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1976 YEAR-CLASS REPORT
FOR THE
MULTIPLANT IMPACT STUDY
OF THE
HUDSON RIVER ESTUARY

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RETURN TO REACTOR DOCKET
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May 1979

TEXAS INSTRUMENTS INCORPORATED

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SECTION I
INTRODUCTION

This report is the fourth in a series of studies conducted by Texas Instruments (TI) to evaluate the effects of one nuclear (Indian Point) and four fossil-fueled (Bowline, Lovett, Roseton, Danskammer) generating stations on fish populations in the Hudson River estuary. Initiated in 1973 and jointly financed by Consolidated Edison Company of New York, Inc. (Con Edison), Orange and Rockland Utilities Inc. (O&R), Central Hudson Gas and Electric Company, Inc. (CH), and the Power Authority of the State of New York (PASNY), the studies involve an intensive year-round sampling program encompassing most of the 150-mile-long estuary. The purpose is to provide information on the life history, distribution, and population dynamics of key fish species for use in assessing any existing and potential impact of once-through cooling at each generating station.

This report emphasizes the collection and analysis of data on the 1976 year class of striped bass (*Morone saxatilis*), white perch (*Morone americana*), and Atlantic tomcod (*Microgadus tomcod*) during the period of entrainment and impingement vulnerability, which encompasses the entire egg, larval, and young-of-the-year stages as well as the first 5 to 6 months of the yearling stage.

The primary objectives were to:

- Describe the spatiotemporal distribution of the early life stages of striped bass, white perch, and Atlantic tomcod
- Assess exposure (vulnerability) to either entrainment or impingement for each life stage of these species at the existing Hudson River power plants
- Estimate each species' biological characteristics
- Investigate the population dynamics of each species and discuss density-independent and density-dependent population regulatory mechanisms and their effects on growth and abundance

Information on life stages older than yearling reflects data collected during 1976 and can consist of several earlier year classes. Where possible, 1976 year-class data are compared with results of studies conducted on the 1973, 1974, and 1975 year classes of these three species and results of previous studies by New York University (NYU) (1965-69) and Raytheon (1969-70). The data collection and analysis on these earlier year classes were described in previous progress reports (TI 1975a, 1977b, 1978a) as well as in McFadden (1977).

Section II of this report provides a concise summary and review of results in terms of a potential for impact on the Hudson River fish population due to the operation of power plants.

Section III summarizes the methods and materials with which the data were collected. These methods are examined in view of the methods from previous years' studies; changes, additions, and deletions in sample design, methods, or materials are noted.

Section IV reviews the general life history of each of the three species. Estimates of the various population parameters, which include population size, mortality, growth, fecundity, sex ratio, and age at maturity and provided. The 1976 estimates are compared with those of the previous studies. Trends through time are noted and factors influencing these trends are investigated.

Section V presents the spatiotemporal patterns in abundance and movements of the three key fish species, emphasizing the early life stages (eggs, larvae, and juveniles). These patterns are compared with those evident in earlier studies, and factors influencing the trends are analyzed and discussed. Information from these comparisons is related to power plant location, and an assessment of the exposure of each life stage to entrainment or impingement at each power plant is developed. This exposure assessment is compared with similar assessments from previous years.

Throughout these multiple plant studies, there has been an attempt to utilize information gained in previous years to refine data collection and analytical techniques. Where possible, the data of previous years have been reanalyzed in view of new information. While these changes in methods can produce different results from year to year, the underlying goal of this evolution is to provide the most complete comprehensive information on the key fish species for use in assessing power plant impact.

To aid the reader, a glossary of the common technical and semi-technical terms used in this report follows. The technical terms are defined as they apply to this study and a knowledge of the definitions of these terms is a key to an understanding of the contents of this report. More specific terms are defined in the text, particularly in Section III (Field and Laboratory Procedures).

GLOSSARY

age composition: the quantitative make-up of a group or population of fish based on age classes (e.g. age I, II, III, etc.).

anadromous: aquatic organisms which spend most of their life cycle at sea but return to rivers and streams to spawn.

biological characteristics: see population characteristics.

biomass: the total weight of a given species or life stage within a prescribed area.

catch curve: a graph of the logarithm of the number of fish taken at successive ages or sizes.

catch curve analysis: use of a catch curve to estimate mortality rates between successive ages or sizes. (see catch curve)

catch-per-unit-area (catch-per-unit-area; swept catch-per-unit-volume): the catch of fish, in numbers or weight, taken by using a specified gear and sampling a defined area or volume.

catch-per-unit effort: the catch of fish, in numbers or in weight, taken by using a specified gear for a defined amount of time or amount of gear deployment.

CHG&E: Central Hudson Gas and Electric Corporation compensation: the group of processes operating in populations which cause population densities to be maintained at pre-impact levels despite mortality from man's activities. Compensation stabilizes numbers, biomass, and/or energy content of populations because birth rates, survival rates, and/or growth rates are inverse (negative) functions of density. Thus, compensation reflects the principles of density-dependent population regulation.

compensatory mechanisms: "compensatory mechanisms" "Sources of density-dependent mortality. As man-made mortality increases, mortality from these sources decreases, and total mortality remains about the same."

competition: the attempt by two organisms or populations to acquire an item needed for survival that is not present in sufficient amounts for both.

conditional mortality rate: the fraction of an initial stock that would be killed due to either entrainment or impingement if no other causes of mortality operated.

conductivity (specific conductance): a measure of the total concentration of the dissolved ionic matter and a capacity measure of a solution to conduct an electric current. Since it is dependent on temperature (conductance increases 2% to 3% per degree centrigrade), conductivity is reported at a standard temperature of 25°C in m Siemens/cm (mS/cm).

density-dependence: population regulatory mechanisms (mortality, fecundity, etc.) that change in magnitude as density changes. Density dependent population regulation is often used synonymously with compensation.

dissolved oxygen: oxygen dissolved in the water through photosynthesis by phytoplankton and vascular plants and diffusion of atmospheric oxygen and expressed as parts per million (ppm) or milligrams per liter (mg/l).

EAI: Ecological Analysts Incorporated

entrainment (pumped): the passage of small organisms into a power plant's condenser system through an intake screen with cooling water withdrawn from a lake or river.

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

euryhaline: the ability to tolerate wide changes in salinity; characteristic of many estuarine species and certain stages in the life history of other species.

exposure: see vulnerablity.

FERC: Federal Energy Regulatory Commission

fecundity: the ability of fish to produce offspring commonly measured by the number of ripening eggs present per female just prior to the upcoming spawning season.

finclip: a method for rapidly marking fish by excising (cutting a piece out of or completely removing) one or more of the fins; this method is widely used on fish that are too small to tag effectively.

gear avoidance: the behavior of a fish which enables it to escape being captured in fishing gear.

ichthyoplankton: the early life stages of fish characterized by generally limited swimming ability and a tendency to drift with currents.

impingement: the process whereby the velocity of water being withdrawn through a cooling water intake screen forces organisms (or objects) to come into contact with and be held against that screen.

incremental growth rate: the gain in size for some time period in relation to the size at the beginning of the time period; or the difference in length from one age group to the next age group.

instantaneous growth rate: the natural logarithm of the ratio of final weight (or length) to initial weight (or length) of a fish for a unit of time, usually a year.

juvenile: the lifestage beginning with aquisition of the full complement of adult fin characteristics and extending to age I (December 31). This lifestage is also referred to as young-of-the-year.

key species: fishes defined as key species in this report are striped bass (Morone saxatilis), white perch (Morone americana), and Atlantic tomcod (Microgadus tomcod). These three species have been designated as key species in this report based on their distribution and abundance relative to Hudson River power plants. In addition, these three species are of interest to regulatory agencies and are included on the lists of Representative Important Species (RIS) designated by the United States Environmental Protection Agency for the Hudson River power plants.

length-frequency: percent composition of a sample or organisms by defined length intervals.

LMS: Lawler, Matusky, and Skelly Engineers mark-recapture: a method of estimating numbers of animals by initially releasing a known number of marked individuals and then sampling to determine what fraction of the total catch consists of marked animals.

microdistribution: differences in the abundance of an organism over a small area, often divided into vertical or lateral differences.

near-field: areas of the Hudson River estuary in the vicinity of a power plant, e.g. for Indian Point, the area from river mile 39 through 43.

NRC: Nuclear Regulatory Commission

NYSDEC: New York State Department of Environmental Conservation

NYU: New York University

O and R: Orange and Rockland Utilities, Inc.

Petersen Method (Petersen-Type Estimate): a mark-recapture estimate in which the marking period and recapture period do not overlap; originally used for estimating fish populations by C.G.J. Petersen in 1896.

pH: the pH of a solution is a measure of its hydrogen ion activity - 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.

plant region (power plant region): region of the estuary 6.5 miles upriver and downriver of a power plant, e.g., for Bowline, river mile 30.5 to 43.5. Water from 6.5 miles in either direction can be moved in front of the power plant by tidal fluctuations.

population characteristics: attributes of a population as a whole, which are set by the interaction of genetic-based characteristics with a particular environment; examples include sex ratios, age composition, fecundity, and age at maturity.

population: A single-specific group of organisms that is reproductively isolated from other groups of the same species.

population dynamics: the study of the forces affecting population densities, usually considered to be mortality, natality, and movements.

post yolk-sac larvae: the stage from initial development of a complete and functional digestive system (regardless of degree of yolk and/or retention) to transformation to the juvenile lifestage (having a full complement of fin rays).

power plant region: see plant region.

random walk: a series of numbers, n-1, such that the magnitude of the changes $[n_i-(n_i-1)]$ are random.

R/C ratio: the fraction of fish in a sample that has been previously marked; in mark-recapture studies, this statistic is used to estimate the parameter M/N (the number of marked fish divided by the population size; the fraction of the total population which is marked).

R/M value: the fraction of recaptured marked fish; this statistic is used as an estimate of the exploitation rate (C/N) to which a population is exposed. C/N is defined as the total catch in the recovery sample divided by the population size; the fraction of the population which is examined.

salt front: the location of the leading edge of the mass of intruding seawater to the estuary. Defined here as the point associated with a conductivity of 0.3 m Siemens/cm (mS/cm) or equivalent to a salinity of about 0.1 ^{o}/oo.

Schaefer Estimate: a type of mark-recapture estimate which is used when the population can be stratified on a temporal and spatial basis; originally developed by M.B. Schaefer in 1951 for estimating spawning stocks of Pacific salmon.

Schumacher-Eschmeyer Estimate: a type of mark-recapture estimate in which marking and recapturing effort concurrently occur. This method was first reported by Schumacher and Eschmeyer in 1943.

spawning stock: the mature or maturing fish that are capable of contributing to the production of that year's spawn (eggs).

standing crop: the total biomass or numbers of organisms present at one time.

stock: fish available (or potentially available) for commercial or sport use.

stock-recruitment relationship: the relationship between parental stock and their offspring. Since the number of offspring are generally measured when they are old enough to be caught by a standard fishing gear (commercial or sport), they are said to be recruited to the population at that time.

stratum (strata pl.): a defined portion of a sampling unit. As used in this report, one of three (shoals, bottom, and channel) classifications of a typical river cross-section based on depth and distance from the bottom.

turbidity: the cloudiness of water caused by the presence of suspended particulate matter (such as clay, silt, microorganisms, and organic and inorganic detritus).

type A error: a systematic error in mark-recapture data which will bias the population estimate by a constant proportion.

type B error: a systematic error in mark-recapture data which produces a temporally increasing amount of bias in the population estimate.

type C error: a systematic error in mark-recapture data which will bias the population estimates in a manner that decreases through time.

vulnerability (exposure): a measure of the potential susceptibility of the population to either entrainment or impingement by power plants. The term is also used to refer to the percent of the population within those river areas which have a physical proximity to power plants.

year class: the fish spawned or hatched during a given calendar year.

year-class abundance (year-class strength): the number (or relative number) of fish of a given species spawned or hatched during a given calendar year. This number is usually calculated late in the year after most density-dependent mortalities no longer operate.

year-class strength: see year class abundance.

yearling: an age classification of a fish which extends from 1 January following the year in which it was spawned through 31 December.

yolk-sac larvae: the transitional stage from hatching through development of a complete and functional digestive system.

young-of-the-year: see juvenile.

SECTION II

SUMMARY AND CONCLUSIONS

Biological characteristics and population dynamics of Hudson River striped bass, white perch, and Atlantic tomcod; the spatiotemporal distribution of their early life stages; and each life stage's exposure to either entrainment and/or impingement were studied to relate them to the ability of each species to compensate for additional mortality above the average level of mortality imposed by natural events or by power plants and other man-related activities. The conclusions presented in this section indicate some of the causes for observed fluctuations in fish populations in the Hudson River estuary and how these fluctuations may influence the assessment of power plant impact. The three species exhibit a wide range of adaptive strategies necessary for survival. Striped bass are anadromous and use the estuary as a spawning and nursery area; they are large, long-lived, and have enormous fecundities (eggs per female). White perch reside year-round in the estuary and are intermediate in size, longevity, and fecundity. Atlantic tomcod, small fish that seldom live much longer than one year, have a temporally well-defined spawning run in the winter when few other fish spawn.

The remainder of this summary is divided into four sections: A) Spatio-temporal Distribution, B) Comparison of Overall Exposure to Power Plant Impact, C) Biological Characteristics, and D) Population Dynamics. The Spatio-temporal Distribution and Biological Characteristics sections are each subdivided to discuss characteristics of each of the three species. The Comparison of Overall Vulnerability section is subdivided into life stages; while Population Dynamics Section, encompasses diet, growth, abundance, and compensation.

A. SPATIOTEMPORAL DISTRIBUTION

1. Striped Bass

The distribution of striped bass eggs in 1976 was similar to that of the two previous years: most eggs were found in the Indian Point (RM 39-46) through West Point (RM 47-55) regions. In 1976, spawning apparently slowed during a temporary drop in water temperature in late May and resumed when water temperature again increased in early June, giving rise to a bimodal temporal distribution of eggs. Since surviving larvae during that year resulted from the second, smaller spawn, larvae spawned first probably suffered high mortality during the temperature decline.

Striped bass yolk-sac larvae also had a bimodal geographic distribution during both 1975 and 1976, with the Indian Point to West Point region and the Poughkeepsie region representing areas of concentration. During 1976, as in 1974 and 1975, post yolk-sac larvae were abundant in the Indian Point-West Point and the Poughkeepsie regions. Temporal distribution of post yolk-sac larvae was unimodal in all three years with peak values occurring from june 5 to June 20. Juveniles (the first lifestage with extensive motility) and yearlings tended to be distributed downriver in the Tappan Zee and Croton-Haverstraw regions. Little interregional movement was noted when individually marked juvenile and yearling fish were recaptured, and movements between shore zone and shoal and deep-water areas were not as evident during 1976 as in 1975. The total number of juveniles was not substantially different from that found in previous years despite the fact that they were derived from only a fraction of the normal spawn; this observation is indicative of the complex relationships between environmental changes, natural mortality, and year class strength.

Striped bass may occupy a distinct home range early in life and later begin to move extensively, a hypothesis supported by data from TI (1978a) and the observation of long-range movements of a few yearlings tagged in 1976. Tagging studies of two-year-old and older fish from the spawning run were intensified in 1976 to elucidate migratory patterns. Two patterns were detected; some fish stayed near the mouth of the river, while others made oceanic movements to the northeast.

2. White Perch

In 1976 white perch began spawning in late April, earlier than in 1974 and 1975, and were collected in all regions above Yonkers. Egg standing crops peaked during mid-May to mid-June. Yolk-sac larvae were also found in all regions above Yonkers, and the standing crop peaked around May 20. Post yolk-sac larvae were abundant in all but the Yonkers and Albany regions though they were more concentrated in regions from Poughkeepsie to Catskill in 1976 than in 1974 and 1975. As in 1974 they were found in highest numbers during the latter part of June 1976.

Juvenile white perch were first collectd in late June and early July, and reached their peak abundance during August, followed by a decline in numbers through the fall and winter. They tended to concentrate in two broad sections of the estuary: from the Tappan Zee to Croton-Haverstraw regions and upriver from the Saugerties to the Catskill regions.

Yearling white perch were most frequently caught during May through July with catches declining thereafter. Highest catches of 2-year-old and older white perch occurred between late May and June in 1976. Yearling and older white perch occupied the same general areas as juveniles.

To examine local white perch movements, shore zone catches were compared with channel catches. Juveniles were first collected in the offshore channel areas during July, in the shore zone during August, and offshore during October. Individuals marked and recaptured during the spring exhibited greater movement than those marked and recaptured during the fall. Only 3% of the September through December recaptures left the region in which they were marked, but 60% of the January-June recaptures moved to a different region. Adult white perch also exhibited less movement in the fall than in the winter.

3. Atlantic Tomcod

Atlantic tomcod spawned in late December through February 1976 when sampling of eggs was impossible because of ice. In late February, some eggs were collected in the West Point and Cornwall regions, and yolk-sac larvae were found in all regions sampled (Yonkers to Poughkeepsie). During 1975 and 1976, Atlantic tomcod yolk-sac larvae were most common in the river during early March and post yolk-sac larvae were primarily found from late

March through late April. The highest proportion of the standing crops of yolk-sac and post yolk-sac during 1976 was in the Croton-Haverstraw and Tappan Zee regions. These distribution patterns are similar to those observed in 1975. Juvenile tomcod were widely distributed but were concentrated primarily from the Yonkers to West Point regions. Standing crops were high in early May and late June, but declined steadily through December. Adult tomcod were concentrated in the West Point region during the spawning season but were found farther upriver during the 1976-77 spawning season than during the previous two seasons (1974-75 and 1975-76). Mark and recapture data indicated that adult fish move downstream after spawning.

B. COMPARISON OF OVERALL EXPOSURE TO POWER PLANT IMPACT

The index of exposure (vulnerability) to power plants is the basis of comparison derived using plant regions. Since the Hudson River estuary is under the influence of tides, the water mass in front of each power plant shifts back and forth with the tides; thus, any organism within this water mass must be considered in the assessment of plant impact. The maximum shift due to tides is approximately 6.5 miles for the area of the estuary in which the power plants are located. Each plant region is defined as a 13-mile region with the plant at midpoint. The exposure index is the percentage of the total standing crop of a given life stage found in a particular plant region during the period of peak abundance for that life stage.

1. Eggs

Striped bass eggs were exposed more to entrainment than those of the other two species for two reasons: the distribution of striped bass eggs was centered in the area of the Indian Point and Lovett plants, and striped bass eggs have a low specific gravity and are more easily distributed through the water column by water currents. A large proportion of white perch eggs were deposited outside the plant regions. White perch eggs are both demersal and adhesive. Atlantic tomcod apparently spawned between the upriver and downriver plants. Also, Atlantic tomcod eggs are demersal (tending to settle to the bottom) and therefore not easily carried to the plant intakes by water currents.

2. Yolk-Sac Larvae

Striped bass yolk-sac larvae were concentrated on the bottom during the day and more evenly distributed throughout the water column at night. This pattern of dispersion reduced exposure, since half the time few larvae were in the vicinity of the intake systems. White perch larvae tended to stay near the bottom and were afforded some protection because of their wide distribution throughout the estuary. Atlantic tomcod were exposed to entrainment at the three downriver plants where they are concentrated.

3. Post Yolk-Sac Larvae

The post yolk-sac larvae of all species are more motile than the earlier stages and are more able to avoid entrainment. Striped bass post yolk-sac larvae have a greater tendency to concentrate near the bottom than yolk-sac larvae. Post yolk-sac larvae are primarily distributed in the Indian Point-Lovett area. Thus, while exposure was probably less than the earlier lifestages, it was still high. White perch post yolk-sac larvae are found in abundance outside the plant regions, which reduces their exposure. Atlantic tomcod post yolk-sac larvae are distributed more downriver, so their exposure is reduced relative to yolk-sac larvae at all plants except Bowline.

4. Juveniles

Comparatively few juvenile striped bass were impinged although they were exposed to impingement at the three downriver plants. Juvenile white perch were found in the same general area and were also exposed to impingement at the downriver plants. Atlantic tomcod juveniles were exposed to impingement mostly at Bowline, but Bowline draws water from a tidal pond and Atlantic tomcod prefer deep water. Also, during their winter spawning run, Atlantic tomcod were exposed to impingement at all plants, especially Danskammer where winter impingement rates have been relatively high.

