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HUDSON RIVER ECOLOGICAL STUDY IN THE AREA OF INDIAN POINT 1989 ANNUAL REPORT

1726

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

July 1990

LMS
LAWLER, MATUSKY & SKELLY ENGINEERS
Environmental Science & Engineering Consultants
One Blue Hill Plaza • Pearl River, New York 10965

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CHAPTER 1

SUMMARY

Impingement monitoring of fish and blue crabs was conducted at the Indian Point Generating Station in 1989, 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 sampling design consisted of 110 sampling days per year, divided into four strata (seasons). However, due to plant outages and associated construction activities during the 1989 spring stratum no impingement sampling was conducted in the spring stratum.

The estimated total number of fish impinged, adjusted for collection efficiency, was 787,767 fish at Unit 2 and 277,403 at Unit 3 for a combined total of 1,065,170 fish weighing an estimated total of 7,499 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 1989 was $609/10^6$ m^3, which is within the range reported for past years ($489\text{-}2910/10^6$ m^3).

Sixty-one species of fish were impinged during 1989, also within the range from past years (43-79). The three most numerous species impinged at Units 2 and 3 combined in 1989 were, in order of abundance, white perch, hogchoker, and blueback herring which together comprised 87.0% of the total estimated impingement abundance. Seasonal impingement patterns and rates of these and other selected species were generally consistent with past years.

The total impingement count of blue crabs in 1989 was 93,432 crabs at Unit 2 and 102,769 crabs at Unit 3 for a combined total of 196,201. This value was 3.5 times higher than the reported value in 1988 and about 16 times higher than those reported for any of the previous study years. The portion of the blue crab collection inspected, was characterized by a male to female ratio of approximately 2 to 1 and a survival rate of 82.8%. Ninety-six percent of the blue crabs inspected were between 40 and 159 mm, with most ranging from 60 to 140 mm. Blue crab impingement rates (no./10^6 m^3) unadjusted for collection efficiency were higher at

Unit 2 than Unit 3. Peak blue crab impingement rates occurred during July and August and ranged from 986/10^6 m^3 at Unit 2 to 240/10^6 m^3 at Unit 3.

CHAPTER 2

INTRODUCTION

This report is the eighteenth 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 Indian Point Generating Station, including impingement sampling, fisheries surveys, mitigation studies, and ichthyoplankton entrainment sampling (TI 1973, 1974, 1975, 1976, 1977, 1979, 1980a, 1980b; Con Edison 1982a, 1982b, 1983; NAI 1984a, 1986, 1987; MMES 1985; EA 1988, 1989). This report discusses the 1989 impingement data and interprets the 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 and Electric Corporation; Orange and Rockland Utilities, Inc.; and Niagara Mohawk Power Corporation) reexamined 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 Generating 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 used 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 1976-1979 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 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 to 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 1989 at Units 2 and 3 of the Indian Point Generating Station was conducted on random, preselected days according to the stratified random sampling design. However, due to plant outages and unusual operating conditions at both units during the spring stratum, no spring samples were collected.

Chapter 3 of this report presents a description of the Indian Point Generating Station, field and laboratory methods, the 1989 sampling design, and the collection efficiency estimates and regression models used to adjust impingement counts. Chapter 4 provides estimates of the number of fish impinged and levels of precision associated with estimates during 1989, presents species composition and relative abundances, describes seasonal and yearly impingement patterns, and describes blue crab impingement patterns. Data calculation procedures are presented in Appendix A. Appendix B provides summary tables for water quality and impingement collection results.

CHAPTER 3

MATERIALS AND METHODS

Impingement collections at Indian Point Units 2 and 3 were taken in three seasonal strata, winter, summer, and fall according to the stratified random sampling design introduced in Chapter 2. No impingement collections were made in the spring stratum because of plant outages and associated construction activities that prevented collections. 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. Except during the spring, impinged blue crabs were collected on all days when the plant was operating. Field and laboratory procedures used in collecting and processing samples are presented below; the formulas used in data calculations are presented in Appendix A.

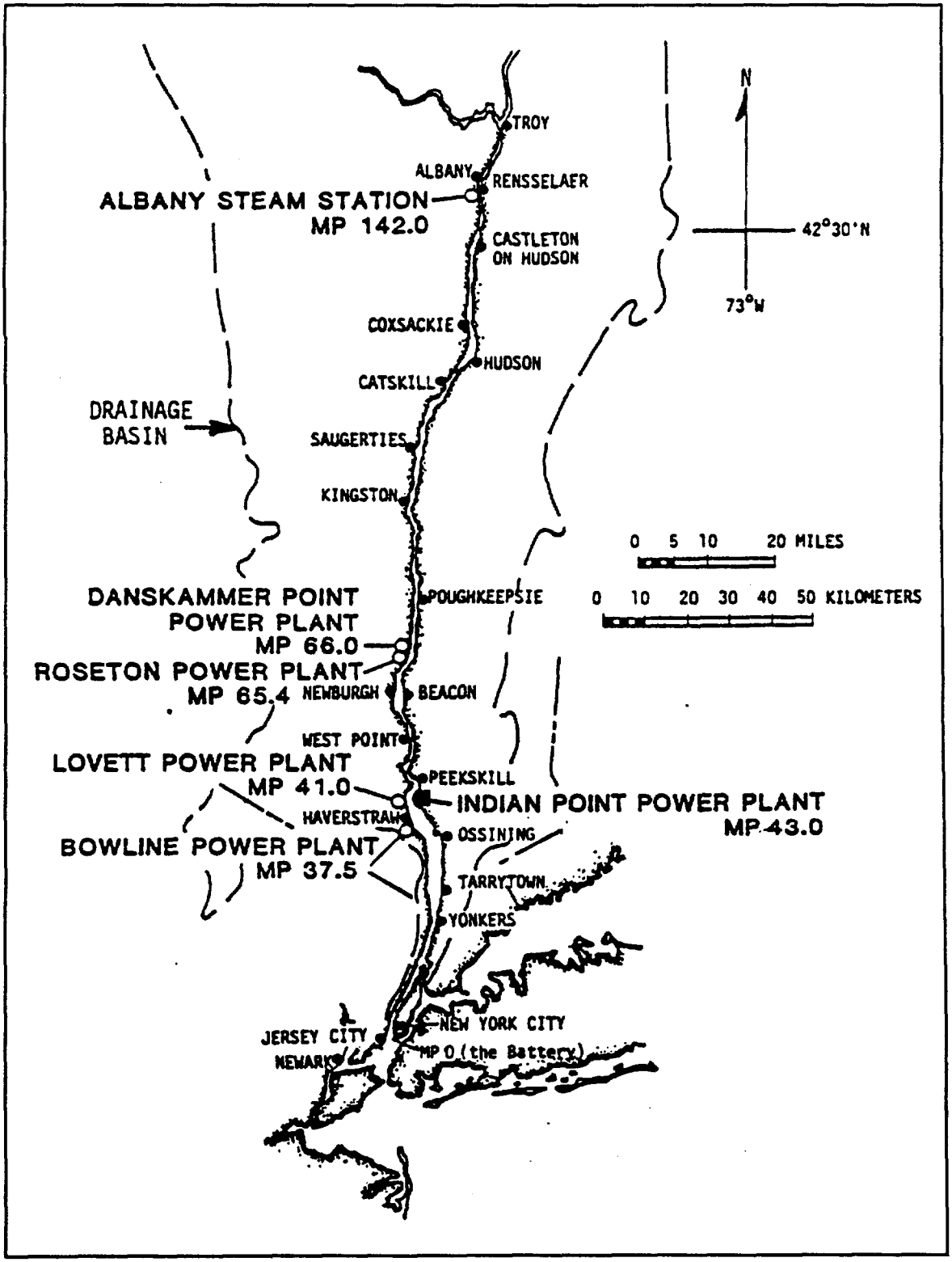
3.1 THE INDIAN POINT GENERATING STATION

The Indian Point Generating Station is located on the east bank of the Hudson River, about 69 km (43 mi) above the Battery (Figure 1). The Indian Point Generating Station began operating with the completion of Unit 1 in 1962. Unit 2, which is operated by Consolidated Edison Company of New York, Inc. (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 uses 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 7,790 m^3/min (2,058,000 gal/min). Unit 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 that withdraw river water. Unit 1 has two service pumps with a total pumping rate of 144 m^3/min (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.

FIGURE 1

LOCATION OF INDIAN POINT GENERATING STATION RELATIVE TO HUDSON RIVER STATIONS



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 2). Unit 2 intake 26 has a Ristroph-modified vertical traveling screen; the fixed screen was not in place during 1989. Unit 3 has vertical traveling screens at the river's edge, but no fixed screens (Figure 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 specified by the Agreement (Table 1), which became effective 14 May 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 2) were required. These flow rates were specified as a measure to reduce water withdrawal from the Hudson River to minimal 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.

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 in 1989 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. However, because of plant outages and associated construction activities in the spring no valid impingement collections for either Unit 2 or 3 could be collected during this stratum.

Fish and blue crab impingement samples were collected on the randomly selected sample days in all strata except spring and analyzed. On days not selected for fish sample collection (non-sample days), only blue crabs were collected and analyzed; fish and debris were discarded when the traveling screens were washed. Excluding the spring, blue crab impingement counts

FIGURE 2

SCHEMATIC INTAKE BAY CROSS-SECTION OF INDIAN POINT UNIT 2

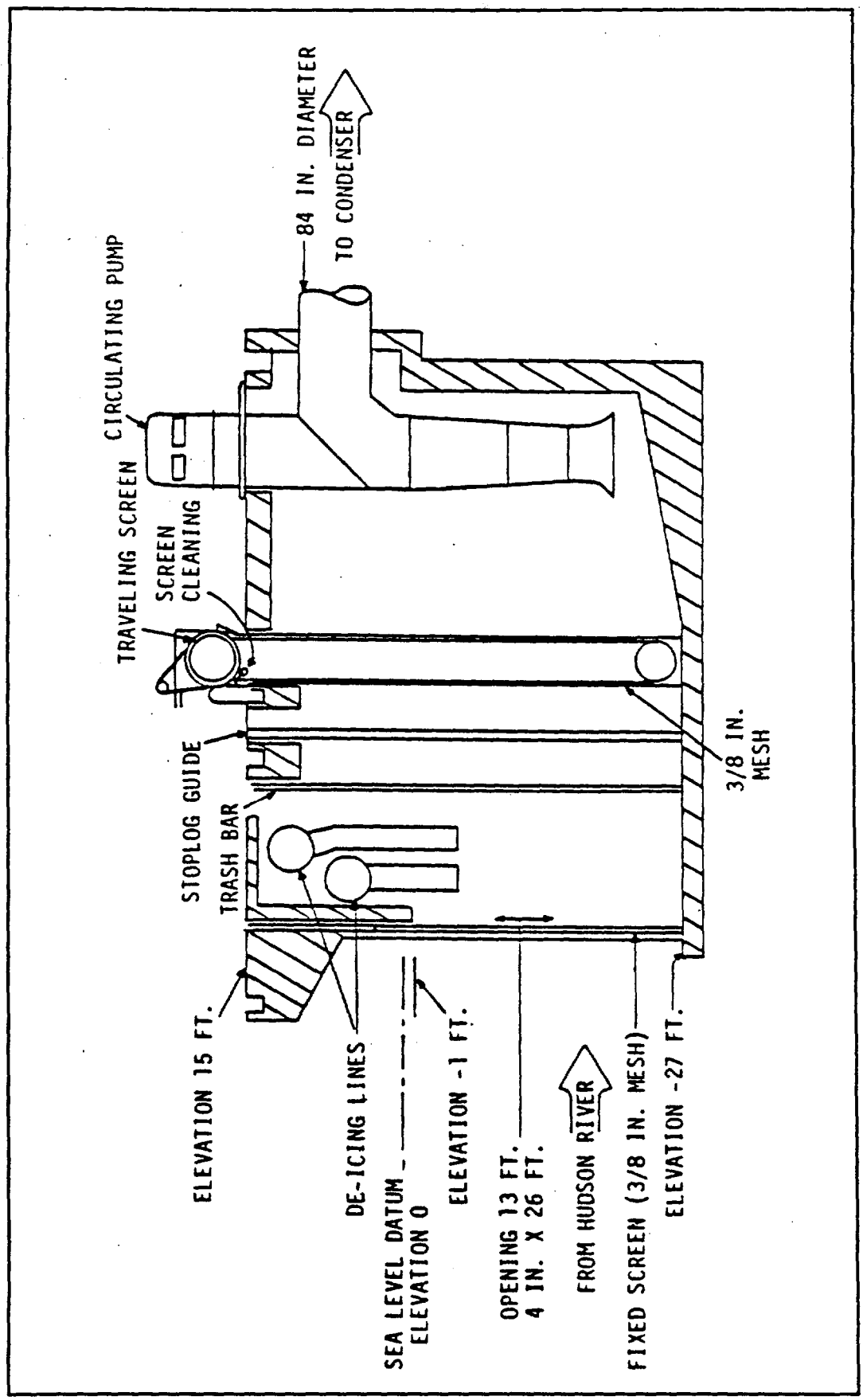


FIGURE 3

SCHEMATIC INTAKE BAY CROSS-SECTION OF INDIAN POINT UNIT 3

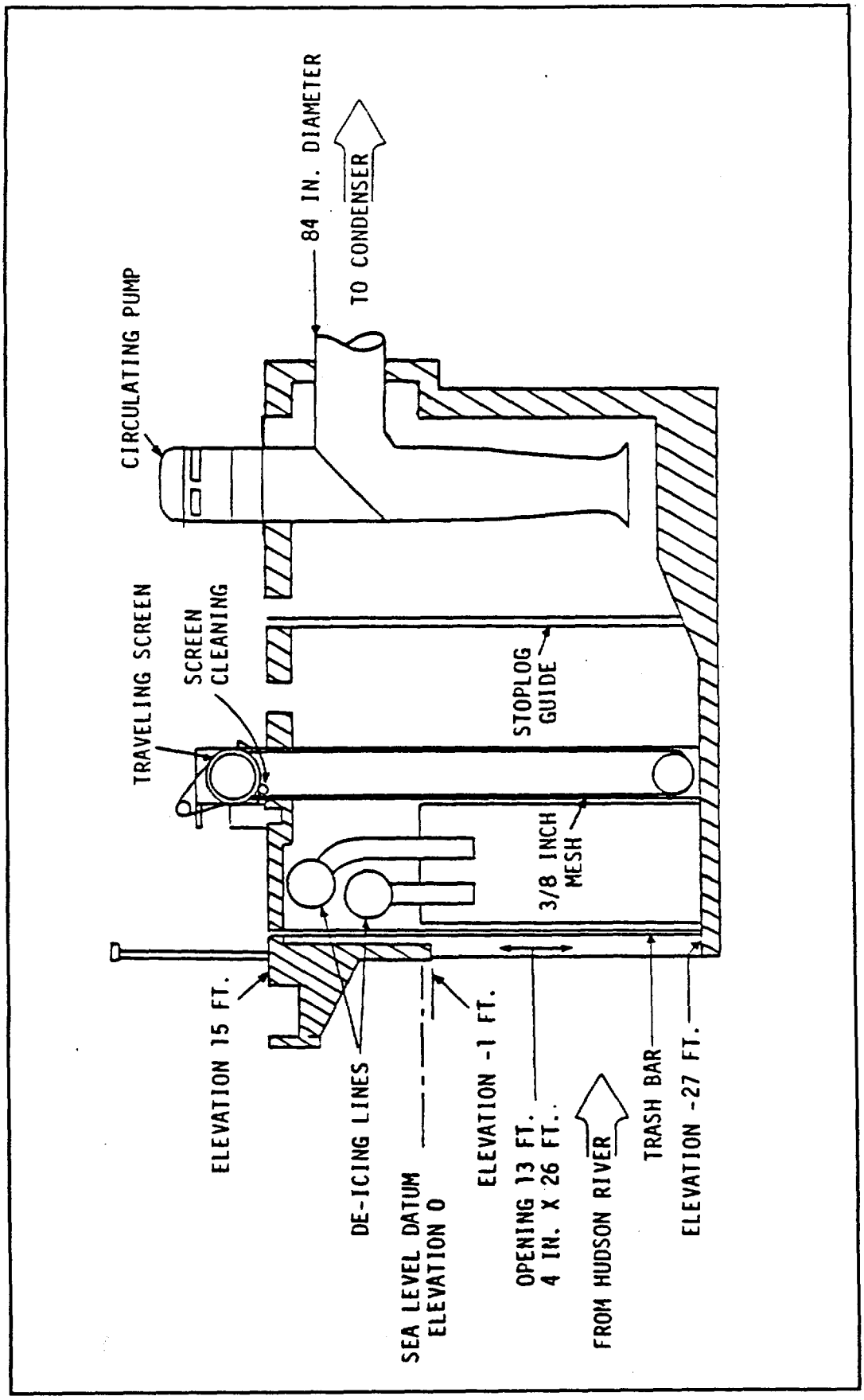


TABLE 1

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)	10^6 m^3/Min/Unit
01 Jan - 15 May	504,000	1.9
16 May - 22 May	560,000	2.1
23 May - 31 May	672,000	2.5
01 Jun - 08 Jun	731,000	2.8
09 Jun - 30 Sep	840,000	3.2
01 Oct - 31 Oct	731,000	2.8
01 Nov - 31 Dec	504,000	1.9

TABLE 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)
01 Jan - 01 May	505,000 gpm (60% flow)
01 May - 01 Jun	Change: From 505,000 gpm to 840,000 gpm (100% flow)
01 Jun - 01 Oct	840,000 gpm
01 Oct - 01 Nov	Change: From 840,000 gpm to 505,000 gpm (60% flow)
01 Nov - 31 Dec	505,000 gpm

and biocharacteristics data were collected on all days in 1989 when blue crabs were present in impingement collections. Water quality data were collected at Units 2 and 3 intakes on days when either fish or blue crabs were collected. At Unit 2, allocation quotas of sampling days were met in the winter strata whereas 10 of the 11 allocated summer samples and 63 of the allocated 68 fall samples were collected. None of the allocated 8 spring stratum samples were collected (Table 3). At Unit 3, allocation quotas were met in only the summer stratum. In the other strata, 23 of the allocated 24 fall samples, 20 of the allocated 35 winter samples and none of the 20 spring allocated samples were collected. No impingement collections were made during plant outages. Refueling outages at Unit 2 occurred between March 22 and July 1, 1990; at Unit 3 the refueling outages occurred between February 11 and July 1, 1990.

Although a plant day is defined as any given day where at least one circulator operated for any time, this does not mean that valid impingement samples were possible on those days. In order for an impingement sample to be valid, a thorough cleaning of all screens (both fixed and traveling screens at Unit 2 and traveling screens at Unit 3) must occur at least 24 hours before the scheduled impingement sample and all circulators operating at the time of collection must have been operating continuously throughout the 24 hr period.

The operational records for circulators at Units 2 and 3 throughout the Spring (April - June) stratum revealed that there were only 11 days at Unit 2 (compared to the 31 days listed in Table 3 as "operating days") which met the valid sampling criteria. However, due to maintenance activities during the refueling outage, daily screen washes of the fixed and travelling screens did not begin at Unit 2 until July 1, 1990. At Unit 3, where there were 26 days that met the valid sampling criteria (compared to 74 days listed in Table 3 as "operating days"); however, construction activites near the screen wash collection pit prevented sample collection until July 1, 1990

Screens were washed daily, generally between 0800 and 1200 hours. Each sample day began at the time of a scheduled daily wash and concluded at the time of the subsequent scheduled wash. On preselected random sampling days fish were collected from the screenwash of Unit 2 intakes 21-25 combined, Unit 2 intake 26 (Ristroph screen), and Unit 3 intakes 31-36 combined. On nonsample days fish and debris were disposed of without enumeration. On occasions when sampling could not be carried out due to outages, abnormal screenwash

TABLE 3

NUMBERS OF FISH IMPINGEMENT COLLECTION DAYS AND DAYS OF PLANT OPERATION AT INDIAN POINT UNITS 2 AND 3 DURING 1989

UNIT	SEASONAL STRACTION	DAYS OF PLANT OPERATION[a]	DAYS OF FISH IMPINGEMENT	DAYS ALLOCATED IN STRATIFIED DESIGN
2	Winter (Jan - Mar)	87	23	23
	Spring (Apr - Jun)	31	0	8
	Summer (Jul - Sept)	92	10	11
	Fall (Oct - Dec)	92	63	68
	Total	302	96	110
3	Winter (Jan - Mar)	43	20	35
	Spring (Apr - Jun)	74	0	20
	Summer (Jul - Sept)	92	31	31
	Fall (Oct - Dec)	92	23	24
	Total	301	74	110

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

Note: A plant operating day as defined here does not mean that valid impingement samples could be collected. See Section 3.2.1 for what defines a valid sample day.

procedures, or unexpected operating conditions, an additional sampling day was randomly selected from the remaining nonsample days in the stratum (if any remained) to replace the one lost. If unscheduled screenwashes 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 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. The validity of this assumption is shown by the close correspondence between sample and operating days in the average daily circulating volumes observed each month at Unit 2 (Table 4) and Unit 3 (Table 5).

