HUDSON RIVER ECOLOGICAL STUDY IN THE AREA OF INDIAN POINT

1979 ANNUAL REPORT

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Front cover: Indian Point Nuclear Generating Station as viewed from the west shore of the Hudson River by D.B. Pizzuto

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SECTION I

SUMMARY

This 1979 Annual Report, written in part to comply with some of the operating requirements for the Indian Point Electric Generating Station, is one of a series of reports prepared by Texas Instruments Incorporated over an eight year period under contract to Consolidated Edison Company of New York, Inc. The report was designed to serve two basic functions: to make available and discuss recent fish abundance, fish impingement, and water quality data associated with the Indian Point region [river mile (RM) 39 through RM 46] of the Hudson River ecosystem and to analyze and interpret these latest study results in conjunction with findings from previous years.

A. IMPINGEMENT COLLECTIONS

The number of fish impinged on intake screens which protect the once-through cooling system is a factor of prime interest in establishing the effect of the Indian Point Generating Station on the ecosystem. Therefore, counts of impinged fish were monitored on a daily basis. However, because some impinged fish have routinely been lost to the river, to scavengers, or decomposed before reaching the collection area, it was necessary to "scale up" actual impingement counts (on the basis of tests designed to estimate collection efficiency) to reflect those numbers presumed to have been impinged.

In past years, a single adjustment factor was utilized to "scale up" impingement counts at each generating unit (3.5 at Unit No. 2, 1.4 at Unit No. 3). Continual refinement of the testing procedures and accumulation of several years' data now permit confirmation of earlier observations that seasonal differences in collection efficiency occur. Thus, in 1979, it was possible to develop two adjustment factors for each unit which were subsequently applied to impingement counts. A "warm period" adjustment factor (3.8 at Unit No. 2 and 1.5 at Unit No. 3) was applied to the count of fish in each impingement collection from

May through October, and a "cold period" adjustment factor (2.1 at Unit No. 2 and 1.2 at Unit No. 3) was applied to each count in the remaining months of 1979.

B. IMPINGEMENT PATTERNS

Patterns of impingement during 1979 for 15 important and/or predominant species were similar to those of previous years. Seasonally, impingement counts were highest during late fall and winter with collections at that time dominated mostly by white perch. Cold water months were also the primary period of impingement for striped bass, adult Atlantic tomcod, white catfish, and spottail shiner. A considerably smaller secondary peak impingement period occurred in summer (involving mostly young Atlantic tomcod and bay anchovy) and in fall (when blueback herring, alewife, and American shad, emigrated out of the estuary). Hogchoker and rainbow smelt exhibited a slightly different impingement pattern than in previous years, i.e., a large rise in numbers impinged during the spring or summer and a slight rise in numbers impinged in late summer or early fall. Shortnose sturgeon and Atlantic sturgeon were impinged in such low numbers (4 and 70, respectively) that seasonal patterns were difficult to establish.

Impingement collections of all species were dominated by small (mostly young-of-the-year) fish. For species where specific size or age information was available, at least 90% of fish impinged were less than 12 months old. Qualitative examination of monthly impingement rate plots revealed that in 1979, as previously reported for 1977 and 1978, Unit No. 2 rates frequently and substantially exceeded those of Unit No. 3.

C. SPECIES COMPOSITION AND ABUNDANCE

During 1979, 74 species of fish were impinged at the Indian Point Generating Station. Three of these species, American sand lance, striped anchovy, and Atlantic mackerel were not previously collected in the Indian Point region. In field sampling, 42 species were collected in the Indian Point nearfield; 38 by beach seine, 25 by bottom trawl, and 11 by surface trawl. These values are consistent with previous years. No species new to the estuary were collected by nearfield sampling, and, except for the absence of emerald shiner, all species present every year during 1974 through 1978 were collected in 1979.

The predominant fish species impinged at the Indian Point Generating Station during 1979 were white perch, blueback herring, Atlantic tomcod, and bay anchovy. These species comprised 91.3% of the total unadjusted impingement collection for the year (unadjusted for collection efficiency). White perch was the most abundant species impinged during 1979; the total number impinged was higher than any previous year (1972 through 1978). Blueback herring, on the other hand, declined considerably in total number impinged during 1979 which appeared to be a result of decreased year class abundance.

Nearfield samples were also numerically dominated by individuals of a small number of species. Ten species comprised 85% of beach seine collections, seven species comprised 93% of lined and unlined bottom trawl collections, and only three species comprised 99% of surface trawl collections. These results are similar to previous years, although overall catches were lower in 1979 than in most previous years primarily due to the reduction of blueback herring catches.

D. HATCHERY-REARED STRIPED BASS

Beginning in 1973, TI began an investigation to determine the feasibility of mitigating entrainment and impingement losses of striped bass by a program of artifical hatching and stocking. A total of 318,000 marked young-of-the-year striped bass were stocked from 1973 through 1975. As of 30 June 1980, 1925 have been recaptured. Evaluations of distribution, growth, and sexual maturity of these recaptured fish indicate that hatchery fish grow and behave in a manner similar to wild striped bass, supporting the position that a stocking program for this species may be a viable mitigative procedure.

E. IMPINGEMENT VARIATION

Daily impingement counts at Indian Point provided an opportunity to compare less-than-daily impingement sampling designs with the actual values derived during 1976 through 1979 daily sampling. Variation in impingement data was analyzed and used to investigate three sampling designs: simple random (nonstratified), seasonal (stratified by three month seasonal periods), and empirical (stratified on the basis of empirical observation of variation in estimated maximum daily impingement counts). Precision of estimating the true mean daily number of fish impinged increased logarithmically for each of the designs as more days of the year were sampled. Simple random sampling proved to be least precise, stratified random sampling using three month seasonal periods was intermediate in precision, and stratified random sampling using empirically determined periods was the most precise design at both Units No. 2 and No. 3 at all fractions of the year sampled. However, differences in precision among the three designs were small, especially between the seasonal and empirical designs. Computer simulated sampling procedures indicated that sampling impingement during only 20% of the days in an average year at Unit No. 3 and 30% of the days at Unit No. 2 provided an estimate of the true mean daily impingement count which was 93% to 95% accurate. This was true for either three month seasonal or empirical stratified random sampling design. The selection and implementation of a reduced impingement sampling program at Indian Point would require an assessment of the desired level of precision and accuracy needed to meet future goals of the study.

F. IMPINGEMENT AS AN INDEX OF ABUNDANCE

Generating stations act as year-round sampling gear as a result of the continuous withdrawal of cooling water from the adjacent water body. Therefore, the possibility of using impingement collection data to monitor fish abundance in the Hudson River estuary was investigated by comparing annual counts of impinged fish at Indian Point and at Bowline, Lovett, Roseton, Danskammer, and Indian Point generating stations combined (corrected for variation due to plant operations and freshwater flow) to annual changes in riverwide abundance for white perch, striped bass, and Atlantic tomcod. These comparisons indicated that impingement collections at the five stations combined can be used to obtain a general indication of juvenile abundance for white perch. However, juvenile abundance of white perch has not been shown to reflect year class strength; thus, changes in annual impingement may not indicate relative year class strength at older ages. The annual ranking of striped bass abundance (measured by a catch-per-effort index of juvenile abundance in seines) and Atlantic tomcod abundance (measured by absolute estimate of spawning stock size) did not significantly correlate with the annual ranking of either Indian Point impingement alone or impingement at all five generating stations combined.

G. EVALUATION OF STANDARD STATION DATA

Fishes in the Indian Point area have been sampled by two distinct programs since 1973: Standard Stations Program and Long River Surveys. The programs originated for different purposes, but both have been capable of gathering the same types of information. Thus, tests were performed to evaluate comparability of inferences which can be drawn from each survey. Gear differences confound comparisons between standard stations and long river bottom trawl data; however, beach seines used in the two surveys are identical and were therefore the basis for this analysis. Past comparisons focused on the degree to which the Indian Point region reflected trends in abundance of individual species and species composition of the estuary in general. The present analyses compared standard stations and long river sampling in the Indian Point region to determine if similar inferences concerning the Indian Point fish community could be drawn from both surveys. Species composition was essentially identical for both surveys, and trends in abundance were usually, but not always, the same. The design of the Long River Survey has several advantages over the Standard Stations Program and may give a better representation of the Indian Point fish community.

SECTION II

INTRODUCTION

A. THE INDIAN POINT ELECTRIC GENERATING STATION

The Indian Point Electric Generating Station began commercial operation with the completion of Unit No. 1 in 1962. Units No. 2 and No. 3 were completed and began commercial operation in 1973 and 1976, respectively. Each unit of this nuclear plant utilizes a once-through cooling system which results in the entrainment of eggs, larvae, and small fish and impingement of primarily juvenile fish.

The combined pumping capacity of the three units for cooling purposes is 7790 $m^3 \cdot min^{-1}$ (2,058,000 $gal \cdot min^{-1}$). Unit No. 1, which has two [530 $m^3 \cdot min^{-1}$ (140,000 $gal \cdot min^{-1}$)] circulator pumps, was retired from commercial operation in October 1974. The two currently operating units (No. 2 and No. 3) each have six (530 $m^3 \cdot min^{-1}$) circulator pumps. Several service pumps with much lower capacities (144 $m^3 \cdot min^{-1}$ at Unit No. 1; 114 $m^3 \cdot min^{-1}$ at both Units No. 2 and No. 3) are also associated with each unit. During winter (approximately December to April) of each year when water temperatures fall below about 4°C, the amount of water drawn through the intake screen associated with each circulator pump is reduced to 60% of the normal pumping capacity to reduce fish impingement. Units No. 1 and No. 2 each have fixed intake screens at the river's edge and traveling screens within each intake forebay. Unit No. 3 has traveling screens at the river's edge but no fixed screens. Details of the plant and associated intake structures have been presented previously (TI 1975b, Con Edison 1977).

B. REPORT OBJECTIVES AND ORGANIZATION

During 1969, a series of ecological studies were initiated to study the effects of operation of the Indian Point Electric Generating Station on the aquatic biota of the Hudson River estuary. This 1979 Indian Point Annual Report, representing the eighth consecutive year of studies conducted by Texas Instruments Incorporated (TI), serves two primary functions: to make available and discuss 1979 data, particularly that related to impinged fish and nearfield river fish populations; and to analyze and interpret these latest study results in conjunction with findings from previous years. Compilations of data from 1979 impingement and nearfield fish collections are provided in Section III along with a summary of all hatchery-reared striped bass recaptured through June 1980 from stockings made during 1973 through 1975. Detailed tabulations of impingement, water quality, and field data in addition to sampling methods are provided in the appendices.

Analytical interpretations and discussions focus on three primary topics. First, daily variations in numbers of impinged fish are examined to determine the sampling frequencies necessary to reliably estimate impingement magnitude given a choice of desired precision levels (Section IV). Second, the reliability of annual impingement counts are evaluated for their value as an index to long-term trends in the annual abundance of selected fish species populations (Section V). Third, nearfield community composition and abundance are examined (Section VI) for presence or absence of long-term trends. TI has been collecting coincident fish samples in the vicinity of the Indian Point Generating Station during Long River (riverwide) Surveys and during the Nearfield Standard Station Program since 1973. Thus, a comparison is now possible of the inferences derived from each of the two programs which sample the same geographic area but with differing temporal and spatial sample allocation schemes.

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SECTION III

1979 IMPINGEMENT AND HUDSON RIVER FISH COLLECTIONS

A. INTRODUCTION

The impingement of fish has been monitored at Indian Point since the late 1960's to provide information used to assess the impact of plant operation on the fish populations in the Hudson River estuary. In this section, the total number of fish impinged at each unit throughout 1979 is presented, and seasonal impingement patterns as well as species composition of impingement and nearfield collections are compared with those of previous years. Annual changes in these seasonal patterns are evaluated for selected species to provide an indication of trends in relative abundance near the power plant. Age distribution of impinged fish is provided to evaluate the age structure of the impingeable portion of each species population. This is important because a given level of mortality inflicted on a population prior to establishment of year class strength should have less impact than a comparable level of mortality of older age classes.

Although intake screens at Indian Point are cleaned daily (Appendix C), not all impinged fish are collected. Losses occur due to a variety of causes such as predation, water currents, and disintegration of fish after impingement. Such losses were aggravated at Unit No. 2 by the screen wash procedure itself in which fish were washed from the fixed screens and into the river prior to being reimpinged on and collected from the traveling screens. This section includes an analysis of collection efficiency testing and subsequent development of adjustment factors which correct total counts for fish impinged but not collected. Impingement counts presented here and throughout the report have been adjusted unless otherwise specified.

This section, in its capacity of making available the most recent data on Hudson River fish populations, also includes a cumulative tabulation of the numbers and biocharacteristics of hatchery-reared striped bass that have been recaptured since TI's initial stocking during the summer of 1973.

B. COLLECTION EFFICIENCY

Previous studies of collection efficiency indicated that fish were lost from intake screens prior to collection (McFadden et al. 1978, TI 1979b, 1980a). To account for this loss, when estimating numbers of fish impinged, it is necessary to apply adjustment factors (based on tests of collection efficiency) to counts of impinged fish. In previous years (1974 through 1978) a single annual adjustment factor had been derived from these test results. By 1979, however, the combined data base (1974 through 1979) was sufficiently large to permit the development of cool and warm water adjustment factors.

Efficiency tests consisted of marking and releasing test fish at each unit's intakes followed by recovery of marked fish beginning with the first screen wash after each release and continuing during all succeeding screen washes. During 1979, collection efficiency tests were performed using colored tags to mark fish in addition to the dyes used in previous years (TI 1980a). Tagging was implemented on an experimental basis to assess its potential for reducing decomposition (thought to be accelerated by the dyeing process) and to permit identification of each test fish. Thus, efficiency tests could be performed more frequently without intertest mixing of returns which could occur with the limited number of distinguishable dye colors available. Collection efficiency methods are described in Appendix C.

1. Derivation of Adjustment Factors

a. Unit No. 2

At Unit No. 2 there was no significant difference ($\alpha = 0.05$) in collection efficiency between tagged and dyed fish (Table III-1, Appendix Tables A-17 and A-19). Therefore, adjustment factors were based on efficiency test results using dyed fish to maintain consistency with previous years and because the use of tags was still considered experimental.

Table III-1

Summary of Collection Efficiency Test Results at Indian Point Unit No. 2 during 1979

Mark Type	Number Released	Number Recovered	Percent Efficiency*
Dye	4,020	1,666	41.4
Tag	3,300	1,551	47.0

*Analysis of variance of transformed (arc sin $\sqrt{x}$) efficiencies indicated no significant (α=0.05) difference between tests using dye versus tag marking methods

Previous analyses (1974 through 1978) indicated that efficiency increased significantly at Unit No. 2 as temperature decreased (TI 1980a). The pattern of this relationship during 1974 through 1979 (Figure III-1) indicated that collection efficiency decreased when water temperatures were greater than 15°C. Efficiency tests conducted at temperatures below 15°C yielded significantly greater (α = 0.05) recovery of marked fish i.e., greater collection efficiency, than tests conducted at or above 15°C (Table III-2). Of the dyed test fish returned while temperatures were less than 15°C, 37.1% were returned on the first day after their release and 30.1% on the second day. When the water temperature was at or above 15°C, 29.5% of the test fish recovered were returned on the first day and 31.4% on the second day. This is somewhat lower than return rates for the first two days after release reported for 1978 collection efficiency tests (50% and 38%, respectively, with no breakdown by temperature) at Unit No. 2 (TI 1980a). Consequently, the year was partitioned into warm and cool water months. Inspection of the water temperature curve in the Indian Point region (Appendix Figure B-1) indicated that during January through April and November through December, temperatures were generally below 15°C, while during May through October, temperatures were generally above 15°C. Thus, a cool water adjustment factor of 2.1 based on combined releases divided by combined recoveries from tests conducted at less than 15°C (Table III-2) was applied to each impingement count during the

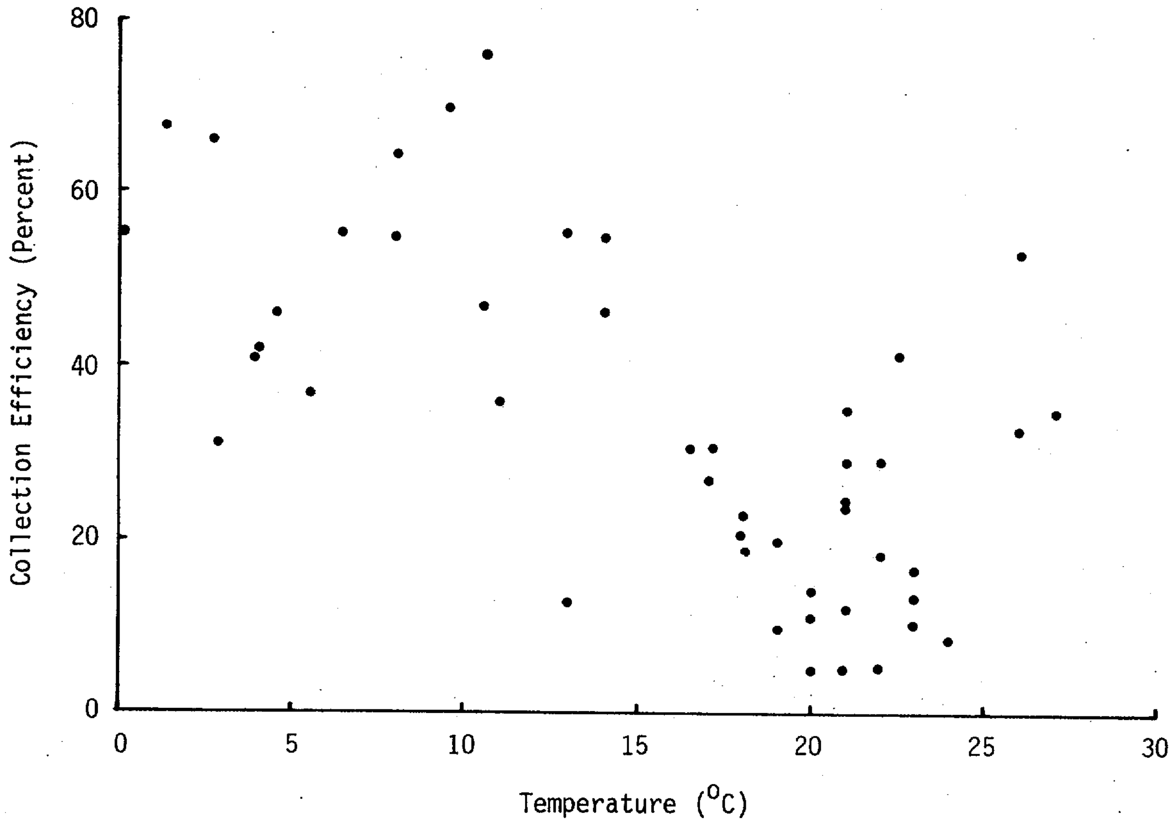


Figure III-1. Variation in Collection Efficiency with Respect to Water Temperature for Dyed Fish at Indian Point Unit No. 2 during 1974 through 1979 (each point represents one test)

Table III-2

Summary of Collection Efficiency Test Results for Dyed Fish at Less Than 15°C and Equal to or Greater Than 15°C at Indian Point Unit No. 2 during 1979

Temperature Range (°C)	Number Released	Number Recovered	Percent Efficiency* (R/Mx100)†	Adjustment Factor (M/R)
0 - 14.9	2,700	1,317	48.8	2.1
15 - 30	1,320	349	26.4	3.8

*Based on a t-test of transformed (arc sin $\sqrt{x}$) efficiencies, tests performed in cold water (0°C - 14.9°C) were significantly higher in efficiency than those in warm water (15°C - 30°C)

†R = number recovered
M = number marked and released

cool water months (January through April, November and December). A warm water adjustment factor of 3.8 was determined in the same manner from efficiency test results at 15°C and greater (Table III-2) and applied to each impingement count during the warm water months (May through October).

b. Unit No. 3

Comparable to Unit No. 2, there was no significant difference ($\alpha = 0.05$) in collection efficiency between tagged and dyed fish at Unit No. 3 (Table III-3, Appendix Tables A-18 and A-20). Also, as at Unit No. 2, efficiency has been shown to increase at Unit No. 3 as temperature decreased (TI 1980a). When 1976 through 1979 efficiencies were plotted, the pattern of this efficiency-temperature relationship was not as distinct as it was at Unit No. 2 (Figure III-2). A higher proportion of recovered fish were recovered the first day after test releases at Unit No. 3 (80.3% at less than 15°C and 79.2% at 15°C or higher) compared to Unit No. 2 (37.1% and 29.5%, respectively). In warm water, impinged fish can be expected to decompose more quickly than in cool water; thus, the extra day required for recovery of impinged fish at Unit No. 2 may explain the greater efficiency differential between warm

Table III-3

Summary of Collection Efficiency Test Results at Indian Point Unit No. 3 during 1979

Mark Type	Number Released	Number Recovered	Percent Efficiency*
Dye	3,660	2,693	73.6
Tag	2,940	1,945	66.2

*Analysis of variance of transformed (arc sin $\sqrt{x}$) efficiencies indicated no significant (α=0.05) difference between tests using dye versus tag marking methods

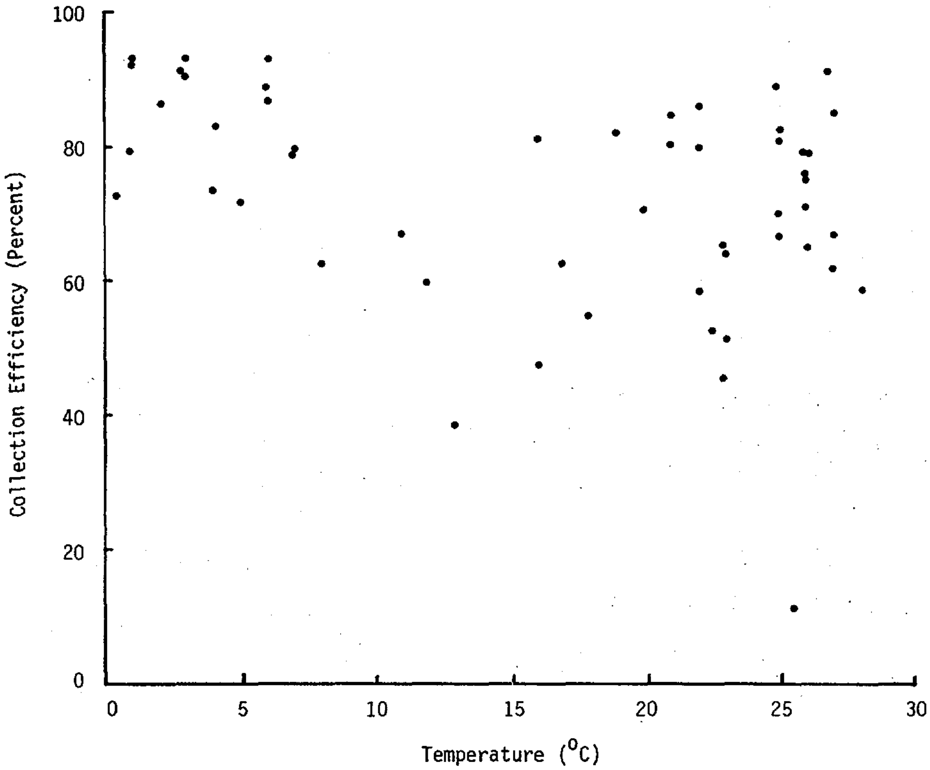


Figure III-2. Variation in Collection Efficiency with Respect to Water Temperature for Dyed Fish at Indian Point Unit No. 3 during 1976 through 1979 (each point represents one test)

and cold water at Unit No. 2 than was seen at Unit No. 3. Thus, due to the low number of tests conducted between 10°C through 20°C and the variable nature of the results, the cutoff temperature between warm and cool water could not be determined. Therefore, for consistency, the same cutoff temperature used for Unit No. 2 (15°C) was used at Unit No. 3. Collection efficiency tests at Unit No. 3 when temperatures were less than 15°C were significantly ($\alpha = 0.05$) greater than those at or above 15°C (Table III-4). The year was thus partitioned into warm and cool water months for Unit No. 3 in the same manner as it was for Unit No. 2. Adjustment factors of 1.2 for the cool water months (January through April, November and December) and 1.5 for the warm water months (May through October) were applied to each impingement count during 1979.

Table III-4

Summary of Collection Efficienty Test Results for Dyed Fish at Less Than 15°C and Equal to and Greater Than 15°C Water Temperature at Indian Point Unit No. 3 during 1979

Temperature Range (°C)	Number Released	Number Recovered	Percent Efficiency* (R/Mx100)†	Adjustment Factor (M/R)
0 - 14.9	1,440	1,206	83.8	1.2
15 - 30	2,220	1,487	67.0	1.5

*Based on a t-test of transformed (arc sin $\sqrt{x}$) efficiencies, tests performed in cold water (0°C - 14.9°C) were significantly higher in efficiency than those in warm water (15°C - 30°C)

†R = number recaptured
M = number marked and recovered

2. Collection Efficiency of Fish Released at Individual Screens

Marking fish with tags allowed sufficient discrimination among marked fish to test for differences in collection efficiency between release points in front of Units No. 2 and No. 3. As dictated by standard procedure, efficiency tests were routinely performed utilizing screen nos. 2 and 6 at each unit. At Unit No. 2, collection efficiency was significantly greater ($\alpha = 0.05$) for fish released in front of screen no. 2 than screen no. 6 throughout the year (Table III-5). At Unit No. 3, however, significantly greater efficiency was noted for fish released in front of screen no. 6 than screen no. 2. The difference at Unit No. 3 appears to have been attributable to collection efficiencies on 3 May, 28 June, and 4 July (Table III-6); however, only the 3 May and 28 June tests differed significantly between screens in a-posteriori comparisons.

Differences in collection efficiency between fish released at different points in front of the units can be influenced by differences in screen operation, such as differing water pressures during washes. However, numerous other factors such as differential trash loading among screens, order of screen washing, or movement of fish from one screen to another (especially important at Unit No. 2 because of fixed screen

Table III-5

Collection Efficiency Test Results for Tagged Fish Released at Screens no. 2 and no. 6 at Indian Point Unit No. 2 during 1979

Test Date	Percent Efficiency	
	Screen no. 2*	Screen no. 6
15 Jan	63.3	33.3
19 Apr	73.3	60.0
26 Apr	75.6	75.6
05 May	15.6	18.9
10 May	22.2	26.7
24 May	15.6	14.4
20 Sep	70.0	58.9
20 Dec	58.9	31.1
Pooled†	49.3	39.9

*Indicates significantly greater efficiency ($\alpha = 0.05$) based on replicated goodness of fit tests (Sokal and Rohlf 1969)

†Derived by dividing total number recovered by total number released for all tests combined

washing) may confound any attempt to assign specific efficiencies to the various screens.

3. Summary

In summary, collection efficiency was found to be significantly greater in cool water (less than 15°C) than warm water (15°C and greater) at both Unit No. 2 and Unit No. 3. The cool water adjustment factors were 2.1 at Unit No. 2 and 1.2 at Unit No. 3. The warm water adjustment factors were 3.8 at Unit No. 2 and 1.5 at Unit No. 3. Statistically significant differences in efficiency were observed between the two screens routinely tested at each unit. These

Table III-6

Collection Efficiency Test Results for Tagged Fish Released at Screens no. 2 and no. 6 at Indian Point Unit No. 3 during 1979

Test Date	Percent Efficiency	
	Screen no. 2	Screen no. 6*
05 Apr	94.4	93.3
11 Apr	92.2	80.0
03 May†	36.7	83.3
17 May	58.9	74.4
31 May	70.0	82.2
14 Jun	71.1	88.9
21 Jun	52.2	82.2
28 Jun†	38.9	83.3
04 Jul	33.3	74.4
19 Jul	73.3	77.8
27 Jul	43.3	48.9
02 Aug	54.4	67.8
09 Aug	82.2	78.9
16 Aug	81.1	82.2
Pooled**	63.0	78.4

*Indicates significantly greater efficiency (α=0.05) based on replicated goodness of fit tests (Sokal and Rohlf 1969)

†Indicates significantly greater differences based on a-posteriori comparisons

**Derived by dividing total number recovered by total number released for all tests combined differences support the procedural change made for the sampling year in progress (1980) where test releases are made at each operating screen to further improve development of a representative estimate of collection efficiency.

C. SEASONAL AND YEARLY IMPINGEMENT PATTERNS

As in previous Indian Point annual reports (TI 1979b, 1980a), this section provides information on seasonal patterns of impingement for the dominant species. Where available, total monthly impingement rates (adjusted unselected monthly counts ÷ total monthly unit discharge) were separated into young-of-the-year (YOY) and yearling and older groupings to evaluate size selectivity in impingement collections. In previous years, selected impingement rates were used for the analysis of impingement patterns (TI 1979b, 1980a) because they provided the most accurate and reliable data available. (Selected rates were developed to precisely match, on a daily basis, fish counts to volumes pumped for examination of daily impingement variation as in Section IV of this report, TI 1979b and 1980a). A new data filing system has improved access to both selected and unselected rate information. Thus, unselected rates have now become the preferred choice for examination of impingement patterns because the objective of seasonal pattern definition is better met by the most complete set of data than by the precision afforded by selected daily rates.

Overall, unselected impingement rates (all species combined) at the Indian Point Generating Station in 1979 were higher during the fall and winter (October through March) than during the spring and summer. Similar seasonal patterns have been seen each year since 1972 (TI 1974b, 1975c, 1979b, 1980a). A rigorous comparison of the seasonal patterns of 1979 impingement to those of previous years could not be readily made since refinements in estimates of collection efficiency resulted in adjustment of 1979 impingement counts in a manner different than was used for the years 1972 through 1978. Impingement collections during previous years were adjusted for collection efficiency with a single, annual adjustment factor at each unit. During 1979, however, two adjustment factors were applied: a warm water (May through October) adjustment which was slightly higher than that in previous years, and a cool water (January through April and November through December) adjustment which was slightly lower (Subsection III.B.1). The net effect of the change on seasonal patterns of overall impingement rates, if the 1979 patterns are compared to earlier years, is to decrease the normally high winter rates and slightly increase the normally lower summer rates. Seasonal patterns are relatively unchanged from previous years despite this "leveling" effect. Impingement rates adjusted by seasonal adjustments are contrasted with rates adjusted by an annual adjustment factor in Appendix Figures A-1 through A-4.

A graphical comparison of impingement rates for Units No. 2 and No. 3 (Figure III-3) indicates that impingement rates were higher at Unit No. 2. A portion of this apparent difference was actually due to an outage during 19 September through 31 December at Unit No. 3. However, during periods when both units operated (January through June),

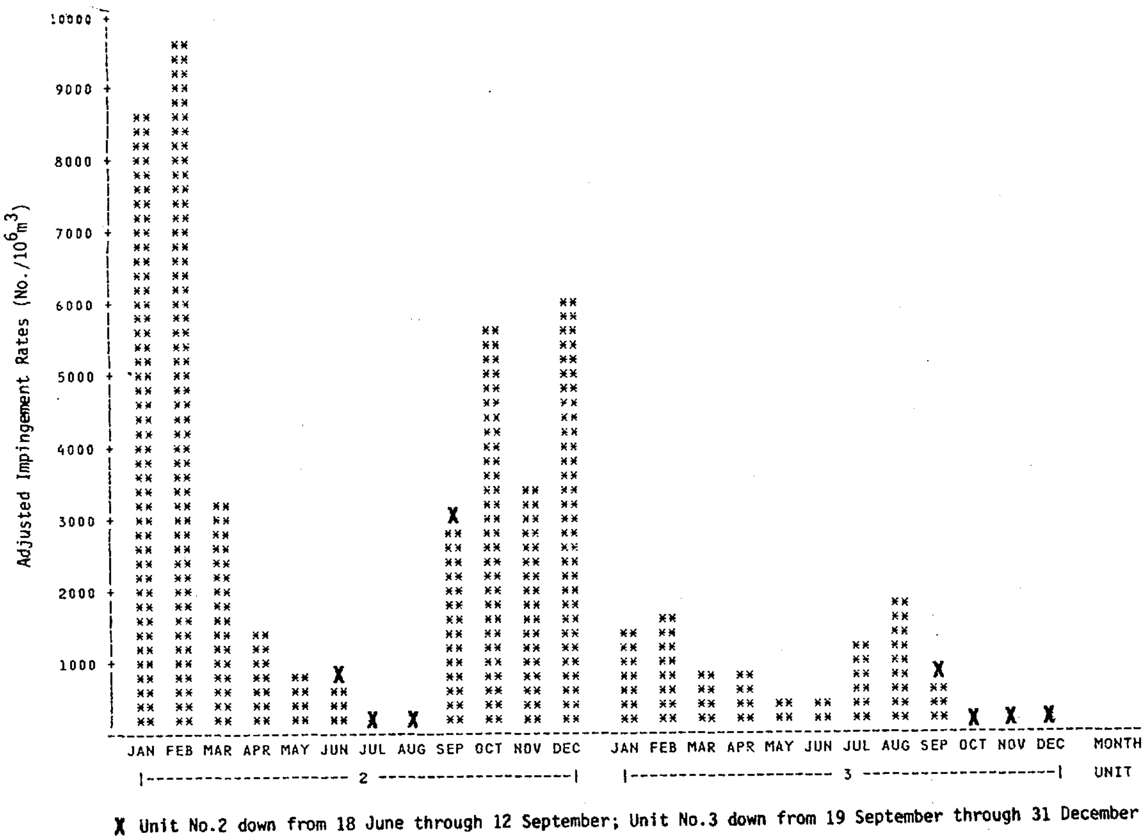


Figure III-3. Monthly Adjusted Impingement Rates for Species Combined at Indian Point Units No. 2 and No. 3 during 1979 impingement rates were still higher at Unit No. 2. This is consistent with results of previous statistical comparisons of impingement rates at the two units during 1977 and 1978 (TI 1979b, 1980a).

Impingement rates for individual species were examined to provide further insight into the overall pattern of impingement observed at the Indian Point Generating Station. The following species were selected due to their designation by the United States Environmental Protection Agency (EPA) as representative important species, due to relative abundance in impingement collections, classification as an endangered species, and/or importance as sport or commercial fish:

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

White perch, spottail shiner, striped bass, and white catfish were impinged mainly during late fall, winter, or early spring (Figures III-4 through III-7). These species inhabit the deeper channel portion of the river during the fall and winter then move into the shoreline regions in the spring as water temperatures increase (TI 1978). Thus, they are impinged mainly while in or moving to and from the channel. Impingement rates for white perch, the most abundant species in the 1979 impingement collections, were partitioned into YOY (i.e., age from time of spawning through 31 December) and yearling and older life stages (Figure III-4). Of the total 1979 white perch impingement, 7.9% (124,757 fish) were older than 12 months. To place this number in perspective, the white perch population estimate of yearling and older white perch in September 1978 was 12.1 million (TI 1980b). Only 10% of the striped bass impinged were YOY; however, 96.2% were less than 12 months old since impingement was heaviest during January through March when they were 9 or 10 months old.

Those species mainly impinged during the summer of 1979 were primarily bay anchovy, bluefish, and weakfish (Figures III-8 through

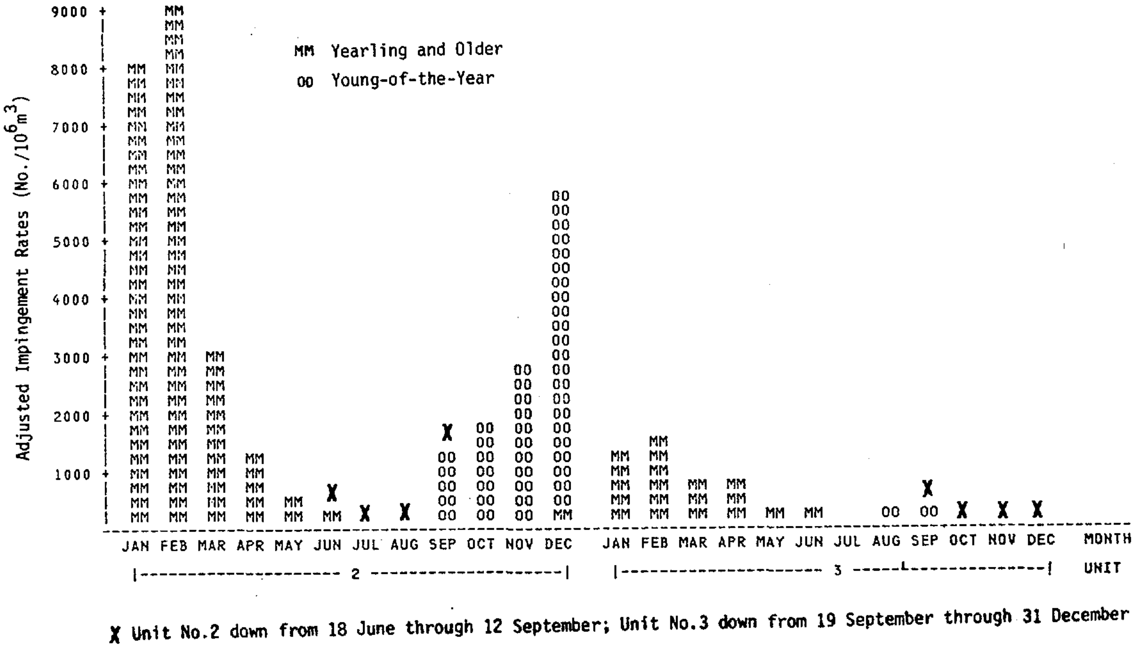


Figure III-4. Monthly Adjusted Impingement Rates for White Perch (yearling and older, and young-of-the-year) at Indian Point Units No. 2 and No. 3 during 1979

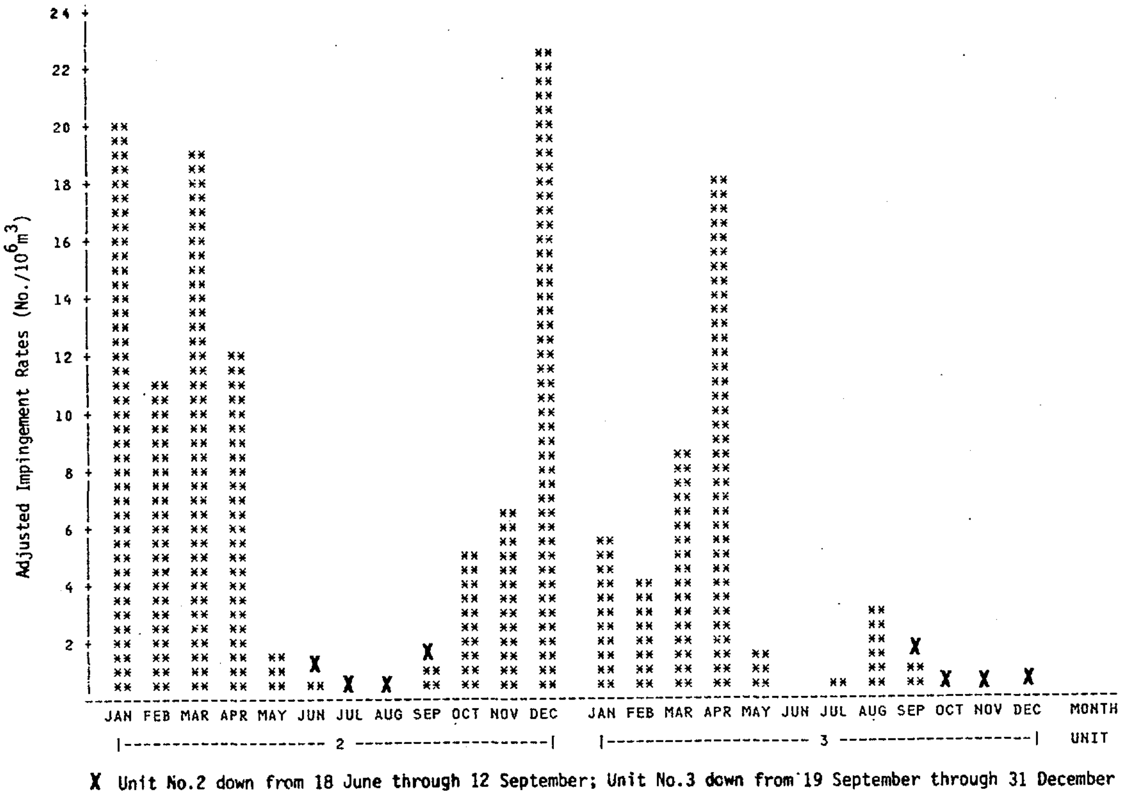
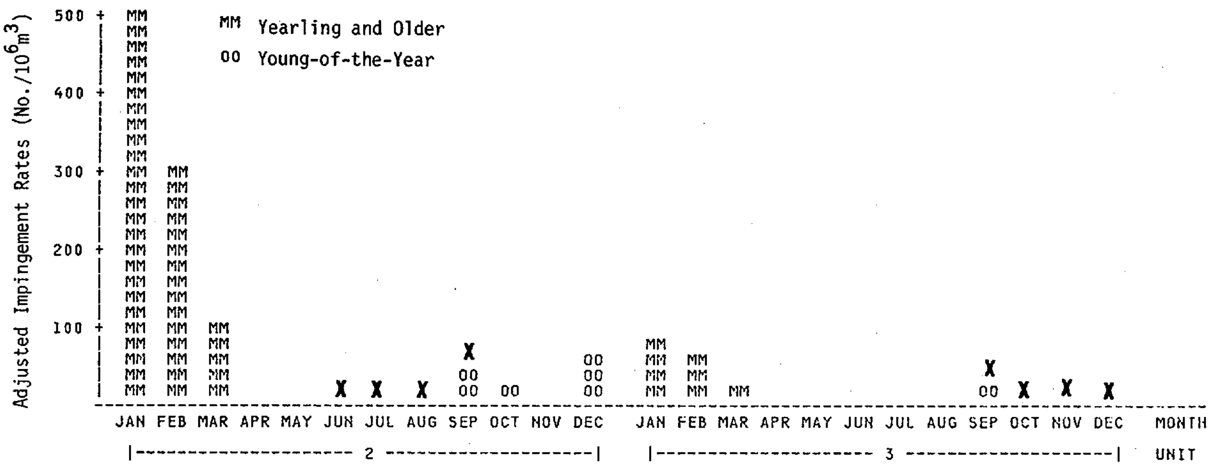
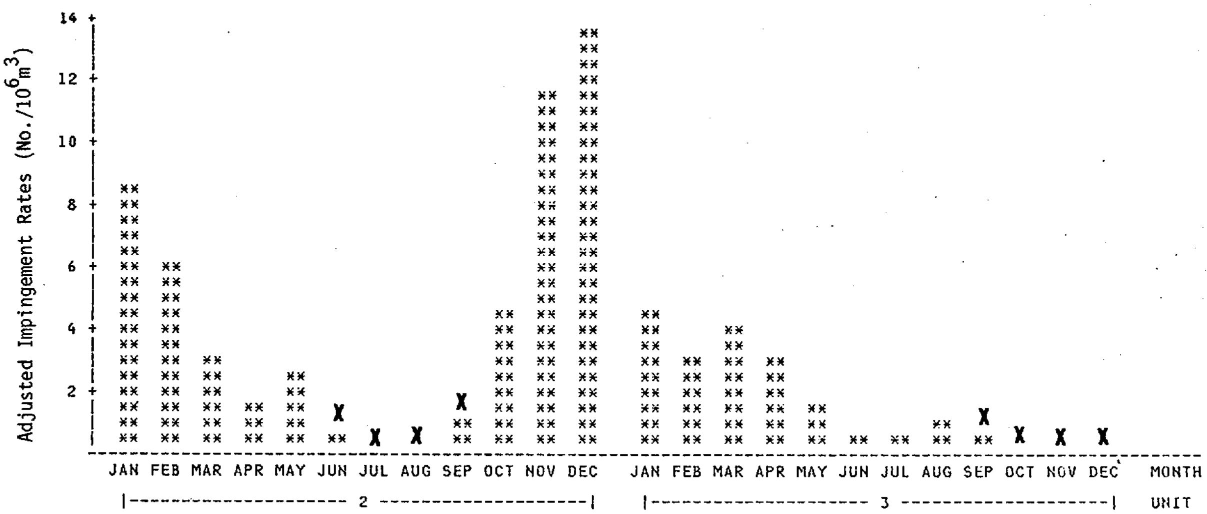


Figure III-5. Monthly Adjusted Impingement Rates for Spottail Shiner (all ages) at Indian Point Units No. 2 and No. 3 during 1979



X Unit No.2 down from 18 June through 12 September; Unit No.3 down from 19 September through 31 December

Figure III-6. Monthly Adjusted Impingement Rates for Striped Bass (yearling and older, and young-of-the-year) at Indian Point Units No. 2 and No. 3 during 1979



X Unit No.2 down from 18 June through 12 September; Unit No.3 down from 19 September through 31 December

Figure III-7. Monthly Adjusted Impingement Rates for White Catfish (all ages) at Indian Point Units No. 2 and No. 3 during 1979

III-10). The young of these species use the estuary as a nursery area during the summer and are impinged as they move into the Indian Point region. When temperatures begin falling and the salt front moves down river in the late summer and early fall, these YOY migrate to a lower portion of the estuary or emigrate to the ocean (Bigelow and Schroeder 1953, U.S. Atomic Energy Commission 1972, TI 1976, Con Edison 1977).