C. BIOLOGICAL CHARACTERISTICS (FECUNDITY, MATURATION)

The analysis of reproduction (natality) includes a number of variables. For any given age, data are needed on the number of females in each age group (age distribution and sex ratio), the percentage mature, and the number eggs expected for those females (fecundity). For discussion of striped bass biological characteristics (fecundity and maturation) see McFadden and Lawler (1977).

White perch age distribution is best measured in late winter through spring before the presence of juveniles confounds the situation. From April through June, 65 to 70% of the white perch collected were yearlings; from July to the end of the year, juveniles dominated the catch and the older age groups tended to be underestimated. The sex ratio in 1976 was 1:1. As in past years, all male white perch and 95% of the female were mature at age IV. Fecundity ranged from 21,946 eggs for a 125-mm female to 690,906 eggs for a 302-mm female in 1976.

Samples of Atlantic tomcod in bottom trawls consistently showed that the proportion of males was high in June (1974 to 1976) or July (1976) but had decreased by September. During the 1974-75 and 1976-77 spawning seasons, the proportion of females (50%) peaked in early January; during the 1975-76 spawning season, the peak was smaller (35%) and occurred one week later. Males apparently arrived on the spawning grounds first, followed in two weeks by the females. The true sex ratio of the population is probably best estimated in September when the least variation over years is evident. At that time the ratio does not differ from 1:1.

During the 1976-77 spawning season, 91.6% of the population consisted of Age I (1976 year class) fish. A total of 8.4% were age II (1975 year class), higher than during the previous spawning season (1975-76) when only 3.3% of the spawning fish were age II (1974 year class). The first three-year-old tomcod (1974 year class) were collected during the 1976-78 spawning season. Sexual maturation began in October of the first year of life; by December, all Atlantic tomcod were sexually mature. The mean fecundity of the 1976-77 spawning population was 16,850 eggs per female.

D. POPULATION DYNAMICS

1. Diet

The 1976 study indicated that small striped bass (less than 75 mm in total length) ate invertebrates exclusively. Larger fish (76 to 150 mm) supplemented this diet with fish, a trend continuing in older fish (151 to 200 mm). One incidence of cannibalism was observed. Large yearling striped bass (>201 mm) fed largely on clupeids. Diversity of prey species eaten increased through the summer and rose sharply in late fall for all size groups of striped bass examined.

All sizes of white perch fed primarily on invertebrates and fish eggs (clupeid and other unidentified species). Diversity of food organisms increased from June to November, and large white perch consumed a greater variety of prey organisms. Juvenile striped bass and white perch utilized many similar food resources, overlap being greatest from June through October. Diets diverged, however, as the fish grew larger. Food habits of Atlantic tomcod were addressed in detail in a previous report (TI 1976c) and are not described in this report.

2. Growth

Growth of striped bass has followed the same basic seasonal patterns since 1973: rate at which young larvae grow is relatively slow in the spring, accelerates in mid-summer, and decreases in the fall. In 1976, juveniles grew slowly, ceased to grow earlier, and were smaller in any given month than in previous years, because of irregular water temperatures. In contrast to data collected in previous years, which indicated that females grew faster than males after age III, data collected in 1976 indicated that growth of adult male and female striped bass did not differ until age VIII, after which females grew faster. Growth rates for adult Hudson River striped bass were similar to those reported for the Chesapeake Bay population (Mcfadden et al. 1978).

May-June water temperature was significantly correlated to predicted length of juvenile striped bass on August 1 (positive) when freshwater flow was held constant. Abundance was negatively (but not significantly) correlated to the instantaneous rate of growth. Other measures of growth in previous analyses demonstrated a significant negative relationship between juvenile growth and abundance.

White perch growth in the first year of life was similar to that of striped bass, i.e., minimal in spring, accelerating in mid-summer, and declining in fall. Total growth was less in 1976 (67 mm) than in 1975 (77 mm), probably because of low spring temperatures and early decline in fall temperatures. Adult females grew faster than males. Hudson River white perch, compared with those of other sytems, exhibit an intermediate growth rate.

Juvenile tomcod growth during 1976 was generally similar to previous years. Growth was highest in May, declined through the summer, and increased in the fall as temperatures decreased. Tomcod growth exhibited strong (but nonsignificant at $\alpha = 0.05$) correlations with April-June freshwater flow (positive) and January-March water temperatures (negative).

3. Abundance

a. Striped Bass

An index of juvenile striped bass abundance was calculated from available beach seine data collected during July and August of each year 1965-1970 and 1972-1976. The trend in the mid-July through August abundance index paralleled the trend in the July through October abundance index when both sets of data were available. In addition, a yearling abundance index was highly correlated with the juvenile abundance index from the previous year. Therefore it can be concluded that the index of juvenile abundance based on July through August catches is an accurate measure of year-class strength.

Standing-crop estimates for the striped bass 1976 year class were similar to those for the 1974 and 1975 year classes. The peak standing crop of 9.4 million juveniles in 1976 occurred August 15-21. Ths was probably an underestimate, since standing-crop data represented only fish in the regions and strata sampled during the time of sampling. Adjustments for catch efficiency of the sampling gear produced a peak population estimate of approximately 20 million. Although the size of the adult striped bass population during the 1976 spawning season was determined with mark/recapture methods, the problem of nonrandom mixing of marked and unmarked fish caused an underestimate of population size. The imprecision of the estimate of 513,000 fish was reflected by the wide 90% confidence intervals, (282,000-2,819,000).

A number of environmental variables influenced the index of juvenile striped bass abundance and explained 54% of the observed variation. Environmental factors potentially related to year-class strength and tested for a relationship with juvenile abundance included April freshwater flow, November through June freshwater flow, the number of days to span 16 and 20°C, a predator abundance index, an index of juvenile white perch abundance, and power plant water withdrawal. The two flow variables and the predator index were most correlated to juvenile abundance but were not significant at $\alpha = 0.05$. No relationship between year-class strength and power plant cooling water withdrawal was observed.

When the total number of striped bass in 1976 (starting with yolk-sac larvae) were plotted against time, two distinct phases of mortality were evident. Mortality from June 13 (yolk-sac larvae) to July 13 (post yolk-sac larvae), averaged 15% per day, while from July 14 to December 31 (juveniles), mortality averaged 0.3% per day. Survival during the early larval stages in 1976 was apparently affected by the unusual water temperture patterns of late May. A large portion of the spawn suffered near complete mortality when the temperatures dropped to 12°C. Essentially all of the surviving post yolk-sac larvae were spawned during a second spawning peak in early June.

b. White Perch

An index of juvenile white perch abundance was derived from mid-July to August beach seine catches and validated as was done with the striped bass index. The presence of strong and weak year classes was aligned between the juvenile abundance and yearling abundance indices (available since 1974) indicating that year-class strength was established by July through August; an expanded index of juvenile white perch abundance (July through October) showed the same relationships, validating the July-August index. The mark-recapture estimate of 209 million juvenile white perch in September 1976 (95% confidence intervals of 158 to 285 million) was higher than estimtes for the October through November populations in 1974 and 1975.

The combined standing-crop approach produced an estimate of 11 million juvenile white perch in mid-August 1976. The difference between mark-recapture and combined standing-crop estimates reflected the limitations associated with the latter approach. Problems of catch efficienty and concentrations of juvenile white perch in regions north of RM 76, which were not sampled during the Fall Shoals Survey, caused underestimates of population size. Adjustments for catch efficiency of the sampling gear resulted in a peak standing crop of 93 million juvenile white perch in mid-August 1976.

Environmental factors selected and tested for a relationship with juvenile white perch abundance were May freshwater flow, June freshwater flow, July freshwater flow, juvenile striped bass abundance index, days to span 16 and 20°C, juvenile bluefish abundance index, and power-plant cooling-water withdrawal. The four that were most related to juvenile perch abundance were: May freshwater flow (negative relationship), June freshwater flow (negative relationship), juvenile striped bass abundance index (positive relationship), days to span 16-20°C (positive relationship). However, none of the variables tested, including the power plant cooling-water showed a withdrawal index significant relationship ($\alpha = 0.05$) with juvenile white perch abundance.

Standing crops declined from 2 billion in late June of 1976 (peak post yolk-sac larvae period) to 3.86 million on December 1, an average of 3.6% per day. The drop in water temperatures in May strongly influenced survival from egg to yolk-sac larvae. As with striped bass, the post yolk-sac larvae were obtained from a fraction of the normal spawn but the resultant number of juveniles was similar to that of previous year.

Mortality estimated from catch curves was 89% (0.6% per day) for the juvenile through yearling stages ad 66% per year for total yearling and older individuals. Since the 1975 and 1976 data were not different they were pooled in calculating the estimate.

c. Atlantic Tomcod

All Atlantic tomcod marked and released for population estimation were obtained from box traps fished in December and January. Recaptures were obtained from box traps and impingement collections, and a small number were collected from botton trawls later in the year. The estimated 10.4 million tomcod population on the spawning grounds during 1976-77 was higher than the estimated 3.36 million in 1974-75 and the estimated 3.50 million in 1975-76. Other indices (bottom trawl and box trap catch data) supported the finding that the 1976 tomcod year class was stronger than the 1974 or 1975 year classes.

An index of juvenile tomcod abundance was previously based on standard station bottom trawl samples collected in the Indian Point area, but in 1976, Atlantic tomcod were not caught in this area in the same abundance evident in the rest of the river; therefore, an improved abundance index consistent with other estimates of year-class strength was developed. It permitted the inclusion of data collected in 1969, 1970, and 1972 through 1976. The abundance index was higher in 1970 than in 1969, declined in 1972 and 1973, and was lowest in 1974. The population recovered in 1975, and the 1976 value was the highest since 1970.

Environmental factors tested for a relationship with the juvenile tomcod abundance index were mean water temperature and freshwater flow for months during spawning and larval stages, maximum cooling-water withdrawal, and juvenile bluefish abundance index. Juvenile tomcod abundance was negatively correlated with the average freshwater flows in December and January. A subsequent analysis of adult spawning locations indicated a mechanism by which December and January flows could inhibit tomcod abundance. In 1974 when December and January freshwater flows were highest, the tomcod spawned farther downstream and the resultant crop of juveniles was lower than in other years. December 1976 and January 1977 flows were the lowest in recent years, and the tomcod spawned farther upstream than usual. The most plausible explanation for these relationships is that tomcod spawn a relatively constant distance upstream from the salt wedge, the position of which is determined by freshwater flow; when spawning occurs farther downriver due to high December and January flows and movement of the salt wedge downriver. Under these conditions the larvae hatch and develop in less than ideal habitats and subsequent survival may be reduced.

The mortality rate estimated for early life stages (January to May) was 99.91% and for older lifestages (May to December), 57.8%. Total annual mortality (January through December) was 99.96%, slightly lower than previous estimates of 99.9% (1974) and 99.98% (1975). The standing crop of eggs was estimated using information from fecundity and the sex ratio of the spawning stock.

4. Compensation

Compensation is generally difficult to demonstrate in fish populations because the environment frequently masks subtle mortality relationships. In this study, an exercise was conducted in which compensation for additional mortality was assumed to be nonexistent. The effects of two power plants with the longest period of operation, Danskammer and Lovett, were calculated based on the premise that plant-induced mortality similar to present conditions had acted in the past. Trends in stock size were predicted in the absence of compensation. Had compensation not been operating in these populations, the striped bass population should have declined by 68% and the white perch population by 46% since 1949. Similar data were not available for Atlantic tomcod, but a potential decline similar to that of striped bass and white perch could be expected. The predicted declines would be the result of the operation of only the two power plants. Cooling-water withdrawal from the Hudson River estuary has increased more than six times since 1965, primarily because additional power plants have been placed on line. Abundance trends demonstrate that these populations have been compensating for the additional mortality: the predicted declines have not occurred. Age composition and age at maturity indicate that neither the striped bass nor the white perch populations are currently overexploited.

The ability to compensate for additional mortality is also related to fecundity. The high fecund striped bass have a high compensatory reserve, compared to an intermediate compensatory ability for white perch, and a somewhat lower compensatory ability for Atlantic tomcod.

Juvenile Atlantic tomcod abundance trends since 1969 have shown no relationships to water withdrawal of the power plants; rather, juvenile abundance has depended largely on freshwater flow in December and January. Atlantic tomcod should be sensitive to power-plant effects for two reasons: tomcod have relatively low compensatory abilities and the tomcod population is mostly an annual crop, so declines in stock size should be noticed on a yearly basis rather than in decades.

Perhaps the most significant finding was the effect of an environmental change during the 1976 spawning period for striped bass and white perch. A sudden drop in temperature eliminated a large proportion of the eggs and yolk-sac larvae. Mortality of the surviving eggs and larvae must have been lower than usual, but the resultant crop of juveniles was about average. In other words, a fraction of the spawned eggs produced an average crop of juveniles. Obviously, the surviving larvae and early juveniles compensated for the added egg and yolk-sac mortality caused by this sudden drop in temperature.

SECTION III

FIELD AND LABORATORY PROCEDURES

A. INTRODUCTION

The 1976 Hudson River studies conducted by Texas Instruments (TI) were designed to identify the relation of any changes in the distribution, abundance, and biological characteristics (i.e., growth, fecundity, etc.) of key fish species to the operation of five power plants (Bowline, Lovett, Indian Point, Roseton, and Danskammer). Table III-1 indicates the schedule for each field task and outlines the applications of the data collected.

For field sampling, the estuary between the George Washington Bridge and Albany (RM 12-152 [KM 19-243]) was divided into 12 geographic regions (Figure III-1). This section briefly describes the equipment and procedures used in the field and laboratory operations; sample collecting and processing are described in more detail in the sections specifically addressing the data.

B. ICHTHYOPLANKTON SAMPLING

Sampling in the 12 regions (Figure III-1) obtained data on the following early life stages of fish:

Egg	The embryonic stage commencing with spawning and lasting until hatching
Yolk-Sac Larva	The transitional stage from hatching through development of a complete and functional digestive system
Post Yolk-Sac Larva	The stage from initial development of a complete and functional digestive system (regardless of degree of yolk and/or oil retention) to transformation to the juvenile life stage (having a full complement of fin rays)
Juvenile (young-of-the-year)	From completed transformation to Age I.

Table III-1

Schedule of Field Tasks and Application of Data during 1976

Task	J	F	M	A	M	J	J	A	S	O	N	D	Data Collected	Data Uses
Ichthyoplankton Survey														
Larval Atlantic Tomcod		—	—	—									Densities of eggs, larvae, and early juvenile fish	Population size estimation Spatiotemporal distribution and abundance for vulnerability assessment Species composition for historical data base Biological characteristics
Longitudinal River				—	—	—	—	—					Densities of eggs, larvae, and early juvenile fish	
Fall Shoal								—	—	—	—	—	Densities of juvenile and adult fish primarily in shoals	
Fisheries Surveys														
Mark-Recapture	—	—	—	—	—	—	—	—	—	—	—	—	Mark release and recovery data on striped bass, white perch, and Atlantic tomcod collected by all programs	Movement of marked individuals for vulnerability assessment Spatiotemporal distribution and abundance for vulnerability assessment Year-class comparisons and species composition for historical data base Species composition for historical data base Population estimates and relative abundance indices Biological characteristics
Standard Station				—	—	—	—	—	—	—	—	—	Numbers and size of juveniles and adult fish in shoals channel, and shore zone	
Beach Seine				—	—	—	—	—	—	—	—	—	Numbers of juvenile and adult fish in shore zone	
Interregional Trawl				—	—	—	—	—	—	—	—		Numbers of juvenile and adult fish in shoals and channel	
Adult Striped Bass Prog.			—	—	—	—							Number, size, sex, mark-recovery, fecundity maturity	Population estimate, movement, year-class comparisons, biological characteristics, age composition
Water Quality Prog.	—	—	—	—	—	—	—	—	—	—	—	—	Temperature, dissolved oxygen, conductivity, pH, and turbidity	Yearly comparisons of physical and chemical variables for historical data base Fish distribution in relation to chemical and physical variables

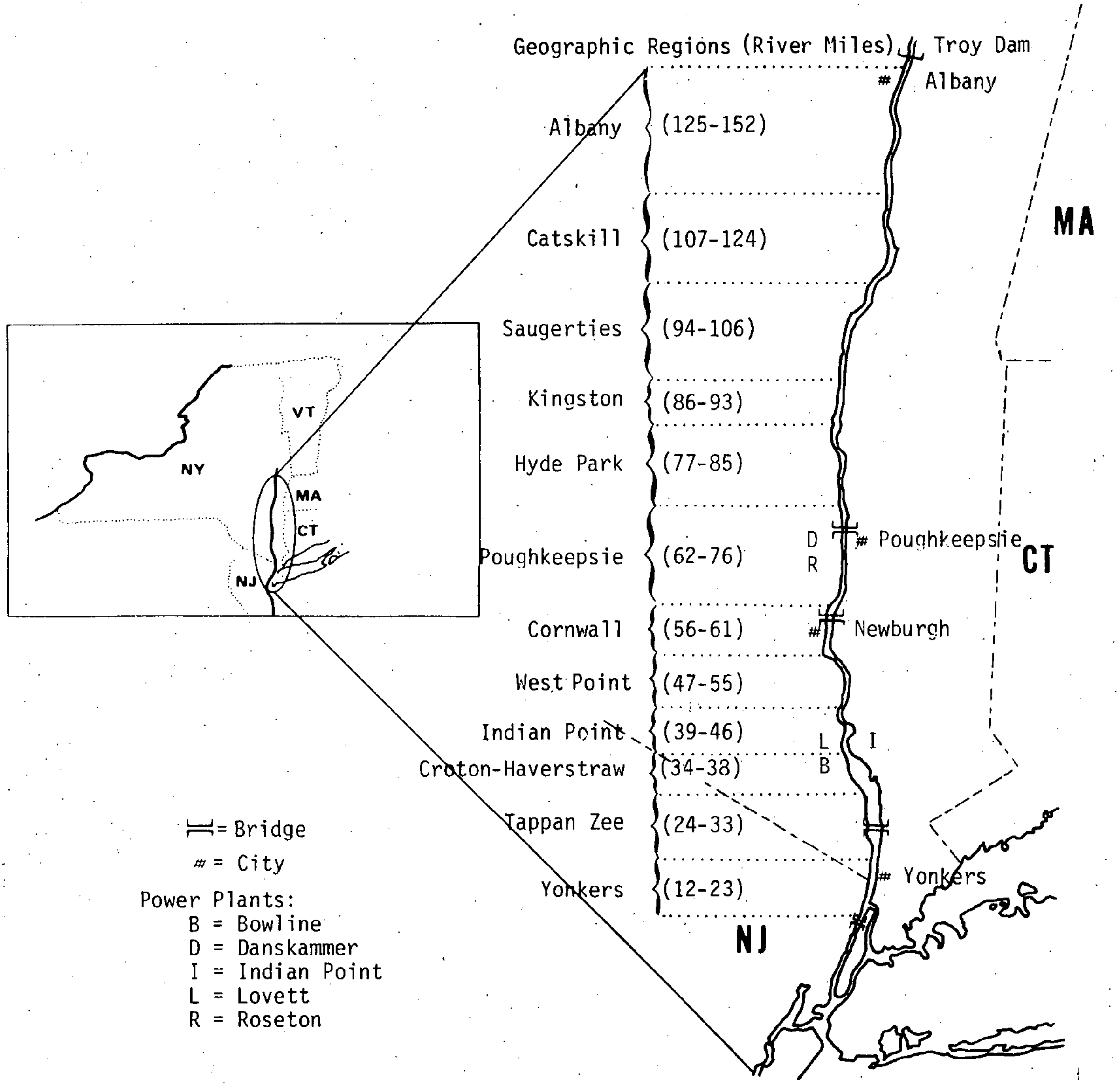


Figure III-1. Location of the Twelve Geographic Regions (with River Mile Boundaries) Used during 1976 Field Sampling Programs in Hudson River Estuary

Each geographic region was defined and subdivided into three strata per region - shoals, bottom, and channel (Table III-2, Figure III-2). The shoal stratum was that portion of the river 20 ft (6 m) or less in depth at mean low tide; the bottom stratum was the zone extending 10 ft (3 m) from the bottom in depths greater than 20 ft (6 m); and the area not defined as shoal or bottom was considered the channel stratum.