3.2.2 Sample Collection

Impingement samples were obtained from collection areas at the end of the Unit 2 and Unit 3 sluiceways and at a separate collection area for the Ristroph screen 26. Each sample effort began with a screenwash 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 increments until the entire screen broke water and 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 1989 so that there was no fixed screen to be washed before washing each traveling screen. Each sample ended with the start of the next scheduled screenwash, 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 nonsample days only blue crabs were kept for processing. Temperature (°C) and conductivity (micro-siemens/cm) were measured

TABLE 4

COMPARISON OF SAMPLING DATES, AVERAGE DAILY SAMPLING VOLUMES, OPERATING DATES, AND AVERAGE DAILY OPERATING VOLUMES AT INDIAN POINT UNIT 2 DURING 1989

MONTH	SAMPLING DATES	AVERAGE DAILY SAMPLING VOLUME (10^6 m^3)	STANDARD DEVIATION	OPERATING DATES	AVERAGE DAILY OPERATING VOLUME (10^6 m^3)*	STANDARD DEVIATION
JAN	5, 10, 15, 18, 19, 20, 22, 27, 29	2.66	0.22	1-31	2.70	0.00
FEB	1, 2, 4, 21, 27, 28	2.78	0.07	1-28	2.75	0.00
MAR	1-4, 7, 8, 10, 20	2.47	0.58	1-21, 25-31	1.93	1.06
APR				1-5, 7-13	0.31	0.27
MAY				-	-	-
JUN				12-30	1.37	0.69
JUL	10, 11, 13, 25, 26	4.21	0.45	1-31	4.38	0.34
AUG	8, 16, 22, 31	4.25	0.68	1-31	4.54	0.09
SEP	19	4.32		1-30	4.53	0.10
OCT	2-5, 8-10, 12-14, 16-18, 20, 22, 24, 26, 29, 31	3.67	0.85	1-31	3.58	0.95
NOV**	4-10, 13, 14, 16-18, 20, 22-24, 26, 28-30	2.34	0.53	1-30	2.38	0.57
DEC**	1, 5-11, 13-16, 18-24, 27-31	2.55	0.52	1-31	2.57	0.47

*Includes service water, except days when no circulating pump operated.
**The 11 November, 12 December, 17 December and 26 December Ristroph only samples not included.

Note:A unit was considered operating on a day if any circular pump operated for any time on that day. However, a plant operating day as defined here does not mean that valid impingement samples could be collected. See Section 3.2.1 for what defines a valid sample day.

TABLE 5

COMPARISON OF SAMPLING DATES, AVERAGE DAILY SAMPLING VOLUMES, OPERATING DATES, AND AVERAGE DAILY OPERATING VOLUMES AT INDIAN POINT UNIT 3 DURING 1989

MONTH	SAMPLING DATES	AVERAGE DAILY SAMPLING VOLUME (10_6 m_3)	STANDARD DEVIATION	OPERATING DATES	AVERAGE DAILY OPERATING VOLUME (10^6 m^3)*	STANDARD DEVIATION
JAN	2, 10, 14, 15, 17-22, 27-29	2.54	0.26	1-31	2.56	0.15
FEB	1, 2, 4, 6, 7, 8, 10	1.25	1.14	1-10	1.29	1.14
MAR				29, 31	0.04	0.01
APR				1-3, 14-23, 26-28	0.18	0.12
MAY				2-6, 8-15, 17-31	0.23	0.18
JUN				1-30	1.52	1.33
JUL	2, 5, 8-11, 13, 17, 19, 23-26, 29	4.40	0.46	1-31	4.44	0.07
AUG	2, 5, 6, 8, 9, 11, 12, 16, 22, 23, 31	4.31	0.22	1-31	4.47	0.09
SEP	1, 3, 9, 19, 21, 25	4.43	0.41	1-30	4.55	0.06
OCT	8, 9, 17, 18, 22	3.36	1.35	1-31	3.64	0.92
NOV	2, 4, 10, 11, 18, 23, 28, 30	2.62	0.22	1-30	2.72	0.01
DEC	1, 2, 5, 12, 15, 18, 21, 23, 27, 31	2.23	0.33	1-31	2.42	0.21

*Includes service water, except days when no circulating pump operated.

Note:
A unit was considered operating on a day if any circular pump operated for any time on that day. However, a plant operating day as defined here does not mean that valid impingement samples could be collected. See Section 3.2.1 for what defines a valid sample day.

at the intake of Units 2 and 3 at 0.3 m (1 ft) 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 (Appendix Table B-1). 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

Length Class 4 = 251 mm and larger

The Division 1 cutoff used to define Length Class 1 represents the upper length limits of young-of-the-year for all species. The Division 2 cutoff represents the upper length limit for yearling alewife, American shad, blueback herring, striped bass, Atlantic tomcod, and white perch. Consequently, Length Class 2 individuals for these species are all yearlings. For all other species, Division 2 is arbitrarily set to 150 mm TL. Values for the division cutoffs were determined from historical and current data obtained from impingement collections. These values were updated weekly during the period of rapid growth for young-of-the-year Atlantic tomcod, white perch, and striped bass. During the remainder of the year, updates were prepared on a biweekly basis.

Subsamples were taken for any species if the total number of fish in Length Class 1 or Length Class 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 in Tables B-2

through B-7. For each species, weights were recorded to the nearest gram for Length Class 1, Length Class 2, and the total of all four length classes (Tables B-8 through B-10).

A maximum of 30 individual specimens from all available length classes were measured for total length (nearest mm) each week for the following 13 selected species:

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

Individual measurements were recorded only from regularly scheduled or rescheduled impingement collections. Length measurement records were compiled by sample number so as to associate individual measurements with the three locations (i.e., Unit 2, 21-25; Unit 2, Ristroph 26; and Unit 3, 31-36).

Total number and total weight of blue crabs impinged each operating day were recorded. If less than 50 blue crabs were present in a sample then the following biocharacteristic data were recorded for each specimen: weight (nearest 0.1 g), survival (alive or dead), condition (intact or missing body parts), sex (Table B-11) and carapace width to the nearest millimeter (Table B-12). If more than 50 blue crabs were present in a sample, then a subsample of 50 blue crabs was 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 the case of subsampling, sex, alive/dead status, and condition were determined only for the 50 crabs in the subsample. After processing, all living crabs were returned to the Hudson River away from the intake structure.

Any shortnose or Atlantic sturgeon collected were measured (total length in mm), weighed, and the data entered in a sturgeon log. Living sturgeon were returned to the Hudson River. All striped bass collected on both sampling and nonsampling days were checked for hatchery implanted magnetic tags. Any suspected recaptures were preserved by freezing for later verification.

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 1 ft 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, length measurements, crab measurements, and examination 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 on the conductivity and temperature measurement systems were performed using standard KCl solutions and NBS traceable thermometers obtained from EA Engineering's (EAs) regional 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 to 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

T_2 and T_3 = intake water temperature (°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). These estimates of collection efficiency were used to adjust impingement collections at Unit 2, screens 21-25, and at Unit 3 to estimate total impingement.

For the Ristroph screen (screen 26) at Unit 2, the following screen-specific collection efficiency values were determined based on the results of Ristroph Screen Special Studies (1 January - 19 April 1985) and the Ristroph Screen Survival Studies (16 July - 31 December 1985):

MONTH	RISTROPH SCREEN COLLECTION EFFICIENCY
January	74.4%
February	74.4%
March	74.4%
July	18.7%
August	18.7%
September	29.6%

These screen-specific collection efficiency estimates were used to adjust impingement collections during months for which estimates were available. The design of the Ristroph screen is such that there is little opportunity for impinged fish to be washed off the screen and not be collected. The low collection efficiency estimates of 18.7% for July and August and 29.6% for September occurred in months when crabs were present and may in part be due to crab predation.

For other months, the collection efficiency for screen 26 was assumed to be the same as for screens 21-25 at Unit 2. Since the Ristroph screen at Unit 2 does not include the use of fixed screens and is operated continuously with the fish being retained in collection buckets, this assumption was most likely conservative resulting in overestimates of impingement for screen 26.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 WATER QUALITY

Daily intake water temperature averaged for both units rose from a seasonal low in late-January of 2.0°C to a high of 33.0°C in early-August and subsequently declined to 4°C by early-December (Figure 1, Table B-1). Daily intake conductivity fluctuated during the year with lowest conductivity levels recorded during early-June when values less than 1,000 µS/cm were recorded with occasional periods of 1,000-3,000 µS/cm. Conductivity was at its highest during the summer and early fall with values of 3,000-11,000 µS/cm. This is a characteristic seasonal pattern. During fall, conductivity once again dropped to levels generally below 1,000 µS/cm.

4.2 ESTIMATED NUMBERS OF FISH IMPINGED DURING 1988

A combined total of 229,523 fish were collected at Indian Point Units 2 and 3 in 1989 (Table B-4). When adjusted for collection efficiency and scaled to the number of operational days, the estimated total number impinged was 787,767 fish at Unit 2 and 277,403 at Unit 3 (Tables 6 and 7) for a combined total of 1,065,170 fish weighing an estimated 7,499 kg (Table B-10). The levels of precision (standard errors) were 7.7 and 12.0% of the total estimates for Unit 2 and Unit 3, respectively. The level of precision for Unit 2 was consistent with levels projected for Unit 2 (9.5% [TI 1980b] and 7.8% [NAI 1984b]) using the stratified random design. The level of precision at Unit 3 was only slightly less precise than the levels projected for Unit 3 (8.2% [TI 1980b] and 7.7% [NAI 1984b]). Historically, precision has ranged from 8.7 to 29.2% at Unit 2 and from 8.3 to 17.2% at Unit 3 (Con Edison 1983, NAI 1984a, 1986, 1987, MMES 1985, EA 1988, 1989).

The total number of fish impinged by Units 2 and 3 combined in 1989, estimated at 1.07 million (Tables 6 and 7), was within the range of other yearly estimates in the 1976-1988 historical database (range 0.85-6.47 million) (Table 8). It was slightly higher than estimates of impingement during the combined winter, summer, and fall strata of 1985-1988 (range 0.93-

FIGURE 4

SEASONAL PATTERN IN WATER TEMPERATURE AND CONDUCTIVITY DURING IMPINGEMENT COLLECTIONS AT INDIAN POINT, 1989

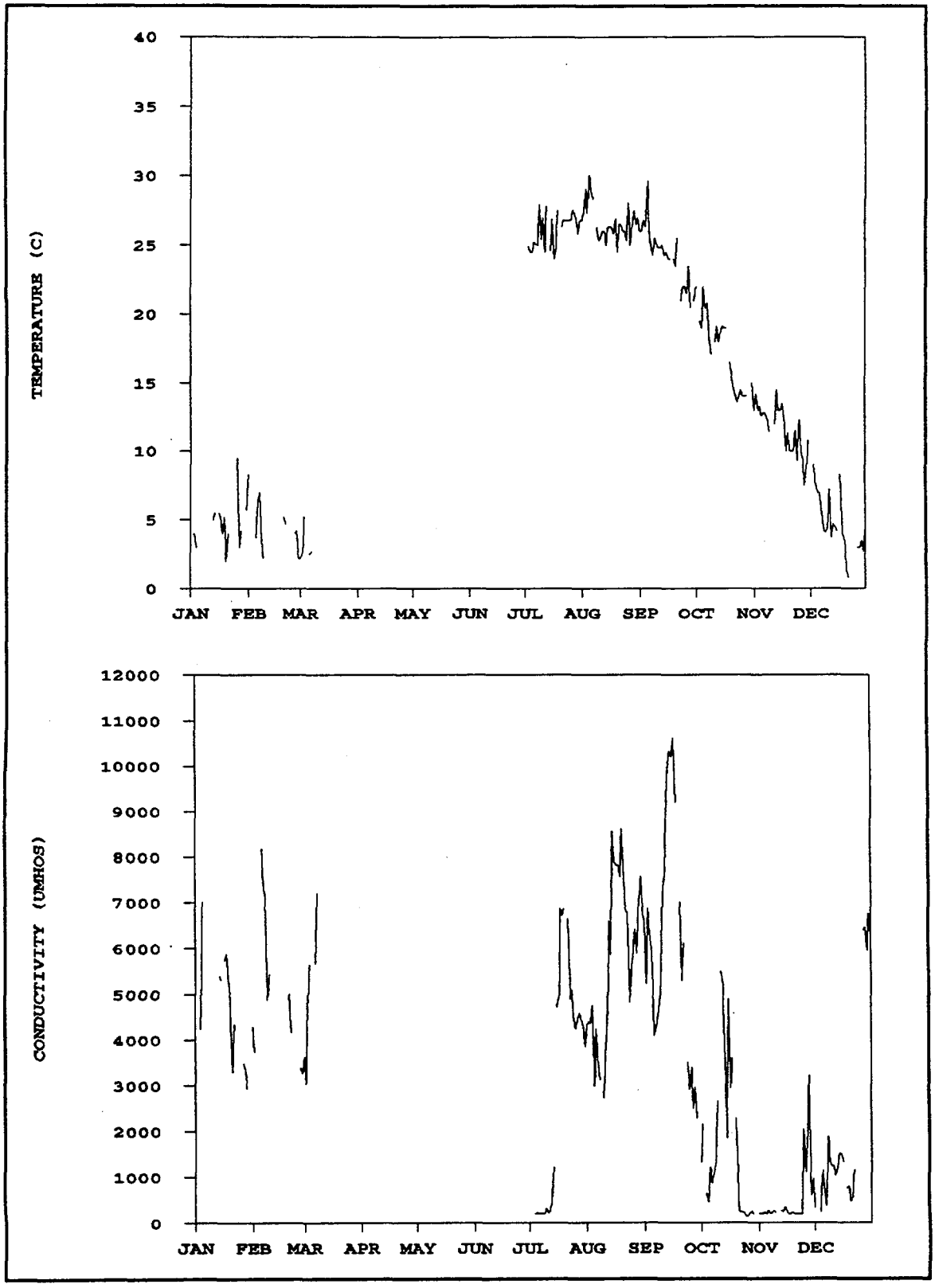


TABLE 6

ESTIMATED NUMBER OF FISH IMPINGED AT INDIAN POINT UNIT 2 DURING 1989 BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

TAXON	STRATUM			1989 TOTAL	STANDARD ERROR	COEFFICIENT OF VARIATION
	WINTER	SUMMER	FALL			
Alewife	4	68	12	584	164	28.1
Bay anchovy	359	313	824	1,496	259	17.3
American shad	8	1,270	2,160	3,438	622	18.1
Bluefish	0	598	29	627	251	40.0
Bluegill	132	248	866	1,246	264	21.2
Brown bullhead	235	0	64	299	92	30.8
Pumpkinseed	647	74	1,095	1,816	246	13.5
Black crappie	4	0	28	32	7	21.9
Carp	23	0	9	32	2	37.5
American eel	159	368	767	1,294	160	12.4
Goldfish	174	0	32	206	44	21.4
Golden shiner	19	46	39	104	46	44.2
Hogchoker	4,596	38,769	43,512	86,877	26,329	30.3
Tessellated darter	91	46	150	287	55	19.2
Banded killifish	1,630	193	165	1,988	473	23.8
Largemouth bass	0	46	23	69	44	63.8
Mummichog	19	0	3	22	12	54.5
Atlantic menhaden	0	147	12	159	139	87.4
Chain pickerel	0	0	3	3	2	66.7
Blueback herring	45	230	22,958	23,233	3,481	15.0
White sucker	0	0	4	4	2	50.0
Rainbow smelt	242	0	64	306	66	21.6
Spottail shiner	1,729	96	1,684	3,809	676	17.7
Striped bass	9,290	4,664	7,093	21,047	2,841	13.5
Fourspine stickleback	19	0	0	19	9	47.4
Atlantic tomcod	469	708	4,905	6,082	714	11.7
White catfish	1,468	304	7,744	9,516	689	7.2
White perch	372,655	10,148	218,542	601,345	45,795	7.8
Yellow perch	189	0	485	674	179	26.6
Redbreast sunfish	68	37	28	133	49	36.8
Crevalle jack	0	64	39	103	61	59.2
Weakfish	0	4,839	1,288	6,127	2,219	36.2
Clupeid unidentified	0	37	66	103	51	49.5
Tautog	4	0	6	10	4	40.0
Fourbeard rockling	11	0	0	11	7	63.6
Atlantic moonfish	0	0	4	4	2	50.0
Winter flounder	11	0	41	52	9	17.3
Tidewater silverside	15	0	15	30	10	33.3
Gizzard shad	3,351	0	9,789	13,140	3,507	26.7
Silver hake	102	0	166	268	74	27.6
Sea lamprey	23	0	6	29	14	48.3
Threespine stickleback	499	0	0	499	100	20.0
Butterfish	0	28	0	28	26	92.9
White crappie	0	0	3	3	2	66.7
Northern puffer	0	0	4	4	2	50.0
Centrarchid unid.	8	0	108	116	19	16.4
Red hake	98	0	188	286	60	21.0
Summer flounder	0	0	19	19	5	26.3
Grubby	8	0	3	11	7	63.6
Striped searobin	0	0	70	70	17	24.3
Atlantic croaker	4	0	6	10	4	40.0
White mullet	0	0	3	3	2	66.7
Naked goby	4	0	48	52	9	17.3
Inshore lizardfish	0	0	4	4	2	50.0
Gray snapper	0	0	13	13	4	30.8
Freshwater drum	0	0	25	25	6	24.0
Total	398,412	63,941	325,414	787,767	60,420	7.7

TABLE 7

ESTIMATED NUMBER OF FISH IMPINGED AT INDIAN POINT UNIT 3 DURING 1989 BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

TAXON	WINTER	SUMMER	FALL	1989 TOTAL	STANDARD ERROR	COEFFICIENT OF VARIATION
Alewife	0	656	204	860	121	14.1
American shad	0	2,588	3,280	5,868	1,081	18.4
Bay anchovy	127	3,689	756	4,572	1,205	26.4
Bluefish	0	597	8	605	86	14.2
Bluegill	34	74	416	524	177	33.8
Brown bullhead	15	24	12	51	15	29.4
Pumpkinseed	168	12	64	244	39	16.0
Black crappie	4	0	8	12	7	58.3
Carp	2	0	20	22	12	54.5
American eel	22	89	104	215	34	15.8
Goldfish	34	0	16	50	14	28.0
Golden shiner	0	0	12	12	8	66.7
Hogchoker	1,253	24,576	8,572	34,401	6,200	18.0
Tessellated darter	0	0	32	32	16	50.0
Banded killifish	77	12	48	137	26	19.0
Largemouth bass	0	6	8	14	8	57.1
Atlantic menhaden	2	71	16	89	28	31.5
Blueback herring	24	2,119	30,592	32,735	10,818	33.0
Rainbow smelt	30	30	24	84	17	20.2
Spottail shiner	151	6	240	397	102	25.7
Striped bass	1,892	1,015	840	3,747	499	13.3
Fourspine stickleback	2	0	0	2	1	50.0
Atlantic tomcod	90	1,416	916	2,422	469	19.4
White catfish	163	113	1,620	1,896	458	24.2
White perch	72,085	3,247	72,380	147,712	30,301	20.6
Yellow perch	9	6	48	63	42	66.7
Northern pipefish	0	18	0	18	11	61.1
Redbreast sunfish	4	0	0	4	2	50.0
Crevalle jack	0	89	8	97	32	33.0
Weakfish	0	31,354	548	31,902	11,151	35.0
Lookdown	0	12	0	12	10	83.3
Clupeid unidentified	0	573	0	573	315	55.0
Tautog	0	0	20	20	12	60.0
Spot	2	0	0	2	1	50.0
Winter flounder	0	0	8	8	7	87.5
Tidewater silverside	6	0	0	6	5	83.3
Sea lamprey	2	0	0	2	1	50.0
Gizzard shad	4,287	6	3,192	7,485	1,117	14.9
Silver hake	17	0	16	33	16	48.5
Threespine stickleback	9	0	0	9	5	55.6
Butterfish	0	157	0	157	47	29.9
Centrarchid unid	0	0	16	16	10	62.5
Red hake	26	0	44	70	29	41.4
Summer flounder	0	77	8	85	22	25.9
Striped searobin	0	0	56	56	35	62.5
Atlantic croaker	0	0	8	8	7	87.5
Naked goby	0	0	16	16	10	62.5
Windowpane	0	24	0	24	9	37.5
Gray snapper	0	0	8	8	7	87.5
Freshwater drum	0	0	20	20	10	50.0
King mackerel	0	6	0	6	5	83.3
Total	80,537	72,662	124,204	277,403	33,205	12.0

TABLE 8

TOTAL VOLUME CIRCULATED AT INDIAN POINT UNITS 2 AND 3 COMBINED, ESTIMATED NUMBER OF FISH IMPINGED, IMPINGEMENT RATE, AND NUMBER OF SPECIES COLLECTED DURING 1976-1989

YEAR	VOLUME (10^6 m^3)*	ESTIMATED NUMBER IMPINGED (10^6)**	IMPINGEMENT RATE (#/10^6 m^3)	NUMBER SPECIES COLLECTED
1976	1,329	1.63	1,190	58
1977	2,159	6.47	2,910	72
1978	2,030	3.91	1,870	72
1979	1,935	4.48	2,230	74
1980	1,822	3.21	1,710	76
1981	1,617	4.57	2,830	72
1982	1,273	1.60	1,260	43
1983	1,286	0.85	661	49
1984	1,710	0.85	496	56
1985	1,977	1.08	556	79
1986	1,892	1.09	577	65
1987	1,815	1.54	848	62
1988	2,322	1.14	489	65
1989	1,748	1.07	609	61

*Including service water.
**Adjusted for collection efficiency.

1.01 million) (Table 9). The volume of water circulated through Indian Point Generating Station during 1989 (1,748 x 10^6 m^3) was within the range (1,273-2,322 x 10^6 m^3) reported over the past 13-year period (Table 8). The resulting overall impingement rate for all taxa (609/10^6 m^3) was also within the range of previously reported values (489-2,910/10^6 m^3).

Total estimated impingement abundance at Unit 2 was highest during the winter stratum followed by fall and summer (Table 6). The high estimated impingement during winter at Unit 2 was similar to the pattern observed in many previous years. Estimated mean daily numbers impinged for each seasonal stratum followed a similar seasonal pattern with higher rates during winter and fall (Table 10). At Unit 3, total estimated impingement abundance followed a similar pattern, being highest during fall, followed by winter and summer (Table 7). As with Unit 2, estimated mean daily numbers impinged at Unit 3 were highest during the winter and fall strata (Table 10).