In previous years, alewife, American shad, rainbow smelt, Atlantic tomcod, and hogchoker have exhibited bimodal patterns of impingement (TI 1980a). During 1979, these bimodal patterns were repeated for Atlantic tomcod and hogchoker but were not as evident for alewife, American shad, and rainbow smelt (Figures III-11 through III-15) due to unit outages during periods of high abundance. Alewife

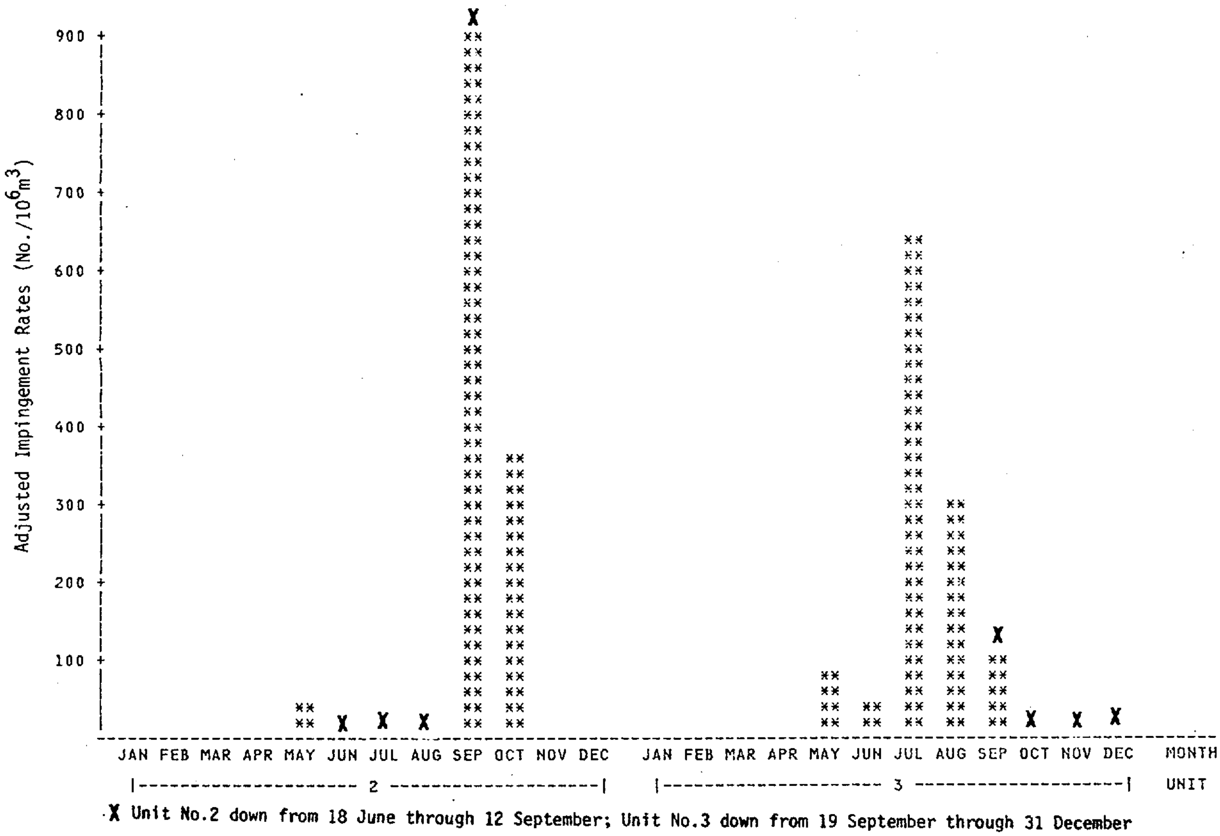


Figure III-8. Monthly Adjusted Impingement Rates for Bay Anchovy (all ages) at Indian Point Units No. 2 and No. 3 during 1979

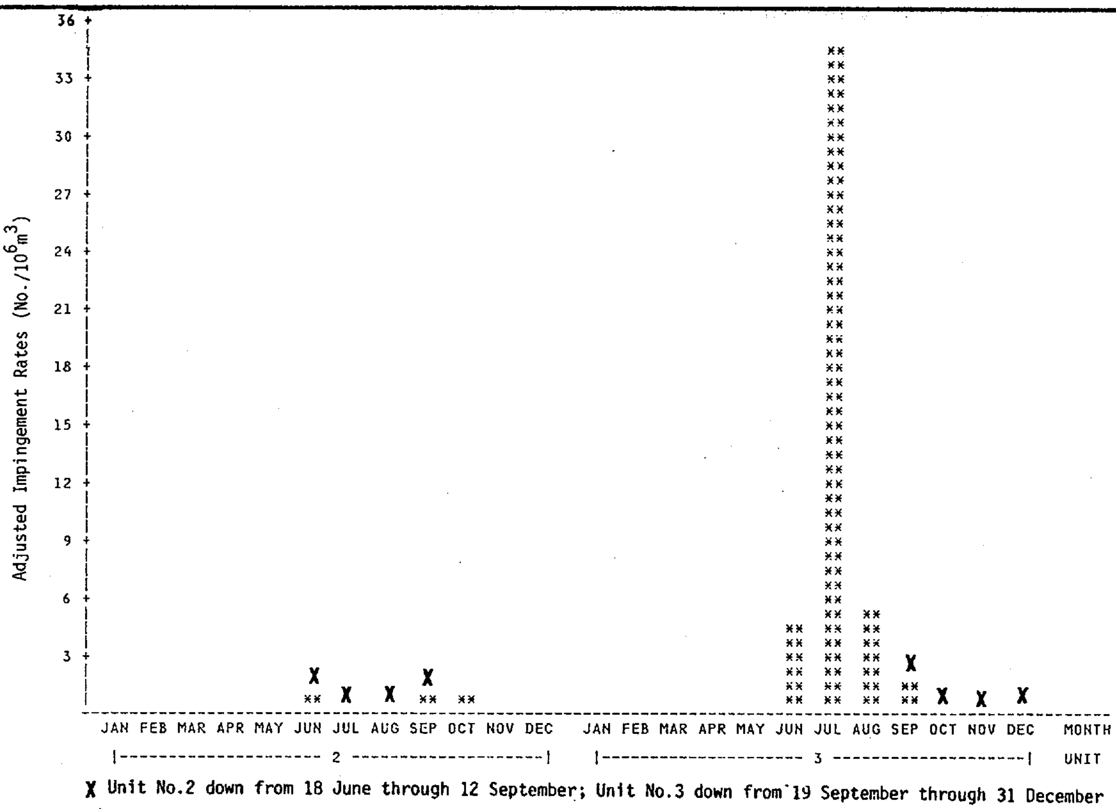


Figure III-9. Monthly Adjusted Impingement Rates for Bluefish (all ages) at Indian Point Units No. 2 and No. 3 during 1979

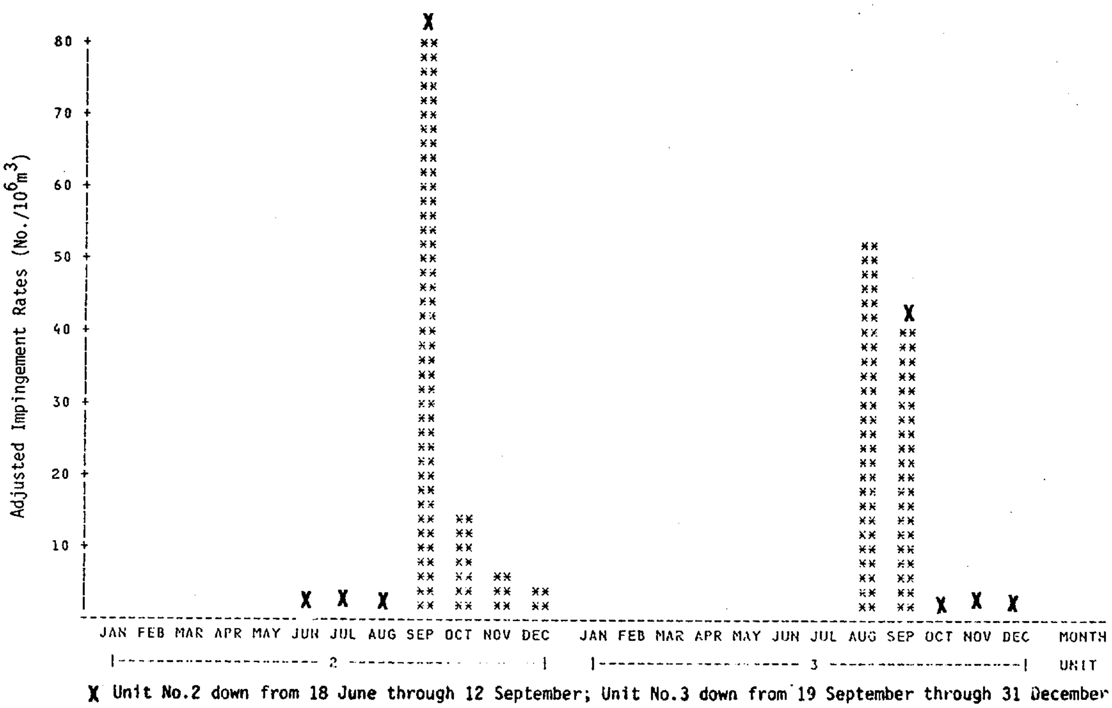


Figure III-10. Monthly Adjusted Impingement Rates for Weakfish (all ages) at Indian Point Units No. 2 and No. 3 during 1979 and American shad, which move about the middle estuary during the summer, were impinged mostly during July and August at Unit No. 3 while Unit No. 2 was not operational. The fall emigration of YOY alewife and American shad was apparent only at Unit No. 2 because Unit No. 3 was not operational at that time.

The early spring peak of rainbow smelt impingement (Figure III-13), reflecting their spawning run, was seen at both units while impingement during the fall emigration of YOY rainbow smelt occurred only at Unit No. 2 since Unit No. 3 was not operational. The outage at Unit No. 3 also obscured the typical fall peak impingement of emigrating YOY blueback herring which was seen only at Unit No. 2 (Figure III-16). The number of Atlantic and shortnose sturgeon (70 and 4, respectively) impinged during 1979 were not sufficient to identify a seasonal pattern; however, their monthly impingement rates are presented in Figures III-17 and III-18.

The clupeids (alewife, American shad, and blueback herring), and Atlantic tomcod impingement rates were partitioned into YOY and yearling and older categories to provide further examples of the age composition of impingement collections. Young-of-the-year comprised 96.6% of all the clupeids impinged and 96.0% of Atlantic tomcod impinged.

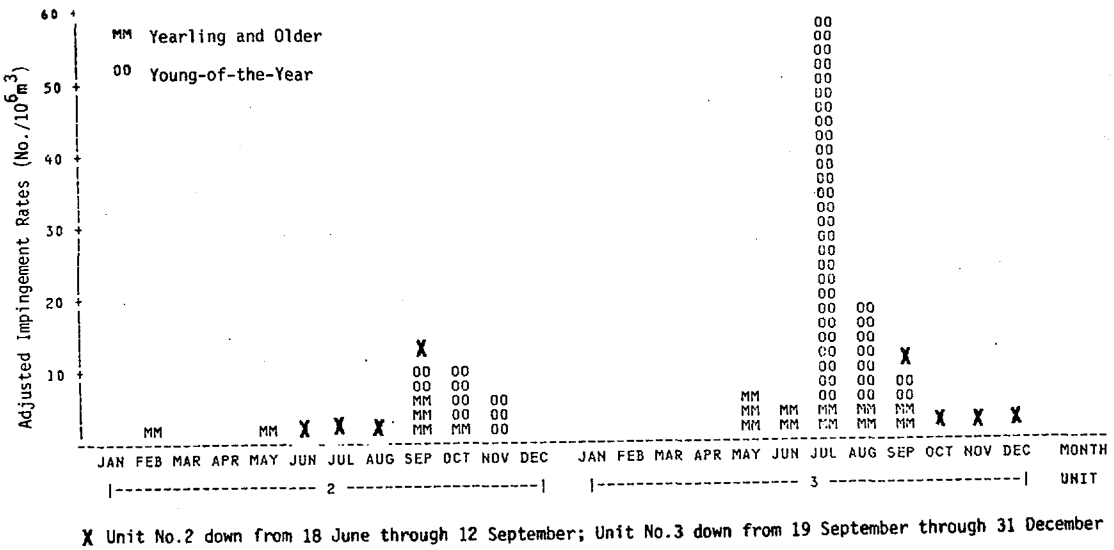


Figure III-11. Monthly Adjusted Impingement Rates for Alewife (yearling and older, and young-of-the-year) at Indian Point Units No. 2 and No. 3 during 1979

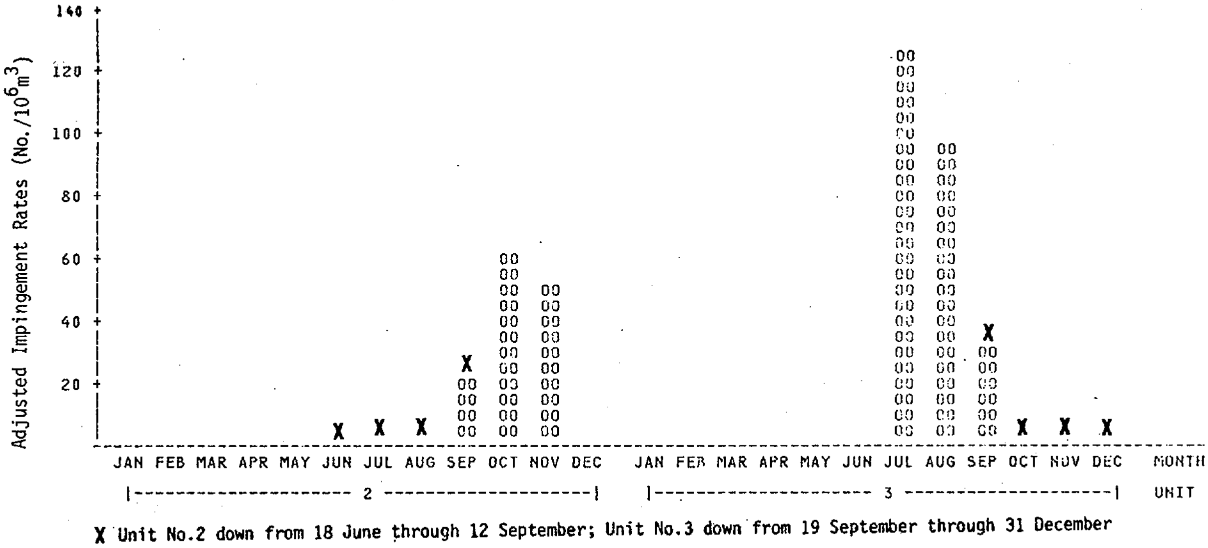


Figure III-12. Monthly Adjusted Impingement Rates for American Shad (young-of-the-year) at Indian Point Units No. 2 and No. 3 during 1979

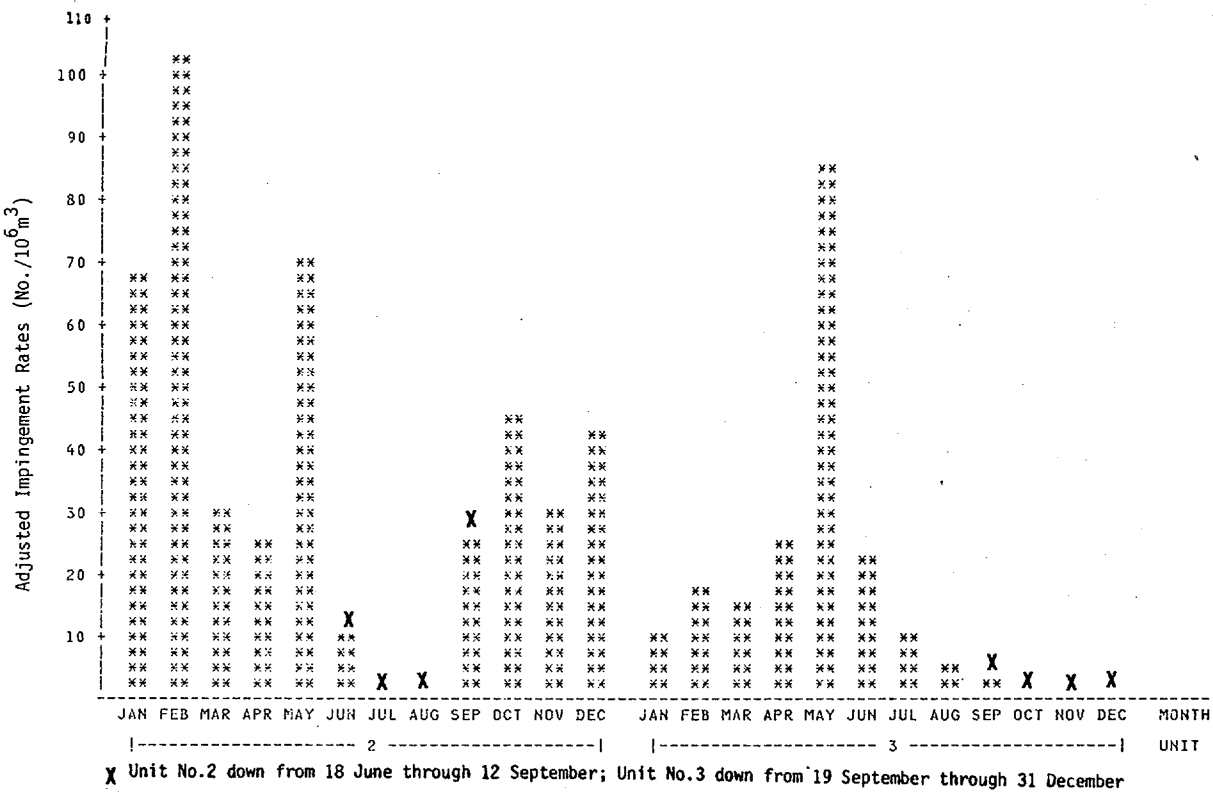


Figure III-13. Monthly Adjusted Impingement Rates for Rainbow Smelt (all ages) at Indian Point Units No. 2 and No. 3 during 1979

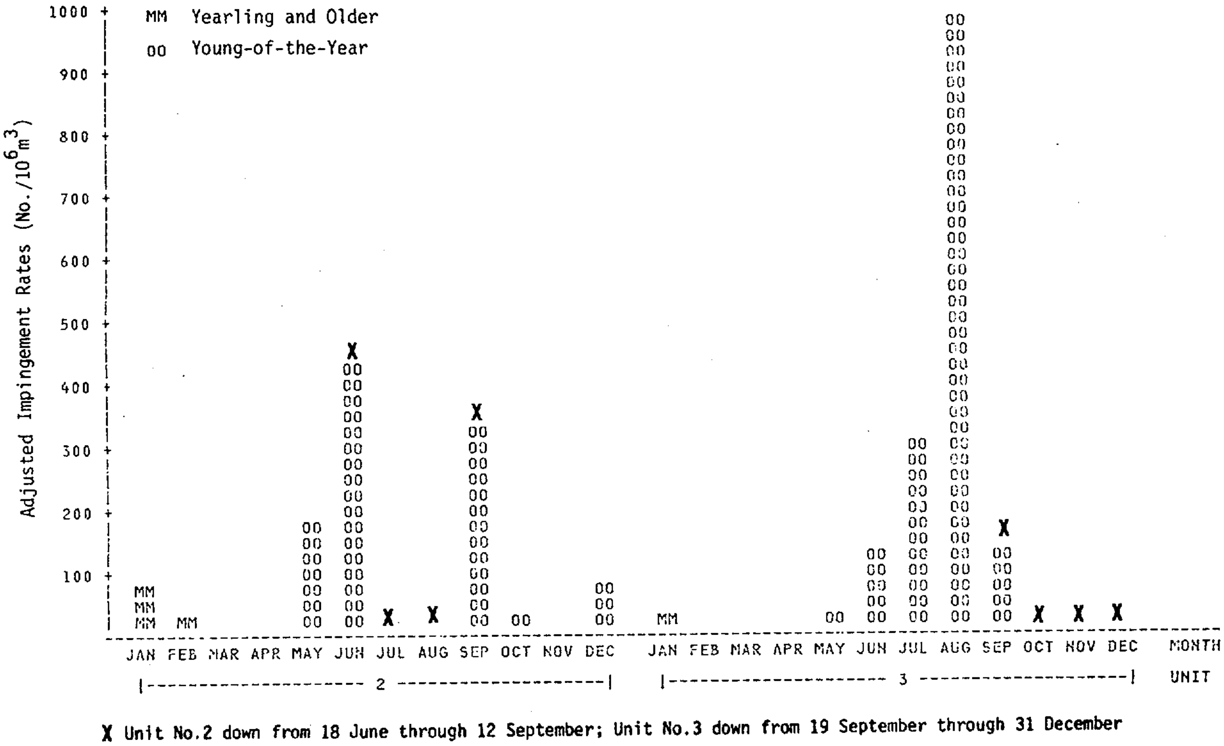


Figure III-14. Monthly Adjusted Impingement Rates for Atlantic Tomcod (yearling and older, and young-of-the-year) at Indian Point Units No. 2 and No. 3 during 1979

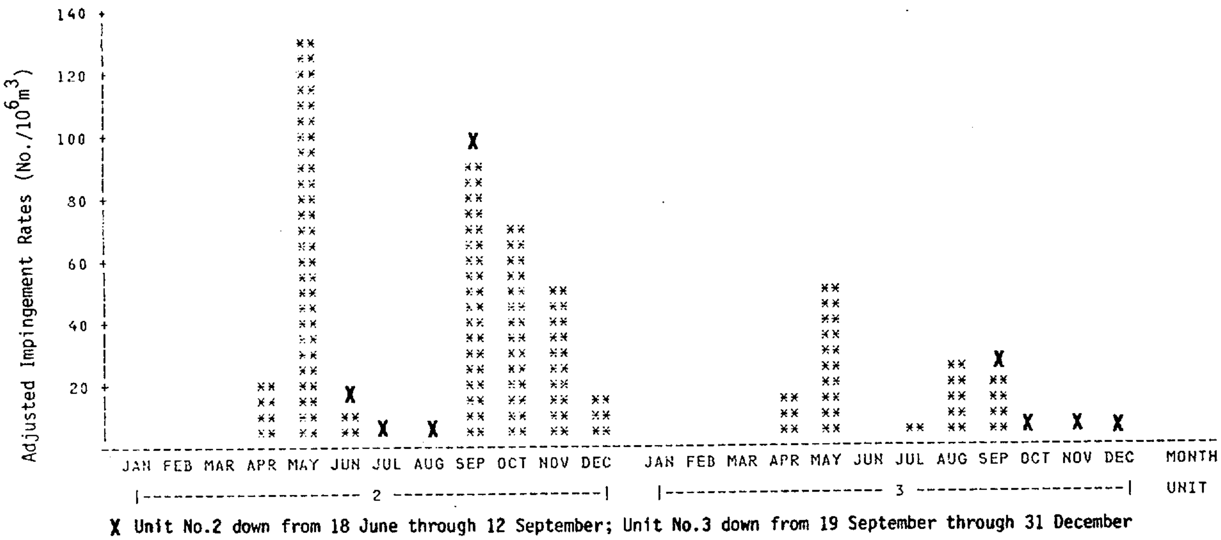


Figure III-15. Monthly Adjusted Impingement Rates for Hogchoker (all ages) at Indian Point Units No. 2 and No. 3 during 1979

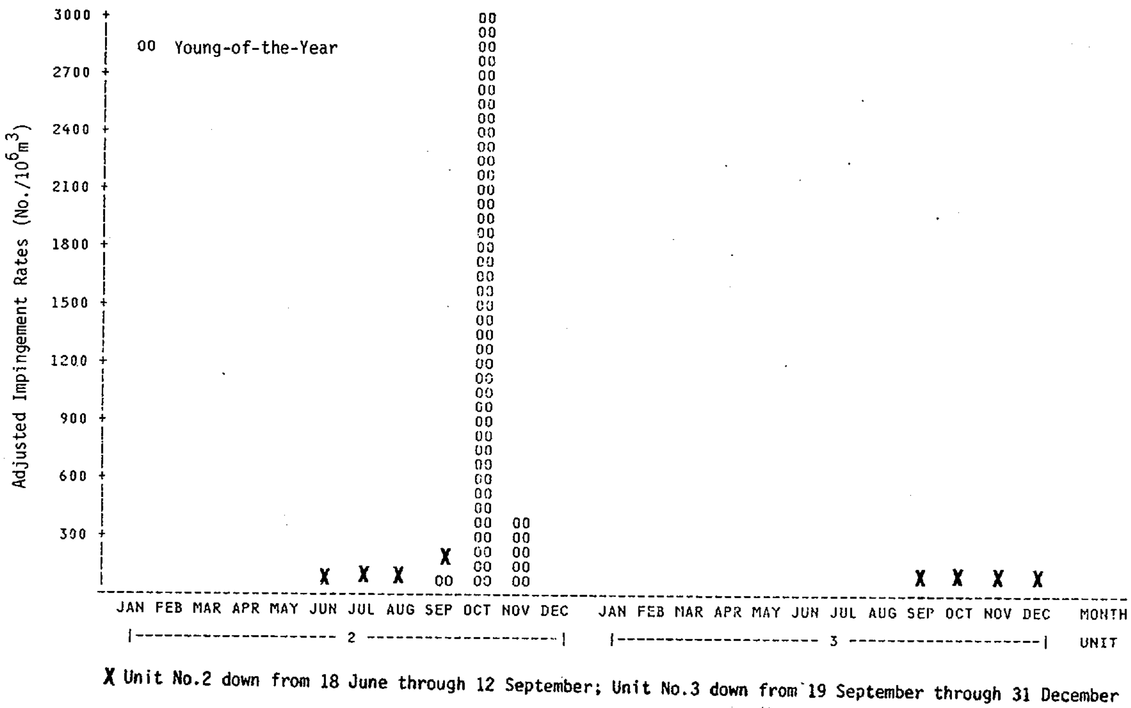


Figure III-16. Monthly Adjusted Impingement Rates for Blueback Herring (young-of-the-year) at Indian Point Units No. 2 and No. 3 during 1979

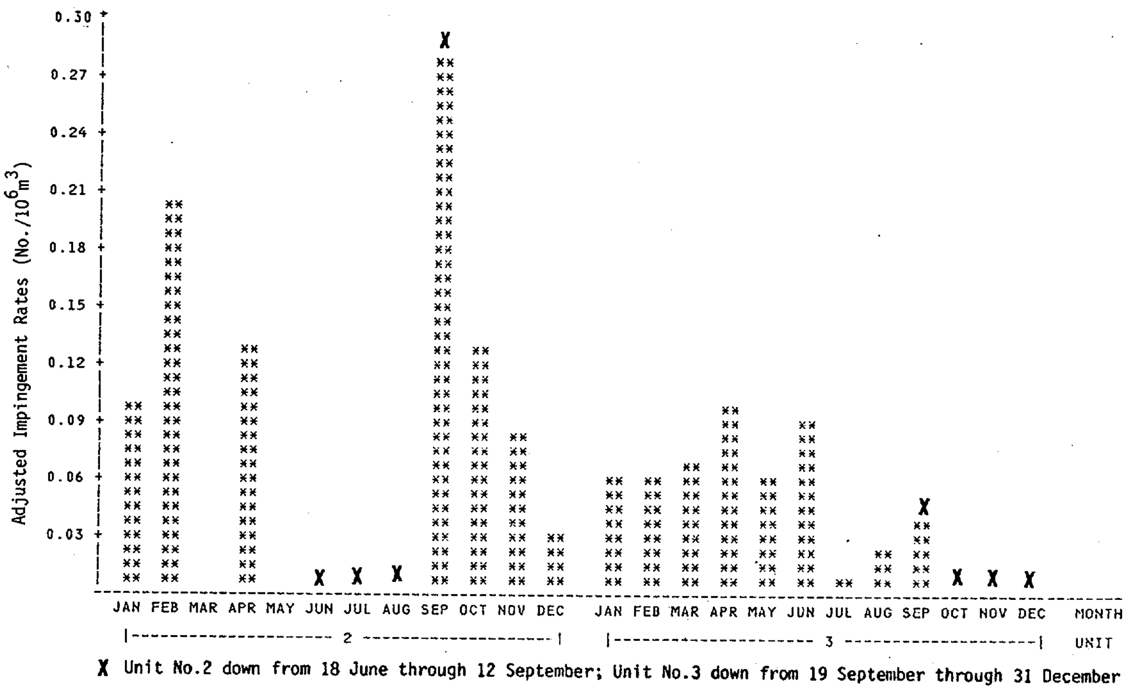


Figure III-17. Monthly Adjusted Impingement Rates for Atlantic Sturgeon (all ages) at Indian Point Units No. 2 and No. 3 during 1979

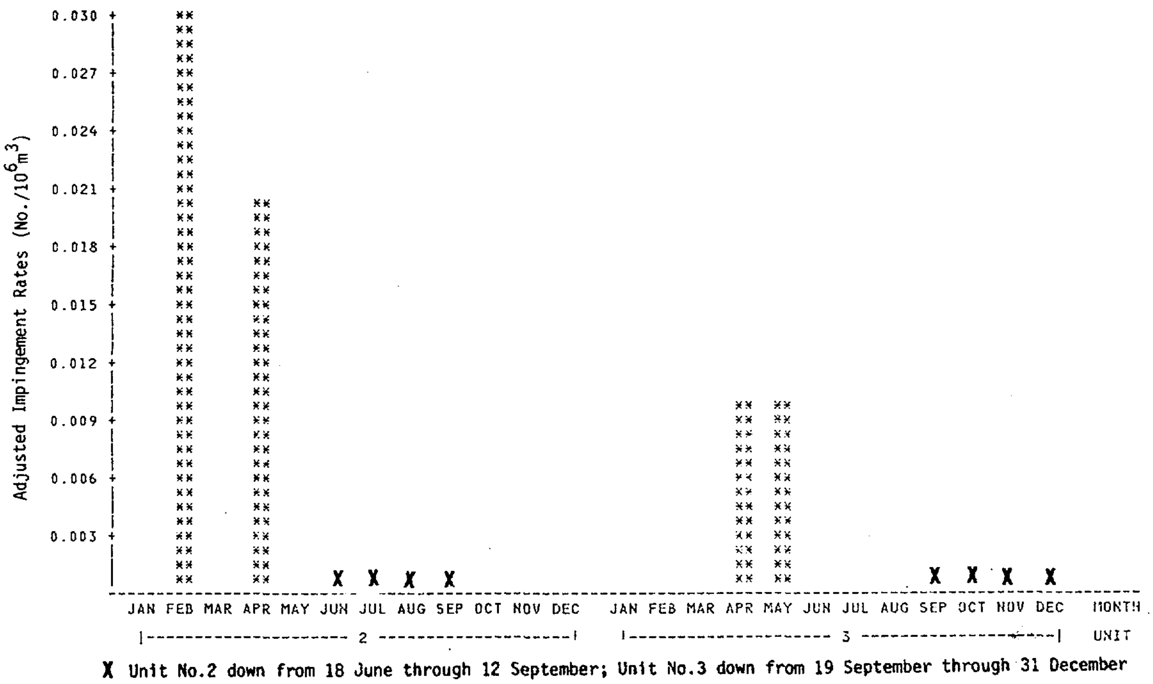


Figure III-18. Monthly Adjusted Impingement Rates for Shortnose Sturgeon (all ages) at Indian Point Units No. 2 and No. 3 during 1979

In summary, overall impingement rates (all species combined) at the Indian Point Generating Station in 1979 were highest during the fall and winter. White perch, striped bass, spottail shiner, and white catfish exhibited a unimodal impingement pattern with a peak in late fall, winter, or early spring. A unimodal pattern with peak impingement occurring during the summer was noted for bay anchovy, bluefish, and weakfish, while the clupeids, rainbow smelt, Atlantic tomcod, and hogchoker had bimodal patterns which were somewhat obscured by unit outages. Of the major species impinged, the majority of the impinged individuals were less than 12 months old.

D. SPECIES COMPOSITION OF IMPINGEMENT AND NEARFIELD COLLECTIONS

1. Number of Species

a. Impingement

Seventy-four species of fish were impinged at the Indian Point

Generating Station during 1979 (Appendix Table B-1), only two more than impinged during 1977 and 1978 (TI 1980a). Three of these species [American sand lance (*Ammodytes americanus*), striped anchovy (*Anchoa hepsetus*), and Atlantic mackerel (*Scomber scrombrus*)] were not previously collected in the Indian Point region (Appendix Table B-1).

b. Nearfield

Forty-two species were collected in the Indian Point nearfield region during 1979 (Appendix Table B-1). Thirty-eight species were collected by beach seine, 25 by bottom trawl, and 11 by surface trawl. These values are consistent with previous years (1972 through 1978) (TI 1980a) when the number of species collected in the nearfield has ranged from 38 to 50. No species new to the estuary were collected by nearfield sampling during 1979. Except for the absence of emerald shiner, all species present every year during 1974 through 1978 were collected in 1979.

2. Species Composition

a. Impingement

White perch, blueback herring, Atlantic tomcod, and bay anchovy were the predominant fish species impinged at the Indian Point Generating Station during 1979. These species comprised 91.3% of the total unadjusted impingement collection for 1979 and have comprised over 85% of impingement since 1975 (Appendix Table A-21).

b. Nearfield

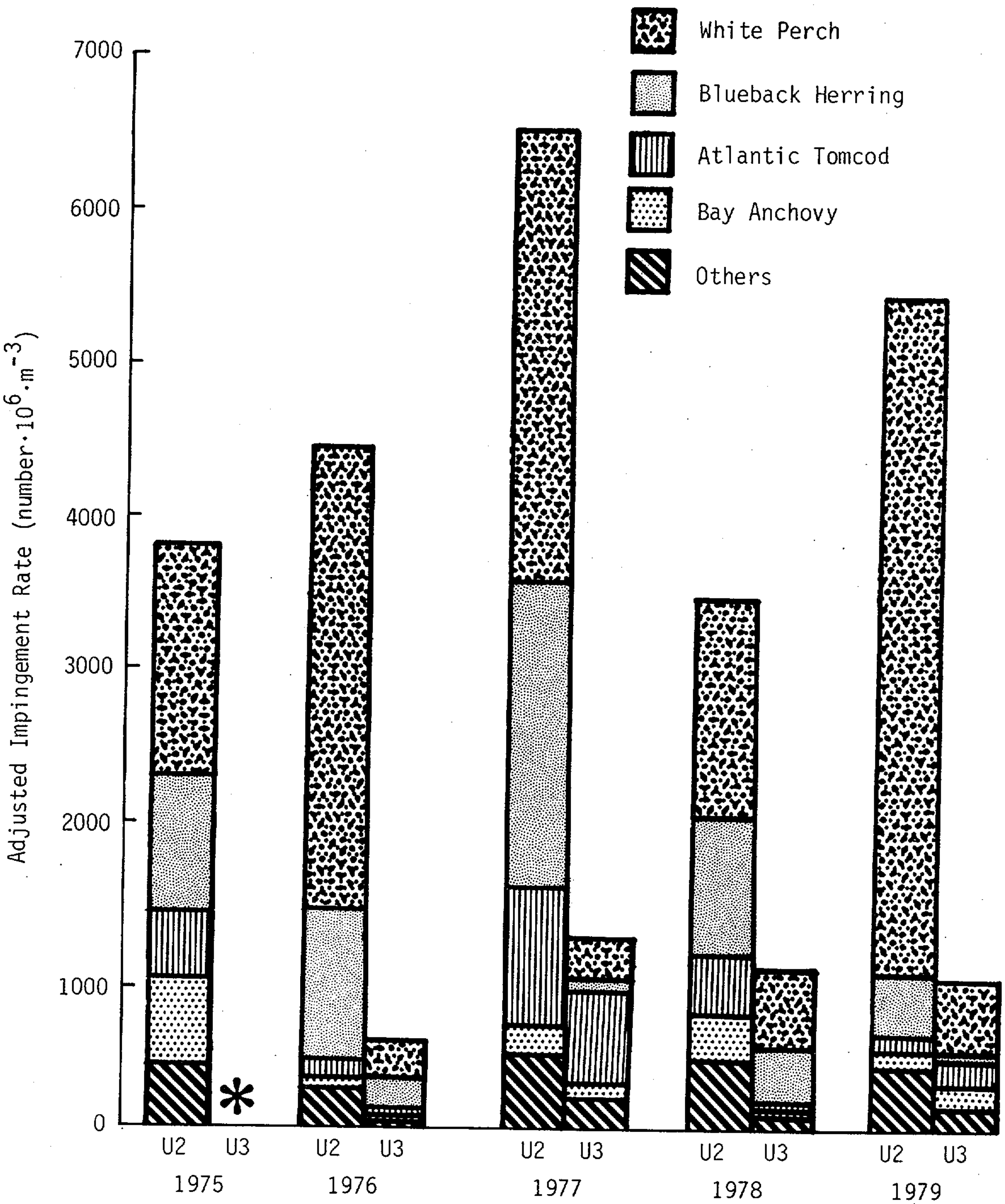
As in impingement collections, nearfield catches were numerically dominated by a small number of species. During 1979, 10 species comprised 86% of beach seine collections, 7 species comprised 93% of lined and unlined bottom trawl collections, and only 3 species comprised 99% of surface trawl collections. These results are similar to previous years (Appendix Tables B-2 through B-5).

3. Relative Abundance

a. Impingement

There was a major change in the relative contribution of white perch and blueback herring to impingement during 1979 with respect to their relative contribution in previous years (1975 through 1978). The proportion of white perch increased dramatically while the proportion of blueback herring decreased (Figure III-19). The drastic decrease in proportion of blueback herring at Unit No. 3 was partly due to lack of Unit No. 3 operation during the fall blueback migration period. However, these changes in proportion did reflect an actual increase in the number of white perch impinged as well as an actual decline in the number of blueback herring impinged. The changes in impingement of these two species were apparently due to changes in their abundance rather than changes in environmental parameters which affect their impingement or changes in plant operation (Appendix Tables A-16, B-1, B-2). This conclusion is based on a decrease in 1979 from previous years in nearfield blueback herring collections (Subsection III.D.3.b). An increase in white perch nearfield catch was not noted; however, the majority of white perch impingement occurred during the winter (Subsection III.C) when nearfield collections were not made. White perch abundance indices for 1979 do however indicate that the 1979 year class, which represents the fall 1979 portion of the 1979 impingement bar in Figure III-19, was higher than in the years 1975 through 1979 [TI 1980c (in preparation)].

Differences in the relative contribution of other species to impingement in 1979 were minimal compared to previous years. The proportion of Atlantic tomcod in impingement collections during 1979 was similar to that seen in 1975, 1976, and 1978 and lower than the 1977 contribution (Figure III-19). Bay anchovy impingement was low during 1976 corresponding to high levels of summer freshwater flow, which kept conductivity near Indian Point low [Appendix Figure B-1 (a and b)]. Bay anchovy impingement has remained rather consistent during 1975, and 1977 through 1979. The lower proportion of bay anchovy at Unit No. 3 in 1978, and Unit No. 2 in 1979 reflect reduced operation of those units (Appendix Table A-16) during the summer when bay anchovy are most susceptible to impingement. The contributions of other



* Unit No. 3 was not operational in 1975

† Annual Adjustments used on all years (Unit No. 2 - 3.5, Unit No. 3 - 1.4)

Figure III-19. Adjusted† Impingement Rates and Relative Proportions of Abundant Species at Indian Point Generating Station, Units No. 2 (U2) and No. 3 (U3), 1975 through 1979 major species impinged (Appendix Table A-21), hogchoker, striped bass, and rainbow smelt, have changed little over the five year period (1975 through 1979). The relative contribution of striped bass to impingement, although low, (0.8% to 2.4%) has increased steadily from 1975 through 1979. The increase in proportion has been accompanied by an increase in actual number impinged from 5,977 in 1975 to 50,511 in 1979 (Appendix Table A-21).

The increase in number of striped bass collected from impingement during 1975 through 1979 appears to have been caused by increases in water withdrawal and also by increases in striped bass abundance. The volume of water withdrawn by Unit No. 2 and Unit No. 3 (represented by total unit discharge) was much larger during 1977, 1978, and 1979 than during 1975 and 1976. Impingement of striped bass (and many other species) was also much greater during 1977 through 1979 than during 1975 and 1976 (Table III-7). Half of the increase in numbers impinged are accounted for when the affect of differences in water withdrawal are removed by dividing number of striped bass collected by the volume withdrawn. The remaining increase in number impinged can be at least partially explained by changes in abundance. Trends in impingement rate and young-of-the-year abundance indexes are similar but do not correspond exactly (Table III-7). The discrepancy is due to the fact that impingement of striped bass occurs primarily during the fall (October through December) and winter (January through March) (Appendix Table A-9 and TI 1980a Appendix Table A-13); therefore, a large year class will cause high impingement rates during the fall of one year (as young-of-the-year) and during the winter of the next year (as yearlings). For example, the large 1978 year class caused high impingement rates during the fall of 1978 and the winter of 1979. Thus, impingement during 1979 was high as a result of the 1978 year class although the 1979 year class was small.

b. Nearfield

During 1979, total catch-per-effort in the nearfield by beach seine and unlined bottom trawl were lower than during any year from 1974 through 1978 (Figure III-20 and III-21), total catch-per-effort by lined bottom trawl and surface trawl (Figures III-22 and III-23) were lower during 1979 than all other years but one (total catch-per-effort was lowest during

Table III-7

Number of Striped Bass Collected during Impingement Sampling at Indian Point Generating Station and Rate of Impingement (Number/Volume) Compared to Water Withdrawal (total unit discharge) and Abundance, Hudson River Estuary, 1975 through 1979

Year	Number Collected	Total Unit Discharge (in million m^3)	Rate Number/Volume	Abundance Indices	
				Beach Seine Survey CPUA*	Combined Standing Crop†
1975	5,977	1118.9	5.34	21.3	20
1976	6,130	1329.1	4.61	15.5	18
1977	27,677	2158.6	12.82	22.8	34
1978	42,282	2030.4	20.82	31.4	33
1979	50,511	1934.9	26.11	13.0	12

*CPUA = catch-per-unit-area; 1975 through 1978 values from TI 1980b

†from TI 1980c

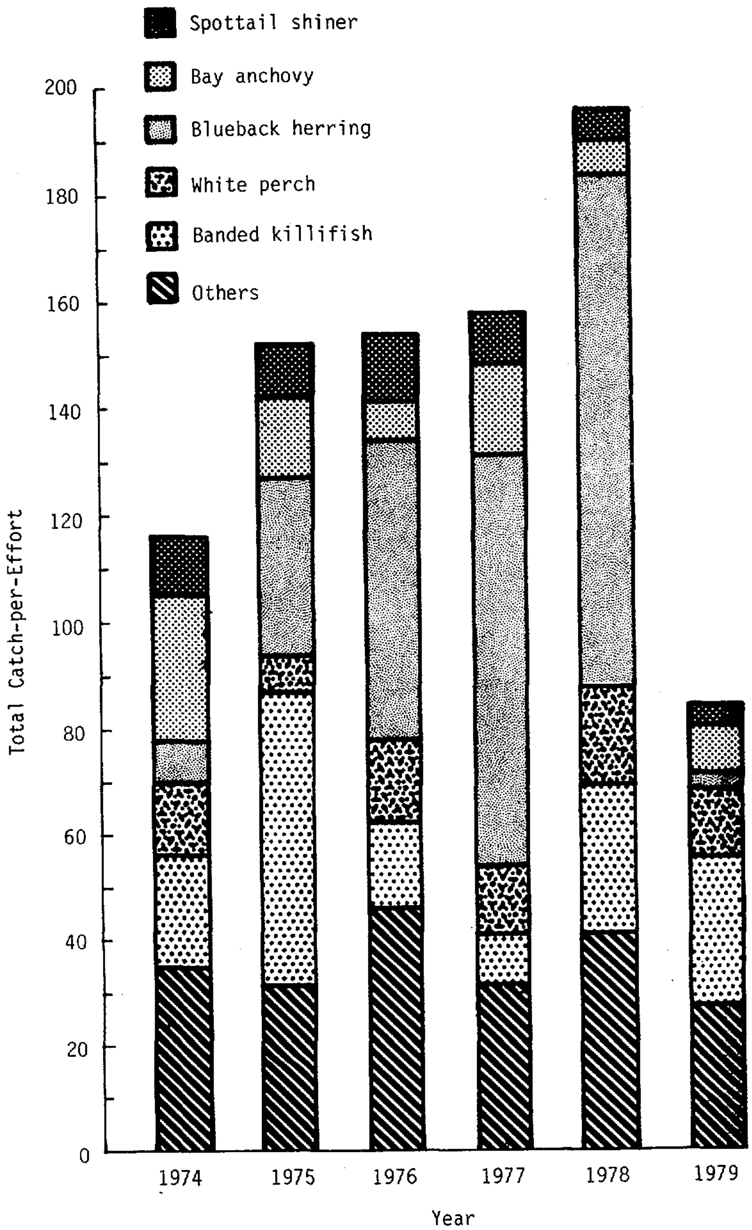


Figure III-20. Total Catch-per-Effort and Relative Proportions of Abundant Species Collected in Beach Seines, Indian Point Nearfield Region, 1974 through 1979

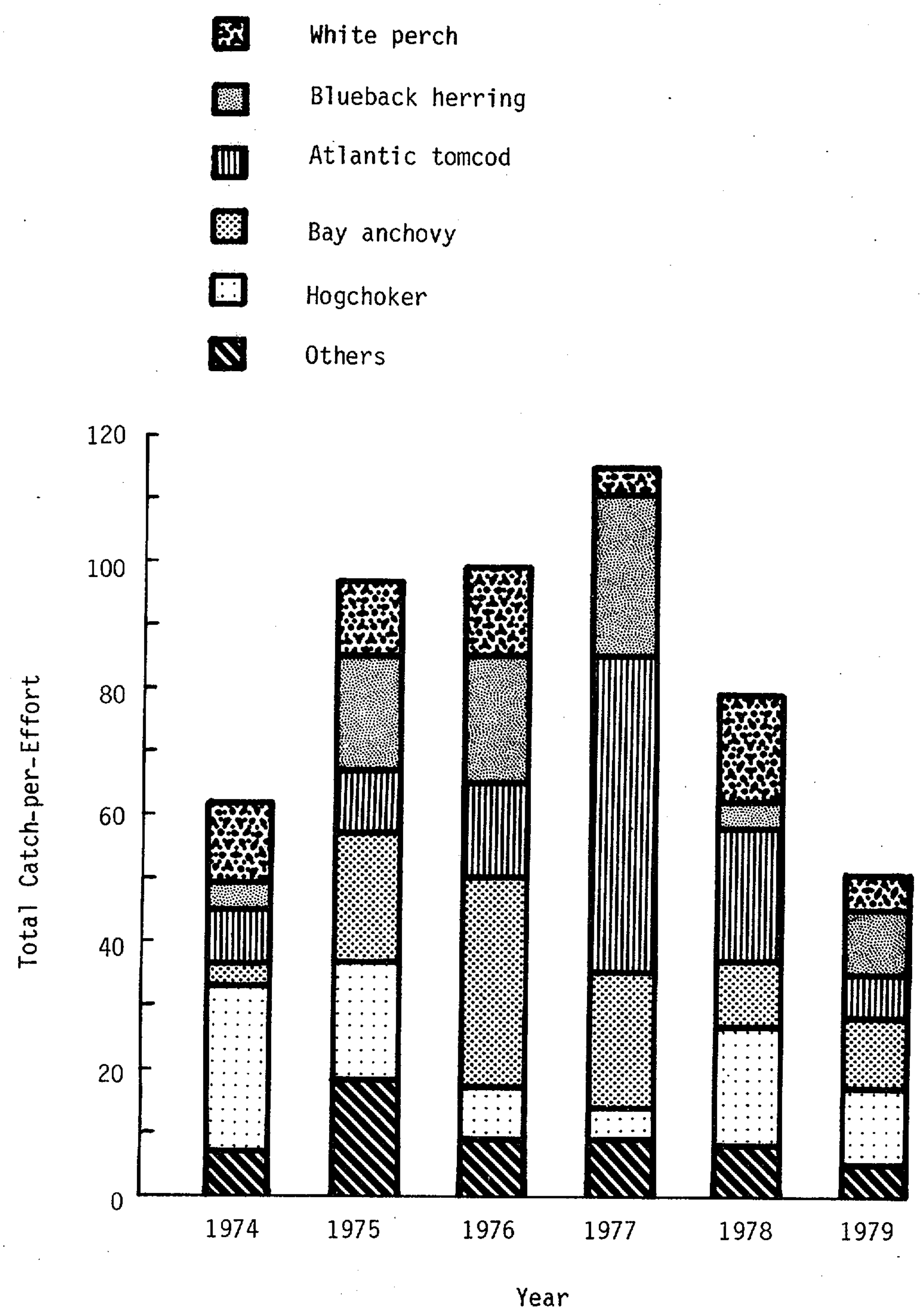


Figure III-21. Total Catch-per-Effort and Relative Proportions of Species Collected with Unlined Bottom Trawl, Indian Point Nearfield Region, 1974 through 1979

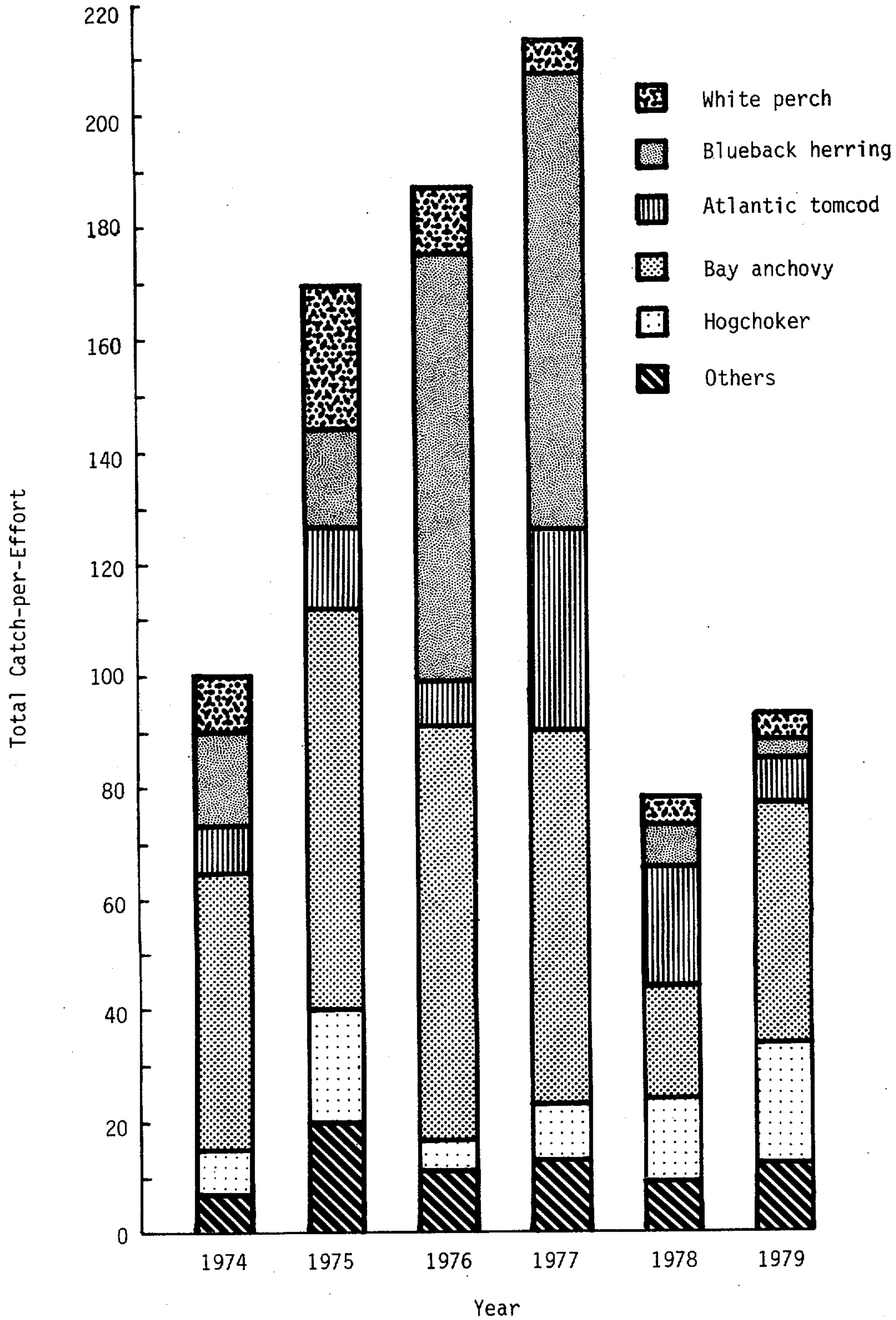


Figure III-22. Total Catch-per-Effort and Relative Proportions of Species Collected with Lined Bottom Trawl, Indian Point Nearfield Region, 1974 through 1979

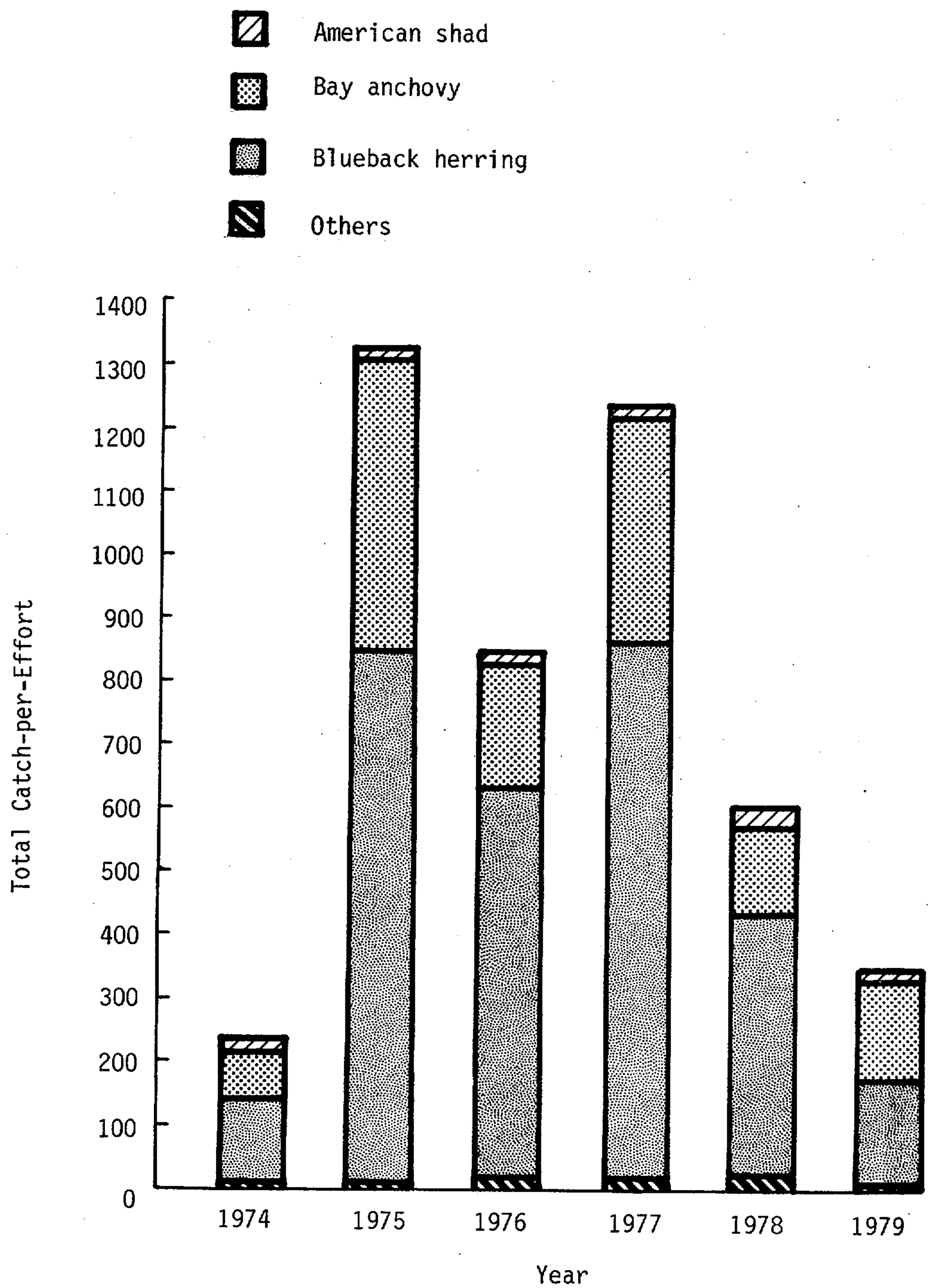


Figure III-23. Total Catch-per-Effort and Relative Proportions of Species Collected with Surface Trawl, Indian Point Nearfield Region, 1974 through 1979

1978 for lined bottom trawl and during 1974 for surface trawl). The lower catches during 1979 were due to greatly reduced numbers of blueback herring in beach seine, lined bottom trawl, and surface trawl collections and smaller catches of Atlantic tomcod by unlined bottom trawl.