Table III-2

Strata Sampled within Geographic Regions of Hudson River Estuary during 1976

		Available Strata		
Geographic Region		Bottom	Channel	Shoal
Albany	(AL)	✓	**	**
Catskill	(CS)	✓	✓	**
Saugerties	(SG)	✓	✓	**
Kingston	(KG)	✓	✓	**
Hyde Park	(HP)	✓	✓	**
Poughkeepsie	(PK)	✓	✓	**
Cornwall	(CW)	✓	✓	✓
West Point	(WP)	✓	✓	**
Indian Point	(IP)	✓	✓	✓
Croton-Haverstraw	(CH)	✓	✓	✓
Tappan Zee	(TZ)	✓	✓	✓
Yonkers	(YK)	*	✓	✓

*Not sampled due to obstructions

**Stratum too limited to sample

✓Sampled

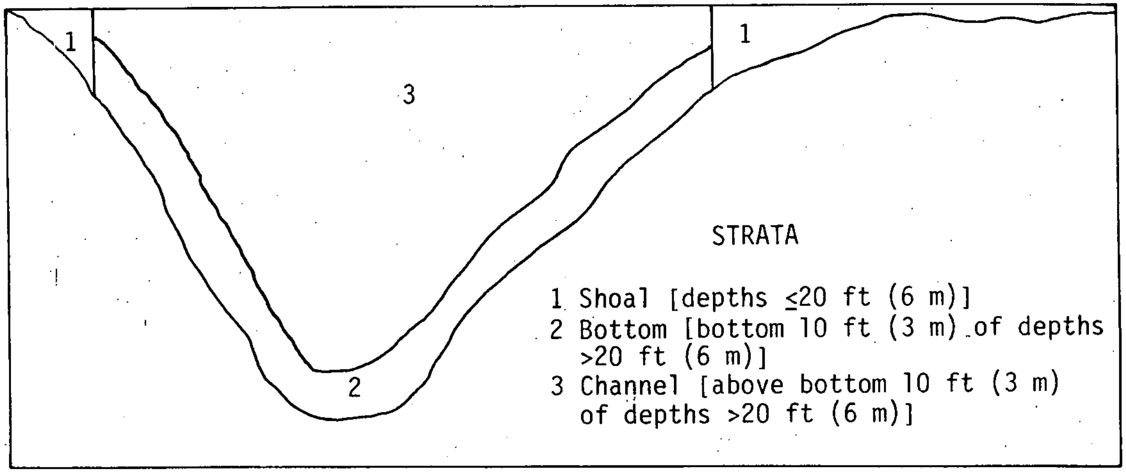


Figure III-2. Diagrammatic Cross-Section of Hudson River Estuary Showing Defined Strata Sampled in 1976

1. Larval Atlantic Tomcod Survey

As in 1975, when it was initiated to obtain data on ichthyoplankton and juvenile distribution and population dynamics of Atlantic tomcod in the Hudson River estuary, the Larval Tomcod Study in 1976 was conducted in late winter and early spring (Table III-1, Appendix Table A-2) using biweekly daytime sampling within the seven geographic regions from Yonkers through Poughkeepsie (RM 14-76, Figure III-1). Effort was allocated to regions and strata randomly selected for both location and depth on the basis of observed distribution of tomcod larvae in 1975 (TI 1978a:A-7). Each biweekly river run (sampling period) collected 100 samples using a 1.0-m^2 epibenthic sled (505- m mesh) in the shoal and bottom strata and a 1.0-m^2 Tucker trawl (505- m mesh) in the channel stratum. Both were equipped with calibrated digital and electronic flowmeters to record sample volume and tow speed, respectively. Digital flowmeters are placed within the net and electronic flow meters are mounted on the cable above the net. (Appendix Figures A-1 and A-2 and Appendix Table A-3). Standard tow duration for both gear was 5 min. When a tow was completed, the net was rinsed and the contents of the collection cup were poured into a pan. All yearling and older fish were removed and the yearling and older Morone spp. and Atlantic tomcod checked for tags, finclips, and tag wounds. Length, date, location of capture, and tag number were recorded for all live (suitable for release) tagged fish prior to release. All dead tag recaptures and suspected recaptures (finclips and tag wounds) were preserved in 10% formalin and taken to the laboratory for verification. All unmarked yearling and older fish were released. The remaining sample was placed in a labeled container and preserved with 10% formalin for laboratory processing.

2. Longitudinal River Survey

Between late April and mid-August 1976 (Table III-1, Appendix Table A-2), the Longitudinal River Survey sampled all available strata (Table III-2) in the Yonkers through Albany regions (RM 14-140 [KM 22-224]) to provide data on the early life history, distribution and population dynamics of striped bass, white perch, and Atlantic tomcod. Each of 15 river runs yielded approximately 210 samples. In early June, the time of sampling was shifted from day to night to reduce possible gear avoidance by the more motile post yolk-sac larvae and juvenile *Morone* spp.

Sampling effort within each geographical region was distributed using a stratified-random design. Effort was allocated to regions and strata on the basis of observed distribution of striped bass ichthyoplankton from previous years with sample location and depth selected using a stratified random sampling design (TI 1978a:A-7). Sampling and processing procedures were identical to those used in the Larval Atlantic Tomcod Survey. Organisms were identified to species where possible, and length-frequency determinations were made for striped bass post yolk-sac larvae and juveniles.

3. Fall Shoal Survey

Fall Shoal Survey data were used to determine the distribution and abundance of key fish species (primarily juveniles) in the shoals and bottom strata of the Hudson River estuary during late summer and fall (Table III-1, Appendix Table A-2). Every other week from mid-August into December, 100 samples were collected at night in the shoals and bottom strata from the Yonkers-through-Poughkeepsie regions (RM 14-76 [KM 22-122]). Sampling effort was distributed and sites selected as described for the Longitudinal River

Survey. A 1.0-m^2 epibenthic sled equipped with a 3000-μ mesh net with an enlarged conical fyke attached to the cod end (Appendix Table A-3, Appendix Figure A-3) was used. During the standard 5-min tow, an electronic flowmeter measured tow speed and a digital flowmeter measured the volume of water sampled.

All young-of-the-year fish were preserved in 10% formalin and transported to the laboratory. Yearling and older striped bass, white perch, and Atlantic tomcod were checked for finclips, tags, and tag wounds and were processed as described for the Larval Tomcod Survey.

4. Laboratory Processing

Fish eggs, larvae, and juveniles collected in the three ichthyoplankton surveys (Larval Atlantic Tomcod, Longitudinal River, and Fall Shoals) were sorted, identified, and counted. Fish specimens were removed from detritus and inorganic material and placed in vials according to taxonomic groups (species or family) and stage of development (egg, yolk-sac larva, post yolk-sac larva, or juvenile). Identifications within each stage of development of each taxonomic group were aided by a reference collection and verified using pertinent literature (Lippson and Moran 1974; Booth 1967).

Samples containing eggs and larvae greater than 400 specimens were subsampled using a plankton splitter similar to that described by Lewis and Garriott (1970), with samples split to no fewer than 200 specimens exclusive of Morone spp. and/or no more than three times (1/8 the original sample). All life stages of Morone spp. in a sample were removed and counted before splitting. Each step of all ichthyoplankton laboratory tasks was subjected to zero–fraction–defective quality control (Appendix A).

C. FISHERIES SAMPLING

Programs designed to collect data on distributions, relative abundances, movements, biological characteristics, and population sizes of juvenile and older fishes in the Hudson River estuary included mark-recapture, a standard station program, a beach seine survey, and an interregional bottom trawl survey.

Several types of gear were used to collect fish from different river strata:

- 100-, 200-, and 500-ft (30.5-, 61.0-, 152.4-m) beach seines sampled the shorezone (the water from shoreline to a depth of approximately 10 ft [3 m])
- Box traps also sampled shallow water (3 to 10 ft [1-3 m]) but were stationary and could sample rocky shorelines, steep banks, and areas near breakwaters and bulkheads that could not be sampled with a beach seine.
- Bottom trawls collected fish near the river bottom in depths generally exceeding 10 ft (3 m).
- Surface trawls collected fish near the surface of the water column in areas that were usually deeper than 10 ft (3 m).

A detailed description and diagram of each gear appear in Appendix Table A-4 and Appendix Figures A-4-7.

1. Mark-Recapture Program

The objectives of the Mark-Recapture Program were to estimate population sizes and determine movements of striped bass, white perch, and Atlantic tomcod. To accomplish these objectives, striped bass (usually juveniles and yearlings) and white perch were collected with beach seines (100-, 200-, and 500-ft [30.5-, 61.0-, 152.4-m]), box traps, and epibenthic sleds; and Atlantic tomcod were collected with box traps.

Fish were marked throughout the study area (RM 12-152 [KM 19-243], Table III-3) during two periods: spring (April-June) and fall (September-November). (Marking was not conducted in July and August because studies had shown extremely low survival rates for fish marked in those months.) Survival tests run for 14 days after marking, were used to adjust the number of marks released for mortality caused by marking.

Table III-3

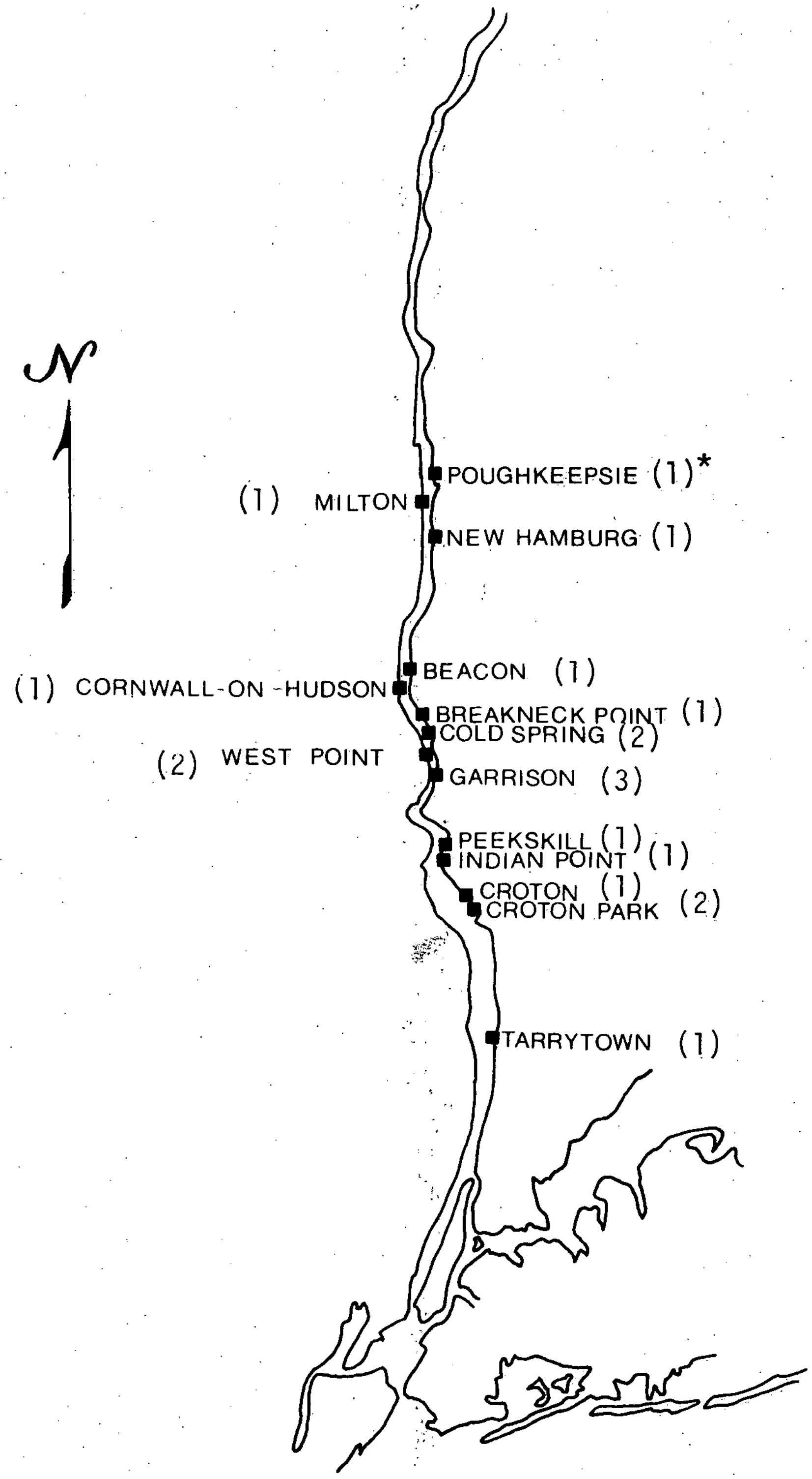
Marking Regions in Relation to Geographic Region during 1976 Mark-Recapture Programs

Species	Region #	Geographic Regions	River Miles (Kilometers)
Striped Bass	1	Yonkers	12- 23(19-37)
and	2	Tappan Zee and Croton-Haverstraw	24- 38(38-61)
White Perch	3	Indian Point	39- 46(62-74)
	4	West Point and Cornwall	47- 61(75-98)
	5	Poughkeepsie through Albany	62-152(99-243)
Atlantic	1	Tappan Zee and Croton-Haverstraw	24- 38(38-61)
Tomcod	2	Indian Point	39- 46(62-74)
	3	West Point and Cornwall	47- 61(75-98)
	4	Poughkeepsie	62- 76(99-122)

One or two fins of young-of-the-year striped bass and white perch were clipped during the fall, while yearlings were finclipped during spring and tagged during fall with either a Floy fingerling tag or a nylon internal anchor tag (Appendix Figure A-8), depending on the size of the fish. Adult striped bass (rarely caught by beach seine or box trap) and adult white perch were tagged during both the spring and fall. Fish captured throughout the entire study area (RM 12-152 [KM 19-243]) were marked, but most fishing effort during this program was concentrated in areas where juvenile striped bass and white perch were abundant.

During December 1976 - March 1977, Atlantic tomcod for marking were collected from double fyke box traps (without wing and lead nets, Appendix Figure A-9) set along the shore. Fourteen sites from RM 24 to RM 76 (KM 38-122) were sampled (Figure III-3). (Atlantic tomcod mature in approximately 11 months, therefore all fish marked at this time were adult.) Without regard to size, fish were either finclipped or Carlin-tagged. Survival studies involved each mark type.

The laboratory regularly received entire catches from selected box traps. The Atlantic tomcod were sorted by length group (total lengths of



*Numbers in parentheses indicates number of box traps.

Figure III-3. Location and Number of Box Trap Sites Used during 1976-1977 Atlantic Tomcod Spawning Season less than 125, 126-150, 151-175, 176-200, 201-225, 226-250, 251-275, and greater than 276 mm), and fish from a random subsample of each length group were weighed, measured, and their sex determined. Otoliths were removed for age determination. To maintain quality control, a continuous sampling plan (CSP-1) was used on all length, weight, and sex data and a lot-by-lot plan on all age data; both plans are described in Appendix A.

2. Standard Stations Program

a. Indian Point Power Plant

The Standard Stations Program directed toward juvenile and older fishes in the vicinity of the Indian Point power plants produces a long-term data series (sampling began in 1969) that can be examined for trends in species composition, relative abundance, distribution, and biological characteristics (see Subsection IV.B.3.a). As shown in Figure III-4, 1976 sampling involved 14 fixed stations between RM 39-43 [KM 62-68].

Beginning in April and continuing through December (Table III-1), seven stations were sampled weekly with a 100-ft (30.5-m) beach seine approximately 2 hours before low tide (see Appendix Table A-4 for gear specifications and Appendix Figure A-7 for deployment procedure), and seven stations were sampled twice bi-weekly on one day using a bottom trawl having a fine mesh liner and on a different day using a trawl without a liner to permit comparison with previous data (Appendix Table A-4). From July through December, each trawl site was also sampled biweekly with a surface trawl (Appendix Table A-4). The entire catch from each sample was kept on ice for laboratory processing.

Each sample was sorted by species into four length classes [0-x, (x+1)-150, 151-250, 251+mm TL].* The number in each length class was recorded for each species. A random subsample (maximum of 20 fish) from each length class for each species was measured and weighed. Scales were removed

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*The value x is the maximum size of the youngest age group of fish for each species and is adjusted regularly during the sampling period to reflect growth.

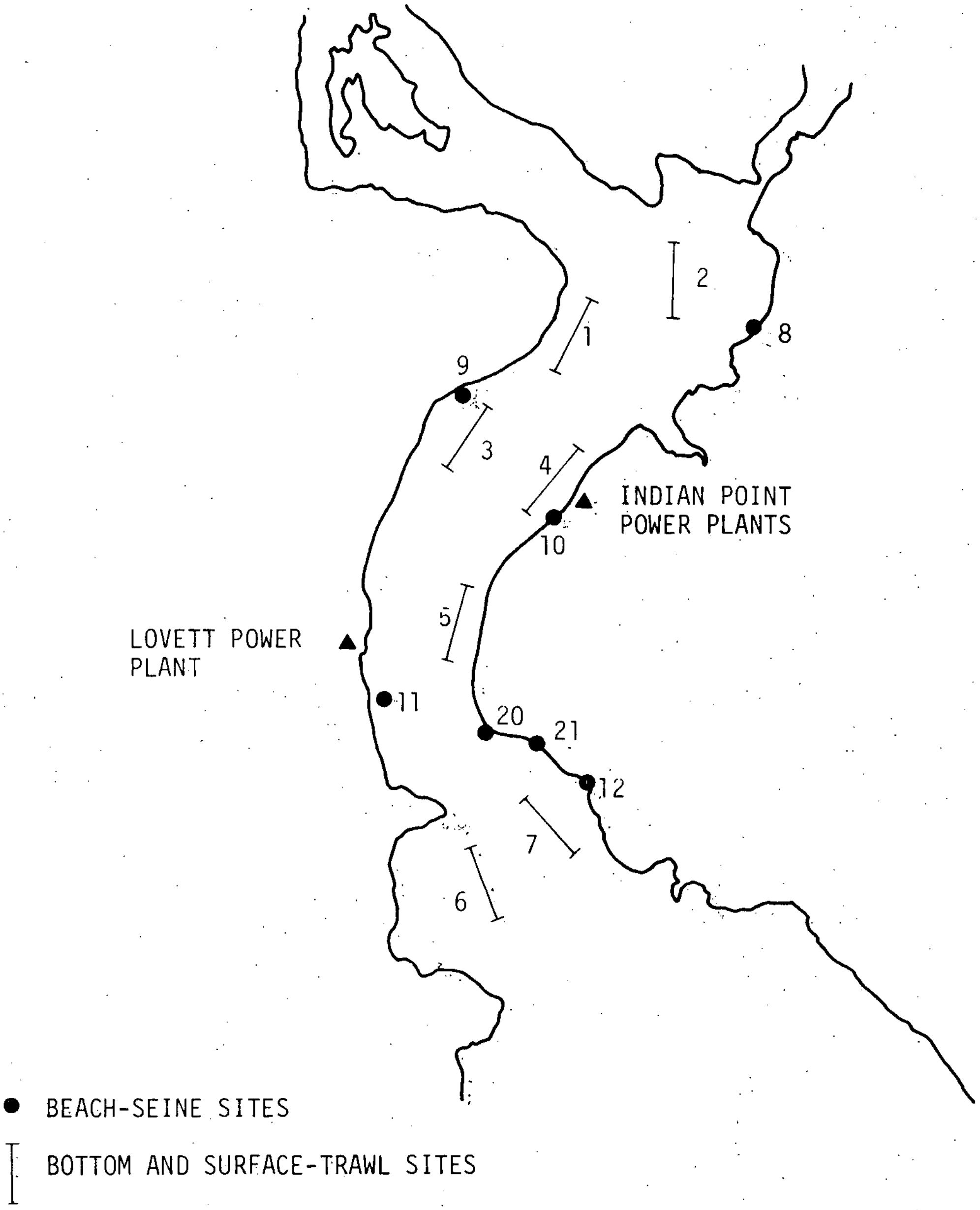

Figure III-4. Standard Station Beach Seine and Bottom and Surface Trawl Sites in Hudson River Estuary, Indian Point Region RM 39-43 (KM 62-74) removed from subsampled striped bass and white perch for age determination. Sex determination was attempted on all subsampled white perch having a total length (TL) exceeding 150 mm. During May, June, and July, the gonads were removed from all subsampled white perch greater than or equal to a 100-mm TL to determine age at maturity. Quality control was maintained on the identification and total count of each species using a lot-by-lot "zero fraction defective" technique (Appendix A). Atlantic tomcod from two standard station bottom trawl samples (collected on different days) were processed for biological characteristics. The total lengths and weights of up to 80 young-of-the-year and 40 adult Atlantic tomcod per sample were recorded, and quality control was monitored using a continuous sampling plan (CSP-1) described in Appendix A. Additionally, striped bass and white perch specimens captured in standard station beach seines during 1974 were used for dietery comparisons between the two species in this report.

b. Other Power Plants

Information regarding the relative abundances and distributions of fishes in nearfield areas of other Hudson River power plants (Bowline, Lovett, Roseton, and Danskammer) was obtained by Lawler, Matusky and Skelly Engineers (O&R 1977, CHG&E 1977).