The precision of estimated total impingement for individual fish species at Units 2 and 3 varied greatly (7-96%). As expected, most species with high coefficients of variation (>60%) occur infrequently and in low numbers (<10) in the impingement collections (Tables B-2 through B-7). Most of these species typically occur infrequently in the Indian Point area (largemouth bass, gray snapper, Atlantic croaker, king mackerel, lookdown, winter flounder, and butterfish). Conversely, a few other fish species with a relatively high degree of precision (coefficients of variation <15%) for impingement abundance estimates were impinged at Unit 2 largely during the fall stratum and to a lesser extent, the winter stratum, which had very large allocations of sampling dates (pumpkinseed, blueback herring, and white catfish). This effect was less evident at Unit 3 where allocation of sampling dates was more uniform among seasonal strata.

4.3 SPECIES COMPOSITION AND RELATIVE ABUNDANCE

Fish collected in impingement samples during 1989 totaled 299,523 and comprised 61 species for Units 2 and 3 combined (Table 11). Among these species, 22 were primarily marine species tolerant of only minimal freshwater influences, 19 were primarily freshwater inhabitants, 19 were euryhaline species tolerant at one time or another of a wide range of

TABLE 9

ESTIMATED NUMBER OF FISH IMPINGED AT INDIAN POINT IN 1982-1989 DURING THE COMBINED FALL, WINTER, AND SUMMER STRATA

YEAR	UNIT 2	UNIT 3	TOTAL
1982	704,757	695,864*	1,400,621
1983	702,985	1,609**	704,594
1984	282,164*	356,546	638,710
1985	625,316	310,531	935,847
1986	650,002	292,842	942,844
1987	771,454	239,374	1,010,820
1988	812,738	169,853	982,591
1989	787,767	277,403	1,065,170

*No summer stratum estimate.
**No winter and fall strata estimates.

TABLE 10

ESTIMATED MEAN DAILY NUMBER OF FISH IMPINGED IN EACH SEASONAL STRATUM AT INDIAN POINT UNITS 2 AND 3 DURING 1989

UNIT	SEASONAL STRATUM	NUMBER OF SAMPLING DAYS	DAYS ALLOCATED IN STRATIFIED DESIGN	MEAN DAILY ESTIMATE*	STANDARD DEVIATION
2	Winter (Jan - Mar)	23	23	4579.4	2883.9
	Spring (Apr - Jun)	0	8	-	-
	Summer (Jul - Sep)	10	11	695.0	1207.6
	Fall (Oct - Dec)	63	68	3537.1	3560.7
	Total	96	110	3490.8**	
3	Winter (Jan - Mar)	20	35	1873.0	1868.6
	Spring (Apr - Jun)	0	20	-	-
	Summer (Jul - Sep)	31	31	789.8	1160.8
	Fall (Oct - Dec)	23	24	1350.0	1998.7
	Total	74	110	1256.7**	

*Adjusted for collection efficiency.
**Stratified mean daily estimate.

TABLE 11 (Page 1 of 2)

FISH SPECIES COLLECTED IN IMPINGEMENT SAMPLING AT INDIAN POINT UNITS 2 AND 3 IN 1989

COMMON NAME	SCIENTIFIC NAME	SALINITY PREFERENCE
Alewife	*Alosa pseudoharengus*	e
Bay anchovy	*Anchoa mitchilli*	e
American shad	*Alosa sapidissima*	e
Bluefish	*Pomatomus saltatrix*	m
Bluegill	*Lepomis macrochirus*	f
Brown bullhead	*Ictalurus nebulosus*	f
Pumpkinseed	*Lepomis gibbosus*	f
Black crappie	*Pomoxis nigromaculatus*	f
Carp	*Cyprinus carpio*	f
American eel	*Anguilla rostrata*	e
Goldfish	*Carassius auratus*	f
Golden shiner	*Notemigonus crysoleucas*	f
Hogchoker	*Trinectes maculata*	e
Tessellated darter	*Etheostoma olmstedi*	f
Banded killifish	*Fundulus diaphanus*	f
Largemouth bass	*Micropterus salmoides*	f
Mummichog	*Fundulus heteroclitus*	e
Atlantic menhaden	*Brevoortia tyrannus*	m
Chain pickerel	*Esox niger*	f
Blueback herring	*Alosa aestivalis*	e
White sucker	*Castosomus commersoni*	f
Rainbow smelt	*Osmerus mordax*	e
Shortnose sturgeon	*Acipenser brevirostrum*	e
Spottail shiner	*Notropis hudsonius*	f
Striped bass	*Morone saxatilis*	e
Fourspine stickleback	*Apeltes quadracus*	e
Atlantic tomcod	*Microgadus tomcod*	e
White catfish	*Ictalurus catus*	f
White perch	*Morone americana*	e
Yellow perch	*Perca flavescens*	f
Northern pipefish	*Syngnathus fuscus*	e
Redbreast sunfish	*Lepomis auritus*	f
Crevalle jack	*Caranx hippos*	e
Weakfish	*Cyanoscion regalis*	m
Lookdown	*Selene vomer*	e
Cluepid unidentified	*Clupea sp.* unidentified	
Tautog	*Tautoga onitis*	m
Fourbeard rockling	*Enchelyopus cimbrius*	m
Spot	*Leiostomus xanthurus*	m
Atlantic moonfish	*Selene setapinnis*	m
Scup	*Stenotomus chrysops*	m
Winter flounder	*Pseudopleuronectes americanus*	m

TABLE 11 (Page 2 of 2)

FISH SPECIES COLLECTED IN IMPINGEMENT SAMPLING AT INDIAN POINT UNITS 2 AND 3 IN 1989

COMMON NAME	SCIENTIFIC NAME	SALINITY PREFERENCE
Tidewater silverside	*Menidia peninsulae*	e
Sea lamprey	*Petromyzon marinus*	a
Gizzard shad	*Dorosoma cepedianum*	f
Silver hake	*Merluccius bilinearis*	m
Threespine stickleback	*Gasterosteus aculeatus*	e
Butterfish	*Peprilus triacanthus*	m
White crappie	*Poxmoxis annularis*	f
Northern puffer	*Sphoeroides maculatus*	m
Centrachid unidentified	*Centrachidae sp.* unidentified	
Red hake	*Urophycis chuss*	m
Grubby	*Myoxocephalus aenaeus*	m
Summer flounder	*Paralichthys dentatus*	m
Striped searobin	*Prionotus evolans*	m
Atlantic croaker	*Micropogonias undulatus*	m
White mullet	*Mugil curema*	m
Naked goby	*Gobiosoma bosci*	e
Windowpane	*Scophthalmus aquosus*	m
Inshore lizard	*Synodus foetens*	m
Gray snapper	*Lutjanus griesus*	m
Freshwater drum	*Aplodinotus grunniens*	f
King mackerel	*Scomberomorus cavalla*	m

salinity conditions and one species was anadramous. The number of species caught in 1989 (61) was well within the range of the previous 11 years (43-79 species).

The three numerically dominant species impinged at Indian Point Units 2 and 3 in 1989 were white perch, hogchoker, and blueback herring (Table 12). Collectively, these species comprised 86.6% of the total estimated impingement abundance at the Indian Point Generating Station in 1989 and were among the top 10 species impinged in previous monitoring programs. White perch was the most abundant species, accounting for approximately 70% of the number of fish impinged (Table 12). Unit 2 collections accounted for most (80%) of the estimated impingement of this species. Hogchoker were considerably less abundant than white perch, accounting for 11.2% of the fish impinged. Unit 2 collections accounted for approximately 70% of the estimated hogchoker impingement. The abundance of blueback herring was approximately half of the hogchoker abundance, accounting for only 5.3% of the collections at both units. In contrast with the previous two species, Unit 2 collections accounted for slightly less than half (41%) of the collections of this species.

At Unit 2 and 3 outages from April through June eliminated or greatly reduced cooling water flow and no sampling was conducted during this time (Tables 4 and 5). On those days in the spring stratum when Unit 2 or 3 operated, no samples are available to estimate impingement and thus total impingement estimates are probably slightly underestimated. The schedule of plant operation at Units 2 and 3 for the rest of the year was similar to previous years, and did not appear to greatly influence estimates of species composition or impingement abundance.

4.4 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). Seasonal patterns and rates for 1989 were compared to the 1982-1988 data which were based on the same stratified sampling design used in the 1989 program.

Impingement patterns in 1989 were generally similar between Unit 2 and Unit 3 (Figure 5). Impingement rates at Units 2 and 3 were high during winter and fall primarily due to the

TABLE 12

ESTIMATED NUMBER IMPINGED AT INDIAN POINT IN 1989 AND TOTAL PERCENT COMPOSITION OF THE 15 MOST ABUNDANT SPECIES* AND ALL SPECIES COMBINED

	UNIT 2		UNIT 3		BOTH UNITS		
SPECIES	NUMBER	PERCENT	NUMBER	PERCENT	NUMBER	PERCENT	CUMULATIVE PERCENT
White perch	601,345	76.3	147,712	53.2	749,057	70.3	70.3
Hogchoker	86,877	11.0	34,401	12.4	121,278	11.4	81.7
Blueback herring	23,233	2.9	32,735	11.8	55,968	5.3	87.0
Weakfish	6,127	0.8	31,902	11.5	38,029	3.6	90.6
Striped bass	21,047	2.7	3,747	1.4	24,794	2.3	92.9
Gizzard shad	13,140	1.7	7,485	2.7	20,625	1.9	94.8
White catfish	9,516	1.2	1,896	0.7	11,412	1.1	95.9
Altantic tomcod	6,082	0.8	2,422	0.9	9,306	0.9	96.8
American shad	3,438	0.4	5,868	2.1	8,504	0.8	97.6
Bay anchovy	1,496	0.2	4,572	1.6	6,068	0.6	98.6
Spotail shiner	3,809	0.5	397	0.1	4,206	0.4	98.8
Banded killfish	1,988	0.3	137	0.0	2,125	0.2	99.0
Pumpkinseed	1,816	0.2	244	0.1	2,060	0.2	99.2
Bluegill	1,246	0.2	524	0.2	1,770	0.2	99.4
American eel	1,294	0.2	215	0.1	1,509	0.1	99.5
All species combined	787,767		277,403		1,065,170		

*Includes 9 of the 15 selected species.

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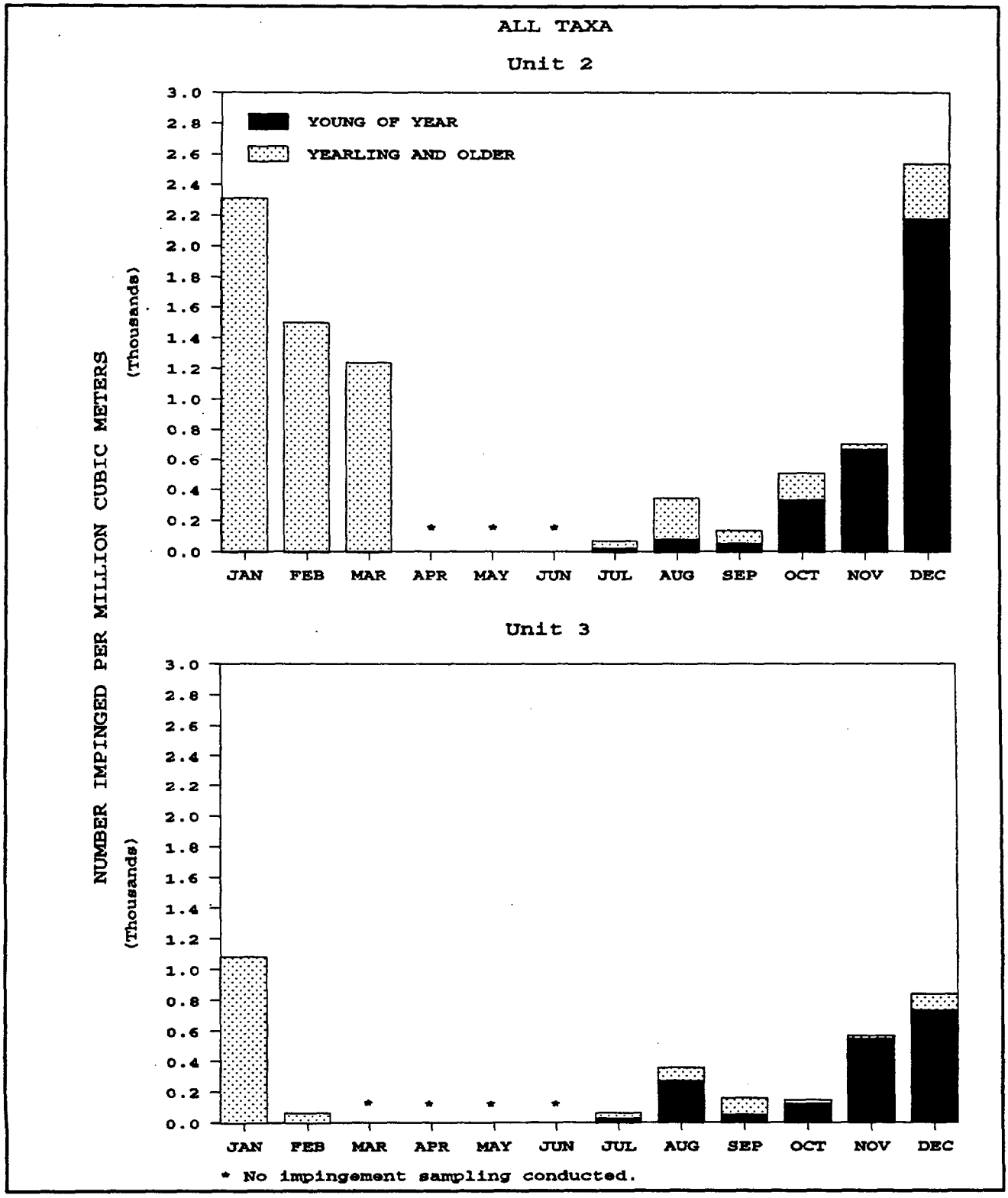
FIGURE 5

MONTHLY ADJUSTED IMPINGEMENT RATES FOR ALL TAXA COMBINED AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY



numbers of white perch (Tables B-2 and B-3). Overall monthly rates at both units were within the range reported for recent years.

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 (EPA), and current or potential importance to commercial or sport fisheries (TI 1980b):

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

Monthly impingement rates for 13 of the above species were high enough to warrant description of seasonal patterns. No Atlantic sturgeon and only one shortnose sturgeon was collected during impingement monitoring in 1989.

Atlantic tomcod were collected during all months sampled in 1989 (Figure 6). Young-of-the-year fish were considerably more abundant in impingement collections than yearling and older. Other than spring months that were not sampled, impingement rates at both units were within ranges or slightly higher than those observed in previous years (NAI 1986, 1987, EA 1988, 1989). In previous years, the highest impingement rate of young-of-the-year Atlantic tomcod occurred in the spring, with peak abundance typically occurring in June. This pattern 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).

White perch were the most numerous fish impinged in 1989 (Table 12), and were collected in all sampled months (Figure 7). Impingement rates were high during winter and fall at both Units 2 and 3 in comparison to the summer. Collections consisted mostly of yearling and older fish in winter and young-of-the-year in the fall. In keeping with conventional nomen-

FIGURE 6

MONTHLY ADJUSTED IMPINGEMENT RATES FOR ATLANTIC TOMCOD AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

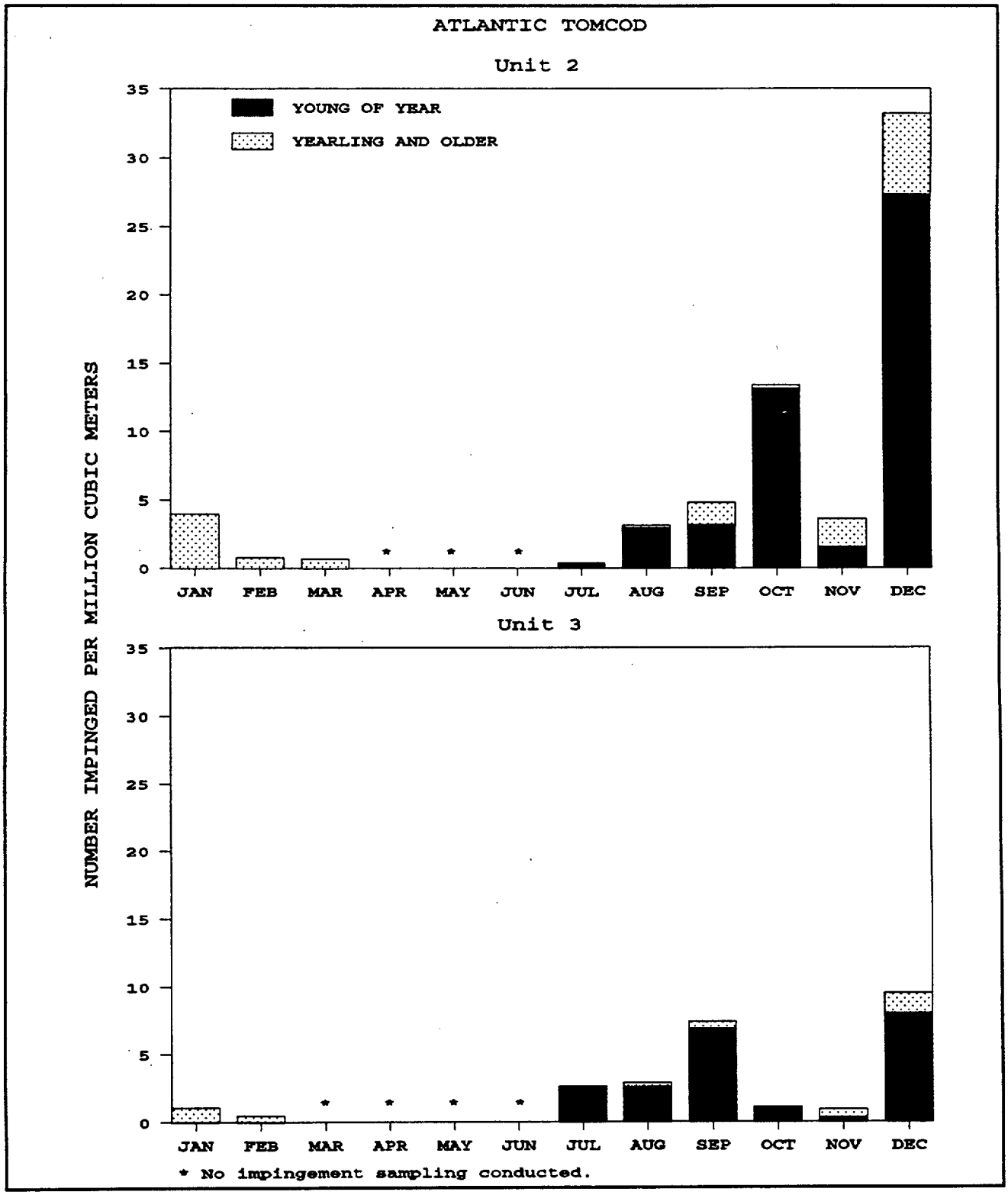
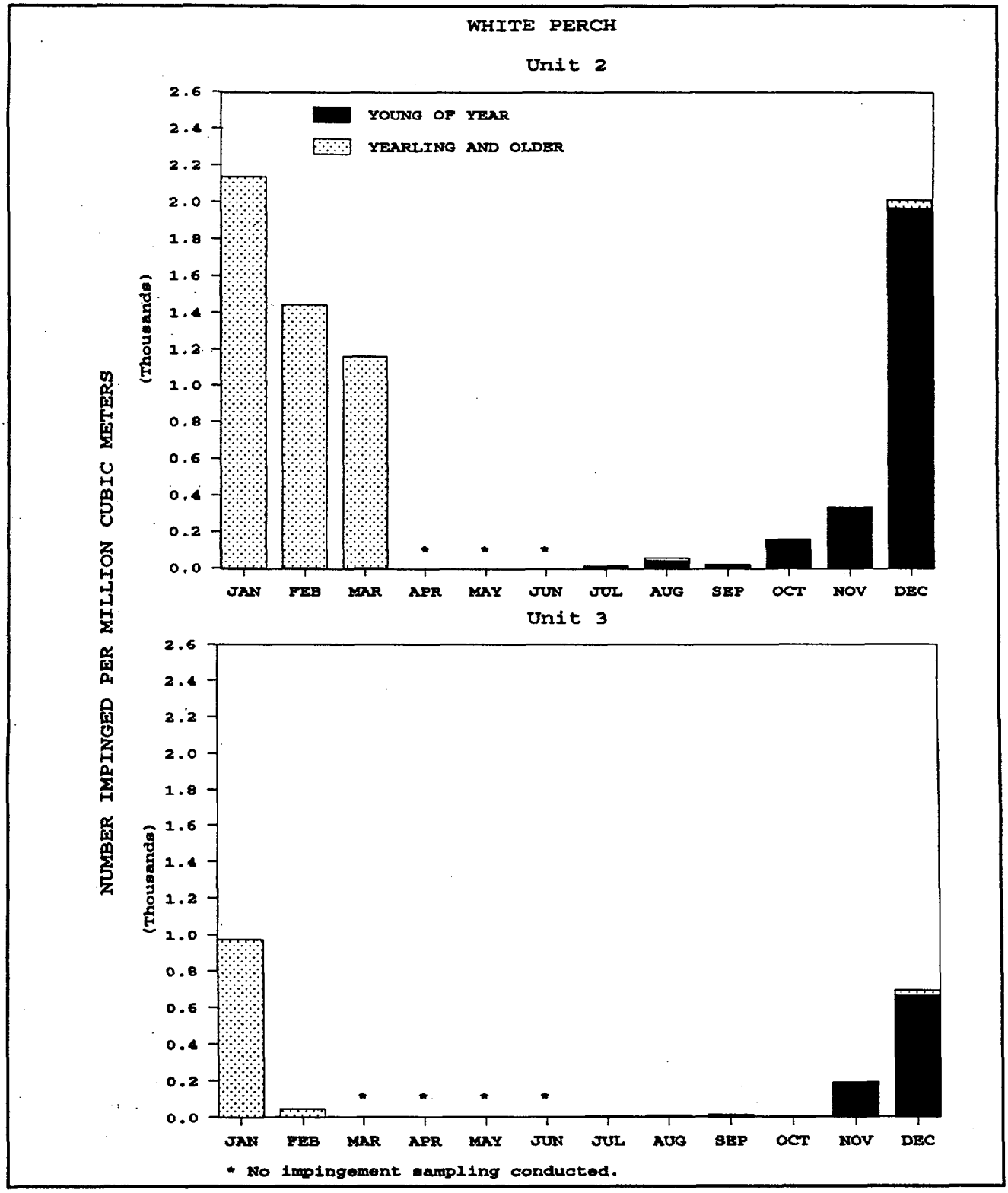