Rankings of species contributing a large percentage of the total catch-per-effort of each gear, as presented in Figures III-20 through III-23 were tested using Kendall's coefficient of concordance (Siegel 1956). In this analysis, the category "others" were considered as one species. The proportional abundance of species in beach seine and surface trawl collections exhibited a consistent pattern across years while species in lined and unlined bottom trawl collections did not (Appendix Table B-8).

E. RECAPTURES OF HATCHERY-REARED STRIPED BASS

1. Description of Hatchery Program

During 1973 through 1975, TI investigated the feasibility of artificially hatching, rearing, and stocking young-of-the-year striped bass. The hatchery program was designed to mitigate losses of wild striped bass due to power plant operation along the Hudson River. Such a study was stipulated as a condition of the license issued by the Federal Energy Regulatory Commission to Consolidated Edison Company of New York, Inc. in 1970 to construct and operate a pumped storage hydroelectric plant at Cornwall, New York.

During the three years (1973 through 1975) that stockable size fingerlings (50 through 150 mm TL) were reared, a total of more than 318,000 striped bass were released into the Hudson River between RM 24 and RM 62 with the intent of monitoring their survival through a recapture effort. These fish were hatched at a pilot facility operated by TI at Verplanck, New York, using induced spawning techniques on wild brood fish captured each spring from the Hudson River. Positive identification of hatchery-reared fish has been assured by marking each individual with a finclip and magnetic nose tag prior to stocking.

As of 30 June 1980, 1,925 hatchery-reared striped bass have been recaptured from the Hudson River and adjacent waters (Table III-8). Short-term (three to nine months) survival of hatchery-reared striped bass was assessed by comparing the change in rate of recapture of marked wild fingerlings versus marked hatchery-reared fingerlings through time, and has been shown to be similar to that of wild fish (TI 1977a). Analysis of stomach contents, growth, and movements have provided evidence that hatchery-reared and wild striped bass behave and grow similarly (TI 1977c, 1979b). The present goal is to confirm that long-term survival occurs and to determine whether hatchery-reared striped bass participate in the spring spawning run. Data on distribution of all recaptured hatchery-reared fish since 1973 are presented. Also, data on size and maturity of those fish recaptured from 1977 through June 1980 are presented and compared with similar data for wild striped bass.

2. Distribution

Hatchery-reared striped bass, stocked between river mile (RM) 24 and RM 62, have dispersed over the entire Hudson River estuary (Figure III-24) within a year after release, as far upriver as Albany (RM 149) and as far downriver as the lowest portions of the estuary in the vicinity of Staten Island, N.Y. and Manhasset Bay on Long Island (TI 1979b). Most wild striped bass appear to emigrate from the river before Age I (TI 1977b) and, since so few hatchery-reared two and three year olds were recaptured during 1976 and 1977 (Table III-8), it appears the hatchery-reared and wild fish emigrate similarly (TI 1979b). Recent collections (1978 through June 1980) indicate hatchery-reared striped bass return to the river as three to six year olds during the spring spawning run.

3. Growth

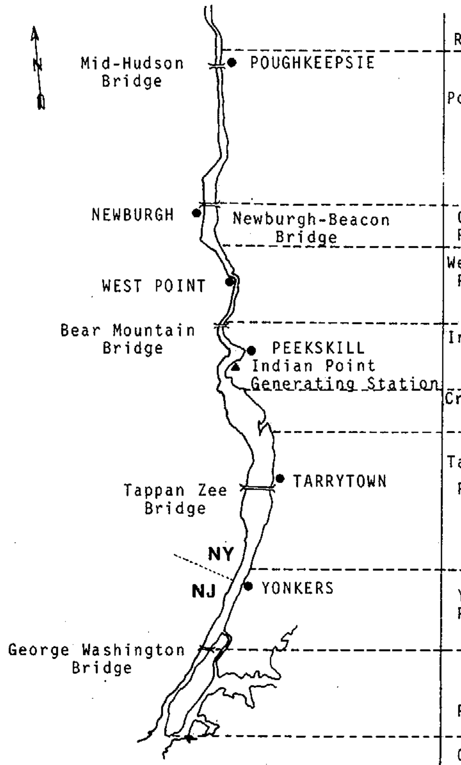
The mean lengths and weights of hatchery-reared striped bass

Table III-8
Summary of Recaptures of Hatchery-Reared Striped Bass during Year of Release and Subsequent Years

Stocked		Recaptured	
Year	Number	Year	Number
1973*	28,674	1973	46
		1974	3
1974	101,524	1974	164
		1975	442
		1976	6
		1977	6
		1978	21
		1979	12
		1980†	5
1975	188,387	1975	925
		1976	259
		1977	10
		1978	11
		1979	13
		1980†	2
All Years Combined	318,585	All Years Combined	1,925

*All fish stocked in 1973 were marked by clipping the second dorsal fin, which has since been observed to be capable of rapid regeneration. Fin regeneration, combined with nose-tag insertion/retention rate of only 17% in 1973 (TI 1974a), may explain why more recaptures from the first year of stocking have not been identified

†through 30 June 1980



Number Stocked

1973	Area
12,666	RM 51-62 (Newburgh – West Point)
6,637	RM 38-47 (Bear Mountain Bridge)
9,371	RM 26-28 (Tappan Zee Bridge)
28,674	Total

Area	1974	1975
Cornwall RM 56-61	3,058	12,802
West Point RM 47-55	6,301	12,732
Indian Point RM 39-46	21,648	42,066
Croton-Haverstraw RM 34-38	37,429	69,352
Tappan Zee RM 24-33	33,088	51,435
Total	101,524	188,387

Number Recaptured

Area	Age 0 and I	Age II through VI
Above RM 77-152	12	1
Poughkeepsie RM 62-76	43	7
Cornwall RM 56-61	8	3
West Point RM 47-55	45	0
Indian Point RM 39-46	1015	14
Croton-Haverstraw RM 34-38	537	30
Tappan Zee RM 24-33	67	30
Yonkers RM 12-23	81	1
RM 0-11	3	0
Outside River	24	0

* Four fish lacked recapture location information and are not shown on map.

Figure III-24. Number of Hatchery-Reared Striped Bass Fingerlings Stocked in Hudson River by Geographical Area during 1973, 1974, and 1975 and Number and Location of Individuals (ages 0 and I, and II through VI) Recaptured through 30 June 1980* caught during 1977 and 1978 were less than those of wild striped bass of the same age and sex (Tables III-9 and III-10). The differences in means (length and weight) may not, however, reflect actual growth differences between hatchery and wild fish, since many of the fish were collected by size selective gear such as gill nets. The smallest mesh (10.1 cm stretch) gill net used is selective for fish >350 mm TL (see Figure B-51 in TI 1980b). Therefore, length and weight data for wild fish, obtained predominantly from gill nets, may be biased high, especially for age groups with lengths ≤350 mm TL (ages II and III). Data for hatchery-reared fish were obtained from several gear types (Table III-11 and TI 1980a) and thus may not be as strongly affected by size selectivity of the capture gear.

4. Sexual Maturity

The presence of mature hatchery-reared striped bass among wild striped bass collected prior to and during the spawning period provides evidence that hatchery-reared striped bass contribute to the Hudson River spawning stock. Sexual maturity has been determined for hatchery-reared fish (for methodology see TI 1980b) recaptured from 1977 through 30 June 1980. Similar to wild striped bass, [most of which are mature at Age IV through VI (TI 1980b)] most four, five, and six year old hatchery males were mature (Table III-12). Female striped bass mature more slowly than males (TI 1980b), therefore it was not unusual that mature hatchery-reared females were not recaptured until 1979 as five year old fish. During the 1979 and 1980 spring spawning seasons, 20% (3 of 16) of the females recaptured were mature (Table III-12).

5. Conclusion

These findings support the position that the stocking program may provide a viable alternative to cooling towers for mitigation of striped bass losses resulting from power plant operations along the Hudson River. The collection of mature hatchery-reared striped bass in the river during the spawning run with characteristics similar to those of wild fish provides evidence that hatchery-reared fish contribute to the Hudson River spawning stock.

Table III-9

Mean Total Length [$\bar{X}$TL(mm)] of Hatchery-Reared and Wild Striped Bass Collected during 1977 through 1980 in Hudson River Estuary during March through June Sampling Period

		Hatchery-Reared Striped Bass						Wild Striped Bass					
		1974 Stocking			1975 Stocking			1974 Year Class			1975 Year Class		
Collection Year	Sex	$\bar{X}$TL (mm)	SE	N	$\bar{X}$TL (mm)	SE	N	$\bar{X}$TL (mm)	SE	N	$\bar{X}$TL (mm)	SE	N
1977	Male	**344**	26	6	227	13	5	369	5	150	239	6	56
	Female	ND	ND	ND	237	10	3	377	8	98	230	6	54
1978	Male	417	16	16	373	24	4	456	4	295	384	5	134
	Female	424	44	2	393	21	7	473	5	187	419	6	99
1979	Male	**496**	32	**6**	**443**	**36**	**5**	**492**	**4**	**423**	**459**	**3**	**357**
	Female	558	44	5	425	15	7	**533**	**5**	**244**	**476**	**4**	**209**
1980	Male	574	61	3	ND	ND	ND	--	--	--	--		--
	Female	609	161	2	570	100	2	--	--	--	--		--

SE = Standard Error
N = Sample Size
ND = No Data
Dashes indicate data not yet available

Table III-10

Mean Weight [$\bar{X}$WT(g)] of Hatchery-Reared and Wild Striped Bass Collected during 1977 through 1980 in Hudson River Estuary during March through June Sampling Period

		Hatchery-Reared Striped Bass						Wild Striped Bass					
		1974 Stocking			1975 Stocking			1974 Year Class			1975 Year Class		
Collection Year	Sex	$\bar{X}$WT(g)	SE	N	$\bar{X}$WT(g)	SE	N	$\bar{X}$WT(g)	SE	N	$\bar{X}$WT(g)	SE	N
1977	Male	434	80	6	133	22	5	559	29	93	175	16	30
	Female	ND	ND	ND	176	7	3	549	42	53	152	14	32
1978	Male	868	110	16	548	90	4	984	38	186	614	29	97
	Female	834	266	2	731	125	7	1114	55	115	790	40	79
1979	Male	1530	372	5*	1032	342	5	1317	48	235	926	31	174
	Female	2080	420	5	688	33	6*	1646	92	109	1043	38	107
1980	Male	2567	858	3	ND	ND	ND	--	--	--	--	--	--
	Female	3300	2400	2	2175	975	2	--	--	--	--	--	--

*Two fish were in such poor condition at time of recapture that weight data were not taken

SE = Standard Error

N = Sample Size

ND = No Data

Dashes indicate data not yet available

Table III-11

Hatchery-Reared Striped Bass Recaptured from Hudson River Estuary, July 1979 through June 1980

Date Recaptured	RM	KM	Site	Gear*	Finclip	Stocking Season (Fall)	Reference Tag Number	Length (mm)	Weight (g)	Nose Tag	Sex	Body Weight/ Gonad Weight	Visible Sexual Condition
20 Sep 1979	59	94	East	61.0 m BS	1st Dorsal	1974	JT 9481	494	1178	No	Male	--†	Immature
21 Mar 1980	34	54	East	10.1 cm GN	1st Dorsal	1975	**	670	3150	No	Female	237	Developing
02 Apr 1980	34	54	East	12.7 cm GN	1st Dorsal	1975	**	470	1200	No	Female	190	Immature
07 Apr 1980	34	54	East	15.2 cm GN	1st Dorsal	1974	**	626	3400	No	Male	17	Ripe
24 Apr 1980	36	58	East	12.7 cm GN	1st Dorsal	1974	**	448	900	No	Female	145	Immature
30 Apr 1980	46	74	West	15.2 cm GN	1st Dorsal	1974	**	643	3450	No	Male	13	Ripe
30 Apr 1980	35	56	East	17.8 cm GN	1st Dorsal	1974	**	770	5700	No	Female	23	Mature
12 May 1980	36	58	East	10.1 cm GN	Both Pelvic	1974	**	452	850	Yes	Male	654	Developing

*BS = Beach Seine; measurement denotes length
GN = Gill Net; measurement denotes stretch mesh size; all gill nets 91.4 m x 2.4 m

†Body weight/gonad weight data were not available for this fish since it was not in spawning condition during September

**Beginning in 1980, hatchery-recaptured striped bass were uniquely identified with a sample number and individual fish identification number. Therefore, reference tag numbers were no longer used in 1980

Table III-12

Maturity by Age of Hatchery-Reared and Wild Striped Bass from Hudson River during 1977 through 30 June 1980

Year Stocked	Year Recaptured	Age (years)	Sex	Hatchery-Reared Number Mature*	Hatchery-Reared Number Immature	Hatchery-Reared Others†	Wild Number Mature*	Wild Number Immature
1974	1977	III	Male	5	1	0	12	22
			Female	0	0	0	0	27
	1978	IV	Male	14	2	3	72	10
			Female	0	2	0	1	58
	1979	V	Male	6	0	1	55	11
			Female	2	3	0	12	38
	1980**	VI	Male	2	1	0	--	--
			Female	1	1	0	--	--
1975	1977	II	Male	0	3	3	3	22
			Female	0	3	0	0	24
	1978	III	Male	1	3	0	15	22
			Female	0	7	0	0	43
	1979	IV	Male	1	4	0	54	17
			Female	0	7	0	0	51
	1980**	V	Male	0	0	0	--	--
			Female	0	2	0	--	--

*Includes fish with body weight:gonad weight less than 70:1 for females; 235:1 for males or fish visually classified as mature

†Number of fish collected outside of spawning season, or fish for which sexual condition not determined

**through 30 June 1980

Dashes indicate data not yet available

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SECTION IV
ANALYSIS OF DAILY IMPINGEMENT VARIATION

A. INTRODUCTION

Data collected at the Indian Point Generating Station has provided one of the most complete records of fish impingement for any power plant (Stupka and Sharma 1977). Regulatory technical specifications require continuous collection and sampling from intake structures at 24 hour intervals to provide daily counts by species of the number of fish impinged (NRC 1975); however, this daily sampling regime may be more than adequate to reliably estimate impingement rates. Recent studies by Johnston (1976), Kumar and Griffith (1977), Murarka and Bodeau (1977), Murarka et al. (1977), and El-Shamy (1979) have each suggested that precise estimates of mean daily and annual total counts of fish impinged may be obtained with a less than daily sampling schedule. If a program of less frequent sampling could be instituted, fish could be returned to the river on non-sample days as is presently done at many other generating stations (Freeman and Sharma 1977), thus allowing a portion of those released to survive.

The sampling effort (number of days) required to obtain a specified level of precision is related primarily to the timing and magnitude of variation in daily impingement counts. Those specific times of the year with high variation among daily impingement counts may require daily sampling while low variation periods may require less frequent sampling to obtain the same degree of precision. This analysis 1) describes the temporal variability among daily impingement total counts at Indian Point, 2) uses estimates of daily variability as a basis for selecting a reduced sampling design, and 3) evaluates the accuracy and precision of annual total impingement estimates using three reduced sampling designs.

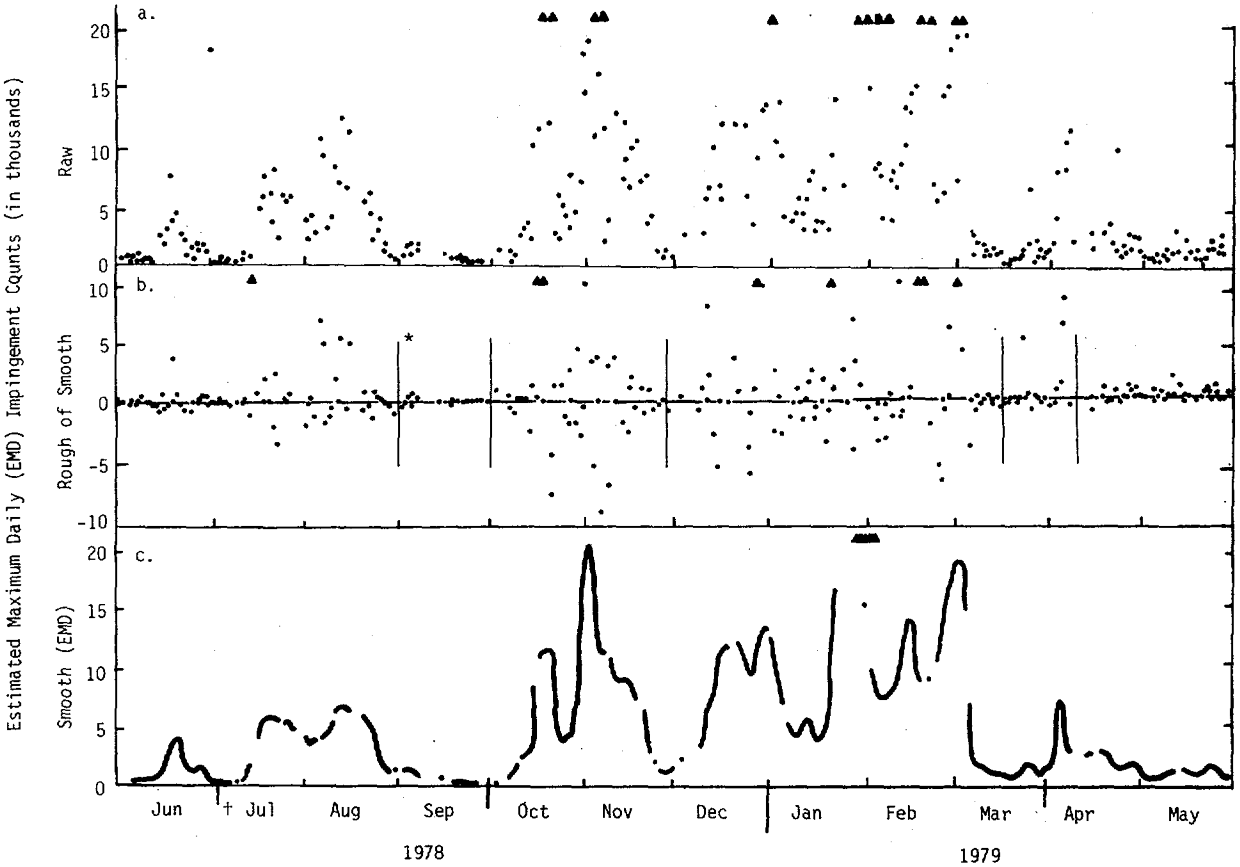
B. ANALYSIS OF DAILY IMPINGEMENT VARIATION

1. Selection of a Nonbiased Measure of Daily Impingement

A daily count of the total number of fish impinged has been used to quantify impingement at Indian Point Units No. 2 and No. 3. Impingement counts, however, have not completely reflected underlying natural variation because they were influenced by variation in volume of cooling water pumped. Therefore, "raw" impingement counts (actual numbers collected from screen washings prior to any adjustments for efficiency) were scaled to reflect the estimated number of fish which could have been impinged if the unit was pumping at maximum capacity. This estimated maximum daily (EMD) impingement count was the product of selected (Appendix Subsection C.1.c) daily impingement rate (numbers$\cdot 10^6 m^{-3}$) and maximum pumping capacity of all six circulator pumps. Two maximum volume constants were used: one for the 100% pumping capacity period from 1 April through 31 December ($4.58 \cdot 10^6 m^3 \cdot day^{-1}$) and one for the 60% period from 1 January through 31 March of each year($2.75 \cdot 10^6 m^3 \cdot day^{-1}$). Dates for the winter period were selected to encompass the time when all circulator pumps at each unit were continuously operated at 60% pumping capacity. The earliest date all 6 circulators were continuously operating at 60% was 20 Dec 1978 at Unit No. 3. The earliest date a 100% pumping rate began was 3 April 1979 for Unit No. 3. Thus, 1 January to 31 March was selected to encompass the period of 60% pumping capacity. All analyses in this section used EMD counts and were performed separately on Indian Point Units No. 2 and No. 3 for the period 1976 through 1979.

2. Analysis of Impingement Variability

Tukey's 3RSSH smoothing technique (Tukey 1977), which classifies raw data into "smooth" and "rough" components, was applied to EMD counts to empirically separate the variation from the temporal pattern of impingement and to aid in identification of periods of high and low daily variation. This procedure also served to smooth across gaps in the impingement data that were due to plant outages. Impingement data for the period from June 1978 through May 1979 for Indian Point Unit No. 2 was selected to demonstrate this smoothing technique (Figure IV-1)



▲Represents points which were out of bounds and not plotted

*Vertical lines denote boundaries of empirically derived strata

†Long slash marks on horizontal axis denote boundaries of seasonal strata

Figure IV-1. Comparison between "Raw" or Actual Estimated Maximum Daily (EMD) Counts and "Smooth" and "Rough" Values Obtained after Application of Tukey's 3RSSH Smoothing Technique to Indian Point Unit No. 2 Impingement Data, 1 June 1978 through 31 May 1979 because it represented a period of nearly continuous operation and typified annual impingement patterns. The degree of scatter in the "rough" component directly reflected the variation which was removed from the raw data to draw the "smooth" curve. "Raw" and "smooth" EMD counts were nearly identical in periods of low variation but differed in high variation periods. In periods when "smooth" EMD counts were small, "rough" values were low and close to zero [e.g., Figure IV-1(b), June 1978, September 1978, and May 1979]. In periods when "smooth" EMD counts were large and variable, "rough" values deviated considerably from the zero base line [e.g., Figure IV-1(b), October 1978 through February 1979].

Visual examination of the scatter presented in "rough" plots and patterns presented in "smooth" plots (Figures IV-2 and IV-3) permitted identification of periods of high and low variation which were relatively distinct in timing and duration across years. The following empirically determined temporal strata were selected for Unit No. 2, and Unit No. 3:

Unit No. 2	Unit No. 3
01 Jun through 31 Aug	01 Jun through 31 Aug
01 Sep through 30 Sep	01 Sep through 30 Sep
01 Oct through 27 Nov	01 Oct through 10 Dec
28 Nov through 15 Mar	11 Dec through 31 Jan
16 Mar through 07 Apr	01 Feb through 25 Mar
08 Apr through 31 May	26 Mar through 15 Apr
	16 Apr through 31 May

C. EVALUATION OF THE EFFECT OF VARIATION ON ESTIMATES OF NUMBER OF FISH IMPINGED

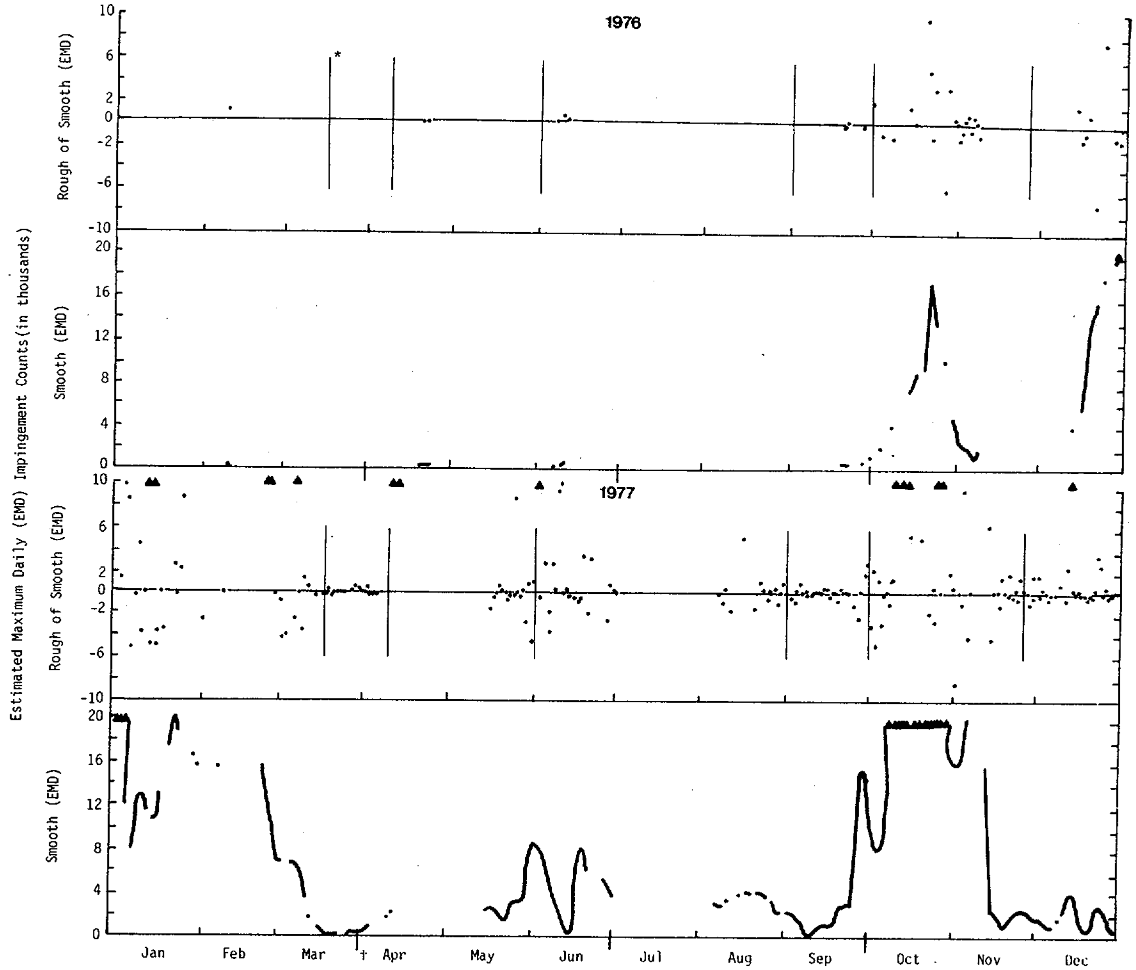
Partitioning of the year into nonoverlapping time intervals, or strata, and differential allocation of sampling effort among these strata provide a means of adjusting effort relative to differences in natural variation and length of the time period. Thus, relatively consistent levels of precision and accuracy are maintained. Using 1976 through 1979 impingement data, two potential stratification schemes were examined for their applicability to reduced sampling designs. One of these, the empirical stratification described above, was based on the natural variability observed in the pooled 1976 through 1979 impingement data; the second, a seasonal stratification, consisted of four, 3 month seasons (January through March, April through June, etc.). A third design, simple random allocation of days throughout the year, was used for reference. Stratification, with random allocation of days within strata, should allow impingement counts to be estimated more precisely than if days were randomly allocated over an entire year (Cochran 1977, Murarka and Bodeau 1977).

1. Statistical Methods for Testing Effects of Variation on Sample Designs

For each of the three sample designs; empirical, seasonal, and simple random, data was pooled across 1976 through 1979 and analyzed separately for Unit No. 2 and No. 3. Precision of the empirical and seasonal stratified designs and the simple random design was compared by plotting the "exact" standard error of the mean EMD counts (Figures IV-4 and IV-5) for each sampling fraction (fraction of the year sampled). Each of the 12 sampling fractions tested, any of which could be chosen as the desired level of impingement sampling, represented a given percentage (5, 10, 20, 25, 30, 40, 50, 60, 70, 75, 80, and 90%) of days within a year on which impingement counts could be made using a reduced sampling plan. The "exact" standard error of the mean for each sampling fraction was mathematically derived from the entire set of available EMD counts using modifications of formulae by Cochran (1977) described below. The standard error is exact in this situation since the total population of EMD counts is known for 1976 through 1979. If the total population of EMD counts were not known, i.e., impingement counts had not been made on each day of operation, the standard error could only have been approximated.

a. Calculation of Exact Standard Error for the Simple Random Sampling Design

$$S.E._{\bar{y}} = \frac{S}{\sqrt{n}} \sqrt{\frac{N-n}{N}} \qquad (1)$$

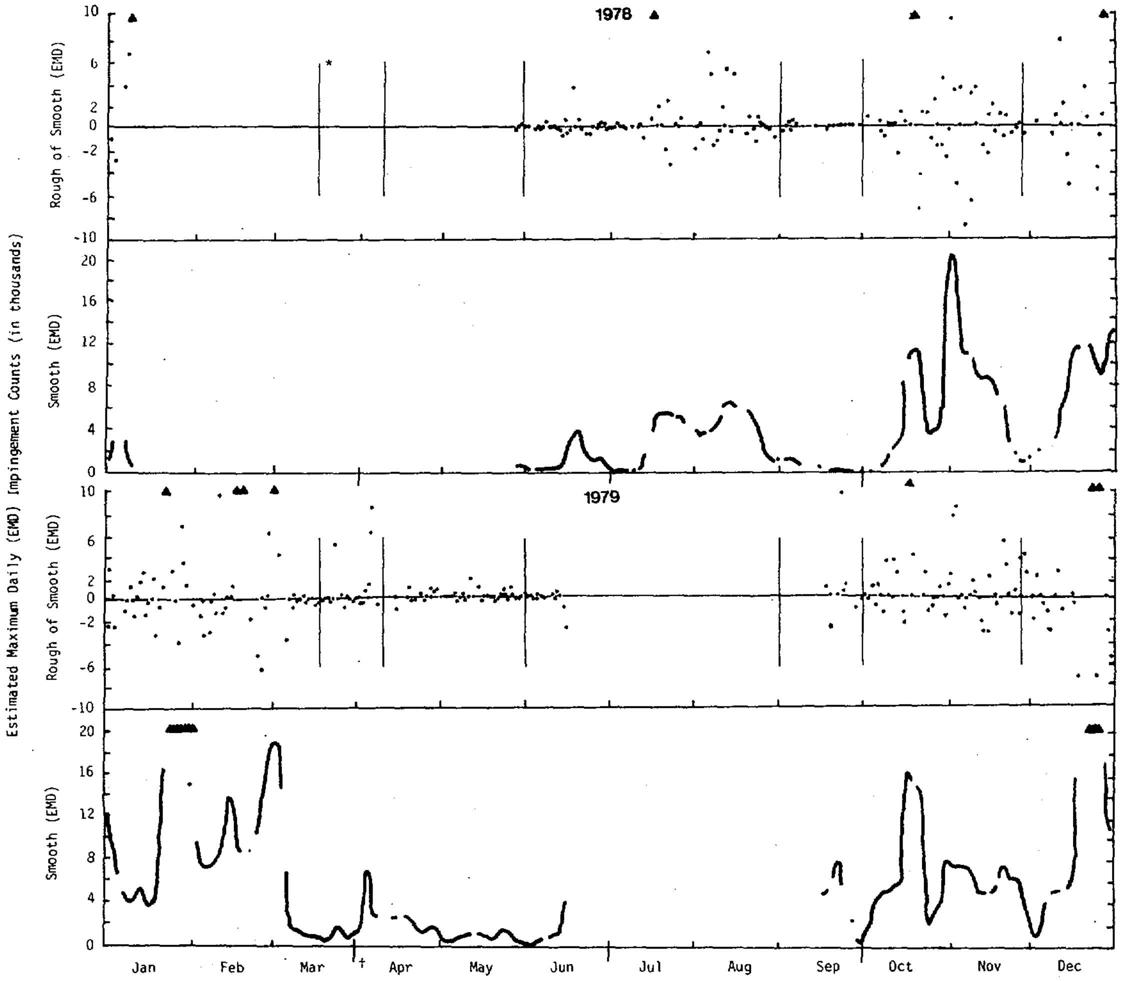


▲Represents points which were out of bounds and not plotted

*Vertical lines denote boundaries of empirically derived strata

†Long slash marks on horizontal axis denote boundaries of seasonal strata

Figure IV-2. Tukey's 3RSSH "Smooth" and "Rough" Plots of Estimated Maximum Daily (EMD) Impingement Counts (all species combined) for Indian Point Unit No. 2, 1976 through 1979 ["Smooth" plots represent curves fitted through scatter plots of the "raw" data; "Rough" plots represent residule scatter (variation) removed from "raw" data in the smoothing procedure]



▲Represents points which were out of bounds and not plotted
*Vertical lines denote boundaries of empirically derived strata
†Long slash marks on horizontal axis denote boundaries of seasonal strata

Figure IV-2 (Contd)

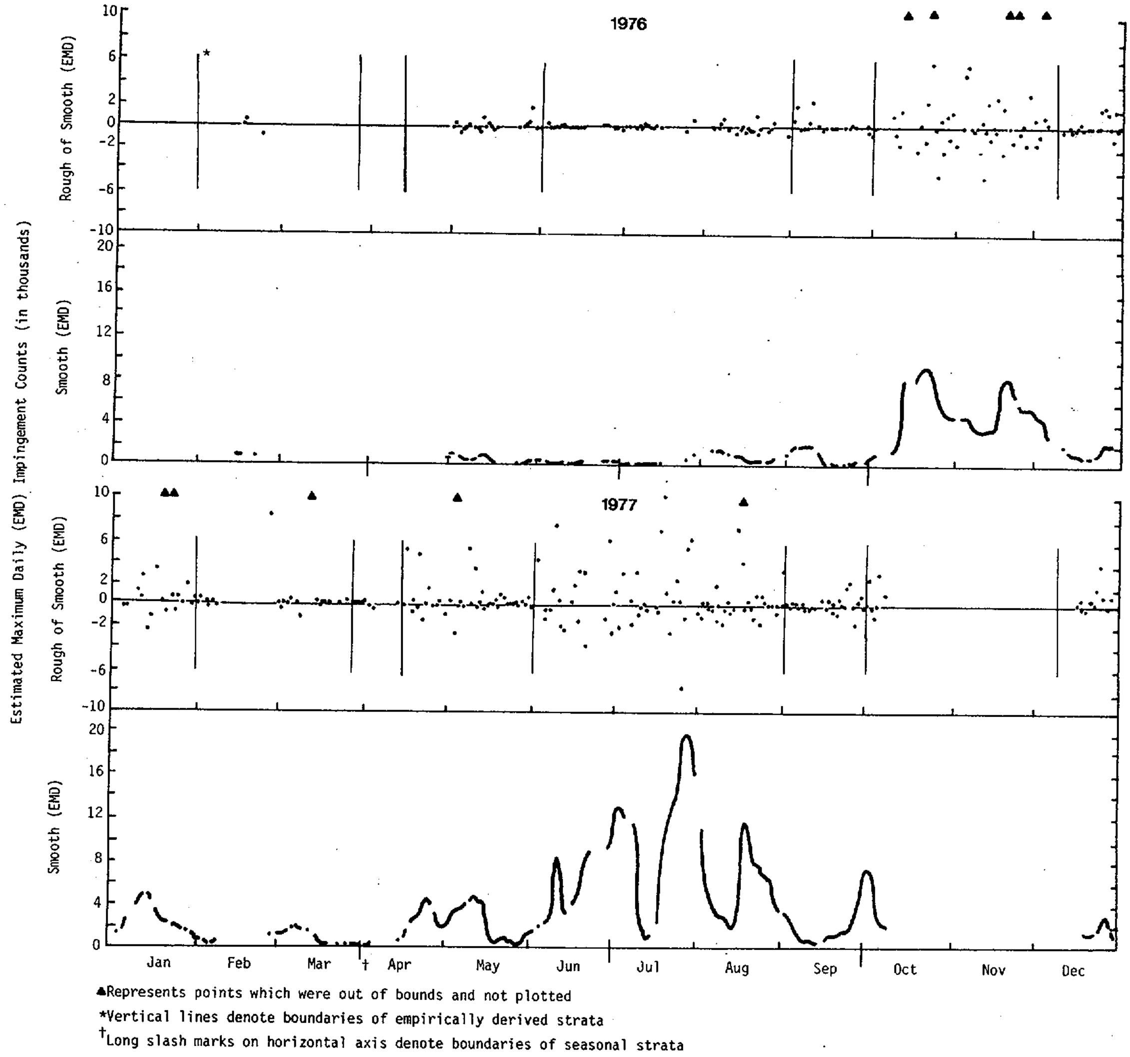
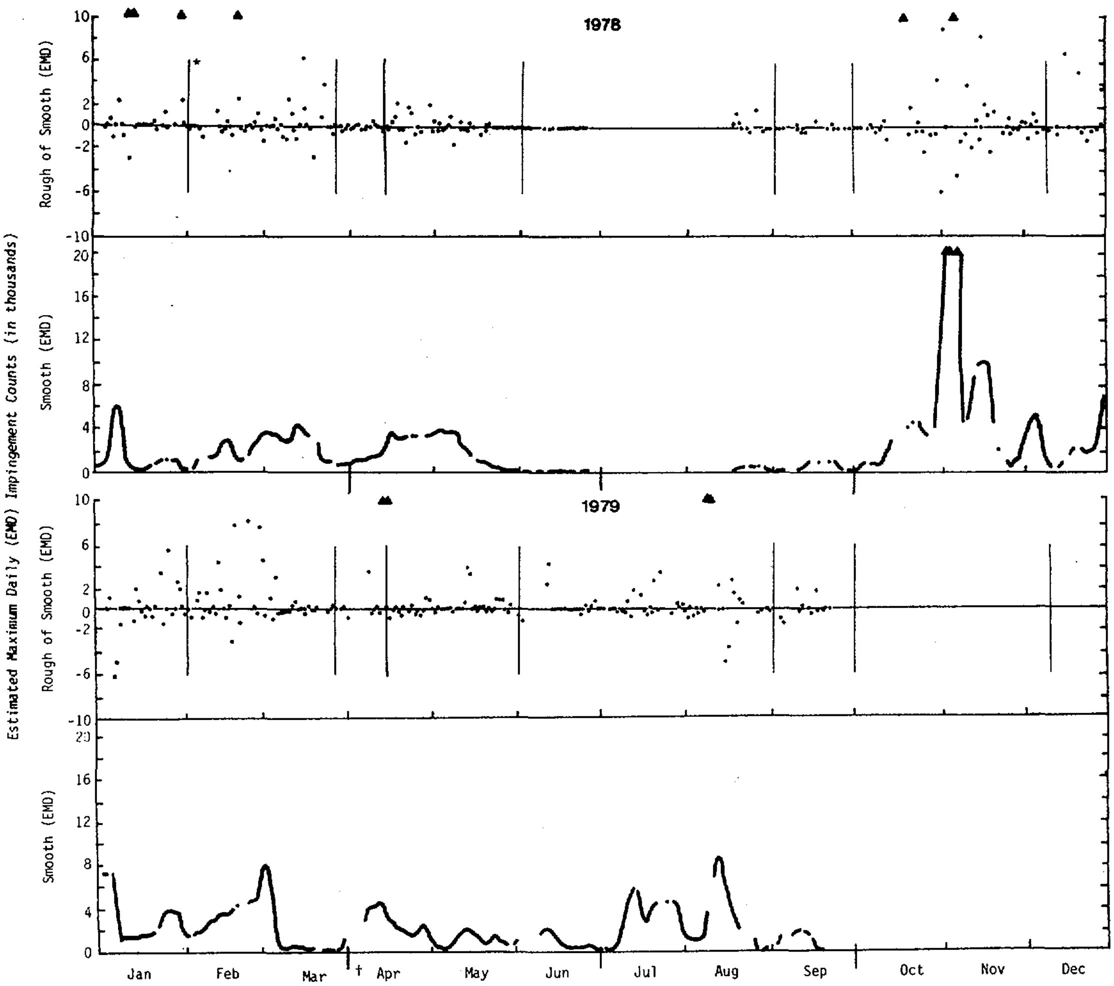


Figure IV-3. Tukey's 3RSSH "Smooth" and "Rough" Plots of Estimated Maximum Daily (EMD) Impingement Counts (all species combined) for Indian Point Unit No. 3, 1976 through 1979 ["Smooth" plots represent curves fitted through scatter plots of the "raw" data; "rough" plots represent residual scatter (variation) removed from "raw" data in the smoothing procedure]



▲Represents points which were out of bounds and not plotted

*Vertical lines denote boundaries of empirically derived strata

†Long slash marks on horizontal axis denote boundaries of seasonal strata

Figure IV-3 (Contd)

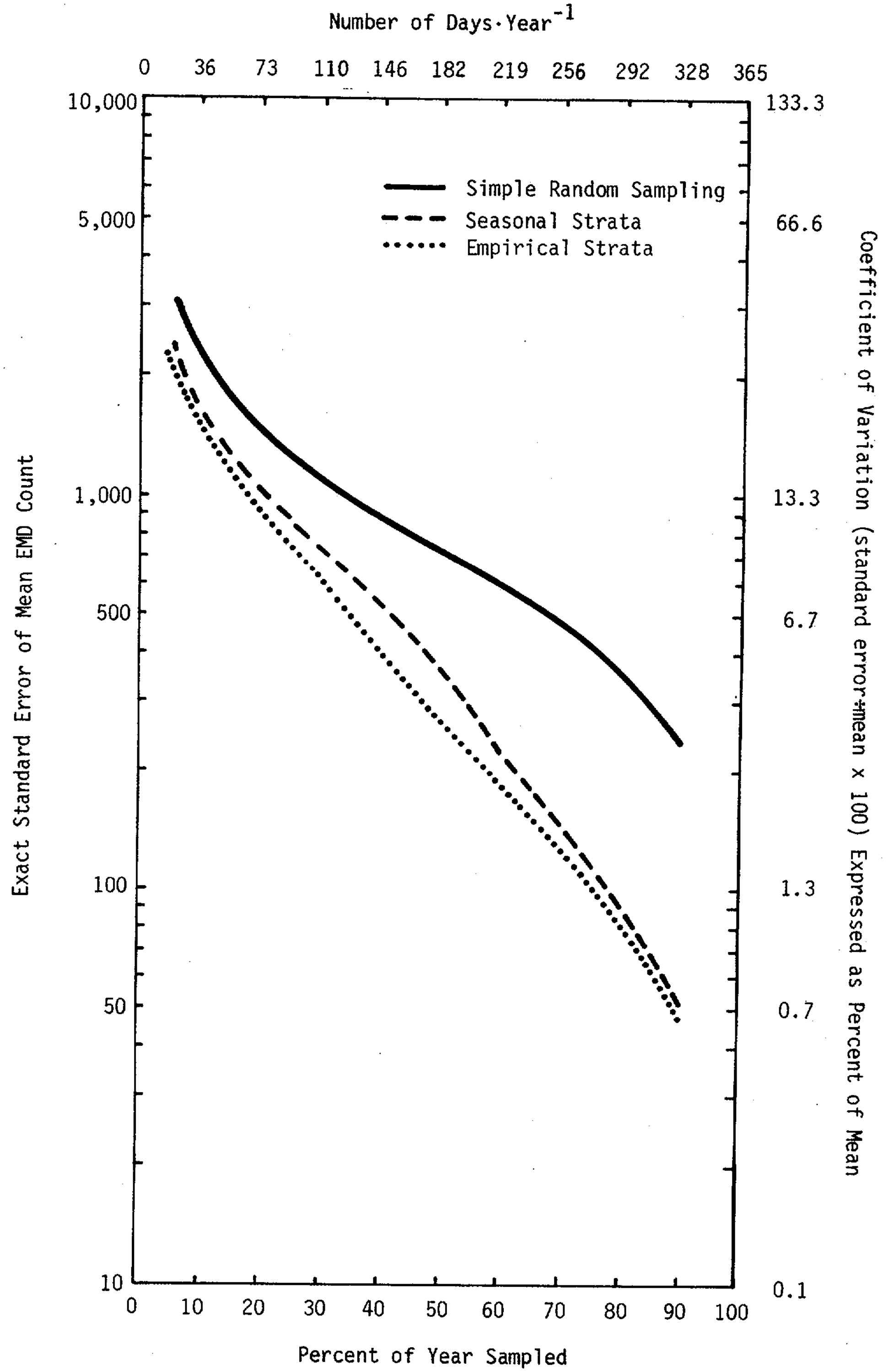


Figure IV-4. Relationship between Precision (standard error or coefficient of variation) of Mean Estimated Maximum Daily (EMD) Impingement at Indian Point Unit No. 2 and Percent of Year Sampled by Three Sampling Designs