3. Beach Seine Survey

The Beach Seine Survey provided data on abundances, distributions, and population characteristics of juvenile and older fishes in the shore zone and information on the growth of juvenile and older striped bass, white perch, and Atlantic tomcod. Each week, approximately 100 samples were collected with 100-ft (30.5-m) beach seines (Appendix Table A-4). During April-June and September-December, samples were collected weekly from the Yonkers-through-Cornwall regions (RM 12-61 [KM 19-98]), where juvenile striped bass and white perch were concentrated. On alternate weeks, sampling was extended to include the Poughkeepsie-through-Albany regions (RM 62-152 [KM 100-243]). During July and August, when young-of-the-year first appear in the shore zone, weekly sampling was conducted in all regions (Yonkers through Albany).

Catches were sorted by species and length groups (as was done for standard stations) and counted. Usually retained for laboratory processing were young-of-the-year fishes except striped bass and white perch, which were finclipped and released during the fall marking period (September-November). Yearling and older striped bass, white perch, and Atlantic tomcod were examined for marks. Unmarked yearling and older striped bass and white perch were marked (Subsection C.4) and released. Yearling and older of other species were released unmarked. Suspected finclipped recaptures were preserved for verification; tag number, length, and recovery information for live, tagged fishes were recorded prior to the fishes' release. Striped bass, white perch, and Atlantic tomcod length and weight quotas (20 per length group per region) were filled on alternate weeks using fishes processed in either the field or laboratory. An additional 40 young-of-the-year striped bass, white perch, and Atlantic tomcod were measured for length frequency analysis. In the laboratory, samples of young-of-the-year were sorted by species and counted. Laboratory processing quality-control was checked using a zero-fraction defective technique (Appendix A).

4. Interregional Bottom Trawl Survey

The Interregional Bottom Trawl Survey (previously termed the Axial Trawl Survey) provided data on the relative abundances, distributions, and population characteristics of juvenile and older fishes inhabiting the bottom strata of the river, as well as deep-water recapture effort for marked fish. On alternate weeks from April through November (Figure III-5), 32 fixed stations from RM 27 to RM 62 (KM 43 to KM 99) were sampled with an otter-type bottom trawl that had a fine mesh cod-end cover (Appendix Table A-4). Catches were sorted by species and length group (same as for standard stations). Yearling and older fish were counted, and young-of-the-year fish were preserved in 10% formalin for laboratory processing. Random subsamples of striped bass, white perch, and Atlantic tomcod from each length group (maximum of 20) were weighed and measured. During each biweekly period, all Atlantic tomcod from two samples (collected on different days when possible) were processed for biological characteristics using methods identical to those with which standard station bottom trawl samples were processed. Quality-control of identifications and counts was checked using the zero-fraction defective method (Appendix A).

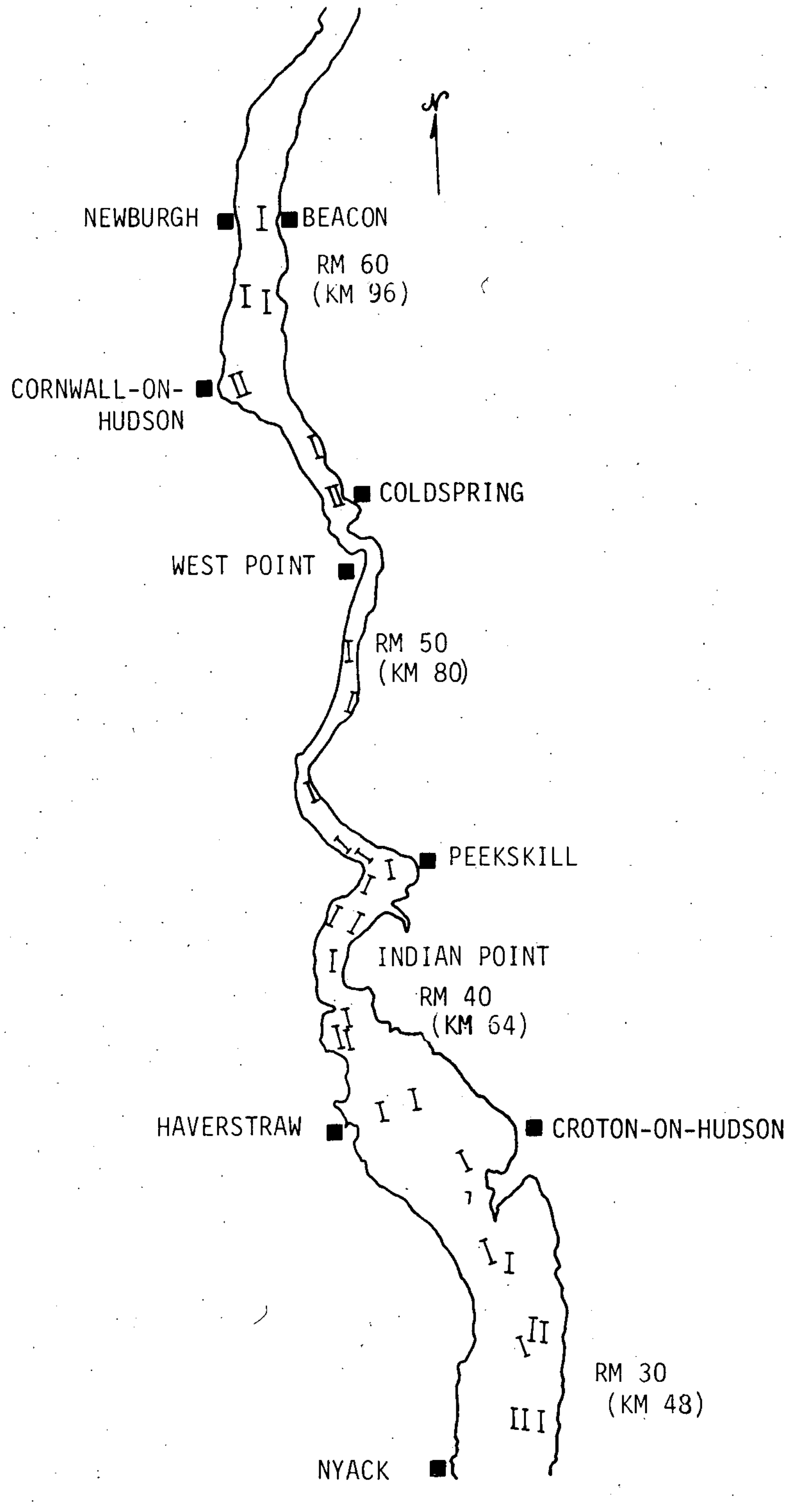

Figure III-5. Interregional Bottom Trawl Survey Sampling Sites during 1976, Hudson River Estuary, RM 27-62 (KM 43-99)

D. ADULT STRIPED BASS STOCK ASSESSMENT PROGRAM

A comprehensive field and laboratory study of adult (TL greater than or equal to 250 mm) striped bass was conducted from mid-March through June 1976 to determine the Hudson River spawning population's structure, mortality rate, movement, and biological characteristics. Field sampling comprised the effort from both Texas Instruments (TI) personnel and contracted commercial fishermen. Since the commercial fishery for striped bass in the Hudson River was officially closed during 1976, age and size composition of the commercial catch were estimated by contracting commercial fishermen to fish using their gear in the usual manner. In addition, tag returns (for a reward of $5.00 per tag) by sport and commercial fishermen provided information on movements and exploitation rates.

1. Field Methods

TI sampling effort was allocated on the basis of adult striped bass distribution; this concentrated it in the vicinity of the Tappan Zee Bridge and Croton-Haverstraw Bay early in the spawning season (March-April), shifted it upriver to the Indian Point area as the season progressed, and moved it downriver again in June at the end of the spawning season (Figure III-6). Two clusters of anchored gill nets (Appendix Table A-5), each cluster containing four nets of different standard mesh sizes (4-, 4.5-, 5-, and 6-inch stretch multifilament) and one or two experimental nets (7- or 8-inch multifilament or 4.5-, 5-, or 6-inch monofilament), were separated longitudinally in the river and tended day and night. Also used in 1976 was a drift gill net with 5.5-inch stretch monofilament mesh. Also, to obtain an unbiased profile of the population, a 900-ft (294-m) haul seine, (believed to be the least size-selective fishing gear available) was used to sample beaches in Haverstraw Bay (RM 33-39 [KM 53-62]). A 200-ft (61-m) haul seine operated from RM 33-42 (KM 53-67) provided additional catch. In 1976, the haul seines were deployed only at night.

Four commercial fishermen (Figure III-6) were subcontracted to fish for striped bass 2 days per week using their own fishing gear (Appendix Table A-5) and techniques, and each was accompanied by TI personnel during net-tending.

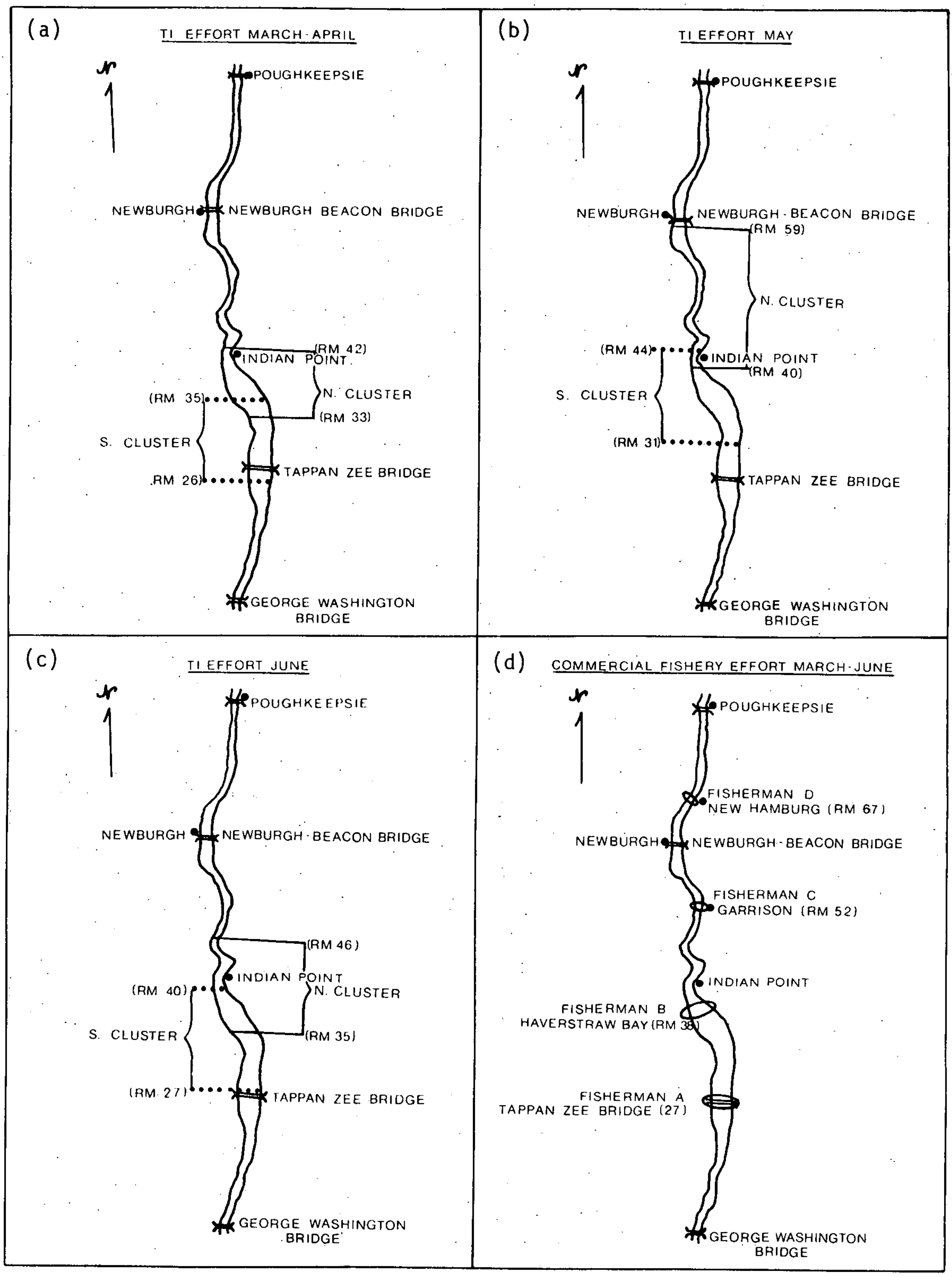

Figure III-6. TI 1976 Sampling Effort for Striped Bass during March-April (a), May (b), and June (c) by North and South Gill Net Clusters and by Commercial Fishery Effort (d)

The measurement of all fish caught was to the nearest millimeter, and scale samples were removed. Live fish that were not required in the laboratory for measurement of biological characteristics were tagged and released. Dead and dying fish and those sacrificed for further examination were taken to the laboratory for processing.

2. Laboratory Methods

In the laboratory, striped bass were examined to determine growth, sex ratio, fecundity, age at maturity, diet, and age composition. To obtain a complete profile of the entire population, quotas were established by time period and length group (TL's of 0-400, 401-549, 550-699, 700-899, 900-1099, and 1100+ mm).

Only fish collected in haul seines were used for stomach content analysis. The fish were injected through the esophagus with 10% formalin immediately after capture to preserve the stomach contents. In the laboratory, organisms in the excised stomach were identified to the lowest practical taxonomic group.

All striped bass exceeding 600 mm in total length were aged by the scale method (Mansueti 1961a). Fish having a TL less than 600 mm were subsampled by length group.

Adult striped bass processed in the laboratory for length, weight, and sex, were subjected to quality control procedures using a continuous sampling plan described in Appendix A. Stomach content and age analyses were subject to lot-by-lot quality control (Appendix A).

E. WATER QUALITY

Water quality data (water temperature, dissolved oxygen, pH, conductivity, and turbidity) were collected concurrently with or subsequently to each ichthyoplankton and fisheries sample. The instruments used to measure water quality parameters, as well as other details, are indicated in Appendix

Table A-6. All instruments and thermometers were calibrated prior to daily sampling and checked for accuracy periodically during the sampling day.

At the completion of each standard station surface and bottom trawl/tow and each interregional bottom trawl/tow, all of the mentioned water quality variables except turbidity were measured in the field; a water sample was collected at the surface for subsequent measurement of turbidity. In the Standard Station and Beach Seine surveys, surface-water temperature and dissolved-oxygen concentration were measured in situ. A water sample was collected at each sampling site and delivered to the laboratory for determination of pH, conductivity, and turbidity.

Water quality measurements taken during mark-recapture efforts were handled according to gear type. During each epibenthic sled tow for fall mark-recapture of adult white perch, a modified Van Dorn 2-litre sampler (Figure III-7) collected a water sample at the sampling depth. After the sample was transferred to a wide-mouth bottle, water temperature was taken; pH, conductivity, and turbidity were determined in the laboratory. Water quality sampling during bottom trawl mark-recapture efforts was handled according to the standard station and interregional trawl water quality procedures just described. During mark-recapture efforts with beach seines, box traps, gill nets, or other gear types, water quality was measured according to the standard station and beach seine survey water quality procedures.

During adult striped bass sampling, surface water temperature was measured and a water sample collected. The latter was delivered to the laboratory for subsequent determination of pH, conductivity, and turbidity. This procedure was used for the first and last gill nets tended per cluster per night and for each haul seine sample.

After each tow during the Larval Atlantic Tomcod, Longitudinal River, and Fall Shoal surveys, water samples were collected in modified Van Dorn 2-litre samplers (Figure III-7) attached to the tow cable. After retrieval of the sampler and transfer of the water sample to a BOD bottle, temperature and dissolved oxygen concentration were measured and the sample then poured into a widemouth sample bottle for conductivity and pH measurements; the bottle was then capped and delivered to the laboratory for turbidity analysis.

A record of Hudson River water temperatures was obtained from the Poughkeepsie Water Works in Poughkeepsie, New York. Freshwater discharge data at Green Island, New York, were obtained from the U.S. Geological Survey. These records extend from 1949 and provide a long-term data base for the Hudson River. The period 1966-1976 is covered in Appendix Table A-7.

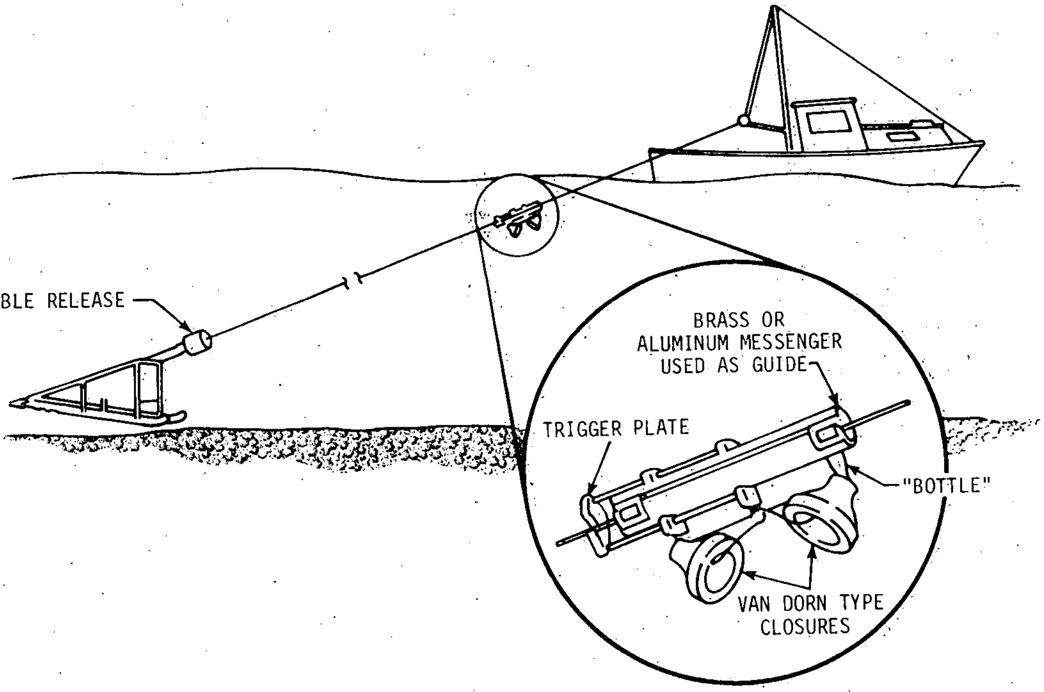

Figure III-7. Modified Van Dorn 2-Liter Sampler Used during Ichthyoplankton and Fall Shoal Surveys

SECTION IV

LIFE HISTORY AND POPULATION DYNAMICS

A. INTRODUCTION

Knowledge of the life histories and population dynamics of the key fish stocks in the Hudson River is essential for the evaluation of the impact of power plants on any of these species. In this section, trends in abundance, feeding interactions between species, and factors affecting growth and abundance are analyzed. The resulting discussion of population dynamics and species interactions include mechanisms of population change and compensation.

