtained from the 1986 Indian Point Station Impingement Program.

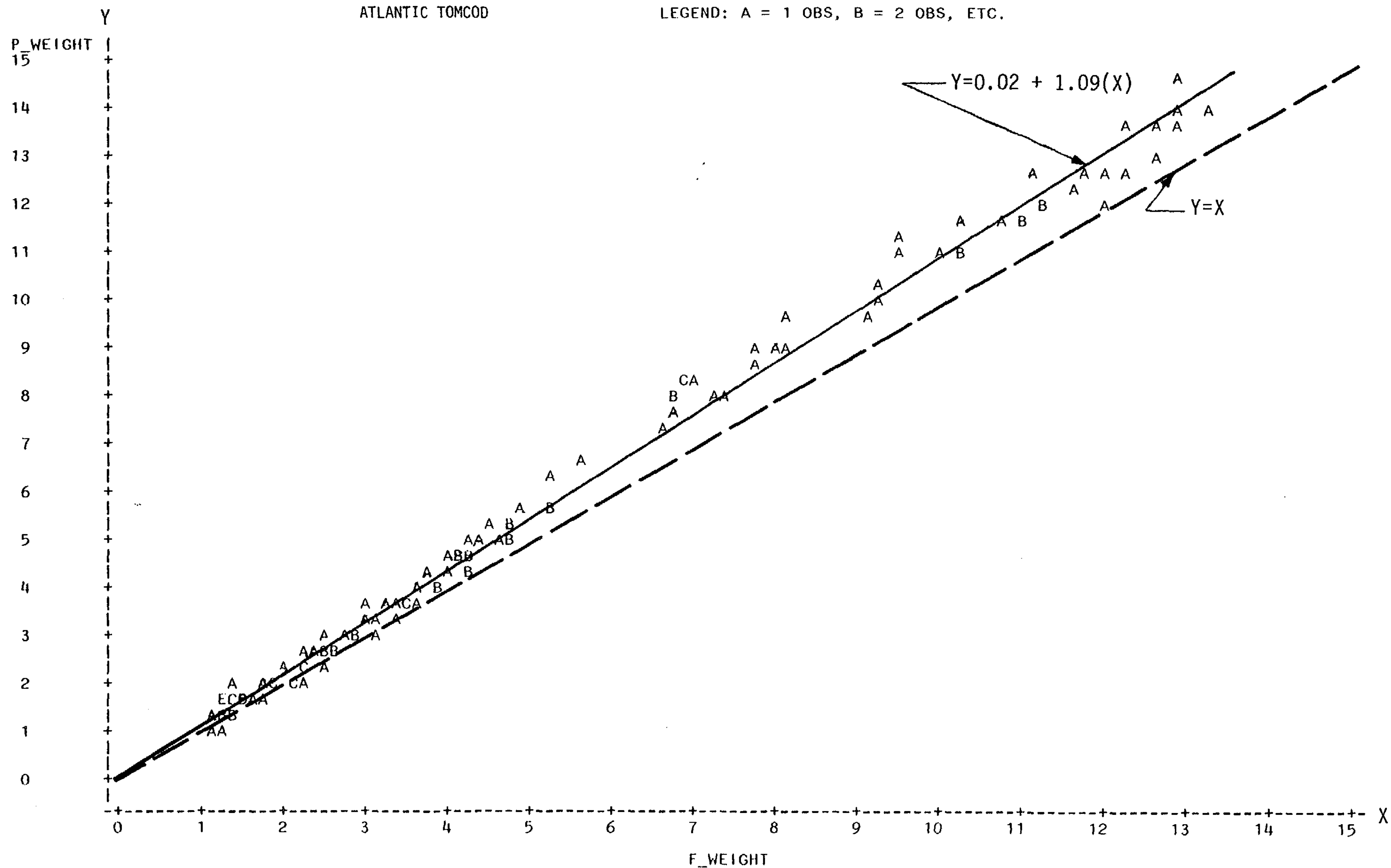


Figure 5-5. Preserved weight (gm) as a function of fresh weight (gm) for Atlantic tomcod obtained from the 1986 Indian Point Station Impingement Program.

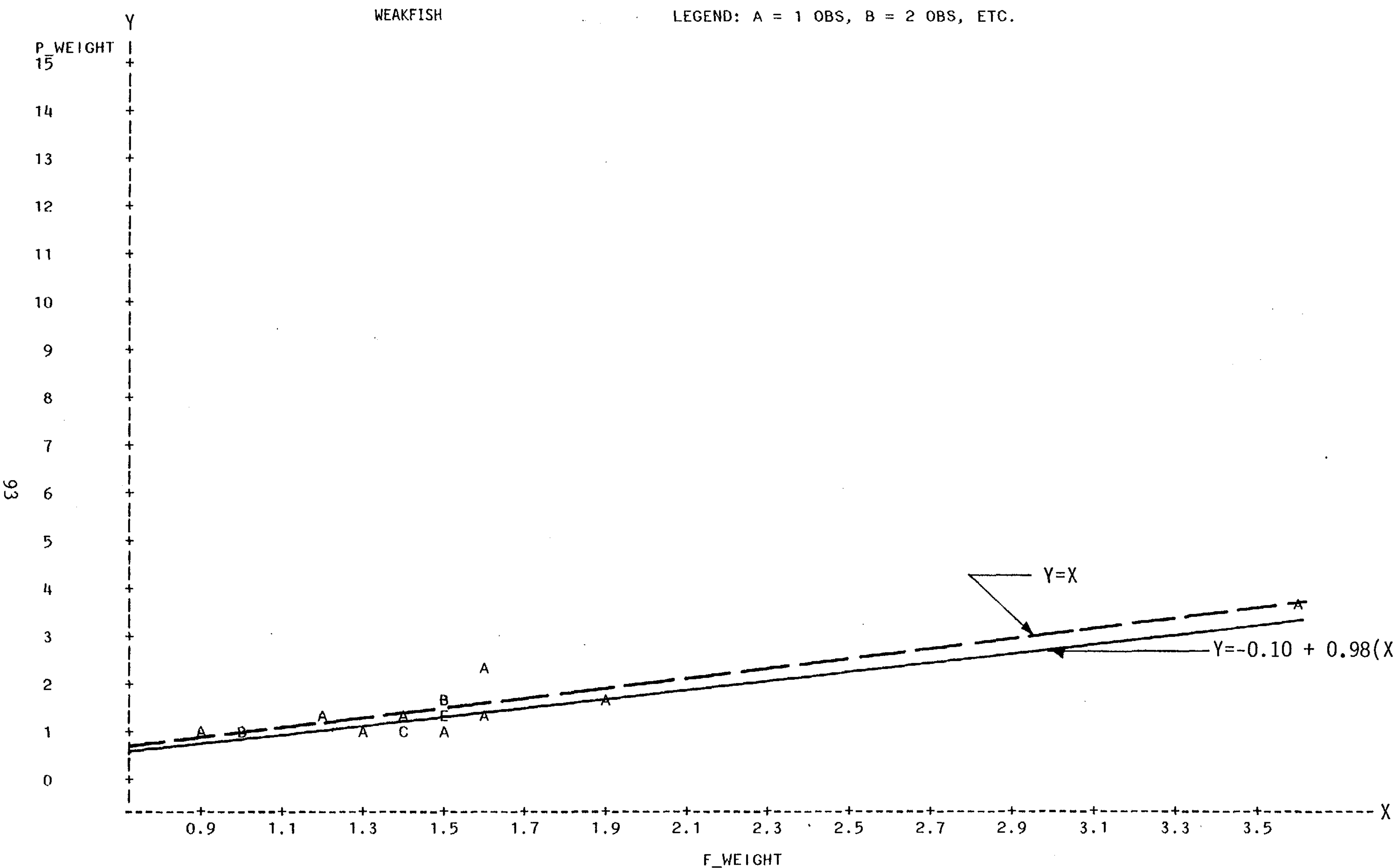


Figure 5-6. Preserved weight (gm) as a function of fresh weight (gm) for weakfish obtained from the 1986 Indian Point Station Impingement Program.

TABLE 5-1. RESULTS OF A t-TEST OF THE HYPOTHESIS THAT THE REGRESSION LINE FOR GROUPS OF PRESERVED (P) AND FRESH (F) SIZE MEASUREMENTS HAS AN INTERCEPT OF 0 AND A SLOPE OF 1.

TAXON	VARIABLES	NO. FISH	T FOR HO: A) Intercept=0 B) Slope=1	SIGNIFICANCE (α=0.05)
Atlantic tomcod	Depth P vs F	119	A) 4.38	S
			B) -7.73	S
	Length P vs F	121	A) -1.49	NS
			B) 0.00	NS
	Weight P vs F	121	A) 0.28	NS
			B) 10.82	S
Weakfish	Depth P vs F	19	A) -0.19	NS
			B) -0.20	NS
	Length P vs F	19	A) -1.46	NS
			B) 0.65	NS
	Weight P vs F	19	A) -0.51	NS
			B) -0.13	NS

S = Significant
NS = Not significant

regression line for weight measurements of Atlantic tomcod was also found to vary significantly from the reference line in slope but not in intercept (Table 5-1, Figure 5-5). These results indicate that both body depth and weight of Atlantic tomcod may be affected by preservation and may vary from the fresh values after a period of 30 days. Based on the percent bias between the regression line and reference line, the effect of preservation on tomcod body depth was found to be small (1.5% or less) for fish 8 to 10 mm in body depth but increasingly larger for deeper bodied fish (6.9% for fish 23 mm in body depth). This trend of increasing bias between preserved and fresh depth measurements is apparent in the regression and reference lines of Figure 5-1 which intersect at the low end of the depth measurements and subsequently diverge. The divergence of the regression line below the reference line illustrates that body depth was reduced by preservation. The bias in preserved weight of tomcod was more consistent throughout the range of weights measured and ranged from 11.0% for 1 gram fish to 9.1% for 15 gram fish. The divergence of the regression line above the reference line illustrates that weight was increased by preservation.

6.0 LITERATURE CITED

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull. Fish Wildl. Serv. 53(74):1-577.

Consolidated Edison Company of New York, Inc. 1977. Nearfield effects of once-through cooling systems operation on Hudson River biota. Indian Point Units No. 2 and No. 3.

___________. 1982a. Hudson River ecological study in the area of Indian Point. 1980 Annual Report. Consolidated Edison Co. of New York, Inc., Power Authority of the State of New York.

___________. 1982b. Hudson River ecological study in the area of Indian Point. 1981 Annual Report. Consolidated Edison Co. of New York, Inc., Power Authority of the State of New York.

___________. 1983. Hudson River ecological study in the area of Indian Point. 1982 Annual Report. Consolidated Edison Co. of New York, Inc., New York Power Authority.

Cormack, R.M. 1968. The statistics of capture-recapture methods. Oceanogr. Mar. Biol. Ann. Rev., 1968(6):455-506.

Lippson, A.J., M.S. Haire, A.F. Holland, F. Jacobs, J. Jensen, R.L. Moran-Johnson, T.T. Polgar, and W.A. Richkus. 1980. Environmental atlas of the Potomac estuary. Environmental Center, Martin Marrietta Corp., Baltimore, MD. 280 pp.

Martin Marrietta Environmental Systems (MMES) 1985. Hudson River ecological study in the area of Indian Point. 1984 Annual Report. Prepared for Consolidated Edison Company of New York and New York Power Authority.

___________. 1986. An overall study design for a hatchery evaluation and population assessment for Hudson River striped bass. Prepared for New York Power Authority.

McFadden, J.T., Texas Instruments Incorporated, and Lawler, Matusky & Skelly Engineers. 1978. Influence of the proposed Cornwall pumped storage project and steam electric generating plants on the Hudson River estuary with emphasis on striped bass and other fish populations, revised. Prepared for Consolidated Edison Company of New York, Inc.

Normandeau Associates, Inc. (NAI). 1984a. Hudson River ecological study in the area of Indian Point. 1983 Annual Report. Prepared for Consolidated Edison Company of New York, Inc. and New York Power Authority.

___________. 1984b. Precision and accuracy of stratified sampling to estimate fish impingement at Indian Point unit No. 2 and unit No. 3. Prepared for Consolidated Edison Company of New York, Inc. and New York Power Authority.

___________. 1985. 1983 Year Class Report for the Hudson River Estuary Monitoring Program. Prepared for Consolidated Edison Company of New York, Inc.

___________. 1986. Hudson River ecological study in the area of Indian Point. 1985 Annual Report. Prepared for Consolidated Edison Company of New York, Inc. and New York Power Authority.

___________. 1987. Standard operating procedures for 1986 Indian Point Station Daily Impingement Sampling Program. Prepared for Consolidated Edison Company of New York, Inc.