FIGURE 7

MONTHLY ADJUSTED IMPINGEMENT RATES FOR WHITE PERCH AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY



clature, on the first day of January the previous fall's young-of-the-year are called yearlings. Collections in December of 1988 were composed primarily of fall young-of-the-year (>90%) (EA 1988). Winter 1989 collections of yearling and older fish are thus most likely to be composed primarily of the previous fall's young-of-the-year. Typically, impingement rates are high in the winter decrease in the spring, and remain low during the summer. Impingement rates increase again in the fall as young-of-the-year white perch move down from the upper and middle estuary as the salt front recedes and the temperature in the upper river portion declines (LMS 1989). This seasonal pattern was consistent with patterns presented in previous years' reports (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

Except for July at Unit 2, bay anchovy were impinged in all sampled months with yearling and older fish most numerous August through October. Young-of-the-year fish were present from August through December and were most abundant late summer to early-fall (Figure 8). Bay anchovy spawn in the high salinity waters of the lower estuary primarily from June through August (NAI 1985). A portion of the bay anchovy yearling and older population use the Indian Point region as a feeding ground prior to spawning (NAI 1985). The young-of-the-year fish impinged from August 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. Except for the peak monthly impingement rate ($7.2/10^6$ m^3) being slightly lower at Unit 2 than previous years, the seasonal pattern of impingement and magnitude of monthly impingement during 1989 were comparable to previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

Hogchoker were impinged during all sampled months in 1989 (Figure 9). Yearling and older fish comprised the majority of the total hogchoker impingement abundance with young- of-the-year primarily recorded from October through December. As young-of-the-year have typically been impinged in high numbers throughout the spring stratum, the seasonal pattern of hogchoker impingement cannot be compared for seasonal patterns with previous years. Overall monthly impingement rates were higher in 1989 than previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

FIGURE 8

MONTHLY ADJUSTED IMPINGEMENT RATES FOR BAY ANCHOVY AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

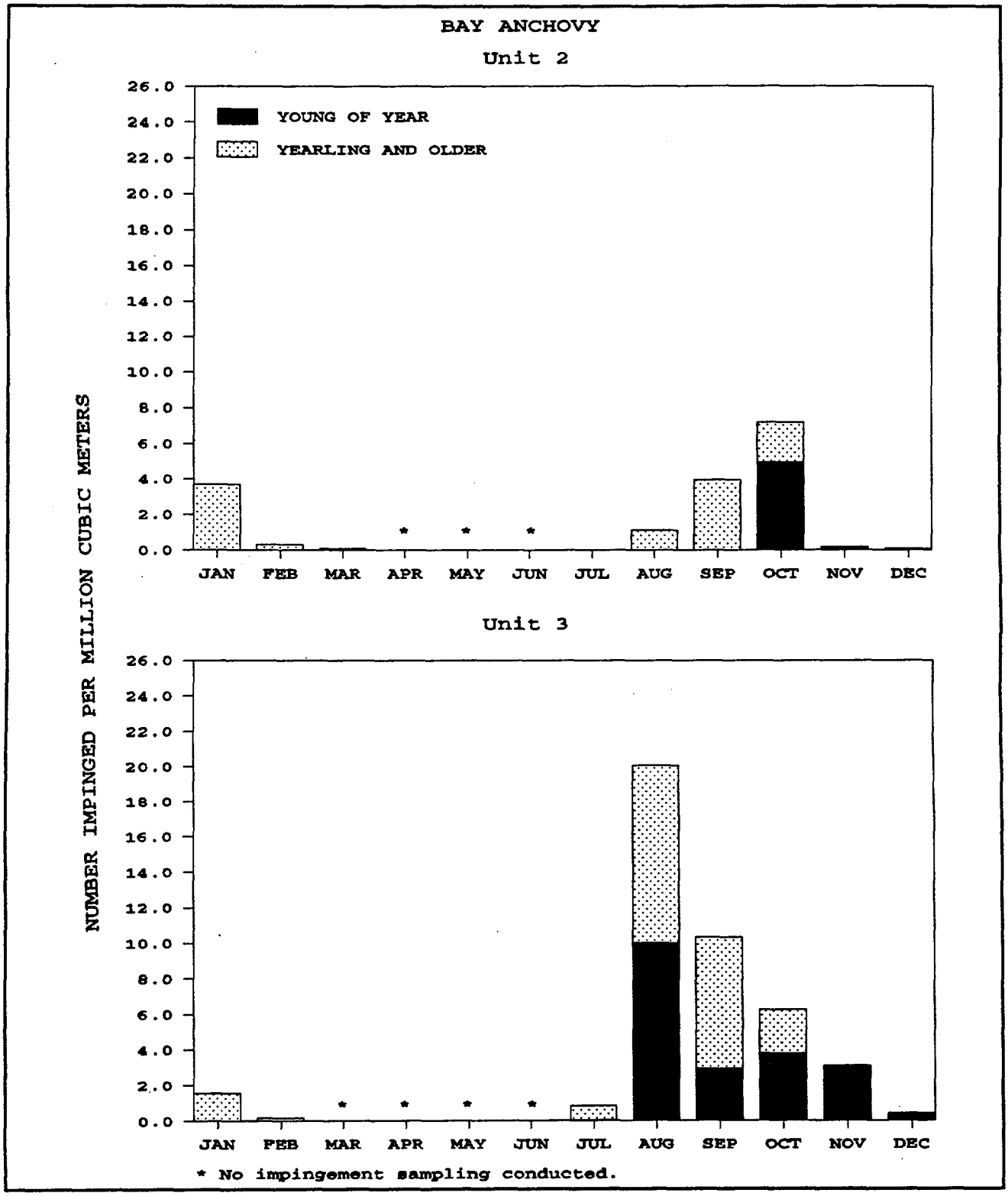
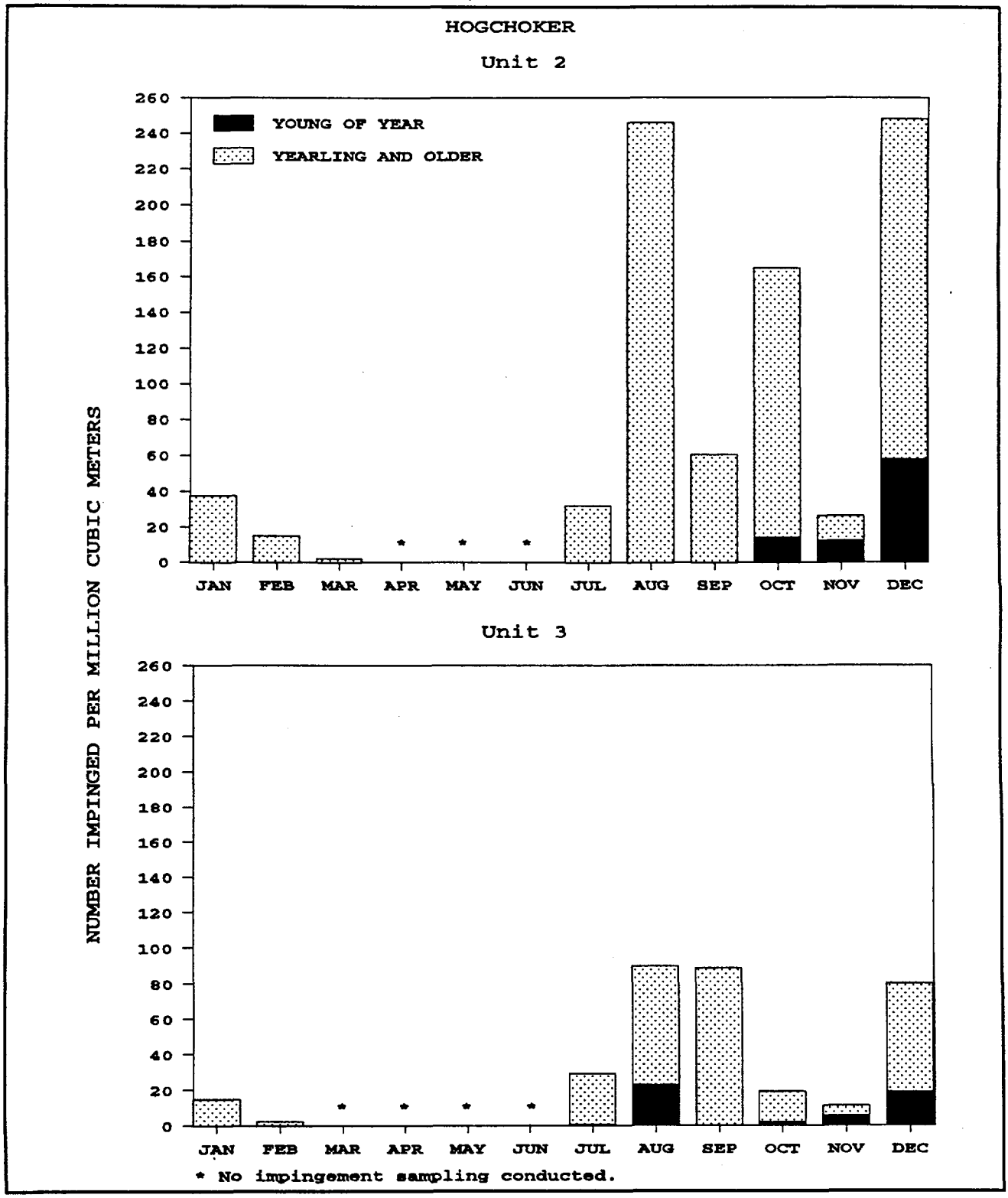


FIGURE 9

MONTHLY ADJUSTED IMPINGEMENT RATES FOR HOGCHOKER AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY



Blueback herring were collected in impingement samples primarily during October and November (Figure 10). This fall peak consisted totally of young-of-the-year. In previous years there was limited spring impingement of yearling and older fish. This pattern was similar to that observed in most prior years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989). Yearling and older fish migrate upriver during spring to spawn in the freshwater areas of the river above Catskill and are subject to impingement by Indian Point and other water intakes which they pass on route. During fall, as young-of-the-year fish migrate downriver toward high salinity waters, they too become vulnerable to impingement by these same water intakes. Peak monthly impingement rates ($246/10^6$ m^3 and $312/10^6$ m^3 for Units 2 and 3, respectively) in 1989 were within the range reported for previous years.

Rainbow smelt were impinged primarily during the winter at Indian Point in 1989 (Figure 11). Rainbow smelt impingement collections consisted almost exclusively of yearling and older fish. Young-of-the-year fish were impinged only in December at Unit 2. Previous reports indicate that impingement patterns have been variable for this species with maximum impingement rates occurring in several different months (NAI 1984a, EA 1989). Peak monthly impingement rates in 1989 ($2.3/10^6$ m^3 and $0.4/10^6$ m^3 at Units 2 and 3, respectively) were lower than peak monthly rates observed in past years, but are comparable to levels seen in these months in previous years.

American shad impingement collections were composed almost exclusively of young-of-the-year and were collected primarily in July through November (Figure 12). Very small numbers of yearling and older fish were found in impingement samples in March and October at Unit 2 and in August and September at Unit 3. In previous years, yearling and older fish were sometimes found in great number during the spring stratum. Peak young-of-the-year numbers occurred in October and November in 1989. This seasonal occurrence pattern and magnitude of impingement were within the range reported for previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, EA 1988, 1989).

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

FIGURE 10

MONTHLY ADJUSTED IMPINGEMENT RATES FOR BLUEBACK HERRING AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

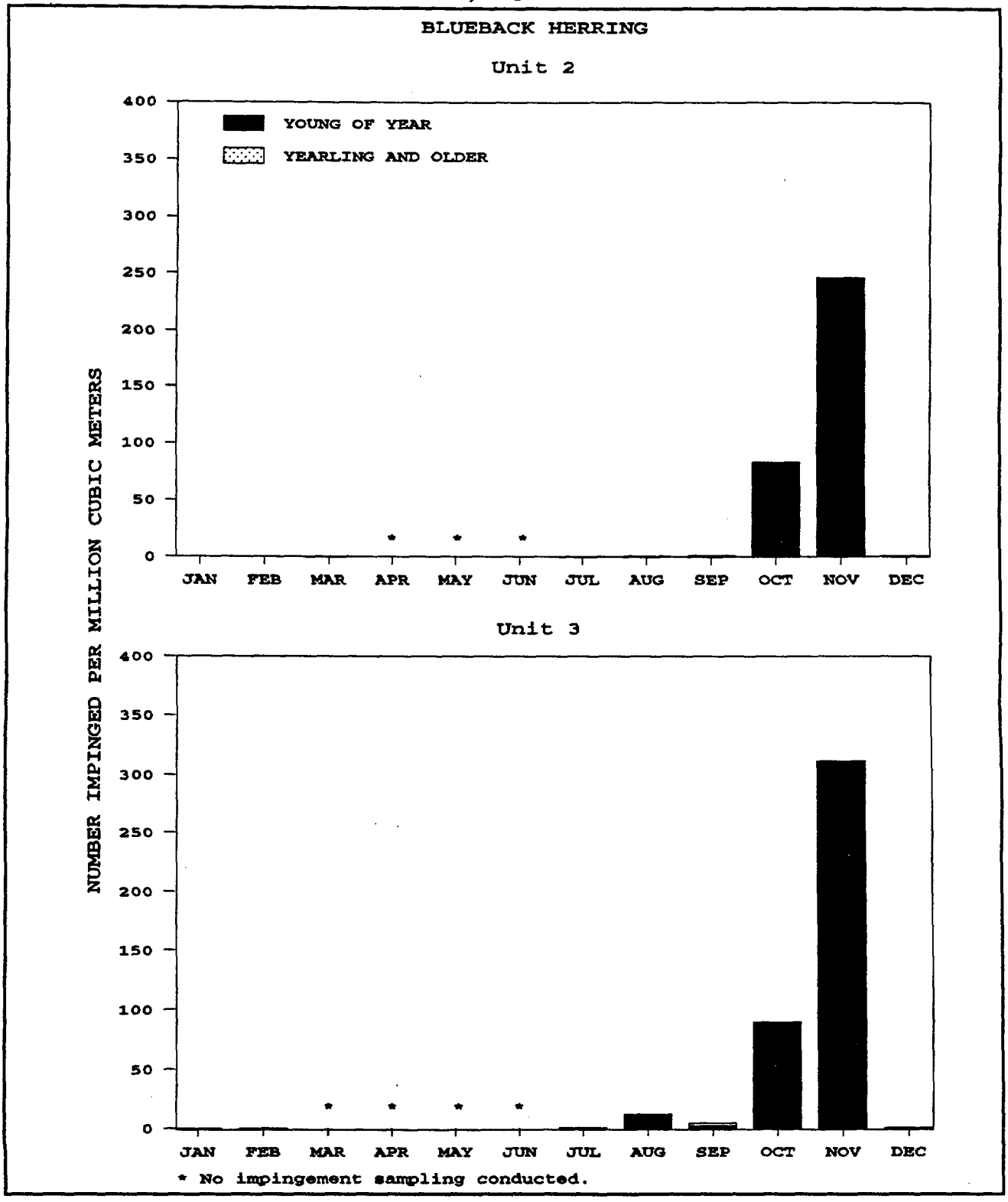


FIGURE 11

MONTHLY ADJUSTED IMPINGEMENT RATES FOR RAINBOW SMELT AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

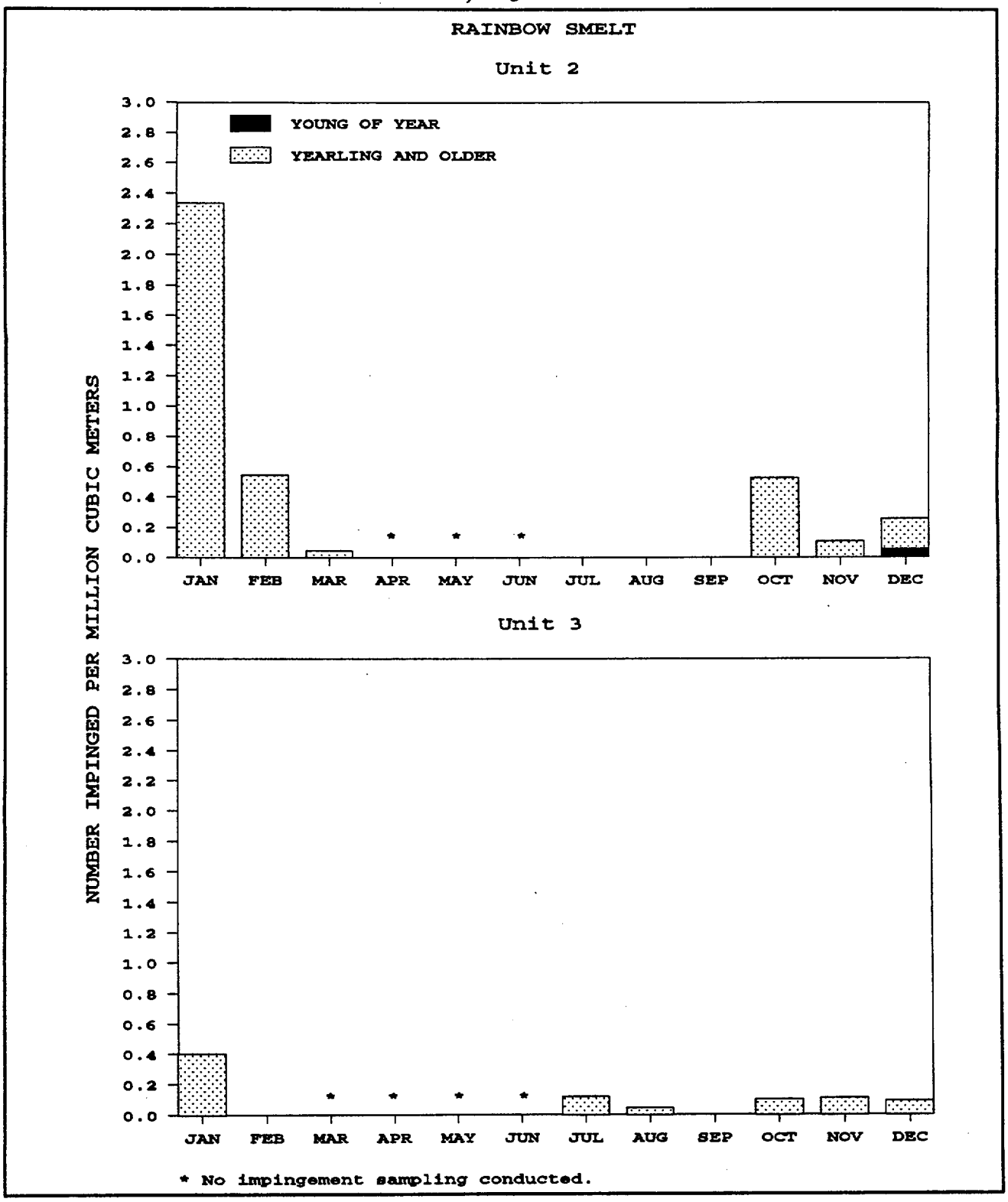
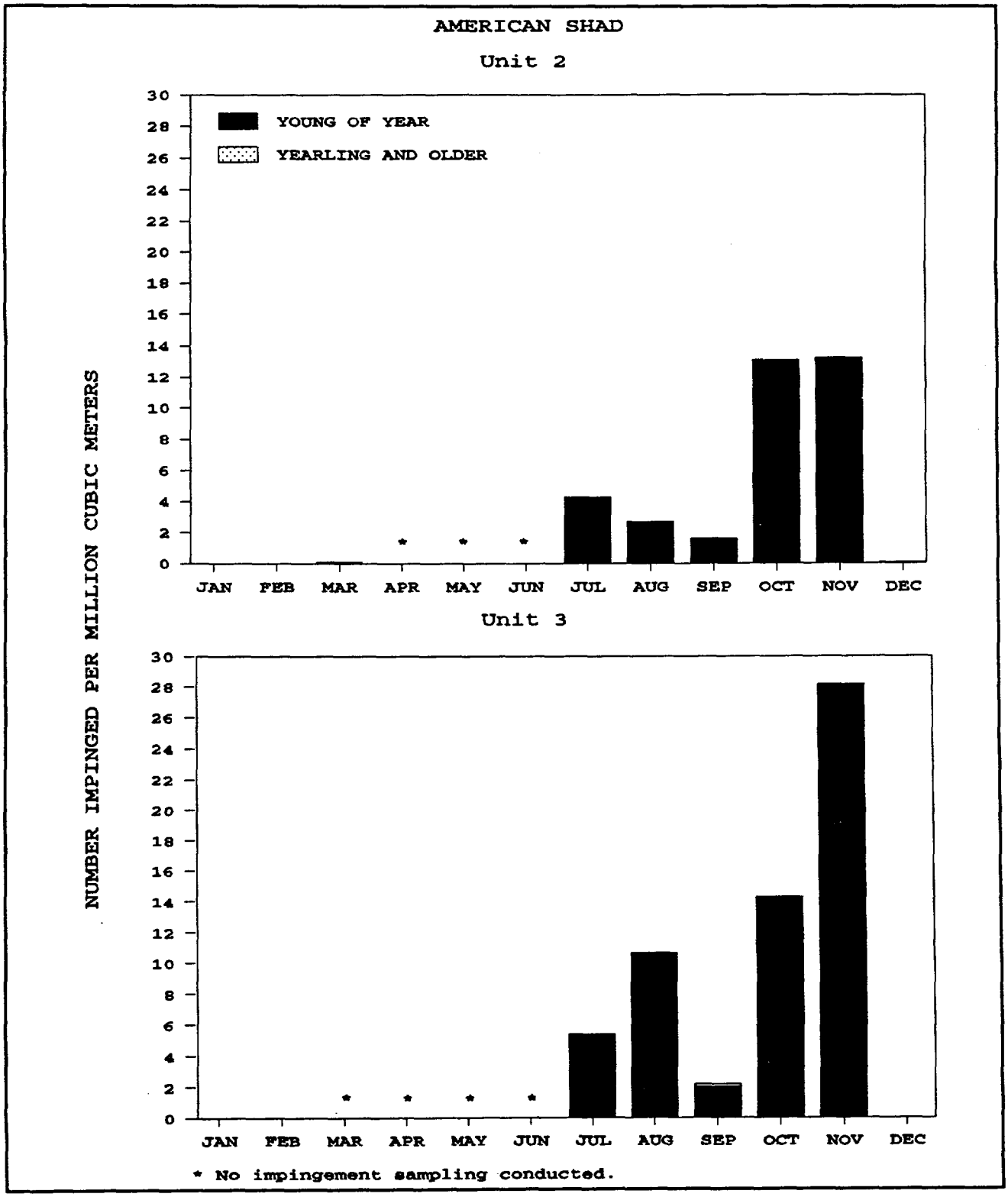