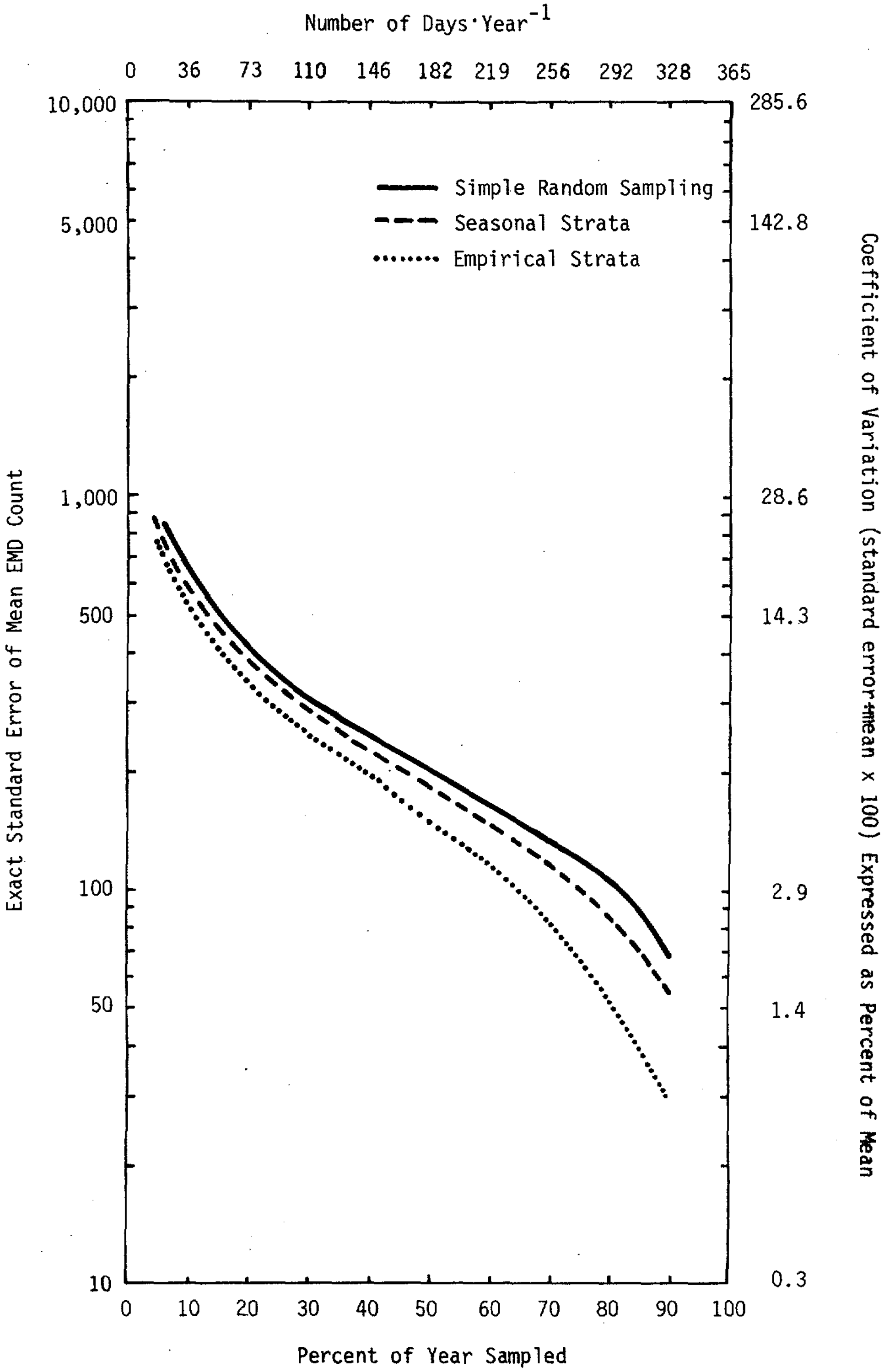


Figure IV-5. Relationship between Precision (standard error or coefficient of variation) of Mean Estimated Maximum Daily (EMD) Impingement at Indian Point Unit No. 3 and Percent of Year Sampled by Three Sampling Designs where

$S.E._{\bar{y}}$ = standard error of the mean EMD count ($\bar{y}$)

S = standard deviation for "parent" population

n = number of days (EMD counts) in the sampling fraction

N = total number of days (EMD countd) in the "parent" population

This formula permitted calculation of the relationship between each sampling fraction and precision ($S.E._{\bar{y}}$) of simple random sampling. A second measure of precision, the coefficient of variation, was calculated at each sampling fraction by expressing the standard error as a percent of the mean ($S.E._{\bar{y}} \div \bar{y}$ X 100%).

b. Calculation of Exact Standard Error for Seasonal and Empirical Stratified Random Sampling Designs

The relationship between each sampling fraction and the standard error of the stratified mean EMD count ($S.E._{\bar{y}_{st}}$) was determined using estimates of the within-stratum variation for both empirical and seasonal stratification schemes. The following formula was used in both computations [modified from Cochran 1977 (formula 5.12)]:

$$S.E._{\bar{y}_{st}} = \frac{1}{N}\sqrt{\sum_{h=1}^{L} N_h (N_h - n_h) \frac{S_h^2}{n_h}} \qquad (2)$$

where

$S.E._{\bar{y}_{st}}$ = standard error of the stratified mean EMD count ($\bar{y}_{st}$)

N = total number of days (EMD counts) in the "parent" population

L = total number of strata

N_h = total number of days in the h^{th} stratum of the "parent" population

n_h = number of days (EMD counts) in the sampling fraction from the h^{th} stratum

S_h^2 = variance for the h^{th} stratum in the "parent" population

The coefficient of variation for stratified sampling was calculated as it was for simple random sampling ($S.E._{\bar{y}_{st}} \div \bar{y}_{st}$ X 100%). The actual number of days (EMD counts) for each sampling fraction was allocated to each temporal stratum using a Neyman allocation scheme (Cochran 1977). This method selected EMD counts (days) in direct proportion to both the number of days and the variance in each stratum. High variance and long time periods received proportionally more samples than low variance or short time periods.

c. Estimates of Mean EMD Counts and Annual Total Impingement Counts

Most inferences made in subsequent analyses pertain to the mean EMD count ($\bar{y}$ for simple random sampling and $\bar{y}_{st}$ for stratified random sampling) and standard error of the mean EMD count ($S.E._{\bar{y}}$ and $S.E._{\bar{y}_{st}}$). These inferences can likewise be made about annual total impingement counts using the following relationships (Cochran 1977):

$$T_1 = N_1 \bar{y} \quad \text{or} \quad N_1 \bar{y}_{st} \qquad (3)$$

$$S.E._{T_1} = N_1 S.E._{\bar{y}} \quad \text{or} \quad N_1 S.E._{\bar{y}_{st}}$$

where

T_1 = annual total impingement count

$S.E._{T_1}$ = standard error of annual total impingement count

$\bar{y}$ or $\bar{y}_{st}$ = mean as in formula (1) or (2), respectively

$S.E._{\bar{y}}$ or $S.E._{\bar{y}_{st}}$ = standard error of the mean as in formula (1) or (2), respectively

N_1 = number of days in a year (365 or 366 in leap year)

For example, if the mean EMD count and standard error of the mean were 1000 $\pm$ 100 fish the annual total and standard error of the total would be 365,000 $\pm$ 36,500 fish. In both cases, the coefficient of variation would be 10%.

2. Effect of Daily Impingement Variation on Precision with Reduced Sampling Effort

Precision increased logarithmically with increasing sampling fraction for all three sampling designs at both Indian Point Units No. 2 (Figure IV-4) and No. 3 (Figure IV-5). Simple random sampling was the least precise, stratified random sampling using four seasonal strata was intermediate in precision, and stratified random sampling using empirical strata was the most precise design at both Units No. 2 and No. 3. However, the relationship between sampling design, precision, and sampling fraction differed between Units No. 2 and No. 3. At Unit No. 2 (Figure IV-4), both stratified designs were considerably more precise than the simple random design, particularly at large sampling fractions. The two stratified designs responded similarly to increased sampling fractions (lines nearly parallel) except at intermediate fractions when the precision of empirical stratification was disproportionately higher than for the seasonal design. In contrast, at Unit No. 3 (Figure IV-5), curves for the relationship between precision and sampling fractions were not as widely separated as at Unit No. 2, and the precision of sampling in seasonal strata more closely resembled that of simple random than of empirical; otherwise, the patterns of precision were very similar for both units.

Standard error of the mean EMD count was higher at Indian Point Unit No. 2 than at Unit No. 3 (Figures IV-4 and IV-5). For the two stratified designs, standard error of the mean EMD count at Unit No. 2 ranged between 2339 at a 5% sampling fraction to 47 at a 90% fraction (Figure IV-4). At Unit No. 3, standard error ranged between 828 at a 5% fraction to 28 at a 90% fraction. These differences were primarily due to higher mean daily impingement (EMD) counts at Unit No. 2 than at Unit

No. 3 and were greatly reduced when precision was expressed as a coefficient of variation (Figures IV-4 and IV-5). For example, with empirical stratification and a 50% sampling fraction, the mean EMD count and standard error at Unit No. 2 were 7502 ± 264 fish and at Unit No. 3 were 3443 ± 149 fish; the coefficient of variation was 3.5% and 4.3%, respectively. For annual impingement based on EMD counts the total and standard error of the total were $2.738 \times 10^6 \pm 0.096 \times 10^6$ at Unit No. 2 and $1.257 \times 10^6 \pm 0.054 \times 10^6$ at Unit No. 3.

3. Effects of Daily Impingement Variation on Accuracy with Reduced Sampling Effort

The 1976 through 1979 impingement data from Indian Point Units No. 2 and No. 3 differed from the normal distribution used in sampling theory (these data were positively skewed), and no exact formula exists for computing the degree of "bias" due to this nonnormality. Simulated sampling was used to determine the effects of nonnormality on the accuracy of 95% confidence limits for estimating yearly mean EMD impingement counts. This appoach is recommended when data are suspected of violating the assumptions of classical theory (i.e., normality) and can be used to determine the sensitivity of a statistic to these violations (Barrett and Goldsmith 1976, Cochran 1977, and Green 1979). The simulation involved repeated application of each of the two stratified designs for each sampling fraction to determine the number of times the actual 95% confidence interval about the estimated yearly mean EMD enclosed the true mean EMD count. The true mean was obtained from daily sampling (1976 through 1979) at Indian Point Unit No. 2 and Unit No. 3, and simulations were repeated 1000 times for each sampling fraction at each unit (No. 2 and No. 3). If a 95% confidence level was achieved by the design, 95% of the confidence intervals calculated for each simulated mean EMD count should "catch" or enclose the true mean.

As an example of how simulated sampling was conducted, assume that an empirical stratification scheme was used for a 20% sampling fraction at Indian Point Unit No. 2. The first step in the simulation was to determine the number of days in a 20% fraction and allocate those days to each of six empirical strata by the Neyman allocation scheme (Cochran 1977). If the 1 June through 31 August stratum received an allocation of 28 days, those 28 days would be randomly selected from the 1976 through 1979 data base of EMD counts for that period. When all six strata were sampled, a stratified mean EMD count with 95% confidence limits was computed. This sample confidence interval was examined to determine if it enclosed the true mean (the mean of all EMD counts for Unit No. 2 in the 1976 through 1979 period). This entire sampling procedure was repeated 1000 times for the 20% fraction at Unit No. 2 for empirical stratification.

Results from simulated sampling indicated that a 95% confidence interval was nearly achieved at any sampling fraction greater than 20% to 30% (Figure IV-6). Differences between empirical and seasonal stratified designs were not apparent. At Unit No. 2, confidence intervals for means from sampling fractions above 30% caught the true mean approximately 94% to 95% of the time. At Unit No. 3, confidence intervals for means of sampling fractions above 20% caught the true mean approximately 93% to 94% of the time. For the small percentage of cases when the true mean was not caught by the 95% confidence interval, the estimated mean was generally lower than the true mean (Table IV-1). Therefore, for sampling intensities above 20% to 30%, a 95% confidence limit about the mean EMD count was accurate 93% to 95% of the time. When it failed, the sample mean EMD count tended to underestimate the true mean.

D. AN APPROACH FOR SELECTING A REDUCED SAMPLING PROGRAM

Selection and implementation of any reduced impingement sampling program at Indian Point requires two types of information: 1) desired and attainable levels of precision and accuracy and 2) an acceptable sampling plan for the goals of the study. Table IV-2 presents the actual sampling allocations for the stratified designs used in the above analysis. To illustrate the selection of a reduced sampling design using the results of this analysis, assume that a seasonal

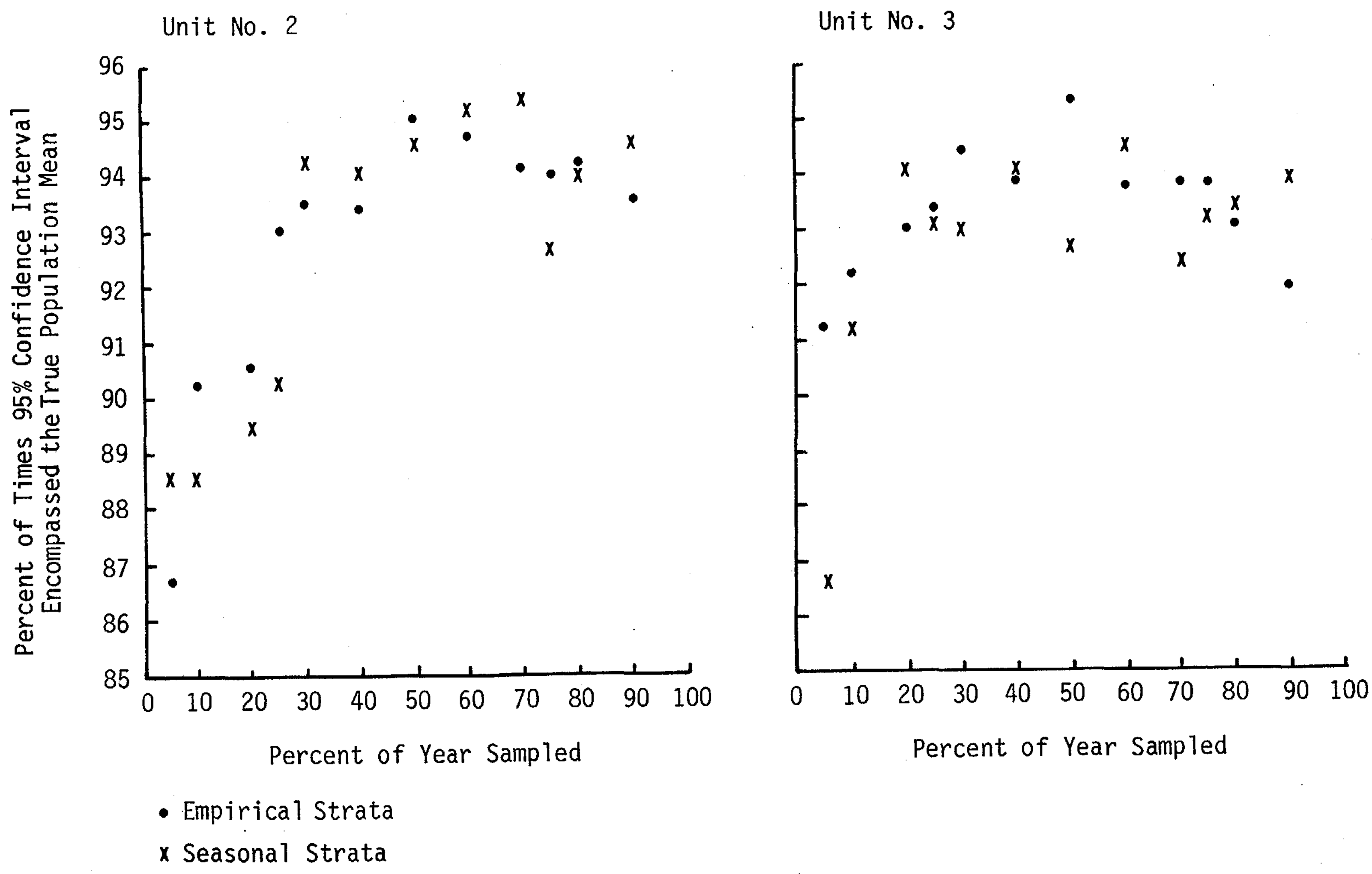


Figure IV-6. Accuracy of Two Stratified Random Sampling Designs for Calculating Mean Estimated Maximum Daily (EMD) Impingement at Various Intensities of Sampling at Indian Point Units No. 2 and No. 3 (accuracy measured as percent of times estimated mean EMD count with a 95% confidence interval enclosed true population mean for 1000 simulations)

Table IV-1

Accuracy and Relative Bias for Two Stratified Random Sampling Designs, Expressed as Percent of Times Calculated Mean Estimated Maximum Daily (EMD) Impingement with 95% Confidence Limits was Higher or Lower than True Mean*

		Seasonal			Empirical		
	Sampling Fraction (percent)	Percent Missing Low	Percent Missing High	Total Percent Missing	Percent Missing Low	Percent Missing High	Total Percent Missing
Unit No. 2	05	11.4	0.0	11.4	12.9	0.4	13.3
	10	11.2	0.2	11.4	9.6	0.2	9.8
	20	10.0	0.5	10.5	9.1	0.4	9.5
	25	8.8	0.9	9.7	6.5	0.5	7.0
	30	5.2	0.5	5.7	5.5	1.0	6.5
	40	5.2	0.7	5.9	5.3	1.3	6.6
	50	4.3	1.1	5.4	4.2	0.8	5.0
	60	4.1	0.7	4.8	3.7	1.6	5.3
	70	3.4	1.2	4.6	4.1	1.7	5.8
	75	5.7	1.6	7.3	5.1	0.9	6.0
	80	4.6	1.3	5.9	4.4	1.4	5.8
	90	4.3	1.1	5.4	5.2	1.2	6.4
Unit No. 3	05	13.1	0.3	13.4	8.7	0.1	8.8
	10	8.5	0.3	8.8	6.8	1.0	7.8
	20	5.2	0.7	5.9	5.9	1.1	7.0
	25	6.2	0.7	6.9	5.1	1.5	6.6
	30	6.7	0.3	7.0	4.8	0.8	5.6
	40	4.7	1.3	6.0	4.9	1.2	6.1
	50	5.6	1.7	7.3	3.6	1.1	4.7
	60	4.7	0.8	5.5	4.9	1.3	6.2
	70	5.7	1.9	7.6	5.0	1.2	6.2
	75	5.3	1.5	6.8	5.0	1.2	6.2
	80	5.9	0.7	6.6	5.4	1.5	6.9
	90	5.8	0.3	6.1	6.8	1.2	8.0

*Results were based on 1000 simulations for each design at each sampling fraction

Table IV-2

Sample Allocations* for Stratified Random Sampling Using Empirical or Seasonal Strata

	Stratified Sampling Design	Stratum Dates	Percent of Year Sampled												
			5	10	20	25	30	40	50	60	70	75	80	90	100
Unit No. 2	Seasonal Stratification	01 Jan - 31 Mar	4	8	16	20	24	32	52	73	92	92	92	92	92
		01 Apr - 30 Jun	2	3	6	8	9	13	20	28	38	47	57	76	90
		01 Jul - 30 Sep	2	3	6	7	9	11	19	26	34	43	51	69	91
		01 Oct - 31 Dec	11	23	45	57	68	90	92	92	92	92	92	92	92
		Total per year	19	37	73	92	110	146	183	219	256	274	292	329	365
	Empirical Stratification	01 Jun - 31 Aug	2	3	7	9	11	18	25	32	44	52	61	79	92
		01 Sep - 30 Sep	2	2	2	3	3	5	8	10	13	16	18	24	30
		01 Oct - 27 Nov	7	18	38	47	57	58	58	58	58	58	58	58	58
		28 Nov - 15 Mar	4	10	20	26	31	52	73	95	108	108	108	108	108
		16 Mar - 07 Apr	2	2	2	2	2	3	4	5	7	9	10	13	23
		08 Apr - 31 May	2	2	4	5	6	10	15	19	26	31	37	47	54
		Total per year	19	37	73	92	110	146	183	219	256	274	292	329	365
Unit No. 3	Seasonal Stratification	01 Jan - 31 Mar	4	7	15	18	22	28	37	44	53	58	64	76	92
		01 Apr - 30 Jun	4	7	14	18	22	29	35	41	50	56	62	73	90
		01 Jul - 30 Sep	4	9	17	21	25	34	42	51	61	68	74	88	91
		01 Oct - 31 Dec	7	14	27	35	41	55	69	83	92	92	92	92	92
		Total per year	19	37	73	92	110	146	183	219	256	274	292	329	365
	Empirical Stratification	01 Jun - 31 Aug	4	9	18	23	28	37	47	58	75	83	92	92	92
		01 Sep - 30 Sep	2	2	2	3	3	4	4	6	8	8	9	13	30
		01 Oct - 10 Dec	5	12	25	32	37	50	64	71	71	71	71	71	71
		11 Dec - 31 Jan	2	6	10	12	15	20	24	31	39	44	48	52	52
		01 Feb - 25 Mar	2	3	7	8	10	13	16	20	26	29	32	50	53
		26 Mar - 15 Apr	2	3	7	9	11	14	18	21	21	21	21	21	21
		16 Apr - 31 May	2	2	4	5	6	8	10	12	16	18	19	30	46
		Total per year	19	37	73	92	110	146	183	219	256	274	292	329	365

*Values represent the number of days to be randomly selected from each temporal stratum for various sampling fractions (percent of year sampled) at Indian Point Units No. 2 or No. 3

stratification scheme and a 50% reduction in sampling was desired for Indian Point Unit No. 2. A 50% reduction in effort would require 183 days of sampling per year. Figure IV-4 indicates that for a seasonal stratified design the mean daily impingement count for one year°s data would have an expected precision level of ±4.6 percent (the coefficient of variation) of the mean daily collection size. Given the size of impingement collection in the 1976 through 1979 period, this precision would allow estimation of the annual mean daily collection size to within ±354 fish (the standard error of the 1976 through 1979 mean EMD count). Using Equation (3), this would allow a precision of ± 129,000 fish when estimating annual total impingement. The 95% confidence interval about the yearly mean daily impingement count would catch the true yearly mean better than 94% of the time (Figure IV-6). If this level of precison and accuracy was desirable and acceptable, the design could be implemented by randomly taking daily impingement samples according to the scheme in Table IV-2. A 50% reduction in sampling effort at Unit No. 2 using seasonal stratification would require that impingement collections be made on the following number of randomly selected days in each season.

01 Jan through 31 Mar = 52
01 Apr through 30 Jun = 20
01 Jul through 30 Sep = 19
01 Oct through 31 Dec = 92

Periods of the year with high and variable daily impingement counts require intensive sampling (e.g., October through December where sampling was every day), while few days need be sampled in low variation periods (e.g., April through September); the object being to achieve a low probability of not sampling days with high impingement counts. This is accomplished by sampling every day during periods of high variation. Low variation periods naturally have a low probability of missing days with high impingement counts since these periods contain few or no high impingement days. For strata with intermediate variability (e.g., January through March), selecting additional days, up to all days, would insure that all days with high impingement counts were selected. It would also be possible, during intermediate periods, to institute a system wherein once high impingement was encountered in a "less-than-daily" sampling mode, sampling could revert to a daily schedule until daily counts decreased.

E. SUMMARY

Daily variation in impingement counts was analyzed to determine its effect on precision and accuracy of reduced sampling plans for Indian Point Unit No. 2 and Unit No. 3. Precision increased logarithmically as more days in the year were sampled. Simple random sampling was the least precise and stratified random sampling was the most precise design at all reduced sampling levels. For stratified sampling, an empirical stratification scheme based on sampling during periods of high and low variation among daily impingement counts was only slightly more precise than seasonal stratification, primarily because of the tendency for periods of natural variation to be seasonal. Sampling more than 30% of the year at Unit No. 2 and 20% of the year at Unit No. 3 achieved an accuracy of approximately 93% to 95% in estimating mean daily or annual total impingement counts. Finally, information was presented which illustrated the use of these results to select a reduced impingement sampling design at Indian Point Units No. 2 and No. 3.

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SECTION V

IMPINGEMENT AS AN INDEX OF FISH ABUNDANCE

A. INTRODUCTION

The Indian Point Generating Station can be viewed as a year-round shoreline fish sampler due to the continuous withdrawal of water from the Hudson River for cooling and the resultant impingement of fish on water intake screens. Thus, it may provide a means of detecting major changes in the abundance of the impingeable life stages of the more common species in impingement collections. For example, studies of North Carolina's Cape Fear estuary in relation to impingement at the Brunswick Steam Electric Generating Station revealed that the relative abundance of impinged organisms generally reflected that organism's relative abundance in the estuary (Carolina Power and Light Company 1980). Claridge and Gardner (1978) assumed impingement provided a reliable sample and monitored growth and movements of the twait shad (*Alosa fallix*) by collecting samples from the cooling water intake screens of three power stations along the Severn Estuary and Bristol Channel in western England. To investigate the possibility of using impingement to monitor fish abundance in the Hudson River estuary, annual changes in riverwide abundance of white perch, striped bass, and Atlantic tomcod as estimated from fisheries collections made during 1973 through 1978 were compared to annual variations in impingement of these species at the Indian Point Generating Station only. Since annual changes in distribution of fish within the river may in itself result in variation in annual impingement magnitude at Indian Point or any other fixed location, impingement at five generating stations along the Hudson River (Bowline, Lovett, Roseton, Danskammer, and Indian Point) was combined and also compared to the riverwide abundances of these three species.

B. DERIVATION OF INDICES AND ANALYTICAL APPROACH

Previous analyses indicated that the major variables affecting impingement at the Indian Point Generating Station were the volume of cooling water circulated through the plant and changes in water temperature and salt front position in the estuary. Changes in salt front position cause changes in fish distribution and thus alter vulnerability to impingement. The primary factor influencing water temperature and salt front position is the volume of fresh water entering the estuary (TI 1976). Therefore, impingement counts were adjusted by covariance analysis (Helwig and Council 1979) to remove variation due to changes both in volume of cooling water circulated and freshwater flow. The remaining annual differences in impingement counts should then be due primarily to changes in the abundance of fish species impinged or to random error. The annual counts (unadjusted for collection efficiency) were used to rank each year in order of greatest to least impingement.

In the course of the Hudson River Ecological Study several indices have been developed to evaluate annual abundance changes of the key species (white perch, striped bass, and Atlantic tomcod) in the estuary (TI 1980b). Abundance indices selected for comparison with impingement counts in this analysis were those which provided an estimate of the life stages impinged. The juvenile abundance index derived from beach seine collections in late summer and fall were used for white perch and striped bass. The summer-fall abundance index for juvenile Atlantic tomcod, however, was not used since an unknown proportion of the juvenile population appears to emigrate from the sampling area during some years. This movement would lead to erroneously low abundance indices for those years that the tomcod left the sampling area. Therefore, the winter spawning population estimate was selected as the most reliable estimate of annual abundance for Atlantic tomcod.

Comparisons between adjusted annual impingement and annual abundance were then made for each species for the Indian Point Generating Station alone and the five stations combined. Two sets of ranks for the years 1973 through 1978 were developed, one based on annual impingement counts adjusted for freshwater flow and volume of water circulated and a second based on selected annual abundance indices. The two rankings were then compared using Kendall's Rank

Correlation Coefficient, τ (Siegel 1956). Significantly similar rankings indicated that impingement reflected annual changes in riverwide abundance of the life stage represented by the selected abundance index. Also, to the extent that the index reflected year class strength, a similar ranking would be indicative that impingement could be useful as a measure of year class strength.

The effect of adjusting impingement counts for freshwater flow was tested by performing the same analyses described above without this adjustment. This evaluation was not done for volume circulated since it has been shown in previous analyses to account for a significant amount of variation in impingement (TI 1980a).

C. RESULTS

1. White Perch

The rankings of white perch based on annual impingement at the Indian Point Generating Station from July 1973 through June 1979 and the rankings based on the riverwide juvenile abundance index for these years were similar; however, the relationship was not significant ($p = 0.85$). The ranking of annual impingement for the five stations combined, however, was significantly similar ($p = 0.01$) to rankings based on the riverwide juvenile abundance index (Table V-1). Removal of the freshwater flow adjustment did not change the white perch impingement ranking.

2. Atlantic Tomcod

Adjusted impingement values for Atlantic tomcod at the Indian Point Generating Station in the months September through March were compared to the ranking of annual adult spawning population estimates made during corresponding time periods for the years 1974 through 1979. The rankings were not significantly similar ($p = 0.14$) (Table V-2). Adjusted impingement at the five power plants combined was also not significantly similar ($p = 0.14$) to adult population size (Table V-2). Ranking Atlantic tomcod without a freshwater flow adjustment changed the

Table V-1

Comparison of Annual Ranking of White Perch Abundance from Adjusted Impingement Collections at Indian Point Alone, and at Indian Point, Bowline, Lovett, Roseton, and Danskammer Generating Stations Combined to Selected Riverwide Abundance Indices for July 1973 through June 1979 Using Kendall's Rank Correlation Coefficient (τ) and Associated Probabilities of Independence (p)

Annual Abundance Ranking*		
Indian Point Impingement	Juvenile Abundance	Combined Impingement
1976	1973	1973
1978	1975	1976
1977	1976	1975
1975	1978	1978
1974	1977	1977
1973	1974	1974
τ = -0.07 $p^{\dagger}$ = 0.85		τ = 0.87 $p^{\dagger}$ = 0.01

*Ranked high to low from top to bottom

$^{\dagger}p \leq 0.05$ indicates significantly similar rankings

Table V-2

Comparison of Annual Ranking of Atlantic Tomcod Abundance from Adjusted Impingement Collections at Indian Point Alone and at Indian Point, Bowline, Lovett, Roseton, and Danskammer Generating Stations Combined to Riverwide Spawning Population Estimates for September 1974 through March 1979 Using Kendall's Rank Correlation Coefficient (τ) and Associated Probabilities of Independence (p)

Annual Abundance Ranking*		
Indian Point Impingement	Spawning Population Estimate	Combined Impingement
1974	1976	1976
1976	1978	1974
1978	1974	1978
1975	1975	1977
1977	1977	1975
τ = 0.60 $p^{\dagger}$ = 0.14		τ = 0.60 $p^{\dagger}$ = 0.14

*Ranked high to low from top to bottom

$^{\dagger}p \leq 0.05$ indicates significantly similar rankings probability for plants combined and Indian Point to $p = 0.33$ which also is not significant.

3. Striped Bass

Rankings based on impingement collections of striped bass at the Indian Point Generating Station were not significantly similar ($p = 0.85$) to the juvenile abundance index ranking from July 1973 through June 1979 (Table V-3). The same comparison for adjusted impingement at the five generating stations combined was also not significantly similar ($p = 0.85$). Removal of the freshwater flow adjustment to impingement did not change the striped bass impingement ranking.

Table V-3

Comparison of Annual Ranking of Striped Bass Abundance from Adjusted Impingement Collections at Indian Point Alone and at Indian Point, Bowline, Lovett, Roseton, and Danskammer Generation Stations Combined to Selected Riverwide Abundance Indices for July 1973 through June 1979 Using Kendall's Rank Correlation Coefficient (τ) and Associated Probabilities of Independence (p)

Annual Abundance Ranking*		
Indian Point Impingement	Juvenile Abundance	Combined Impingement
1977	1973	1973
1978	1978	1974
1976	1977	1975
1974	1975	1977
1975	1976	1978
1973	1974	1976
Indian Point vs. Juvenile: $\tau = -0.07$, $p^{\dagger} = 0.85$		Juvenile vs. Combined: $\tau = 0.07$, $p^{\dagger} = 0.85$

*Ranked high to low from top to bottom

†$p \leq 0.05$ indicates significantly similar rankings

D. SUMMARY OF IMPINGEMENT TO RIVER ABUNDANCE INDICES COMPARISONS

To evaluate the usefulness of impingement collections for monitoring year class strength, annual impingement counts (adjusted for variation due to changes in volume circulated through the plant and freshwater flow into the estuary) at the Indian Point Generating Station and at Bowline, Lovett, Roseton, Danskammer, and Indian Point generating stations combined were compared to selected annual abundance indices for white perch, Atlantic tomcod, and striped bass. The abundance indices were developed from riverwide fisheries gear collections and selected for these comparisons based on previous evaluations of their representation of year class strength (TI 1980b) for the life stages impinged.

Impingement collections at the five stations combined can be used to obtain a general indication of juvenile abundance for white perch. However, white perch juvenile abundance has not been shown to reflect relative abundance of the year class in later years (TI 1980b), thus changes in annual impingement may not indicate relative year class strength. VanWinkle et al. (1980) performed a similar comparison for white perch using a portion of the data set (1972 through 1976) used in this report. They selected portions of each year's impingement, used abundance indices based on a shorter sampling period, and reported a nonsignificant correlation between annual rankings of impingement and juvenile abundance indices.

Impingement collections cannot be used to obtain a general indication of abundance of the other two key species (i.e., striped bass and Atlantic tomcod). For Atlantic tomcod, the annual ranking of the spawning population size did not match the annual ranking of impingement collections; thus, year class strength of this species was not reflected by impingement either. Although impingement collections of striped bass did not reflect annual abundance of juvenile striped bass, the years included in this analysis covered a time span with only one large year class (1973). The low degree of variation in the juvenile abundance index during 1974 through 1978 may have been smaller than the sampling error. In other words, impingement collections could reflect large differences in juvenile striped bass abundance but appear not to be sensitive enough to reflect small changes.

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SECTION VI

EVALUATION OF INFERENCES DRAWN FROM STANDARD STATIONS DATA

A. INTRODUCTION

The objective of this section is to determine if similar inferences concerning fish populations in the Indian Point area can be drawn from the two separate but overlapping sampling programs currently being performed. Since 1973, TI has sampled the Hudson River estuary in the vicinity of the Indian Point Generating Station (RM 42) with two distinct beach seine programs: the "Standard Stations" Program in which fixed sites from RM 39 through RM 43 are sampled, and the "Long River" Beach Seine Survey in which a subset of sites is randomly chosen for sampling from all available sites in each of 12 river regions (Yonkers through Albany, RM 12 through RM 152), one of which is the Indian Point region (RM 39 through RM 46). This section seeks to answer the question: "Will standard stations sampling reveal the same trends in relative abundance and species composition as long river sampling conducted in the Indian Point region?"

The origin and development of the Standard Stations Program and the subsequent development of the more extensive Long River Surveys will be reviewed. The gear and sampling designs will be compared to determine the redundancy of the two sampling programs. Past comparisons of standard station and long river data will be reviewed. Species composition and relative abundance, as indicated by standard stations and long river beach seining in the Indian Point region, will be compared statistically to determine if the same inferences can be derived from both surveys. Finally, an assessment will be made to determine which type of sampling would be more worthwhile if only one survey was continued.

B. ORIGIN AND DEVELOPMENT OF STANDARD STATIONS AND LONG RIVER SAMPLING

An intensive study of the Hudson River estuary in the area of Indian Point was begun in June 1969 to provide information necessary for the evaluation of the ecological impact of the Indian Point Nuclear Generating Station. Raytheon Company (1971) conducted an initial baseline study during which fish, invertebrate, and water chemistry samples were collected at a number of fixed stations between Croton Point (RM 34) and the Bear Mountain Bridge (RM 46). Based on the results of the baseline survey which ended in October 1970, an expanded study was initiated in early 1972 to permit assessment and mathematical modeling of plant impact. This expanded study included the present Standard Stations Program (TI 1973). Some changes have occurred since the inception of standard stations sampling, but the overall program has remained essentially the same (TI 1980a). The objectives of standard stations sampling were: 1) to determine the relative abundance and species composition of juvenile and older fishes in the Indian Point area and 2) to provide biocharacteristic data to determine the age structure, growth rates, and fecundity of the Hudson River populations of striped bass, white perch, and Atlantic tomcod (identified as the key species). Standard station sampling also continued the data base established by the initial baseline study.

As new electric generating plants came on line and proposals for new sites along the Hudson River were presented, the need for an environmental study of the entire estuary became apparent. Beginning in 1973, more extensive surveys were conducted in addition to standard stations sampling (TI 1975a). Beach seine samples were collected weekly from the George Washington Bridge (RM 12) to the Troy Dam (RM 153) using a stratified random design to select sample sites. Also, bottom trawl samples were collected biweekly at fixed stations between the Tappan Zee (RM 27) and Newburgh-Beacon (RM 62) bridges. These Long River Surveys were designed to gather information on the spatiotemporal distribution of the estuarine fishes and provide additional effort for the ongoing Mark-Recapture Program.

Thus, since 1973, TI has been sampling juvenile and older fishes of the Indian Point area using two separate but similar programs: 1) the Long River Program including Beach Seine and Interregional Bottom Trawl Surveys and 2) Standard Stations Program including beach seine, bottom trawl, and surface trawl sampling (Table IV-1). The same types of data (i.e., fish collections with concurrent water quality data) have been collected by both surveys, and to this extent the two sampling programs have overlapped and duplicated effort.

Although beach seines used by the two programs have been identical, the programs have differed in sampling design. The sites sampled in the Standard Stations Program have been fixed (i.e., the same sites have been sampled consistently and always at low tide) while those sampled in the Long River Survey are randomly chosen from all available sites and are sampled without regard for tidal stage. However, neither of the two beach seine sampling programs has had a truly random or totally fixed design. Because beach seine sampling is restricted to areas suitable for seining (i.e., unobstructed beaches), the Long River Survey has sampled a randomly selected subset of fixed stations. Furthermore, because estuaries are highly variable (e.g., fluctuations in salinity, freshwater flow, etc.), fixed location sampling is not as consistent in the lower Hudson as it would be in systems where the environment is more constant (e.g., terrestrial ecosystems or small lakes). Thus, long river and standard station beach seining designs have differed only minimally and therefore might provide similar results.

Bottom trawls, used by the two programs have not been the same. The Standard Stations Program has used a trawl equipped with smaller trawl doors and both a trawl with a fine-mesh liner and a trawl without the liner in the cod end. The Long River Survey has used only one trawl equipped with larger trawl doors and a fine-mesh cod-end cover. These gear differences would confound any differences due to sampling design that exist between Standard Station and Long River Bottom Trawl Programs. Differences between programs in trends in abundance for juvenile Atlantic tomcod during 1965 through 1977 have been attributed to gear differences (TI 1979b). Therefore, only beach seine data have been used in the new analyses presented in this section.

Table VI-1

Comparison of Standard Stations and Long River Fisheries Sampling in Indian Point Region, Hudson River Estuary

Gear*	Standard Stations		Long River in Indian Point Region	
30.5-m Beach Seine	Stations:	7 fixed sites	Stations:	Chosen randomly from all recognized available beaches
	Frequency:	weekly	Frequency:	one or more days/week until regional allocation filled
	Time:	day, 2 hr before low tide	Time:	day, no regard to tidal stage
	Season:	April through December	Season:	April through December
13.5-m Bottom Trawl	Stations:	7 fixed sites	Stations:	11 fixed sites
	Frequency:	biweekly (2 sets of samples) a. one using unlined net b. one using fine mesh liner	Frequency:	biweekly (alternate weeks from Standard Stations)
	Time:	day	Time:	day
	Season:	April through December	Season:	April through December
	Tow Duration:	10 min.	Tow Duration:	5 min.
	Gear:	trawl doors, 0.38 m x 0.76 m	Gear:	trawl doors, 0.76 m x 1.22 m fine mesh cod-end cover
15.0-m Surface Trawl	Stations:	7 fixed sites		Not Used
	Frequency:	biweekly		
	Time:	day		
	Season:	July through December		

*For complete gear descriptions see TI 1980a and TI 1980b

C. COMPARISONS OF STANDARD STATIONS AND LONG RIVER DATA

1. Previous Comparisons of Species Composition and Abundance

Previous analyses of standard stations and long river beach seine data have focused on the degree to which nearfield (standard stations) data represented the species composition of the estuary and patterns of abundance in the estuary for selected species examined individually. Qualitative comparison of species composition during 1974 through 1978 revealed that the same 10 species contributed from 91% to 97% of the beach seine catches of both surveys (TI 1980a). Comparisons of juvenile blueback herring and bay anchovy abundance during 1975 through 1977 indicated that standard stations and long river data each yielded the same inferences concerning yearly patterns and magnitude (TI 1979b).

2. New Analyses: Community Comparison within Indian Point Area

a. Species Composition

To determine if standard stations and long river beach seining in the Indian Point region produced the same representations of species composition, rankings based on percentages of the combined catch-per-effort (C/f) of the 10 most abundant species (Appendix Table B-6) were compared for each year, 1976 through 1979*, and across years using Kendall's τ (a non-parametric rank correlation test, Siegel 1956). The rankings were significantly correlated for each year except 1979 and for the across years comparison (Table VI-2). Thus, standard stations and long river beach seining in the Indian Point region usually reflected the same species composition for the Indian Point region.

The lack of a significant correlation during 1979 was due to a difference in the proportions of blueback herring collected in the two surveys. During 1976 through 1978, blueback herring was the most abundant species in both surveys comprising 34% to 60% of the combined

*Although data have been collected from 1973 through 1979, at the time of this writing the 1973 through 1975 beach seine data from long river sampling were in a format that was incompatible with this analysis.

Table VI-2

Comparison of Catch/Effort Rankings of Ten Most Abundant Fish Species Collected by Standard Stations and Long River Beach Seining in Indian Point Region, Hudson River Estuary, during 1976 through 1979

	Catch/Effort Rankings									
	Standard Stations Survey					Long River Survey (Indian Point Region)				
Species	1976	1977	1978	1979	1976-1979	1976	1977	1978	1979	1976-1979
Blueback herring	1	1	1	8	1	1	1	1	1	1
White perch	2	3	4	2	3	2	3	3	4	4
Banded killifish	3	4	2	1	2	4	8	4	2	5
American shad	4	7	3	7	4	5	4	2	5	3
Spottail shiner	5	5	6	5	6	6	5	8	6	6
Tessellated darter	6	8	8	4	8	8	9	9	9	9
Bay anchovy	7	2	7	3	5	3	2	6	3	2
Alewife	8	9	9	10	9	7	6	5	10	7
Striped bass	9	6	5	6	7	10	7	7	8	8
Pumpkinseed	10	10	10	9	10	9	10	10	7	10

	1976	1977	1978	1979	1976-1979
Kendall's τ	0.73	0.64	0.64	0.33	0.64
Probability Level	<0.005	<0.005	<0.005	0.10	<0.005

C/f of the 10 species (Appendix Table B-6). However, in 1979, blueback herring contributed only 5% of the standard stations combined C/f while continuing to contribute the majority of the long river C/f. Apparently, blueback herring migrated through the Indian Point region quickly in 1979 and were "missed" by standard stations sampling. This interpretation is based upon the fact that 78.2% of the blueback herring collected during long river beach seine sampling came from only one tow made on 18 October (Appendix Table B-9). Standard stations were sampled on the previous day when 21.8% of the total blueback herring catch by the Standard Stations Program was collected in one sample. Standard stations were not sampled again for a week, a period during which the blueback herring migration through the Indian Point area probably peaked. Standard stations sampling may have missed the peak of the migration in 1979 because of a rapid movement through the Indian Point region. Examination of biweekly catch-per-effort values for young-of-the-year blueback herring from 1976, which is thought to have been a smaller year class than that of 1979, revealed that blueback were present in the Indian Point region for an extended period (July through November) and were reasonably well represented in nearfield catches (TI 1977c). Thus, the duration of the period in which blueback herring occupy the Indian Point region appears to be more important than year class size in determining catch sizes of standard stations samples.

b. Trends in Community Abundance

Trends in abundance of the major species comprising the Indian Point fish community were compared between programs using a multivariate analysis of variance (MANOV), (Morrison 1976). Catch data from each sample was transformed to reduce problems of nonnormality and variance heterogeneity. The common tranformation $\ell n(x+1)$ was used (Gnanadesikan 1977), where x was the number caught, for each of the 10 most abundant species (all life stages combined). Mean annual C/f's were calculated from the transformed data for each program. For each species, the mean transformed C/f was subtracted from that of the previous year for each pair of years: 1976-1977, 1977-1978, 1978-1979. The standard stations differences were then subtracted from the long river differences and the results compared to zero (zero would indicate that exactly the same changes were occurring in both programs) using MANOV (Figure VI-1). This technique tested the "community" of major species rather than each species individually and avoided the problem of multiple species comparisons and inflated α levels. Because station 11 was not sampled

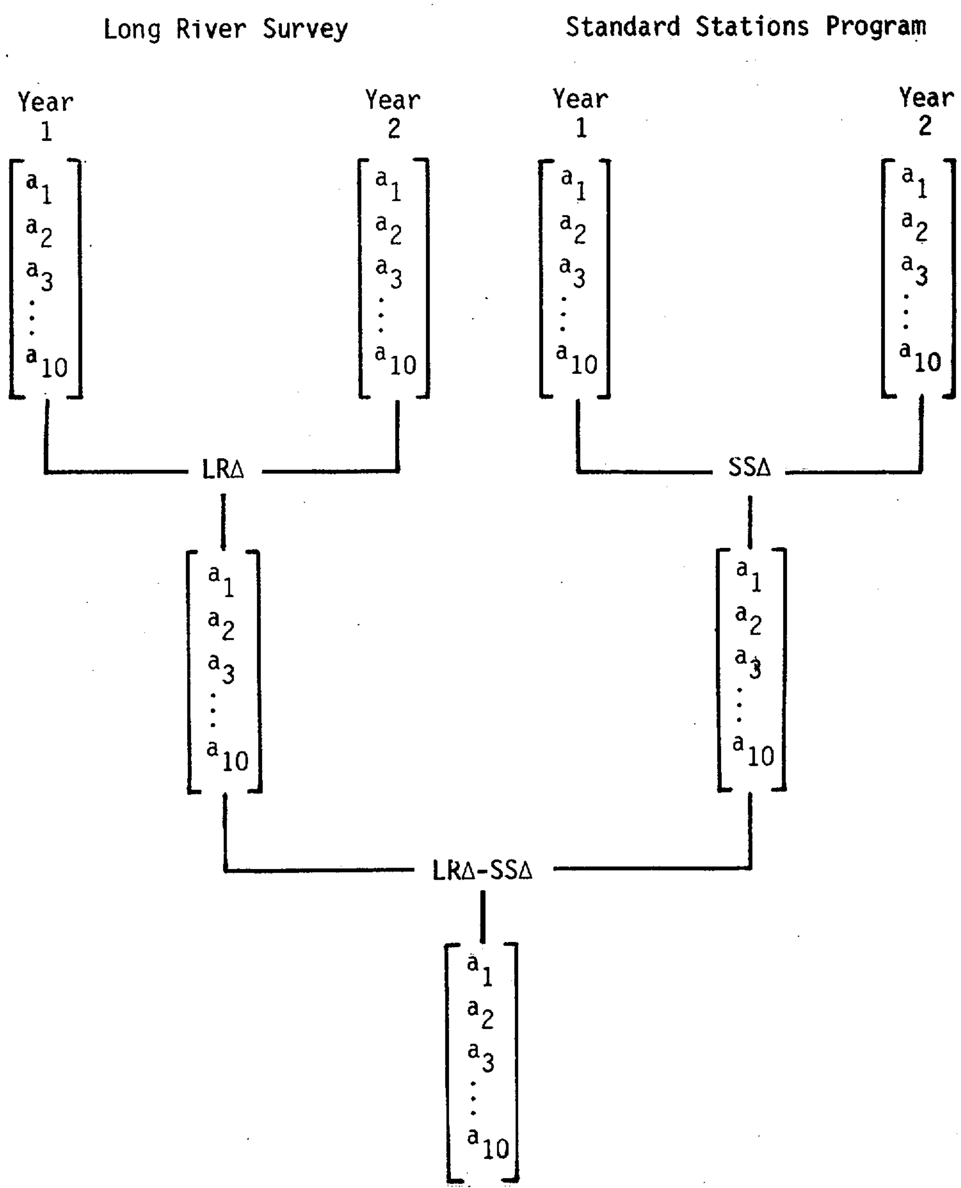

Figure VI-1. Diagrammatic Origin of Values Used in Multivariate Analysis of Variance (MANOV) for Comparing Trends in Abundance in Standard Stations (SS) versus Long River (LR) Beach Seine Collections in Indian Point Region, Hudson River Estuary, during 1976 through 1979 (values a_1 through a_{10} = annual transformed C/f's or ΔC/f's) after September during 1979 (Appendix Section C.2), the analysis was performed both with and without the data for that station during that year to determine if the loss of that station half way through the sampling year affected the results.