Perry, W.G., Jr. and J.W. Avault, Jr. 1968. Preliminary experiment on the culture of blue, channel and white catfish in brackish water ponds. Proc. Ann. Conf. S.E. Assoc. Game Fish Comm. 22:397-406.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. Bulletin 191, 382 pp.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. 4th ed. Amer. Fish. Soc. Special Pub. 12. 174 pp.

Smith, C.L. 1985. The Inland Fishes of New York State. Sponsored and Published by the New York State Department of Environmental Conservation.

Texas Instruments Incorporated. 1973. Hudson River ecological study in the area of Indian Point. First Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

___________. 1974. Indian Point impingement study report for the period 15 June 1972 through 31 December 1973. Prepared for Consolidated Edison Company of New York, Inc.

___________. 1975. Hudson River ecological study in the area of Indian Point. 1974 Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

___________. 1976. Hudson River ecological study in the area of Indian Point. 1975 Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

____________. 1977. Hudson River ecological study in the area of Indian Point. 1976 Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

____________. 1979. Hudson River ecological study in the area of Indian Point. 1977 Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

____________. 1980a. Hudson River ecological study in the area of Indian Point. 1978 Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

____________. 1980b. Hudson River ecological study in the area of Indian Point. 1979 Annual Report. Prepared for Consolidated Edison Company of New York, Inc.

____________. 1981. 1979 year class report for the multiplant impact study of the Hudson River estuary. Prepared for Consolidated Edison Company of New York, Inc.

Williams, A.B. 1965. Marine decapod crustaceans of the Carolinas. Fish. Bull. Fish Wildl. Serv. 65(1):168-172.

APPENDIX A

DATA CALCULATION PROCEDURES

Impingement data were collected separately at intake screens 21-25, 26 and 31-36. In order to provide standard, unit-wide sample data for unit 2, impingement data from screens 21-25 and 26 were combined within each sample day. The impingement statistics calculated from unit 2 and 3 1986 data are:

- Number of fish impinged on each sampling day at each unit (Equation 1)
- Total number of fish impinged over the whole year (Equation 2)
- Standard error of the total estimated number of fish impinged (Equation 3) and the coefficient of variation (Equation 4)
- Total estimated weight of fish impinged in each stratum and at each unit (Equation 5)
- Mean daily fish impingement rates standardized to the volume of water sampled (Equation 6)
- Mean daily blue crab impingment rates standardized to the volume of water sampled (Equation 7)

An analysis of fresh and preserved fish length, weight and body depth was performed on Length Class 1 Atlantic tomcod and weakfish collected in impingement collections from late March through mid-August 1986. Data were tested to determine if differences existed between fresh and preserved measurements using a one-way analysis of variance and Duncan's Multiple Range Test. Paired size data were then compared using Linear Regression Analyses to determine the relationship between these data.

<u>Calculations</u>

To estimate the number of fish actually impinged on a sampling day, the count from that day's impingement collection was divided by the corresponding collection efficiency (Equation 1):

$$Y_{im} = \sum_{L=1}^{4} C_{Lim}/E_{im} \qquad \text{(Equation 1)}$$

where Y_{im} = estimated number of fish impinged on day i at unit m,

C_{Lim} = count for length class L on day i at unit m, and

E_{im} = collection efficiency estimate for day i at unit m (calculated as shown in Section 3.2).

Within each seasonal stratum (h), a mean ($\bar{Y}_{hm}$) and a variance (S^2_{hm}) were calculated for the n_{hm} values of the daily estimate Y_{im} (where n_{hm} = the number of sampling days in stratum h at unit m). The total number of fish impinged over the whole year was estimated by Equation 2:

$$T_m = \sum_{h=1}^{4} N_{hm} \bar{Y}_{hm} \qquad \text{(Equation 2)}$$

where T_m = total estimated number of fish impinged at unit m,

N_{hm} = number of days in stratum h that unit m operated (a unit was considered to be operating if any circulating water was being pumped), and

$\bar{Y}_{hm}$ = mean daily estimate for stratum h at unit m.

This estimate of the total number of fish impinged (T_m) is equivalent to the number which would result from generating an annual estimate from each of the daily estimates and then averaging them using the appropriate stratified sampling formula. Therefore its standard error can be calculated from the within-stratum variances as a measure of the estimate's precision (Equation 3):

$$S.E._m = \sqrt{\left(\sum_{h=1}^{4} N_{hm} (N_{hm} - n_{hm})/n_{hm}\right) S^2_{hm}} \qquad \text{(Equation 3)}$$

where $S.E._m$ = standard error of the total estimated number of fish impinged at unit m, and

N_{hm}, n_{hm}, S^2_{hm} = as defined on the previous page.

The stratified mean daily impingement estimate and standard error of the stratified mean can be calculated by dividing T_m or $S.E._m$ by the total number of operating days at Unit m. The coefficient of variation was calculated to relate the precision to the total estimate (Equation 4):

$$C.V. = \frac{S.E._m}{T_{hm}} \times 100\% \qquad \text{(Equation 4)}$$

where C.V. = coefficient of variation,

$S.E._m$ = as defined above, and

T_{hm} = estimated number of fish impinged in stratum h at unit m.

The total weight of fish impinged for each stratum was estimated using Equation 5:

$$W_{hm} = \left(w_{hm} / \sum_{L=1}^{4} C_{Lhm}\right) \bar{Y}_{hm} N_{hm} \qquad \text{(Equation 5)}$$

where W_{hm} = total estimated weight of fish impinged in stratum h at unit m,

w_{hm} = total weight of fish actually collected in stratum h at unit m,

C_{Lhm} = total count of fish actually collected in length class L in stratum h at unit m, and N_{hm}, Y_{hm} = as defined above.

Mean daily impingement rates were calculated by standardizing the daily impingement estimates (adjusted for collection efficiency) by dividing by each sample day's circulating water volume:

$$A_{km} = 1/n_{km} \sum_{i=1}^{n_{km}} \left[\left(\sum_{L=1}^{4} C_{Likm}/E_{ikm}\right) / V_{ikm}\right] \qquad \text{(Equation 6)}$$

Mean daily impingement rates standardized to the volume of water sampled were calculated by summing within each month the quotient of the adjusted daily impingement estimate divided by the corresponding volume of circulating water sampled and dividing this sum by the total number of sample days.

where A_{km} = Mean daily adjusted impingement rate for month k at unit m,

n_{km} = number of sampling days in month k at unit m,

C_{Likm} = count for length class L on day i of month k at unit m,

V_{ikm} = volume of circulating water sampled on day i of month k at unit m, and

E_{ikm} = collection efficiency on day i of month k at unit m.

Mean daily impingement rates unadjusted for collection efficiency were calculated for blue crabs by summing within each month the quotient of the daily count divided by the daily sampling volume and dividing this sum by the number of plant operating days:

$$A_{km} = 1/n_{km} \sum_{i=1}^{n_{km}} (C_{ikm}/V_{ikm}) \qquad \text{(Equation 7)}$$

where

A_{km} = mean daily unadjusted impingement rate for month k at unit m,

n_{km} = number of plant operating days in month k at unit m,

C_{ikm} = count of blue crabs on day i of month k at unit m, and

V_{ikm} = volume of circulating water sampled on day i of month k at unit m.

The number of operating days was used rather than the number of sample days since a blue crab sample day was defined as any day that the plant operated. Collection efficiency data were not available for blue crabs impinged at the Indian Point Station consequently, blue crab impingement rates were not adjusted.

TABLE A-1
DAILY INTAKE TEMPERATURE (DEGREES CELSIUS)
AT THE INDIAN POINT GENERATING STATION DURING 1986

DATE	UNIT 2	UNIT 3	MEAN	DATE	UNIT 2	UNIT 3	MEAN
02JAN86	2.00	2.00	2.00	16APR86		12.00	12.00
04JAN86		2.50	2.50	17APR86		13.00	13.00
07JAN86	2.20		2.20	20APR86		10.50	10.50
09JAN86	2.00	2.00	2.00	22APR86		10.00	10.00
10JAN86	2.00	2.10	2.05	25APR86		10.00	10.00
11JAN86	2.00		2.00	29APR86		11.00	11.00
12JAN86	2.40		2.40	03MAY86	11.50	11.50	11.50
13JAN86	3.00		3.00	24MAY86		18.50	18.50
14JAN86	2.50	3.00	2.75	31MAY86	21.00		21.00
15JAN86	1.00	1.00	1.00	06JUN86	22.00		22.00
16JAN86		1.50	1.50	08JUN86	21.90		21.90
22JAN86		2.50	2.50	09JUN86	23.00	24.00	23.50
25JAN86		2.00	2.00	10JUN86	22.00	22.00	22.00
28JAN86		3.00	3.00	10JUN86	22.00	22.00	22.00
29JAN86		2.30	2.30	11JUN86	22.50	22.00	22.25
30JAN86		3.50	3.50	12JUN86	23.00	22.50	22.75
01FEB86		1.20	1.20	13JUN86	23.00	22.50	22.75
02FEB86		1.00	1.00	14JUN86	22.00	22.50	22.25
06FEB86		1.00	1.00	15JUN86	22.00		22.00
07FEB86		1.00	1.00	16JUN86	22.00	21.90	21.95
09FEB86		3.00	3.00	17JUN86	21.90	21.90	21.90
12FEB86		1.00	1.00	18JUN86	23.00	22.50	22.75
14FEB86		0.50	0.50	19JUN86	23.00	22.00	22.50
17FEB86		0.00	0.00	20JUN86	23.00	23.00	23.00
03MAR86		2.00	2.00	21JUN86	23.00	23.10	23.05
05MAR86		2.00	2.00	22JUN86	23.00	23.00	23.00
06MAR86		2.00	2.00	23JUN86	23.70	24.80	24.25
08MAR86		3.20	3.20	23JUN86	24.50	24.80	24.65
10MAR86		4.30	4.30	24JUN86	24.50	28.50	26.50
11MAR86		7.80	7.80	25JUN86	22.00	22.00	22.00
15MAR86		4.30	4.30	26JUN86	22.00		22.00
17MAR86		1.50	1.50	27JUN86	22.50	22.00	22.25
19MAR86		3.50	3.50	28JUN86	23.00	23.00	23.00
20MAR86	5.00	4.00	4.50	29JUN86	23.50		23.50
21MAR86	4.00		4.00	30JUN86	24.00	24.00	24.00
22MAR86	5.00	5.00	5.00	01JUL86	24.00		24.00
23MAR86	4.50	5.50	5.00	02JUL86	23.50		23.50
24MAR86	5.50		5.50	03JUL86	24.50	25.00	24.75
25MAR86	5.00	6.00	5.50	04JUL86		24.00	24.00
26MAR86	6.20		6.20	05JUL86	24.50	24.50	24.50
27MAR86	6.00	6.00	6.00	06JUL86	25.00		25.00
28MAR86	5.50		5.50	07JUL86	25.00	25.50	25.25
30MAR86		8.20	8.20	08JUL86	24.50	25.00	24.75
31MAR86	6.00		6.00	09JUL86	24.00		24.00
02APR86		7.80	7.80	10JUL86	26.00	26.00	26.00
05APR86		8.90	8.90	11JUL86	24.00	24.50	24.25
08APR86		10.00	10.00	12JUL86	24.00	24.00	24.00
11APR86		10.00	10.00	13JUL86	24.00	24.00	24.00

(CONTINUED)

TABLE A-1 (CONTINUED).