FIGURE 12

MONTHLY ADJUSTED IMPINGEMENT RATES FOR AMERICAN SHAD AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY



drop, young-of-the-year shad actively emigrate from the estuary. Variability in the timing of peak impingement of American shad at Indian Point reflects differences in growth and emigration. Peak monthly impingement rates in 1989 were within ranges observed in previous reports (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

The seasonal impingement pattern for striped bass in previous years exhibited a bimodal pattern with peak impingement occurring in winter and fall and lowest abundance occurring in the spring. Striped bass impingement in 1989 exhibited peak abundance in winter and fall like previous years (Figure 13). Impingement collections during the winter were exclusively composed of yearling and older fish, whereas in the summer and fall the collections were almost exclusively composed of young-of-the-year. Since December 1988 collections were primarily composed of young-of-the-year (> 90%) (EA 1988) the winter 1989 yearling and older category is most likely composed of these previous fall's young-of-the-year. Yearling and older striped bass overwinter in the deep waters of the lower estuary, which includes the Indian Point area (TI 1980b). Impingement rates for both young-of-the-year and yearling and older striped bass were within the range reported for previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

Weakfish were impinged at Units 2 and 3 in 1989 only as young-of-the-year fish (Figure 14). Impingement occurred from July through October with the peak impingement rate during September at Unit 2 and in August at Unit 3. Adult weakfish are marine animals. 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 1989 (up to $200/10^6$ m^3) were considerably higher than impingement rates reported for all years except 1988 (up to $213/10^6$ m^3) (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

Bluefish were impinged at Indian Point from July through October and collections were composed almost exclusively of young-of-the-year (Figure 15). Peak impingement occurred during the summer. Monthly impingement rates at Indian Point in 1989 were generally within the range presented in previous reports (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

FIGURE 13

MONTHLY ADJUSTED IMPINGEMENT RATES FOR STRIPED BASS AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

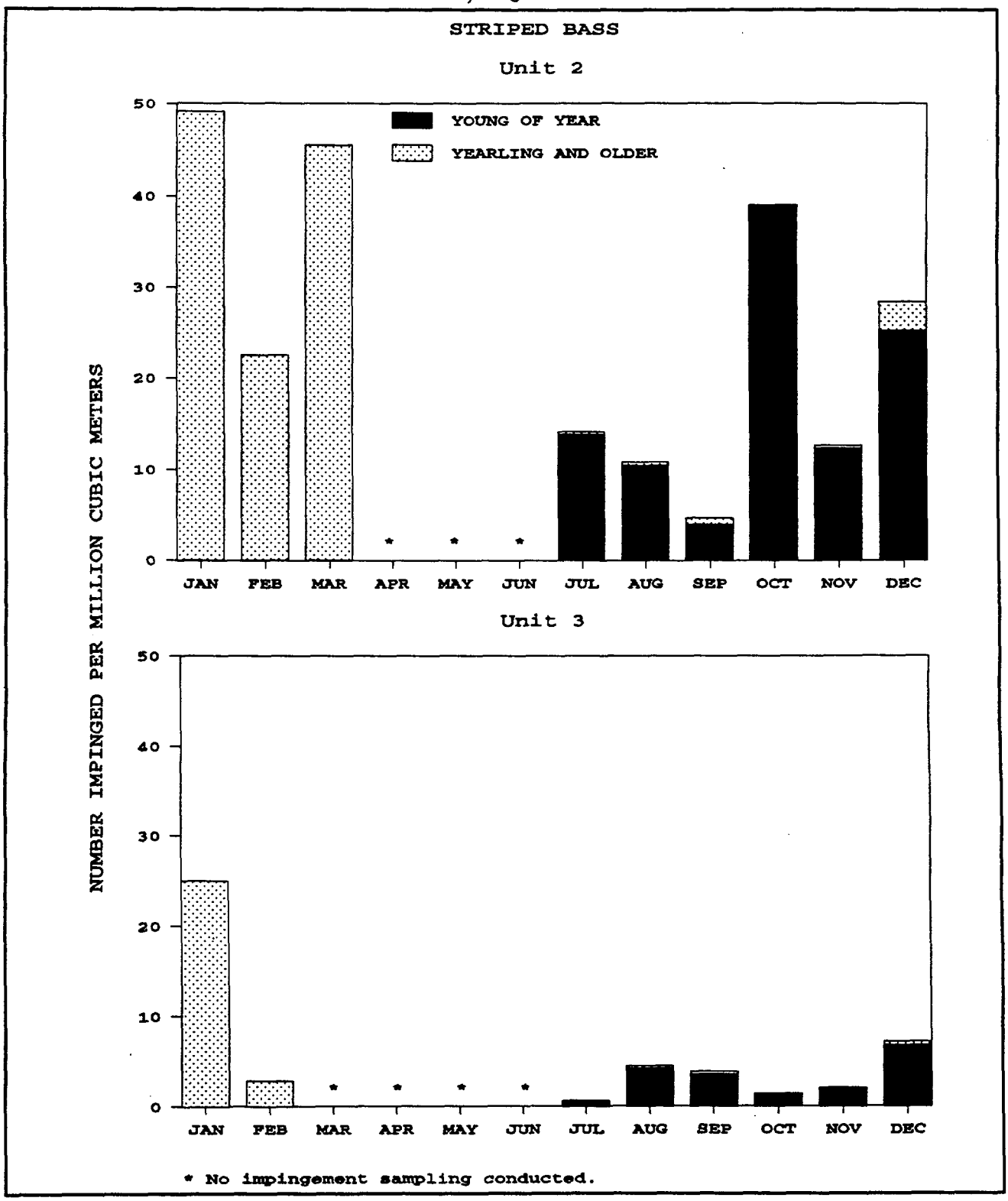


FIGURE 14

MONTHLY ADJUSTED IMPINGEMENT RATES FOR WEAKFISH AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

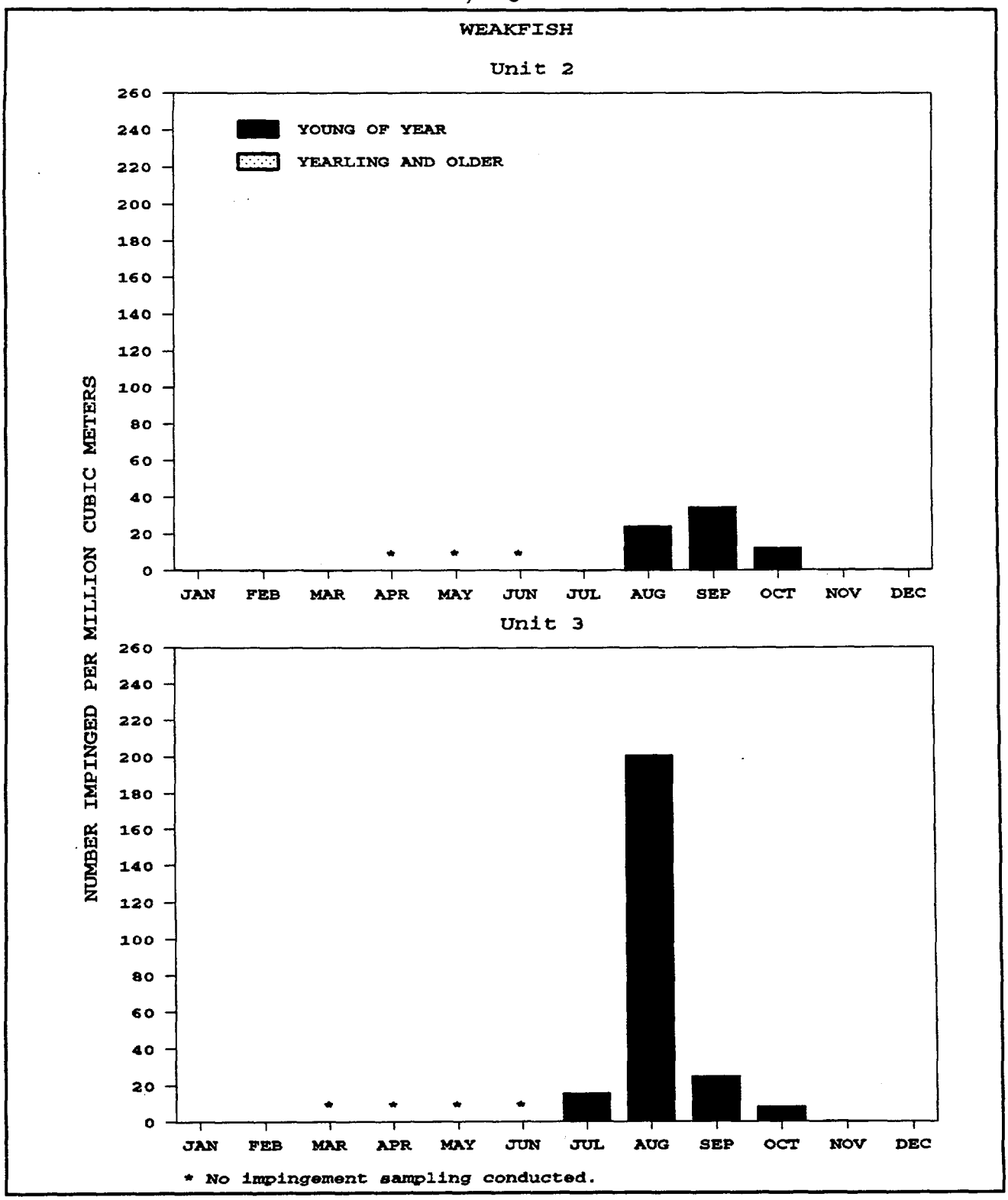
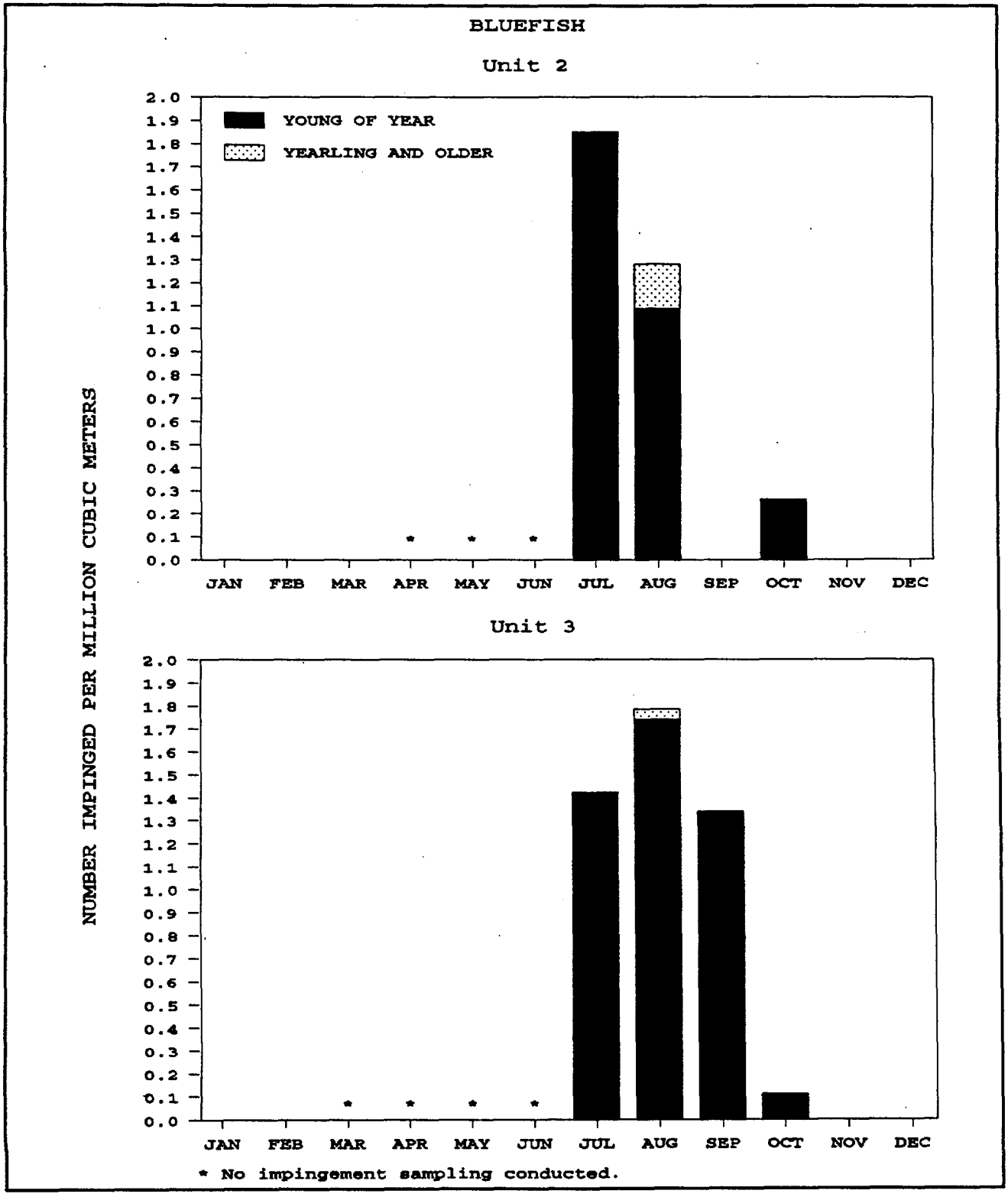


FIGURE 15

MONTHLY ADJUSTED IMPINGEMENT RATES FOR BLUEFISH AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY



White catfish impingement was greatest in late fall (November and December) (Figure 16). Yearling and older white catfish predominated during winter whereas young-of-the-year dominanted during fall collections. Adult white catfish overwinter in deep water areas of the lower Hudson River such as Indian Point and then during spring move upstream into the low salinity, shallow water regions of the middle and upper estuary to spawn (TI 1981). Spawning occurs during spring in waters with salinities below 2 ppt and young-of-the-year fish are first present beginning around July and continue through December with peak densities upstream of Indian Point (NAI 1985). Monthly adjusted impingement rates in 1989 were higher than the range observed in recent years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

Alewife were found in impingement collections primarily from July through December (Figure 17) and were composed primarily of young-of-the-year fish. In previous years, yearling and older fish were recorded primarily during May and June and young-of-the-year from August through November. This pattern corresponds 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 at Unit 2 in 1989 were slightly lower than levels in recent years and for Unit 3 were within the range observed in past years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

Spottail shiner were impinged principally during the winter and late fall (Figure 18). The majority of the spottail shiners impinged in the winter were yearling and older fish and were probably overwintering in deeper water areas such as Indian Point (NAI 1985). The majority of spottail shiners impinged in late fall were young-of-the-year. The young-of-the-year fish impinged during late fall are probably the product of spring and summer spawning in the upper estuary. The seasonal pattern and magnitudes of monthly impingement rates in 1989 were consistent with previous years (Con Edison 1983; MMES 1985; NAI 1984a, 1986, 1987; EA 1988, 1989).

No Atlantic sturgeon were collected in any impingement sample. One shortnose sturgeon was impinged and collected alive and was returned to the Hudson River away from the plant intakes (Table 13). The sturgeon had a total length of 530 mm and weighed 600 g.