Data from ecological surveys, water quality studies, and power plant operations were utilized in order to achieve the following specific objectives for striped bass, white perch, and Atlantic tomcod:

- Describe diets and growth rates
- Describe sex ratios, age composition, age at maturity, and fecundity
- Describe fluctuations in abundance of juvenile (young-of-the-year) striped bass and white perch (1965-1970, 1972-1976), and Atlantic tomcod (1969-1970, 1972-1976)
- Examine mortality rates
- Examine potential relationships between various environmental factors and abundance and growth of juveniles
- Examine potential relationships between combined power plant operations and annual juvenile abundances
- Discuss the compensatory ability of the populations

B. STRIPED BASS (Morone saxatilis)

1. General Life History

The striped bass (Figure IV-1), an anadromous member of the family Percichthyidae (temperate basses), is native to the Atlantic coast from the St. Lawrence River in Canada to the St. Johns River in northern Florida, and the Gulf coast from western Florida to Louisiana. Because of the value of striped bass as a commercial and sport fish, its range has been extended to the Pacific coast by successful stocking in 1879 and 1882 and into inland lakes and reservoirs within the last decade (Figure IV-2).

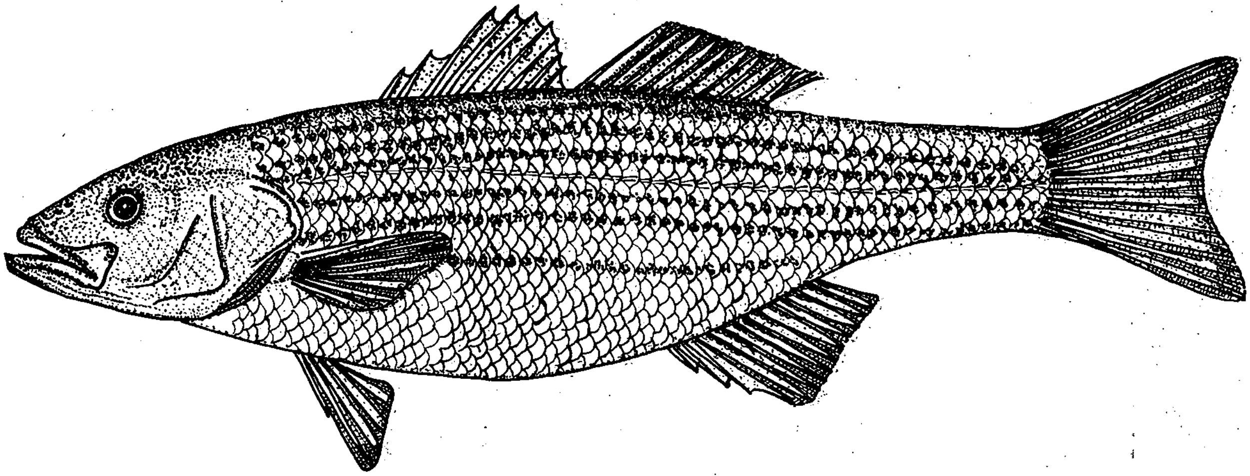

Figure IV-1. Striped Bass (Morone saxatilis), Anadromous Member of Family Percichthyidae

Adult striped bass enter estuaries in late winter to early summer and swim upstream to spawn in freshwater. Timing of spawning depends in part on water temperature and ranges from late February in Florida (Barkuloo 1967) to early July in New Brunswick (Raney 1954). In the Hudson River, the peak period of spawning usually occurs in May (McFadden 1977). A spawning run in most systems ordinarily lasts several weeks. Sexual maturity is attained by most striped bass males when 2 to 4 years old and by most females when 3 to 7 years old (McFadden and Lawler 1977). During spawning, ripe females become surrounded by several males. Eggs and milt are expelled rapidly amidst much thrashing (Raney 1952). Fecundity increases with age

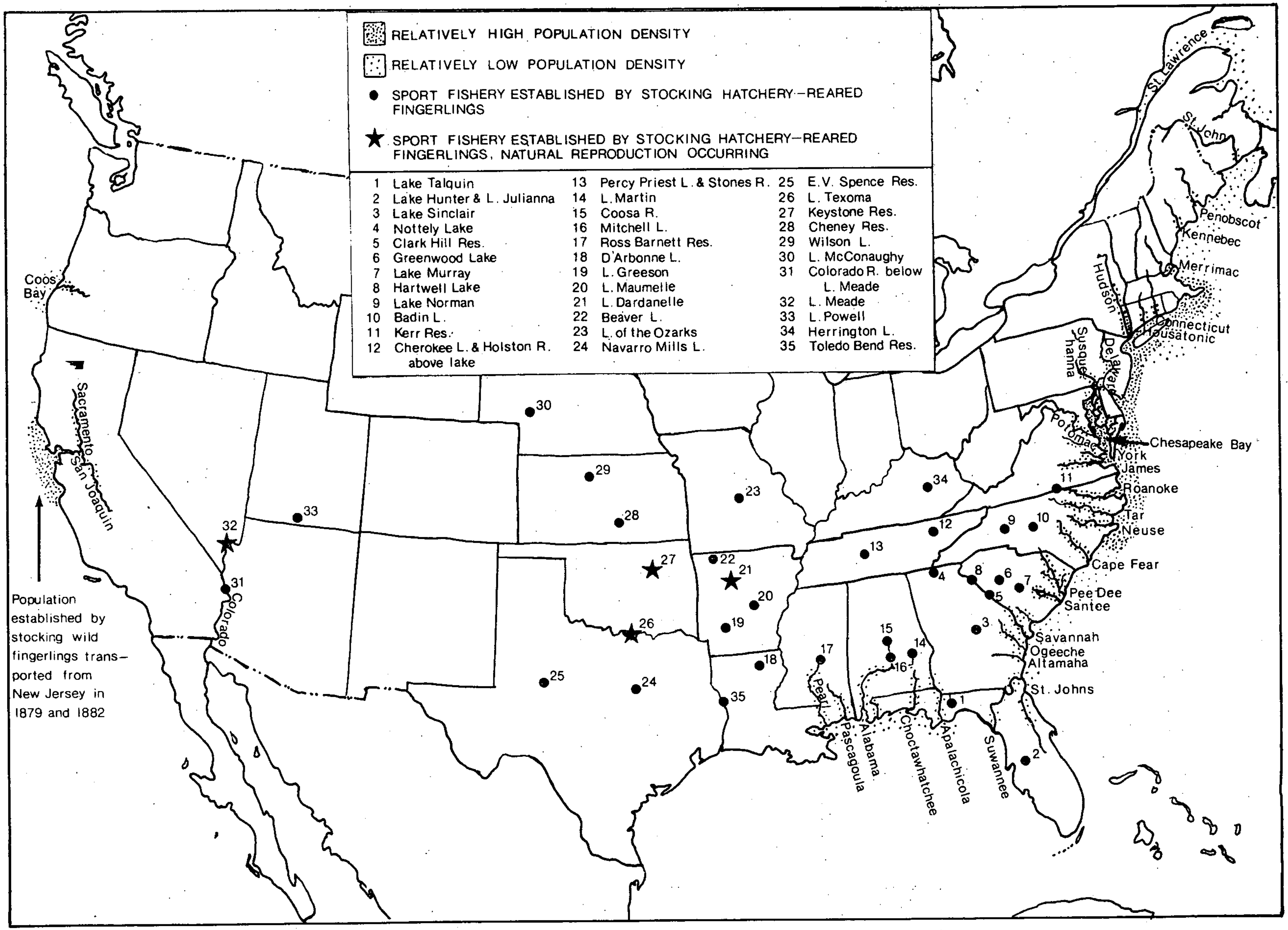

Figure IV-2. Distribution of Striped Bass in North America as of 1976 (Parsons 1974, Bailey 1974, and Reports of Striped Bass Committee of American Fisheries Society Southern Division 1972-1975, Karas 1974).

and size; 5-kg and 17-kg females in the Hudson River produce approximately 0.7 million and 3.6 million eggs, respectively (TI 1977a,e). Eggs are semibuoyant and hatch after 34 to 100 hours, depending on temperature (TI 1977a,e). The current must be swift enough to keep them off the river bottom to prevent possible suffocation (Albrecht 1964).

After hatching, yolk-sac larvae (prolarvae) are approximately 3-mm long and capable of only short bursts of swimming while drifting with the current (Bayless 1972). Swimming ability increases and the mouth and gut begin functioning after 5 to 9 days when larvae enter the post yolk-sac (postlarval) stage and begin feeding on small zooplankton (TI 1977a,d). When 9 to 12 days old, most larvae have inflated their gas bladders and are feeding actively, although some nourishment is obtained from the oil of the yolk-sac (Doroshev 1970). Post yolk-sac larvae transform into the juvenile form when approximately 5 weeks old and 15 mm long (Mansueti 1958).

During the summer, juveniles (young-of-the-year) assume the adult body shape and form schools in bay and shoal areas (TI 1976a). Midge larvae, small crustaceans, and zooplankton are important food items (TI 1974). During the fall, juveniles range from 76 to 115 mm in length and their diet consists primarily of small crustaceans, especially <u>Gammarus</u> spp. (TI 1974; Subsection B.2.b.). Some juvenile population of striped bass, especially larger ones (TI 1977c), may emigrate out of the estuary before or during winter; others apparently overwinter in the deeper portions of the nursery areas (McFadden 1977). Growth practically ceases during the winter (McFadden 1977) and in the spring; yearlings in the estuary leave overwintering areas, move to shore zones, and are distributed throughout the estuary by early summer (McFadden 1977).

Young adults inhabit enclosed bays of the ocean or the lower portions of estuaries while older adults may migrate long distances along the coast, foraging up to ten miles from shore. Migration tends to be northward during the spring and summer and southward during the fall (Raney 1954). The spawning migration in spring may involve a homing instinct; however, the evidence for this is largely indirect and primarily based on the existence of distinct riverine populations that can be identified by meristic and morphometric characteristics (McFadden 1977).

Various factors affect the survival of the life stages of striped bass. Abiotic environmental factors, predation by other fish, disease, or entrainment in the cooling water of power plants may affect the survival of fertilized eggs and yolk-sac larvae. The survival of post yolk-sac larvae and juveniles may also be limited by food availability. As juveniles grow, they become vulnerable to impingement on intake screens of power plants (McFadden 1977). Adult striped bass are strong swimmers and generally avoid impingement at power plants. They are harvested by commercial and/or sport fisheries, the legality of which varies with place and season. In 1976, commercial fishing in the Hudson River for striped bass was banned by New York State because of PCB contamination.

Combined sources of mortality affecting striped bass populations contribute to a cumulative rate that may exceed 99% through the juvenile life stage (McFadden 1977). The striped bass is a species with high reproductive potential; in addition, some individuals have been reported to live as long as 30 years (Merriman 1941). Their populations have fluctuated in abundance over the years, with a "dominant year class" emerging irregularly when factors combine favorably to enhance spawning and/or survival (Raney 1954). Through density-dependent changes in natality and mortality rates, population size tends toward an equilibrium level (a process termed "compensation" [McFadden 1977]).

2. Feeding and Growth

This section describes the feeding habits and growth patterns of both juvenile, yearling, and older striped bass collected in the Hudson River estuary. This information will be used in sections concerned with the analyses of feeding interaction between striped bass and white perch and factors affecting their growth.

a. Diet

The stomach contents of young-of-the-year, yearling, and adult striped bass were identified and recorded. The effect of season, age, and size on diet were analyzed and general food habits were compared to those of striped bass studied in other systems.

1) Juveniles, Yearlings and Older Ages

a) Methods

Stomach contents were examined from striped bass captured in beach seines between river miles 39 and 46 (KM 62-74) from April through November 1974. Fish were preserved in 10% formalin in the field and the stomachs were later removed in the laboratory. The contents of the stomach were sorted under a dissecting microscope, identified, and counted. Numbers of those dismembered organisms which were identifiable were estimated by counting the number of heads or portions of animals judged to constitute 50% or more of the original organism. Items such as filamentous algae, unidentifiable animal and plant remains, and detritus were not counted but were noted as being present or absent. Data were analyzed by month and length group of the striped bass collected (less than or equal to 75 mm, 76 to 150 mm, 151 to 200 mm and 201 to 270 mm). Length groups were the basis for later comparisons with white perch diets (Section IV.B.3.c.).

The percent frequency of each countable food item was calculated for each striped bass as follows:

$$f_{ij} = \frac{m_{ij}}{m_j} \times 100\%$$

where

f_{ij} = percent frequency of food item i in stomach j

m_{ij} = number of organisms of food item i in stomach j

m_j = total number of organisms counted in stomach j

The mean percent frequency of each countable food item was then obtained on a monthly basis for striped bass in each length group and for all length groups combined using the formula:

$$\bar{f}_i = \frac{1}{n} \sum_{j=1}^{n} f_{ij}$$

where

$\bar{f}_i$ = mean percent frequency of food item i for all stomachs

f_{ij} = percent frequency of food item i in stomach j

n = total number of stomachs with at least one countable food item

Trends in food habits of striped bass were obtained by ranking all food items consumed according to mean percent frequency. The top eight food item, which accounted for at least 90% of food items eaten (total f_i is at least 90.0), were then compared among different length groups.

b) Results and Discussion

A total of 428 stomachs from juvenile, and yearling, and older striped bass were analyzed and 111 (26%) contained either no food or uncountable food items. Seventy-six (18%) had empty stomachs, while 35 (8%) fish contained only uncountable food items such as filamentous algae, plant and animal remains, and detritus. The remaining 317 (74%) of the juvenile and yearling striped bass consumed a wide variety of prey organisms (Table IV-1, Appendix Table B-1).

During April, cladocerans and calanoid copepods were the main food items for striped bass less than or equal to 75 mm in length (Table IV-1). During June, Gammarus replaced cladocerans as the most common organism eaten but calanoid copepods were still eaten. Their diet became more diversified during September through November; Gammarus composed more than 50% of the organisms eaten by striped bass less than or equal to 75 mm TL during September and October, and the remainder of the diet included amphipods, polychaetes, chironomid larvae, copepods, and isopods.

Table IV-1

Comparison of Major Countable Food Items of Striped Bass by Mean Percent Frequency, April-November, 1974

		April			May			June	
Length Group (mm)	Sample Size	Food Item	Mean Percent Frequency	Sample Size	Food Item	Mean Percent Frequency	Sample Size	Food Item	Mean Percent Frequency
≤ 75	2	Cladocera	50.00		No samples		3	*Gammarus*	66.83
		Calanoida	48.88					Calanoida	32.21
		Gammarus	0.56					Harpacticoida	0.81
		Chironomid (L)	0.56					Chironomid (L)	0.16
76-150	7	*Gammarus*	59.73	3	*Gammarus*	100.0	51	*Gammarus*	34.33
		Calanoida	24.11					Atlantic tomcod	21.90
		Chironomid (L)	10.88					Calanoida	11.64
		Cassidina	2.86					*Cyathura*	9.60
		Chirodotea	2.38					*Leptocheirus*	9.09
		Monoculodes	0.04					Chironomid (P)	3.96
								Chironomid (L)	2.86
								Lironeca ovalis	1.96
								Cladocera (unid)	1.96
151-200		No samples			No samples		3	Blueback herring	33.33
								Atlantic tomcod	33.33
								Clupeid (unid)	33.33
200-270		No samples			No samples			No samples	
		July			August			September	
≤ 75		No samples			No samples		29	*Gammarus*	54.74
								Leptocheirus	10.35
								Polychaeta	8.62
								Corophium	6.35
								Chironomid (L)	5.66
								Calanoida	3.35
								Cyclopoida	2.97
								Cyathura	2.81
76-150	21	*Gammarus*	34.76	30	*Gammarus*	39.06	38	*Gammarus*	47.33
		Cyathura	27.65		*Corophium*	23.72		*Crangon*	6.63
		Chironomid (L)	14.59		Chironomid (L)	9.69		Bay anchovy	6.42
		Harpacticoida	7.35		*Rhithropanopeus*	8.56		Chironomid (L)	5.34
		Clupeid (unid)	4.76		*Neomysis*	6.11		Banded killifish	5.26
		Chironomid (P)	2.85		Fish remains	5.83		Diptera (L)	4.40
		Adult insect remains	2.70		Banded killifish	3.75		*Corophium*	3.80
		Leptocheirus	2.38		Diptera (P)	0.83		Polychaeta	3.67
		Polychaeta	2.38						
151-200	9	Polychaeta	43.83	7	Fish remains	57.14	4	*Gammarus*	37.50
		Cyathura	29.79		Atlantic tomcod	25.71		Clupeid (unid)	25.00
		Crangon	11.11		*Corophium*	12.38		*Neomysis*	21.21
		Bay anchovy	11.11		*Gammarus*	4.76		Fish remains	4.92
		Chironomid (L)	2.31					Atlantic tomcod	4.92
		Leptocheirus	1.85					*Crangon*	4.17
								Cyathura	1.52
								Rhithropanopeus	0.76
201-270		No samples		1	Fish remains	100.0	2	*Cyathura*	50.00
								Atlantic tomcod	37.50
								Gammarus	12.50
		October			November				
≤ 75	26	*Gammarus*	56.47	7	Calanoida	67.72			
		Corophium	10.83		*Gammarus*	15.08			
		Monoculodes	6.28		*Cyathura*	14.29			
		Leptocheirus	5.41		Cyclopoida	1.93			
		Polychaeta	4.90		*Cassidina*	0.99			
		Cyathura	4.22						
		Chironomid (L)	3.67						
		Cyclopoida	3.37						
76-150	37	*Gammarus*	63.70	19	*Gammarus*	44.92			
		Fish remains	7.88		Calanoida	23.96			
		Chironomid (P)	6.05		Oligochaeta	5.26			
		Rhithropanopeus	5.54		Nemertea (unid)	4.63			
		Cyathura	4.45		*Neomysis*	4.21			
		Leptocheirus	2.93		Fish remains	3.92			
		Calanoida	2.61		Polychaeta	3.16			
		Monoculodes	1.80		*Crangon*	3.11			
151-200	4	Striped bass	25.00	4	Mummichog	50.00			
		Chirodotea	25.00		Clupeid (unid)	25.00			
		Gammarus	20.83		*Neomysis*	24.47			
		Clupeid (unid)	16.67		*Crangon*	0.53			
		Banded killifish	12.50						
201-270	8	Clupeid (unid)	62.50	2	*Morone* (unid)	50.00			
		Fish remains	37.50		*Crangon*	31.25			
					Clupeid (unid)	18.75			

U = Unidentified

L = Larvae

P = Pupae

Striped bass 76 to 150 mm TL were sampled from April to November. Gammarus was the major food item consumed during all months, with the mean percent frequencies ranging from 34 to 100. During April, calanoid copepods and chironomid larvae were in their diet in addition to Gammarus, and fish were consumed in the striped bass diet during the summer and fall months. A variety of fish were consumed but only during June did fish represent a substantial portion (21.9%) of the diet.

Striped bass of 151-200 mm TL were collected from June through November. Fish composed a large proportion of their diet, although invertebrates were still consumed. One striped bass (total length = 151 mm) collected in October had consumed one other striped bass.

Thirteen striped bass 201-270 mm in length were bass were collected from August to November for stomach analysis; fish remains were the major constituents of their diets. One collected in November contained two unidentifiable Morone. From the samples available for analysis, it appears that striped bass greater than 200 mm in length are almost exclusively piscivorous. Additional data on food habits of striped bass greater than 200 mm, especially adult fish collected during the spawning season, are described in the next subsection.