DATE	UNIT 2	UNIT 3	MEAN	DATE	UNIT 2	UNIT 3	MEAN
14JUL86	24.00	24.00	24.00	31AUG86	25.00		25.00
15JUL86	24.00	24.00	24.00	01SEP86	25.50	24.50	25.00
16JUL86	24.00	24.00	24.00	02SEP86	26.10	24.00	25.05
17JUL86	24.00		24.00	09SEP86	23.00	23.60	23.30
18JUL86	25.00	24.50	24.75	11SEP86	23.00	23.60	23.30
19JUL86	24.50	24.50	24.50	14SEP86	22.60	24.30	23.45
20JUL86	30.00	30.00	30.00	15SEP86	24.00		24.00
21JUL86	26.00	26.00	26.00	16SEP86	22.20	22.50	22.35
22JUL86	25.50	26.00	25.75	17SEP86	22.30	22.20	22.25
23JUL86	25.00	25.50	25.25	18SEP86	22.00	22.20	22.10
24JUL86	27.00	27.00	27.00	19SEP86	22.80	22.70	22.75
25JUL86	26.00		26.00	20SEP86	22.00	18.00	20.00
26JUL86	24.90	25.60	25.25	21SEP86	22.40	22.00	22.20
27JUL86	26.00	26.00	26.00	22SEP86	22.80	23.00	22.90
28JUL86	26.00	26.00	26.00	23SEP86	24.30	25.00	24.65
29JUL86	26.50	26.00	26.25	24SEP86	24.00		24.00
30JUL86	26.00	26.50	26.25	25SEP86	24.40	24.40	24.40
31JUL86	25.00		25.00	26SEP86	20.00	21.00	20.50
01AUG86	26.00	26.50	26.25	27SEP86	21.00	20.20	20.60
02AUG86	28.00	28.00	28.00	28SEP86	21.00	20.10	20.55
03AUG86	26.50		26.50	29SEP86	22.00	20.00	21.00
04AUG86	26.50	26.50	26.50	30SEP86	22.50	23.00	22.75
05AUG86	27.00		27.00	01OCT86	23.90	23.40	23.65
06AUG86	28.00	28.00	28.00	02OCT86	22.00	22.00	22.00
07AUG86	29.00		29.00	03OCT86	21.10	21.80	21.45
08AUG86	27.00	27.00	27.00	04OCT86	22.00	22.00	22.00
09AUG86	33.00	26.00	29.50	05OCT86	22.30	23.00	22.65
10AUG86	26.00	26.80	26.40	06OCT86	20.00	21.00	20.50
11AUG86	26.00	26.00	26.00	07OCT86	20.30	20.70	20.50
12AUG86	25.50		25.50	08OCT86	21.00	21.20	21.10
13AUG86	25.50	26.00	25.75	09OCT86		21.00	21.00
14AUG86	25.90		25.90	10OCT86	19.90	19.50	19.70
15AUG86	26.00	26.00	26.00	11OCT86	19.00	19.00	19.00
16AUG86	26.00	26.00	26.00	12OCT86	18.90	19.90	19.40
17AUG86	26.50	27.50	27.00	13OCT86	18.70	19.20	18.95
18AUG86	27.00	27.00	27.00	14OCT86	19.00	19.10	19.05
19AUG86	•28.00		28.00	15OCT86	17.90	17.70	17.80
20AUG86	27.00	27.00	27.00	16OCT86	18.20	17.90	18.05
21AUG86	26.00	26.00	26.00	17OCT86	18.00	18.00	18.00
22AUG86	26.00		26.00	18OCT86	18.00	17.00	17.50
23AUG86	27.00		27.00	19OCT86	19.00	18.50	18.75
24AUG86	26.00	26.00	26.00	20OCT86	17.80	18.30	18.05
25AUG86	25.00	25.00	25.00	21OCT86	18.00	18.70	18.35
26AUG86	26.00	25.00	25.50	22OCT86	17.90	17.90	17.90
27AUG86	26.00		26.00	23OCT86	20.00	20.00	20.00
28AUG86	27.00		27.00	24OCT86	19.00	18.00	18.50
29AUG86	26.00	26.00	26.00	25OCT86	16.00	16.00	16.00
30AUG86	26.00		26.00	26OCT86	16.00	16.00	16.00

(CONTINUED)

TABLE A-1 (CONTINUED).

DATE	UNIT 2	UNIT 3	MEAN
27OCT86	15.80		15.80
28OCT86	16.00		16.00
29OCT86	16.20	16.10	16.15
30OCT86	16.00	16.00	16.00
31OCT86	15.50	15.50	15.50
01NOV86	15.50	16.00	15.75
03NOV86	14.80	15.10	14.95
04NOV86	15.00	15.90	15.45
05NOV86	15.00	15.00	15.00
06NOV86	16.50	16.00	16.25
07NOV86		15.50	15.50
08NOV86	13.50		13.50
09NOV86	15.00	14.50	14.75
10NOV86	15.10		15.10
11NOV86	12.00		12.00
13NOV86	12.00		12.00
14NOV86	11.40		11.40
15NOV86	10.00		10.00
16NOV86	11.50	12.00	11.75
17NOV86	11.10		11.10
18NOV86	11.80		11.80
19NOV86	12.00		12.00
19NOV86	12.00		12.00
20NOV86	11.10		11.10
21NOV86	12.80	12.20	12.50
22NOV86	11.00		11.00
23NOV86	11.00		11.00
26NOV86	12.00		12.00
27NOV86	9.00		9.00
28NOV86	6.00		6.00
29NOV86	6.90	5.60	6.25
30NOV86	7.50		7.50
01DEC86	6.00		6.00
02DEC86	4.90		4.90
03DEC86	6.50		6.50
04DEC86	8.00	6.10	7.05
05DEC86	7.80	7.80	7.80
07DEC86	4.20		4.20
08DEC86	5.50		5.50
09DEC86	4.50		4.50
10DEC86	5.70	6.50	6.10
11DEC86	4.00	6.80	5.40
12DEC86	4.20	5.30	4.75
13DEC86	2.50	3.00	2.75
15DEC86	5.50	6.50	6.00
16DEC86	5.50		5.50
17DEC86	5.90		5.90
18DEC86	5.90		5.90

DATE	UNIT 2	UNIT 3	MEAN
19DEC86	9.50		9.50
20DEC86		7.00	7.00
21DEC86	3.50	2.20	2.85
22DEC86	7.20		7.20
23DEC86	5.00		5.00
24DEC86	4.00		4.00
26DEC86	4.00		4.00
27DEC86	4.50		4.50
28DEC86	4.50		4.50
29DEC86	3.50		3.50
30DEC86	3.20	2.00	2.60

TABLE A-2
DAILY INTAKE CONDUCTIVITY (MICRO SIEMANS)
AT THE INDIAN POINT GENERATING STATION DURING 1986

DATE	UNIT 2	UNIT 3	MEAN	DATE	UNIT 2	UNIT 3	MEAN
02JAN86	2055	2072	2064	16APR86		145	145
04JAN86		1547	1547	17APR86		193	193
07JAN86	1012		1012	20APR86		5334	5334
09JAN86	2314	2279	2297	22APR86		8832	8832
10JAN86	1899	1979	1939	25APR86		3765	3765
11JAN86	1986		1986	29APR86		1432	1432
12JAN86	2080		2080	03MAY86	581	774	678
13JAN86	1539		1539	24MAY86		559	559
14JAN86	2056	2025	2041	31MAY86	234		234
15JAN86	607	607	607	06JUN86	763		763
16JAN86		684	684	08JUN86	425		425
22JAN86		3807	3807	09JUN86	374	346	360
25JAN86		3971	3971	10JUN86	256	265	261
28JAN86		1037	1037	10JUN86		265	265
29JAN86		527	527	11JUN86	252	271	262
30JAN86		288	288	12JUN86	820	860	840
01FEB86		252	252	13JUN86	358		358
02FEB86		250	250	14JUN86	238	241	240
06FEB86		232	232	15JUN86	329		329
07FEB86		232	232	16JUN86	954	956	955
09FEB86		233	233	17JUN86	558	595	577
12FEB86		228	228	18JUN86	623	619	621
14FEB86		230	230	19JUN86	311	371	341
17FEB86		683	683	20JUN86	296	332	314
03MAR86		2072	2072	21JUN86	208	205	207
05MAR86		2434	2434	22JUN86	213	218	216
06MAR86		1174	1174	23JUN86	205	450	328
08MAR86		283	283	23JUN86	86	450	268
10MAR86		982	982	24JUN86	86	167	127
11MAR86		584	584	25JUN86	137	343	240
15MAR86		1993	1993	26JUN86	180		180
17MAR86		211	211	27JUN86	189	185	187
19MAR86		218	218	28JUN86	196	189	193
20MAR86	189	192	191	29JUN86	210		210
21MAR86	182		182	30JUN86	338	338	338
22MAR86	166	170	168	01JUL86	183		183
23MAR86	173	166	170	02JUL86	729		729
24MAR86	168		168	03JUL86	1278	1524	1401
25MAR86	172	172	172	04JUL86		3081	3081
26MAR86	168		168	05JUL86	3724	4126	3925
27MAR86	169	169	169	06JUL86	4273		4273
28MAR86	187		187	07JUL86	3785	4023	3904
30MAR86		162	162	08JUL86	3542	3984	3763
31MAR86	166		166	09JUL86	3610		3610
02APR86		159	159	10JUL86	4001	4499	4250
05APR86		172	172	11JUL86	3467	3794	3631
08APR86		1980	1980	12JUL86	4118	4321	4220
11APR86		172	172	13JUL86	4443	4931	4687

(CONTINUED)

TABLE A-2 (CONTINUED).

DATE	UNIT 2	UNIT 3	MEAN	DATE	UNIT 2	UNIT 3	MEAN
14JUL86	4118	4271	4195	31AUG86	3686		3686
15JUL86	3833	3813	3823	01SEP86	5028	5032	5030
16JUL86	3396	3976	3686	02SEP86	6525		6525
17JUL86	4454		4454	09SEP86	6124		6124
18JUL86	4981	5233	5107	11SEP86			
19JUL86	5022	4941	4982	14SEP86			
20JUL86	8367	8534	8451	15SEP86	4555		4555
21JUL86	7878	6777	7328	16SEP86	3567	3671	3619
22JUL86	3254	3901	3578	17SEP86	4634	5066	4850
23JUL86	2181	2465	2323	18SEP86	5511	6438	5975
24JUL86	3146	3146	3146	19SEP86	4482	4564	4523
25JUL86	3318		3318	20SEP86	3582	5883	4733
26JUL86	3244	2381	2813	21SEP86	4635	4812	4724
27JUL86	2225	2245	2235	22SEP86	5003	5190	5097
28JUL86	2040	2254	2147	23SEP86	4775	4831	4803
29JUL86	2270	2332	2301	24SEP86	4093		4093
30JUL86	2293	2367	2330	25SEP86	2269	2309	2289
31JUL86	2311		2311	26SEP86	2244	2175	2210
01AUG86	2020	2367	2194	27SEP86	2500	2884	2692
02AUG86	4610	4620	4615	28SEP86	3355	3695	3525
03AUG86	4328		4328	29SEP86	4133	4200	4167
04AUG86	3980	3951	3966	30SEP86	4615	4982	4799
05AUG86	3060		3060	01OCT86	6928	6589	6759
06AUG86	3907	3917	3912	02OCT86	7737	7419	7578
07AUG86	4453		4453	03OCT86	7668	7663	7666
08AUG86	3443	3347	3395	04OCT86	7207	6889	7048
09AUG86	1508	1679	1594	05OCT86	7057	6540	6799
10AUG86	1083	835	959	06OCT86	4311	4112	4212
11AUG86	1532	1610	1571	07OCT86	3624	3267	3446
12AUG86	789		789	08OCT86	3463	3212	3338
13AUG86	779	927	853	09OCT86		2478	2478
14AUG86	792		792	10OCT86	1977	1955	1966
15AUG86	634	678	656	11OCT86	1953	2010	1982
16AUG86	605	576	591	12OCT86	2093	2005	2049
17AUG86	551		551	13OCT86	1523	1686	1605
18AUG86	746	689	718	14OCT86	2935	3425	3180
19AUG86	553		553	15OCT86	1931	1533	1732
20AUG86	622	602	612	16OCT86	2550	2948	2749
21AUG86	420	420	420	17OCT86	2365	2295	2330
22AUG86	336		336	18OCT86	2192	2181	2187
23AUG86	555		555	19OCT86	2202	2008	2105
24AUG86	361	366	364	20OCT86	2097	2155	2126
25AUG86	313	314	314	21OCT86	1684	1625	1655
26AUG86	307	309	308	22OCT86	1572	1734	1653
27AUG86	591		591	23OCT86	1442	1437	1440
28AUG86	348		348	24OCT86	1355	1730	1543
29AUG86	644	683	664	25OCT86	940	1325	1133
30AUG86	2557		2557	26OCT86	2036	1868	1952

(CONTINUED)

TABLE A-2 (CONTINUED).