The trends in abundance were not significantly different between programs from 1977 to 1978 and 1978 to 1979, but were significantly different from 1976 to 1977 (Table VI-3). The deletion of data from station 11 for 1979 did not affect the results. The discordance between programs for the 1976 to 1977 comparison was produced primarily by differences for certain species in the magnitude of the change in abundance from 1976 to 1977 (Figure VI-2). For example, while abundance of tessellated darter declined from 1976 to 1977 in both programs, the decrease was much larger in the Standard Stations Program. Banded killifish, pumpkinseed, alewife, and bay anchovy also exhibited differences in the magnitude of the change in abundance from 1976 to 1977. However, the change in abundance from 1976 to 1977 was quite similar between programs for striped bass, American shad, white perch, spottail shiner, and blueback herring.

Table VI-3

Results of Multivariate Analysis of Variance of Trends in Abundance as Determined from Standard Stations Sampling Program versus Long River Beach Seine Sampling in Indian Point Region, Hudson River Estuary, 1976 through 1979

	Comparison			
	1976 to 1977	1977 to 1978	1978 to 1979	1978 to 1979*
T^2	25.65	15.98	4.93	6.72
Probability Level	0.01	0.15	0.91	0.79

*Excluding station 11

c. Discussion

The two programs exhibited similar trends in species composition and community abundance. The differences that occurred may have been related to sampling intensity. During 1976 through 1978 when samples were allocated to each region based on the distribution of

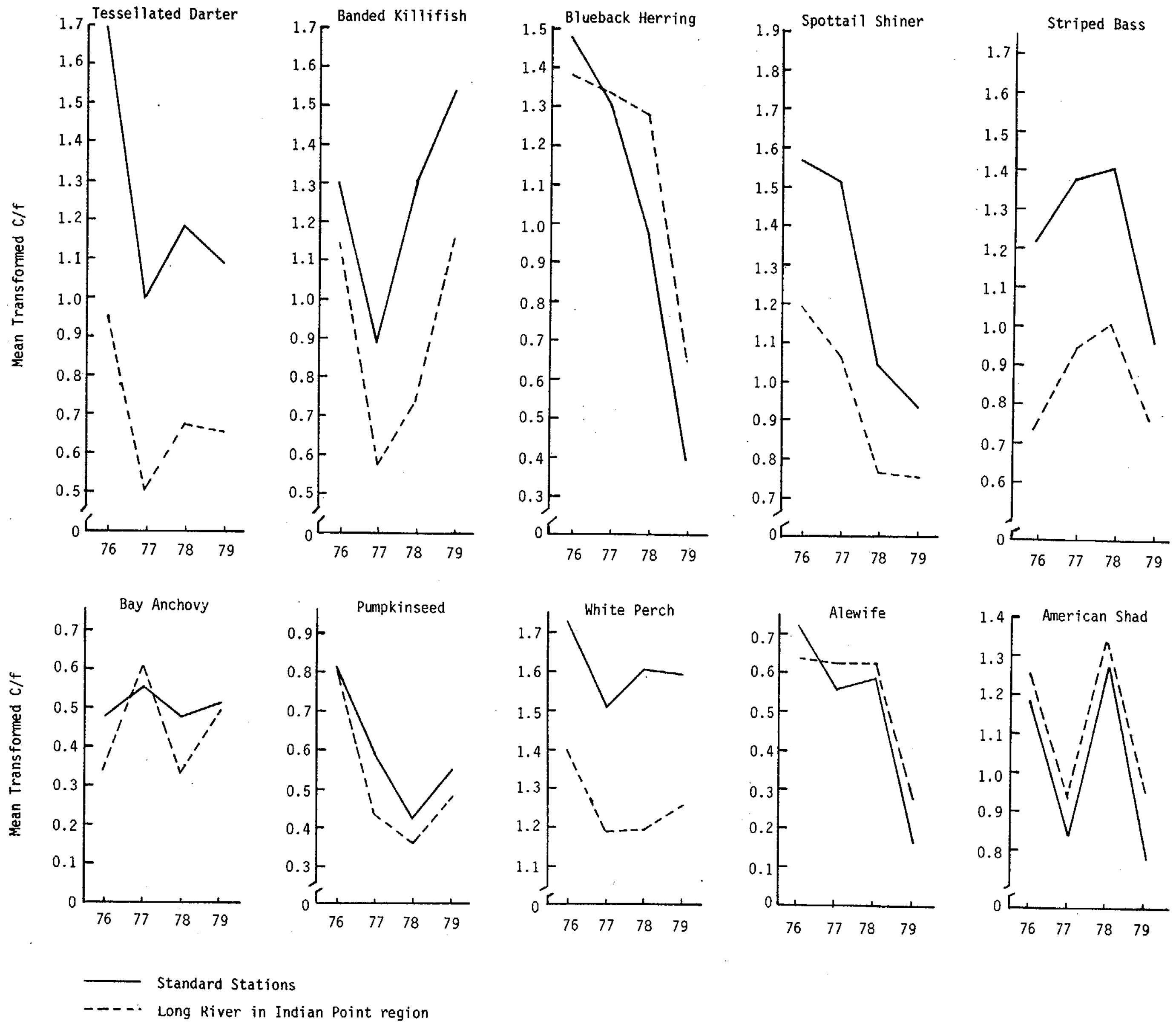

Figure VI-2. Comparison of Year-to-Year Changes in Abundance of Ten Most Abundant Fish Species as Determined during Standard Stations and Long River Beach Seine Survey in Indian Point Region, Hudson River Estuary, 1976 through 1979 juvenile striped bass, the number of long river beach seine tows in the Indian Point region was more than twice that of standard stations tows (Table VI-4). Beginning in 1979, long river samples were allocated to each region based on shore zone surface area, and the sampling efforts of the two programs were almost equal.

Table VI-4

Number of Beach Seine Samples Collected during Standard Stations and Long River Sampling in Indian Point Region, Hudson River Estuary, 1976 through 1979

Year	Standard Stations Program	Long River Survey
1976	251	712
1977	271	703
1978	267	584
1979	242	226

Because of the greater sampling effort, relative abundance was probably more accurately depicted by the Long River Survey during 1976 through 1978. While the allocation scheme adopted in 1979 has removed this advantage of long river sampling, other features of the long river sampling design make it the better program.

The fixed station design of standard stations increases the danger of bias due to confounding with natural features within the Indian Point region. One such confounding natural feature is the tendency for the catches of some species to be larger at low tides than at other tidal stages (TI 1973). This may result from increased density due to a reduction in available habitat. Larger catch at low tide explains the greater abundance of most species in standard station beach seine collections than in long river collections (Figure VI-2), because standard stations are always sampled immediately prior to low tide while long river beach seining is scheduled without regard to tidal condition.

However, abundance was not greater in standard station collections for all species. Therefore, if comparisons of relative abundance among species are made, standard station data would include a bias not present in long river beach seine data. Additionally, cluster analysis of standard stations beaches indicated that each beach appeared to have its own unique species composition (TI 1980a). Therefore, the Long River Survey which selects sites from all available beaches in the region would give a better representation of the overall fish community.

The Long River Survey also has more beaches available for sampling; thus, the loss of one station would not threaten to disrupt the program as it did for standard stations in 1979 when one of the seven stations became unavailable for sampling. Furthermore, the Long River Survey has a greater frequency of sampling days during each week. All standard stations beaches are usually sampled on the same day each week while long river samples are generally taken over several days. Therefore, a species such as blueback herring which migrates through the Indian Point area would have a lesser chance of being "missed" by long river sampling.

D. SUMMARY AND CONCLUSIONS

Fishes in the Indian Point area have been sampled by two distinct but similar programs since 1973: Standard Stations and Long River. The programs originated for different purposes, but both are capable of gathering the same types of information. Gear differences confound comparisons of standard stations and long river bottom trawls; however, the beach seines are identical and have been shown to yield similar results. Past comparisons focused on the degree to which the Indian Point area reflected trends in fish abundance and species composition of the estuary in general. New analyses presented in this report compared standard stations and long river beach seine sampling in the Indian Point region to determine if the same inferences concerning the Indian Point fish community could be drawn from both surveys. Results indicated that species composition is usually the same for both surveys and that trends in abundance are usually, but not always, the same. The design of the Long River Survey has several advantages over the Standard Stations Program and may give a better representation of the Indian Point fish community.

SECTION VII

GLOSSARY

Age Composition (age structure): The quantitative make-up of a group or population of fish based on age classes (e.g., age I, II, III, etc.); usually expressed as the proportion or percentage of individuals of a given age in the population.

Brood Fish: Fish used for spawning in a hatchery.

Catch-Per-Effort (C/f): The catch of fish, in number or weight, collected using a specified gear for a defined amount of time or effort, e.g., catch per tow, catch per volume.

Conductivity (specific conductance): A measure of the total concentration of the solutes in water (i.e., a measure of salinity) determined by a solution's capacity to conduct an electrical current. Since conductivity increases 2% to 3% for each degree centrigrade, it is reported at a standard temperature of 25°C in millisiemens per centimeter (mS/cm).

Con Edison: Consolidated Edison Company of New York, Inc.

Dissolved Oxygen: Oxygen dissolved in water; derived from photosynthesis and diffusion of atmospheric oxygen. Expressed in milligrams per liter (mg/ℓ).

Estimated Maximum Daily (EMD) Impingement: The number of fish which would have been impinged on the collection screens at Indian Point Unit No. 2 or No. 3 if the unit was pumping cooling water at maximum capacity at all six intake structures per unit. EMD impingement counts are obtained from the product of the daily impingement rate (numbers $\cdot 10^6 m^{-3}$) and maximum pumping capacity ($10^6 m^3$).

Entrainment: The passage of small organisms along with water through a power plant cooling system. Entrained organisms are organisms too small to be impinged (see Impingement).

Estuary: A semi-enclosed coastal body of water which has free access to the sea and which has salinity that is measurably diluted below the salinity of open ocean water by freshwater tributaries and surface drainage. For the Hudson system, the estuary is that portion of the Hudson River downstream from the Troy Dam at RM 153.

Finclip: A method for marking fish by excising one or more of the fins; this method is used on fish that are too small to be tagged effectively.

Fingerling: Juvenile fish approximately 50-150 mm total length.

Impingement: The process whereby the force of water being withdrawn through an intake screen forces organisms to come in contact with and be held against that screen.

Indian Point Region: An area of the Hudson River near the Indian Point Electric Generating Station (RM 39 through RM 46).

Juvenile (Young-of-the-Year): The lifestage beginning when a fish acquires the full complement of adult fin characteristics and extending to Age I (i.e., through 31 December of the year spawned).

Long River (surveys): Sampling programs that include several or all river regions (e.g., Interregional Bottom Trawl and Beach Seine Surveys).

Lower Estuary: As used in this report, includes the Yonkers (RM 12 through RM 23) and Tappan Zee (RM 24 through RM 33) river regions (characterized by variable but usually salt or brackish water).

Magnetic Nose Tag: Small piece of fine gauge wire magnetized for electronic detection and inserted into nasal cartilage of fish.

Nearfield: Area of the Hudson River estuary in the vicinity of a power plant. In this report, it refers to the area near the Indian Point Generating Station (RM 39 through RM 43).

NRC: Nuclear Regulatory Commission.

Parent Population (sampling statistics): Synonym for population, but used in connection with computer sampling routines which select subsets of data from a data base. The parent population is a data set containing all possible observations, e.g., the parent population of days in a year contains all 365 days.

pH: The measure of the hydrogen ion activity of a solution, i.e., its acidity or alkalinity. Neutral pH is 7, with increasing acidity from pH 7 to pH 1 and increasing alkalinity from pH 7 to pH 14.

Population (sampling statistics): Any collection of things (living or nonliving) about which information is required. For example, one can sample a population of days, fish, or rivers.

Relative Abundance: A measure of the number of organisms in a given time period or area relative to another time period or area.

Riverwide: As used in this report, refers to the "long river" study area encompassed by river miles 12 through 152.

Salt Front: The leading gradient area of a mass of seawater intruding into the estuary. Salt front is defined as the area associated with a conductivity of 0.3 mS/cm or equivalent to a salinity of about 0.1 part per thousand ($^{o}/oo$).

Size Selectivity: Differential probability of capture of fish of varying sizes due to avoidance by the fish or to size of net mesh.

Species Composition: The assemblage of species found in an area. Also, the proportion of individuals of a given species making up the total number of individuals represented by all species (i.e., relative species composition).

Standard Stations: Standard sampling areas in the nearfield (RM 39 through RM 43) of the Indian Point Generating Station.

Stratum (sampling statistics): A subpopulation or subset of data. For example, the months in a year would represent 12 strata.

TI: Texas Instruments Incorporated.

Turbidity: The opacity of water caused by the presence of suspended particulate matter (such as clay, silt, microorganisms, or organic and inorganic detritus).

Year Class: A cohort of fish spawned or hatched during a given calendar year.

Year Class Abundance: The number or relative number of fish of a given species spawned or hatched during a given calendar year.

Year Class Strength: The abundance of each year class relative to other year classes.

Yearling: The age of fish during the calendar year following the year in which they were spawned.

Young-of-the-Year: See Juvenile.

SECTION VIII

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APPENDIX A

IMPINGEMENT STUDIES

APPENDIX A.1

Total Counts of Each Species Impinged

Table A-1

Total Monthly Actual Count of Each Species Collected from Intake Screens at Indian Point Unit No. 2 during 1979

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR_TOTAL
ALEWIFE	10	39	7	4	57	28	0	0	210	276	288	10	929
BAY ANCHOVY	57	0	0	0	1834	187	0	0	17126	11566	213	84	31067
AMERICAN SHAD	8	3	0	0	5	0	0	0	428	1835	2422	42	4743
BLUEFISH	0	0	0	0	0	17	0	0	11	15	0	0	43
BLUEGILL	21	5	9	7	5	2	0	0	45	14	18	107	233
BROWN BULLHEAD	21	2	3	7	6	0	0	0	10	69	17	30	165
PUMPKINSEED	325	179	225	57	43	20	0	0	37	265	773	1095	3019
BLACK CRAPPIE	7	3	4	0	2	1	0	0	0	1	0	3	21
CARP	3	4	8	0	0	0	0	0	0	0	0	8	23
AMERICAN EEL	319	44	57	129	227	97	0	0	22	54	101	111	1161
GOLDFISH	89	59	168	20	12	2	0	0	0	1	11	14	376
GOLDEN SHINER	12	10	32	13	1	0	0	0	0	2	3	9	82
HOGCHOKER	76	11	20	1167	4825	219	0	0	1737	2228	2273	551	13107
TESSELLATED DARTER	69	13	55	438	70	3	0	0	6	22	249	80	1005
BANDED KILLIFISH	104	51	97	22	16	2	0	0	26	109	101	316	844
EMERALD SHINER	1	0	0	0	2	0	0	0	0	0	0	0	3
LARGEMOUTH BASS	8	3	11	0	2	0	0	0	0	0	8	52	84
MUMMICHOG	2	4	9	2	0	2	0	0	0	2	3	6	30
ATLANTIC MENHADEN	0	0	0	0	1	1	0	0	3	4	1	2	12
MINNOW UNIDENTIFIED	0	0	1	0	0	0	0	0	0	0	0	0	1
BLUEBACK HERRING	41	11	0	14	176	85	0	0	994	95200	18939	111	115571
WHITE SUCKER	1	0	0	1	1	0	0	0	0	0	0	0	3
ATLANTIC SILVERSIDE	0	9	0	0	2	0	0	0	0	0	0	0	11
RAINBOW SMELT	2657	3382	1175	1309	2624	211	0	0	453	1459	1444	1548	16262
SHORTNOSE STURGEON	0	1	0	1	0	0	0	0	0	0	0	0	2
SPOTTAIL SHINER	782	368	774	634	59	8	0	0	16	164	310	830	3945
ATLANTIC STURGEON	4	7	0	7	0	0	0	0	5	4	4	1	32
STRIPED BASS	19522	9669	4366	449	166	63	0	0	621	594	366	2466	38282
4-SPINE STICKLEBACK	1	0	1	3	0	0	0	0	0	4	33	39	81
ATLANTIC TOMCOD	2515	891	434	496	6759	8521	0	0	5985	756	329	2817	29503
WHITE CATFISH	329	202	113	67	90	14	0	0	18	148	551	508	2040
WHITE PERCH	315681	296928	122191	64074	15465	3065	0	0	24206	60324	126019	210140	1238093
YELLOW PERCH	130	36	72	59	18	7	0	0	1	0	22	81	426
ROCK BASS	1	2	10	1	0	0	0	0	0	0	0	0	14
NORTHERN PIPEFISH	1	0	0	0	3	3	0	0	58	27	4	4	100
REDBREAST SUNFSH	0	0	2	0	2	0	0	0	1	0	1	3	9
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	1	0	0	0	1
CREVALLE JACK	0	0	0	0	0	0	0	0	1	2	1	0	4
WEAKFISH	0	0	0	0	0	0	0	0	1516	472	306	131	2425
CLUPEID UNIDENTIFIED	0	9	0	0	0	0	0	0	88	4501	692	1	5291
SPOT	0	0	0	0	0	0	0	0	1	0	0	0	1
WINTER FLOUNDER	1	12	5	2	0	0	0	0	1	2	0	0	23
TIDEWATER SILVERSIDE	2	0	0	0	0	1	0	0	0	0	0	0	3
SEA LAMPREY	0	1	0	0	0	0	0	0	0	0	0	1	2
GIZZARD SHAD	573	7	2	0	0	0	0	0	0	1	3	55	641
SILVER HAKE	0	0	0	0	0	0	0	0	0	0	1	3	4
STRIPED MULLET	1	0	0	0	0	0	0	0	0	0	0	0	1
3-SPINE STICKLEBACK	32	148	107	15	2	0	0	0	0	0	0	0	304
BUTTERFISH	0	0	0	0	0	0	0	0	0	1	1	0	2
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0	0	2	2
SILVER PERCH	0	0	0	0	0	0	0	0	2	0	0	0	2
CENTRARCHID UNID	21	33	92	37	30	2	0	0	631	1373	2325	1408	5952
SQUIRREL OR RED HAKE	14	4	0	0	0	0	0	0	0	0	0	3	21
GRUBBY	0	1	0	0	0	0	0	0	0	0	0	0	1
EAST MUDMINNOW	0	1	2	1	0	0	0	0	0	0	0	0	4
WHITE BASS	9	2	0	0	0	0	0	0	0	0	0	0	11
ROUGH SILVERSIDE	0	0	0	0	0	1	0	0	0	0	0	0	1
SUMMER FLOUNDER	1	0	0	0	0	0	0	0	11	11	1	0	24
STRIPED SEAROBIN	0	0	0	0	0	0	0	0	0	7	1	3	11
NORTHERN SEAROBIN	0	0	0	0	0	0	0	0	0	0	9	0	9
ATLANTIC CROAKER	1	0	0	0	0	0	0	0	0	2	11	247	261
LONGHORN SCULPIN	0	0	0	0	0	0	0	0	0	0	0	1	1
HICKORY SHAD	0	0	0	0	0	0	0	0	0	1	0	0	1
STRIPED ANCHOVY	0	0	0	0	0	0	0	0	1	0	0	0	1
WINDOWPANE	0	0	0	0	0	0	0	0	1	1	3	0	5
SEAROBIN	0	0	0	0	0	0	0	0	0	0	2	0	2
BLACK SEA BASS	0	0	0	0	0	0	0	0	0	0	0	1	1
SAND LANCE	1	0	0	0	0	0	0	0	0	0	0	0	1
COLUMN TOTAL	343453	312154	130052	69036	32505	12562	0	0	54273	181517	157859	222924	1516335

Table A-2

Total Monthly Actual Count of Each Species Collected from Intake Screens at Indian Point Unit No. 3 during 1979

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR_TOTAL
ALEWIFE	5	38	9	46	523	269	5252	1429	228	0	0	0	7799
BAY ANCHOVY	10	0	0	16	7951	3483	57720	26096	3632	0	0	0	98908
AMERICAN SHAD	5	0	0	1	33	9	11354	7943	995	0	0	0	20340
BLUEFISH	0	0	0	0	0	371	3119	446	51	0	0	0	3987
BLUEGILL	21	3	12	27	37	21	3	15	8	0	0	0	147
BROWN BULLHEAD	5	5	14	10	8	4	17	829	35	0	0	0	927
PUMPKINSEED	216	106	169	110	205	81	57	82	46	0	0	0	1072
BLACK CRAPPIE	5	0	3	6	0	3	0	0	0	0	0	0	17
CARP	3	1	5	0	0	0	0	1	0	0	0	0	10
AMERICAN EEL	306	94	85	263	238	244	191	123	32	0	0	0	1576
GOLDFISH	101	102	256	104	47	10	2	0	4	0	0	0	626
GOLDEN SHINER	16	9	54	70	4	2	2	0	2	0	0	0	159
HOGCHOKER	68	17	15	1767	4715	204	671	2037	633	0	0	0	10127
TESSELLATED DARTER	11	3	27	477	66	7	24	23	17	0	0	0	655
BANDED KILLIFISH	53	23	41	32	12	9	9	21	38	0	0	0	238
EMERALD SHINER	0	0	0	0	1	0	0	0	0	0	0	0	1
LARGEMOUTH BASS	4	2	11	1	1	0	2	2	0	0	0	0	23
MUMMICHOG	1	1	1	1	1	2	0	0	0	0	0	0	7
ATLANTIC MENHADEN	0	0	0	0	19	31	182	177	30	0	0	0	439
CHAIN PICKEREL	0	1	0	1	0	0	0	0	0	0	0	0	2
BLUEBACK HERRING	17	9	0	218	1107	683	576	3036	789	0	0	0	6435
WHITE SUCKER	0	1	2	1	1	0	1	0	0	0	0	0	6
ATLANTIC SILVERSIDE	1	3	0	0	0	0	0	1	0	0	0	0	5
RAINBOW SMELT	543	863	707	2579	7938	2021	882	402	80	0	0	0	16015
SMALLMOUTH BASS	0	0	1	0	0	0	0	0	0	0	0	0	1
SHORTNOSE STURGEON	0	0	0	1	1	0	0	0	0	0	0	0	2
SPOTTAIL SHINER	305	202	432	1904	134	20	63	256	26	0	0	0	3342
ATLANTIC STURGEON	4	4	4	13	4	6	1	1	1	0	0	0	38
STRIPED BASS	4589	3293	1497	974	518	59	284	622	393	0	0	0	12229
4-SPINE STICKLEBACK	0	0	0	2	0	0	0	0	0	0	0	0	2
ATLANTIC TOMCOD	829	187	47	328	1540	10026	28135	84369	4719	0	0	0	130180
WHITE CATFISH	245	165	196	320	139	38	42	73	10	0	0	0	1228
WHITE PERCH	69841	83457	35228	82177	17648	11606	4678	26232	10239	0	0	0	341106
YELLOW PERCH	23	7	25	95	7	3	2	3	0	0	0	0	165
ROCK BASS	0	0	8	1	0	0	0	1	0	0	0	0	10
NORTHERN PIPEFISH	0	0	0	0	2	1	0	3	20	0	0	0	26
REDBREAST SUNFSH	0	0	1	3	1	3	0	6	0	0	0	0	14
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	1	0	0	0	0	1
CREVALLE JACK	0	0	0	0	0	0	2	2	0	0	0	0	4
WEAKFISH	0	0	0	0	0	0	1	4462	1373	0	0	0	5836
LOOKDOWN	0	0	0	0	0	0	0	0	1	0	0	0	1
CLUPEID UNIDENTIFIED	0	0	0	0	1	0	211	460	61	0	0	0	733
4-BEARDED ROCKLING	1	0	0	0	0	0	1	0	0	0	0	0	2
MOONFISH	0	0	0	0	0	0	0	1	0	0	0	0	1
NORTHERN PORGY OR SCUP	0	0	0	0	0	0	0	1	0	0	0	0	1
WINTER FLOUNDER	2	13	4	14	1	0	2	0	0	0	0	0	36
SEA LAMPREY	0	1	0	0	1	0	0	0	0	0	0	0	2
GIZZARD SHAD	372	9	0	0	0	0	0	0	0	0	0	0	381
3-SPINE STICKLEBACK	5	50	40	26	3	0	0	0	0	0	0	0	124
BROWN TROUT	0	0	0	0	0	0	1	0	0	0	0	0	1
BUTTERFISH	0	0	0	0	0	0	0	2	1	0	0	0	3
WHITE CRAPPIE	1	1	0	0	0	0	0	0	0	0	0	0	2
SILVER PERCH	0	0	0	0	0	0	0	0	1	0	0	0	1
CENTRARCHID UNID	8	8	17	23	25	3	3	12	62	0	0	0	161
SQUIRREL OR RED HAKE	8	3	0	1	0	0	0	0	0	0	0	0	12
CENTRAL MUDMINNOW	0	0	0	0	0	0	3	0	0	0	0	0	3
GRUBBY	0	1	0	0	0	0	0	0	0	0	0	0	1
EAST MUDMINNOW	0	1	1	1	0	0	0	0	0	0	0	0	3
WHITE BASS	9	0	0	0	0	0	0	0	0	0	0	0	9
ROUGH SILVERSIDE	0	0	0	0	1	0	2	0	0	0	0	0	3
SUMMER FLOUNDER	0	0	0	0	0	1	61	94	44	0	0	0	200
ATLANTIC CROAKER	1	0	0	0	0	0	0	0	0	0	0	0	1
HICKORY SHAD	0	0	0	0	0	2	0	6	2	0	0	0	10
AMERICAN SANDLANCE	0	0	0	1	0	0	0	0	0	0	0	0	1
ATLANTIC MACKEREL	0	0	0	0	0	0	0	5	1	0	0	0	6
MUDMINNOW UNIDENTIFIED	0	0	0	1	0	0	0	0	0	0	0	0	1
MACKEREL SCAD	0	0	0	0	0	0	1	0	0	0	0	0	1
COLUMN TOTAL	77634	88683	38912	91615	42933	29222	113557	159275	23574	0	0	0	665405

Table A-3

Total Monthly Actual Count of Each Species Collected from Intake Screens at Indian Point Units No. 2 and No. 3 Combined during 1979

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR_TOTAL
ALEWIFE	15	77	16	50	580	297	5252	1429	438	276	288	10	8728
BAY ANCHOVY	67	0	0	16	9785	3670	57720	26096	20758	11566	213	84	129975
AMERICAN SHAD	13	3	0	1	38	9	11354	7943	1423	1835	2422	42	25083
BLUEFISH	0	0	0	0	0	388	3119	446	62	15	0	0	4030
BLUEGILL	42	8	21	34	42	23	3	15	53	14	18	107	380
BROWN BULLHEAD	26	7	17	17	14	4	17	829	45	69	17	30	1092
PUMPKINSEED	541	285	394	167	248	101	57	82	83	265	773	1095	4091
BLACK CRAPPIE	12	3	7	6	2	4	0	0	0	1	0	3	38
CARP	6	5	13	0	0	0	0	1	0	0	0	8	33
AMERICAN EEL	625	138	142	392	465	341	191	123	54	54	101	111	2737
GOLDFISH	190	161	424	124	59	12	2	0	4	1	11	14	1002
GOLDEN SHINER	28	19	86	83	5	2	2	0	2	2	3	9	241
HOGCHOKER	144	28	35	2934	9540	423	671	2037	2370	2228	2273	551	23234
TESSELLATED DARTER	80	16	82	915	136	10	24	23	23	22	249	80	1660
BANDED KILLIFISH	157	74	138	54	28	11	9	21	64	109	101	316	1082
EMERALD SHINER	1	0	0	0	3	0	0	0	0	0	0	0	4
LARGEMOUTH BASS	12	5	22	1	3	0	2	2	0	0	8	52	107
MUMMICHOG	3	5	10	3	1	4	0	0	0	2	3	6	37
ATLANTIC MENHADEN	0	0	0	0	20	32	182	177	33	4	1	2	451
MINNOW UNIDENTIFIED	0	0	1	0	0	0	0	0	0	0	0	0	1
CHAIN PICKEREL	0	1	0	1	0	0	0	0	0	0	0	0	2
BLUEBACK HERRING	58	20	0	232	1283	768	576	3036	1763	95200	18939	111	122006
WHITE SUCKER	1	1	2	2	2	0	1	0	0	0	0	0	9
ATLANTIC SILVERSIDE	1	12	0	0	2	0	0	1	0	0	0	0	16
RAINBOW SMELT	3200	4245	1882	3888	10562	2232	882	402	533	1459	1444	1548	32277
SMALLMOUTH BASS	0	0	1	0	0	0	0	0	0	0	0	0	1
SHORTNOSE STURGEON	0	1	0	2	1	0	0	0	0	0	0	0	4
SPOTTAIL SHINER	1087	570	1206	2538	193	28	63	256	42	164	310	830	7287
ATLANTIC STURGEON	8	11	4	20	4	6	1	1	6	4	4	1	70
STRIPED BASS	24111	12962	5863	1423	684	122	284	622	1014	594	366	2466	50511
4-SPINE STICKLEBACK	1	0	1	5	0	0	0	0	0	4	33	39	83
ATLANTIC TOMCOD	3344	1078	481	824	8299	18547	28135	84369	10704	756	329	2817	159683
WHITE CATFISH	574	367	309	387	229	52	42	73	28	148	551	506	3268
WHITE PERCH	385522	380385	157419	146251	33113	14671	4678	26232	34445	60324	126019	210140	1579199
YELLOW PERCH	153	43	97	154	25	10	2	3	1	0	22	81	591
ROCK BASS	1	2	18	2	0	0	0	1	0	0	0	0	24
NORTHERN PIPEFISH	1	0	0	0	5	4	0	3	78	27	4	4	126
REDBREAST SUNFISH	0	0	3	3	3	3	0	6	1	0	1	3	23
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	1	1	0	0	0	2
CREVALLE JACK	0	0	0	0	0	0	2	2	1	2	1	0	8
WEAKFISH	0	0	0	0	0	0	1	4462	2889	472	306	131	8261
LOOKDOWN	0	0	0	0	0	0	0	0	1	0	0	0	1
CLUPEID UNIDENTIFIED	0	9	0	0	1	0	211	460	149	4501	692	1	6024
4-BEARDED ROCKLING	1	0	0	0	0	0	1	0	0	0	0	0	2
SPOT	0	0	0	0	0	0	0	0	1	0	0	0	1
MOONFISH	0	0	0	0	0	0	0	1	0	0	0	0	1
NORTHERN PORGY OR SCUP	0	0	0	0	0	0	0	1	0	0	0	0	1
WINTER FLOUNDER	3	25	9	16	1	0	2	0	1	2	0	0	59
TIDEWATER SILVERSIDE	2	0	0	0	0	1	0	0	0	0	0	0	3
SEA LAMPREY	0	2	0	0	1	0	0	0	0	0	0	1	4
GIZZARD SHAD	945	16	2	0	0	0	0	0	0	1	3	55	1022
SILVER HAKE	0	0	0	0	0	0	0	0	0	0	1	3	4
STRIPED MULLET	1	0	0	0	0	0	0	0	0	0	0	0	1
3-SPINE STICKLEBACK	37	198	147	41	5	0	0	0	0	0	0	0	428
BROWN TROUT	0	0	0	0	0	0	1	0	0	0	0	0	1
BUTTERFISH	0	0	0	0	0	0	0	2	1	1	1	0	5
WHITE CRAPPIE	1	1	0	0	0	0	0	0	0	0	0	2	4
SILVER PERCH	0	0	0	0	0	0	0	0	3	0	0	0	3
CENTRARCHID UNID	29	41	109	60	55	5	3	12	693	1373	2325	1408	6113
SQUIRREL OR RED HAKE	22	7	0	1	0	0	0	0	0	0	0	3	33
CENTRAL MUDMINNOW	0	0	0	0	0	0	3	0	0	0	0	0	3
GRUBBY	0	2	0	0	0	0	0	0	0	0	0	0	2
EAST MUDMINNOW	0	2	3	2	0	0	0	0	0	0	0	0	7
WHITE BASS	18	2	0	0	0	0	0	0	0	0	0	0	20
ROUGH SILVERSIDE	0	0	0	0	1	1	2	0	0	0	0	0	4
SUMMER FLOUNDER	1	0	0	0	0	1	61	94	55	11	1	0	224
STRIPED SEAROBIN	0	0	0	0	0	0	0	0	0	7	1	3	11
NORTHERN SEAROBIN	0	0	0	0	0	0	0	0	0	0	9	0	9
ATLANTIC CROAKER	2	0	0	0	0	0	0	0	0	2	11	247	262
LONGHORN SCULPIN	0	0	0	0	0	0	0	0	0	0	0	1	1
HICKORY SHAD	0	0	0	0	0	2	0	6	2	1	0	0	11
STRIPED ANCHOVY	0	0	0	0	0	0	0	0	1	0	0	0	1
WINDOWPANE	0	0	0	0	0	0	0	0	1	1	3	0	5
SEAROBIN	0	0	0	0	0	0	0	0	0	0	2	0	2
AMERICAN SANDLANCE	0	0	0	1	0	0	0	0	0	0	0	0	1
ATLANTIC MACKEREL	0	0	0	0	0	0	0	5	1	0	0	0	6
BLACK SEA BASS	0	0	0	0	0	0	0	0	0	0	0	1	1
MUDMINNOW UNIDENTIFIED	0	0	0	1	0	0	0	0	0	0	0	0	1
MACKEREL SCAD	0	0	0	0	0	0	1	0	0	0	0	0	1
SAND LANCE	1	0	0	0	0	0	0	0	0	0	0	0	1
COLUMN TOTAL	421087	400837	168964	160651	75438	41784	113557	159275	77847	191517	157859	222924	2181740

Table A-4

Total Estimated Count of Each Species Impinged Monthly at Indian Point Unit No. 2 during 1979
(adjusted to account for collection efficiency)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR_TOTAL
ALEWIFE	20	78	14	8	218	109	0	0	798	1048	603	20	2916
BAY ANCHOVY	120	0	0	0	6970	712	0	0	65079	43947	442	173	117443
AMERICAN SHAD	16	6	0	0	19	0	0	0	1626	6974	5087	87	13815
BLUEFISH	0	0	0	0	0	66	0	0	43	59	0	0	168
BLUEGILL	43	10	18	14	20	8	0	0	170	55	36	221	595
BROWN BULLHEAD	42	4	6	14	24	0	0	0	40	265	34	61	490
PUMPKINSEED	685	375	472	118	164	78	0	0	141	1011	1623	2302	6969
BLACK CRAPPIE	14	6	8	0	8	4	0	0	0	4	0	6	50
CARP	6	8	16	0	0	0	0	0	0	0	0	17	47
AMERICAN EEL	669	88	115	271	662	369	0	0	86	213	207	230	3110
GOLDFISH	182	121	351	40	46	8	0	0	0	4	22	28	802
GOLDEN SHINER	24	20	64	27	4	0	0	0	0	8	6	18	171
HOGCHOKER	160	22	40	2450	18337	834	0	0	6603	8471	4773	1157	42847
TESSELLATED DARTER	142	26	114	919	266	12	0	0	24	86	515	165	2269
BANDED KILLIFISH	218	104	203	45	63	8	0	0	99	418	208	661	2027
EMERALD SHINER	2	0	0	0	8	0	0	0	0	0	0	0	10
LARGEMOUTH BASS	16	6	22	0	8	0	0	0	0	0	16	108	176
MUMMICHOG	4	8	18	4	0	8	0	0	0	8	6	12	68
ATLANTIC MENHADEN	0	0	0	0	4	4	0	0	12	16	2	4	42
MINNOW UNIDENTIFIED	0	0	2	0	0	0	0	0	0	0	0	0	2
BLUEBACK HERRING	87	22	0	29	669	324	0	0	3777	361764	39773	232	406677
WHITE SUCKER	2	0	0	2	4	0	0	0	0	0	0	0	8
ATLANTIC SILVERSIDE	0	18	0	0	8	0	0	0	0	0	0	0	26
RAINBOW SMELT	5581	7103	2469	2751	9973	803	0	0	1722	5545	3033	3249	42229
SHORTNOSE STURGEON	0	2	0	2	0	0	0	0	0	0	0	0	4
SPOTTAIL SHINER	1644	773	1628	1335	227	31	0	0	61	625	649	1743	8716
ATLANTIC STURGEON	8	14	0	14	0	0	0	0	20	16	8	2	82
STRIPED BASS	40999	20307	9171	942	633	238	0	0	2361	2258	771	5181	82861
4-SPINE STICKLEBACK	2	0	2	6	0	0	0	0	0	16	66	81	173
ATLANTIC TOMCOD	5283	1873	914	1039	25687	32379	0	0	22743	2877	692	5917	99404
WHITE CATFISH	691	427	236	139	342	55	0	0	71	564	1153	1067	4745
WHITE PERCH	662932	623548	256602	134557	58766	11646	0	0	91984	229232	264643	441293	2775203
YELLOW PERCH	270	73	150	121	71	27	0	0	4	0	44	169	929
ROCK BASS	2	4	20	2	0	0	0	0	0	0	0	0	28
NORTHERN PIPEFISH	2	0	0	0	12	12	0	0	221	104	8	8	367
REDBREAST SUNFSH	0	0	4	0	8	0	0	0	4	0	2	6	24
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	4	0	0	0	4
CREVALLE JACK	0	0	0	0	0	0	0	0	4	8	2	0	14
WEAKFISH	0	0	0	0	0	0	0	0	5761	1799	643	275	8478
CLUPEID UNIDENTIFIED	0	18	0	0	0	0	0	0	335	17106	1452	2	18913
SPOT	0	0	0	0	0	0	0	0	4	0	0	0	4
WINTER FLOUNDER	2	24	10	4	0	0	0	0	4	8	0	0	52
TIDEWATER SILVERSIDE	4	0	0	0	0	4	0	0	0	0	0	0	8
SEA LAMPREY	0	2	0	0	0	0	0	0	0	0	0	2	4
GIZZARD SHAD	1202	14	4	0	0	0	0	0	0	4	6	114	1344
SILVER HAKE	0	0	0	0	0	0	0	0	0	0	2	6	8
STRIPED MULLET	2	0	0	0	0	0	0	0	0	0	0	0	2
3-SPINE STICKLEBACK	65	307	224	30	8	0	0	0	0	0	0	0	634
BUTTERFISH	0	0	0	0	0	0	0	0	0	4	2	0	6
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0	0	4	4
SILVER PERCH	0	0	0	0	0	0	0	0	8	0	0	0	8
CENTRARCHID UNID	43	69	193	77	115	8	0	0	2398	5220	4886	2960	15969
SQUIRREL OR RED HAKE	30	8	0	0	0	0	0	0	0	0	0	6	44
GRUBBY	0	2	0	0	0	0	0	0	0	0	0	0	2
EAST MUDMINNOW	0	2	4	2	0	0	0	0	0	0	0	0	8
WHITE BASS	18	4	0	0	0	0	0	0	0	0	0	0	22
ROUGH SILVERSIDE	0	0	0	0	0	4	0	0	0	0	0	0	4
SUMMER FLOUNDER	2	0	0	0	0	0	0	0	43	44	2	0	91
STRIPED SEAROBIN	0	0	0	0	0	0	0	0	0	27	2	6	35
NORTHERN SEAROBIN	0	0	0	0	0	0	0	0	0	0	19	0	19
ATLANTIC CROAKER	2	0	0	0	0	0	0	0	0	8	23	518	551
LONGHORN SCULPIN	0	0	0	0	0	0	0	0	0	0	0	2	2
HICKORY SHAD	0	0	0	0	0	0	0	0	0	4	0	0	4
STRIPED ANCHOVY	0	0	0	0	0	0	0	0	4	0	0	0	4
WINDOWPANE	0	0	0	0	0	0	0	0	4	4	6	0	14
SEAROBIN	0	0	0	0	0	0	0	0	0	0	4	0	4
BLACK SEA BASS	0	0	0	0	0	0	0	0	0	0	0	2	2
SAND LANCE	2	0	0	0	0	0	0	0	0	0	0	0	2
COLUMN TOTAL	721238	655496	273094	144962	123544	47751	0	0	206258	689824	331471	468115	3661753

Table A-5

Total Estimated Count of Each Species Impinged Monthly at Indian Point Unit No. 3 during 1979 (adjusted to account for collection efficiency)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR_TOTAL
ALEWIFE	5	44	10	54	791	414	7887	2150	347	0	0	0	11702
BAY ANCHOVY	12	0	0	19	11930	5234	86587	39154	5453	0	0	0	148389
AMERICAN SHAD	5	0	0	1	54	16	17039	11920	1497	0	0	0	30532
BLUEFISH	0	0	0	0	0	563	4685	676	79	0	0	0	6003
BLUEGILL	25	3	13	31	63	35	6	27	14	0	0	0	217
BROWN BULLHEAD	5	5	15	10	14	8	28	1251	56	0	0	0	1392
PUMPKINSEED	258	129	204	133	317	128	93	129	74	0	0	0	1465
BLACK CRAPPIE	5	0	3	6	0	6	0	0	0	0	0	0	20
CARP	3	1	5	0	0	0	0	2	0	0	0	0	11
AMERICAN EEL	366	113	100	313	366	372	294	188	54	0	0	0	2166
GOLDFISH	121	118	308	125	77	19	4	0	6	0	0	0	778
GOLDEN SHINER	16	10	63	81	8	3	4	0	4	0	0	0	189
HOGCHOKER	80	19	17	2121	7079	313	1015	3063	955	0	0	0	14662
TESSELLATED DARTER	12	3	30	575	103	14	42	39	29	0	0	0	847
BANDED KILLIFISH	62	25	46	36	22	18	17	35	60	0	0	0	321
EMERALD SHINER	0	0	0	0	2	0	0	0	0	0	0	0	2
LARGEMOUTH BASS	4	2	13	1	2	0	4	4	0	0	0	0	30
MUMMICHOG	1	1	1	1	2	4	0	0	0	0	0	0	10
ATLANTIC MENHADEN	0	0	0	0	32	53	281	273	47	0	0	0	686
CHAIN PICKEREL	0	1	0	1	0	0	0	0	0	0	0	0	2
BLUEBACK HERRING	19	10	0	264	1669	1035	874	4561	1188	0	0	0	9620
WHITE SUCKER	0	1	2	1	2	0	2	0	0	0	0	0	8
ATLANTIC SILVERSIDE	1	3	0	0	0	0	0	2	0	0	0	0	6
RAINBOW SMELT	654	1032	847	3097	11916	3039	1334	611	123	0	0	0	22653
SMALLMOUTH BASS	0	0	1	0	0	0	0	0	0	0	0	0	1
SHORTNOSE STURGEON	0	0	0	1	2	0	0	0	0	0	0	0	3
SPOTTAIL SHINER	362	242	519	2283	209	33	99	390	42	0	0	0	4179
ATLANTIC STURGEON	4	4	4	13	8	12	2	2	2	0	0	0	51
STRIPED BASS	5504	3953	1795	1169	787	95	432	941	594	0	0	0	15270
4-SPINE STICKLEBACK	0	0	0	2	0	0	0	0	0	0	0	0	2
ATLANTIC TOMCOD	995	226	56	393	2315	15045	42209	126564	7082	0	0	0	194885
WHITE CATFISH	293	196	235	366	216	65	70	119	19	0	0	0	1599
WHITE PERCH	83811	100146	42274	98615	26479	17416	7025	39356	15362	0	0	0	430484
YELLOW PERCH	25	7	25	114	13	6	4	6	0	0	0	0	200
ROCK BASS	0	0	9	1	0	0	0	2	0	0	0	0	12
NORTHERN PIPEFISH	0	0	0	0	4	2	0	6	33	0	0	0	45
REDBREAST SUNFSH	0	0	1	3	2	6	0	12	0	0	0	0	24
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	2	0	0	0	0	2
CREVALLE JACK	0	0	0	0	0	0	4	4	0	0	0	0	8
WEAKFISH	0	0	0	0	0	0	2	6701	2064	0	0	0	8767
LOOKDOWN	0	0	0	0	0	0	0	0	2	0	0	0	2
CLUPEID UNIDENTIFIED	0	0	0	0	2	0	320	697	95	0	0	0	1114
4-BEARDED ROCKLING	1	0	0	0	0	0	2	0	0	0	0	0	3
MOONFISH	0	0	0	0	0	0	0	2	0	0	0	0	2
NORTHERN POPGY OR SCUP	0	0	0	0	0	0	0	2	0	0	0	0	2
WINTER FLOUNDER	2	14	4	15	2	0	4	0	0	0	0	0	41
SEA LAMPREY	0	1	0	0	2	0	0	0	0	0	0	0	3
GIZZARD SHAD	446	9	0	0	0	0	0	0	0	0	0	0	455
3-SPINE STICKLEBACK	5	59	47	28	6	0	0	0	0	0	0	0	145
BROWN TROUT	0	0	0	0	0	0	2	0	0	0	0	0	2
BUTTERFISH	0	0	0	0	0	0	0	4	2	0	0	0	6
WHITE CRAPPIE	1	1	0	0	0	0	0	0	0	0	0	0	2
SILVER PERCH	0	0	0	0	0	0	0	0	2	0	0	0	2
CENTRARCHID UNID	8	9	20	27	39	6	6	22	96	0	0	0	233
SQUIRREL OR RED HAKE	9	3	0	1	0	0	0	0	0	0	0	0	13
CENTRAL MUDMINNOW	0	0	0	0	0	0	5	0	0	0	0	0	5
GRUBBY	0	1	0	0	0	0	0	0	0	0	0	0	1
EAST MUDMINNOW	0	1	1	1	0	0	0	0	0	0	0	0	3
WHITE BASS	9	0	0	0	0	0	0	0	0	0	0	0	9
ROUGH SILVERSIDE	0	0	0	0	2	0	4	0	0	0	0	0	6
SUMMER FLOUNDER	0	0	0	0	0	2	95	148	71	0	0	0	316
ATLANTIC CROAKER	1	0	0	0	0	0	0	0	0	0	0	0	1
HICKORY SHAD	0	0	0	0	0	4	0	12	4	0	0	0	20
AMERICAN SANDLANCE	0	0	0	1	0	0	0	0	0	0	0	0	1
ATLANTIC MACKEREL	0	0	0	0	0	0	0	9	2	0	0	0	11
MUDMINNOW UNIDENTIFIED	0	0	0	1	0	0	0	0	0	0	0	0	1
MACKEREL SCAD	0	0	0	0	0	0	2	0	0	0	0	0	2
COLUMN TOTAL	93130	106392	46668	109924	64537	43966	170483	239086	35458	0	0	0	909644

Table A-6

Total Estimated Count of Each Species Impinged Monthly at Indian Point Units No. 2 and No. 3 Combined during 1979 (adjusted to account for collection efficiency)

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR_TOTAL
ALEWIFE	25	122	24	62	1009	523	7887	2150	1145	1048	603	20	14618
BAY ANCHOVY	132	0	0	19	18900	5946	86587	39154	70532	43947	442	173	265832
AMERICAN SHAD	21	6	0	1	73	16	17039	11920	3123	6974	5087	87	44347
BLUEFISH	0	0	0	0	0	629	4685	676	122	59	0	0	6171
BLUEGILL	65	13	31	45	83	43	6	27	184	55	36	221	812
BROWN BULLHEAD	47	9	21	24	38	8	28	1251	96	265	34	61	1882
PUMPKINSEED	943	504	676	251	481	206	93	129	215	1011	1623	2302	8434
BLACK CRAPPIE	19	6	11	6	8	10	0	0	0	4	0	6	70
CARP	9	9	21	0	0	0	0	2	0	0	0	17	58
AMERICAN EEL	1035	201	215	584	1228	741	294	188	140	213	207	230	5276
GOLDFISH	303	239	639	165	123	27	4	0	6	4	22	28	1560
GOLDEN SHINER	40	30	127	108	12	3	4	0	4	8	6	18	360
HOGCHOKER	240	41	57	4571	25416	1147	1015	3063	7558	8471	4773	1157	57509
TESSELLATED DARTER	154	29	144	1494	369	26	42	39	53	86	515	165	3116
BANDED KILLIFISH	280	129	249	81	85	26	17	35	159	418	208	661	2348
EMERALD SHINER	2	0	0	0	10	0	0	0	0	0	0	0	12
LARGEMOUTH BASS	20	8	35	1	10	0	4	4	0	0	16	108	206
MUMMICHOG	5	9	19	5	2	12	0	0	0	8	6	12	78
ATLANTIC MENHADEN	0	0	0	0	36	57	281	273	59	16	2	4	728
MINNOW UNIDENTIFIED	0	0	2	0	0	0	0	0	0	0	0	0	2
CHAIN PICKEREL	0	1	0	1	0	0	0	0	0	0	0	0	2
BLUEBACK HERRING	106	32	0	293	2338	1359	874	4561	4965	361764	39773	232	416297
WHITE SUCKER	2	1	2	3	6	0	2	0	0	0	0	0	16
ATLANTIC SILVERSIDE	1	21	0	0	8	0	0	2	0	0	0	0	32
RAINBOW SMELT	6235	8135	3316	5848	21869	3842	1334	611	1845	5545	3033	3249	64882
SMALLMOUTH BASS	0	0	1	0	0	0	0	0	0	0	0	0	1
SHORTNOSE STURGEON	0	2	0	3	2	0	0	0	0	0	0	0	7
SPOTTAIL SHINER	2006	1015	2147	3618	436	64	99	390	103	625	649	1743	12895
ATLANTIC STURGEON	12	18	4	27	8	12	2	2	22	16	8	2	133
STRIPED BASS	46503	24260	10966	2111	1420	333	432	941	2955	2258	771	5181	98131
4-SPINE STICKLEBACK	2	0	2	8	0	0	0	0	0	16	66	81	175
ATLANTIC TOMCOD	6278	2099	970	1432	28002	47424	42209	126564	29825	2877	692	5917	294289
WHITE CATFISH	984	623	471	525	558	120	70	119	90	564	1153	1067	6344
WHITE PERCH	746743	723694	298876	233172	85245	29062	7025	39356	107346	229232	264643	441293	3205687
YELLOW PERCH	295	80	175	235	84	33	4	6	4	0	44	169	1129
ROCK BASS	2	4	29	3	0	0	0	2	0	0	0	0	40
NORTHERN PIPEFISH	2	0	0	0	16	14	0	6	254	104	8	8	412
REDBREAST SUNFSH	0	0	5	3	10	6	0	12	4	0	2	6	48
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	2	4	0	0	0	6
CREVALLE JACK	0	0	0	0	0	0	4	4	4	8	2	0	22
WEAKFISH	0	0	0	0	0	0	2	6701	7825	1799	643	275	17245
LOOKDOWN	0	0	0	0	0	0	0	0	2	0	0	0	2
CLUPEID UNIDENTIFIED	0	18	0	0	2	0	320	697	430	17106	1452	2	20027
4-BEARDED ROCKLING	1	0	0	0	0	0	2	0	0	0	0	0	3
SPOT	0	0	0	0	0	0	0	0	4	0	0	0	4
MOONFISH	0	0	0	0	0	0	0	2	0	0	0	0	2
NORTHERN POPGY OR SCUP	0	0	0	0	0	0	0	2	0	0	0	0	2
WINTER FLOUNDER	4	38	14	19	2	0	4	0	4	8	0	0	93
TIDEWATER SILVERSIDE	4	0	0	0	0	4	0	0	0	0	0	0	8
SEA LAMPREY	0	3	0	0	2	0	0	0	0	0	0	2	7
GIZZARD SHAD	1648	23	4	0	0	0	0	0	0	4	6	114	1799
SILVER HAKE	0	0	0	0	0	0	0	0	0	0	2	6	8
STRIPED MULLET	2	0	0	0	0	0	0	0	0	0	0	0	2
3-SPINE STICKLEBACK	70	366	271	58	14	0	0	0	0	0	0	0	779
BROWN TROUT	0	0	0	0	0	0	2	0	0	0	0	0	2
BUTTERFISH	0	0	0	0	0	0	0	4	2	4	2	0	12
WHITE CRAPPIE	1	1	0	0	0	0	0	0	0	0	0	4	6
SILVER PERCH	0	0	0	0	0	0	0	0	10	0	0	0	10
CENTRARCHID UNID	51	78	213	104	154	14	6	22	2494	5220	4886	2960	16202
SQUIRREL OR RED HAKE	39	11	0	1	0	0	0	0	0	0	0	6	57
CENTRAL MUDMINNOW	0	0	0	0	0	0	5	0	0	0	0	0	5
GRUBBY	0	3	0	0	0	0	0	0	0	0	0	0	3
EAST MUDMINNOW	0	3	5	3	0	0	0	0	0	0	0	0	11
WHITE BASS	27	4	0	0	0	0	0	0	0	0	0	0	31
ROUGH SILVERSIDE	0	0	0	0	2	4	4	0	0	0	0	0	10
SUMMER FLOUNDER	2	0	0	0	0	2	95	148	114	44	2	0	407
STRIPED SEAROBIN	0	0	0	0	0	0	0	0	0	27	2	6	35
NORTHERN SEAROBIN	0	0	0	0	0	0	0	0	0	0	19	0	19
ATLANTIC CROAKER	3	0	0	0	0	0	0	0	0	8	23	518	552
LONGHORN SCULPIN	0	0	0	0	0	0	0	0	0	0	0	2	2
HICKORY SHAD	0	0	0	0	0	4	0	12	4	4	0	0	24
STRIPED ANCHOVY	0	0	0	0	0	0	0	0	4	0	0	0	4
WINDOWPANE	0	0	0	0	0	0	0	0	4	4	6	0	14
SEAROBIN	0	0	0	0	0	0	0	0	0	0	4	0	4
AMERICAN SANDLANCE	0	0	0	1	0	0	0	0	0	0	0	0	1
ATLANTIC MACKEREL	0	0	0	0	0	0	0	9	2	0	0	0	11
BLACK SEA BASS	0	0	0	0	0	0	0	0	0	0	0	2	2
MUDMINNOW UNIDENTIFIED	0	0	0	1	0	0	0	0	0	0	0	0	1
MACKEREL SCAD	0	0	0	0	0	0	2	0	0	0	0	0	2
SAND LANCE	2	0	0	0	0	0	0	0	0	0	0	0	2
COLUMN TOTAL	814368	761888	319762	254886	188081	91717	170483	239086	241716	689824	331471	468115	4571397

APPENDIX A.2

Number and Weights of Major Impinged Species

Total counts and total weights of 15 species predominant in impingement collections (adjusted for collection efficiency) are summarized in the following tables by week, month, season, and year. The following codes denote the 15 species presented.