FIGURE 16

MONTHLY ADJUSTED IMPINGEMENT RATES FOR WHITE CATFISH AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

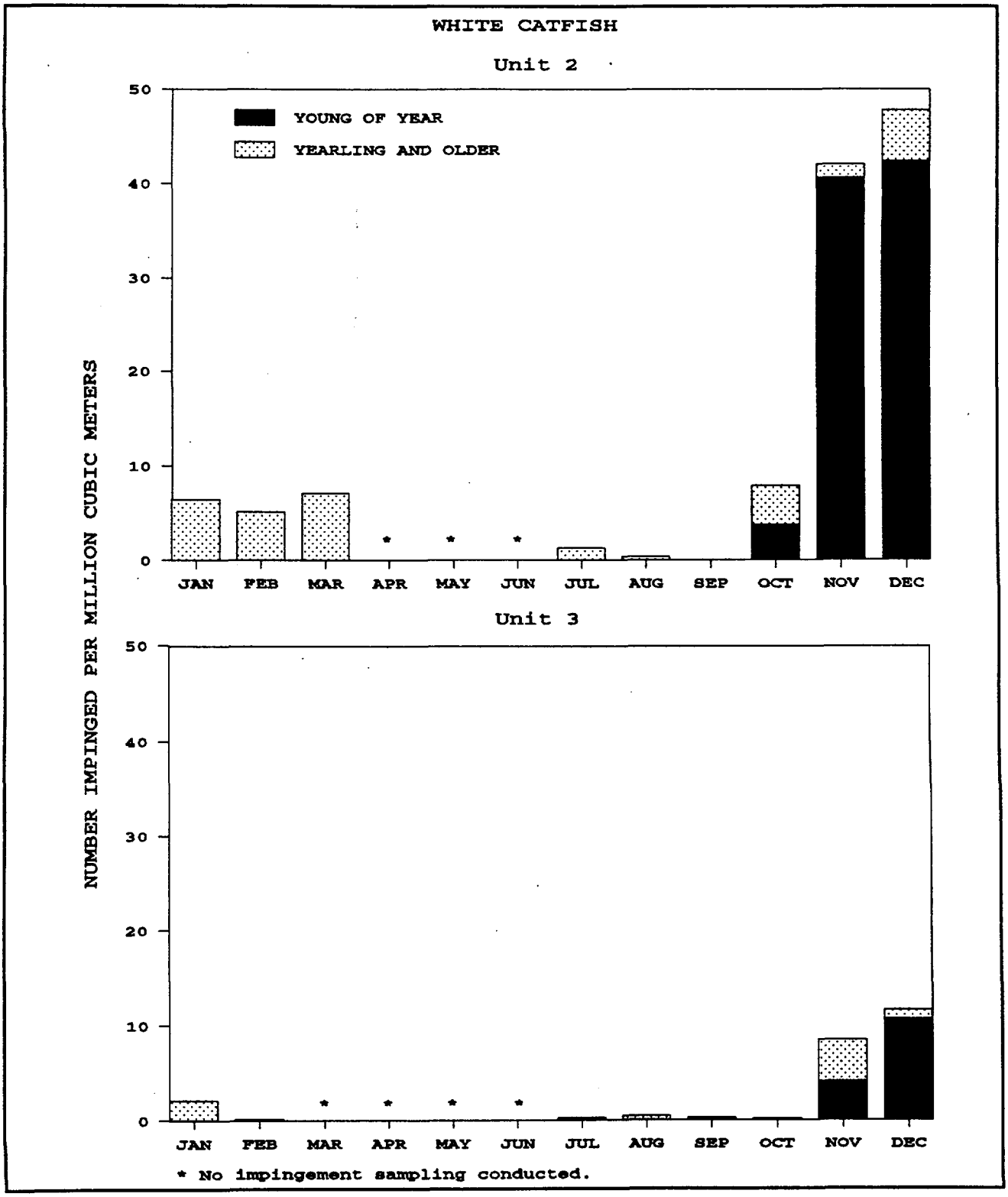


FIGURE 17

MONTHLY ADJUSTED IMPINGEMENT RATES FOR ALEWIFE AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

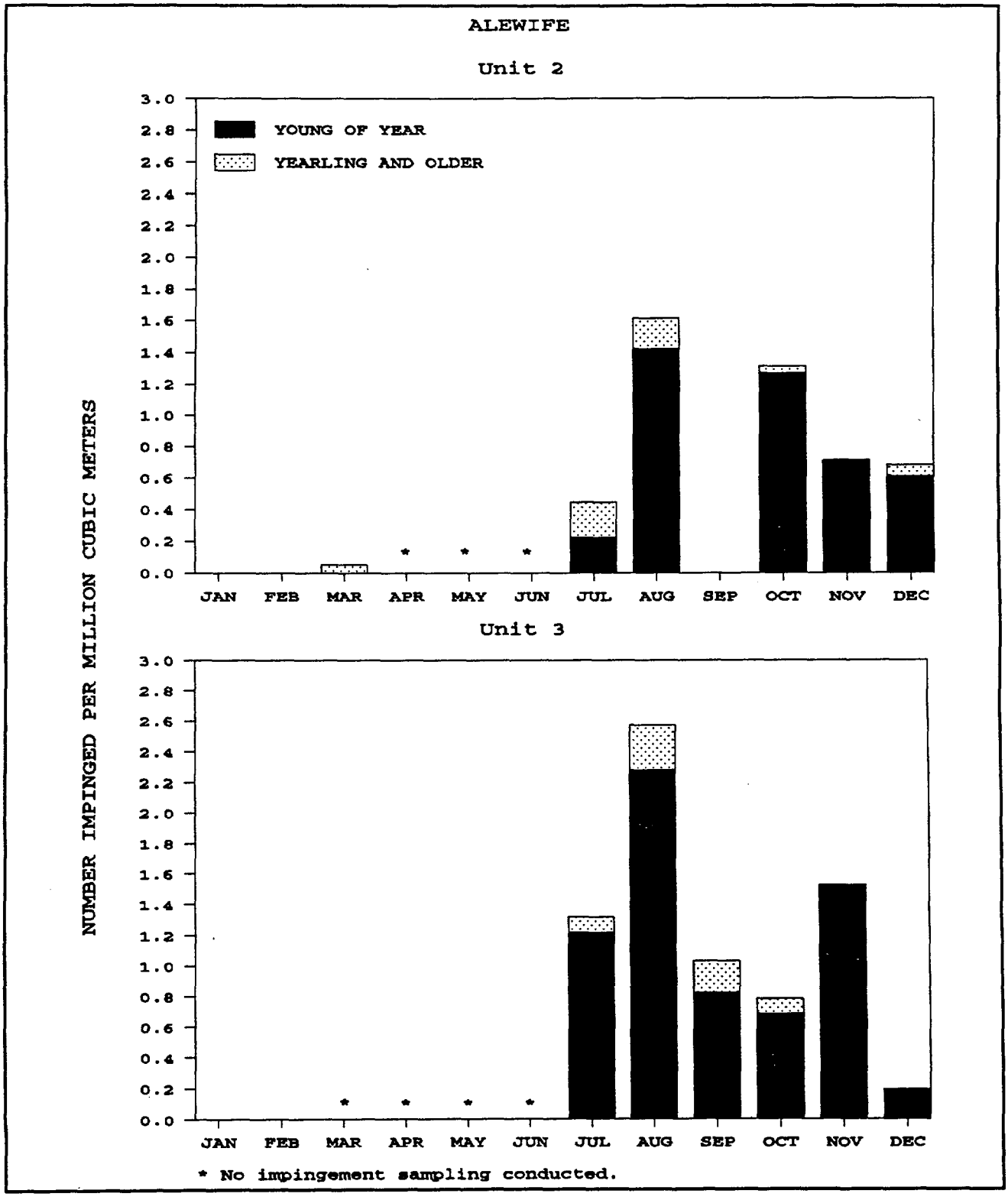


FIGURE 18

MONTHLY ADJUSTED IMPINGEMENT RATES FOR SPOTTAIL SHINER AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

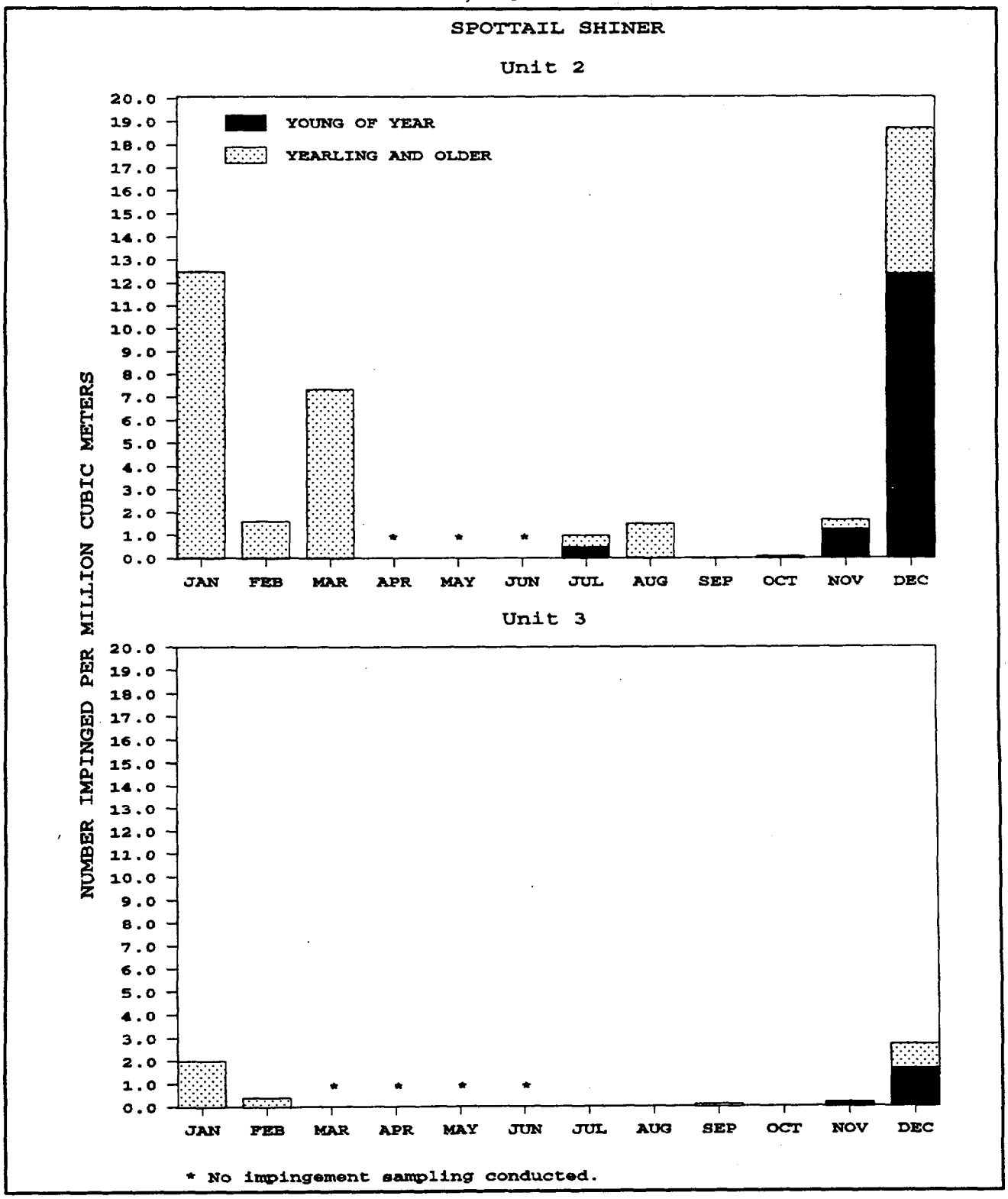


TABLE 13

STURGEON IMPINGED AT INDIAN POINT UNITS 2 AND 3 DURING 1989

SPECIES	DATE	UNIT	LENGTH (mm TL)	WEIGHT (grams)	CONDITION
Shortnose	06 OCT	3	530	600	Alive*

*Alive fish were released to the river away from the intake screens.

4.5 BLUE CRAB IMPINGEMENT

Blue crabs were not observed in impingement samples in the winter. Blue crabs were impinged in July through December 1989 (Table 14). A total of 196,201 crabs were collected, with a total weight of 11,576 kg. This number of crabs was considerably higher than numbers observed at Indian Point since blue crab impingement monitoring began in 1983 (previous high at 56,596 in 1988). Impingement rates were notably higher at Unit 2 than at Unit 3 with peak rates occurring in July and August. Peak values ranged from $986/10^6$ m^3 at Unit 2 to $240/10^6$ m^3 at Unit 3 (Figure 19).

Impingement abundance decreased through summer and declined to near zero by December. This is similar to the impingement pattern in 1985 (NAI 1986). Total weight, on the other hand, peaked in September due to the prevalence of larger crabs at this time. 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 downriver 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 2-9 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 waters where they burrow into the bottom and become inactive.

Blue crab males accounted for 65% of blue crabs examined from impingement samples at the Indian Point Generating Station in 1989 (Tables 15, B-11, and B-13). A greater number of males than females 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. In examined samples, males were more abundant than females during every month blue crabs were collected and the proportion of female crabs decreased throughout the rest of the year from 43.9% in July to 0% in December (Table 15).

TABLE 14

TOTAL NUMBERS AND WEIGHTS OF BLUE CRABS IMPINGED EACH MONTH AT INDIAN POINT DURING JANUARY - DECEMBER 1989

	COUNT												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Unit													
2	0	0	0	NS	NS	NS	32,156	30,357	17,933	10,268	2,717	1	93,432
3	0	0	NS	NS	NS	NS	31,384	32,403	21,485	15,707	1,789	1	102,769
Total	0	0	0	NS	NS	NS	63,540	62,760	39,418	25,975	4,506	2	196,201

	WEIGHT (G)												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Unit													
2	0	0	0	NS	NS	NS	11,066,100	1,876,255	1,882,050	715,672	65,613	0	5,605,690
3	0	0	NS	NS	NS	NS	974,669	1,880,990	2,124,750	909,761	80,114	27	5,970,311
Total	0	0	0	NS	NS	NS	2,040,769	3,757,245	4,006,800	1,625,433	145,727	27	11,576,001

NS - Not sampled.

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FIGURE 19

MONTHLY ADJUSTED IMPINGEMENT RATES FOR BLUE CRAB AT INDIAN POINT UNITS 2 AND 3 IN 1989, ADJUSTED FOR COLLECTION EFFICIENCY

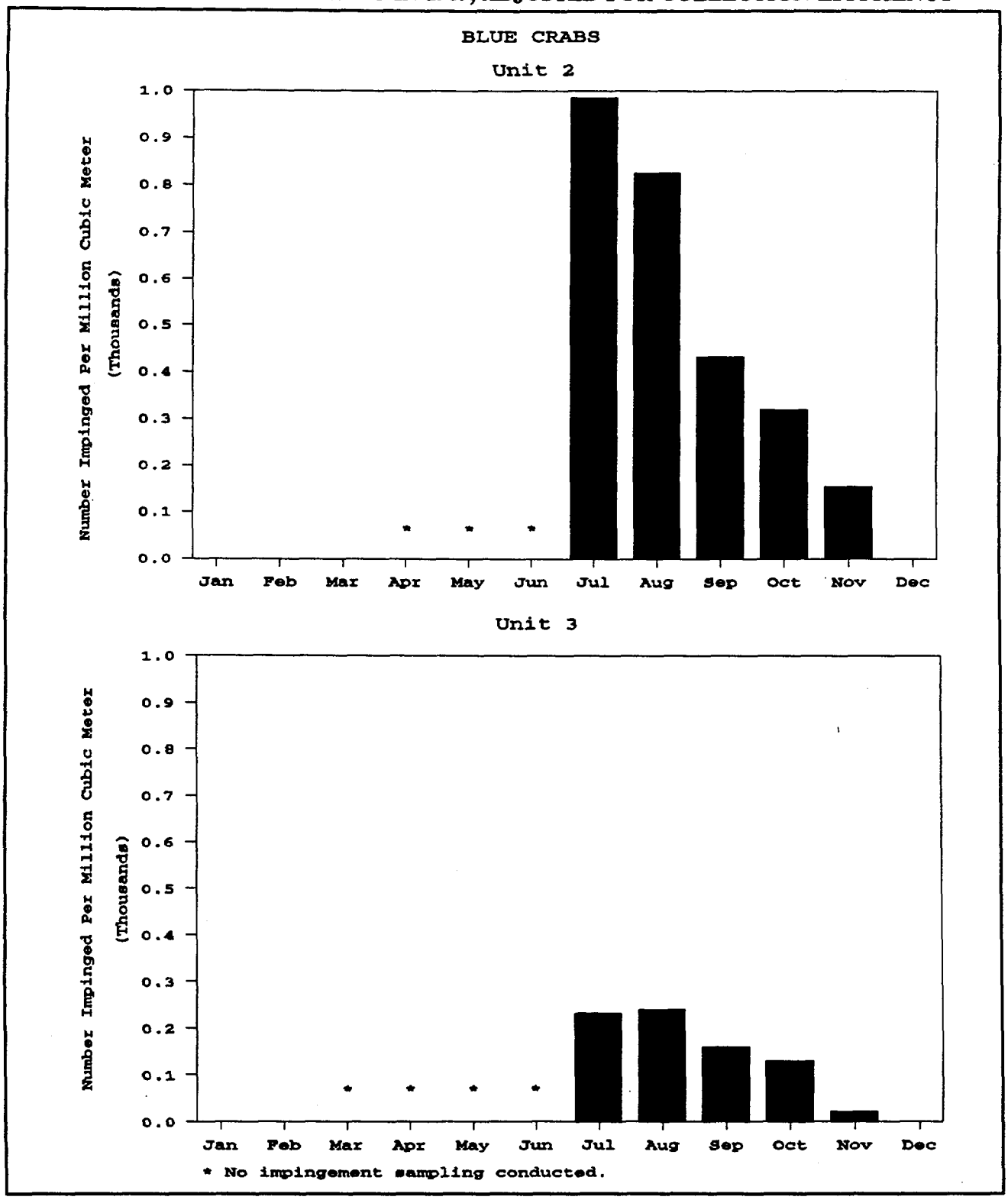

TABLE 15

MONTHLY COUNTS BY SEX, SURVIVAL, AND CONDITION OF BLUE CRABS IMPINGED AT INDIAN POINT, JANUARY - DECEMBER 1989*

	JAN	FEB	MAR	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
SEX										
Male	0	0	0	2,391	2,659	2,818	3,612	1,936	2	13,418
Female	0	0	0	1,870	2,272	1,631	1,066	570	0	7,409
Undetermined	0	0	0	0	0	0	1	2	0	3
Total Measured	0	0	0	4,261	4,931	4,449	4,679	2,508	2	20,830
SURVIVAL										
Alive	0	0	0	3,387	4,082	3,888	4,119	2,307	1	17,784
Dead	0	0	0	874	849	561	560	201	1	3,046
Total Measured	0	0	0	4,261	4,931	4,449	4,679	2,508	2	20,830
CONDITION										
Intact	0	0	0	2,658	2,070	2,230	1,867	1,117	1	9,943
Missing Parts	0	0	0	1,600	2,860	2,219	2,812	1,391	1	10,883
Total Measured	0	0	0	4,258	4,930	4,449	4,679	2,508	2	20,826**
Total Collected	0	0	0	63,540	62,760	39,418	25,975	4,506	2	196,201

* Not sampled in April, May, and June.
**Four crabs have missing condition information.

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The carapace width distribution of examined blue crab samples was similar for both units throughout the year (Tables B-12 and B-13). In July, approximately 40% of the blue crabs examined were 60 to 79 mm in width; this mode increased through late summer and fall such that by October 40% of the blue crabs were between 90-119 mm (Table B-14). This mode reflects use of the Indian Point region by adult crabs with the increases in modal size reflecting the rapid growth and molting which occurs in estuaries during the summer. A second and smaller mode at 40-59 mm carapace width became evident in impingement collections in November. This mode is probably young-of-the-year blue crabs using the estuary as a late summer nursery area. Similar bimodal distributions have been observed in previous years (EA 1988, 1989).

Survival averaged 85.5% for crabs subsampled for survival (Table 15). This was within the range of monthly rates observed in previous years (47-100 percent) (NAI 1984a, 1986, 1987; MMES 1985; EA 1988, 1989) (Table 16). Survival increased from a low of approximately 79% in July to 92% in November. The higher survival rates during the fall was similar to the pattern observed in 1983-1985, 1987, and 1988. In the examined blue crab impingement samples, the highest proportion of intact crabs occurred in July (62.4%) and the lowest proportion in October (40.0%) (Table 15). Overall, the proportion of intact crabs at Units 2 and 3 averaged 47.7%.

TABLE B-16

SUMMARY OF PROPORTIONS OF BLUE CRABS RECOVERED ALIVE AND INTACT IN IMPINGEMENT COLLECTIONS AT INDIAN POINT, 1985 - 1988

YEAR		JUN	JUL	AUG	SEP	OCT	NOV
1985	% Alive	89.9	66.4	61.6	76.2	88.1	86.9
	% Intact	36.5	24.7	36.4	54.3	48.0	59.4
1986	% Alive	64.4	84.9	72.8	65.5	75.1	75.0
	% Intact	45.2	58.4	45.0	28.2	39.3	40.0
1987	% Alive	85.7	96.2	79.4	75.5	90.7	96.7
	% Intact	57.1	35.4	51.0	53.5	77.4	96.1
1988	% Alive	86.4	81.0	68.3	73.8	92.2	91.1
	% Intact	51.7	43.1	51.7	43.2	77.1	77.8
1989	% Alive	NS	79.5	82.8	87.4	88.0	92.0
	% Intact	NS	62.4	42.0	50.1	40.0	44.5

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APPENDIX A

DATA CALCULATION PROCEDURES

APPENDIX A

DATA CALCULATION PROCEDURES

Impingement data were collected separately at intake screens 21-25, 26, and 31-36. 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 Units 2 and 3 1989 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 impingement rates standardized to the volume of water sampled (Equation 7).

Calculations

To estimate the number of fish actually impinged on a sampling day, the count from the 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

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

At Unit 2, the non-Ristroph (screens 21-25) and the Ristroph screens were treated separately through Equation 1. The adjusted daily estimates (Y_{im}) for each screen type were then summed to produce the overall adjusted daily estimate for Unit 2.

Within each seasonal stratum (h), a mean (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:

$$T_m = \sum_{h=1}^{4} (N_{hm} \times Y_{hm}) \qquad \text{(Equation 2)}$$

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)

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 that 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):

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

where

$S.E._m$ = Standard error of the total estimated number of fish impinged at Unit m

Nh_m, 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

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:

$$W_{hm} = \frac{w_{hm}}{\sum_{L=1}^{4} C_{L_{hm}}} Y_{hm} N_{hm} \qquad \text{(Equation 5)}$$

where

W_{hm} = Total estimated weight of fish impinged in stratum h at Unit m

w_{hm} = Total weight of fish actually impinged in stratum h at Unit m

C_{Lhm} = Total count of fish actually collected in length class L in stratum h at Unit m

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:

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

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

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:

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

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

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 Generating Station. Consequently, blue crab impingement rates were not adjusted.