DATE	UNIT 2	UNIT 3	MEAN
27OCT86	2693		2693
28OCT86	4458		4458
29OCT86	5734	5819	5777
30OCT86	7230	7109	7170
31OCT86	7188	7797	7493
01NOV86	8407	8194	8301
03NOV86	7178	7498	7338
04NOV86	7392	6642	7017
05NOV86	5914	5729	5822
06NOV86	5518	5398	5458
07NOV86		4142	4142
08NOV86	3186		3186
09NOV86	2710	3738	3224
10NOV86	1229		1229
11NOV86	1452		1452
13NOV86	825		825
14NOV86	489		489
15NOV86	457		457
16NOV86	527	561	544
17NOV86	501		501
18NOV86	424		424
19NOV86			
19NOV86	323		323
20NOV86	364		364
21NOV86	236	247	242
22NOV86	263		263
23NOV86	263		263
26NOV86	218		218
27NOV86			
28NOV86	207		207
29NOV86	198	202	200
30NOV86	767		767
01DEC86	184		184
02DEC86	182		182
03DEC86	191		191
04DEC86	175	181	178
05DEC86	189	187	188
07DEC86	186		186
08DEC86	187		187
09DEC86	184		184
10DEC86	187	183	185
11DEC86	195	180	188
12DEC86	197	191	194
13DEC86	187	192	190
15DEC86	185	189	187
16DEC86	179		179
17DEC86	177		177
18DEC86	262		262

DATE	UNIT 2	UNIT 3	MEAN
19DEC86	154		154
20DEC86		299	299
21DEC86	190	189	190
22DEC86	587		587
23DEC86	521		521
24DEC86	276		276
26DEC86	974		974
27DEC86	192		192
28DEC86	1280		1280
29DEC86	1681		1681
30DEC86	1181	1540	1361

TABLE A-3
TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNIT 2 DURING 1986
(UNADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ALEWIFE			2		2	20	12	8	27	20	30		121
AMERICAN EEL	50		3			28	23	3	4	35	47	76	269
AMERICAN SHAD	2				1	36	51	64	33	169	176	1	533
ATHERINID UNID.									1				1
ATLANTIC CROAKER						1				1			2
ATLANTIC MENHADEN						201	3	2	39	9	5	1	260
ATLANTIC NEEDLEFISH								1					1
ATLANTIC SILVERSIDE	2									6	2		10
ATLANTIC STURGEON							1					1	2
ATLANTIC TOMCOD	23		8		1	832	3040	87	112	265	21	1046	5435
BANDED KILLIFISH	45		15			4	3		2	116	589	269	1043
BAY ANCHOVY						1081	608	400	897	1287	51	2	4326
BLACK CRAPPIE	2										2	1	5
BLACK SEA BASS											3		3
BLUEBACK HERRING	4				1	49	14	6	6	715	755	2	1552
BLUEFISH	3					20	107	11	5	3	1		150
BLUEGILL	6		3		1	8		4	11	80	88	33	234
BROWN BULLHEAD	6		3			2		1	2	4	5	8	31
BUTTERFISH								1	4				5
CARP	2		4								6	9	21
CLUPEID UNID.						13				6			19
CREVALLE JACK										7	16		23
FOURSPINE STICKLEBACK						3				2	28	8	41
GIZZARD SHAD	524										24	53	601
GOLDEN SHINER			12			1						2	15
GOLDFISH	2		3									4	9
GRAY SNAPPER										1			1
HICKORY SHAD									1				1
HOGCHOKER	391		13		6	351	208	125	865	1526	659	39	4183
LARGEMOUTH BASS	1					1				2	1	10	15
LOGPERCH										20			20
LOOKDOWN									1	2	3		6
MUMMICHOG			2										2
NAKED GOBY	2									9	10	5	26
NORTHERN PIKE			1										1
NORTHERN PIPEFISH					1			1		5	1		8
OYSTER TOADFISH											1		1
PUMPKINSEED	60		30			2		1	3	240	436	85	857
RAINBOW SMELT	78		75			220	88	39	2	76	200	56	834

(CONTINUED)

TABLE A-3 (CONTINUED).

COMMOM NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
REDBREAST SUNFISH									4	18	42	4	68
ROUGH SILVERSIDE									1				1
SEA LAMPREY	2								1			2	5
SILVER LAMPREY												1	1
SPOTTAIL SHINER	13		28								42	119	202
STRIPED BASS	759		5			18	106	26	22	68	87	315	1406
STRIPED MULLET	2												2
STRIPED SEAROBIN											1		1
SUMMER FLOUNDER						121	29	5	8	27	5		195
TESSELLATED DARTER			1								20	32	53
THREESPINE STICKLEBACK			8										8
TIDEWATER SILVERSIDE							1				3	2	6
WEAKFISH							6	55	169	79	18		327
WHITE CATFISH	120		29			4	1	8	2	11	197	309	681
WHITE PERCH	47987		542		63	310	551	582	97	2369	7732	67721	127954
WINTER FLOUNDER	1								1			1	3
YELLOW PERCH	5		14							1	70	29	119
TOTAL ALL TAXA	50092		801		76	3326	4852	1430	2320	7179	11377	70246	151699

TABLE A-4
TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNIT 3 DURING 1986
(UNADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ALEWIFE			41	41	3	43	6		48	42	7		231
AMERICAN EEL	54	13	10	11	2	10	3	1	3	4	2	8	121
AMERICAN SHAD	3		1	1		26	81	3	85	428	183		811
ATLANTIC CROAKER	1					2							3
ATLANTIC MENHADEN						209	73	2	182	13	6	1	486
ATLANTIC NEEDLEFISH									1				1
ATLANTIC SILVERSIDE	1								1	2	1		5
ATLANTIC STURGEON		1											1
ATLANTIC TOMCOD	96	39	9	2	287	712	44	89	287	51	4	439	2059
BANDED KILLIFISH	11	2	14	1	1	2			1	2	13	9	56
BAY ANCHOVY				1	45	1089	178	11	477	151	448	1	2401
BLACK CRAPPIE	5	2	4									1	12
BLUEBACK HERRING	4	1	1	15	58	150	12	2	42	645	763		1693
BLUEFISH						122	43	4	43	1			213
BLUEGILL	13	1	5	1	1	1				8	10	6	46
BROWN BULLHEAD	2	2	6	2		2	1		1		1	3	20
BUTTERFISH									10	5			15
CARP	11		2								1	2	16
CLUPEID UNID.						3							3
CREVALLE JACK									3	7	7		17
FOURSPINE STICKLEBACK				1									1
GIZZARD SHAD	1983	35	1								8	53	2080
GOLDEN SHINER	7	9	10	5									31
GOLDFISH	5	3	5			1						1	15
HICKORY SHAD									1				1
HOGCHOKER	235	22	16	372	57	98	22	12	2667	372	97	5	3975
LARGEMOUTH BASS	4											1	5
LOOKDOWN											2		2
MOONFISH										1			1
MUMMICHOG			1			1							2
NORTHERN PIPEFISH				5			1				1		7
NORTHERN SEAROBIN				1									1
PUMPKINSEED	110	42	75	9	5		1		3	18	15	4	282
RAINBOW SMELT	38	3	78	30	10	219	5	6	1	12	14	8	424
RED HAKE	10		1	10									21
REDBREAST SUNFISH									1	1			2
SEA LAMPREY	1												1
SEAHORSE				1									1
SMALLMOUTH BASS										1		2	3

(CONTINUED)

TABLE A-4 (CONTINUED).

COMMOM NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
SPOTTAIL SHINER	46	17	70	3							2	26	164
SPOTTED HAKE							1	1					2
STRIPED BASS	321	32	79	12	2	4	2	1	28	13	13	49	556
STRIPED MULLET	1												1
STRIPED SEAROBIN											1		1
SUMMER FLOUNDER						13	7	6	14	8	1		49
TAUTOG					1								1
THREESPINE STICKLEBAC	1	7	22	1									31
TIDEWATER SILVERSIDE						2				1		1	4
WEAKFISH							1	2	279	25	12		319
WHITE BASS X STRIPED BASS*			1										1
WHITE CATFISH	117	24	29	10		1	1		6	8	13	41	250
WHITE PERCH	25558	15102	9745	3234	963	425	89	44	150	677	576	6309	62872
WHITE SUCKER			1										1
WINTER FLOUNDER	2		1										3
YELLOW PERCH	9	5	11	9	3							2	39
TOTAL ALL TAXA	28649	15362	10239	3778	1438	3135	571	184	4334	2496	2201	6972	79359

*White bass x striped bass hybrid verified by the New York State DEC.

TABLE A-5
TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1986
(UNADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ALEWIFE			43	41	5	63	18	8	75	62	37		352
AMERICAN EEL	104	13	13	11	2	38	26	4	7	39	49	84	390
AMERICAN SHAD	5		1	1	1	62	132	67	118	597	359	1	1344
ATHERINID UNID.									1				1
ATLANTIC CROAKER	1					3				1			5
ATLANTIC MENHADEN						410	76	4	221	22	11	2	746
ATLANTIC NEEDLEFISH								1	1				2
ATLANTIC SILVERSIDE	3								1	8	3		15
ATLANTIC STURGEON		1					1					1	3
ATLANTIC TOMCOD	119	39	17	2	288	1544	3084	176	399	316	25	1485	7494
BANDED KILLIFISH	56	2	29	1	1	6	3		3	118	602	278	1099
BAY ANCHOVY				1	45	2170	786	411	1374	1438	499	3	6727
BLACK CRAPPIE	7	2	4								2	2	17
BLACK SEA BASS											3		3
BLUEBACK HERRING	8	1	1	15	59	199	26	8	48	1360	1518	2	3245
BLUEFISH	3					142	150	15	48	4	1		363
BLUEGILL	19	1	8	1	2	9		4	11	88	98	39	280
BROWN BULLHEAD	8	2	9	2		4	1	1	3	4	6	11	51
BUTTERFISH								1	14	5			20
CARP	13		6								7	11	37
CLUPEID UNID.						16				6			22
CREVALLE JACK									3	14	23		40
FOURSPINE STICKLEBACK				1		3				2	28	8	42
GIZZARD SHAD	2507	35	1								32	106	2681
GOLDEN SHINER	7	9	22	5		1						2	46
GOLDFISH	7	3	8			1						5	24
GRAY SNAPPER										1			1
HICKORY SHAD									2				2
HOGCHOKER	626	22	29	372	63	449	230	137	3532	1898	756	44	8158
LARGEMOUTH BASS	5					1				2	1	11	20
LOGPERCH										20			20
LOOKDOWN									1	2	5		8
MOONFISH										1			1
MUMMICHOG			3			1							4
NAKED GOBY	2									9	10	5	26
NORTHERN PIKE			1										1
NORTHERN PIPEFISH				5	1		1	1		5	2		15
NORTHERN SEAROBIN				1									1
OYSTER TOADFISH											1		1

(CONTINUED)

TABLE A-5 (CONTINUED).

COMMOM NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
PUMPKINSEED	170	42	105	9	5	2	1	1	6	258	451	89	1139
RAINBOW SMELT	116	3	153	30	10	439	93	45	3	88	214	64	1258
RED HAKE	10		1	10									21
REDBREAST SUNFISH									5	19	42	4	70
ROUGH SILVERSIDE									1				1
SEA LAMPREY	3								1			2	6
SEAHORSE				1									1
SILVER LAMPREY												1	1
SMALLMOUTH BASS										1		2	3
SPOTTAIL SHINER	59	17	98	3							44	145	366
SPOTTED HAKE							1	1					2
STRIPED BASS	1080	32	84	12	2	22	108	27	50	81	100	364	1962
STRIPED MULLET	3												3
STRIPED SEAROBIN											2		2
SUMMER FLOUNDER						134	36	11	22	35	6		244
TAUTOG					1								1
TESSELLATED DARTER			1								20	32	53
THREESPINE STICKLEBAC	1	7	30	1									39
TIDEWATER SILVERSIDE						2	1			1	3	3	10
WEAKFISH							7	57	448	104	30		646
WHITE BASS X STRIPED BASS *			1										1
WHITE CATFISH	237	24	58	10		5	2	8	8	19	210	350	931
WHITE PERCH	73545	15102	10287	3234	1026	735	640	626	247	3046	8308	74030	190826
WHITE SUCKER			1										1
WINTER FLOUNDER	3		1						1			1	6
YELLOW PERCH	14	5	25	9	3					1	70	31	158
TOTAL ALL TAXA	78741	15362	11040	3778	1514	6461	5423	1614	6654	9675	13578	77218	231058

*White bass x striped bass hybrid verified by the New York State DEC.

TABLE A-6
TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM
AT INDIAN POINT UNIT 2 DURING 1986
(UNADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
ALEWIFE	2	22	47	50	121
AMERICAN EEL	53	28	30	158	269
AMERICAN SHAD	2	37	148	346	533
ATHERINID UNID.			1		1
ATLANTIC CROAKER		1		1	2
ATLANTIC MENHADEN		201	44	15	260
ATLANTIC NEEDLEFISH			1		1
ATLANTIC SILVERSIDE	2			8	10
ATLANTIC STURGEON			1	1	2
ATLANTIC TOMCOD	31	833	3239	1332	5435
BANDED KILLIFISH	60	4	5	974	1043
BAY ANCHOVY		1081	1905	1340	4326
BLACK CRAPPIE	2			3	5
BLACK SEA BASS				3	3
BLUEBACK HERRING	4	50	26	1472	1552
BLUEFISH	3	20	123	4	150
BLUEGILL	9	9	15	201	234
BROWN BULLHEAD	9	2	3	17	31
BUTTERFISH			5		5
CARP	6			15	21
CLUPEID UNID.		13		6	19
CREVALLE JACK				23	23
FOURSPINE STICKLEBACK		3		38	41
GIZZARD SHAD	524			77	601
GOLDEN SHINER	12	1		2	15
GOLDFISH	5			4	9
GRAY SNAPPER				1	1
HICKORY SHAD			1		1
HOGCHOKER	404	357	1198	2224	4183
LARGEMOUTH BASS	1	1		13	15
LOGPERCH				20	20
LOOKDOWN			1	5	6
MUMMICHOG	2				2
NAKED GOBY	2			24	26
NORTHERN PIKE	1				1
NORTHERN PIPEFISH		1	1	6	8
OYSTER TOADFISH				1	1
PUMPKINSEED	90	2	4	761	857
RAINBOW SMELT	153	220	129	332	834
REDBREAST SUNFISH			4	64	68
ROUGH SILVERSIDE			1		1

(CONTINUED)

TABLE A-6 (CONTINUED).