AL	Alewife
AS	American Shad
BH	Blueback Herring
SNS	Shortnose Sturgeon
ATS	Atlantic Sturgeon
SB	Striped Bass
TC	Atlantic Tomcod
WP	White Perch
BA	Bay Anchovy
BF	Bluefish
HC	Hogchoker
RS	Rainbow Smelt
SS	Spottail Shiner
WC	White Catfish
WKF	Weakfish

Table A-7

Total Estimated Count of Fifteen Major Species and All Species Combined Impinged at Indian Point Unit No. 2 Intake Screens during 1979 (summarized by week, month, season, and year and adjusted for collection efficiency)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	RS	SS	WC	WKF	ALL SPEC
WEEK																
1	8	10	25	0	0	12678	1134	74344	120	0	148	2653	412	147	0	92887
2	0	0	4	0	2	7592	685	55247	0	0	0	559	346	142	0	65673
3	2	0	0	0	0	9045	1234	62216	0	0	4	298	295	78	0	73856
4	8	6	45	0	4	7737	1690	231510	0	0	8	1797	375	237	0	293643
5	4	0	15	0	4	5852	1265	238803	0	0	2	325	325	135	0	247256
6	4	0	0	0	4	2644	573	89025	0	0	2	193	91	57	0	92861
7	32	6	14	0	4	4595	153	239766	0	0	10	3034	65	135	0	248110
8	26	0	4	0	2	3388	216	146757	0	0	4	2078	112	101	0	152905
9	22	0	2	2	4	13933	358	242633	0	0	6	1949	646	137	0	260228
10	4	0	0	0	2	2047	131	69027	0	0	14	271	324	54	0	72310
11	0	0	0	0	0	607	240	10922	0	0	4	882	597	91	0	14170
12	0	0	0	0	0	215	90	7506	0	0	0	501	190	22	0	8738
13	2	0	0	0	0	144	301	25326	0	0	18	613	269	18	0	26991
14	0	0	0	0	0	45	111	41621	0	0	56	160	420	28	0	42704
15	2	0	0	0	2	218	303	36062	0	0	114	476	712	39	0	38293
16	0	0	0	0	0	262	495	29418	0	0	165	500	72	24	0	31340
17	4	0	23	0	4	296	120	19436	0	0	1355	1428	89	33	0	23340
18	6	0	6	2	8	139	33	18306	0	0	2843	898	58	61	0	22730
19	12	0	35	0	0	28	598	10331	1654	0	12739	4085	20	114	0	30074
20	65	4	319	0	0	179	3907	16869	2500	0	2663	3450	54	60	0	30406
21	87	0	208	0	0	213	13301	11426	2496	0	632	1620	91	69	0	30546
22	50	15	122	0	0	239	6664	11803	324	0	304	145	61	65	0	22119
23	32	0	68	0	0	68	5434	2998	145	0	176	156	8	19	0	9309
24	69	0	210	0	0	91	20405	6023	563	0	532	601	8	20	0	28863
25	8	0	11	0	0	15	5734	676	0	66	42	8	0	4	0	6533
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	11	12	50	0	0	12	357	1091	263	0	0	34	0	0	69	1983
38	369	767	1591	0	4	1063	16170	53253	31722	12	3463	602	38	28	3269	113926
39	414	847	2060	0	16	1256	6205	37271	32684	31	3063	882	23	39	2279	89250
40	304	722	4557	0	0	556	1778	14007	16891	51	1411	251	54	42	1501	43394
41	99	928	63609	0	4	634	199	41041	17402	8	1678	1101	4	144	61	129930
42	113	688	185797	0	8	419	221	62468	7030	0	2330	2707	407	137	88	274950
43	455	3531	94256	0	0	592	602	76314	2616	0	2509	1232	156	171	257	189775
44	279	3757	32270	0	4	215	340	76524	696	0	2372	642	29	145	143	120062
45	217	1393	13878	0	2	243	179	67020	33	0	1364	1182	110	523	25	88761
46	90	422	4178	0	0	97	71	39036	61	0	592	531	421	340	103	48908
47	76	273	2246	0	6	123	64	77474	33	0	820	619	49	88	337	83354
48	22	158	879	0	0	169	126	42328	37	0	252	125	48	136	71	45504
49	6	21	117	0	0	86	6	7275	4	0	114	45	12	63	0	7950
50	2	22	14	0	2	295	85	46895	35	0	118	898	179	203	4	53139
51	10	25	26	0	0	660	1155	101226	74	0	429	1458	515	219	168	108086
52	2	8	18	0	0	3027	3215	262509	58	0	456	718	810	500	103	273786
53	0	0	0	0	0	1102	1456	19420	2	0	13	122	223	57	0	22910
MONTH																
JAN	20	16	87	0	8	40999	5283	662932	120	0	160	5581	1644	691	0	721238
FEB	78	6	22	2	14	20307	1873	623548	0	0	22	7103	773	427	0	655496
MAR	14	0	0	0	0	9171	914	256602	0	0	40	2469	1628	236	0	273094
APR	8	0	29	2	14	942	1039	134557	0	0	2450	2751	1335	139	0	144962
MAY	218	19	669	0	0	633	25687	55766	6970	0	18337	9973	227	342	0	123544
JUN	109	0	324	0	0	238	32379	11646	712	66	834	803	31	55	0	47751
JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEP	798	1626	3777	0	20	2361	22743	91984	65079	43	6603	1722	61	71	5761	206258
OCT	1048	6974	361764	0	16	2258	2877	229232	43947	59	8471	5545	625	564	1799	689824
NOV	603	3087	39773	0	8	771	692	264643	442	0	4773	3033	649	1153	643	331471
DEC	20	87	232	0	2	5181	5917	441293	173	0	1157	3249	1743	1067	275	466115
SEASON																
WIN	112	22	109	2	22	70477	8070	1543082	120	0	222	15153	4045	1354	0	1649828
SPR	335	19	1022	2	14	1813	59105	204969	7682	66	21621	13527	1593	536	0	316257
SUM	798	1626	3777	0	20	2361	22743	91984	65079	43	6603	1722	61	71	5761	206258
FAL	1671	12148	401769	0	26	8210	9466	935168	44562	59	14401	11827	3017	2784	2717	1489410
YEAR	2916	13815	406677	4	82	82861	99404	2775203	117443	168	42847	42229	8716	4745	8478	3661753

Table A-8

Total Estimated Count of Fifteen Major Species and All Species Combined Impinged at Indian Point Unit No. 3 Intake Screens during 1979 (summarized by week, month, season, and year and adjusted for collection efficiency)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	RS	SS	WC	WKF	ALL SPEC
WEEK																
1	1	2	11	0	0	2904	103	17435	12	0	70	387	84	97	0	21546
2	0	0	2	0	1	722	151	6050	0	0	2	54	92	69	0	9521
3	0	0	0	0	0	772	324	7784	0	0	3	14	83	32	0	9188
4	3	3	5	0	3	847	285	34725	0	0	4	167	73	80	0	36478
5	2	0	1	0	0	366	216	20017	0	0	1	18	49	32	0	20956
6	0	0	0	0	1	347	42	16487	0	0	4	40	26	26	0	17079
7	16	0	6	0	2	440	14	24258	0	0	4	309	21	46	0	25206
8	10	0	2	0	1	694	65	24526	0	0	9	406	49	60	0	25935
9	18	0	2	0	0	3408	32	55066	0	0	4	294	194	62	0	59229
10	0	0	0	0	0	463	10	12938	0	0	1	40	127	41	0	13792
11	0	0	0	0	0	170	10	2358	0	0	1	403	179	60	0	3598
12	1	0	0	0	0	80	7	1107	0	0	1	232	68	30	0	1626
13	2	0	0	0	4	39	18	1480	0	0	12	149	78	69	0	2036
14	10	1	1	1	0	36	18	24968	0	0	71	265	891	77	0	26655
15	9	0	2	0	5	461	170	37463	0	0	161	768	918	112	0	40536
16	11	0	39	0	2	260	106	17347	0	0	210	1091	211	65	0	19620
17	15	0	164	0	4	326	94	15741	0	0	1163	867	240	107	0	19099
18	34	0	125	2	4	155	11	6346	19	0	1834	326	39	65	0	9205
19	90	0	155	0	2	73	39	3888	3900	0	3687	5262	60	71	0	17502
20	257	35	834	0	0	315	341	9681	4922	0	1552	4084	57	53	0	22359
21	336	19	513	0	2	262	1713	6423	2914	0	398	2325	63	38	0	15262
22	95	0	117	0	2	68	241	3483	206	0	110	36	13	19	0	4554
23	58	5	153	0	0	6	175	1733	258	0	73	113	2	13	0	2746
24	170	7	406	0	4	66	13695	8656	1911	107	100	2506	15	16	0	28048
25	86	0	338	0	2	4	415	4584	39	86	32	221	5	16	0	5976
26	86	4	121	0	6	19	535	2177	3014	370	82	188	11	15	0	6815
27	64	61	56	0	0	10	100	640	2475	133	42	133	0	12	0	3884
28	149	6509	126	0	2	56	12088	1962	25311	3168	490	504	34	10	0	50698
29	690	3040	59	0	0	99	15048	1353	25626	685	262	324	19	18	0	47449
30	5933	6448	370	0	0	181	13078	2137	27895	592	169	280	24	15	0	57446
31	1318	1330	440	0	0	141	3440	2312	7933	150	107	121	50	30	18	17723
32	597	5011	1184	0	2	389	116579	20246	13709	303	620	376	50	31	1048	160981
33	942	5680	2739	0	0	295	7921	13694	13745	221	1519	187	241	37	3437	52301
34	290	798	358	0	0	186	475	3246	8180	93	727	13	68	24	1966	16834
35	62	96	114	0	0	18	49	633	873	16	142	7	5	14	242	2360
36	148	1021	546	0	0	305	5153	6043	2320	46	444	41	34	7	1345	17764
37	182	456	606	0	2	283	1897	8991	3083	33	472	77	4	8	700	17108
38	9	6	25	0	0	4	27	286	44	0	39	5	2	2	11	479
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONTH																
JAN	5	5	19	0	4	5504	995	83811	12	0	80	654	362	293	0	93130
FEB	44	0	10	0	4	3953	226	100146	0	0	19	1032	242	196	0	106392
MAR	10	0	0	0	4	1795	56	42274	0	0	17	847	519	235	0	46668
APR	34	1	264	1	13	1169	393	98615	19	0	2121	3097	2283	386	0	109324
MAY	791	54	1669	2	8	787	2315	26479	11930	0	7079	11916	209	216	0	64537
JUN	414	16	1035	0	12	95	15045	17416	5234	563	313	3039	33	65	0	43966
JUL	7887	17039	874	0	2	432	42209	7025	86587	4685	1015	1334	99	70	2	170463
AUG	2150	11920	4561	0	2	941	126564	39336	39154	676	3063	611	390	119	6701	239066
SEP	347	1497	1168	0	2	594	7082	15362	3453	79	955	123	42	19	2064	35458
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEASON																
WIN	59	5	29	0	12	11252	1277	226231	12	0	116	2533	1123	724	0	246190
SPR	1259	71	2968	3	33	2051	17753	142510	17163	563	9513	18052	2525	667	0	218427
SUM	10384	30456	6623	0	6	1967	175835	61743	131194	5440	5033	2068	531	208	8767	445027
FAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YEAR	11702	30532	9620	3	31	15270	194865	430484	148369	6003	14662	22653	4179	1599	8767	909644

Table A-9

Total Estimated Count of Fifteen Major Species and All Species Combined Impinged at Indian Point Units No. 2 and No. 3 Intake Screens Combined during 1979 (summarized by week, month, season, and year and adjusted for collection efficiency)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	RS	SS	WC	WKF	ALL SPEC
WEEK																
1	9	12	36	0	0	15582	1237	91779	132	0	218	3040	496	244	0	114433
2	0	0	6	0	3	8314	836	63297	0	0	2	613	438	211	0	75194
3	2	0	0	0	0	9817	1558	70000	0	0	7	312	378	110	0	83044
4	11	9	50	0	7	6584	1975	316235	0	0	12	1984	448	317	0	330321
5	6	0	16	0	4	6218	1401	256620	0	0	3	343	374	167	0	266212
6	4	0	0	0	5	2991	615	105512	0	0	6	233	117	83	0	109940
7	48	6	20	0	4	5035	167	264024	0	0	14	3343	84	181	0	273316
8	36	0	2	0	5	4052	221	171283	0	0	13	2484	161	161	0	178840
9	40	0	4	2	2	17341	390	297699	0	0	12	2243	840	199	0	319457
10	4	0	0	0	0	2510	141	61965	0	0	15	311	451	95	0	86102
11	6	0	0	0	0	777	250	13290	0	0	5	1255	776	151	0	17768
12	1	0	0	0	0	295	97	8613	0	0	1	733	258	52	0	10364
13	4	0	0	0	4	163	319	26806	0	0	30	762	347	107	0	29027
14	10	1	1	1	2	81	129	66589	0	0	127	425	1311	105	0	69359
15	11	0	2	0	5	679	473	73525	0	0	295	1244	1630	151	0	78529
16	11	0	39	0	6	542	601	46765	0	0	375	1591	283	89	0	50960
17	19	0	187	0	12	622	214	35177	0	0	2538	2295	329	140	0	42439
18	40	0	131	4	4	294	44	24652	19	0	4677	1224	97	126	0	31935
19	102	0	190	0	2	101	637	14219	5554	0	16426	9347	80	185	0	47576
20	322	39	1153	0	0	494	4248	26550	7422	0	4215	7534	111	113	0	52765
21	425	19	721	0	2	475	15014	17849	5410	0	1030	3945	154	107	0	45828
22	145	15	239	0	2	307	6905	15286	530	0	414	161	74	64	0	26673
23	90	5	241	0	0	74	5609	4751	403	0	249	269	10	32	0	12055
24	239	7	616	0	4	157	34300	14679	2474	173	632	3107	23	36	0	56911
25	94	0	349	0	2	19	6149	5260	39	86	74	229	5	20	0	12509
26	86	4	121	0	6	19	535	2177	3014	370	82	188	11	15	0	6515
27	64	61	56	0	0	10	100	640	2475	133	42	133	0	12	0	3664
28	149	6509	126	0	2	56	12088	1962	25311	3168	490	504	34	10	0	50698
29	690	3040	59	0	0	99	15048	1353	25626	685	262	326	19	18	0	47449
30	5933	6448	370	0	0	181	13078	2137	27695	592	169	280	24	15	0	57446
31	1318	1330	440	0	0	141	3440	2312	7933	150	107	121	50	30	18	17723
32	597	5011	1184	0	2	389	116579	20246	13709	303	620	376	50	31	1048	160981
33	942	5680	2739	0	0	295	7921	13894	13745	221	1519	187	241	37	3437	52301
34	290	798	358	0	0	136	475	3246	8180	93	727	13	68	24	1966	16834
35	62	96	114	0	0	18	49	633	873	16	142	7	5	14	242	2360
36	148	1021	546	0	0	305	5153	6043	2320	45	444	41	34	7	1345	17764
37	193	468	656	0	2	295	2254	10082	3346	33	472	111	4	8	769	19091
38	378	773	1616	0	4	1087	16197	53539	31766	12	3502	807	40	30	3280	114403
39	414	847	2060	0	16	1258	6205	37271	32684	31	3083	882	23	39	2279	89250
40	304	722	4557	0	0	556	1778	14007	16891	51	1411	251	54	42	1501	43394
41	99	928	63609	0	4	634	199	41041	17402	8	1678	1101	4	164	61	129930
42	113	868	185797	0	8	419	221	62468	7030	0	2330	2707	407	137	88	274950
43	455	3531	94256	0	0	592	602	76314	2616	0	2509	1252	156	171	257	189775
44	279	3757	32270	0	4	215	340	76524	696	0	2372	842	29	145	143	120062
45	217	1393	13376	0	2	243	179	67020	33	0	1364	1182	110	523	25	88761
46	90	422	4178	0	0	97	71	39036	61	0	592	531	421	340	103	48908
47	76	273	2246	0	6	123	64	77474	33	0	820	619	49	88	337	83354
48	22	158	879	0	0	169	126	42328	37	0	252	125	48	136	71	45504
49	6	21	117	0	0	86	6	7275	4	0	114	45	12	63	0	7950
50	2	22	14	0	2	295	85	48695	35	0	118	898	179	203	4	53139
51	10	25	26	0	0	660	1155	101226	74	0	429	1458	515	219	168	108086
52	2	8	18	0	0	3027	3215	262509	58	0	456	718	810	500	103	273786
53	0	0	0	0	0	1102	1456	19420	2	0	13	122	223	57	0	22910
MONTH																
JAN	25	21	106	0	12	46503	6278	746743	132	0	240	6235	2006	984	0	814368
FEB	122	6	32	2	18	24260	2099	723694	0	0	41	8135	1015	623	0	761868
MAR	24	0	0	0	4	10966	970	298676	0	0	57	3316	2147	471	0	319762
APR	62	1	293	3	27	2111	1432	233172	19	0	4571	5848	3618	525	0	254886
MAY	1009	73	2338	2	8	1420	28002	65245	18900	0	25416	21889	436	558	0	168081
JUN	523	16	1359	0	12	333	47424	29062	5946	629	1147	3842	64	120	0	91717
JUL	7887	17039	874	0	2	432	42209	7025	86567	4665	1015	1334	99	70	2	170483
AUG	2150	11920	4561	0	2	941	126594	39356	39154	676	3063	611	390	119	6701	239066
SEP	1145	3123	4965	0	22	2955	29825	107346	70532	122	7558	1645	103	40	7825	241716
OCT	1048	6974	361764	0	16	2258	2877	229232	43947	59	8471	5545	625	564	1799	689624
NOV	603	5087	39773	0	8	771	692	264643	442	0	4773	3033	649	1153	643	331471
DEC	20	87	232	0	2	5161	5917	441293	173	0	1157	3249	1743	1067	275	468115
SEASON																
WIN	171	27	138	2	34	81729	9347	1769313	132	0	338	17686	5168	2078	0	1896018
SPR	1594	90	3990	5	47	3864	76858	347479	24865	629	31134	31579	4118	1203	0	534684
SUM	11182	32082	10400	0	26	4328	198598	153727	196273	5483	11636	3790	592	279	14528	651285
FAL	1671	12148	401769	0	26	8210	9486	935168	44562	59	14401	11827	3017	2784	2717	1489410
YEAR	14618	44347	416297	7	133	98131	294289	3205687	265832	6171	57509	64882	12895	6344	17245	4571397

Table A-10

Total Estimated Weight (g) of Fifteen Major Species and All Species Combined Impinged at Indian Point Unit No. 2 Intake Screens during 1979 (summarized by week, month, season, and year and adjusted for collection efficiency)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	RS	SS	WC	WKF	ALL SPEC
WEEK																
1	212	80	58	0	0	163210	36719	584458	95	0	1590	8997	2584	10700	0	878682
2	0	0	8	0	37	107239	18216	444506	0	0	0	1687	1926	7901	0	647887
3	166	0	0	0	0	129379	30718	506543	0	0	66	1088	1769	6866	0	716417
4	137	69	109	0	294	113448	36900	3594015	0	0	107	5693	1781	23003	0	3798254
5	57	0	31	0	382	102806	29425	2674949	0	0	21	1218	1546	9646	0	2846067
6	59	0	0	0	369	50425	13165	908899	0	0	36	605	469	2563	0	994176
7	520	61	37	0	365	73109	3220	3205084	0	0	345	8546	297	8299	0	3311116
8	631	0	13	0	935	63815	4790	1747916	0	0	78	5626	414	7505	0	1840159
9	363	0	4	1191	435	328947	8495	2480922	0	0	187	6278	3337	11832	0	2859532
10	93	0	0	0	0	79997	3122	607205	0	0	272	1535	1332	8372	0	723191
11	0	0	0	0	0	41146	7677	220553	0	0	77	11841	3059	6622	0	330920
12	0	0	0	0	0	11041	1926	169569	0	0	0	7489	918	1268	0	205537
13	651	0	0	0	0	2960	7072	455877	0	0	259	7648	1168	914	0	494240
14	0	0	0	0	286	659	2214	376792	0	0	883	2319	1510	703	0	398300
15	735	0	0	0	0	3178	6277	419039	0	0	1165	4063	3144	2592	0	453927
16	0	0	0	0	527	4450	14281	261778	0	0	2611	3626	994	5480	0	314047
17	1386	0	3277	0	1314	3979	3830	189335	0	0	24907	5872	441	784	0	255872
18	851	0	403	1313	0	1416	1203	126407	0	0	52943	3666	248	328	0	219421
19	1663	0	3944	0	0	772	1235	50429	6004	0	149682	18221	122	2656	0	280612
20	9728	95	11712	0	0	1965	4252	113935	8170	0	42241	17746	254	5313	0	254107
21	12194	0	14858	0	0	2668	16567	114733	8987	0	8379	9899	514	1638	0	248096
22	4993	293	6308	0	0	3082	13444	140228	1154	0	4179	966	349	2143	0	206429
23	1732	0	2091	0	0	749	17301	70646	512	0	1691	1007	57	475	0	117260
24	2360	0	14330	0	0	2817	54834	206530	1783	134	2307	3572	38	2603	0	328932
25	228	0	1083	0	0	160	16112	15162	0	0	148	27	0	285	0	36671
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	19	31	262	0	0	19	2223	4032	505	0	0	72	0	0	216	8429
38	8177	3074	9542	0	91	4864	100818	153467	87172	372	43183	2725	140	8763	21105	453834
39	11541	3272	9796	0	2367	4306	38696	137617	86640	1357	45431	2975	163	4047	16986	380388
40	7688	3313	14809	0	0	3416	17229	84930	43491	1885	27987	782	327	12973	13866	240197
41	1451	4788	161614	0	798	8045	1922	155173	26140	274	34720	1927	11	13731	657	433771
42	623	4208	427139	0	756	1685	2770	171156	8960	0	38627	3657	315	9048	604	699469
43	2298	18261	159710	0	0	2720	8687	257092	2944	0	35432	3698	691	7398	1897	534728
44	2288	19157	66476	0	760	1578	4689	258695	951	0	30466	2974	94	6285	1144	411996
45	1296	7318	28934	0	592	1475	3027	293934	41	0	20477	2107	450	6265	135	380247
46	527	2421	8292	0	0	614	1616	166909	105	0	7728	1088	1519	4509	929	211308
47	519	1809	5538	0	2878	767	1167	282283	82	0	8534	2860	166	3479	3334	324505
48	129	1014	2284	0	0	1098	4311	181966	106	0	3555	434	136	5928	810	215789
49	36	118	271	0	0	707	192	39723	21	0	1517	90	52	683	0	48818
50	23	115	38	0	0	3222	1138	173131	23	0	1245	1706	864	3224	2	197426
51	72	159	50	0	0	7725	34152	436739	49	0	4862	3549	2409	5316	120	509900
52	15	70	38	0	0	37025	112061	1418879	61	0	6850	2048	4119	9011	69	1616058
53	0	0	0	0	0	16223	55230	110094	4	0	164	364	1470	3125	0	194351
MONTH																
JAN	526	149	202	0	502	580675	134413	7231461	95	0	1763	18440	9087	54640	0	8246953
FEB	1502	61	58	1191	2335	342840	43388	7682896	0	0	591	20240	3805	29811	0	8182754
MAR	681	0	0	0	0	344007	23644	2686139	0	0	684	29571	7708	21040	0	3216471
APR	2136	0	3680	1313	2127	13438	27030	1302268	0	0	44760	16605	6242	9660	0	1505102
MAY	29434	388	33748	0	0	7929	36400	460236	24304	0	241250	49499	1270	11753	0	1083352
JUN	4320	0	20578	0	0	4528	90120	322510	2306	134	5126	4880	159	3587	0	525220
JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEP	19847	6377	19908	0	2458	9273	141786	296826	175039	1729	92906	5791	303	14387	39466	849798
OCT	12580	35236	791008	0	2314	16215	31664	772300	81345	2159	143648	11026	1348	45663	16215	2066234
NOV	4129	26975	83351	0	3470	4994	13705	1069339	753	0	62162	8447	2348	18449	6002	1363821
DEC	146	540	526	0	0	65007	202773	2187355	158	0	15062	7792	8927	25286	191	2581361
SEASON																
WIN	2909	210	260	1191	2837	1267522	201445	17600496	95	0	3038	68251	20600	105491	0	19646178
SPR	35890	388	58006	1313	2127	25895	153550	2085014	26610	134	291136	70984	7671	25000	0	3113674
SUM	19847	6377	19908	0	2458	9273	141786	296826	175039	1729	92906	5791	303	14387	39466	849798
FAL	16855	62751	874885	0	5784	86216	248142	4028994	82256	2159	220872	27265	12623	89398	22408	6011416
YEAR	75501	69726	953059	2504	13206	1388906	744923	24011330	284000	4022	607952	172291	41197	234276	61874	29621066

Table A-11

Total Estimated Weight (g) of Fifteen Major Species and All Species Combined Impinged at Indian Point Unit No. 3 Intake Screens during 1979 (summarized by week, month, season, and year and adjusted for collection efficiency)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	RS	SS	WC	WKF	ALL SPEC
WEEK																
1	7	12	253	0	0	33805	2509	133998	10	0	1032	2475	551	6774	0	208999
2	0	0	56	0	174	10002	4656	51990	0	0	50	223	666	7230	0	98162
3	0	0	0	0	0	10559	9474	53248	0	0	112	54	654	3499	0	97807
4	42	78	12	0	349	10164	7546	268616	0	0	87	635	492	5724	0	337674
5	37	0	2	0	0	4611	5379	136386	0	0	24	55	343	1640	0	183709
6	0	0	0	0	132	4908	991	122046	0	0	130	207	220	3369	0	144626
7	344	0	59	0	221	4896	323	231541	0	0	52	1306	128	3110	0	250729
8	188	0	6	0	98	11129	1206	211194	0	0	221	2064	309	5034	0	248904
9	317	0	6	0	0	98819	788	474771	0	0	114	2167	1390	4460	0	593170
10	0	0	0	0	0	18817	252	92400	0	0	54	420	606	4722	0	135598
11	1866	0	0	0	0	10836	192	56840	0	0	30	7015	1304	6309	0	134587
12	516	0	0	0	0	6338	128	40960	0	0	49	3990	457	4063	0	69623
13	660	0	0	0	476	3316	505	45005	0	0	288	2139	555	6386	0	75149
14	1751	1344	5	540	0	2145	545	438488	0	0	1168	3525	5347	3647	0	478670
15	2394	0	304	0	789	5760	4634	412013	0	0	2946	6096	6253	6242	0	482291
16	2886	0	8664	0	372	3246	25840	198552	0	0	3438	10698	1716	4284	0	280417
17	3342	0	36630	0	822	8190	2952	295439	0	0	26700	5922	1944	2718	0	410641
18	7246	0	23334	893	536	3567	338	82599	3816	0	40728	2062	273	1434	0	191186
19	11053	0	10626	0	138	1229	428	31408	18407	0	61557	33550	388	1663	0	228407
20	26507	752	29885	0	0	3361	372	87586	19269	0	28554	25397	303	2280	0	254346
21	23784	2353	45872	0	210	3368	2790	103711	11471	0	6297	15690	421	2357	0	243070
22	8439	0	11296	0	295	979	413	79501	647	0	2065	234	81	2443	0	121642
23	3617	117	19119	0	0	116	427	71390	1135	0	910	771	9	1039	0	115608
24	9638	127	36415	0	578	978	31482	326993	6368	236	616	20095	116	1284	0	458985
25	4448	0	45849	0	248	42	1553	237227	140	235	691	1631	24	1714	0	310643
26	6256	87	16646	0	218	369	2682	94876	13736	1132	820	1530	80	1364	0	162038
27	6659	90	7598	0	0	805	626	31667	9855	583	137	962	0	2859	0	84221
28	5311	14049	8547	0	230	1597	73439	51498	108374	18577	3299	2207	235	1327	0	309255
29	9049	6188	4901	0	0	2100	101418	53926	91913	5536	2448	950	165	2596	0	306504
30	28912	16065	3155	0	0	1400	96579	64973	100441	5844	1981	846	196	4538	0	338151
31	8616	3402	2784	0	0	1808	36227	79145	28845	1303	2027	464	430	6797	9	165612
32	7431	16829	5675	0	653	2621	556408	122585	52109	6396	9865	1177	777	11476	918	811828
33	9384	16867	10968	0	0	1645	44011	155245	46982	6607	28742	517	2185	7569	5366	371247
34	2328	2326	2814	0	0	2733	3774	58522	26468	3174	12647	47	679	5153	5239	144811
35	860	251	632	0	0	358	318	21899	2305	409	2817	6	47	3382	612	38548
36	2693	3287	3055	0	0	1926	37780	48541	8300	2035	5330	235	296	2101	6427	130321
37	6057	1936	4440	0	428	2351	13652	70696	10412	1558	6651	327	33	953	3885	136587
38	330	8	95	0	0	15	144	2176	131	0	817	26	15	14	71	4951
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONTH																
JAN	56	90	323	0	523	67373	27488	611858	10	0	1305	3433	2573	23700	0	873121
FEB	851	0	71	0	451	63638	5120	894850	0	0	435	5585	1705	15652	0	1048541
MAR	3070	0	0	0	476	97209	1341	414287	0	0	503	13742	3597	22736	0	657275
APR	12213	1344	57099	540	2301	21650	34129	1377418	3816	0	44866	27801	15414	17545	0	1723983
MAY	73886	3105	108024	893	851	10195	4085	338019	49934	0	148196	81201	1312	9073	0	946605
JUN	25242	331	119522	0	1044	1505	36222	744346	23639	1603	3228	24099	229	5871	0	1067356
JUL	56892	38854	26119	0	230	7104	292343	238709	330233	31201	8743	5154	769	13601	2	1136754
AUG	21567	37175	20928	0	653	7867	620419	398421	137036	19228	55220	1922	3911	31846	12622	1448351
SEP	9151	5269	7617	0	428	4416	51614	123543	18606	3593	14998	568	353	3316	10403	274931
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEASON																
WIN	3977	90	394	0	1450	228220	33949	1920995	10	0	2243	22760	7875	62320	0	2578937
SPR	111341	4780	284645	1433	4196	33350	74436	2459783	77389	1603	196290	133101	16955	32459	0	3737944
SUM	87630	81298	54664	0	1311	19389	964376	760673	486135	54022	78961	7664	5058	48765	23027	2662036
FAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YEAR	202948	86168	339703	1433	6957	280959	1072761	5141451	563534	55625	277494	163525	29888	143574	23027	9178917

Table A-12

Total Estimated Weight (g) of Fifteen Major Species and All Species Combined Impinged at Indian Point Units No. 2 and No. 3 Intake Screens Combined during 1979 (summarized by week, month, season, and year and adjusted for collection efficiency)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	RS	SS	WC	WKF	ALL SPEC
WEEK																
1	219	92	311	0	0	197015	39228	718456	105	0	2622	11472	3135	17474	0	1067681
2	0	0	64	0	231	117241	22872	496496	0	0	50	1910	2592	15131	0	746049
3	166	0	0	0	0	139938	40192	559791	0	0	178	1142	2423	10365	0	814224
4	179	147	121	0	643	123632	44446	3862631	0	0	194	6328	2273	28727	0	4135928
5	94	0	33	0	382	107417	34804	2813335	0	0	45	1283	1889	11286	0	3029776
6	59	0	0	0	501	55333	14156	1030945	0	0	166	812	689	5932	0	1138802
7	864	61	96	0	566	78005	3543	3436625	0	0	397	9852	425	11409	0	3541845
8	819	0	19	0	1033	74944	5996	1959110	0	0	299	7690	723	12539	0	2089663
9	700	0	10	1191	435	427766	9283	2955693	0	0	301	6445	4727	16292	0	3452702
10	93	0	0	0	0	98814	3374	699605	0	0	326	1955	2138	13094	0	855789
11	1866	0	0	0	0	51982	7869	277393	0	0	107	18856	4363	12931	0	465507
12	516	0	0	0	0	17379	2054	210529	0	0	49	11479	1375	5331	0	275360
13	1311	0	0	0	476	6276	7577	500882	0	0	547	9787	1723	7300	0	569369
14	1731	1344	5	540	286	2804	2759	815260	0	0	2051	5644	6857	4350	0	876970
15	3129	0	304	0	789	8938	10911	831052	0	0	4111	11059	9397	6834	0	936218
16	2886	0	8664	0	899	7696	40121	460330	0	0	6049	14324	2710	9764	0	594464
17	4728	0	39907	0	2136	12169	6782	484774	0	0	51607	11794	2385	3502	0	666513
18	8097	0	23737	2206	536	4983	1541	209006	3816	0	93671	5728	521	1762	0	410607
19	12736	0	14570	0	138	2001	1663	81837	24411	0	231239	56771	510	4339	0	509019
20	36235	847	41597	0	0	5326	4624	201521	27439	0	70795	43143	557	7593	0	508453
21	35978	2353	60730	0	210	6036	21357	218444	20458	0	14676	25569	935	3995	0	491166
22	13432	293	17604	0	285	4061	13557	219729	2001	0	6244	1200	430	4586	0	328071
23	5349	117	21210	0	0	665	17728	142036	1647	0	2601	1778	65	1514	0	232868
24	11998	127	50745	0	578	3795	86316	533523	10351	370	2923	23667	154	3387	0	787917
25	4676	0	46932	0	248	202	17645	252389	140	235	639	1658	24	1999	0	347314
26	6256	87	16646	0	218	369	2682	94876	13736	1132	820	1530	80	1364	0	162038
27	6659	90	7598	0	0	805	626	31667	9655	583	137	862	0	2859	0	84221
28	5311	14049	8547	0	230	1597	73439	51498	108374	18577	3299	2207	235	1327	0	309255
29	9049	6188	4901	0	0	2100	101418	53926	91913	5536	2448	950	165	2596	0	306504
30	28912	16063	3155	0	0	1400	96579	64973	100441	5844	1981	846	196	4533	0	338151
31	8616	3402	2784	0	0	1808	36227	79145	28845	1303	2027	464	430	6797	9	185612
32	7431	16829	5675	0	653	2621	556408	122585	52109	8396	9865	1177	777	11476	918	811828
33	9384	16867	10968	0	0	1645	44011	155245	46982	6607	28742	517	2185	7569	5866	371247
34	2328	2326	2814	0	0	2733	3774	58322	26468	3174	12647	47	679	5155	5239	144611
35	860	251	632	0	0	386	318	21899	2305	409	2817	6	47	3382	612	38548
36	2693	3287	3055	0	0	1926	37780	48541	8300	2035	5330	235	296	2101	6427	130321
37	6076	1967	4702	0	428	2370	15875	74728	10917	1558	8851	399	33	353	4101	145016
38	8507	3082	9637	0	91	4879	100962	155643	87303	372	44000	2751	155	8777	21176	458785
39	11541	3272	9796	0	2367	4306	38696	137617	66640	1357	48431	2975	163	4047	16986	380389
40	7688	3313	14809	0	0	3416	17229	84930	34491	1885	27987	782	327	12973	13666	240197
41	1451	4788	161614	0	798	8045	1922	155173	26140	274	34720	1927	11	13731	657	433771
42	623	4208	427139	0	756	1685	2770	171156	8960	0	38627	3657	315	9048	204	699469
43	2298	18261	159710	0	0	2720	8687	257092	2944	0	35432	3698	691	7398	1697	534728
44	2288	19157	66476	0	760	1578	4689	256693	951	0	30466	2974	94	6285	1144	411996
45	1296	7318	28934	0	592	1475	3027	293934	41	0	20477	2107	450	6265	135	330247
46	527	2421	8292	0	0	614	1616	166909	105	0	7728	1088	1519	4509	929	211308
47	519	1809	5538	0	2878	767	1167	282283	82	0	8534	2860	166	3479	3334	324505
48	129	1014	2284	0	0	1098	4311	181966	106	0	3555	434	136	5928	810	215769
49	36	118	271	0	0	707	192	39723	21	0	1517	90	52	683	0	48818
50	23	115	38	0	0	3222	1138	173131	23	0	1245	1706	864	3224	2	197426
51	72	159	50	0	0	7725	34152	436739	49	0	4862	3549	2409	5316	120	509900
52	15	70	38	0	0	37025	112061	1418879	61	0	6850	2048	4119	9011	69	1616056
53	0	0	0	0	0	16223	55230	110094	4	0	164	364	1470	3125	0	194351
MONTH																
JAN	582	239	525	0	1025	648048	161901	7843319	105	0	3068	21873	11660	78340	0	9120074
FEB	2353	61	129	1191	2786	406478	48506	8577746	0	0	1026	25825	5510	45693	0	9031295
MAR	3951	0	0	0	476	441216	24985	3100426	0	0	1187	43313	11305	43778	0	3873746
APR	14349	1344	60779	1853	4428	35088	61159	2679686	3816	0	89626	44406	21656	27205	0	3229085
MAY	103320	3493	141772	893	851	18124	40485	798253	74238	0	389446	130700	2582	20826	0	2029957
JUN	29562	331	140100	0	1044	6033	126342	1066856	25945	1737	8354	28979	388	9455	0	1592576
JUL	56892	38854	26119	0	230	7104	292343	238709	330233	31201	8743	5154	789	13601	2	1138754
AUG	21587	37175	20928	0	653	7867	620419	398421	137036	19228	55220	1922	3911	31846	12622	1446331
SEP	28998	11646	27525	0	2886	13691	193400	420369	193905	5322	107904	6379	661	17703	49869	1124729
OCT	12580	35236	791008	0	2314	16215	31664	772300	81345	2159	143648	11026	1348	45663	16215	2066234
NOV	4129	26975	83351	0	3470	4994	13705	1069339	753	0	62162	8447	2348	18449	6002	1303821
DEC	146	540	526	0	0	65007	202773	2187355	158	0	15062	7792	8927	25286	191	2581361
SEASON																
WIN	6886	300	654	1191	4287	1495742	235394	19521491	105	0	5281	91011	28475	167811	0	22225115
SPR	147231	5168	342651	2746	6323	59245	227986	4544797	103999	1737	487426	204085	24626	57489	0	6851618
SUM	107477	87675	74572	0	3769	28662	1106162	1057499	661174	55751	171867	13455	5361	63152	62493	3711834
FAL	16655	62751	874885	0	5784	86216	248142	4028994	82256	2159	220872	27265	12623	89398	22408	6011416
YEAR	278449	155894	1292762	3937	20163	1669865	1817684	29152781	847534	59647	885446	335816	71085	377850	84901	38799983

APPENDIX A.3

Adjusted Impingement Rates

Impingement rates of 15 species predominant in impingement collections (adjusted for collection efficiency) are summarized in the following tables by week, month, season, and year. The following codes denote the 15 species presented.