Previous studies indicate that young-of-the-year and yearling striped bass feed primarily on small invertebrates, with fish becoming increasingly important in the diets of yearling and older fish (Markle and Grant 1970; Gomez 1970; Manooch 1973; and Ware 1971). The 1974 data from the Hudson River estuary support these findings. Striped bass greater than 75 mm in total length primarily feed on small invertebrates (cladocerans, copepods, and amphipods). Young-of-the-year Atlantic tomcod were the first fish which appeared in the stomachs of striped bass between 76 to 150 mm in total length collected during June. Markle and Grant (1970) and Gomez (1970) also reported striped bass foraging on prey fish at about this size. Striped bass 151 to 200 mm in total length continued to eat invertebrates; however, fish became increasingly important in their diet. Hudson River striped bass greater than 200 mm in total length primarily consumed fish (clupeids, Atlantic tomcod, and Morone). Manooch (1973) found fish to be the dominant food of striped bass 125 to 304 mm in length in Albemarle Sound, North Carolina, and reported that approximately 1% of the yearlings examined contained young striped bass. Cannibalism was also uncommon in the Hudson River estuary during 1974 and only one striped bass was found to have consumed another.

2) Age Two and Older

a) Methods

The stomachs examined for this analysis were obtained from striped bass captured at night in haul seines (200- and 900-ft) during April and May 1976. Only fish from haul seines were examined since retention of stomach contents can be influenced by the method of capture (Manooch 1973 and Stevens 1966; fish caught in gill nets have a higher frequency of empty stomachs, caused either by continuing digestion or regurgitation while the fish are trapped in the nets. Immediately upon capture, the fish used for stomach analysis were injected through the esophagus with 10% formalin. The stomachs were later dissected in the lab. Data were analyzed by month of capture (April and May) and length group (200-399, 400-599, 600-799, 800+ mm).

b) Results and Discussion

Twenty-two fish (19 countable fish remains, 2 unidentifiable Clupeids and a blueback herring) had been consumed recently before capture by the striped bass examined in this study. Uncountable fish remains were found in four additional stomachs. Fish constituted the major food item for the two largest size groups examined. Vegetative material and fish remains were most numerous in the stomachs of the two smallest size groups.

Feeding appears to decrease during the spawning season. Thirty-three (24%) of the 138 stomachs examined from all size groups were empty (Table IV-2). Of the 105 nonempty stomachs, 84 (80%) contained only detritus and inorganic material. Of the 84 stomachs which had only detritus or inorganic material, approximately 80% were empty except for sand grains which were probably ingested while within the confines of the net during capture. Therefore, the incidence of stomachs with items of no nutritive value was

Table IV-2

Stomach Contents of Adult Striped Bass Caught in Haul Seines in Hudson River Estuary during April and May 1976

Length Group and Food Item Description	April		May		April and May Combined	
	No. Stomachs with Item	Count for All Stomachs	No. Stomachs with Item	Count for All Stomachs	No. Stomachs with Item	Count for All Stomachs
200 - 399 mm (TL)	19 stomachs,	11% empty	29 stomachs,	41% empty	48 stomachs,	29% empty
Filamentous algae			1	*	1	*
Animal remains	1	*	1	*	2	*
Plant remains	1	*	5	*	6	*
Detritus	17	*	14	*	31	*
Fish remains			1	1	1	1
Cyathura	1	1	1	1	2	2
400 - 599 mm (TL)	18 stomachs,	17% empty	31 stomachs,	29% empty	49 stomachs,	25% empty
Fish remains			3	*	3	*
Animal remains			2	*	2	*
Plant remains	4	*	4	*	8	*
Detritus	14	*	15	*	29	*
Fish remains	1	1	1	1	2	2
600 - 799 mm (TL)	7 stomachs,	14% empty	12 stomachs,	17% empty	19 stomachs,	16% empty
Fish remains	1	*			1	*
Plant remains	1	*	1	*	2	*
Detritus	6	*	9	*	15	*
Fish remains			1	1	1	1
800 + mm (TL)	8 stomachs,	12% empty	14 stomachs,	21% empty	22 stomachs,	18% empty
Plant remains	2	*	2	*	4	*
Detritus	6	*	4	*	10	*
Blueback herring			1	1	1	1
Clupeid (unid)			1	2	1	2
Fish remains	3	8	6	7	9	15
Combined length groups	52 stomachs,	13% empty	86 stomachs,	30% empty	138 stomachs,	24% empty
Fish remains	1	*	3	*	4	*
Filamentous algae			1	*	1	*
Animal remains	1	*	3	*	4	*
Plant remains	8	*	12	*	20	*
Detritus	42	*	42	*	84	*
Blueback herring			1	1	1	1
Clupeid (unid)			1	2	1	2
Fish remains	4	9	9	10	13	19
Cyathura	1	1	1	1	2	2

*Uncountable

much higher than the 24% of the stomachs that were completely empty. In April, the stomachs of approximately 15% of the fish in each length group were empty. The percentage of empty stomachs increased in May about the time of spawning (Subsection V.B.1.1).

The low incidence of identifiable food items in April-May may be explained by the fact that feeding decreases during the spawning season (Scofield 1931, Manooch 1973, Stevens 1966, Woodhull 1947, Trent and Hassler 1966, and Hollis 1952). Sampling occurred only at night and although digestion is rapid (Heuback et al 1963), striped bass are known to be evening feeders. Although this study was conducted only during the months of the spawning season, many other studies report the feeding habits of large striped bass throughout the year (Schaefer 1970, Stevens 1966, Thomas 1967, Manooch 1973, Hollis 1952). Results of this present study (when detritus and inorganic material are excluded) are similar to the results of Trent and Hassler (1966) who found that the stomachs of only 15% of the males and 20% of the females in the spawning areas of the Chesapeake contained food.

Fish species such as menhaden, silverside, killifish, herring, anchovy, shad, and croaker have been reported as most common in the diets of large striped bass in other populations (Hollis 1952, Manooch 1973, Raney 1952, Merriman 1941, Dovel 1968, and Stevens 1966). Only Schaefer (1970) found invertebrates, especially amphipods, to be important items in the diets of large fish (up to 940 mm TL). Although cannibalism was not detected with the small sample size of this study, it has been reported in the Albemarle Sound by Manooch (1973), in the Hudson River by Dew (1977), and on the west coast by Scofield (1931), Stevens (1966), and Thomas (1967).

b. Growth

1) Larvae and Juveniles

This section presents data on growth rates for striped bass larvae and juveniles of the 1976 year class. These data are compared with those for the 1973, 1974, and 1975 year classes of striped bass previously presented (McFadden 1977).

a) Methods

Growth for the 1976 year class of striped bass was estimated with the same procedures used for the 1973, 1974, and 1975 year classes (McFadden 1977) and was estimated from changes in mean length over time. Data on mean lengths for larvae were provided by LMS and combined with juvenile data from the TI surveys to get estimates of mean length for each week from the time of first spawning (early May) through mid-December. Growth curves were fitted by eye.

b) Results and Discussion

The growth curve for the 1976 year class was similar to those reported for the 1973, 1974, and 1975 year classes (McFadden 1977). Growth was slow during June, rapid during July and early August, and decreased from late August through October (Figure IV-3). Essentially no growth was evident after mid-October. The stabilization of mean length observed during September and early October may be an artifact due to due to gear avoidance and emigration (Subsection IV.B.3.b.).

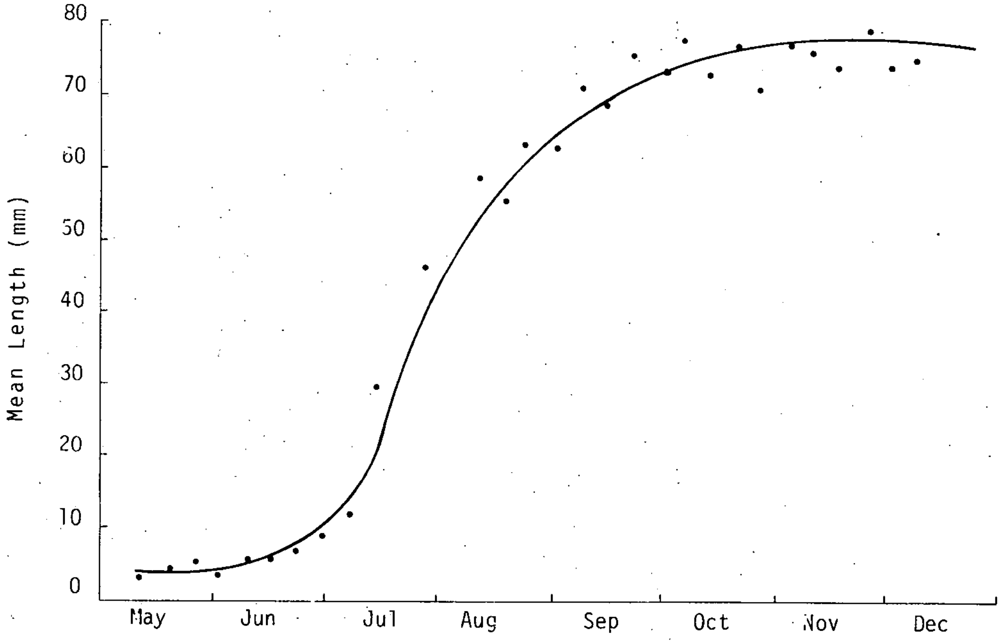

Figure IV-3. Estimates of Mean Length and Growth of Larvae and Juveniles of 1976 Year Class of Striped Bass in Hudson River Estuary

Individuals from the 1976 year class were smaller than individuals in the 1973, 1974, and 1975 year classes during comparable time periods (Figure IV-4). Temporal patterns in larval abundance suggest that the majority of the 1976 year class originated from the second peak in egg abundance as will be discussed in Section IV.B.3.b. This second peak occurred 2 to 3 weeks later than the periods of peak egg abundance from 1973 through 1975; the larvae in 1976 were 5 to 10 mm smaller than were the previous three year classes at the same time of the year. During the period of rapid growth, 1976 growth rates were similar to those of previous years so the 5 to 10 mm size differential was maintained through early August.

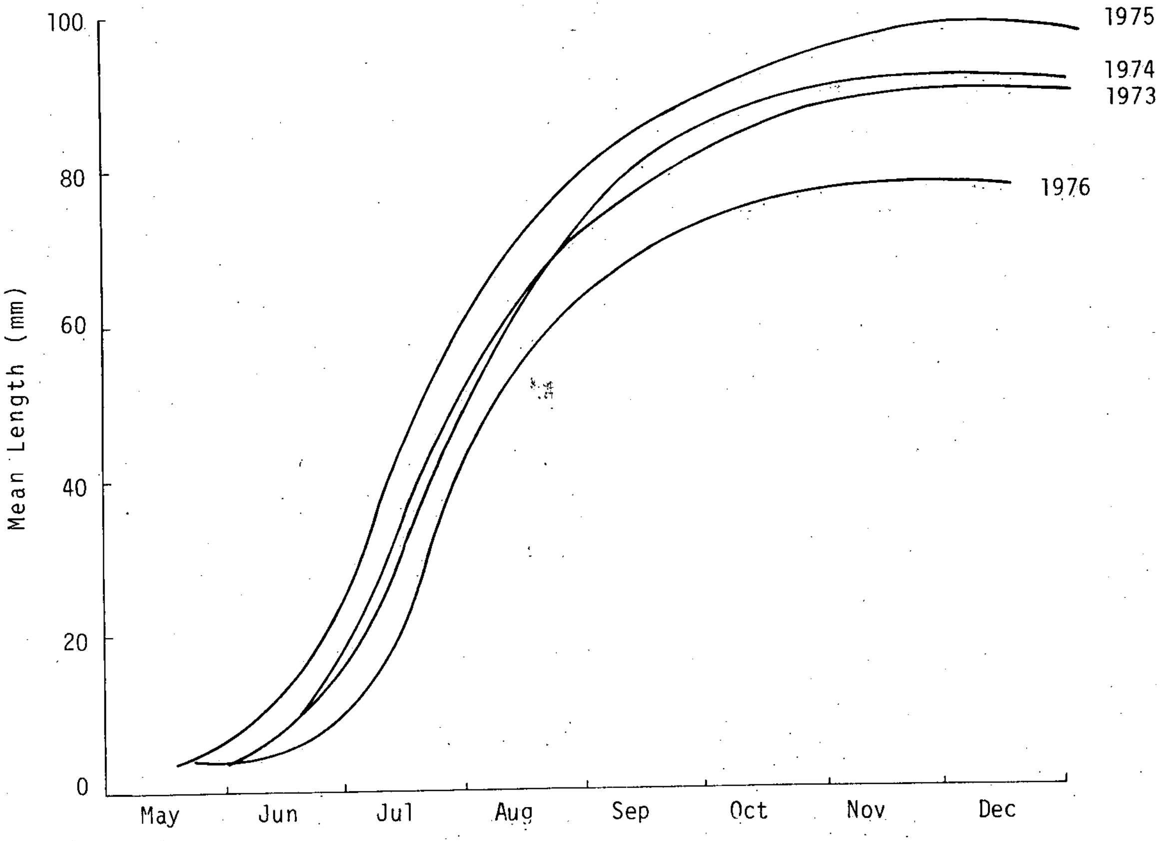

Figure IV-4. Comparison of Growth of Larvae and Juveniles from 1973, 1974, 1975, and 1976 Year Classes of Striped Bass in Hudson River Estuary

The rate of growth decreased during August of 1976, whereas in the previous three years, rapid growth continued through August. As a result, the size difference increased during late summer. By mid-October, the mean length of the 1976 year class juvenile was from 10 to 20 mm less than those in the previous three years. The difference in August growth among the 1973-1976 year classes may be related to differences in summer water temperatures. In 1973, 1974, and 1975, water temperatures increased through July, reached a maximum in August, and declined in September (Table IV-3). In 1976, the water temperature reached a maximum in early July rather than in August as in the previous three years and August temperatures were lower during 1976 than during 1973-1975. Therefore, the size of the juveniles at the end of the young-of-the-year stage is partially determined by the length of the growing season (from hatching to mid-October) and the summer water temperatures during this period.

Table IV-3

Periods of Maximum Water Temperature (^{o}C) and Mean July and August Temperatures (^{o}C) during 1973-1976 in Hudson River Estuary*

Year	Period of Maximum Water Temperature	Maximum Temperature	Mean July Water Temperature	Mean August Water Temperature
1973	Aug 9-11, 29-30 Sep 10-13	25.6	23.7	24.8
1974	Aug 21-26,28, 30	25.0	22.9	24.4
1975	Aug 5	27.2	24.9	25.0
1976	Jun 29-Jul 6, 13	25.0	24.5	23.3

*Water temperatures measured off Poughkeepsie, New York, by the Poughkeepsie Water Works Department.

2) Fish Two Years of Age and Older

Growth is important since it affects the age specific fecundity and age at maturity of striped bass. Growth rates in fishes are more variable than those of many other organisms, and may be sensitive indicators of changes in the environment (Ricker 1975).

a) Methods

Striped bass two years of age and older (hereafter called "older") were collected with haul seines and gill nets from March through June 1976. Total length was recorded for each fish and subsampled scales (Subsection III.C) were taken for aging. Two possible methods of growth calculations (McFadden 1977: subsection 7.8.2.) include direct measurement of mean length at a given age, and estimation of length at annulus formation by back calculations from scale dimensions. Only the first method was used for adult striped bass collected during 1976. The size of each fish captured and the age of the subsampled fish (Subsection III.C) were determined and the mean size for each age group was then calculated. Instantaneous and incremental growth rates were calculated from the mean total length of striped bass in each age group.

The incremental growth rate can be calculated as the difference between the mean total length of two consecutive age groups collected at the same time. The equation for calculating instantaneous growth rate (G) in weight is given (Ricker 1975) as:

$$G = b\ (\ln L_2 - \ln L_1) \qquad \text{(IV-1)}$$

where b is derived from a regression of logarithm of weight against the logarithm of length.

b) Results and Discussion

The 1976 analysis of growth for striped bass collected in the Hudson River from March through June indicated that the length of males and females was the same after the first eight years of life (Table IV-4). Age IX+ females were larger than males of comparable age. Incremental growth rates ranged from -3.7 mm (an anomaly of small sample size of females from age XIV to XV) to 169 mm per year (females from age VIII to IX). The striped bass captured in 1976 averaged approximately 50 mm of growth each year. Growth occurred slightly faster among the younger age groups. The instantaneous growth rate (G) showed a general decrease from young to older fish (Table IV-4).

Table IV-4

Mean Total Length, Annual Instantaneous Growth Rates (G), and Incremental Growth Rates of Hudson River Striped Bass Populations Collected March-June, 1976

	Males				Females			
Age	No. Examined	Mean Total Length (mm)	Incremental Growth Rates (mm) *	G	No. Examined	Mean Total Length (mm)	Incremental Growth Rates (mm) *	G
II	9	311	---	----	4	271	---	----
III	174	385	74	0.64	158	389	118	1.09
IV	145	439	54	0.39	163	456	67	0.48
V	282	521	82	0.51	312	524	68	0.42
VI	164	565	44	0.24	237	577	53	0.29
VII	52	640	75	0.37	135	690	113	0.54
VIII	23	741	101	0.44	32	737	47	0.20
IX	15	781	40	0.16	11	906	169	0.63
X	19	867	86	0.31	34	937	31	0.10
XI	24	873	6	0.02	35	958	21	0.07
XII	9	877	4	0.01	20	973	15	0.05
XIII	2	916	39	0.13	10	1010	37	0.11
XIV	---	---	---	----	2	977	-33	-0.10
XV	---	---	---	----	1	940	-37	-0.12
XVI	---	---	---	----	---	---	---	----
XVII	---	---	---	----	---	---	---	----
XVIII	---	---	---	----	1	1025	---	----
	Total 918				Total 1155			

G = Instantaneous growth rate (see equation [(IV-1)]; constant b = 2.988 for males and 3.028 for females)

* = Incremental growth rate (the difference in mean total length between two consecutive age groups)

The 1976 data appears to be in contrast to earlier data from the Hudson River (McFadden 1977) where significant differences were found between males and females older than age III. The similar sizes of male and female fish up to age VIII found in 1976 also differed from data in the literature for other anadromous populations, where the females were found to grow significantly faster after the first two to three years of life (Merriman 1941, Robinson 1960, Mansueti 1961a, and Jones et al 1977). A possible explanation for these differences is that the male and female striped bass of the Hudson River apparently coexist throughout their life cycle as shown by the overall even sex ratio encountered during 1976 sampling (McFadden and Lawler 1977). Therefore, both are subjected to exploitation by the commercial fishery. This, however, would be in marked contrast to the Chesapeake Bay striped bass (Jones et al 1977) where many females underwent coastal migrations while most males remained in the estuary. Since males in the Chesapeake Bay remained in the estuary, they were more susceptible to commercial fishing with the faster growing males being caught first. This would result in a selection for slower growing males (Ricker 1969) to survive past the ages of initial exploitation. Males at older ages would then be smaller than females of the same age.

3. Population Dynamics

This section describes the population dynamics of larval, juvenile and older striped bass collected in the Hudson River estuary. Estimates of the relative and absolute abundance and mortality rates for striped bass during 1976 are presented and the potential for feeding interactions between striped bass and white perch is discussed. Finally, density-dependent and density-independent factors affecting growth and abundance of juvenile striped bass are investigated.

a. Abundance Trends and Population Estimates

1) Juvenile Abundance Trends

Trends in the abundance of juvenile striped bass in the Hudson River can be detected with an index of year-class strength. Developed in 1975 (TI 1975a), the index has been periodically refined to provide a more accurate measure of year-class variations in the juvenile striped bass population since 1965. A description of the environmental surveys which were evaluated in the development of the index and an explanation of the rationale for selection of beach seine data as the best data set for the abundance index were presented in earlier reports (TI 1975a and McFadden and Lawler 1977).

a) Methods

Catches of juvenile striped bass per 10,000 ft^2 sampled by beach seines from mid-July through August of each year formed the basis of the annual abundance indices for 1965-1976 (excluding 1971). The applicability of this index as an indicator of year class strength was tested by comparing it to an index based on a longer sampling interval (July-October) for the years 1973-1976. Friedman and Multiple Comparisons Tests of the alternate index (1973-1976) provided a statistical basis for further evaluating the July-August abundance indices and trends in abundance over the 12-year period. In addition, yearling abundance was calculated and correlated with the juvenile abundance of the preceding year to determine if year class strength is set by mid-July through August.