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
SEA LAMPREY	2		1	2	5
SILVER LAMPREY				1	1
SPOTTAIL SHINER	41			161	202
STRIPED BASS	764	18	154	470	1406
STRIPED MULLET	2				2
STRIPED SEAROBIN				1	1
SUMMER FLOUNDER		121	42	32	195
TESSELLATED DARTER	1			52	53
THREESPINE STICKLEBACK	8				8
TIDEWATER SILVERSIDE			1	5	6
WEAKFISH			230	97	327
WHITE CATFISH	149	4	11	517	681
WHITE PERCH	48529	373	1230	77822	127954
WINTER FLOUNDER	1		1	1	3
YELLOW PERCH	19			100	119
TOTAL ALL TAXA	50893	3402	8602	88802	151699

TABLE A-7
TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM
AT INDIAN POINT UNIT 3 DURING 1986
(UNADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
ALEWIFE	41	87	54	49	231
AMERICAN EEL	77	23	7	14	121
AMERICAN SHAD	4	27	169	611	811
ATLANTIC CROAKER	1	2			3
ATLANTIC MENHADEN		209	257	20	486
ATLANTIC NEEDLEFISH			1		1
ATLANTIC SILVERSIDE	1		1	3	5
ATLANTIC STURGEON	1				1
ATLANTIC TOMCOD	144	1001	420	494	2059
BANDED KILLIFISH	27	4	1	24	56
BAY ANCHOVY		1135	666	600	2401
BLACK CRAPPIE	11			1	12
BLUEBACK HERRING	6	223	56	1408	1693
BLUEFISH		122	90	1	213
BLUEGILL	19	3		24	46
BROWN BULLHEAD	10	4	2	4	20
BUTTERFISH			10	5	15
CARP	13			3	16
CLUPEID UNID.		3			3
CREVALLE JACK			3	14	17
FOURSPINE STICKLEBACK		1			1
GIZZARD SHAD	2019			61	2080
GOLDEN SHINER	26	5			31
GOLDFISH	13	1		1	15
HICKORY SHAD			1		1
HOGCHOKER	273	527	2701	474	3975
LARGEMOUTH BASS	4			1	5
LOOKDOWN				2	2
MOONFISH				1	1
MUMMICHOG	1	1			2
NORTHERN PIPEFISH		5	1	1	7
NORTHERN SEAROBIN		1			1
PUMPKINSEED	227	14	4	37	282
RAINBOW SMELT	119	259	12	34	424
RED HAKE	11	10			21
REDBREAST SUNFISH			1	1	2
SEA LAMPREY	1				1
SEAHORSE		1			1
SMALLMOUTH BASS				3	3
SPOTTAIL SHINER	133	3		28	164
SPOTTED HAKE			2		2

(CONTINUED)

TABLE A-7 (CONTINUED).

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
STRIPED BASS	432	18	31	75	556
STRIPED MULLET	1				1
STRIPED SEAROBIN				1	1
SUMMER FLOUNDER		13	27	9	49
TAUTOG		1			1
THREESPINE STICKLEBACK	30	1			31
TIDEWATER SILVERSIDE		2		2	4
WEAKFISH			282	37	319
WHITE BASS X STRIPED BASS*	1				1
WHITE CATFISH	170	11	7	62	250
WHITE PERCH	50405	4622	283	7562	62872
WHITE SUCKER	1				1
WINTER FLOUNDER	3				3
YELLOW PERCH	25	12		2	39
TOTAL ALL TAXA	54250	8351	5089	11669	79359

*White bass x striped bass hybrid verified by the New York State DEC.

TABLE A-8
TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM
INDIAN POINT UNITS 2 & 3 COMBINED DURING 1986
(UNADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
ALEWIFE	43	109	101	99	352
AMERICAN EEL	130	51	37	172	390
AMERICAN SHAD	6	64	317	957	1344
ATHERINID UNID.			1		1
ATLANTIC CROAKER	1	3		1	5
ATLANTIC MENHADEN		410	301	35	746
ATLANTIC NEEDLEFISH			2		2
ATLANTIC SILVERSIDE	3		1	11	15
ATLANTIC STURGEON	1		1	1	3
ATLANTIC TOMCOD	175	1834	3659	1826	7494
BANDED KILLIFISH	87	8	6	998	1099
BAY ANCHOVY		2216	2571	1940	6727
BLACK CRAPPIE	13			4	17
BLACK SEA BASS				3	3
BLUEBACK HERRING	10	273	82	2880	3245
BLUEFISH	3	142	213	5	363
BLUEGILL	28	12	15	225	280
BROWN BULLHEAD	19	6	5	21	51
BUTTERFISH			15	5	20
CARP	19			18	37
CLUPEID UNID.		16		6	22
CREVALLE JACK			3	37	40
FOURSPINE STICKLEBACK		4		38	42
GIZZARD SHAD	2543			138	2681
GOLDEN SHINER	38	6		2	46
GOLDFISH	18	1		5	24
GRAY SNAPPER				1	1
HICKORY SHAD			2		2
HOGCHOKER	677	884	3899	2698	8158
LARGEMOUTH BASS	5	1		14	20
LOGPERCH				20	20
LOOKDOWN			1	7	8
MOONFISH				1	1
MUMMICHOG	3	1			4
NAKED GOBY	2			24	26
NORTHERN PIKE	1				1
NORTHERN PIPEFISH		6	2	7	15
NORTHERN SEAROBIN		1			1
OYSTER TOADFISH				1	1
PUMPKINSEED	317	16	8	798	1139
RAINBOW SMELT	272	479	141	366	1258

(CONTINUED)

TABLE A-8 (CONTINUED).

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
RED HAKE	11	10			21
REDBREAST SUNFISH			5	65	70
ROUGH SILVERSIDE			1		1
SEA LAMPREY	3		1	2	6
SEAHORSE		1			1
SILVER LAMPREY				1	1
SMALLMOUTH BASS				3	3
SPOTTAIL SHINER	174	3		189	366
SPOTTED HAKE			2		2
STRIPED BASS	1196	36	185	545	1962
STRIPED MULLET	3				3
STRIPED SEAROBIN				2	2
SUMMER FLOUNDER		134	69	41	244
TAUTOG		1			1
TESSELLATED DARTER	1			52	53
THREESPINE STICKLEBACK	38	1			39
TIDEWATER SILVERSIDE		2	1	7	10
WEAKFISH			512	134	646
WHITE BASS X STRIPED BASS*	1				1
WHITE CATFISH	319	15	18	579	931
WHITE PERCH	98934	4995	1513	85384	190826
WHITE SUCKER	1				1
WINTER FLOUNDER	4		1	1	6
YELLOW PERCH	44	12		102	158
TOTAL ALL TAXA	105143	11753	13691	100471	231058

*White bass x striped bass hybrid verified by the New York State DEC.

TABLE A-9
TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNIT 2 DURING 1986, BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
ALEWIFE	1941	40251	49510	3088	81924
AMERICAN EEL	24580	72583	81558	61077	273945
AMERICAN SHAD	59	1070	15885	6272	28899
ATHERINID UNID.			26		26
ATLANTIC CROAKER		78		8	74
ATLANTIC MENHADEN		17085	246002	7280	293572
ATLANTIC NEEDLEFISH			30		30
ATLANTIC SILVERSIDE	6			109	112
ATLANTIC STURGEON			10565	1553	13919
ATLANTIC TOMCOD	2244	70694	619882	88765	1180694
BANDED KILLIFISH	1086	257	855	9933	11894
BAY ANCHOVY		82775	147138	6635	203914
BLACK CRAPPIE	15			385	392
BLACK SEA BASS				101	101
BLUEBACK HERRING	33	118925	16009	20844	51673
BLUEFISH	91	1128	20189	546	25020
BLUEGILL	455	2338	1278	3817	8054
BROWN BULLHEAD	5015	8987	6874	3887	24087
BUTTERFISH			981		981
CARP	1371			1375	2716
CLUPEID UNID.		322		66	561
CREVALLE JACK				2803	2803
FOURSPINE STICKLEBACK		53		194	310
GIZZARD SHAD	32489			1622	34081
GOLDEN SHINER	2540	940		472	4611
GOLDFISH	1009			401	1398
GRAY SNAPPER				8	8
HICKORY SHAD			2549		2549
HOGCHOKER	19335	98689	451423	94502	642094
LARGEMOUTH BASS	191	27		722	1397
LOGPERCH				236	236
LOOKDOWN			158	88	227
MUMMICHOG	16				16
NAKED GOBY	9			98	107
NORTHERN PIKE	171				171
NORTHERN PIPEFISH		58	30	26	99
OYSTER TOADFISH				431	431
PUMPKINSEED	15515	2079	1905	8442	27232
RAINBOW SMELT	5863	2097	6524	1902	36773
REDBREAST SUNFISH			179	457	667
ROUGH SILVERSIDE			77		77

(CONTINUED)

TABLE A-9 (CONTINUED).

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
SEA LAMPREY	33		109	30	201
SILVER LAMPREY				12	12
SPOTTAIL SHINER	1094			2792	3870
STRIPED BASS	44878	5187	24783	25221	147664
STRIPED MULLET	611				611
STRIPED SEAROBIN				93	93
SUMMER FLOUNDER		11228	22227	4009	51851
TESSELLATED DARTER	22			697	718
THREESPINE STICKLEBACK	59				59
TIDEWATER SILVERSIDE			54	18	56
WEAKFISH			15793	1843	21730
WHITE CATFISH	26404	5293	118280	36543	89603
WHITE PERCH	1223408	366338	360510	1344793	2924150
WINTER FLOUNDER	126		26	62	695
YELLOW PERCH	5580			3833	9423
TOTAL ALL TAXA	1414986	913631	2236832	1737893	5784120

TABLE A-10
TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT
UNIT 3 DURING 1986, BY TAXON AND SEASONAL STRATUM
(ADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
ALEWIFE	47226	110710	17770	4962	190045
AMERICAN EEL	46704	20113	7278	15192	91919
AMERICAN SHAD	2179	10893	5067	19932	36835
ATLANTIC CROAKER	4	17			20
ATLANTIC MENHADEN		19692	238506	12890	318134
ATLANTIC NEEDLEFISH			17		17
ATLANTIC SILVERSIDE	4		22	96	114
ATLANTIC STURGEON	2797				2797
ATLANTIC TOMCOD	15562	24904	16443	67056	149957
BANDED KILLIFISH	745	161	43	1429	2344
BAY ANCHOVY		34817	10845	4025	47539
BLACK CRAPPIE	1504			11	1568
BLUEBACK HERRING	150	168668	9652	35136	180533
BLUEFISH		2608	3981	179	7483
BLUEGILL	3492	910		2537	7560
BROWN BULLHEAD	8591	4908	852	2666	18054
BUTTERFISH			912	500	1416
CARP	4293			656	5139
CLUPEID UNID.		137			137
CREVALLE JACK			127	1985	2094
FOURSPINE STICKLEBACK		7			7
GIZZARD SHAD	225914			3101	231005
GOLDEN SHINER	5143	1174			6560
GOLDFISH	7350	1562		96	9026
HICKORY SHAD			869		869
HOGCHOKER	20053	65539	236434	55313	377918
LARGEMOUTH BASS	2492			223	2852
LOOKDOWN				30	30
MOONFISH				12	12
MUMMICHOG	12	75			73
NORTHERN PIPEFISH		82	6	6	92
NORTHERN SEAROBIN		55			55
PUMPKINSEED	59925	8201	1014	2671	75408
RAINBOW SMELT	7584	12700	714	590	25182
RED HAKE	2574	955			4353
REDBREAST SUNFISH			606	6	662
SEA LAMPREY	22				22
SEAHORSE		7			7
SMALLMOUTH BASS				482	482
SPOTTAIL SHINER	4932	81		976	6147
SPOTTED HAKE			608		608

(CONTINUED)

TABLE A-10 (CONTINUED).