AL	Alewife
AS	American Shad
BH	Blueback Herring
SNS	Shortnose Sturgeon
ATS	Atlantic Sturgeon
SB	Striped Bass
TC	Atlantic Tomcod
WP	White Perch
BA	Bay Anchovy
BF	Bluefish
HC	Hogchoker
RS	Rainbow Smelt
SS	Spottail Shiner
WC	White Catfish
WKF	Weakfish

Table A-13

Adjusted Impingement Rates (No./$10^6 m^3$) for Fifteen Major Species and All Species Combined Impinged at Indian Point Unit No. 2 during 1979 (summarized by week, month, season, and year)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	PS	SS	WC	WKP	ALL SPEC
WEEK																
1	0.49	0.62	1.54	0.00	0.00	782.38	69.98	4587.90	7.41	0.00	9.13	163.72	25.43	9.07	0.00	5732.53
2	0.00	0.00	0.21	0.00	0.10	394.52	35.60	2870.92	0.00	0.00	0.00	29.05	17.98	7.38	0.00	3412.82
3	0.10	0.00	0.00	0.00	0.00	468.53	63.93	3223.47	0.00	0.00	0.21	15.44	15.28	4.04	0.00	3826.50
4	0.49	0.37	2.74	0.00	0.24	470.70	102.82	[illegible]	0.00	0.00	0.49	109.32	22.81	14.42	0.00	17876.03
5	0.21	0.00	0.80	0.00	0.21	311.77	67.39	12722.47	0.00	0.00	0.11	17.31	17.31	7.19	0.00	13172.91
6	0.21	0.00	0.00	0.00	0.21	137.40	29.78	4626.20	0.00	0.00	0.10	10.03	4.73	2.96	0.00	4826.01
7	1.56	0.31	0.73	0.00	0.10	238.78	7.95	12459.50	0.00	0.00	0.52	157.66	3.27	7.02	0.00	12893.51
8	2.13	0.00	0.33	0.00	0.33	276.07	17.73	12045.24	0.00	0.00	0.33	170.55	9.19	8.29	0.00	12250.01
9	1.15	0.00	0.10	0.10	0.10	726.19	18.66	12646.12	0.00	0.00	0.42	101.58	33.67	7.14	0.00	13563.26
10	0.21	0.00	0.00	0.00	0.00	108.98	9.97	3674.99	0.00	0.00	0.75	14.43	27.25	2.87	0.00	3849.94
11	0.00	0.00	0.00	0.00	0.00	31.54	12.47	567.56	0.00	0.00	0.21	45.23	31.02	4.73	0.00	736.43
12	0.00	0.00	0.00	0.00	0.00	11.17	4.68	390.05	0.00	0.00	0.00	26.03	9.87	1.14	0.00	454.44
13	0.10	0.00	0.00	0.00	0.00	7.48	15.64	1316.07	0.00	0.00	0.94	31.85	13.93	0.94	0.00	1402.96
14	0.00	0.00	0.00	0.00	0.10	2.34	5.77	2162.84	0.00	0.00	2.91	8.31	21.83	1.46	0.00	2219.59
15	0.10	0.00	0.00	0.00	0.00	10.69	14.85	1767.54	0.00	0.00	5.59	23.33	34.90	1.91	0.00	1850.09
16	0.00	0.00	0.00	0.00	0.14	9.86	17.30	1028.22	0.00	0.00	5.77	17.48	2.52	0.84	0.00	1095.41
17	0.12	0.00	0.72	0.00	0.25	9.23	3.74	606.00	0.00	0.00	42.25	44.52	2.77	1.03	0.00	727.81
18	0.19	0.00	0.19	0.06	0.00	4.39	1.04	577.64	0.00	0.00	89.71	28.34	1.63	1.92	0.00	717.15
19	0.57	0.00	1.09	0.00	0.00	0.87	13.65	322.11	51.57	0.00	397.19	127.37	0.62	3.55	0.00	637.49
20	2.05	0.12	9.95	0.00	0.00	5.58	121.82	525.96	77.95	0.00	63.03	107.57	1.60	1.87	0.00	447.97
21	2.71	0.00	6.49	0.00	0.00	6.64	414.71	355.25	77.82	0.00	19.71	50.51	2.64	2.15	0.00	952.24
22	1.56	0.47	3.50	0.00	0.00	7.45	270.14	358.01	10.10	0.00	9.48	4.52	1.90	2.03	0.00	689.43
23	1.01	0.00	2.79	0.00	0.00	2.16	172.35	95.09	[illegible]	0.00	5.58	4.95	0.25	0.60	0.00	295.07
24	2.15	0.00	6.55	0.00	0.00	2.84	636.16	187.78	17.55	2.06	16.59	18.74	0.25	0.62	0.00	899.65
25	4.61	0.00	6.34	0.00	0.00	8.65	3306.63	389.83	0.00	0.00	24.22	4.61	0.00	2.32	0.00	3766.82
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	1.77	1.93	8.04	0.00	0.00	1.43	57.44	175.54	42.32	0.00	0.00	5.47	0.00	0.00	11.10	318.58
38	11.35	23.60	48.95	0.00	0.12	33.32	497.50	1038.44	975.99	0.37	106.55	24.68	1.17	0.86	100.58	2504.66
39	14.35	27.36	71.41	0.00	0.55	43.61	215.09	1291.96	1132.95	1.07	106.87	30.57	0.80	1.35	79.00	3083.54
40	0.66	22.86	145.06	0.00	0.00	17.70	56.00	445.68	553.99	0.42	44.92	7.99	1.72	1.34	47.78	1380.68
41	3.52	31.10	2131.77	0.00	0.13	21.25	6.97	1375.44	583.21	0.27	56.24	36.00	0.13	5.50	2.04	4354.06
42	4.12	32.39	6776.40	0.00	0.29	15.23	8.06	2278.34	255.10	0.00	84.98	98.73	14.84	5.00	3.21	10027.59
43	18.65	144.73	5843.49	0.00	0.00	24.27	24.68	3128.06	107.23	0.00	102.84	50.50	6.59	7.01	10.53	7778.26
44	11.31	152.36	1308.45	0.00	0.16	8.72	13.79	3103.28	28.22	0.00	95.19	34.15	1.18	5.65	5.80	4848.67
45	5.11	52.04	518.47	0.00	0.07	9.08	6.69	2303.82	1.23	0.00	50.95	44.16	4.11	10.54	0.93	3516.54
46	3.51	16.82	467.51	0.00	0.00	3.89	2.85	[illegible]	2.45	0.00	23.74	21.29	16.28	13.63	6.23	1961.09
47	3.55	12.77	135.05	0.00	0.29	5.75	2.99	3523.54	1.54	0.00	35.35	26.95	2.29	4.12	15.76	3599.02
48	1.32	9.16	52.42	0.00	0.00	10.12	7.54	2555.76	2.21	0.00	15.08	7.48	2.87	8.14	4.25	2724.41
49	0.65	2.28	22.69	0.00	0.00	9.33	0.65	780.29	0.43	0.00	12.37	4.83	1.30	6.84	0.00	843.39
50	0.08	0.92	0.53	0.00	0.03	12.25	3.54	2034.67	1.10	0.00	4.91	37.37	7.45	8.45	0.17	2211.87
51	0.56	1.46	1.51	0.00	0.00	38.42	67.23	5892.37	4.31	0.00	24.97	54.87	29.58	12.75	9.78	6292.16
52	0.11	0.42	0.95	0.00	0.00	100.70	170.68	13435.90	3.08	0.00	24.21	38.12	43.00	26.54	5.47	14534.72
53	0.00	0.00	0.00	0.00	0.00	189.68	250.68	3346.13	0.34	0.00	2.24	21.02	38.42	9.82	0.00	3947.35
MONTH																
JAN	0.24	0.19	1.05	0.00	0.10	494.40	63.71	7394.15	1.45	0.00	1.93	67.30	19.82	8.35	0.00	8697.41
FEB	1.14	0.09	0.32	0.05	0.20	295.60	27.26	9076.82	0.00	0.00	0.32	103.40	11.25	9.22	0.00	9542.23
MAR	0.17	0.00	0.00	0.00	0.00	108.27	10.79	3029.40	0.00	0.00	0.47	29.15	19.22	2.72	0.00	3224.29
APR	0.07	0.00	0.27	0.02	0.13	8.63	9.52	1233.21	0.00	0.00	22.45	25.21	12.24	1.27	0.00	1328.72
MAY	1.53	0.13	4.71	0.00	0.00	4.45	160.73	413.46	49.04	0.00	129.01	70.17	3.40	2.41	0.00	[illegible]
JUN	1.46	0.00	4.55	0.00	0.00	3.20	435.16	150.52	9.57	0.59	11.21	10.79	0.42	0.74	0.00	[illegible]
JUL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEP	11.02	22.45	52.14	0.00	0.28	32.40	313.98	1269.90	898.49	0.59	91.16	23.77	0.54	0.98	78.53	[illegible]
OCT	8.62	57.38	2975.52	0.00	0.13	19.58	23.67	1865.08	361.59	0.49	69.70	45.62	5.14	4.64	16.80	5475.24
NOV	6.15	51.26	405.43	0.00	0.08	7.86	7.05	2697.66	4.51	0.00	48.65	30.92	9.82	11.75	9.55	3379.29
DEC	0.26	1.11	2.97	0.00	0.03	66.36	75.76	5651.53	2.22	0.00	14.82	41.01	22.32	13.67	3.32	5995.71
SEASON																
WIN	0.47	0.09	0.46	0.01	0.09	299.22	34.15	6529.42	0.51	0.00	0.94	66.12	17.12	5.73	0.00	6951.33
SPR	1.03	0.06	3.14	0.01	0.04	5.57	181.50	624.42	23.59	0.20	66.39	41.54	4.29	1.65	0.00	[illegible]
SUM	11.02	22.45	52.14	0.00	0.28	32.40	313.98	1269.90	898.49	0.59	91.16	23.77	0.54	0.98	78.53	[illegible]
FAL	5.61	40.60	1349.49	0.00	0.09	27.58	31.86	3141.11	149.68	0.20	46.37	39.73	10.13	9.35	4.10	5002.76
YEAR	3.13	14.82	436.29	0.00	0.09	28.89	106.64	2977.27	125.99	0.18	45.97	45.30	9.35	5.09	9.10	[illegible]

Table A-14

Adjusted Impingement Rates (No./$10^6 m^3$) for Fifteen Major Species and All Species Combined Impinged at Indian Point Unit No. 3 during 1979 (summarized by week, month, season, and year)

PERIOD	AL	AS	BH	SNS	ATS	SB	TC	WP	BA	BF	HC	PS	SS	WC	WKF	ALL SPEC
WEEK																
1	0.09	0.18	0.97	0.00	0.00	255.65	9.07	1534.89	1.06	0.00	6.16	34.07	7.39	8.54	0.00	1897.33
2	0.00	0.00	0.12	0.00	0.06	44.89	9.39	500.49	0.00	0.00	0.12	3.36	5.72	4.29	0.00	592.20
3	0.00	0.00	0.00	0.00	0.00	51.06	21.43	514.81	0.00	0.00	0.20	0.93	5.49	2.12	0.00	608.47
4	0.18	0.18	0.30	0.00	0.18	50.37	16.95	2065.01	0.00	0.00	0.24	11.12	4.34	4.76	0.00	2169.73
5	0.12	0.00	0.06	0.00	0.00	22.82	13.47	1248.23	0.00	0.00	0.06	1.12	3.06	2.00	0.00	1307.09
6	0.00	0.00	0.00	0.00	0.06	21.64	2.62	1028.10	0.00	0.00	0.25	2.49	1.62	1.62	0.00	1065.33
7	0.99	0.00	0.37	0.00	0.12	27.36	0.87	1508.20	0.00	0.00	0.25	19.21	1.31	2.86	0.00	1567.51
8	0.69	0.00	0.14	0.00	0.07	47.73	4.47	1686.87	0.00	0.00	0.62	27.92	3.37	4.13	0.00	1784.33
9	1.13	0.00	0.13	0.00	0.00	213.15	2.00	3444.07	0.00	0.00	0.25	18.39	12.13	3.88	0.00	3705.07
10	0.00	0.00	0.00	0.00	0.00	28.87	0.62	806.79	0.00	0.00	0.06	2.49	7.92	2.56	0.00	860.42
11	0.37	0.00	0.00	0.00	0.00	10.60	0.62	147.04	0.00	0.00	0.06	25.13	11.16	3.74	0.00	224.80
12	0.11	0.00	0.00	0.00	0.00	8.48	0.74	117.32	0.00	0.00	0.11	24.59	7.21	3.18	0.00	172.54
13	0.17	0.00	0.00	0.00	0.34	3.29	1.52	124.83	0.00	0.00	1.01	12.57	6.58	7.51	0.00	172.15
14	0.50	0.05	0.05	0.05	0.00	1.79	0.89	1240.54	0.00	0.00	3.53	13.17	44.27	3.83	0.00	1325.95
15	0.28	0.00	0.06	0.00	0.16	14.33	5.28	1164.60	0.00	0.00	5.63	23.87	28.54	3.48	0.00	1260.38
16	0.54	0.00	1.22	0.00	0.06	8.11	3.30	540.86	0.00	0.00	6.55	34.02	6.58	2.03	0.00	611.86
17	0.47	0.00	5.11	0.00	0.12	10.16	2.93	490.79	0.00	0.00	36.85	27.03	7.48	3.34	0.00	595.58
18	1.07	0.00	3.94	0.06	0.13	4.89	0.35	200.25	0.60	0.00	57.87	10.29	1.23	2.05	0.00	289.83
19	2.81	0.00	4.85	0.00	0.06	2.28	1.22	121.59	121.96	0.00	115.30	164.55	1.88	2.22	0.00	546.45
20	8.01	1.09	26.00	0.00	0.00	9.82	10.63	301.85	153.46	0.00	48.39	127.34	1.78	1.65	0.00	696.26
21	10.54	0.59	15.99	0.00	0.06	8.17	53.41	200.26	90.86	0.00	12.41	72.49	1.96	1.18	0.00	475.42
22	3.09	0.00	3.80	0.00	0.06	2.21	7.83	113.17	6.69	0.00	3.57	1.17	0.42	0.62	0.00	147.19
23	2.11	0.18	5.58	0.00	0.00	0.22	6.38	63.92	9.41	0.00	2.66	4.12	0.07	0.47	0.00	99.11
24	5.30	0.22	12.66	0.00	0.12	2.06	433.23	269.89	59.58	3.34	3.12	78.13	0.47	0.50	0.00	873.39
25	2.67	0.00	10.51	0.00	0.06	0.12	12.90	142.50	1.21	2.67	0.99	6.87	0.16	0.50	0.00	184.87
26	2.68	0.12	3.77	0.00	0.19	0.59	16.66	67.78	93.83	11.52	2.55	5.85	0.34	0.47	0.00	211.20
27	2.32	2.21	2.03	0.00	0.00	0.36	3.62	23.20	89.72	4.82	1.52	4.82	0.00	0.43	0.00	139.89
28	4.66	203.55	3.94	0.00	0.06	1.75	378.02	61.36	791.53	99.07	15.32	15.76	1.06	0.31	0.00	1584.50
29	21.51	94.78	1.84	0.00	0.00	3.09	469.18	42.19	799.00	21.36	8.17	10.10	0.59	0.56	0.00	1478.42
30	197.84	215.01	12.34	0.00	0.00	6.04	436.09	71.26	930.17	19.74	5.64	9.34	0.80	0.50	0.00	1914.36
31	41.21	41.59	13.76	0.00	0.00	4.41	107.56	72.29	248.04	4.69	3.35	3.73	1.56	0.94	0.55	553.11
32	18.83	158.05	37.34	0.00	0.06	12.27	3676.90	638.56	432.38	9.56	19.55	11.86	1.58	0.98	33.05	5076.27
33	29.33	176.83	85.27	0.00	0.00	9.18	246.60	432.56	427.92	6.88	47.29	5.82	7.50	1.15	107.00	1626.66
34	10.54	29.01	13.02	0.00	0.00	6.76	17.27	113.02	297.42	3.38	26.43	0.47	2.47	0.87	71.48	610.79
35	2.93	4.53	5.38	0.00	0.00	0.85	2.31	29.88	41.21	0.76	6.70	0.33	0.24	0.66	11.42	109.98
36	8.41	58.04	31.04	0.00	0.00	17.34	292.95	343.54	131.89	2.62	25.24	2.33	1.93	0.40	76.46	1007.93
37	7.28	16.24	24.24	0.00	0.08	11.32	75.89	359.68	123.33	1.32	16.88	3.08	0.16	0.32	28.00	682.75
38	1.46	0.97	4.05	0.00	0.00	0.65	4.37	46.29	7.12	0.00	6.31	0.61	0.32	0.32	1.73	75.10
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONTH																
JAN	0.07	0.07	0.28	0.00	0.06	80.30	14.52	1222.76	0.18	0.00	1.17	9.54	5.28	4.27	0.00	1359.20
FEB	0.70	0.00	0.16	0.00	0.06	63.10	3.61	1599.54	0.00	0.00	0.30	16.47	3.86	3.13	0.00	1698.64
MAR	0.17	0.00	0.00	0.00	0.07	29.60	0.93	701.80	0.00	0.00	0.28	14.06	8.62	3.90	0.00	775.17
APR	0.43	0.01	2.11	0.01	0.10	9.34	3.14	788.12	0.15	0.00	16.95	24.75	18.25	3.08	0.00	876.63
MAY	5.61	0.38	11.83	0.01	0.06	5.58	16.41	187.70	84.57	0.00	50.18	84.47	1.49	1.53	0.00	456.56
JUN	3.12	0.12	7.80	0.00	0.09	0.72	113.45	131.33	39.47	4.25	2.36	22.92	0.25	0.49	0.00	330.57
JUL	58.24	125.62	6.45	0.00	0.01	3.19	311.68	51.87	639.39	34.60	7.49	9.65	0.73	0.52	0.01	1257.87
AUG	16.79	93.08	35.61	0.00	0.02	7.35	988.26	307.31	305.73	5.28	23.92	4.77	3.05	0.93	52.32	1865.59
SEP	6.75	29.13	23.11	0.00	0.04	11.56	137.79	298.86	106.09	1.54	18.53	2.39	0.82	0.37	40.16	628.02
OCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DEC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEASON																
WIN	0.31	0.03	0.15	0.00	0.06	58.78	6.67	1181.81	0.06	0.00	0.61	13.23	5.87	3.78	0.00	1286.51
SPR	3.16	0.18	7.44	0.01	0.08	5.14	44.51	357.33	43.09	1.41	23.85	45.26	6.33	1.67	0.00	547.09
SUM	32.98	96.72	21.03	0.00	0.02	6.25	558.47	196.08	416.64	17.28	15.96	6.57	1.69	0.66	27.64	1412.02
FAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEAR	12.93	33.73	10.63	0.00	0.06	16.87	215.31	475.60	163.94	6.63	16.20	25.03	4.62	1.77	9.69	1004.37

APPENDIX A.4

Volumes Circulated and Days of Operation
at Indian Point

Table A-15

Number of Days of Operation at Indian Point Units No. 2 and No. 3 and Number of Days Selected for Computation of Impingement Rates, 1976 through 1979

		Number of Days						Number of Days			
		Unit No. 2		Unit No. 3				Unit No. 2		Unit No. 3	
Year	Month	Operation*	Selected	Operation*	Selected	Year	Month	Operation*	Selected	Operation*	Selected
1976	Jan	31	0	0	0	1978	Jan	31	5	31	28
	Feb	29	1	24	3		Feb	17	0	28	23
	Mar	31	0	31	0		Mar	0	0	31	28
	Apr	4	2	30	0		Apr	0	0	30	28
	May	0	0	30	20		May	12	3	31	29
	Jun	14	3	30	19		Jun	30	28	25	21
	Jul	0	0	31	14		Jul	31	23	0	0
	Aug	0	0	31	18		Aug	31	24	19	11
	Sep	16	3	30	19		Sep	30	17	30	14
	Oct	31	13	31	21		Oct	31	24	31	20
	Nov	13	9	30	27		Nov	30	24	30	23
	Dec	24	10	31	23		Dec	31	18	31	23
Total		193	41	329	164	Total		274	166	317	248
1977	Jan	31	20	31	22	1979	Jan	31	27	31	28
	Feb	27	5	28	6		Feb	28	22	28	23
	Mar	31	22	31	18		Mar	31	28	31	25
	Apr	14	6	30	17		Apr	30	22	30	24
	May	18	16	31	30		May	31	30	31	29
	Jun	30	23	30	19		Jun	17	14	30	22
	Jul	3	1	31	25		Jul	0	0	31	25
	Aug	28	15	31	30		Aug	0	0	31	22
	Sep	30	27	30	28		Sep	19	9	19	12
	Oct	31	26	12	7		Oct	31	29	0	0
	Nov	30	24	0	0		Nov	30	29	0	0
	Dec	31	29	18	11		Dec	30	20	0	0
Total		303	214	303	213	Total		278	230	262	210

*Data obtained from Con Edison plant performance records

Table A-16

Total Unit Discharge* ($10^6 m^3$) at Indian Point Units No. 2 and No. 3, 1976 through 1979

		Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	Unit 2	462.4	79.9	75.1	81.9	4.3	0	12.9	0	0	32.3	107.1	17.6	51.3
	Unit 3	866.7	0	30.6	25.5	53.7	85.9	93.7	107.0	113.1	80.1	104.9	98.1	74.1
	Combined	1329.1	79.9	105.7	107.4	58.0	85.9	106.6	107.0	113.1	112.4	212.0	115.7	125.4
1977	Unit 2	1016.5	58.8	56.5	71.8	39.9	88.1	133.3	13.0	106.8	140.9	123.3	95.4	88.7
	Unit 3	1142.1	73.0	63.9	82.3	100.5	139.5	135.7	139.8	146.0	141.0	53.7	0	66.7
	Combined	2158.6	131.8	120.4	154.1	140.0	227.6	269.0	152.8	252.8	281.9	177.0	95.4	155.4
1978	Unit 2	1015.2	79.0	34.0	0	1.6	40.2	141.5	144.1	145.6	82.6	129.5	107.4	109.7
	Unit 3	1015.2	88.1	71.4	86.1	76.0	122.0	47.2	2.1	38.7	121.7	140.8	133.6	87.5
	Combined	2030.4	167.1	105.4	86.1	77.6	162.2	188.7	146.2	184.3	204.3	270.3	241.0	197.2
1979	Unit 2	976.0	88.2	74.8	87.8	113.8	145.2	77.1	3.8	4.0	78.1	123.1	97.4	82.7
	Unit 3	958.8	75.1	66.6	66.0	136.5	145.2	136.7	144.8	130.9	53.6	1.7	0.9	0.9
	Combined	1934.9	163.2	141.4	153.8	250.3	290.4	213.9	148.6	134.9	131.7	124.8	98.2	83.6

*Including service water

APPENDIX A.5

Collection Efficiency Test Results

Table A-17

Collection Efficiency Test Results for Dyed Fish Released at Indian Point Unit No. 2 during 1979

Test Date	Number Released	Number Recovered	Percent Recovered
05 Jan	180	119	66.1
01 Feb	180	122	67.8
15 Feb	180	105	58.3
13 Mar	180	57	31.7
27 Mar	180	74	41.1
19 Apr	180	100	55.6
26 Apr	180	126	70.0
05 May	180	24	13.3
10 May	180	56	31.1
24 May	180	33	18.3
07 Jun	180	10	5.6
20 Sep	180	75	41.7
04 Oct	120	29	24.2
06 Oct	120	43	35.8
20 Oct	180	56	31.1
25 Oct	180	47	26.1
31 Oct	180	84	46.7
08 Nov	180	100	55.5
15 Nov	180	65	36.1
20 Nov	180	85	47.2
11 Dec	180	99	55.0
20 Dec	180	83	46.1
28 Dec	180	74	41.1
Total	4,020	1,666	41.4

Table A-18

Collection Efficiency Test Results for Dyed Fish Released at Indian Point Unit No. 3 during 1979

Test Date	Number Released	Number Recovered	Percent Recovered
10 Jan	180	164	91.1
26 Jan	180	130	72.2
07 Feb	180	168	93.3
21 Feb	180	166	92.2
06 Mar	180	143	79.4
05 Apr	180	167	92.8
11 Apr	180	160	88.9
03 May	180	108	60.0
17 May	180	112	62.2
31 May	180	99	55.0
14 Jun	180	152	84.4
21 Jun	180	117	65.0
28 Jun	180	95	52.8
04 Jul	180	106	58.9
12 Jul	120	55	45.8
19 Jul	180	161	89.4
26 Jul	120	14	11.7
27 Jul	180	143	79.4
02 Aug	180	122	67.8
09 Aug	180	163	90.6
16 Aug	180	148	82.2
Total	3,660	2,693	73.6

Table A-19

Collection Efficiency Test Results for Tagged Fish Released at Indian Point Unit No. 2 during 1979

Test Date	Number Released	Number of Tagged Fish Recovered	Number of Tags Only Recovered	Percent of Tagged Fish Recovered
15 Jan	180	87	4	48.3
19 Apr	180	120	2	66.7
26 Apr	180	136	4	75.6
05 May	180	31	41	17.2
10 May	180	44	32	24.4
24 May	180	27	21	15.0
20 Sep	180	116	24	64.4
04 Oct	120	46	22	38.3
06 Oct	120	67	10	55.8
13 Oct*	180	65	26	36.1
20 Oct	180	69	21	38.3
25 Oct	180	55	31	30.6
31 Oct	180	78	24	43.3
08 Nov	180	125	12	69.4
15 Nov	180	77	19	42.8
20 Nov	180	99	11	55.0
11 Dec	180	126	13	70.0
20 Dec	180	81	22	45.0
28 Dec	180	102	1	56.7
Total	3,300	1,551	340	47.0

*Indicates a multiple screen test as described in Appendix C

Table A-20

Collection Efficiency Test Results for Tagged Fish Released at Indian Point Unit No. 3 during 1979

Test Date	Number Released	Number of Tagged Fish Recovered	Number of Tags Only Recovered	Percent of Tagged Fish Recovered
05 Apr	180	169	1	93.9
11 Apr	180	155	2	86.1
03 May	180	108	5	60.0
17 May	180	120	11	66.7
31 May	180	137	4	76.1
14 Jun	180	144	9	80.0
21 Jun	180	121	11	67.2
28 Jun	180	110	13	61.1
04 Jul	180	97	14	53.9
12 Jul	120	75	13	62.5
19 Jul	180	136	13	75.6
26 Jul	120	44	35	36.7
27 Jul	180	83	22	46.1
02 Aug	180	110	20	61.1
09 Aug	180	145	7	80.6
16 Aug	180	147	6	81.7
23 Aug*	180	44	39	24.4
Total	2,940	1,945	225	66.2

*Indicates a multiple screen test as described in Appendix C

APPENDIX A.6

Number, Percent, and Rank of Major Impinged Species at Indian Point

Table A-21

Number of Individuals (unadjusted for collection efficiency), Percent, and Rank of Seventeen Fish Species Impinged at Indian Point Generating Station during 1975 through 1979

	1975*			1976*			1977			1978			1979		
Species†	Number	Percent	Rank	Number	Percent	Rank	Number	Percent	Rank	Number	Percent	Rank	Number	Percent	Rank
White perch	299,325	43.0	1	440,641	54.0	1	1,094,592	37.8	1	807,235	44.9	1	1,579,199	72.4	1
Blueback herring	155,707	22.3	2	258,303	31.6	2	637,519	22.0	3	510,741	28.4	2	122,006	5.6	4
Atlantic tomcod	78,627	11.3	4	34,236	4.2	3	747,702	25.8	2	120,275	6.7	3	159,683	7.3	2
Bay anchovy	96,058	13.8	3	12,142	1.5	6	146,879	5.1	4	106,737	5.9	4	129,975	6.0	3
Hogchoker	18,839	2.7	5	14,795	1.8	5	25,472	.9	8	46,524	2.6	5	23,234	1.1	8
Striped bass	5,977	.9	9	6,130	.8	7	27,677	1.0	6	42,282	2.4	6	50,511	2.3	5
Rainbow smelt	7,790	1.1	8	3,049	.4	12	26,988	.9	7	38,945	2.2	7	32,277	1.5	6
American shad	1,148	.2	13	4,223	.5	9	12,704	.4	13	31,993	1.8	8	25,083	1.1	7
Alewife	4,243	.6	10	3,549	.4	10	58,592	2.0	5	30,908	1.7	9	8,728	.4	9
Clupeid unid.	108	.1	21	179	.1	25	19,743	.7	11	25,444	1.4	10	6,024	.3	13
Weakfish	8,969	1.3	7	556	.1	19	7,587	.3	14	12,927	.7	11	8,261	.4	10
White catfish	10,171	1.5	6	18,767	2.3	4	24,755	.9	9	7,498	.4	12	3,268	.1	16
Spottail shiner	3,949	.6	11	5,154	.6	8	5,308	.2	16	3,886	.2	13	7,287	.3	11
American eel	773	.1	15	877	.1	17	2,827	.1	19	1,999	.1	14	2,737	.1	17
Pumpkinseed	573	.1	17	1,718	.2	14	2,949	.1	18	1,738	.1	15	4,091	.2	14
Gizzard shad	921	.1	14	2,777	.3	13	6,636	.2	15	1,684	.1	16	1,022	<.1	21
Spot	0	0.0	N/A	1,471	.2	16	16,267	.6	12	3	<.1	56	1	<.1	60
Bluefish	1,616	.2	12	1,525	.2	15	21,403	.7	10	889	<.1	18	4,030	.2	15
Centrarchid unid.	277	.1	18	3,135	.4	11	3,283	.1	17	537	<.1	22	6,113	.3	12
Others	1,643			2,903			7,349			5,781			8,210		
Total	696,714			816,130			2,896,232			1,798,026			2,181,740		

*Units No. 1, No. 2, and No. 3 combined for 1975 and 1976, Units No. 2 and No. 3 for 1977, 1978, and 1979
†Unidentifiable clupeids were primarily blueback herring and alewives, unidentifiable Clupeidae and Centrarchidae are not counted as separate species

APPENDIX A.7

Annually and Seasonally Adjusted
Monthly Impingement Rates

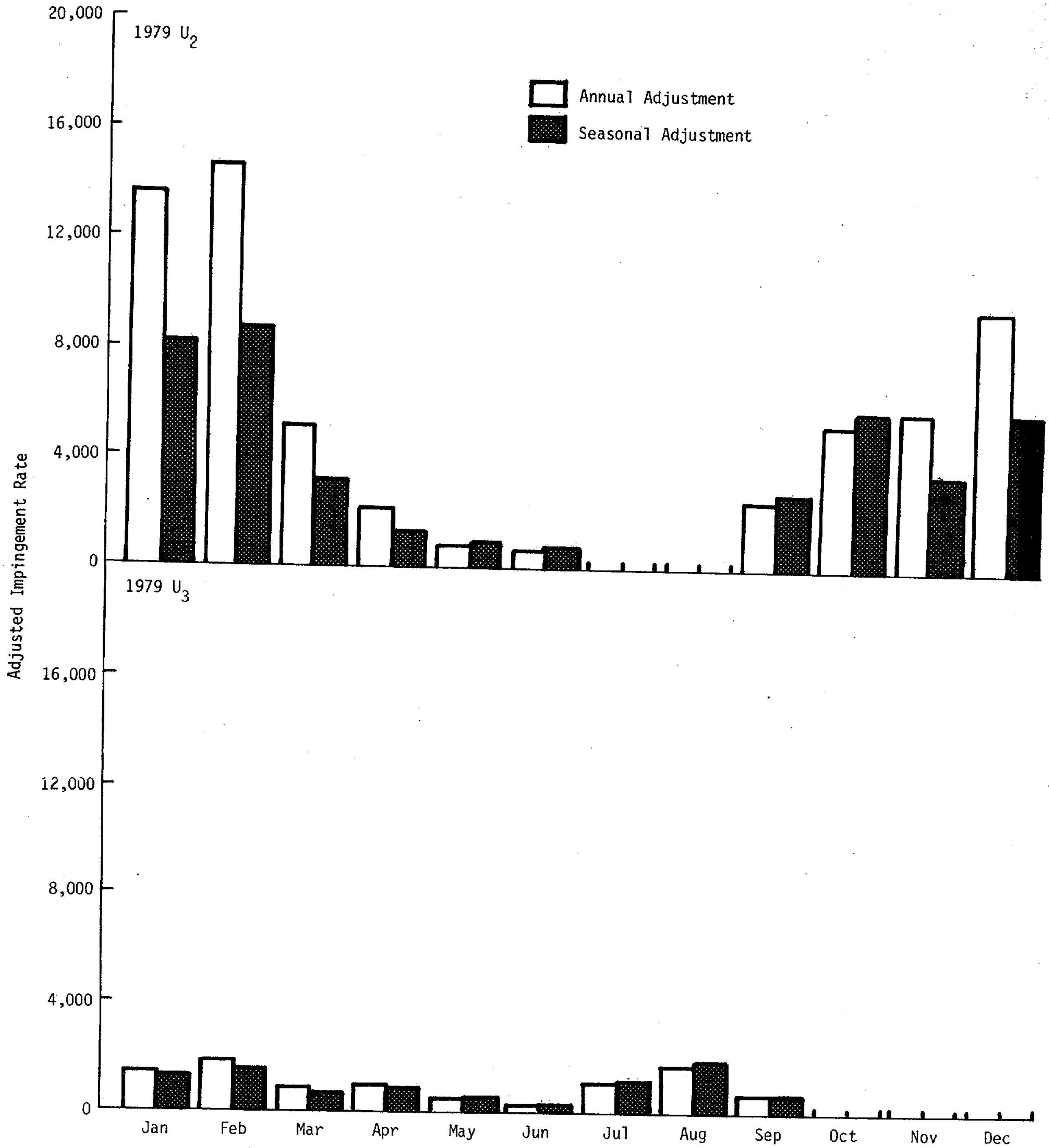


Figure A-1. Annually and Seasonally Adjusted Monthly Impingement Rates for All Species Combined (number impinged/volume pumped) at (a) Unit No. 2 (annual adjustment = 3.5; seasonal = 3.8 for May through October and 2.1 for the remainder of the year) and (b) Unit No. 3 during 1979 (annual adjustment = 1.4, seasonal = 1.5 for May through October and 1.2 for the remainder of the year)

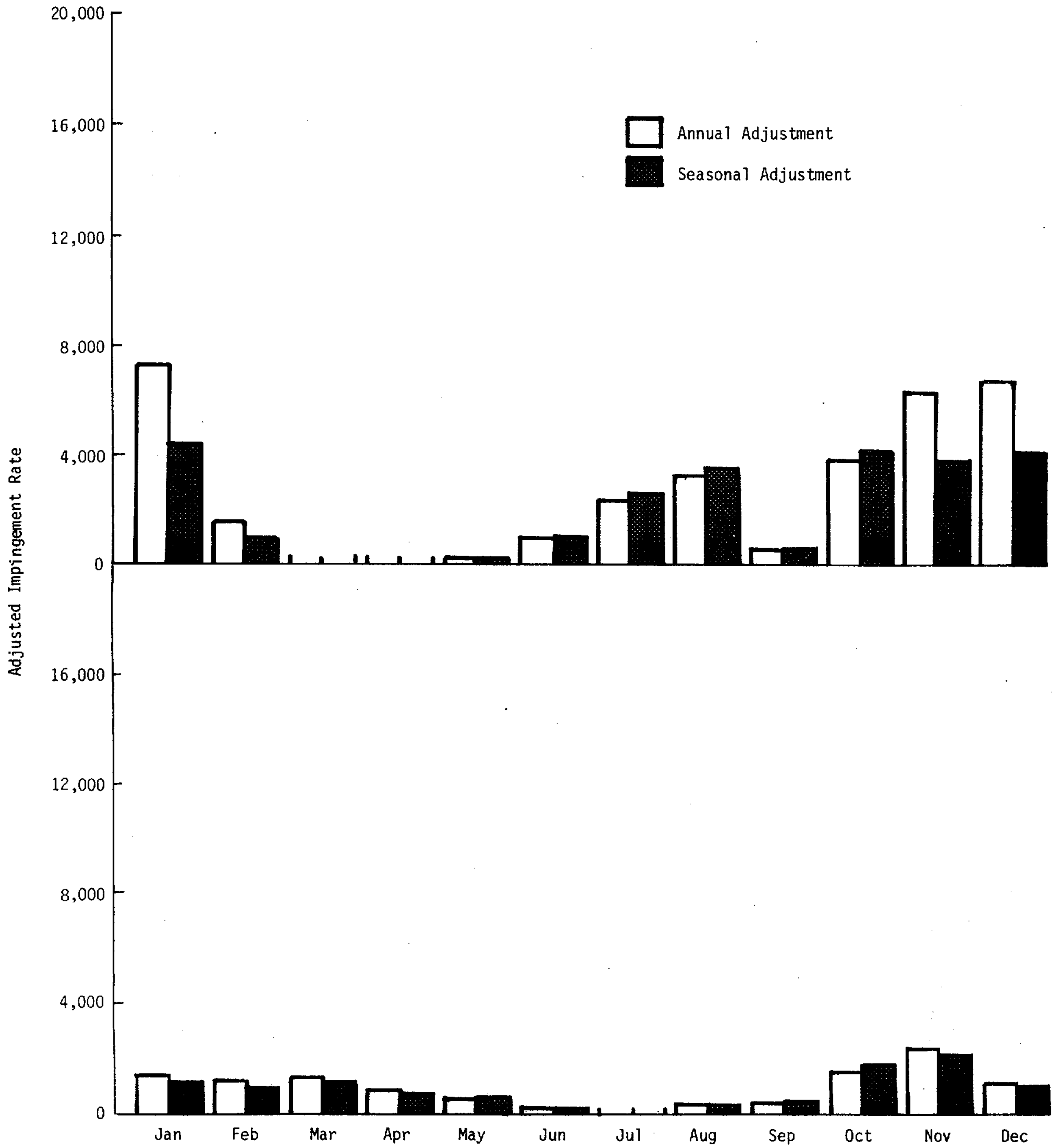


Figure A-2. Annually and Seasonally Adjusted Monthly Impingement Rates for All Species Combined (number impinged/volume pumped) at (a) Unit No. 2 (annual adjustment = 3.5; seasonal = 3.8 for May through October and 2.1 for the remainder of the year), and (b) Unit No. 3 during 1978 (annual adjustment = 1.4, seasonal = 1.5 for May through October and 1.2 for the remainder of the year)

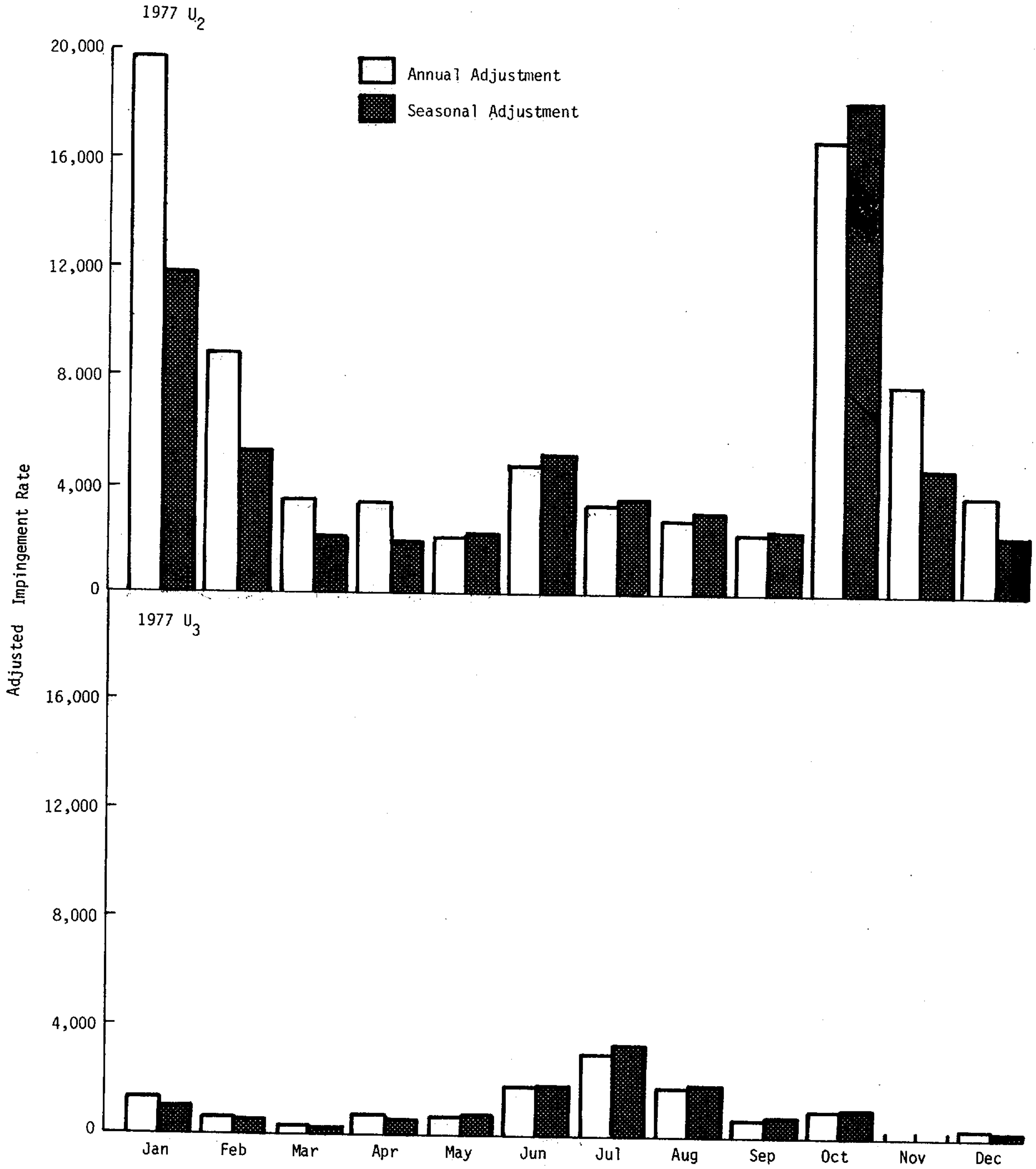
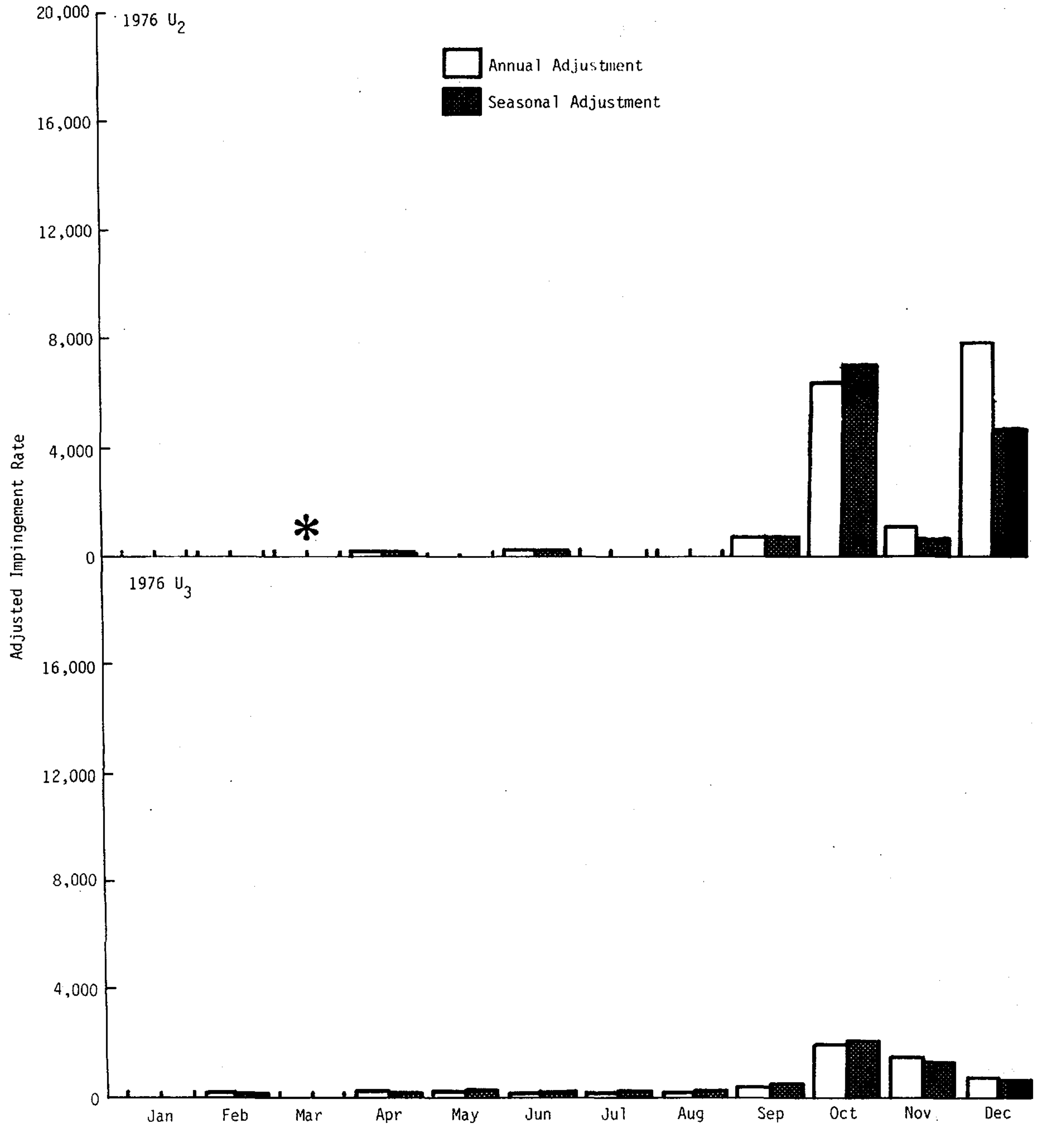


Figure A-3. Annually and Seasonally Adjusted Monthly Impingement Rates for All Species Combined (number impinged/volume pumped) at (a) Unit No. 2 (annual adjustment = 3.5; seasonal = 3.8 for May through October and 2.1 for the remainder of the year), and (b) Unit No. 3 during 1977 (annual adjustment = 1.4, seasonal = 1.5 for May through October and 1.2 for the remainder of the year)



* Part time use of air curtain prior to this time makes comparison inappropriate

Figure A-4. Annually and Seasonally Adjusted Monthly Impingement Rates for All Species Combined (number impinged/volume pumped) at (a) Unit No. 2 (annual adjustment = 3.5; seasonal = 3.8 for May through October and 2.1 for the remainder of the year), and (b) Unit No. 3 during 1976 (annual adjustment = 1.4, seasonal = 1.5 for May through October and 1.2 for the remainder of the year)

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APPENDIX B

RIVER STUDIES

APPENDIX B.1

Species Collected in Impingement and Nearfield Sampling, 1974 through 1979

Table B-1

Species Collected in Impingement Sampling (Indian Point Units No. 2 and No. 3) during 1975 through 1979 and in Nearfield Sampling, Hudson River Estuary, during 1974 through 1979

Species	Salinity Preference*	Impingement					Nearfield					
		1975	1976	1977	1978	1979	1974	1975	1976	1977	1978	1979
White Perch	e	X**	X	X	X	X	X	X	X	X	X	X
Blueback Herring	e	X	X	X	X	X	X	X	X	X	X	X
Atlantic Tomcod	e	X	X	X	X	X	X	X	X	X	X	X
Bay Anchovy	e	X	X	X	X	X	X	X	X	X	X	X
Hogchoker	e	X	X	X	X	X	X	X	X	X	X	X
Striped Bass	e	X	X	X	X	X	X	X	X	X	X	X
Rainbow Smelt	e	X	X	X	X	X	X	X	X	X	X	X
American Shad	e	X	X	X	X	X	X	X	X	X	X	X
Alewife	e	X	X	X	X	X	X	X	X	X	X	X
Weakfish	m	X	X	X	X	X	X	X	X	X	X	X
White Catfish	f	X	X	X	X	X	X	X	X	X	X	X
Spottail Shiner	f	X	X	X	X	X	X	X	X	X	X	X
American Eel	e	X	X	X	X	X	X	X	X	X	X	X
Pumpkinseed	f	X	X	X	X	X	X	X	X	X	X	X
Gizzard Shad	f	X	X	X	X	X	X	X	X	X	X	X
Tesselated Darter	f	X	X	X	X	X	X	X	X	X	X	X
Bluefish	m	X	X	X	X	X	X	X	X	X	X	X
Northern Pipefish	m	X	X	X	X	X	X	X	X	X	X	X
Atlantic Menhaden	m	X	X	X	X	X	X	X	X	X	X	X
Goldfish	f	X	X	X	X	X	X	X	X	X	X	X
Banded Killifish	f	X	X	X	X	X	X	X	X	X	X	X
Yellow Perch	f	X	X	X	X	X	X	X	X	X	X	X
Bluegill	f	X	X	X	X	X	X	X	X	X	X	X
Golden Shiner	f	X	X	X	X	X	X	X	X	X	X	X
Crevalle Jack	m	X	X	X	X	X	X	X	X	X	X	X
Three-Spined Stickleback	e	X	X	X	X	X	X					
Brown Bullhead	f	X	X	X	X	X	X	X	X	X	X	X
Silver Hake	m	X	X	X	X	X						
Striped Searobin	m			X	X	X						
White Bass	f	X	X	X	X	X				X		
Squirrel or Red Hake	m	X			X	X						
Butterfish	m	X	X	X	X	X						
Carp	f	X	X	X	X	X	X	X	X	X	X	X
Atlantic Sturgeon	e	X	X	X	X	X	X	X	X	X	X	X
Largemouth Bass	f	X	X	X	X	X	X	X	X	X	X	X
Lookdown	m			X	X	X						
Brown Trout	f		X	X		X				X		
Brook Trout	f		X									
Central Mudminnow	f			X		X						
Redfin Pickerel	f			X				X				
Northern Pike	f			X			X					
Chain Pickerel	f		X			X	X				X	
Cutlips Minnow	f			X								
Satinfin Shiner	f			X								
Blacknose Dace	f			X			X				X	
Longnose Dace	f									X		
Northern Hog Sucker	f			X								
Black Bullhead	f								X			
White Hake	m	X										
Brook Stickleback	f			X			X	X		X		
Green Sunfish	f							X				
Atlantic Croaker	m		X	X		X	X		X			X
Tautog	m			X								
Striped Mullet	m		X			X						
Silvery Minnow	f						X					
Comely Shiner	f											
Fallfish	f										X	
American Sand Lance	m					X						
Striped Anchovy	m					X						
Atlantic Mackerel	m					X						

*m = marine, e = euryhaline, f = freshwater
**X - indicate species was collected

Table B-1 (Contd)

Species	Salinity Preference*	Impingement 1975	Impingement 1976	Impingement 1977	Impingement 1978	Impingement 1979	Nearfield 1974	Nearfield 1975	Nearfield 1976	Nearfield 1977	Nearfield 1978	Nearfield 1979
Winter Flounder	m	X**	X	X	X	X				X	X	
Black Crappie	f	X	X	X	X	X	X	X	X	X	X	X
Mummichog	e	X	X	X	X	X	X	X	X	X	X	X
Sea Lamprey	m	X	X	X	X	X		X				
Atlantic Silverside	m	X	X	X	X	X	X	X	X	X	X	X
Hickory Shad	e				X	X					X	X
Redbreast Sunfish	f	X	X	X	X	X	X	X	X	X	X	X
Rough Silverside	m	X		X	X	X		X	X	X	X	X
White Mullet	m		X		X			X			X	
Atlantic Needlefish	m		X	X	X	X	X	X	X	X	X	X
Four-Spine Stickleback	e	X	X	X	X	X	X	X	X	X	X	X
White Sucker	f	X	X	X	X	X	X	X	X	X	X	X
Shortnose Sturgeon	e	X	X	X	X	X	X	X	X		X	X
White Crappie	f	X	X	X	X	X				X		
Black Sea Bass	m				X	X						
Four-Beard Rockling	m			X	X	X						
Silver Perch	m				X	X	X					
Spot	m		X	X	X	X			X	X		
Grubby	m		X	X	X	X						
Common Shiner	f		X	X	X		X			X		
Emerald Shiner	f	X	X	X	X	X	X	X	X	X	X	
Smallmouth Bass	f	X	X	X	X	X						
Moonfish	m				X	X		X				
Scup	m			X	X	X						
Smallmouth Flounder	m				X							
Northern Puffer	m		X	X	X							
Northern Searobin	m			X	X	X						
Summer Flounder	m		X	X	X	X	X					X
Windowpane	m				X	X						
Tidewater Silverside	e			X	X	X	X	X	X	X	X	X
Sea Horse	m				X							
Rock Bass	f	X		X	X	X				X		
Spotfin Shiner	f			X	X		X	X				
Eastern Mudminnow	f	X		X	X	X						
Conger Eel	m				X							
Rainbow Trout	f		X									
Silver Lamprey	f				X							
Longhorn Sculpin	m					X						
Mackerel Scad	m					X						
Totals	m- 39	50	58	72	72	74	50	47	43	48	47	42
	e- 17											
	f- 43											
Totals for All Years	99	93					67					