(1) Calculation of the Eleven-Year Index

Beach seine catch and effort data from June, July, and August were the only consistent data available for the period 1965-1976 (excluding 1971 when insufficient sampling was done) [Figure IV-5]. Since juvenile striped bass were beginning to move from the shoal and channel areas to the shore in July (Figure V-13), only data from mid-July to the end of August were used to generate each annual index of abundance.

Beach seines of three different lengths (50-, 75-, and 100-ft) were used from 1965 to 1976, (Appendix Table B-2). To standardize the catch in the three seines, the number of juvenile striped bass caught per unit area swept (CPUA) was used as the index of year-class strength. The area swept by the 50-ft seines which were used in the New York University (NYU) Survey, was measured at the time samples were taken (Perlmutter et al 1967). The area swept by a 100-ft seine was found to have a mean of 4844 ft^2 (TI 1975a). The 75-ft seine used by Raytheon (RAY) for part of 1969 was assumed to sweep an area similar in shape to the 100-ft seine and calculated to be 2725 ft^2 (TI 1975a). The three seines were assumed to be equally efficient when catches were expressed on a unit-area-swept basis. The efficiencies of the 50-ft and 100-ft seines have been compared and no significant difference ($\alpha = 0.05$) between the catches of juvenile striped bass per unit area swept was observed (TI 1977b).

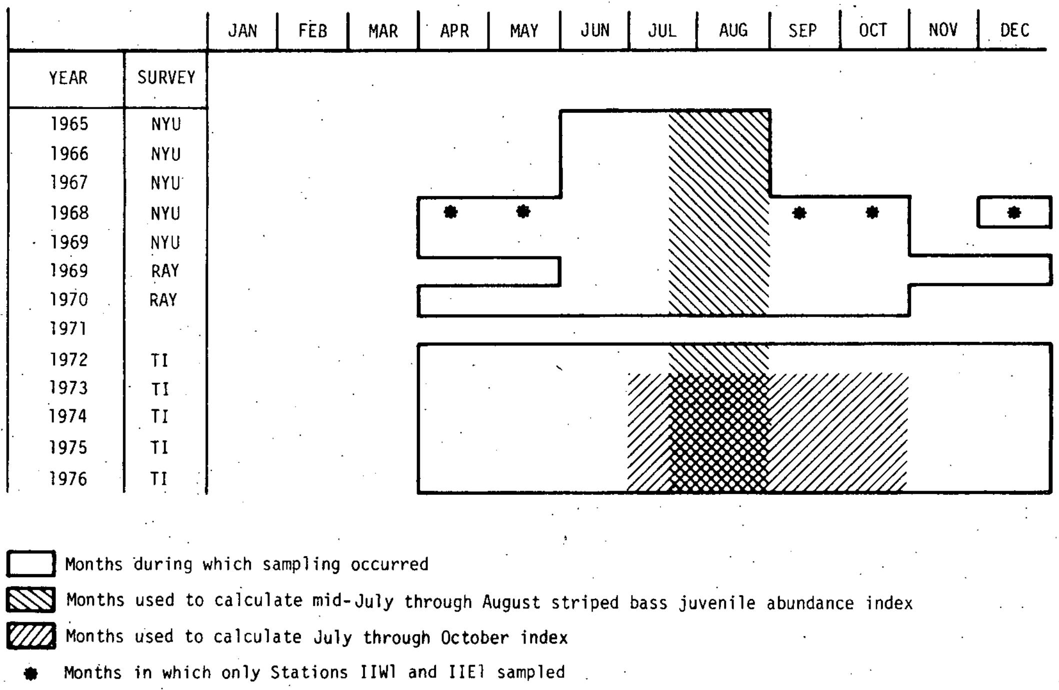

Figure IV-5. Beach Seine Sampling of Hudson River Estuary from 1965-1976

To avoid biases introduced by the variation in local densities, the abundance index was based on river-wide data. In 1969, 1970, and 1972, sampling was concentrated in the Indian Point and Croton-Haverstraw regions (Table IV-5) which frequently had the highest densities of juvenile striped bass (Figure V-12). Indices calculated from these samples alone would likely overestimate river-wide juvenile abundance. In order to adjust for this bias, indices from each year of restricted sampling (1969, 1970, 1972) were adjusted to correspond to river-wide estimates. This was done by calculating the geometric mean of the ratios of river-wide abundance to Indian Point standard station abundance from mid-July through August from the years 1973-1976 (when both river-wide and near-field sampling were done). Then, the Standard Stations CPUA values for 1969, 1970, and 1972 were multiplied by this geometric mean ratio (0.43; Appendix Table B-3).

Table IV-5

Geographical Regions of Hudson River Estuary Sampled by Beach Seines from 1965-1976

		Region (River Mile)											
Year	Survey	YK (12-23)	TZ (24-33)	CH (34-38)	IP (39-46)	WP (47-55)	CW (56-61)	PK (62-76)	HP (77-85)	KG (86-93)	SG (94-106)	CS (107-124)	AL (125-152)
1965	NYU		*		*		*	*		*	*		
1966	NYU		*		*		*	*		*	*		
1967	NYU		*		*		*	*		*	*		
1968	NYU		*		*		*	*		*	*		
1969	NYU				*		*			*			
1969	RAY			*	*	*							
1970	RAY			*	*	*							
1971													
1972	TI		*	*	*	**	**						
1973	TI	*	*	*	*	*	*	*	*	*	*	*	*
1974	TI	*	*	*	*	*	*	*	*	*	*	*	*
1975	TI	*	*	*	*	*	*	*	*	*	*	*	*
1976	TI	*	*	*	*	*	*	*	*	*	*	*	*

*Beach seine samples taken in these regions

**Beach seine samples taken from October-December only (not included in the July-October index)

(2) Four Year Alternate Index

Prior to 1969, limited sampling occurred after August restricting the abundance index to the mid-July through August sampling period (Figure IV-5), however peak catches of striped bass in the shore zone usually occurred later in the season (Figure V-13). To determine if the mid- July through August index accurately reflected juvenile abundance, river-wide indices based upon data from the period July-October were calculated for 1973 through 1976. The beach seine data from each of these years, when divided into nine biweekly intervals, allows a statistical analysis of the differences between years using the Friedman and Multiple Comparison Tests (Appendix Table B-4 and B-5) (Hollander and Wolfe 1973). The results of these analyses were then compared to those abundance indices observed for the same years when the mid-July through August abundance index was used.

(3) Juvenile Abundance versus Yearling Abundance in the Following Year

For the purpose of determining trends in year class abundance, it is assumed that the mid-July through August index adequately represents striped bass abundance after year-class strength had been established. If this assumption is true, the abundances of juvenile striped bass in one year and yearling striped bass the following year should be positively correlated. Numbers of yearling striped bass collected in beach seine were recorded during 1974-1976. From 1965 to 1973, the numbers of yearling versus striped bass two years of age and older were not reported separately. For the 1974-1976 catch data, yearlings represented 91% of the combined yearling and older striped bass catches (Appendix Table B-6). Therefore, the combined catches for the years 1965 to 1973 should be highly correlated with the actual yearling abundance. An index of catch-per-unit area for yearling and older striped bass was calculated (Appendix Table B-16). Data from nine year classes were used in the analysis to correlate juvenile abundance in year t with estimated yearling abundance in the year t + 1.

b) Results and Discussion

(1) Juvenile Abundance Index (Eleven Years)

During the period 1965-1976, estimated year-class abundance of striped bass varied by a factor of 25.6 (Table IV-6). Three weak year classes (1965, 1967, and 1968), four strong year classes (1969, 1970, 1973, and 1975), and four intermediate year classes (1966, 1972, 1974, and 1976), were apparent (Figure IV-6). After a sharp recovery from the intermediate to weak year classes of 1965-1968, the juvenile striped bass population had been fluctuating with high and intermediate abundances from 1969 through 1976. Factors contributing to the variation in year-class strength are presented in Subsection IV.B.3.e.

Table IV-6

Beach Seine Data Used to Calculate River-Wide Index of Abundance (Catch Per Unit Area) for Juvenile Striped Bass, Hudson River Estuary, 1965-1976

Year	Survey	Sample Date	Number Caught	Area Swept(ft^2)	Index of Abundance
1965	NYU	7/19-8/17	27	227,000	1.2
1966	NYU	7/13-8/24	292	356,225	8.2
1967	NYU	7/17-8/21	116	275,000	4.2
1968	NYU	7/15-8/19	51	389,700	1.3
1969	RAY & NYU	7/13-8/30	431	60,325	30.7*
1970	RAY	7/12-8/29	986	266,420	15.9*
1971	**	**	**	**	**
1972	TI	7/16-9/02	447	208,292	9.2*
1973	TI	7/15-9/08	6,127	2,145,892	28.6
1974	TI	7/14-9/07	2,713	2,853,116	9.5
1975	TI	7/13-9/06	6,574	3,599,092	18.3
1976	TI	7/11-9/04	4,240	3,758,944	11.3

*Abundance indices have been adjusted by a factor of 0.43 to correspond to river-wide abundance

**Insufficient sampling

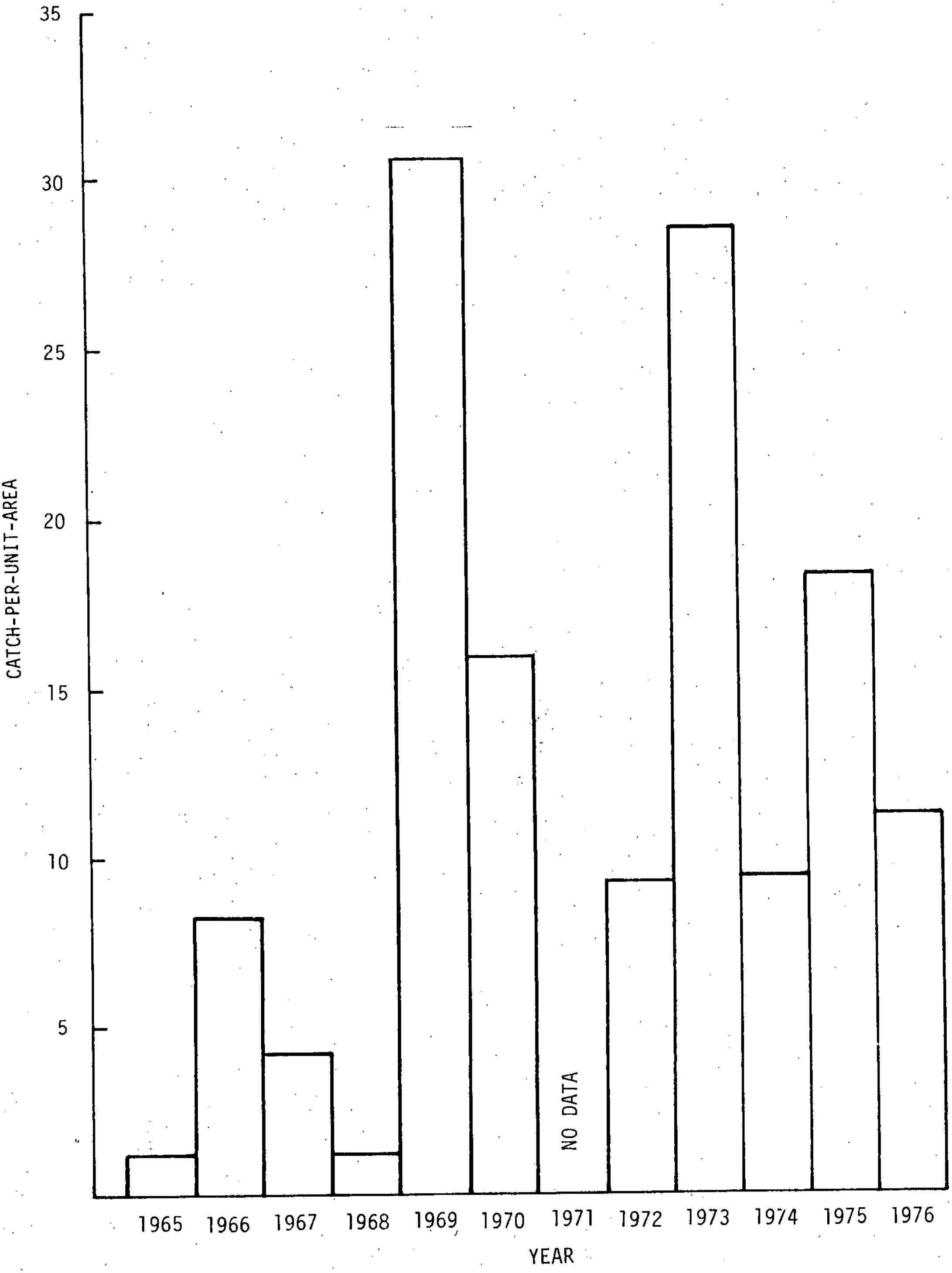

Figure IV-6. Juvenile Striped Bass Abundance Indices (Catch-Per-Unit-Area) for Period Mid-July through August, 1965-1976, Hudson River Estuary

(2) Alternate Index (Four Years)

The striped bass abundance index (mid-July through August) was compared with the July through October index of 1973-1976. Both indices exhibited similar trends of juvenile abundance (Figure IV-7), with the 1973 and 1975 indices being higher than those for 1974 and 1976. A Multiple Comparison Test based on Friedman rank sums of the July-October indices, revealed that the 1973 July-October index was significantly ($\alpha = 0.05$) different from those of 1974 and 1976 (Table IV-7), but the 1973 and 1975 indices were not significantly different.

Table IV-7

Results of Friedman Multiple Comparisons Test of July-October Index of Abundance for Juvenile Striped Bass, Hudson River Estuary 1973-1976 (Those years between which no significant [$\alpha = 0.05$] difference exists are underlined)

1974	1976	1975	1973

There was no significant difference between 1974, 1975, and 1976 July-October abundance indices for juvenile striped bass. Trends reflected by the July-October index, when peak catches for juvenile striped bass occurred, were similar to those of the mid-July through August abundance index. This similarity of the two indices corroborated the conclusion that the use of the mid-July through August data provided a valid measure of relative abundance. Therefore all subsequent analyses of year class strength used the mid-July through August index.

(3) Juvenile Abundance versus Yearling Abundance in the Following Year

A significant correlation ($r = 0.833$, $P = 0.005$) was found between the juvenile CPUA values in year t and the combined yearling and older CPUA values in year t + 1 (Figure IV-8). Therefore year-to-year differences in young-of-the-year abundance as measured by the mid-July through August index were maintained through the following year. This relationship strongly suggests that the juvenile striped bass abundance index reflects abundance levels after the establishment of year class strength and thus reflects future relative abundance of recruits.

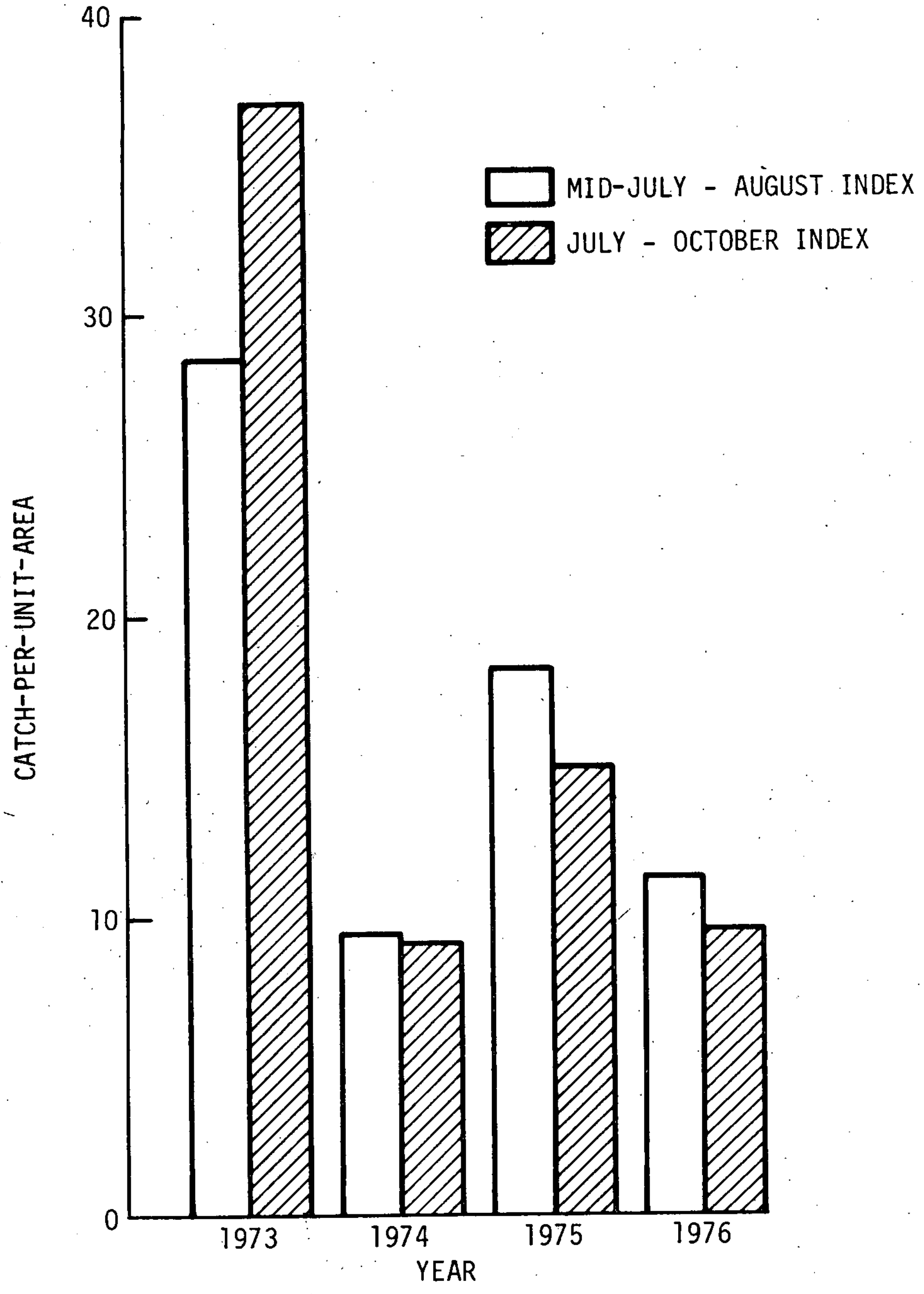

Figure IV-7. Comparison of Mid-July-August and July-October Indices of Juvenile Striped Bass Abundance (Catch-Per-Unit-Area) in Hudson River Estuary, 1973-1976

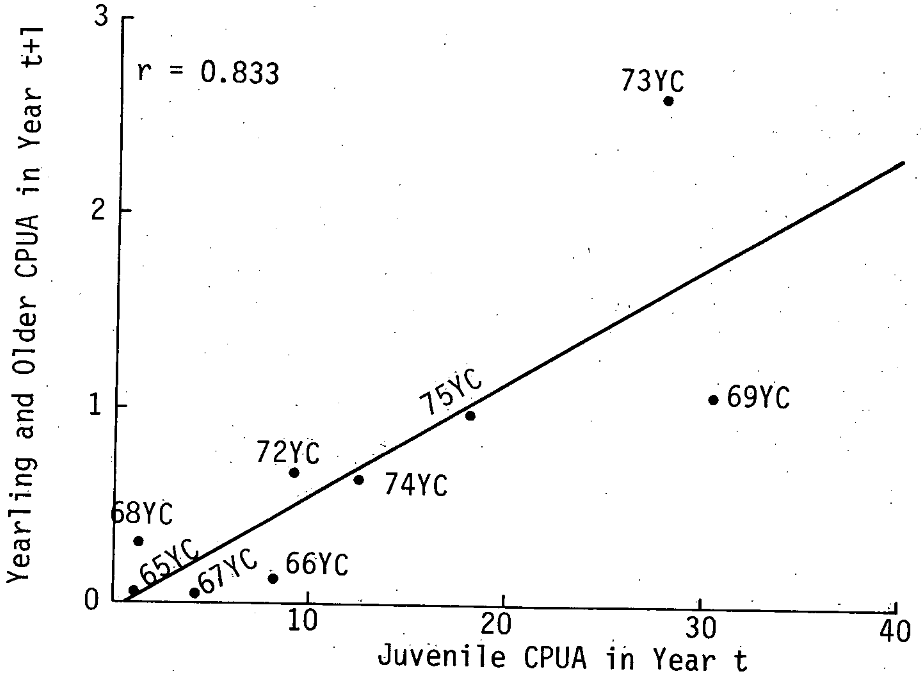

Figure IV-8. Striped Bass Year Class (YC) Abundance of Juveniles vs Yearling and Older of Following Year

2) Juvenile Population Estimates

Several factors were considered in estimating the absolute population size of juvenile striped bass. The population was distributed over the estuary (RM 12-152 [KM 19-243]) in habitats which often were not easy to sample effectively. In addition, the population was constantly changing due to the processes of recruitment, mortality, and emigration. Therefore, several methods were employed so that estimates could be compared and an assessment of the sources of bias for each method could be made.

a) Methods

Both mark-recapture and density extrapolation methods were examined for use in estimating the number of juvenile striped bass in the estuary during 1976. The estuary was divided into five regions for the mark-recapture program. Juvenile fish were marked in September, October, and November by clipping combinations of two fins. These finclip combinations were specific to regions and months so that recaptured fish could be identified according to the time and location of their release. Fish were also finclipped from April through June but during these months, clip combinations were specific only to regions. Recapture effort included all TI field sampling programs from September of 1976 through June 1977, and recaptures from impingement collections at the Bowline, Lovett, Indian Point, Roseton, and Danskammer power plants from the same time period.