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
STRIPED BASS	35150	17843	2021	11843	60191
STRIPED MULLET	308				308
STRIPED SEAROBIN				24	24
SUMMER FLOUNDER		245	2753	4407	7845
TAUTOG		107			107
THREESPINE STICKLEBACK	300	7			312
TIDEWATER SILVERSIDE		41		52	98
WEAKFISH			7378	1512	8854
WHITE BASS X STRIPED BASS	2493				2493
WHITE CATFISH	62444	5451	12246	20750	102391
WHITE PERCH	1453544	1242790	54847	258174	2601128
WHITE SUCKER	15				15
WINTER FLOUNDER	404				404
YELLOW PERCH	14157	12169		997	27555
TOTAL ALL TAXA	2036020	1820288	629760	529919	4498434

TABLE A-11
TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT
UNITS 2 & 3 DURING 1986, BY TAXON AND SEASONAL STRATUM
(ADJUSTED FOR COLLECTION EFFICIENCY)

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
ALEWIFE	49168	150960	67280	8050	271969
AMERICAN EEL	71285	92697	88836	76269	365864
AMERICAN SHAD	2238	11963	20952	26204	65734
ATHERINID UNID.			26		26
ATLANTIC CROAKER	4	94		8	94
ATLANTIC MENHADEN		36777	484509	20171	611706
ATLANTIC NEEDLEFISH			47		47
ATLANTIC SILVERSIDE	10		22	205	226
ATLANTIC STURGEON	2797		10565	1553	16716
ATLANTIC TOMCOD	17806	95597	636325	155821	1330651
BANDED KILLIFISH	1831	418	897	11361	14238
BAY ANCHOVY		117591	157984	10660	251453
BLACK CRAPPIE	1519			395	1960
BLACK SEA BASS				101	101
BLUEBACK HERRING	183	287594	25661	55979	232206
BLUEFISH	91	3737	24170	725	32503
BLUEGILL	3946	3248	1278	6354	15613
BROWN BULLHEAD	13606	13894	7726	6553	42142
BUTTERFISH			1893	500	2397
CARP	5664			2031	7855
CLUPEID UNID.		459		66	698
CREVALLE JACK			127	4789	4897
FOURSPINE STICKLEBACK		60		194	317
GIZZARD SHAD	258403			4723	265086
GOLDEN SHINER	7683	.2114		472	11171
GOLDFISH	8359	1562		498	10424
GRAY SNAPPER				8	8
HICKORY SHAD			3418		3418
HOGCHOKER	39388	164228	687857	149814	1020012
LARGEMOUTH BASS	2684	27		945	4249
LOGPERCH				236	236
LOOKDOWN			158	118	256
MOONFISH				12	12
MUMMICHOG	27	75			89
NAKED GOBY	9			98	107
NORTHERN PIKE	171				171
NORTHERN PIPEFISH		141	36	32	191
NORTHERN SEAROBIN		55			55
OYSTER TOADFISH				431	431
PUMPKINSEED	75440	10280	2919	11113	102639
RAINBOW SMELT	13447	14797	7239	2492	61956

(CONTINUED)

TABLE A-11 (CONTINUED).

COMMOM NAME	WINTER	SPRING	SUMMER	FALL	TOTAL
RED HAKE	2574	955			4353
REDBREAST SUNFISH			785	463	1329
ROUGH SILVERSIDE			77		77
SEA LAMPREY	55		109	30	223
SEAHORSE		7			7
SILVER LAMPREY				12	12
SMALLMOUTH BASS				482	482
SPOTTAIL SHINER	6026	81		3767	10017
SPOTTED HAKE			608		608
STRIPED BASS	80029	23030	26803	37063	207854
STRIPED MULLET	919				919
STRIPED SEAROBIN				117	117
SUMMER FLOUNDER		11473	24980	8415	59697
TAUTOG		107			107
TESSELLATED DARTER	22			697	718
THREESPINE STICKLEBACK	360	7			371
TIDEWATER SILVERSIDE		41	54	71	155
WEAKFISH			23171	3355	30584
WHITE BASS X STRIPED BASS	2493				2493
WHITE CATFISH	88847	10743	130526	57293	191993
WHITE PERCH	2676953	1609128	415356	1602966	5525278
WHITE SUCKER	15				15
WINTER FLOUNDER	529		26	62	1099
YELLOW PERCH	19737	12169		4830	36978
TOTAL ALL TAXA	3451006	2733918	2866592	2267812	10282555

TABLE A-12. TOTAL NUMBER OF BLUE CRABS* COLLECTED EACH MONTH AT INDIAN POINT DURING 1986, INCLUDING TAGGED RECAPTURES.

UNIT	SEX	SURVIVAL	CONDITION	JAN	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
2	Male	Alive	Intact				2	53	614	675	187	37	7	1575
			Missing Parts					36	309	476	230	27	2	1080
		Dead	Intact			1		6	18	50	15			90
			Missing Parts				4	42	135	344	162	25	3	8715
	Female	Alive	Intact	1			2	3	137	160	55	8	1	367
			Missing Parts					3	63	154	86	10	2	318
		Dead	Intact					2	3	21	7	2		35
			Missing Parts					4	33	133	65	7	1	243
3	Male	Alive	Intact		2		2	22	17	11	83	24		161
			Missing Parts				2	14	12	9	138	28	3	206
		Dead	Intact					6	5		5	1		17
			Missing Parts				1	12	10	4	130	10	1	168
	Female	Alive	Intact					1	7	1	24	7		40
			Missing Parts					2	7	1	71	10		91
		Dead	Intact					1	1	1	2			5
			Missing Parts						3	1	89	5		87
2 and 3	Male	Alive	Intact		2		4	75	631	686	270	61	7	1736
			Missing Parts				2	5-	321	485	368	55	5	1286
		Dead	Intact			1		12	23	50	20	1		107
			Missing Parts				5	54	145	348	292	35	4	883
	Female	Alive	Intact	1			2	4	144	161	79	15	1	407
			Missing Parts					5	70	155	157	20	2	409
		Dead	Intact					3	4	22	9	2		40
			Missing Parts					4	36	134	143	12	1	330

*Excluding 7 crabs for which sex was not designated.

TABLE A-13
SIZE DISTRIBUTION OF BLUE CRABS IN IMPINGEMENT COLLECTIONS
AT INDIAN POINT DURING 1986, BY MONTH

		MONTH										
		JAN	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
UNIT 2	SIZECLASS											
	20-29	0	0	0	0	0	0	0	0	1	0	1
	30-39	0	0	0	1	0	1	1	0	0	2	5
	40-49	0	0	0	0	5	4	0	0	0	0	9
	50-59	0	0	1	0	6	6	2	0	1	0	16
	60-69	0	0	0	0	5	38	8	1	0	2	54
	70-79	0	0	0	0	6	115	18	3	1	2	145
	80-89	0	0	0	1	5	209	112	5	4	0	336
	90-99	1	0	0	1	3	271	201	13	6	1	497
	100-109	0	0	0	0	9	178	240	29	2	2	460
	110-119	0	0	0	1	13	105	261	51	6	0	437
	120-129	0	0	0	1	16	55	255	51	11	0	389
	130-139	0	0	0	2	17	44	155	86	8	2	314
	140-149	0	0	0	1	22	45	110	71	9	0	258
	150-159	0	0	0	0	18	35	95	102	13	0	263
	160-169	0	0	0	0	12	30	102	85	10	0	239
	170-179	0	0	0	0	2	23	50	34	6	1	116
	180-189	0	0	0	0	0	12	17	27	4	1	61
	190-199	0	0	0	0	0	5	11	5	0	0	21
	> 199	0	0	0	0	0	1	2	2	0	0	5

(CONTINUED)

TABLE A-13 (CONTINUED).

UNIT 3	SIZECLASS	JAN	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
		MONTH										
	30-39	0	0	0	0	1	0	0	0	1	0	2
	50-59	0	0	0	1	4	2	2	0	0	0	9
	60-69	0	0	0	1	5	2	0	1	0	0	9
	70-79	0	1	0	0	2	7	0	2	1	0	13
	80-89	0	1	0	0	4	14	1	3	4	0	27
	90-99	0	0	0	0	0	14	5	8	4	0	31
	100-109	0	0	0	1	5	5	2	9	6	0	28
	110-119	0	0	0	0	4	0	5	29	4	0	42
	120-129	0	0	0	0	4	5	3	42	5	2	61
	130-139	0	0	0	1	9	2	1	34	5	0	52
	140-149	0	0	0	0	7	0	2	31	14	1	55
	150-159	0	0	0	0	3	0	2	41	13	0	59
	160-169	0	0	0	1	3	1	1	41	6	0	53
	170-179	0	0	0	0	1	2	0	32	1	0	36
	180-189	0	0	0	0	0	0	0	13	1	0	14
	190-199	0	0	0	0	0	0	0	2	1	0	3
	> 199	0	0	0	0	0	0	0	2	1	0	3

(CONTINUED)

TABLE A-13 (CONTINUED).

		MONTH										
		JAN	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
TOTAL	SIZECLASS											
	20-29	0	0	0	0	0	0	0	0	1	0	1
	30-39	0	0	0	1	1	1	1	0	1	2	7
	40-49	0	0	0	0	5	4	0	0	0	0	9
	50-59	0	0	1	1	10	8	4	0	1	0	25
	60-69	0	0	0	1	10	40	8	2	0	2	63
	70-79	0	1	0	0	8	122	18	5	2	2	158
	80-89	0	1	0	1	9	223	113	8	8	0	363
	90-99	1	0	0	1	3	285	206	21	10	1	528
	100-109	0	0	0	1	14	183	242	38	8	2	488
	110-119	0	0	0	1	17	105	266	80	10	0	479
	120-129	0	0	0	1	20	60	258	93	16	2	450
	130-139	0	0	0	3	26	46	156	120	13	2	366
	140-149	0	0	0	1	29	45	112	102	23	1	313
	150-159	0	0	0	0	21	35	97	143	26	0	322
	160-169	0	0	0	1	15	31	103	126	16	0	292
	170-179	0	0	0	0	3	25	50	66	7	1	152
	180-189	0	0	0	0	0	12	17	40	5	1	75
	190-199	0	0	0	0	0	5	11	7	1	0	24
	> 199	0	0	0	0	0	1	2	4	1	0	8

TABLE A-14.
THE PROPORTION OF BLUE CRABS IMPINGED IN 1986, BY SEX, SURVIVAL, AND CONDITION AT THE INDIAN POINT GENERATING STATION, INCLUDING TAGGED RECAPTURES.

UNIT	SEX	SURVIVAL	CONDITION	TOTAL	(a) I/M, A/D BY M/F %	(b) I VS M BY A/D %	(c) I VS M A/D %	(d) A VS D BY M/F %	(e) M VS F %
2	Male	Alive	Intact	1575	45.5	59.3	48.1	76.7	78.2
			Missing Parts	1080	31.2	40.7			
		Dead	Intact	90	2.6	11.2		23.3	
			Missing Parts	715	20.7	88.8	51.9		
	Female	Alive	Intact	367	38.1	53.6	41.7	71.1	21.8
			Missing Parts	318	33.0	46.4			
		Dead	Intact	35	3.6	12.6		28.9	
			Missing Parts	243	25.2	87.4	58.3		
3	Male	Alive	Intact	161	29.2	43.9	32.2	66.5	71.2
			Missing Parts	206	37.3	56.1			
		Dead	Intact	17	3.1	9.2		33.5	
			Missing Parts	168	30.4	90.8	67.8		
	Female	Alive	Intact	40	17.9	30.5	20.2	58.7	28.8
			Missing Parts	91	40.8	69.5			
		Dead	Intact	5	2.2	5.4		41.3	
			Missing Parts	87	39.0	94.6	79.8		
2 & 3	Male	Alive	Intact	1736	43.3	57.4	45.9	75.3	77.2
			Missing Parts	1286	32.1	42.6			
		Dead	Intact	107	2.7	10.8		24.7	
			Missing Parts	883	22.0	89.2	54.1		
	Female	Alive	Intact	407	34.3	49.9	37.7	68.8	22.8
			Missing Parts	409	34.5	50.1			
		Dead	Intact	40	3.4	10.8		31.2	
			Missing Parts	330	27.8	89.2	62.3		

a-% of total number by sex and unit.
b-% of crabs intact and missing parts by survival status, sex, and unit.
c-% of crabs intact and missing parts, summed over survival status, by sex and unit
d-% of alive and dead crabs by sex and unit
e-% of male and female crabs by unit.