APPENDIX B

SUMMARY TABLES FOR WATER QUALITY AND IMPINGEMENT COLLECTION RESULTS

APPENDIX B

LIST OF TABLES

TABLE B-1 (Page 1 of 3)

DAILY INTAKE WATER QUALITY RECOREDED AT THE INDIAN POINT GENERATING STATION DURING 1989

DATE	Unit 2	Unit 3	Mean	Unit 2	Unit 3	Mean
01/02/89		3.75	3.7		2016.70	2016.70
01/05/89	3.00	3.00	3.0	7011.33	7011.33	7011.00
01/10/89	5.75		5.7	6605.51		6605.51
01/14/89		5.00	5.0		5396.63	5396.63
01/15/89	5.50		5.5	5310.35		5310.35
01/17/89		5.50	5.5		5737.18	5737.18
01/18/89	5.25	5.25	5.2	5875.03	5875.03	5875.00
01/19/89	4.00	4.00	4.0	5342.67	5342.67	5343.00
01/20/89	5.25	5.25	5.2	4896.04	4896.04	4896.00
01/21/89		2.00	2.0		3289.08	3289.08
01/22/89	4.00		4.0	4343.97		4343.97
01/27/89	9.50	9.50	9.5	3482.53	3482.53	3483.00
01/28/89		3.00	3.0		3296.49	3296.49
01/29/89	4.25	4.25	4.2	2933.83	2933.83	2934.00
02/01/89	5.75	5.75	5.7	4287.59	4287.59	4288.00
02/02/89	8.25	8.25	8.3	3730.71	3730.71	3731.00
02/04/89			5.3			6399.00
02/06/89		3.75	3.7		8177.82	8177.82
02/07/89		6.25	6.2		7392.53	7392.53
02/08/89		7.00	7.0		7109.95	7109.95
02/10/89		2.25	2.2		5438.44	5438.44
02/21/89	5.25		5.2	5011.21		5011.21
02/22/89	4.75		4.7	4171.75		4171.75
02/27/89	4.00		4.0	3383.86		3383.86
02/28/89	4.25		4.2	3266.90		3266.90
03/01/89	2.25		2.2	3630.62		3630.62
03/02/89	2.25		2.2	3040.24		3040.24
03/03/89	2.50		2.5	4894.42		4894.42
03/04/89	5.25		5.2	5638.36		5638.36
03/07/89	2.50		2.5	5659.17		5659.17
03/08/89	2.75		2.7	7200.14		7200.14
03/10/89	3.50		3.5	7374.07		7374.07
03/20/89	3.75		3.7	4613.54		4613.54
07/02/89		24.05	24.1		205.18	205.18
07/05/89	24.50	24.50	24.5	205.84	205.84	206.00
07/08/89	25.10		25.1	199.00		199.00
07/09/89	25.00		25.0	199.00		199.00
07/10/89	27.90	27.90	27.9	318.42	318.42	318.00
07/11/89	25.35		25.4	207.69		207.69
07/13/89	24.50		24.5	461.93		461.93
07/17/89	26.90		26.9	4946.00		4946.00
07/19/89	24.80		24.8	6707.00		6707.00
07/23/89		26.75	26.8		4901.84	4901.84
07/24/89	26.80		26.8	5093.00		5093.00
07/25/89	26.75		26.8	4521.09		4521.09
07/26/89	26.75		26.8	4253.19		4253.19
07/29/89	27.30		27.3	4447.00		4447.00
08/02/89	26.80		26.8	4398.00		4398.00
08/05/89		27.25	27.3		2973.01	2973.01
08/06/89		30.00	30.0		4229.28	4229.28
08/08/89	28.25	28.25	28.3	3118.61	3118.61	3119.00
08/09/89			27.0			2852.00
08/11/89	25.50		25.5	4378.00		4378.00
08/12/89		25.50	25.5		4377.68	4377.68
08/16/89	26.25		26.3	7913.32		7913.32

TABLE B-1 (Page 2 of 3)

DAILY INTAKE WATER QUALITY RECORDED AT THE INDIAN POINT GENERATING STATION DURING 1989

DATE	Unit 2	Unit 3	Mean	Unit 2	Unit 3	Mean
08/22/89	26.50	26.50	26.5	6858.87	6858.87	6859.00
08/23/89		26.50	26.5		6762.27	6762.27
08/31/89	26.50		26.5	6810.49		6810.49
09/01/89		27.00	27.0		6550.33	6550.33
09/03/89		26.00	26.0		6880.39	6880.39
09/09/89		24.25	24.3		4754.22	4754.22
09/19/89			24.0			7745.00
09/21/89	23.50		23.5	5292.00		5292.00
09/25/89	21.00		21.0	3512.00		3512.00
10/02/89	22.00		22.0	2140.82		2140.82
10/03/89			20.3			1134.00
10/04/89	19.50		19.5	631.13		631.13
10/05/89	19.00		19.0	438.62		438.62
10/08/89	20.75	20.75	20.8	1086.56	1086.56	1087.00
10/09/89	18.25	18.25	18.3	1428.22	1428.22	1428.00
10/10/89		17.10	17.1		2644.00	2644.00
10/12/89	18.05		18.0	5497.14		5497.14
10/13/89	19.05		19.1	5224.84		5224.84
10/14/89	18.00		18.0	3530.05		3530.05
10/16/89	19.10		19.1	4900.77		4900.77
10/17/89	19.00	19.00	19.0	2935.45	2935.45	2935.00
10/18/89	19.00		19.0	3592.48		3592.48
10/20/89	16.50		16.5	2276.25		2276.25
10/22/89	14.60		14.6	234.96		234.96
10/24/89	13.60		13.6	221.16		221.16
10/26/89	14.50		14.5	144.40		144.40
10/29/89	14.10		14.1	191.74		191.74
10/31/89			14.8			201.00
11/02/89	13.00		13.0	199.19		199.19
11/04/89	12.95		13.0	223.97		223.97
11/05/89	13.25		13.3	192.27		192.27
11/06/89	12.60		12.6	260.26		260.26
11/07/89	12.80		12.8	203.35		203.35
11/08/89	12.75		12.8	228.92		228.92
11/09/89	12.25		12.3	255.84		255.84
11/10/89	11.40		11.4	214.16		214.16
11/11/89			11.7			254.00
11/13/89	12.00		12.0	264.05		264.05
11/14/89	14.50		14.5	243.05		243.05
11/16/89	13.00		13.0	235.93		235.93
11/17/89	13.50		13.5	192.49		192.49
11/18/89	12.50		12.5	203.55		203.55
11/20/89	11.25		11.3	192.75		192.75
11/22/89	10.00		10.0	193.11		193.11
11/23/89	10.00	10.00	10.0	195.27	195.27	195.00
11/24/89	11.50		11.5	198.21		198.21
11/26/89	11.50		11.5	1969.33		1969.33
11/27/89	10.00		10.0	1723.48		1723.48
11/28/89	9.25	9.25	9.3	3209.37	3209.37	3209.00
11/29/89	7.50		7.5	585.94		585.94
11/30/89	8.75		8.8	956.49		956.49
12/01/89	10.75		10.8	326.30		326.30
12/02/89			9.9			
12/05/89	7.50		7.5	1135.30		1135.30
12/06/89	7.00		7.0	664.78		664.78

TABLE B-1 (Page 3 of 3)

DAILY INTAKE WATER QUALITY RECORDED AT THE INDIAN POINT GENERATING STATION DURING 1989

DATE	Unit 2	Unit 3	Mean	Unit 2	Unit 3	Mean
12/07/89	7.00		7.0	366.45		366.45
12/08/89	5.50		5.5	1875.09		1875.09
12/09/89	4.25		4.2	1316.67		1316.67
12/10/89	4.10		4.1	1234.44		1234.44
12/11/89	4.45		4.4	1246.27		1246.27
12/12/89		7.25	7.2		1016.89	1016.89
12/13/89	3.75		3.7	1246.12		1246.12
12/14/89	4.75		4.7	1511.37		1511.37
12/15/89	4.50		4.5	1500.44		1500.44
12/16/89	4.25		4.2	1330.35		1330.35
12/18/89	8.25		8.3	751.96		751.96
12/19/89	4.00		4.0	784.16		784.16
12/20/89	3.50		3.5	457.68		457.68
12/21/89	1.50	1.50	1.5	565.28	565.28	565.00
12/22/89	0.75		0.8	1147.45		1147.45
12/23/89			1.1			2588.00
12/24/89	1.25		1.3	3308.89		3308.89
12/27/89	3.00		3.0	6400.55		6400.55
12/28/89	3.00		3.0	6447.08		6447.08
12/29/89	3.50		3.5	5947.69		5947.69
12/30/89	2.75		2.7	6759.98		6759.98
12/31/89	4.50		4.5	6241.94		6241.94

TABLE B-2 (Page 1 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNIT 2 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Month									
Taxon	JAN	FEB	MAR	JUL	AUG	SEP	OCT	NOV	DEC	Total
Alewife	--	--	1	4	7	--	29	12	18	71
Bay anchovy	43	3	1	--	5	5	191	5	4	257
American shad	--	--	2	28	8	2	323	286	1	650
Bluefish	--	--	--	8	5	--	7	--	--	20
Bluegill	22	--	1	1	--	7	94	123	35	283
Brown bullhead	29	8	4	--	--	--	4	3	16	64
Pumpkinseed	79	12	19	2	--	--	94	109	141	456
Black crappie	--	--	1	--	--	--	2	5	2	10
Carp	1	--	3	--	--	--	--	2	1	7
American eel	12	11	8	46	2	--	59	56	143	337
Goldfish	17	1	10	--	--	--	--	2	9	39
Golden shiner	1	1	2	1	1	--	1	--	14	21
Hogchoker	494	155	21	157	721	78	4129	565	8827	15147
Tessellated darter	6	6	5	1	--	--	2	6	41	67
Banded killifish	217	33	30	4	--	--	--	11	48	343
Largemouth bass	--	--	--	1	--	--	--	4	5	10
Mummichog	3	--	--	--	--	--	--	--	1	4
Atlantic menhaden	--	--	--	3	--	--	3	--	--	6
Chain pickerel	--	--	--	--	--	--	--	--	1	1
Blueback herring	1	2	6	2	4	2	2060	4769	15	6861
White sucker	--	--	--	--	--	--	1	--	--	1
Rainbow smelt	27	6	1	1	--	--	10	2	6	53
Spottail shiner	169	18	108	5	4	--	2	38	597	941
Striped bass	590	261	609	61	35	6	946	259	840	3607
Fourspine stickleback	3	--	--	--	--	--	--	--	--	3
Atlantic tomcod	51	9	11	40	11	6	353	112	1127	1720
White catfish	84	64	97	6	1	--	186	967	1506	2911
White perch	27304	15471	14131	100	161	23	3761	7408	64394	132753
Yellow perch	29	3	2	--	--	--	--	90	72	196
Redbreast sunfish	12	1	--	--	1	--	--	7	2	23
Crevalle jack	--	--	--	--	--	2	9	1	--	12
Weakfish	--	--	--	1	90	44	313	--	--	448
Clupeid unidentified	--	--	--	1	--	--	16	--	--	17
Tautog	--	--	1	--	--	--	--	--	2	3
Four bearded rockling	1	--	1	--	--	--	--	--	--	2
Atlantic moonfish	--	--	--	--	--	--	1	--	--	1
Winter flounder	1	--	2	--	--	--	4	1	7	15
Tidewater silverside	2	--	--	--	--	--	--	1	4	7
Sea lamprey	3	2	1	--	--	--	--	--	3	9
Gizzard shad	371	89	69	--	--	--	2	138	3248	3917
Silver hake	14	--	--	--	--	--	--	30	33	77
Threespine stickleback	8	31	60	--	--	--	--	--	--	99
Butterfish	--	--	--	--	1	--	--	--	--	1
White crappie	--	--	--	--	--	--	--	--	1	1
Northern puffer	--	--	--	--	--	--	1	--	--	1

(CONTINUED)

TABLE B-2 (Page 2 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNIT 2 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Month									
	JAN	FEB	MAR	JUL	AUG	SEP	OCT	NOV	DEC	Total
Taxon										
Centrarchid unid.	1	--	--	--	--	--	6	24	1	32
Red hake	10	1	4	--	--	--	--	--	65	80
Grubby	1	--	--	--	--	--	--	--	2	3
Summer flounder	--	--	--	--	--	--	4	1	--	5
Striped searobin	--	--	--	--	--	--	17	--	--	17
Atlantic Croaker	1	--	--	--	--	--	--	--	2	3
White mullet	--	--	--	--	--	--	--	1	--	1
Naked goby	--	2	--	--	--	--	3	10	1	16
Inshore lizardfish	--	--	--	--	--	--	1	--	--	1
Grey snapper	--	--	--	--	--	--	3	--	--	3
Freshwater drum	--	--	--	--	--	--	2	4	1	7
Total	29607	16190	15211	473	1057	175	12639	15052	81236	171640

TABLE B-3 (Page 1 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNIT 3 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Month								
Taxon	JAN	FEB	JUL	AUG	SEP	OCT	NOV	DEC	Total
Alewife	--	--	38	58	14	8	19	3	140
Bay anchovy	39	2	23	463	141	71	34	6	779
American shad	--	--	164	243	30	147	347	--	931
Bluefish	--	--	41	41	18	1	--	--	101
Bluegill	11	1	3	3	7	--	46	20	91
Brown bullhead	7	--	3	1	--	--	--	2	13
Pumpkinseed	52	5	1	1	--	--	7	3	69
Black crappie	2	--	--	--	--	--	1	--	3
Carp	5	--	--	--	--	--	--	3	8
American eel	8	1	7	6	2	--	4	12	40
Goldfish	12	1	--	--	--	--	--	3	16
Golden shiner	--	--	--	--	--	--	1	1	2
Hogchoker	381	26	865	2111	1229	204	150	1048	6014
Tessellated darter	--	--	--	--	--	--	2	3	5
Banded killifish	25	4	1	--	1	1	2	5	39
Largemouth bass	--	--	--	1	--	--	1	--	2
Atlantic menhaden	1	--	9	1	2	2	--	--	15
Blueback herring	8	1	21	272	62	912	3726	3	5005
Rainbow smelt	11	--	4	1	--	1	1	1	19
Spottail shiner	51	4	--	--	1	--	2	37	95
Striped bass	576	31	18	104	51	15	25	95	915
Fourspine stickleback	1	--	--	--	--	--	--	--	1
Atlantic tomcod	28	3	79	68	97	9	11	131	426
White catfish	55	2	6	10	3	1	103	159	339
White perch	22287	453	162	224	173	52	2592	9375	35318
Yellow perch	3	--	1	--	--	--	--	8	12
Northern pipefish	--	--	1	2	--	--	--	--	3
Redbreast sunfish	2	--	--	--	--	--	--	--	2
Crevalle jack	--	--	10	3	2	1	--	--	16
Weakfish	--	--	426	4532	337	76	1	--	5372
Lookdown	--	--	--	2	--	--	--	--	2
Clupeid unidentified	--	--	32	65	--	--	--	--	97
Tautog	--	--	--	--	--	--	2	1	3
Spot	1	--	--	--	--	--	--	--	1
Winter flounder	--	--	--	--	--	--	--	1	1
Tidewater silverside	2	--	--	--	--	--	--	--	2
Sea lamprey	1	--	--	--	--	--	--	--	1
Gizzard shad	1278	83	--	--	1	--	88	444	1894
Silver hake	6	--	--	--	--	--	2	--	8
Threespine stickleback	3	--	--	--	--	--	--	--	3
Butterfish	--	--	2	3	22	--	--	--	27
Centrarchid unid.	--	--	--	--	--	--	2	--	2
Red hake	9	--	--	--	--	--	--	8	17
Summer flounder	--	--	4	7	2	1	--	--	14
Striped searobin	--	--	--	--	--	8	--	--	8

(CONTINUED)

TABLE B-3 (Page 2 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNIT 3 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Month								
	JAN	FEB	JUL	AUG	SEP	OCT	NOV	DEC	Total
Taxon									
Atlantic Croaker	--	--	--	--	--	--	--	1	1
Naked goby	--	--	--	--	--	--	2	--	2
Windowpane	--	--	1	3	--	--	--	--	4
Grey snapper	--	--	--	--	--	1	--	--	1
Freshwater drum	--	--	--	--	--	--	--	3	3
King Mackerel	--	--	--	--	1	--	--	--	1
Total	24865	617	1922	8225	2196	1511	7171	11376	57883

TABLE B-4 (Page 1 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

Taxon	Month									
	JAN	FEB	MAR	JUL	AUG	SEP	OCT	NOV	DEC	Total
Alewife	--	--	1	42	65	14	37	31	21	211
Bay anchovy	82	5	1	23	468	146	262	39	10	1036
American shad	--	--	2	192	251	32	470	633	1	1581
Bluefish	--	--	--	49	46	18	8	--	--	121
Bluegill	33	1	1	4	3	14	94	169	55	374
Brown bullhead	36	8	4	3	1	--	4	3	18	77
Pumpkinseed	131	17	19	3	1	--	94	116	144	525
Black crappie	2	--	1	--	--	--	2	6	2	13
Carp	6	--	3	--	--	--	--	2	4	15
American eel	20	12	8	53	8	2	59	60	155	377
Goldfish	29	2	10	--	--	--	--	2	12	55
Golden shiner	1	1	2	1	1	--	1	1	15	23
Hogchoker	875	181	21	1022	2832	1307	4333	715	9875	21161
Tessellated darter	6	6	5	1	--	--	2	8	44	72
Banded killifish	242	37	30	5	--	1	1	13	53	382
Largemouth bass	--	--	--	1	1	--	--	5	5	12
Mummichog	3	--	--	--	--	--	--	--	1	4
Atlantic menhaden	1	--	--	12	1	2	5	--	--	21
Chain pickerel	--	--	--	--	--	--	--	--	1	1
Blueback herring	9	3	6	23	276	64	2972	8495	18	11866
White sucker	--	--	--	--	--	--	1	--	--	1
Rainbow smelt	38	6	1	5	1	--	11	3	7	72
Spottail shiner	220	22	108	5	4	1	2	40	634	1036
Striped bass	1166	292	609	79	139	57	961	284	935	4522
Fourspine stickleback	4	--	--	--	--	--	--	--	--	4
Atlantic tomcod	79	12	11	119	79	103	362	123	1258	2146
White catfish	139	66	97	12	11	3	187	1070	1665	3250
White perch	49591	15924	14131	262	385	196	3813	10000	73769	168071
Yellow perch	32	3	2	1	--	--	--	90	80	208
Northern pipefish	--	--	--	1	2	--	--	--	--	3
Redbreast sunfish	14	1	--	--	1	--	--	7	2	25
Crevalle jack	--	--	--	10	3	4	10	1	--	28
Weakfish	--	--	--	427	4622	381	389	1	--	5820
Lookdown	--	--	--	--	2	--	--	--	--	2
Clupeid unidentified	--	--	--	33	65	--	16	--	--	114
Tautog	--	--	1	--	--	--	--	2	3	6
Four bearded rockling	1	--	1	--	--	--	--	--	--	2
Spot	1	--	--	--	--	--	--	--	--	1
Atlantic moonfish	--	--	--	--	--	--	1	--	--	1
Winter flounder	1	--	2	--	--	--	4	1	8	16
Tidewater silverside	4	--	--	--	--	--	--	1	4	9
Sea lamprey	4	2	1	--	--	--	--	--	3	10
Gizzard shad	1649	172	69	--	--	1	2	226	3692	5811
Silver hake	20	--	--	--	--	--	--	32	33	85
Threespine stickleback	11	31	60	--	--	--	--	--	--	102

(CONTINUED)

TABLE B-4 (Page 2 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND MONTH
AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Month									
Taxon	JAN	FEB	MAR	JUL	AUG	SEP	OCT	NOV	DEC	Total
Butterfish	--	--	--	2	4	22	--	--	--	28
White crappie	--	--	--	--	--	--	--	--	1	1
Northern puffer	--	--	--	--	--	--	1	--	--	1
Centrarchid unid.	1	--	--	--	--	--	6	26	1	34
Red hake	19	1	4	--	--	--	--	--	73	97
Grubby	1	--	--	--	--	--	--	--	2	3
Summer flounder	--	--	--	4	7	2	5	1	--	19
Striped searobin	--	--	--	--	--	--	25	--	--	25
Atlantic Croaker	1	--	--	--	--	--	--	--	3	4
White mullet	--	--	--	--	--	--	--	1	--	1
Naked goby	--	2	--	--	--	--	3	12	1	18
Windowpane	--	--	--	1	3	--	--	--	--	4
Inshore lizardfish	--	--	--	--	--	--	1	--	--	1
Grey snapper	--	--	--	--	--	--	4	--	--	4
Freshwater drum	--	--	--	--	--	--	2	4	4	10
King Mackerel	--	--	--	--	--	1	--	--	--	1
Total	54472	16807	15211	2395	9282	2371	14150	22223	92612	229523

TABLE B-6 (Page 1 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM
AT INDIAN POINT UNIT 2 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

Taxon	Stratum			
	WINTER	SUMMER	FALL	Total
Alewife	1	11	59	71
Bay anchovy	47	10	200	257
American shad	2	38	610	650
Bluefish	--	13	7	20
Bluegill	23	8	252	283
Brown bullhead	41	--	23	64
Pumpkinseed	110	2	344	456
Black crappie	1	--	9	10
Carp	4	--	3	7
American eel	31	48	258	337
Goldfish	28	--	11	39
Golden shiner	4	2	15	21
Hogchoker	670	956	13,521	15,147
Tessellated darter	17	1	49	67
Banded killifish	280	4	59	343
Largemouth bass	--	1	9	10
Mummichog	3	--	1	4
Atlantic menhaden	--	3	3	6
Chain pickerel	--	--	1	1
Blueback herring	9	8	6,844	6,861
White sucker	--	--	1	1
Rainbow smelt	34	1	18	53
Spottail shiner	295	9	637	941
Striped bass	1,460	102	2,045	3,607
Fourspine stickleback	3	--	--	3
Atlantic tomcod	71	57	1,592	1,720
White catfish	245	7	2,659	2,911
White perch	56,906	284	75,563	132,753
Yellow perch	34	--	162	196
Redbreast sunfish	13	1	9	23
Crevalle jack	--	2	10	12
Weakfish	--	135	313	448
Clupeid unidentified	--	1	16	17
Tautog	1	--	2	3
Four bearded rockling	2	--	--	2
Atlantic moonfish	--	--	1	1
Winter flounder	3	--	12	15
Tidewater silverside	2	--	5	7
Sea lamprey	6	--	3	9
Gizzard shad	529	--	3,388	3,917
Silver hake	14	--	63	77
Threespine stickleback	99	--	--	99
Butterfish	--	1	--	1
White crappie	--	--	1	1
Northern Puffer	--	--	1	1

(CONTINUED)

TABLE B-6 (Page 2 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM
AT INDIAN POINT UNIT 2 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
	WINTER	SUMMER	FALL	Total
Taxon				
Centrarchid unid.	1	--	31	32
Red hake	15	--	65	80
Grubby	1	--	2	3
Summer flounder	--	--	5	5
Striped searobin	--	--	17	17
Atlantic croaker	1	--	2	3
White mullet	--	--	1	1
Naked goby	2	--	14	16
Inshore lizardfish	--	--	1	1
Grey snapper	--	--	3	3
Freshwater drum	--	--	7	7
Total	61,008	1,705	108,927	171,640

TABLE B-6 (Page 1 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM AT INDIAN POINT UNIT 3 DURING 1989 (UNADJUSTED FOR COLLECTION EFFICIENCY)

Taxon	Stratum			
	WINTER	SUMMER	FALL	Total
Alewife	--	110	30	140
Bay anchovy	41	627	111	779
American shad	--	437	494	931
Bluefish	--	100	1	101
Bluegill	12	13	66	91
Brown bullhead	7	4	2	13
Pumpkinseed	57	2	10	69
Black crappie	2	--	1	3
Carp	5	--	3	8
American eel	9	15	16	40
Goldfish	13	--	3	16
Golden shiner	--	--	2	2
Hogchoker	407	4,205	1,402	6,014
Tessellated darter	--	--	5	5
Banded killifish	29	2	8	39
Largemouth bass	--	1	1	2
Atlantic menhaden	1	12	2	15
Blueback herring	9	355	4,641	5,005
Rainbow smelt	11	5	3	19
Spottail shiner	55	1	39	95
Striped bass	607	173	135	915
Fourspine stickleback	1	--	--	1
Atlantic tomcod	31	244	151	426
White catfish	57	19	263	339
White perch	22,740	559	12,019	35,318
Yellow perch	3	1	8	12
Northern pipefish	--	3	--	3
Redbreast sunfish	2	--	--	2
Crevalle jack	--	15	1	16
Weakfish	--	5,295	77	5,372
Lookdown	--	2	--	2
Clupeid unidentified	--	97	--	97
Tautog	--	--	3	3
Spot	1	--	--	1
Winter flounder	--	--	1	1
Tidewater silverside	2	--	--	2
Sea lamprey	1	--	--	1
Gizzard shad	1,361	1	532	1,894
Silver hake	6	--	2	8
Threespine stickleback	3	--	--	3
Butterfish	--	27	--	27
Centrarchid unid.	--	--	2	2
Red hake	9	--	8	17
Summer flounder	--	13	1	14
Striped searobin	--	--	8	8