*m = marine, e = euryhaline, f = freshwater
**X - indicate species was collected

APPENDIX B.2

Dominant Fish Species Collected during Nearfield and Indian Point Long River Sampling

Table B-2

Catch/Effort (C/f) and Percentage (C/f of individual species ÷ C/f of all species combined X 100) of Ten Most Abundant Fish Species Collected during Indian Point Nearfield Sampling Using 30.5-m Beach Seine, Hudson River Estuary, 1974 through 1979

	1974		1975		1976		1977		1978		1979	
Species	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent
Blueback herring	8.08	7	33.10	22	56.28	37	77.14	49	96.07	49	3.31	4
Banded killifish	21.10	18	56.25	37	15.71	10	10.43	7	28.10	14	28.21	34
American shad	10.13	9	4.73	3	13.53	9	5.19	3	19.18	10	3.48	4
White perch	14.15	12	6.58	4	16.09	10	12.61	8	19.10	10	12.95	15
Striped bass	7.50	6	6.10	4	5.72	4	9.25	6	7.73	4	3.53	4
Bay anchovy	27.14	23	14.55	10	7.31	5	16.77	11	5.58	3	9.05	11
Spottail shiner	10.61	9	10.06	7	12.83	8	9.74	6	5.64	3	3.88	5
Tesselated darter	3.70	3	5.27	3	7.54	5	3.86	2	4.38	2	4.71	6
Alewife	1.29	1	1.41	1	6.05	4	2.28	1	2.42	1	0.43	1
Pumpkinseed	3.30	3	3.51	2	2.47	2	1.58	1	1.02	1	1.76	2
Others	9.02	8	10.60	7	10.36	7	9.20	6	6.57	3	12.43	15
All species combined	116.02	99	152.16	100	153.89	101	158.05	100	195.79	100	83.74	101

Table B-3

Catch/Effort (C/f) and Percentage (C/f of individual species ÷ C/f of all species combined X 100) of Seven Most Abundant Fish Species Collected during Indian Point Nearfield Sampling Using Unlined Bottom Trawl, Hudson River Estuary, 1974 through 1979

Species	1974		1975		1976		1977		1978		1979	
	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent
Atlantic tomcod	8.07	13	9.71	10	15.09	15	49.99	44	20.84	26	5.73	11
White perch	12.96	21	11.61	12	13.96	14	4.28	4	17.18	22	6.29	12
Hogchoker	25.91	42	18.94	19	8.23	8	5.32	5	18.87	24	11.80	23
Bay anchovy	4.33	7	19.95	21	32.65	33	21.05	18	10.14	13	10.67	21
Blueback herring	3.65	6	18.31	19	20.36	21	25.51	22	4.24	5	10.67	21
Rainbow smelt	0.09	<1	1.16	1	0.88	1	1.40	1	2.32	3	1.01	2
Alewife	2.86	5	11.21	12	2.55	3	3.41	3	0.83	1	1.39	3
Others	4.11	7	6.32	7	5.56	6	3.63	3	4.24	5	3.49	7
All species combined	61.98	101	97.21	101	99.28	101	114.59	100	78.66	99	51.05	100

Table B-4

Catch/Effort (C/f) and Percentage (C/f of individual species ÷ C/f of all species combined X 100) of Seven Most Abundant Fish Species Collected during Indian Point Nearfield Sampling Using Bottom Trawl with Fine-Mesh Liner, Hudson River Estuary, 1974 through 1979

Species	1974		1975		1976		1977		1978		1979	
	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent
Bay anchovy	49.91	50	72.20	43	74.24	40	66.50	31	19.87	25	42.83	46
Hogchoker	8.19	8	19.94	12	5.59	3	9.92	5	14.94	19	21.64	23
Atlantic tomcod	7.84	8	14.74	9	8.45	5	35.57	17	21.62	28	7.69	8
White perch	9.65	10	25.82	15	11.85	6	5.62	3	5.28	7	4.79	5
Blueback herring	17.42	17	16.81	10	76.34	41	80.77	38	6.75	9	3.39	4
Rainbow smelt	0.63	1	0.89	1	2.67	1	4.24	2	5.20	7	3.28	4
Alewife	2.42	2	9.90	6	1.99	1	5.53	3	0.78	1	2.86	3
Others	4.05	4	9.47	6	6.10	3	4.97	2	3.52	5	6.10	7
All species combined	100.11	100	169.77	102	187.12	100	213.12	101	77.96	101	92,58	100

Table B-5

Catch/Effort (C/f) and Percentage (C/f of individual species ÷ C/f of all species combined X 100) of Five Most Abundant Fish Species Collected during Indian Point Nearfield Sampling Using Surface Trawl, Hudson River Estuary, 1974 through 1979

Species	1974		1975		1976		1977		1978		1979	
	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent	C/f	Percent
Blueback herring	136.99	58	840.23	63	626.26	74	855.93	69	416.52	69	164.33	47
Bay anchovy	75.96	32	464.35	35	200.45	24	360.23	29	135.46	22	167.10	48
American shad	20.32	9	13.32	1	11.69	1	9.02	1	31.15	5	13.30	4
Alewife	0.55	<1	6.65	1	0.54	<1	6.74	1	19.01	3	1.23	<1
Bluefish	3.68	2	1.30	<1	0.57	<1	1.62	<1	0.61	<1	0.58	<1
Others	0.22	<1	0.32	<1	7.08	1	0.48	<1	2.50	<1	0.28	<1
All species combined	237.72	**101**	1326.17	**100**	846.59	**100**	1234.02	**100**	605.25	**99**	346.82	**99**

Table B-6

Percentage of Combined Catch/Effort (C/f of individual species ÷ C/f of all species combined X 100) during Standard Stations (SS) and Long River (LR) Beach Seining in Indian Point Region, Hudson River Estuary during 1976 through 1979

Species	1976		1977		1978		1979	
	SS	LR	SS	LR	SS	LR	SS	LR
Alewife	4	4	2	3	1	4	1	1
Bay anchovy	5	12	11	13	3	4	13	10
American shad	9	9	3	5	10	16	5	6
Pumpkinseed	2	3	1	1	1	1	2	3
Tessellated darter	5	4	3	1	2	2	7	2
Banded killifish	11	9	7	3	15	4	40	12
Blueback herring	39	34	52	60	51	57	5	52
Spottail shiner	9	9	7	5	3	3	5	4
Striped bass	4	2	6	3	4	3	5	2
White perch	11	13	8	6	10	6	18	9

Table B-7

Catch/Efforts for Ten Most Abundant Species Collected during Long River Beach Seining in Indian Point Region, Hudson River Estuary, during 1976 through 1979

Species	1976	1977	1978	1979
Alewife	3.69	3.64	4.50	0.85
Bay anchovy	11.54	13.82	4.39	10.24
American shad	8.38	5.62	19.19	6.61
Pumpkinseed	2.58	0.98	0.92	2.68
Tessellated darter	3.49	1.43	1.85	2.04
Banded killifish	8.71	2.76	5.05	12.91
Blueback herring	31.90	63.70	69.07	55.58
Spottail shiner	8.35	5.42	3.82	3.73
Striped bass	2.26	3.58	3.92	2.46
White perch	11.95	6.80	7.79	9.44
Total	92.85	107.75	120.50	106.54

Table B-8

Results of Kendall's Coefficient of Concordance Test on Ranking of Proportional Abundance of Species Collected by Indian Point Nearfield Sampling, Hudson River Estuary 1974 through 1979

	Kendall Coefficient of Concordance (W)
Beach Seine	0.38*
Unlined Bottom Trawl	0.12
Lined Bottom Trawl	0.30
Surface Trawl	0.94*

*Significant at α=0.05

Table B-9

Collection of Blueback Herring by Long River and Standard Station Beach Seine Sampling in Indian Point, Hudson River Estuary during Late October, 1979

Long River				Standard Stations			
Sample Number	Period	Number Caught	Percent of Total Catch*	Sample Number	Period	Number Caught	Percent of Total Catch*
2909	17 Oct	43	0.3	471	17 Oct	1	0.1
2938	17 Oct	50	0.4	472	17 Oct	1	0.1
2928	18 Oct	1	<0.1	473	17 Oct	11	1.4
2929	18 Oct	27	0.2	474	17 Oct	175	21.8
2930	18 Oct	9826	78.2	475	17 Oct	47	5.9
2931	18 Oct	5	<0.1	476	17 Oct	0	0
2932	18 Oct	81	0.6	478	25 Oct	7	0.9
3055	25 Oct	3	<0.1	479	25 Oct	0	0
3056	25 Oct	1	<0.1	480	25 Oct	0	0
3057	25 Oct	1320	10.5	481	25 Oct	2	0.2
3065	26 Oct	0	0	482	25 Oct	0	0
3066	26 Oct	0	0	483	25 Oct	0	0
3107	30 Oct	0	0	496	30 Oct	73	9.1
2866	31 Oct	0	0	497	30 Oct	0	0
2867	31 Oct	0	0	498	30 Oct	0	0
3106	31 Oct	0	0	499	30 Oct	69	8.6
3108	31 Oct	0	0	500	30 Oct	2	0.2
3109	31 Oct	6	0.1	501	30 Oct	0	0
3110	31 Oct	100	0.8				
3131	31 Oct	0	0				

*This refers to only blueback herring of which 12,561 were caught by Long River Beach Seine and 802 were caught by Standard Station Beach Seine efforts during 1979

APPENDIX B.3

Water Quality Parameters for
Indian Point Region, 1975 through 1979

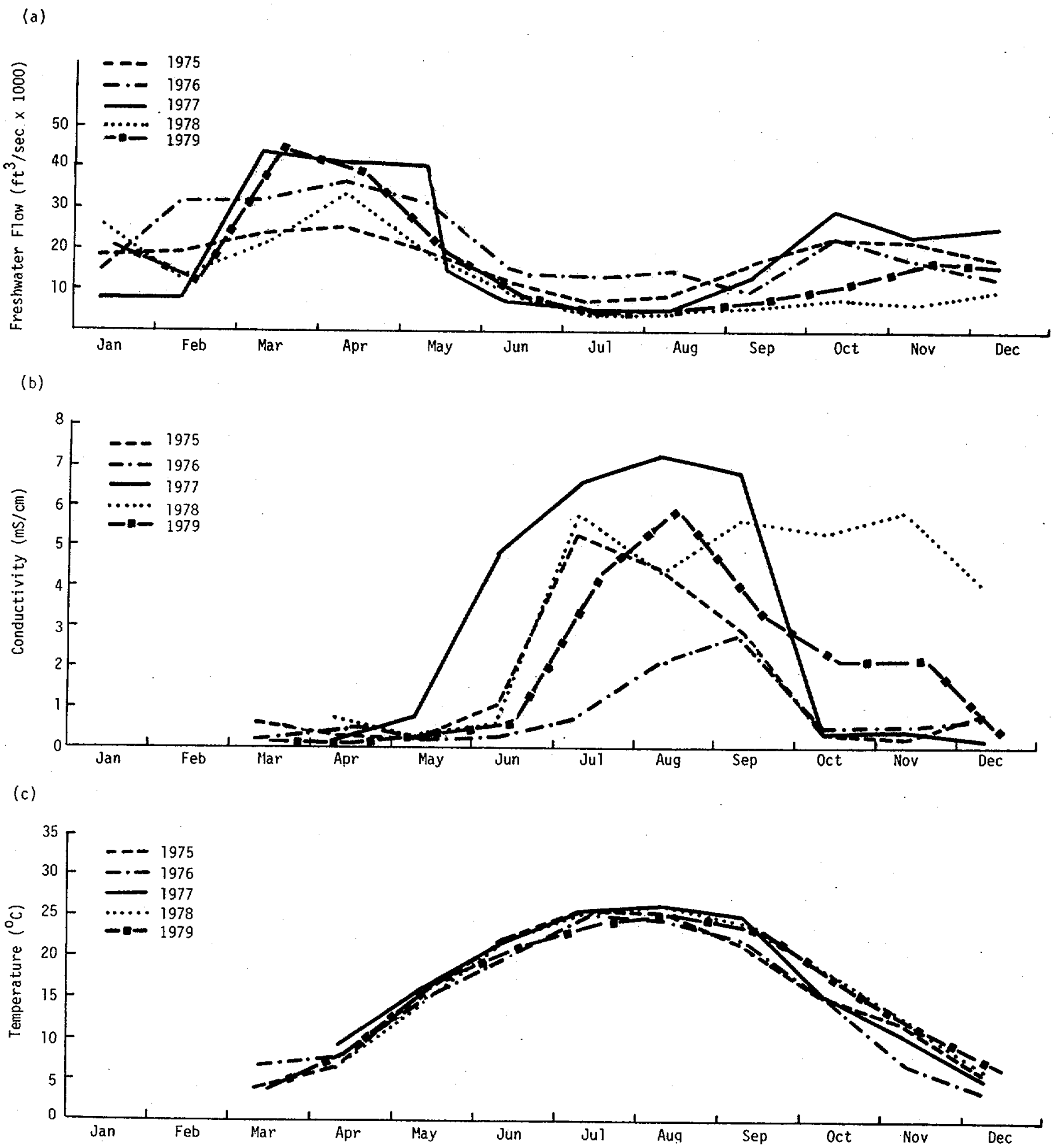

Figure B-1. Monthly Mean Freshwater Flow at Green Island (a) and Conductivity (b) and Water Temperature (c) in Indian Point Region, Hudson River Estuary, 1975 through 1979

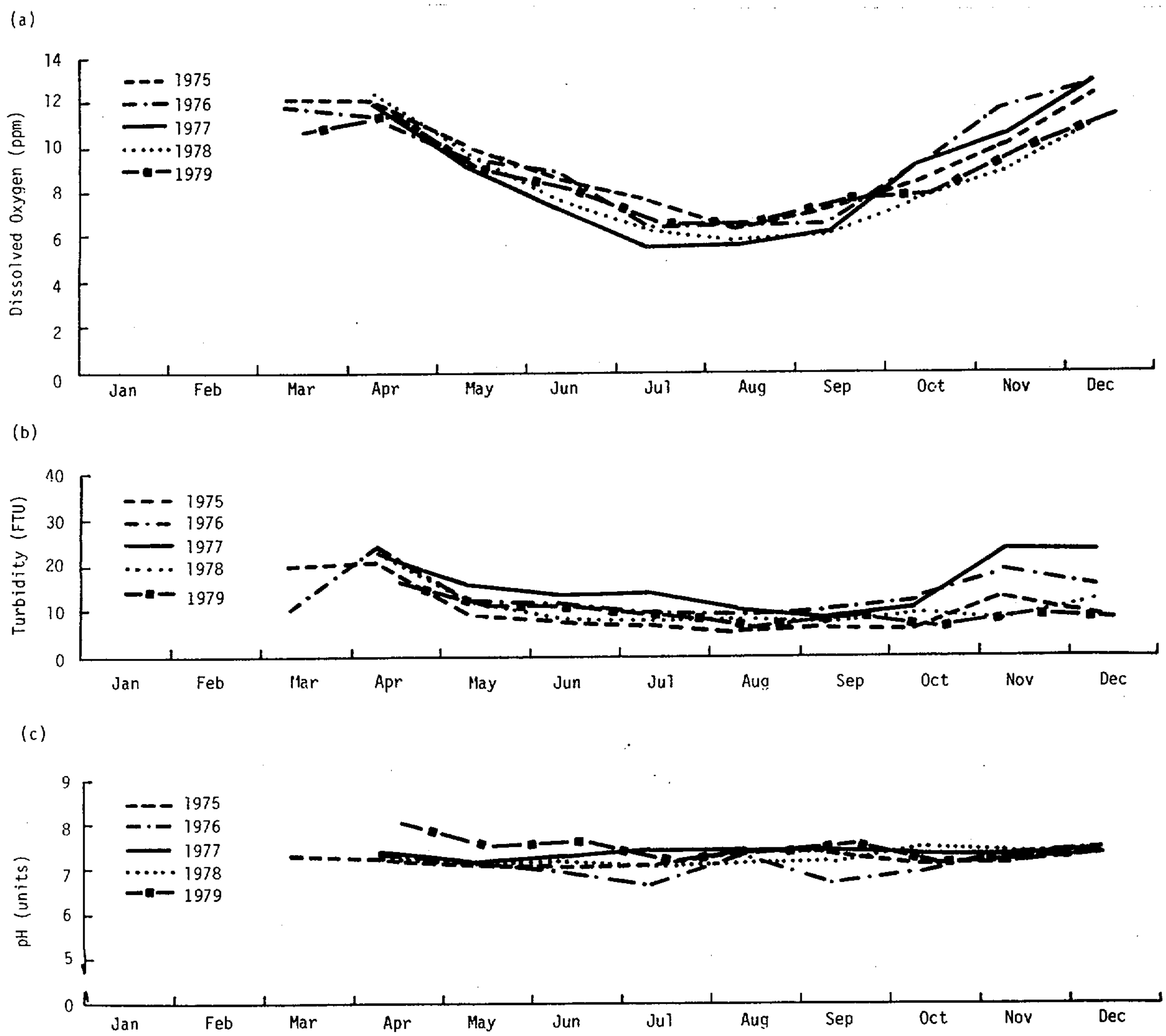

Figure B-2. Monthly Mean Dissolved Oxygen (a), Turbidity (b), and pH (c) in Indian Point Region, Hudson River Estuary, 1975 through 1979

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APPENDIX C

FIELD AND LABORATORY PROCEDURES

APPENDIX C

FIELD AND LABORATORY PROCEDURES

Field and laboratory procedures summarized in this section encompass those methods used for the collection of data during the 1979 sampling year. The data collected specifically for this report and task-specific schedules are described in Table C-1 and in detail below. The study designs used in previous years for impingement monitoring, Standard Stations and Long River Fisheries Sampling, the Adult Striped Bass Stock Assessment Program, and water quality data collection has been presented in previous reports (TI 1979a, 1980a). Quality control procedures were maintained in all sampling programs to ensure an average accuracy rate of 90% or better for the identification and total count of striped bass, white perch, Atlantic tomcod, and all other species combined.

1. Impingement Monitoring at Indian Point Electric Generating Station

a. Collection and Processing

During 1979, fish impinged on the intake screens of Units No. 2 and No. 3 of the Indian Point Generating Station were collected when the intake screens were routinely washed once daily between 0630 and 1200 hrs to remove accumulated fish and debris. Occasionally, heavy trash loading or fixed screen malfunction required more frequent or even continuous screen washing. Whenever possible, on those occasions fish were collected and counted using the same basic procedures as in routine sampling. Intake screens at Unit No. 1, which was not operational, were not routinely washed. When occasional washing occurred, the impinged fish were collected and processed following standard operating procedures as for the other units.

For each collection of fish (all screen washes per unit), individuals were identified to species and enumerated. Striped bass, white perch, Atlantic tomcod, blueback herring, alewife, and American shad were separated into four length classes (LC):

Table C-1

Schedule of Field Tasks during 1979 and Application of Data to Indian Point Annual Report

Task	J	F	M	A	M	J	J	A	S	O	N	D	Data Collected	Data Uses (Indian Point Annual)
Standard Station													Number and size of juvenile and older fish in shoals, channel, and shore zone. Biocharacteristics data	Species composition and relative abundance
Beach Seine				—	—	—	—	—	—	—	—	—		
Bottom Trawl				—	—	—	—	—	—	—	—	—		
Surface Trawl							—	—	—	—	—	—		
Long River Fisheries													Number and size of juvenile and older fish in shoal, channel, and shore zone. Biocharacteristics data	Species composition and relative abundance
Beach Seine				—	—	—	—	—	—	—	—	—		
Bottom Trawl				—	—	—	—	—	—	—	—	—		
Adult Striped Bass Program			—	—	—	—							Number, size, sex, mark-recovery, fecundity, and maturity	Recovery of hatchery-reared individuals
Water Quality Program	—	—	—	—	—	—	—	—	—	—	—	—	Temperature, dissolved oxygen, conductivity, pH, and turbidity	Environmental factors affecting impingement, abundance, and species composition
Impingement Monitoring	—	—	—	—	—	—	—	—	—	—	—	—	Number, size, and age (length class) of fish impinged	Annual and seasonal impingement patterns, relative abundance, and species composition

- LC 1 = 0 mm through Div_1
- LC 2 = Div_1 + 1 mm through Div_2
- LC 3 = Div_2 + 1 mm through 250 mm
- LC 4 = 251 mm and larger

The division values defined the upper total length limit for each age group [i.e., LC 1 contained young-of-the-year (YOY) fish, while LC 2 contained primarily yearling fish] and were determined by examining size distributions of previous years' data, spot checking age by scale analysis, and using reference literature. The division values were updated periodically to allow for growth.

Striped bass and white perch in each sample were individually counted and tallied by length class. Other species, except Atlantic tomcod, were processed as follows: 1) total weight of each species was determined (by length class where appropriate), and up to 100 individuals per length class were counted per sample; 2) if the collection of a species/length class exceeded 100, the total number was estimated by extrapolation using the total weight, and the weight of the 100 fish subsample. Adult Atlantic tomcod from each sample were individually counted, as were YOY tomcod during the winter marking season (15 November through 31 December). From 1 April to 15 November, numbers of YOY tomcod were estimated by subsampling when total daily counts were greater than 100 (using the subsampling technique described above). For the key species (striped bass, white perch, and Atlantic tomcod), individual lengths and weights were determined from biweekly subsamples of 25 fish per length class (when available).

b. Power Plant Operation and Environmental Variables

To provide a basis for computing impingement rates and for analyzing the factors affecting impingement rates at Units No. 2 and No. 3, cooling water circulator flow rates and the duration of circulator pump operation were monitored along with fish collections from the intake screens. Frequency of pump start-ups and shutdowns was also monitored along with water quality parameters which were recorded daily at the intake of each unit and in the common discharge for all three units.

c. Determination of Impingement Rates

The magnitude of fish impingement under ideal conditions is best assessed by dividing the total number of impinged fish by the total volume of cooling water circulated for each desired time period [adjusted (unselected) impingement rates, Appendix A]. However, factors such as ice floes, trash loading, unscheduled screen washes, equipment failure, and plant maintenance sometimes interfere with computing an accurate volume of water pumped during a particular collection period. To calculate more accurate daily impingement rates, daily impingement collection data were screened by TI to select days on which fish counts could be accurately matched to the water volume from which those fish were impinged. Rates computed from selected days are termed selected rates and are used in the calculation of estimated maximum daily counts (EMD's) (Section IV) for the analysis of impingement variation in this report. Selected rates were originated by TI in 1977 and compared to more conventional unselected rates in a previous report (TI 1979b). Recent refinements of the selection process, made possible by improved organization of the data base, have allowed a revision of the selection process. The net result of improved selection procedures was the inclusion of a greater portion of the impingement data than was used in previous reports. The extent of change can be determined by comparing percent of days selected in this most recent selection process (Appendix Table A-15) with similar tables in previous reports (TI 1979b and 1980a). Selection criteria for data used in the analyses presented in Section IV have been built into a standard computer function which can be easily and consistently applied to future data. Key criteria applied in deciding whether to include each individual screen wash were as follows:

1) The circulator associated with each screen being washed at a unit at a given time must have operated continuously since the last time that screen was washed.

2) The duration of the collection period for any screen being washed at a given time must not have exceeded 28 hours. (This was to allow a maximum fish accumulation period of approximately one day, yet encompass regularly scheduled washes which occurred between 0800 and 1200 daily.)

3) A collection period could only be selected for inclusion when each screen at the unit being washed was washed normally and its associated circulator was operating or was not washed regardless of whether the circulator was operating. Unusual operating conditions at any screen such as an unscheduled wash, an abnormal collection, etc. caused the entire unit's collection to not be selected for that particular screen wash.

4) Any wash during which an air curtain was operated at the unit was excluded. (This affected only washes at Unit No. 2 prior to 1 April, 1976.)

These criteria are essentially identical to those applied in earlier analyses (TI 1979b and 1980a) with the exceptions of a more precise definition of the collection period ($\leq$28 hours) and the ability to select on the basis of individual screen washes rather than selecting or excluding an entire day regardless of how many washes occurred that day. It was this latter change, made possible by an improved organization of the data base, which primarily provided the increase in data included compared to prior analyses.

d. Collection Efficiency Tests

Tests were conducted during 1979 to estimate the percentage of fish that were impinged but not collected during the impingement monitoring process. Losses of impinged fish occurred due to a variety of causes such as predation, water currents, and disintegration of fish after impingement. Such losses were aggravated at Unit No. 2 by the screen wash procedure itself in which fish were washed from the fixed screens and into the river prior to being reimpinged on and collected from the traveling screens.

To measure collection efficiency, dead striped bass and white perch were dyed various colors or tagged, and released at three depths in front of intake screen nos. 22 and 26 (Unit No. 2) and nos. 32 and 36 (Unit No. 3). Each test was composed of three releases at each of the two screens; the units were not tested simultaneously. A different color of dye was used in each release to examine the effect of impingement duration on fish loss. The first fish were released at about 1000 hrs, immediately after the morning screen wash. Subsequent releases were made at 1600 hrs and on the following day at 0600 hrs. When unscheduled washes interrupted a test, releases were halted, but collections continued. Recovery of dyed fish began with the next screen wash and continued during all succeeding screen washes. Fish were released at three depths (2.7 m, 4.6 m, and 6.4 m) at both Unit No. 2 and Unit No. 3. Because previous studies had indicated greater impingement near the surface (TI 1975b), 18 test fish were released at the 2.7 m, 6 at 4.6 m, and 6 at 6.4 m depths. At Unit No. 3, the three release locations (depths) were about 1.5 m in front of the traveling screen, while at Unit No. 2, the three positions were located about 1 m in front of the fixed screen. Individual screen efficiency was tested one time at each unit by releasing 30 dyed and tagged white perch as described above at each screen at 1600 hrs. Recovery of these fish began with the next screen wash and continued during all succeeding screen washes.

2. Standard Stations Program at Indian Point

The Standard Stations Program sampled juvenile and older fishes in the vicinity of the Indian Point Generating Station. Sample collection and laboratory processing were similar from 1975 through 1979. Sampling in 1979 involved 14 fixed stations between RM 39 and RM 43 (Figure C-1). Beginning in April and continuing through December, seven shore zone stations (Table C-2) were sampled weekly during the day, approximately two hours before low tide, with a 30.5 m beach seine.

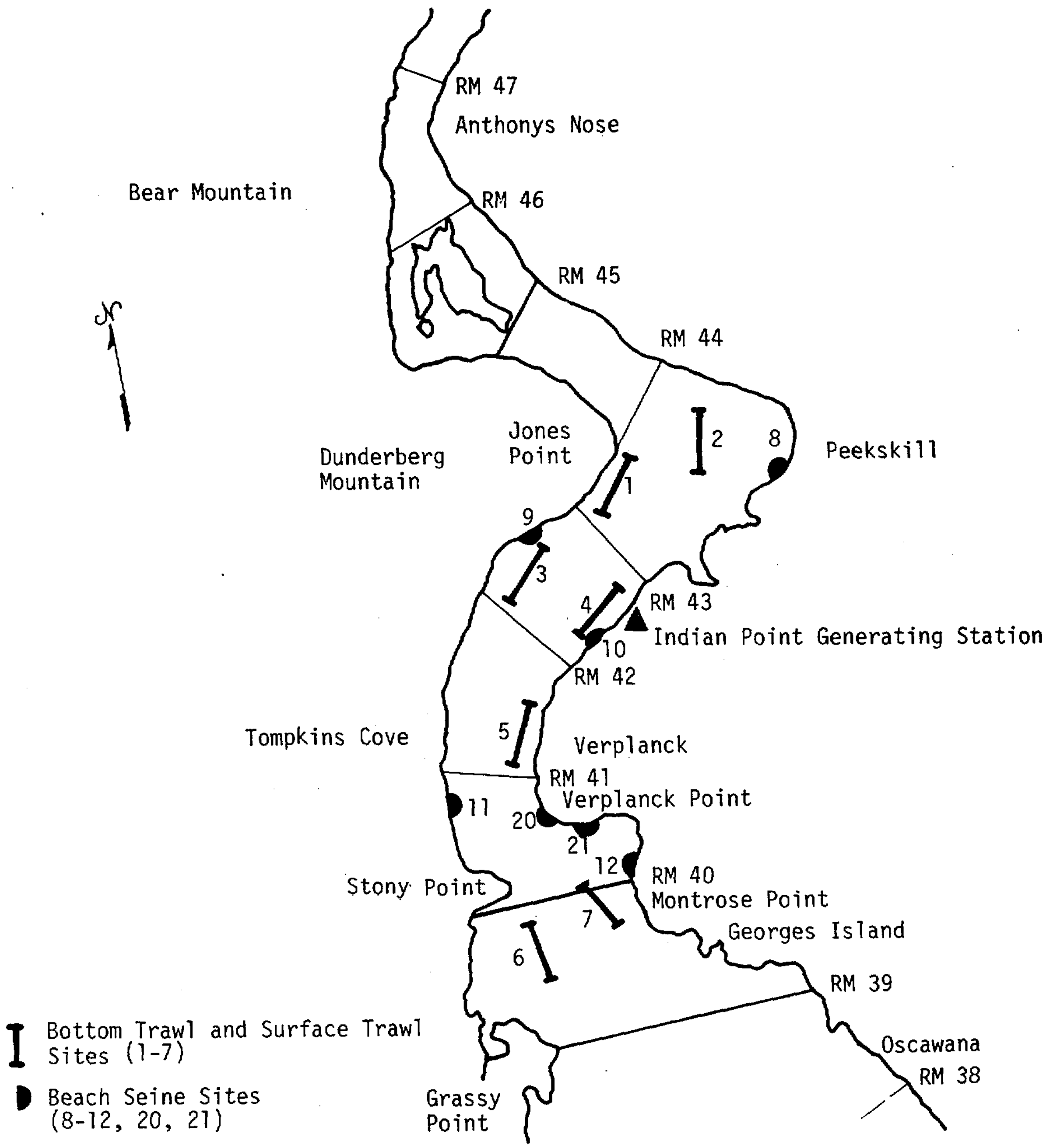

Figure C-1. Indian Point Standard Station Beach Seine, Bottom Trawl, and Surface Trawl Sites, Hudson River Estuary, RM 39 through 43, 1979

Table C-2

Location and Description of Standard Station Beach Seine Sites near Indian Point, Hudson River Estuary, 1979

Station	Location	Description
8	In Peekskill Bay (RM 43, east side) immediately south of public launching ramp	Mud bottom, beach covered with accumulation of glass; maximum depth* 1.5 m; heavy aquatic vegetation during summer; far from channel
9	South of Jones Pt. (RM 42, west side) near former reserve fleet headquarters	Medium sized rocks and gravel changing to mud as depth increases; maximum depth 1.0 m; heavy aquatic vegetation during summer; far from channel
10	100 m south of Indian Point discharge canal (RM 42, east side)	Sand/gravel beach, changing to mud bottom with increasing depth; maximum depth 3.7 m; little vegetation; close to channel
11	35 m south of Trap Rock Corp. barge mooring area (RM 40, west side)	Sand bottom; beach sloping steeply to 2.1 m; little vegetation; close to channel
12	Greens Cove (RM 40, east side) 100 m south of Cortlandt Yacht Club	Brick and rock beach, changing to mud with increasing depth; maximum depth 1.0 m; very dense vegetation in summer; far from channel
20	Verplanck Point (RM 40, east side) 10 m south of wharf	Sand beach, with an accumulation of detritus on bottom as depth increases; maximum depth 1.7 m; little vegetation; close to channel
21	South of Verplanck Point (RM 40, east side) near trailer park	Sand/gravel bottom; maximum depth 1.4 m; far from channel

*At a distance of approximately 30 m from the shoreline at low tide

During the latter half of 1979, one beach (Station 11, see Figure C-1) was often obstructed by barges from a nearby rock quarry and therefore not sampled. Seven offshore stations (Table C-3) were sampled twice biweekly during the day from April through December using a bottom trawl; once with a fine (1.5 cm stretch) mesh liner and again on another day the same week without the fine mesh liner (3.2 cm stretch mesh cod end). From July through December, each offshore trawl station was also sampled biweekly during the day with a surface trawl (4 mm stretch mesh). Additional gear dimensions have been detailed in a previous report (TI 1980a).

Table C-3

Location and Depth of Standard Station Trawl Sites near Indian Point, Hudson River Estuary, 1979

Station	Location	Depth (m)
1	RM 43 west side, off Jones Pt.	9
2	RM 43 east side, in Peekskill Bay	5
3	RM 42 west side, south of Jones Pt.	6
4	RM 42 east side, in front of Indian Point Generating Station	15
5	RM 41 east side, south of overhead power cables	14
6	RM 39 west side, south of Stony Pt.	14
7	RM 39 east side, between Verplanck Pt. and Montrose Pt.	5

All fish collected by each tow were placed on ice to retard deterioration for subsequent laboratory processing. Each sample was sorted by species into four length classes (LC) as defined below. The number of fish in each length class was recorded for each species, and a random subsample (maximum of 20 fish) from each length class for each species was measured and weighed. The four length classes were defined as:

- LC 1 = 0 mm through Div_1
- LC 2 = Div_1 + 1 mm through 150 mm
- LC 3 = 151 mm through 250 mm
- LC 4 = 251 mm and larger

The division value (Div_1) was a variable length which changed seasonally and was used to separate the youngest age group from older fish. The division value was determined for each species by examining the size distribution of the population at regular intervals (when data were available) during the year. Length class 1 contained fish from the current year class; i.e., YOY from the current spawning season through 31 December and yearlings from 1 January until the following spawning season. The division values were reduced at the beginning of each spawning season; thus, any yearlings collected thereafter were counted in LC 2. The division value was revised on 1 June for all species except the winter-breeding Atlantic tomcod for which the revision occurred on 1 April.

Atlantic tomcod from two standard station bottom trawl samples per biweek, collected on different days, were processed for biological characteristics; total length and weight was recorded for up to 80 YOY and 40 adult Atlantic tomcod per sample.

3. Long River Fisheries Sampling

a. Beach Seine Survey

The Beach Seine Survey yielded data on abundance and distribution of juvenile and older fishes in the shore zone of the estuary and provided a major portion of the mark-recapture effort. During April through June and September through December of each year, the estuary from the Yonkers through Albany regions (RM 12 through RM 152) was sampled biweekly using 30.5 m beach seines; on alternate weeks, sampling was confined to an area from Yonkers through Poughkeepsie (RM 12 through RM 76). During July and August of each year, all regions (RM 12 through RM 152) were sampled weekly.

One hundred samples per week were collected during the daytime from nearly 300 available beach sites. In 1979, samples were allocated on a regional basis based on the amount of shore zone surface area within each region but with a minimum of five samples per region (prior to 1979, the allocation was primarily keyed to the distribution of young-of-the-year striped bass). Sites were chosen daily and sampled only once per day, although some sites could have been sampled two or more times per week. The 30.5 m seine was set perpendicular to the shore, then towed clockwise to the beach to form a semicircular impoundment. The wings (end panels) of the net were pulled onto the beach thereby concentrating the catch in the middle (bunt) of the net (TI 1978, 1979a).

For each sample (beach seine tow), fish were sorted by species and length group as in Appendix Subsection C.2. YOY fish were preserved for identification and enumerated in the laboratory, with the exception of YOY striped bass and white perch during the fall marking period, YOY Atlantic tomcod during the winter marking period, and readily identifiable and easily counted species (e.g., bluefish), which were processed in the field. Yearling and older fish were counted and released in the field except for yearling striped bass and white perch needed to fill length/weight quotas and certain uncommon species which were kept for the reference collection.

Up to 45 length and 25 weight measurements of yearling striped bass and white perch during April through June and YOY during July through December were recorded each week in each of two super-regions (Yonkers through Poughkeepsie and Hyde Park through Albany). Up to 20 length measurements were recorded each week during July through December for YOY alewife, blueback herring, American shad, bay anchovy, spottail shiner, white catfish, weakfish, shortnose sturgeon, and Atlantic sturgeon per the following regions:

Region	RM (inclusive)
Yonkers	12 - 23
Tappan Zee	24 - 33
Croton-Haverstraw	34 - 38
Indian Point	39 - 46
West Point	47 - 55
Cornwall	56 - 61
Poughkeepsie	62 - 76
Hyde Park through Albany	77 - 152

All YOY striped bass and white perch were checked for marks during the fall marking season (September through December) and possible recaptures were preserved and taken to the laboratory for verification. All unmarked YOY striped bass and white perch, if in good condition and not needed to fill length/weight quotas, were marked by clipping one or two fins and released. Yearling striped bass and white perch were finclipped from April through June (spring marking season) and tagged during September through December. Two year old and older striped bass and white perch were tagged during both spring and fall marking periods. Yearling and older fish were tagged using either a Floy fingerling tag or a nylon internal anchor tag, dependant upon the total length of the fish. Atlantic tomcod were marked (finclipped or tagged using Carlin tags) during their spawning season (approximately November through February).

b. Interregional Bottom Trawl Survey

The Interregional Bottom Trawl (IRT) Survey yielded data on the abundance and distribution of juvenile and older fishes inhabiting the offshore bottom strata of the river. It also provided a deep-water recapture effort for marked fish. On alternate weeks during April through November, 38 fixed stations (Figure C-2) from RM 27 through RM 76 were sampled once during daytime with an otter-type bottom trawl equipped with a fine mesh (1.3 cm) cod-end cover (see TI 1979a for gear dimensions). Catches were sorted and counted by species and length group as in Appendix Subsection C.2. Young-of-the-year fish were usually preserved for laboratory processing while yearling and older fish were processed in the field and released. Up to 40 length and 20 weight measurements per super-region (YK through PK and HP through AL)

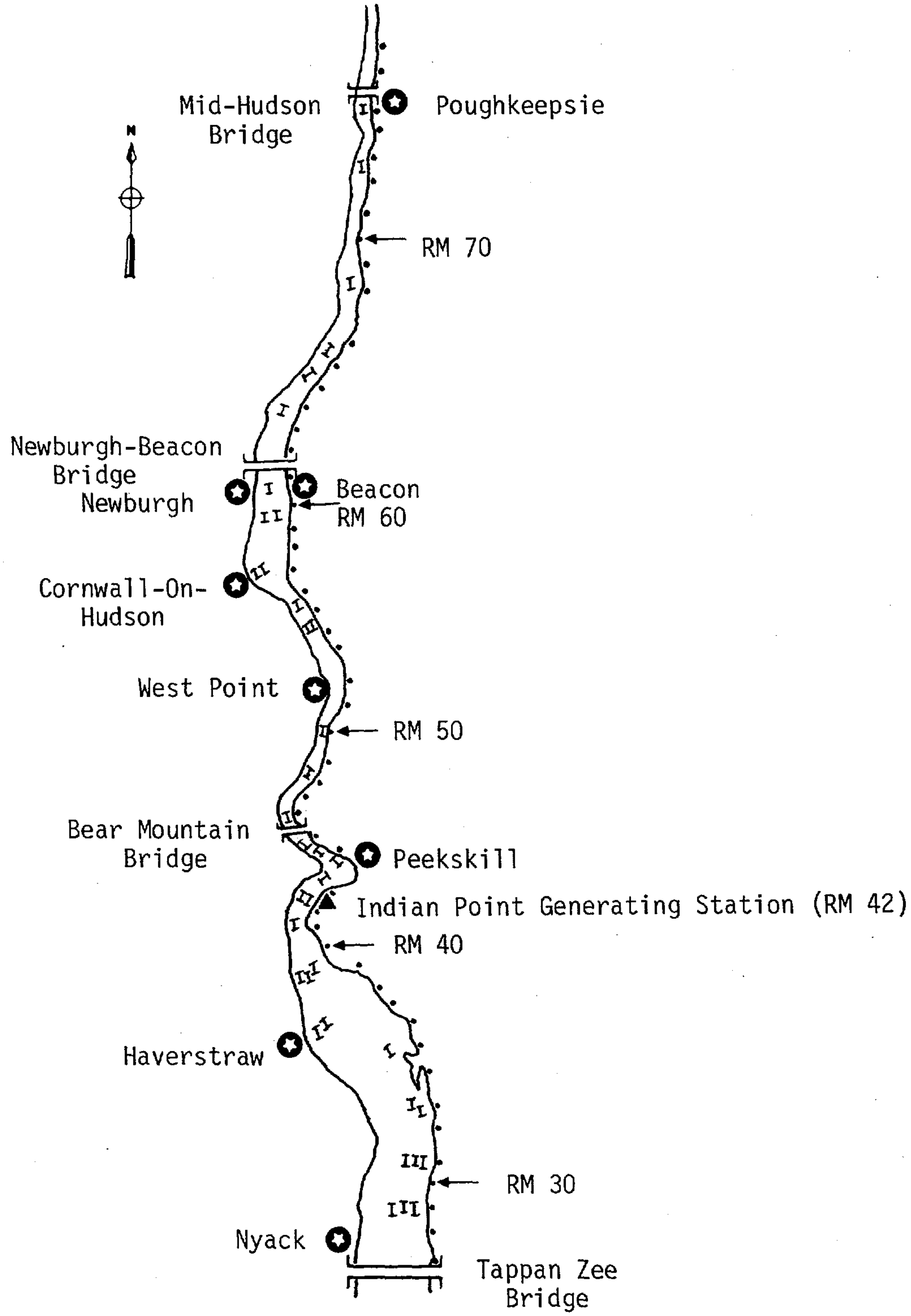

Figure C-2. Interregional Bottom Trawl Survey Sampling Sites, Hudson River Estuary, RM 27 through RM 76, 1979 were taken each sampling period (biweek) for yearling striped bass and white perch during April through June. When available, two samples containing at least 50 Atlantic tomcod were collected and returned to the laboratory per sampling period. Randomly selected subsamples from these two samples were processed for biological characteristics using methods identical to those described for Standard Stations bottom trawl samples. No fish were marked from the IRT Survey.

4. Adult Striped Bass Stock Assessment Program

A comprehensive study of adult striped bass ($\geq$200 mm TL) has been conducted since 1976 to determine the age and size structure, sex ratios, mortality rates, movements, and biological characteristics of the Hudson River spawning population. Adult striped bass have been collected for this program by both TI personnel and commercial fishermen. Because the commercial fishery for striped bass in the Hudson River was officially closed in early 1976, age and size composition of the commercial catch were estimated in 1979 by contracting three commercial fishermen to fish two days per week with their usual gear (gill nets) and to supply fish directly to TI. Each fisherman was accompanied by TI personnel during net-tending. In addition, tag returns (reward of $5.00 or $10.00 per tag) from sport and commercial fishermen provided information on movements and exploitation rates. Striped bass collected in this program also provided brood fish for the ongoing Hatchery Program as well as an opportunity to recover mature hatchery-reared individuals that were stocked during 1973 through 1975.

Gill nets, haul seines, and a 15 m bottom trawl were used by TI to collect adult striped bass. Based on distribution during the previous year, the gill net effort was concentrated in the vicinity of the Tappan Zee Bridge, Croton Bay, and Haverstraw Bay early in the spawning season (March and April), then shifted upriver to the Indian Point area in May, and returned downriver in June as the spawning season was ending. Two clusters of anchored gill nets (91 m x 2.4 m each) separated by an interval of several river miles were tended regularly during the day and night. Each cluster contained four standard nets of different mesh sizes (10, 13, 15, and 18 cm stretch multifilament) and usually from one to four additional nets of comparable mesh sizes. The less size selective haul seines were used to collect striped bass in the shore zone, primarily in Haverstraw Bay (RM 33 through RM 38). The 15 m trawl was used for the first time in mid-May 1979. Tows were made from the Tappan Zee through Cornwall regions and although sampling was conducted on an experimental and not routine basis, the adult striped bass collected were used by the Adult Striped Bass Stock Assessment Program.

Suspected hatchery-reared striped bass were brought to the laboratory and examined for evidence of fin clips and magnetic nose tags to verify their hatchery origin. Dead striped bass were kept for laboratory processing and were also checked for evidence of fin clips and nose tags. The maturity of recaptured hatchery-reared fish was determined by calculating the ratio of body weight to gonad weight. A ratio of less than 235:1 for males and less than 70:1 for females indicated sexual maturity and therefore the ability to spawn. Live fish that were in good condition, showed no evidence of fin clips, and were not needed for biological characteristics purposes (stomach or gonad samples, etc.) were measured, scale sample removed, sex determined (if possible), tagged and released.

5. Water Quality Tasks

In 1979, water quality data were collected concurrently with or subsequent to each impingement, standard stations, ichthyoplankton and long river fisheries sample. The instrumentation used to measure water quality parameters, as well as other details, are described in Table C-4. All instruments and thermometers were calibrated prior to daily sampling and checked for accuracy periodically during the sampling day.

Water quality data were collected at different depths and measured differently depending upon the task. Ichthyoplankton and fall shoal water samples were collected upon tow completion and at ichthyoplankton gear depth with a modified Van Dorn sampler. Temperature and dissolved oxygen concentration were measured upon retrieval of the Van Dorn sampler. A sample bottle was filled and returned to the laboratory for conductivity determination. In situ measurements of temperature, dissolved oxygen, pH, and conductivity were taken upon completion of the biological sampling for standard station trawls and, except for pH, interregional bottom trawls. Readings were taken at the following depth strata:

Task	Depth Strata		
	Surface	Middle	Bottom
Standard Station Bottom Trawl	Yes	Yes	Yes
Standard Station Surface Trawl	Yes	No	No
Interregional Bottom Trawl	No	No	Yes

NOTE: pH measurements were determined at surface only

Water temperature and dissolved oxygen were measured in situ for standard station and long river beach seine sampling efforts. Surface water samples were collected and returned to the laboratory for measurement of turbidity (from standard stations beach seine and trawl efforts), and conductivity (from standard stations and long river beach seine efforts). For the impingement task, water quality measurements were taken 0.3 m below the surface at each location as follows:

Unit 1 - off the pier

Unit 2 - at the south end of the intake near screen no. 21

Unit 3 - along the metal sea wall at the south end of the intake near screen no. 31

Discharge Canal - south of Unit No. 3 at the de-icing pump

In situ water temperature, dissolved oxygen measurements, and a surface water sample for conductivity determination were taken at Indian Point Units No. 1, No. 2, and No. 3. Only water temperature was collected in the discharge canal. Variables related to plant operation were obtained directly from plant engineers.

Table C-4

Water Quality Measurements Taken with Each Biological Sample; Sample Depth*, Field or Laboratory Determination†, and Instrumentation** Used to Measure Each Parameter during 1979

Task	Sample* Depth	Instrumentation** for each Task and Water Quality Factor: Water Temperature	pH	D.O.	Conductivity	Turbidity
Standard Station						
Beach Seines	S	F4†	F7	F4	L5	L3
Surface Trawls	S	F1	F7	F1	F1	L3
Bottom Trawls	S,M,B	F1	F7	F1	F1	L3‡
Long River						
Beach Seines	S	F4	--	F4	L5	--
Bottom Trawls (IRT)	B	F1	--	F1	F1	--
Ichthyoplankton	G	F2	--	F2	L5***	--
Impingement	S	F4	--	F4	L5	--

*S = Surface, M = Middle, B = Bottom, G = At biological gear sampling depth

†F = Field, L = Laboratory

**(1) Hydrolab Surveyor Model 6D in situ Water Quality Analyzer

Reserve Equipment:

(a) YSI Model 57 Dissolved Oxygen Meter (Temperature, D.O.)
(b) YSI Model 33 Salinity-Conductivity-Temperature Meter
(No in situ pH measurement was taken when reserve equipment was used)

(2) YSI Model 57 or 54 Dissolved Oxygen Meter or B.O.D. - Weston and Stack

(3) Hach Model 2100-A or Ecolab 104 Turbidimeter

(4) YSI Model 57 Dissolved Oxygen Meter

(5) YSI Model 31 or 33 Conductivity Bridge or Markson Model 10 Conductivity Meter

(6) YSI Model 33 Salinity-Conductivity-Temperature Meter

(7) IL Model 175 Porto-matic pH meter

‡Turbidity was measured for surface samples only

***F(6) prior to approximately 22 October 1979

Dashes indicate no physicochemical measurements taken

Note: Temperature and conductivity measurements which were not taken in situ because of meter problems were determined from a sample collected at the surface. Water temperature was determined with a mercury, alcohol, ordial thermometer and the sample bottle was capped and returned to the laboratory for futher analysis.