NOTE: I = Intact, M = Missing Parts, A = Alive, D = Dead, M = Male, F = Female

TABLE A-15.
TOTAL NUMBER OF TAGGED BLUE CRABS RECAPTURED EACH MONTH IN 1986 AT THE INDIAN POINT GENERATING STATION.

UNIT	SEX	SURVIVAL	CONDITION	JAN	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
2	Male	Alive	Intact						4	6				10
			Missing Parts							8	5	5		18
		Dead	Intact							1	1			2
			Missing Parts							5	1	1		7
	Female	Alive	Intact											0
			Missing Parts							3	3	1		7
		Dead	Intact									1		1
			Missing Parts							1	1			2
3	Male	Alive	Intact						1	2	10	2		15
			Missing Parts							3	22	3	2	30
		Dead	Intact								3			3
			Missing Parts					1	1	1	48	4		55
	Female	Alive	Intact								4			4
			Missing Parts								13	5		18
		Dead	Intact											0
			Missing Parts							1	36	1		38
2 and 3	Male	Alive	Intact						5	8	10	2		25
			Missing Parts							11	27	8	2	48
		Dead	Intact							1	4			5
			Missing Parts					1	1	6	49	5		62
	Female	Alive	Intact								4			4
			Missing Parts							3	16	6		25
		Dead	Intact									1		1
			Missing Parts							2	37	1		40

TABLE A-16.
THE PROPORTION OF TAGGED BLUE CRABS RECAPTURED IN 1986, BY SEX, SURVIVAL, AND CONDITION AT THE INDIAN POINT GENERATING STATION, INCLUDING TWO- AND THREE-TIME RECAPTURES.

UNIT	SEX	SURVIVAL	CONDITION	TOTAL	(a) I/M, A/D BY M/F %	(b) I VS M BY A/D %	(c) I VS M A/D %	(d) A VS D BY M/F %	(e) M VS F %
2	Male	Alive	Intact	10	27.8	37.0	33.3	75.0	78.3
			Missing Parts	17	47.2	63.0			
		Dead	Intact	2	5.6	22.2		25.0	
			Missing Parts	7	19.4	77.8	66.7		
	Female	Alive	Intact	0	0.0	0.0	10.0	70.0	21.7
			Missing Parts	7	70.0	100.0			
		Dead	Intact	1	10.0	33.3		30.0	
			Missing Parts	2	20.0	66.7	90.0		
3	Male	Alive	Intact	15	14.9	34.1	17.8	43.6	63.5
			Missing Parts	29	28.7	65.9			
		Dead	Intact	3	3.0	5.3		56.4	
			Missing Parts	54	53.5	94.7	82.2		
	Female	Alive	Intact	4	6.9	20.0	6.9	34.5	36.5
			Missing Parts	16	27.6	80.0			
		Dead	Intact	0	0.0	0.0		65.5	
			Missing Parts	38	65.5	100.0	93.1		
2 & 3	Male	Alive	Intact	25	18.2	35.2	21.9	51.8	66.8
			Missing Parts	46	33.6	64.8			
		Dead	Intact	5	3.6	7.6		48.2	
			Missing Parts	61	44.5	92.4	78.1		
	Female	Alive	Intact	4	5.9	14.8	7.4	39.7	33.2
			Missing Parts	23	33.8	85.2			
		Dead	Intact	1	1.5	2.4		60.3	
			Missing Parts	40	58.8	97.6	92.6		

a-% of total number by sex and unit.
b-% of grabs intact and missing parts by survival status, sex, and unit.
c-% of grabs intact and missing parts, summed over survival status, by sex and unit
d-% of alive and dead grabs by sex and unit
e-% of male and female grabs by unit.

TABLE A-17.
TOTAL NUMBER OF BLUE CRABS COLLECTED EACH MONTH AT INDIAN POINT DURING 1986, EXCLUDING TAGGED RECAPTURES.

UNIT	SEX	SURVIVAL	CONDITION	JAN	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
2	Male	Alive	Intact				2	53	610	669	187	37	7	1565
			Missing Parts					36	309	468	226	22	2	1063
		Dead	Intact			1		6	18	49	14			88
			Missing Parts				4	42	135	339	161	24	3	708
	Female	Alive	Intact	1			2	3	137	160	55	8	1	367
			Missing Parts					3	63	151	83	9	2	311
		Dead	Intact					2	3	21	7	1		34
			Missing Parts					4	33	132	64	7	1	241
3	Male	Alive	Intact		2		2	22	16	9	73	22		146
			Missing Parts				2	14	12	6	117	25	1	177
		Dead	Intact					6	5		2	1		14
			Missing Parts				1	11	9	3	83	6	1	114
	Female	Alive	Intact					1	7	1	20	7		36
			Missing Parts					2	7	1	60	5		75
		Dead	Intact					1	1	1	2			5
			Missing Parts						3		42	4		49
2 and 3	Male	Alive	Intact		2		4	75	626	678	260	59	7	1711
			Missing Parts				2	50	321	474	343	47	3	1240
		Dead	Intact			1		12	23	49	16	1		102
			Missing Parts				5	53	144	342	244	30	4	822
	Female	Alive	Intact	1			2	4	144	161	75	15	1	403
			Missing Parts					5	70	152	143	14	2	386
		Dead	Intact					3	4	22	9	1		39
			Missing Parts					4	36	132	106	11	1	290

TABLE A-18.
THE PROPORTION OF BLUE CRABS IMPINGED IN 1986, BY SEX, SURVIVAL, AND CONDITION AT THE INDIAN POINT GENERATING STATION, EXCLUDING TAGGED RECAPTURES.

UNIT	SEX	SURVIVAL	CONDITION	TOTAL	(a) I/M, A/D BY M/F %	(b) I VS M BY A/D %	(c) I VS M Σ A/D %	(d) A VS D BY M/F %	(e) M VS F %
2	Male	Alive	Intact	1565	45.7	59.6	48.3	76.8	78.2
			Missing Parts	1063	31.1	40.5			
		Dead	Intact	88	2.6	11.1		23.3	
			Missing Parts	708	20.7	88.9	51.7		
	Female	Alive	Intact	367	38.5	54.1	42.1	71.1	21.8
			Missing Parts	311	32.6	45.9			
		Dead	Intact	34	3.6	12.4		28.9	
			Missing Parts	241	25.3	87.6	57.9		
3	Male	Alive	Intact	146	32.4	45.2	35.5	71.6	73.2
			Missing Parts	177	39.2	54.8			
		Dead	Intact	14	3.1	10.9		28.4	
			Missing Parts	114	25.3	89.1	64.5		
	Female	Alive	Intact	36	21.8	32.4	24.8	67.3	26.8
			Missing Parts	75	45.5	67.6			
		Dead	Intact	5	3.0	9.3		32.7	
			Missing Parts	49	29.7	90.7	75.2		
2 & 3	Male	Alive	Intact	1711	44.2	58.0	46.8	76.2	77.6
			Missing Parts	1240	32.0	42.0			
		Dead	Intact	102	2.6	11.0		23.8	
			Missing Parts	822	21.2	89.0	53.2		
	Female	Alive	Intact	403	36.0	51.1	39.5	70.6	22.4
			Missing Parts	386	34.5	48.9			
		Dead	Intact	39	3.5	11.9		29.4	
			Missing Parts	290	25.9	88.1	60.5		

a-% of total number by sex and unit.
b-% of crabs intact and missing parts by survival status, sex, and unit.
c-% of crabs intact and missing parts, summed over survival status, by sex and unit
d-% of alive and dead crabs by sex and unit
e-% of male and female crabs by unit.

TABLE A-19.
FRESH (F) AND PRESERVED (P) FISH LENGTH (MM), WEIGHT (GM),
AND BODY DEPTH (MM) DATA, 1986 INDIAN POINT IMPINGEMENT PROGRAM

TAXON	FISH_ID	TAG_N	F_DATE	F_LENGTH	F_DEPTH	F_WEIGHT	P_DATE	P_LENGTH	P_DEPTH	P_WEIGHT
32	1	87104	06/09/86	55	9	1.4	07/09/86	55	9	1.3
32	2	87105	06/09/86	49	8	1.1	07/09/86	48	9	0.9
32	3	87106	06/09/86	52	8	1.2	07/09/86	52	8	1.0
32	4	87107	06/09/86	56	9	1.4	07/09/86	56	9	1.3
32	5	87156	06/10/86	56	10	1.5	07/09/86	55	9	1.7
32	6	87157	06/10/86	53	10	1.3	07/09/86	53	9	1.5
32	7	87158	06/10/86	54	10	1.4	07/09/86	54	9	1.7
32	8	87159	06/10/86	53	9	1.2	07/09/86	52	9	1.5
32	9	87160	06/10/86	51	9	1.1	07/09/86	50	9	1.2
32	10	87161	06/10/86	56	10	1.4	07/09/86	56	10	1.9
32	11	87162	06/10/86	51	9	1.2	07/09/86	51	9	1.6
32	12	87163	06/10/86	55	10	1.4	07/09/86	55	10	1.8
32	13	87164	06/10/86	55	9	1.3	07/09/86	54	9	1.3
32	14	87165	06/10/86	54	9	1.3	07/09/86	54	9	1.5
32	15	87166	06/10/86	56	10	1.4	07/09/86	55	9	1.6
32	16	87167	06/10/86	52	8	1.1	07/09/86	51	9	.
32	17	87168	06/10/86	56	11	1.5	07/09/86	56	10	1.6
32	18	87169	06/10/86	53	9	1.2	07/09/86	52	9	1.2
32	19	87170	06/10/86	54	10	1.6	07/09/86	54	10	1.7
32	20	87171	06/10/86	54	9	1.2	07/09/86	54	9	1.6
32	1	87108	06/09/86	68	12	2.9	07/09/86	68	12	3.0
32	2	87109	06/09/86	67	12	2.5	07/09/86	67	11	2.7
32	3	87110	06/09/86	63	11	2.1	07/09/86	64	11	2.1
32	4	87111	06/09/86	65	11	2.2	07/09/86	65	11	2.2
32	5	87112	06/09/86	66	12	2.5	07/09/86	66	11	2.4
32	6	87113	06/09/86	61	11	1.9	07/09/86	61	11	2.0
32	7	87114	06/09/86	62	11	1.9	07/09/86	62	11	1.9
32	8	87115	06/09/86	67	11	2.6	07/09/86	67	11	2.5
32	9	87116	06/09/86	62	11	2.1	07/09/86	61	11	2.0
32	10	87117	06/09/86	66	11	2.3	07/09/86	65	11	2.5
32	11	87118	06/09/86	64	12	2.2	07/09/86	64	11	2.3
32	12	87119	06/09/86	65	11	2.2	07/09/86	64	11	2.1
32	13	87120	06/09/86	60	10	1.7	07/09/86	60	9	1.7
32	14	87121	06/09/86	61	11	2.1	07/09/86	61	11	2.0
32	15	87122	06/09/86	65	11	2.3	07/09/86	64	11	2.3
32	16	87123	06/09/86	60	11	1.7	07/09/86	59	11	1.9
32	17	87124	06/09/86	68	12	2.6	07/09/86	68	12	2.7
32	18	87125	06/09/86	63	11	2.0	07/09/86	63	11	2.2
32	19	87126	06/09/86	61	12	1.9	07/09/86	61	11	1.9
32	20	87127	06/09/86	68	12	2.4	07/09/86	67	11	2.5
32	1	87128	06/09/86	79	14	3.9	07/09/86	78	14	3.9
32	2	87129	06/09/86	75	13	3.5	07/09/86	74	13	3.7
32	3	87130	06/09/86	72	12	3.1	07/09/86	72	13	2.9
32	4	87131	06/09/86	78	15	3.9	07/09/86	78	14	4.1
32	5	87132	06/09/86	77	14	3.6	07/09/86	76	13	3.9
32	6	87133	06/09/86	76	14	3.6	07/09/86	75	13	3.7
32	7	87134	06/09/86	74	13	3.4	07/09/86	73	13	3.6
32	8	87135	06/09/86	71	13	2.8	07/09/86	70	12	3.0
32	9	87136	06/09/86	73	14	3.2	07/09/86	73	13	3.5
32	10	87137	06/09/86	74	13	3.5	07/09/86	74	13	3.6
32	11	87138	06/09/86	75	15	3.4	07/09/86	75	13	3.3
32	12	87139	06/09/86	70	12	2.5	07/09/86	69	12	2.6
32	13	87140	06/09/86	76	13	3.5	07/09/86	75	13	3.8

(CONTINUED)

TABLE A-19 (CONTINUED).