(CONTINUED)

TABLE B-6 (Page 2 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM
AT INDIAN POINT UNIT 3 DURING 1989
(UNADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
	WINTER	SUMMER	FALL	Total
Taxon				
Atlantic croaker	--	--	1	1
Naked goby	--	--	2	2
Windowpane	--	4	--	4
Grey snapper	--	--	1	1
Freshwater drum	--	--	3	3
King mackerel	--	1	--	1
Total	25,482	12,343	20,058	57,883

TABLE B-7 (Page 1 of 2)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1989 (UNADJUSTED FOR COLLECTION EFFICIENCY)

Taxon	Stratum			
	WINTER	SUMMER	FALL	Total
Alewife	1	121	89	211
Bay anchovy	88	637	311	1,036
American shad	2	475	1,104	1,581
Bluefish	--	113	8	121
Bluegill	35	21	318	374
Brown bullhead	48	4	25	77
Pumpkinseed	167	4	354	525
Black crappie	3	--	10	13
Carp	9	--	6	15
American eel	40	63	274	377
Goldfish	41	--	14	55
Golden shiner	4	2	17	23
Hogchoker	1,077	5,161	14,923	21,161
Tessellated darter	17	1	54	72
Banded killifish	309	6	67	382
Largemouth bass	--	2	10	12
Mummichog	3	--	1	4
Atlantic menhaden	1	15	5	21
Chain pickerel	--	--	1	1
Blueback herring	18	363	11,485	11,866
White sucker	--	--	1	1
Rainbow smelt	45	6	21	72
Spottail shiner	350	10	676	1,036
Striped bass	2,067	275	2,180	4,522
Fourspine stickleback	4	--	--	4
Atlantic tomcod	102	301	1,743	2,146
White catfish	302	26	2,922	3,250
White perch	79,646	843	87,582	168,071
Yellow perch	37	1	170	208
Northern pipefish	--	3	--	3
Redbreast sunfish	15	1	9	25
Crevalle jack	--	17	11	28
Weakfish	--	5,430	390	5,820
Lookdown	--	2	--	2
Clupeid unidentified	--	98	16	114
Tautog	1	--	5	6
Four bearded rockling	2	--	--	2
Spot	1	--	--	1
Atlantic moonfish	--	--	1	1
Winter flounder	3	--	13	16
Tidewater silverside	4	--	5	9
Sea lamprey	7	--	3	10
Gizzard shad	1,890	1	3,920	5,811
Silver hake	20	--	65	85
Threespine stickleback	102	--	--	102

(CONTINUED)

TOTAL NUMBERS ACTUALLY COLLECTED BY TAXON AND SEASONAL SAMPLING STRATUM AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1989 (UNADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
Butterfish	--	28	--	28
White crappie	--	--	1	1
Northern Puffer	--	--	1	1
Centrarchid unid.	1	--	33	34
Red hake	24	--	73	97
Grubby	1	--	2	3
Summer flounder	--	13	6	19
Striped searobin	--	--	25	25
Atlantic croaker	1	--	3	4
White mullet	--	--	1	1
Naked goby	2	--	16	18
Windowpane	--	4	--	4
Inshore lizardfish	--	--	1	1
Grey snapper	--	--	4	4
Freshwater drum	--	--	10	10
King mackerel	--	1	--	1
Total	86,490	14,048	128,985	229,523

TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNIT 2 DURING 1987, BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
Alewife	159	4,204	1,903	6,266
Bay anchovy	526	1,150	1,354	3,030
American shad	129	3,579	11,713	15,421
Bluefish	0	13,119	498	13,617
Bluegill	2,368	3,100	16,195	21,663
Brown bullhead	7,894	0	4,634	12,528
Pumpkinseed	17,351	6,228	19,834	43,413
Black crappie	49	0	812	861
Carp	1,475	0	110	1,585
American eel	26,077	19,725	87,533	133,335
Goldfish	4,993	0	3,202	8,195
Golden shiner	125	1,233	2,025	3,383
Hogchoker	73,659	380,770	521,370	975,799
Tessellated darter	435	101	533	1,069
Banded killifish	8,745	488	1,184	10,417
Largemouth bass	0	46	1,349	1,395
Mummichog	87	0	12	99
Atlantic menhaden	0	24,159	34	24,193
Chain pickerel	0	0	1,535	1,535
Blueback herring	409	15,208	61,966	77,583
White sucker	0	0	984	984
Rainbow smelt	522	0	676	1,198
Spottail shiner	8,378	2,410	10,849	21,637
Striped bass	62,492	13,432	48,215	124,139
Fourspine stickleback	19	0	0	19
Atlantic tomcod	13,931	9,366	159,207	182,504
White catfish	23,944	37,012	123,051	184,007
White perch	1,951,595	258,318	1,220,291	3,430,204
Yellow perch	11,102	0	6,326	17,428
Northern pipefish	0	0	0	0
Redbreast sunfish	560	975	394	1,929
Crevalle jack	0	64	778	842
Weakfish	0	14,619	9,220	23,839
Lookdown	0	0	0	0
Clupeid unidentified	0	37	289	326
Tautog	49	0	980	1,029
Four bearded rockling	193	0	0	193
Spot	0	0	0	0
Atlantic Moonfish	0	0	41	41
Winter flounder	106	0	1,459	1,565
Tidewater silverside	23	0	20	43
Sea Lamprey	140	0	29	169
Gizzard shad	61,498	0	117,415	178,913
Silver hake	1,596	0	1,319	2,915
Threespine stickleback	1,313	0	0	1,313
Butterfish	0	1,122	0	1,122

(CONTINUED)

TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNIT 2
DURING 1987, BY TAXON AND SEASONAL STRATUM
(ADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
White crappie	0	0	540	540
Northern Puffer	0	0	29	29
Centrarchid unid.	8	0	204	212
Red hake	2,614	0	7,563	10,177
Grubby	72	0	9	81
Summer flounder	0	0	4,144	4,144
Striped searobin	0	0	2,459	2,459
Atlantic croaker	454	0	6	460
White mullet	0	0	74	74
Naked goby	4	0	82	86
Windowpane	0	0	0	0
Inshore lizardfish	0	0	285	285
Grey Snapper	0	0	64	64
Freshwater Drum	0	0	301	301
King Mackerel	0	0	0	0
Total	2,285,094	810,465	2,455,099	5,550,658

TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNIT 3 DURING 1987, BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
Alewife	0	2,917	1,276	4,193
Bay anchovy	198	12,821	1,184	14,203
American shad	0	7,556	19,160	26,716
Bluefish	0	11,663	684	12,347
Bluegill	1,079	3,276	15,524	19,879
Brown bullhead	2,070	2,618	2,600	7,288
Pumpkinseed	11,481	392	1,540	13,413
Black crappie	22	0	44	66
Carp	258	0	2,048	2,306
American eel	7,280	5,202	19,860	32,342
Goldfish	2,356	0	4,672	7,028
Golden shiner	0	0	236	236
Hogchoker	22,341	243,189	125,240	390,770
Tessellated darter	0	0	88	88
Banded killifish	598	62	388	1,048
Largemouth bass	0	231	144	375
Mummichog	0	0	0	0
Atlantic menhaden	1,812	13,061	36	14,909
Chain pickerel	0	0	0	0
Blueback herring	157	12,913	79,912	92,982
White sucker	0	0	0	0
Rainbow smelt	71	231	252	554
Spottail shiner	1,045	50	1,540	2,635
Striped bass	13,685	4,579	9,268	27,532
Fourspine stickleback	2	0	0	2
Atlantic tomcod	5,059	10,814	34,468	50,341
White catfish	4,881	36,729	28,700	70,310
White perch	411,927	87,694	406,672	906,293
Yellow perch	2,073	439	2,328	4,840
Northern pipefish	0	18	0	18
Redbreast sunfish	43	0	0	43
Crevalle jack	0	142	232	374
Weakfish	0	70,505	4,912	75,417
Lookdown	0	42	0	42
Clupeid unidentified	0	795	0	795
Tautog	0	0	3,428	3,428
Four bearded rockling	0	0	0	0
Spot	75	0	0	75
Atlantic Moonfish	0	0	0	0
Winter flounder	0	0	300	300
Tidewater silverside	9	0	0	9
Sea Lamprey	22	0	0	22
Gizzard shad	91,177	24	60,640	151,841
Silver hake	198	0	180	378
Threespine stickleback	19	0	0	19
Butterfish	0	2,724	0	2,724

(CONTINUED)

TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNIT 3
DURING 1987, BY TAXON AND SEASONAL STRATUM
(ADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
White crappie	0	0	0	0
Northern Puffer	0	0	0	0
Centrarchid unid.	0	0	20	20
Red hake	1,026	0	2,028	3,054
Grubby	0	0	0	0
Summer flounder	0	3,867	1,716	5,583
Striped searobin	0	0	1,004	1,004
Atlantic croaker	0	0	8	8
White mullet	0	0	0	0
Naked goby	0	0	16	16
Windowpane	0	65	0	65
Inshore lizardfish	0	0	0	0
Grey Snapper	0	0	44	44
Freshwater Drum	0	0	512	512
King Mackerel	0	246	0	246
Total	580,964	534,865	832,904	1,948,733

TABLE B-10 (Page 1 of 2)

TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1987, BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
Alewife	159	7,121	3,179	10,459
Bay anchovy	724	13,971	2,538	17,233
American shad	129	11,135	30,873	42,137
Bluefish	0	24,782	1,182	25,964
Bluegill	3,447	6,376	31,719	41,542
Brown bullhead	9,964	2,618	7,234	19,816
Pumpkinseed	28,832	6,620	21,374	56,826
Black crappie	71	0	856	927
Carp	1,733	0	2,158	3,891
American eel	33,357	24,927	107,393	165,677
Goldfish	7,349	0	7,874	15,223
Golden shiner	125	1,233	2,261	3,619
Hogchoker	96,000	623,959	646,610	1,366,569
Tessellated darter	435	101	621	1,157
Banded killifish	9,343	550	1,572	11,465
Largemouth bass	0	277	1,493	1,770
Mummichog	87	0	12	99
Atlantic menhaden	1,812	37,220	70	39,102
Chain pickerel	0	0	1,535	1,535
Blueback herring	566	28,121	141,878	170,565
White sucker	0	0	984	984
Rainbow smelt	593	231	928	1,752
Spottail shiner	9,423	2,460	12,389	24,272
Striped bass	76,177	18,011	57,483	151,671
Fourspine stickleback	21	0	0	21
Atlantic tomcod	18,990	20,180	193,675	232,845
White catfish	28,825	73,741	151,751	254,317
White perch	2,363,522	346,012	1,626,963	4,336,497
Yellow perch	13,175	439	8,654	22,268
Northern pipefish	0	18	0	18
Redbreast sunfish	603	975	394	1,972
Crevalle jack	0	206	1,010	1,216
Weakfish	0	85,124	14,132	99,256
Lookdown	0	42	0	42
Clupeid unidentified	0	832	289	1,121
Tautog	49	0	4,408	4,457
Four bearded rockling	193	0	0	193
Spot	75	0	0	75
Atlantic Moonfish	0	0	41	41
Winter flounder	106	0	1,759	1,865
Tidewater silverside	32	0	20	52
Sea Lamprey	162	0	29	191
Gizzard shad	152,675	24	178,055	330,754
Silver hake	1,794	0	1,499	3,293
Threespine stickleback	1,332	0	0	1,332
Butterfish	0	3,846	0	3,846

(CONTINUED)

TOTAL ESTIMATED WEIGHT (GRAMS) OF FISH IMPINGED AT INDIAN POINT UNITS 2 & 3 COMBINED DURING 1987, BY TAXON AND SEASONAL STRATUM (ADJUSTED FOR COLLECTION EFFICIENCY)

	Stratum			
Taxon	WINTER	SUMMER	FALL	Total
White crappie	0	0	540	540
Northern Puffer	0	0	29	29
Centrarchid unid.	8	0	224	232
Red hake	3,640	0	9,591	13,231
Grubby	72	0	9	81
Summer flounder	0	3,867	5,860	9,727
Striped searobin	0	0	3,463	3,463
Atlantic croaker	454	0	14	468
White mullet	0	0	74	74
Naked goby	4	0	98	102
Windowpane	0	65	0	65
Inshore lizardfish	0	0	285	285
Grey Snapper	0	0	108	108
Freshwater Drum	0	0	813	813
King Mackerel	0	246	0	246
Total	2,866,058	1,345,330	3,288,003	7,499,391

TABLE B-11

TOTAL NUMBER OF BLUE CRABS COLLECTED EACH MONTH AT INDIAN POINT GENERATING STATION DURING 1989

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
UNIT 2													
Male/Alive													
Intact	0	0	0	NS	NS	NS	893	808	1057	965	617	1	4,341
Missing Parts	0	0	0	NS	NS	NS	384	774	725	1,178	589	0	3,650
Male/Dead													
Intact	0	0	0	NS	NS	NS	98	28	56	55	7	0	244
Missing Parts	0	0	0	NS	NS	NS	184	198	120	205	47	0	754
Female/Alive													
Intact	0	0	0	NS	NS	NS	660	534	429	278	211	0	2,112
Missing Parts	0	0	0	NS	NS	NS	298	684	459	361	190	0	1,992
Female/Dead													
Intact	0	0	0	NS	NS	NS	90	31	23	8	0	0	152
Missing Parts	0	0	0	NS	NS	NS	157	226	110	78	19	0	742
Undetermined/Alive													
Intact	0	0	0	NS	NS	NS	0	0	0	0	1	0	1
Total Measured	0	0	0	NS	NS	NS	2,764	3,283	2,979	3,128	1,681	1	13,988
Total Count	0	0	0	NS	NS	NS	32,156	30,357	17,933	10,268	2,717	1	93,432
UNIT 3													
Male/Alive													
Intact	0	0	NS	NS	NS	NS	435	336	380	417	214	0	1,782
Missing Parts	0	0	NS	NS	NS	NS	210	338	347	623	355	0	1,873
Male/Dead													
Intact	0	0	NS	NS	NS	NS	69	38	28	23	10	0	168
Missing Parts	0	0	NS	NS	NS	NS	116	138	105	146	97	1	603
Female/Alive													
Intact	0	0	NS	NS	NS	NS	356	258	233	113	53	0	1,013
Missing Parts	0	0	NS	NS	NS	NS	150	349	258	183	77	0	1,017
Female/Dead													
Intact	0	0	NS	NS	NS	NS	57	37	24	7	4	0	129
Missing Parts	0	0	NS	NS	NS	NS	101	153	95	38	16	0	403
Undetermined/Alive													
Intact	0	0	NS	NS	NS	NS	0	0	0	1	0	0	1
Undetermined/Dead													
Missing Parts	0	0	NS	NS	NS	NS	0	0	0	0	1	0	1
Total Measured	0	0	NS	NS	NS	NS	1,494	1,647	1,470	1,551	827	1	6,990
Total Count	0	0	NS	NS	NS	NS	31,384	32,403	21,485	15,707	1,789	1	102,769
UNIT 2 AND 3													
Male/Alive													
Intact	0	0	0	NS	NS	NS	1,328	1,144	1,437	1,382	831	1	6,123
Missing Parts	0	0	0	NS	NS	NS	594	1,112	1,072	1,801	944	0	5,523
Male/Dead													
Intact	0	0	0	NS	NS	NS	167	66	84	78	17	0	412
Missing Parts	0	0	0	NS	NS	NS	300	336	225	351	144	1	1,357
Female/Alive													
Intact	0	0	0	NS	NS	NS	1,016	792	662	391	264	0	3,125
Missing Parts	0	0	0	NS	NS	NS	448	1,033	717	544	267	0	3,009
Female/Dead													
Intact	0	0	0	NS	NS	NS	147	68	47	15	4	0	281
Missing Parts	0	0	0	NS	NS	NS	258	379	205	116	35	0	993
Undetermined/Alive													
Missing Parts	0	0	0	NS	NS	NS	0	0	0	0	0	0	0
Undetermined/Dead													
Intact	0	0	0	NS	NS	NS	0	0	0	0	0	0	0
Missing Parts	0	0	0	NS	NS	NS	0	0	0	0	1	0	1
Total Measured	0	0	0	NS	NS	NS	4,258	4,930	4,449	4,679	2,508	2	20,978
Total Count	0	0	0	NS	NS	NS	63,540	62,760	39,418	25,975	4,506	2	196,201

Note: Excludes crabs for which information for all categories was not recorded.

Table B-12 (Page 1 of 3)

Carapace Width (mm) Distribution of Blue Crabs in Impingement Collections
at Indian Point Generating Station During 1989
Unit 2

Length Class	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
10-19											2		2
20-29							3		2	7	61		73
30-39							44	2	2	60	185		293
40-49							152	8	2	74	307		543
50-59							360	70		67	255	1	753
60-69							510	197	8	43	57		815
70-79							559	444	56	128	89		1276
80-89							494	469	170	353	153		1639
90-99							291	468	240	562	215		1776
100-109							193	520	328	580	175		1796
110-119							103	434	427	390	97		1451
120-129							35	274	581	321	43		1254
130-139							13	181	542	270	19		1025
140-149							1	119	403	177	10		710
150-159							1	73	166	66	1		307
160-169							4	17	39	22	1		83
170-179							1	6	9	4			20
180-189								1	2	2			5
190-199								1	2				3
200-209													0
210-219													0
220-229													0
230-239													0
240-249													0
250-259													0
260-269													0
270-279							1						1
Total Measured							2765	3284	2979	3126	1670	1	13825
Total Collected	0	0	0	NS	NS	NS	32156	30357	17933	10268	2717	1	93432

Table B-12 (Page 2 of 3)

Carapace Width (mm) Distribution of Blue Crabs in Impingement Collections
at Indian Point Generating Station During 1989
Unit 3

Length Class	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
10-19													0
20-29							4		2	4	6		16
30-39							27		3	15	39		84
40-49							113	7	5	11	69		205
50-59							224	47	1	25	73		370
60-69							329	118	7	18	34		506
70-79							271	220	35	61	57	1	645
80-89							219	216	71	175	131		812
90-99							132	234	101	239	155		861
100-109							98	236	171	265	128		898
110-119							51	199	222	203	76		751
120-129							18	138	242	163	32		593
130-139							7	102	285	166	14		574
140-149							1	77	194	136	3		411
150-159							1	37	104	57	1		200
160-169								12	23	11	1		47
170-179							1	1	4	2			8
180-189								2					2
190-199								1					1
200-209													0
210-219													0
220-229													0
230-239													0
240-249													0
250-259													0
260-269													0
270-279													0
Total Measured							1496	1647	1470	1551	819	1	6984
Total Collected	0	0	0	NS	NS	NS	31384	32403	21485	15707	1789	1	102769

Carapace Width (mm) Distribution of Blue Crabs in Impingement Collections
at Indian Point Generating Station During 1989
Unit 2 and 3 Combined

Length Class	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
10-19							0	0	0	0	2		2
20-29							7	0	4	11	67		89
30-39							71	2	5	75	224		377
40-49							265	15	7	85	376		748
50-59							584	117	1	92	328	1	1123
60-69							839	315	15	61	91		1321
70-79							830	664	91	189	146	1	1921
80-89							713	685	241	528	284		2451
90-99							423	702	341	801	370		2637
100-109							291	756	499	845	303		2694
110-119							154	633	649	593	173		2202
120-129							53	412	823	484	75		1847
130-139							20	283	827	436	33		1599
140-149							2	196	597	313	13		1121
150-159							2	110	270	123	2		507
160-169							4	29	62	33	2		130
170-179							2	7	13	6			28
180-189								3	2	2			7
190-199								2	2				4
200-209													0
210-219													0
220-229													0
230-239													0
240-249													0
250-259													0
260-269													0
270-279							1						1
Total Measured							4261	4931	4449	4677	2489	2	20809
Total Collected	0	0	0	NS	NS	NS	63540	62760	39418	25975	4506	2	196201

TABLE B-13

THE PROPORTION OF BLUE CRABS IN MEASURED SAMPLES IMPINGED IN 1989 BY SEX, SURVIVAL, AND CONDITION

UNIT	SEX	SURVIVAL	CONDITION	TOTAL	I/M, A/D BY MIF %[a]	I VS M BY A/D %[b]	I VS M BY A/D %[c]	A VS D BY A/D %[d]	M VS F %[e]
2	Male	Alive	Intact	4,341	48.3	54.3	51.0	88.9	65.0
			Missing Parts	3,650	40.6	45.7			
		Dead	Intact	244	2.7	24.4		11.1	
			Missing Parts	754	8.4	75.6	49.0		
	Female	Alive	Intact	2,112	43.6	51.5	46.7	84.7	35.0
			Missing Parts	1,992	41.1	48.5			
		Dead	Intact	152	3.1	20.5		15.3	
			Missing Parts	590	12.2	79.5	53.3		
3	Male	Alive	Intact	1,782	40.3	48.8	44.1	82.6	63.3
			Missing Parts	1,873	42.3	51.2			
		Dead	Intact	168	3.8	21.8		17.4	
			Missing Parts	603	13.6	78.2	55.9		
	Female	Alive	Intact	1,013	39.5	49.9	44.6	79.2	36.7
			Missing Parts	1,017	39.7	50.1			
		Dead	Intact	129	5.0	24.2		20.8	
			Missing Parts	403	15.7	75.8	55.4		

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