TAXON	FISH_ID	TAG_N	F_DATE	F_LENGTH	F_DEPTH	F_WEIGHT	P_DATE	P_LENGTH	P_DEPTH	P_WEIGHT
32	14	87141	06/09/86	70	13	3.0	07/09/86	69	13	3.3
32	15	87142	06/09/86	73	12	3.1	07/09/86	72	12	3.3
32	16	87143	06/09/86	78	14	3.7	07/09/86	78	13	4.3
32	17	87144	06/09/86	79	14	4.0	07/09/86	79	14	4.8
32	18	87145	06/09/86	71	12	3.0	07/09/86	70	13	3.6
32	19	87146	06/09/86	70	13	2.9	07/09/86	71	12	3.1
32	20	87147	06/09/86	70	11	2.5	07/09/86	70	12	3.1
32	1	87148	06/09/86	84	17	5.2	07/09/86	85	15	5.8
32	2	87149	06/09/86	82	15	4.4	07/09/86	83	14	5.0
32	3	87150	06/09/86	81	16	4.6	07/09/86	82	15	5.0
32	4	87151	06/09/86	85	16	5.3	07/09/86	85	15	6.2
32	5	87152	06/09/86	83	16	4.5	07/09/86	84	14	5.4
32	6	87153	06/09/86	84	15	4.7	07/09/86	84	14	5.0
32	7	87154	06/09/86	81	16	4.3	07/09/86	81	14	4.7
32	8	87155	06/09/86	87	16	5.6	07/09/86	88	16	6.7
32	9	87172	06/10/86	81	16	4.1	07/09/86	81	15	4.7
32	10	87173	06/10/86	82	15	4.0	07/09/86	81	14	4.3
32	11	87174	06/10/86	82	16	4.8	07/09/86	81	16	5.3
32	12	87175	06/10/86	81	16	4.3	07/09/86	80	15	4.3
32	13	87176	06/10/86	83	16	4.8	07/09/86	84	15	5.0
32	14	87177	06/10/86	81	16	4.8	07/09/86	81	15	5.4
32	15	87178	06/10/86	85	16	4.9	07/09/86	84	15	5.5
32	16	87179	06/10/86	81	15	4.2	07/09/86	79	13	4.2
32	17	87180	06/10/86	87	15	5.2	07/09/86	88	15	5.6
32	18	87181	06/10/86	83	14	4.2	07/09/86	83	14	4.9
32	19	87182	06/10/86	81	15	4.2	07/09/86	82	14	4.5
32	20	87183	06/10/86	81	15	4.1	07/09/86	81	14	4.7
32	1	87184	06/16/86	96	18	6.9	10/21/86	96	17	8.3
32	2	87185	06/16/86	93	18	6.9	10/21/86	92	17	8.2
32	3	87186	06/30/86	102	20	9.2	10/21/86	102	18	10.0
32	4	87187	06/30/86	94	19	7.0	10/21/86	94	16	8.4
32	5	87188	06/30/86	94	18	7.3	10/21/86	94	17	7.9
32	6	87189	07/08/86	103	19	9.1	10/21/86	102	17	9.6
32	7	87190	07/08/86	94	18	6.6	10/21/86	93	16	7.2
32	8	87191	07/08/86	98	18	7.4	10/21/86	97	17	8.0
32	9	87192	07/08/86	99	19	9.2	10/21/86	100	18	10.2
32	10	87194	07/10/86	102	20	9.5	10/21/86	103	19	11.2
32	11	87195	07/10/86	99	18	8.1	10/21/86	99	18	9.7
32	12	87196	07/11/86	100	18	8.1	10/21/86	100	18	9.1
32	13	87197	07/11/86	95	18	6.8	10/21/86	93	17	8.0
32	14	87198	07/11/86	98	18	7.8	10/21/86	99	18	8.9
32	15	87199	07/11/86	95	17	6.7	10/21/86	94	17	7.8
32	16	87301	07/12/86	97	18	6.9	10/21/86	96	17	8.3
32	17	87302	07/13/86	96	17	6.7	10/21/86	97	17	8.1
32	18	87303	07/13/86	99	18	8.0	10/21/86	96	17	9.1
32	19	87304	07/13/86	95	18	7.7	10/21/86	95	17	8.8
32	20	87305	07/13/86	103	20	9.5	10/21/86	104	19	11.0
32	1	87300	07/11/86	115	22	13.3	10/21/86	113	21	14.1
32	2	87306	07/14/86	106	21	.	10/21/86	106	20	11.7
32	3	87307	07/15/86	113	21	12.6	10/21/86	112	20	13.5
32	4	87308	07/15/86	116	21	12.9	10/21/86	116	19	13.6
32	5	87309	07/15/86	105	21	11.0	10/21/86	105	21	11.8
32	6	87310	07/16/86	108	21	10.7	10/21/86	109	20	11.8

(CONTINUED)

TABLE A-19 (CONTINUED).

TAXON	FISH_ID	TAG_N	F_DATE	F_LENGTH	F_DEPTH	F_WEIGHT	P_DATE	P_LENGTH	P_DEPTH	P_WEIGHT
32	7	87311	07/16/86	108	22	10.3	10/21/86	109	20	11.5
32	8	87312	07/16/86	105	21	10.2	10/21/86	106	19	11.0
32	9	87313	07/17/86	106	23	11.0	10/21/86	107	21	11.7
32	10	87314	07/17/86	106	21	10.0	10/21/86	105	20	11.0
32	11	87315	07/17/86	108	22	11.1	10/21/86	107	21	12.5
32	12	87316	07/19/86	110	20	12.2	10/21/86	111	19	12.6
32	13	87317	07/19/86	112	21	12.0	10/21/86	112	20	12.0
32	14	87318	07/19/86	111	21	12.3	10/21/86	111	21	13.6
32	15	87319	07/19/86	106	20	10.2	10/21/86	104	19	10.9
32	16	87320	07/19/86	111	21	12.0	10/21/86	110	19	12.8
32	17	87321	07/19/86	109	21	11.3	10/21/86	108	20	12.0
32	18	87322	07/19/86	107	21	11.3	10/21/86	108	20	12.0
32	19	87323	07/19/86	111	21	12.6	10/21/86	109	19	13.1
32	20	87324	07/20/86	109	22	11.7	10/21/86	108	21	12.7
32	1	87325	07/20/86	117	22	12.9	10/21/86	117	20	14.7
32	2	87326	07/29/86	117	22	11.6	10/21/86	117	20	12.4
32	3	87327	08/10/86	118	20	12.9	10/21/86	118	21	14.1
45	1	90003	07/19/86	51	11	1.5	10/22/86	50	10	1.4
45	2	90004	07/20/86	55	11	1.5	10/22/86	52	9	1.2
45	3	90005	07/20/86	51	11	1.6	10/22/86	50	11	1.2
45	4	90006	07/20/86	54	11	1.5	10/22/86	53	11	1.2
45	5	90007	07/20/86	52	11	1.5	10/22/86	51	9	1.0
45	6	90009	07/20/86	55	10	1.4	10/22/86	54	9	1.1
45	7	90010	07/20/86	59	12	1.9	10/22/86	59	12	1.6
45	8	90015	07/22/86	59	11	1.5	10/22/86	58	11	1.7
45	9	90017	07/23/86	58	11	1.5	10/22/86	57	12	1.7
45	10	90018	07/23/86	54	10	1.4	10/22/86	53	11	1.4
45	11	90019	07/28/86	65	13	1.6	10/22/86	64	13	2.4
45	1	90020	07/29/86	74	16	3.6	10/22/86	73	15	3.5
45	1	90000	07/19/86	47	10	1.0	10/22/86	44	9	1.1
45	2	90001	07/19/86	43	9	1.0	10/22/86	41	8	0.9
45	3	90002	07/19/86	47	9	0.9	10/22/86	46	9	0.9
45	4	90008	07/20/86	48	10	1.4	10/22/86	45	9	0.9
45	5	90011	07/20/86	49	10	1.5	10/22/86	48	10	1.2
45	6	90012	07/20/86	50	11	1.5	10/22/86	49	10	1.3
45	7	90013	07/20/86	45	10	1.3	10/22/86	45	9	1.0
45	8	90014	07/20/86	46	10	1.4	10/22/86	46	9	1.1
45	9	90016	07/22/86	49	10	1.2	10/22/86	48	10	1.2

APPENDIX TABLE A-20. RESULTS OF LINEAR REGRESSION ANALYSES ON FRESH (F) AND PRESERVED (P) FISH LENGTH, WEIGHT AND DEPTH DATA, 1986 INDIAN POINT STATION IMPINGEMENT PROGRAM.

				LINEAR REGRESSION MODEL UNTRANSFORMED DATA			EQUATION			
TAXON	NO. FISH	RESPONSE VARIABLE	INDEPENDENT VARIABLE	F	PR>F	R^2	SLOPE	STD ERROR	INTER-CEPT	STD ERROR
Atlantic tomcod	121	P_Depth	F_Depth	4060.39	0.0001	0.97	0.89	0.014	0.95	0.218
Atlantic tomcod	121	P_Length	F_Length	70910.19	0.0001	1.00	1.00	0.004	-0.47	0.314
Atlantic tomcod	119	P_Weight	F_Weight	16668.88	0.0001	0.99	1.09	0.009	0.02	0.054
Atlantic tomcod	120	F_Length	F_Weight	1971.40	0.0001	0.94	5.18	0.117	53.76	0.748
Atlantic tomcod	121	F_Length	F_Depth	3443.67	0.0001	0.97	4.59	0.078	12.28	1.219
Atlantic tomcod	120	F_Depth	F_Weight	1358.23	0.0001	0.92	1.09	0.030	9.21	0.190
Atlantic tomcod	120	P_Length	P_Weight	2211.00	0.0001	0.95	4.73	0.101	53.56	0.714
Atlantic tomcod	121	P_Length	P_Depth	3966.02	0.0001	0.97	5.11	0.081	7.76	1.201
Atlantic tomcod	120	P_Depth	P_Weight	1916.41	0.0001	0.94	0.91	0.021	9.06	0.147
Atlantic tomcod	121	F_Depth	F_Length	3443.67	0.0001	0.97	0.21	0.004	-2.07	0.299
Atlantic tomcod	121	P_Depth	P_Length	3966.02	0.0001	0.97	0.19	0.003	-1.05	0.251
Weakfish	19	P_Depth	F_Depth	61.95	0.0001	0.77	0.98	0.124	-0.26	1.353
Weakfish	19	P_Length	F_Length	1388.35	0.0001	0.99	1.02	0.027	-2.13	1.458
Weakfish	19	P_Weight	F_Weight	59.26	0.0001	0.76	0.98	0.128	-0.10	0.204
Weakfish	19	F_Length	F_Weight	38.20	0.0001	0.67	11.18	1.809	36.03	2.887
Weakfish	19	F_Length	F_Depth	87.00	0.0001	0.82	4.37	0.468	5.68	5.109
Weakfish	19	F_Depth	F_Weight	111.72	0.0001	0.85	2.62	0.248	6.85	0.396
Weakfish	19	P_Length	P_Weight	100.04	0.0001	0.84	11.38	1.137	36.01	1.705
Weakfish	19	P_Length	P_Depth	95.64	0.0001	0.83	4.05	0.414	10.10	4.309
Weakfish	19	P_Depth	P_Weight	99.71	0.0001	0.84	2.57	0.257	6.74	0.386
Weakfish	19	F_Depth	F_Length	87.00	0.0001	0.82	0.19	0.020	0.87	1.075
Weakfish	19	P_Depth	P_Length	95.64	0.0001	0.83	0.21	0.021	-0.38	1.101

				LINEAR REGRESSION MODEL LOG 10 TRANSFORMED			EQUATION			
TAXON	NO. FISH	RESPONSE VARIABLE	INDEPENDENT VARIABLE	F	PR>F	R^2	SLOPE	STD ERROR	INTER-CEPT	STD ERROR
Atlantic tomcod	120	F_Length	F_Weight	17795.51	0.0001	0.99	0.33	0.003	1.70	0.017
Atlantic tomcod	120	F_Depth	F_Weight	4131.71	0.0001	0.97	0.38	0.006	0.93	0.004
Atlantic tomcod	120	P_Length	P_Weight	8462.93	0.0001	0.99	0.32	0.004	1.69	0.003
Atlantic tomcod	120	P_Depth	P_Weight	4839.08	0.0001	0.98	0.35	0.005	0.91	0.004
Weakfish	19	F_Length	F_Weight	35.99	0.0001	0.65	0.38	0.064	1.66	0.013
Weakfish	19	F_Depth	F_Weight	94.87	0.0001	0.83	0.42	0.043	0.96	0.009
Weakfish	19	P_Length	P_Weight	98.42	0.0001	0.84	0.37	0.038	1.67	0.007
Weakfish	19	P_Depth	P_Weight	113.84	0.0001	0.86	0.43	0.040	0.96	0.007