Most mark-recapture methods require that several basic assumptions are met:

- Marked and unmarked fish suffer the same mortality.
- Marked and unmarked fish are equally vulnerable to the fishing or sampling program.
- Marked fish do not lose their marks.
- Either marked fish become randomly mixed with unmarked or the recapture samples are selected randomly from the entire population.
- All marked fish in the recapture sample are recognized.
- Recruitment to the population is negligible.

To obtain the best population estimate, a technique for which most, or all, of the assumptions can be met is desired. Violation of assumptions introduces error into the mark-recapture population estimates. Error has been classified as one of three types by Ricker (1975) based on the effect each type would have on the parameters (slope or intercept) of a regression analysis. Type A errors are those that affect only the intercept of a regression analysis of mark-recapture data over time (Figure IV-9). This type of error could be caused by marking-related mortality that was manifested immediately after release of the fish but that did not affect subsequent survival; thus the actual number of marked fish available for

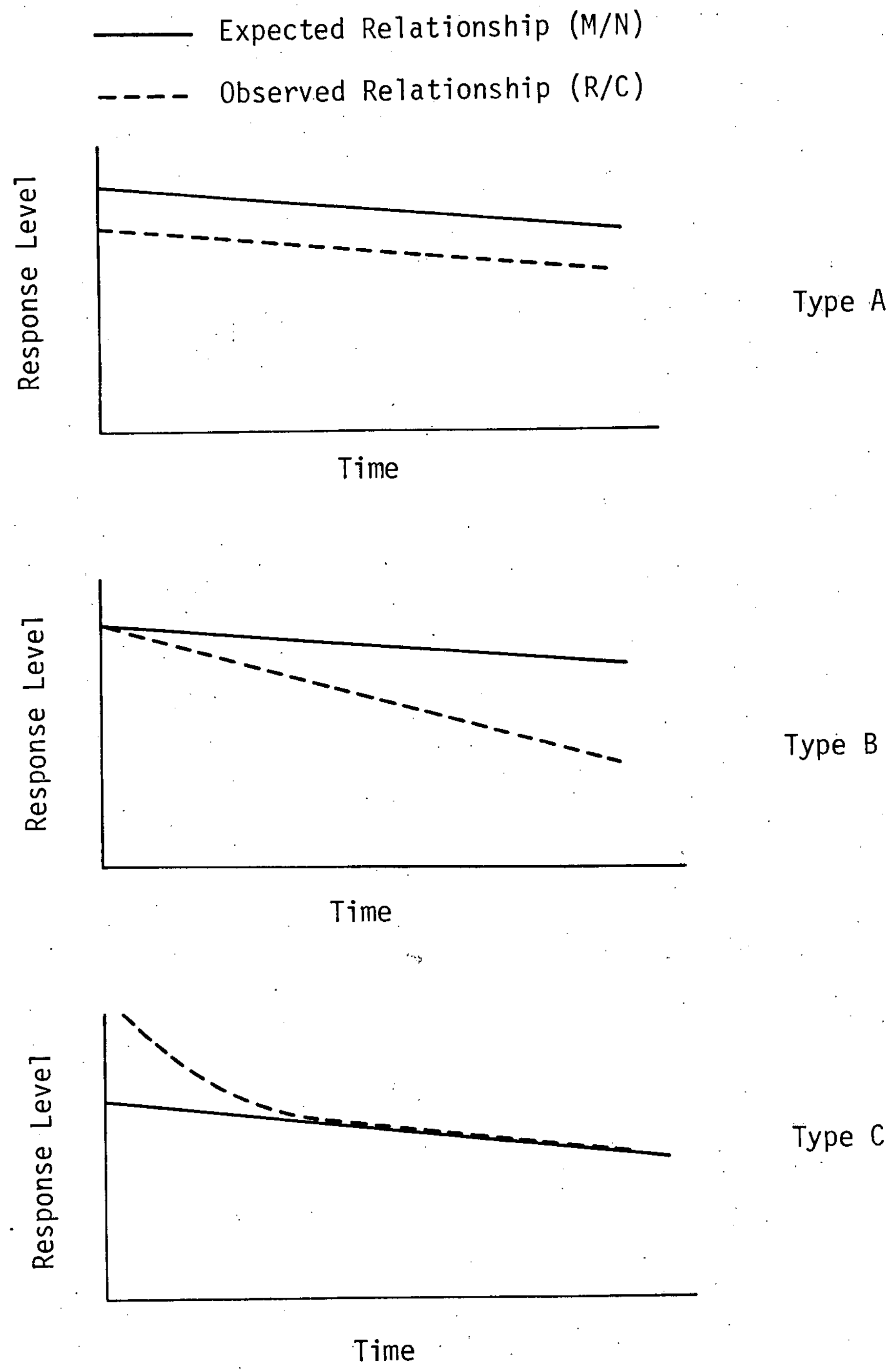

Figure IV-9. Diagrammatic Representation of Types of Systematic Errors Possible in Mark-Recapture Data. (M/N) Represents the Fraction of Total Population (N) That Is Marked (M). (R/C) Represents Fraction of the Sample (C) That Is Marked (R). (Adapted From Jones 1977) recapture would be less than the total number marked. Other causes of Type A error would be a consistent failure to report a fraction of the recaptured fish or immediate tag loss (Type 1, Beverton & Holt 1957).

Type B errors are those which affect the slope of the regression line but not the intercept (Figure IV-9). Factors which cause Type B errors include continued higher mortality of marked fish or continuous tag loss (Type 2, Beverton & Holt 1957). In both cases the decreasing fraction of marked fish in the catch through time will underestimate the fraction of the total population originally marked.

Type C errors are those which would have an effect immediately after marking but observed values would approximate expected values after some period of time (Figure IV-9). Thus some "waiting period" would be required before unbiased population estimates could be made. Causes of Type C error include abnormal behavior of marked fish immediately after release and incomplete mixing of marked and unmarked fish.

Very few mark-recapture studies can meet all of the necessary assumptions, thus adjustments must be made to the data so that the assumptions are at least approximately true. Many of these adjustments have been reported in the fisheries literature (see Seber [1973] and Ricker [1975] for thorough reviews of mark-recapture methods) and are now well-accepted techniques. In this study, adjustments for immediate (14-day) marking mortality and removal of recaptured fish from estimates of marked fish during the study were made to aid in satisfying assumptions.

Estimates of absolute abundance were also derived by density-area and density-volume extrapolation methods using region and stratum standing crops developed from the Beach Seine, Long River Ichthyoplankton, Fall Shoal surveys. Methods for calculating standing crops from each of these surveys were presented in an earlier report (TI 1975a). The standing crops from the separate surveys were combined as follows:

$$RSC_{ij} = (BSSC_{ij} \cdot R/E) + (0.75 \cdot SSC_{ij} /S) + (BSC_{ij}/S) + (CSC_{ij}/S)$$

where

RSC_{ij} = regional standing crop in region i during time period j

$BSSC_{ij}$ = daytime beach seine standing crop in region i during time period j

R = night/day catch ratio in beach seines

E = catch efficiency of beach seines

SSC_{ij} = shoal standing crop in region i during time period j

BSC_{ij} = bottom standing crop in region i during time period j

CSC_{ij} = channel standing crop in region i during time period j

S = catch efficienty of epibenthic sleds and Tucker trawls

The total standing crop (TSC_j) was then the sum of the regional standing crops:

$$TSC_j = \sum_i RSC_{ij}$$

Data from several surveys were combined because the entire population of a fish species can rarely be adequately sampled by a single type of fishing gear. Thus the gear that would provide the best quantitative estimates of abundance in each depth strata was selected.

The night/day catch ratio, R, was necessary because the Beach Seine Survey was conducted during daylight hours while the Ichthyoplankton and Fall Shoal surveys were done at night. Thus to avoid excluding fish which might stay in deeper water during the day and move into the shorezone at night, an adjustment factor (R) was derived from ratios of night-to-day beach seine catches in years when both night and day samples were taken (1973 and 1974) (McFadden 1977).

The catch efficiency adjustments, E and S, were included in the calculation of absolute abundances because it was not realistic to assume that the sampling gear were 100% efficient. The catch efficiency value for the 100 ft beach seine (0.39) was empirically derived (TI 1978b). Catch efficiency values for the epibenthic sled and Tucker trawl were assummed to be 0.50 based on data from the literature for other towed gear (Kjelson and Colby 1977).

Depths less than 20 ft (6.5 m) are sampled by both ichthyoplankton gear and beach seines. To avoid a duplication of standing crop estimates from the two data sources, the shoals standing crop was adjusted by a factor of 0.75 to remove the portion of the 0 to 20-ft (0-6.5 m) depth stratum that is sampled by beach seines, i.e. depths less than 10 ft (3.0 m). Therefore, the shoals standing crop estimates after this adjustment pertained only to 10 to 20-ft (3.0 to 6.5-m) depths. The slope of the bottom was assumed to be constant so that, in a cross-section of the river, the volume for the 0 to 10 ft (0 to 3.0 m) stratum would be 1/4 of the volume of the 0 to 20-ft (0 to 6.5 m) stratum (Figure IV-10).

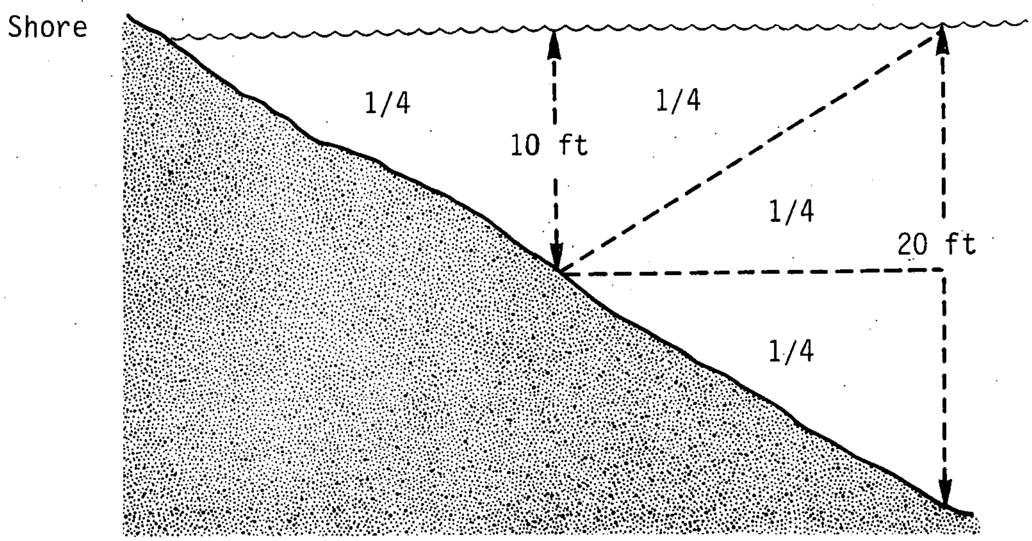

Figure IV-10. Generalized Cross Sectional View of Shoal Zone with 1/4 of the Total Volume in the 0 to 10-ft (0-35 m) Stratum

b) Results and Discussion

(1) Mark-Recapture

Type A errors resulting from immediate mortality of marked fish were assessed by holding samples of marked and unmarked fish for 14 days.

These tests provided an estimate of immediate handling related mortality which was used to adjust the number of fish released to estimate the number of fish available for recapture (Appendix Table B-41). Adjustment factors used were 0.95 for September and 0.77 for October and November. A second source of Type A error, incomplete reporting of recaptured fish, was minimized by using only recaptures from sources (environmental contractors) that were specifically charged with reporting them. All suspected fin-clipped fish were preserved and taken to the laboratory for verification so that a standard set of criteria could be used to distinguish fish actually marked from those missing fins due to abnormal development or disease. Also, quality control procedures on recognition of marked fish from impingement collections, which contributed to a large portion of the recapture sample, were applied in the laboratory processing facilities at TI.

Type B errors were more difficult to detect and adjust. Type B errors caused by higher mortality of marked fish could have occurred but no adjustment was attempted. The fact that clipping fins can reduce the survival of marked fish has been documented by Coble (1971) and Mears and Hatch (1976), but Shetter (1952) found no significant differences in the growth or survival of marked and unmarked fish. Errors due to continuous mark loss (in this case, fin regeneration) were reduced by marking the fish near the end of the growing season when regeneration is slow, and by completing the recapture effort before extensive regeneration would be likely. In general, Type B errors can be minimized by conducting intensive mark-recapture programs over a short time period so that expected and observed values will not differ greatly.

Type C errors are the most difficult type to overcome in an extremely large system such as the Hudson River estuary. In a relatively long-term mark-recapture program, the Type C errors caused by aberrant behavior of fish immediately after marking can probably be ignored. A more serious problem is the error caused by nonrandom distribution of fishing effort or marked fish. To overcome this problem, sampling effort was roughly proportional to the distribution of the population and the recapture period was delayed (for Petersen Estimates) to allow time for marked fish to disperse.

Other studies have encountered similar problems, even in systems smaller than the Hudson River (Schumacher and Eschmeyer 1943, Ricker 1975, Van Den Avyle 1976, Swingle and Smitherman 1965, and Cooper 1952), but beyond identifying the error, nothing could be done.

The effects of nonrandom distribution of marked fish or of recapture effort usually act to inflate the observed fraction of marked fish in the recapture sample (R/C) so that (M/N), the actual fraction of the marked population is less than (R/C) and population estimates derived from these samples will be too low (Figure IV-11). In situations where mixing is slow, it is possible to delay the recapture effort until observed values align more closely with expected values; however, the delay will increase the effect of Type B error. Mixing can be evaluated through analysis of movements of marked fish, or comparison of (R/C) values from different sampling methods or locations. When the Type C error is substantial, multiple-census type estimates will always be affected since marking and recapture effort occur concurrently.

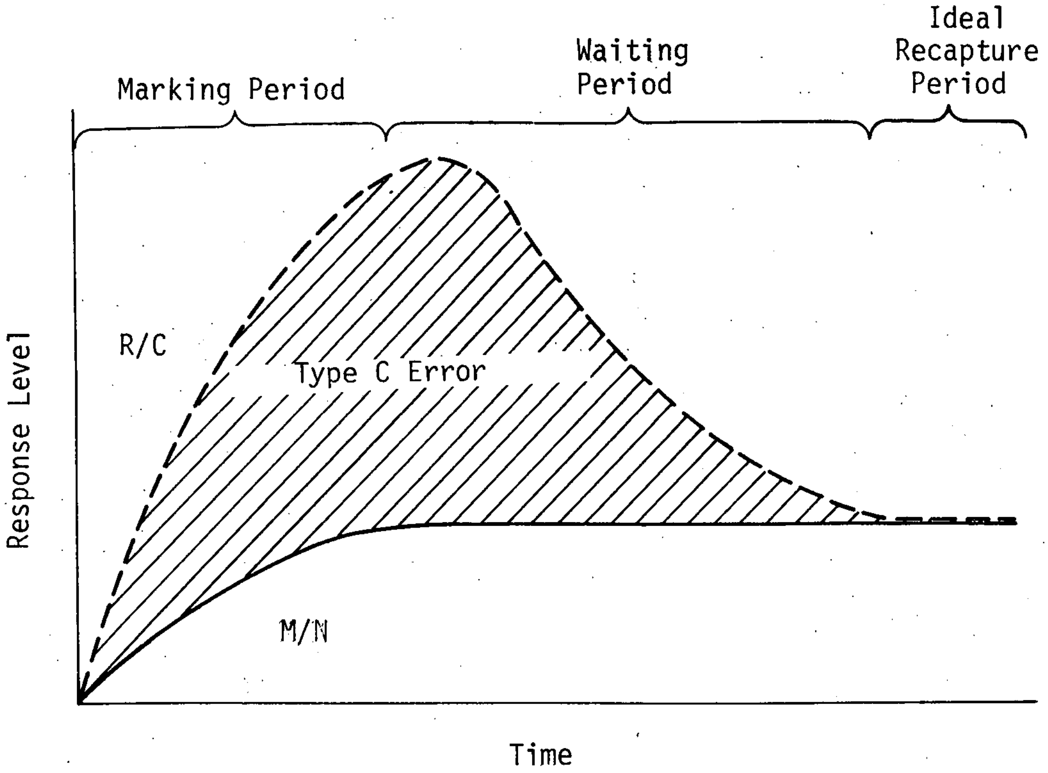

Figure IV-11. Relationship of Observed (R/C) and Expected (M/N) Values When Complete Mixing of Marked and Unmarked Fish is Delayed

Juvenile striped bass exhibited R/C values that suggested Type C error could be severe in multiple-census estimates (Figure IV-12). The observed values climbed rapidly during marking, then declined rapidly to zero over 2 months. Ideally, the observed values (R/C) should decline as the fish become mixed and stabilize at the expected value (M/N). The fact that the values continue to decline indicated that even a Petersen-type estimate would not be appropriate during the time period shown.

Several lines of supplementary evidence support the view that marked striped bass do not mix rapidly with the unmarked. First, the lack of interregional movement of marked fish, both during the fall and subsequent spring (Subsection V.B.1, TI 1978a), indicates that marked fish do not generally travel long distances during the period when they can be recaptured. Second, since striped bass are caught primarily in beach seines, any tendency of the fish to return to the place of initial capture could greatly inflate R/C values for field sampling. This tendency to return to the place of initial capture is well documented for centrarchids (Larimore 1952, Gunning 1959 and 1963, Parker and Hasler 1959, Hasler and Wisby 1958, Harden-Jones 1968, Gerking 1953) and some evidence exists for homing in other Morone species (Hasler et al 1958, Horrall 1961). The fact that striped bass can also return to the place of original capture is apparent from the lack of movements (less than 1 mile) of sub-adult striped bass marked with individually numbered tags (TI 1978a and Subsection V.B.1). Five juvenile striped bass have been recaptured at the site of original capture in the Hudson River after being transported approximately 5-mi (8-km) upriver, from Hastings to the Tappan Zee Bridge (Byron Young, NYSDEC, personal communication). Finally, the difference in R/C ratios for field sampling (primarily beach seines) and impingement collections indicates that mixing may not be complete even after several months (TI 1978a). Therefore, to eliminate Type C error, a truly random recapture sample would be necessary; mixing alone did not appear to be sufficient to eliminate the error.

In past years, juvenile striped bass have been estimated with the Petersen method from a recapture sample taken from March through June of the year after marking (TI 1978a). This method produced late-October estimates of approximately 1.5 and 2.4 million for the 1974 and 1975 year classes, but

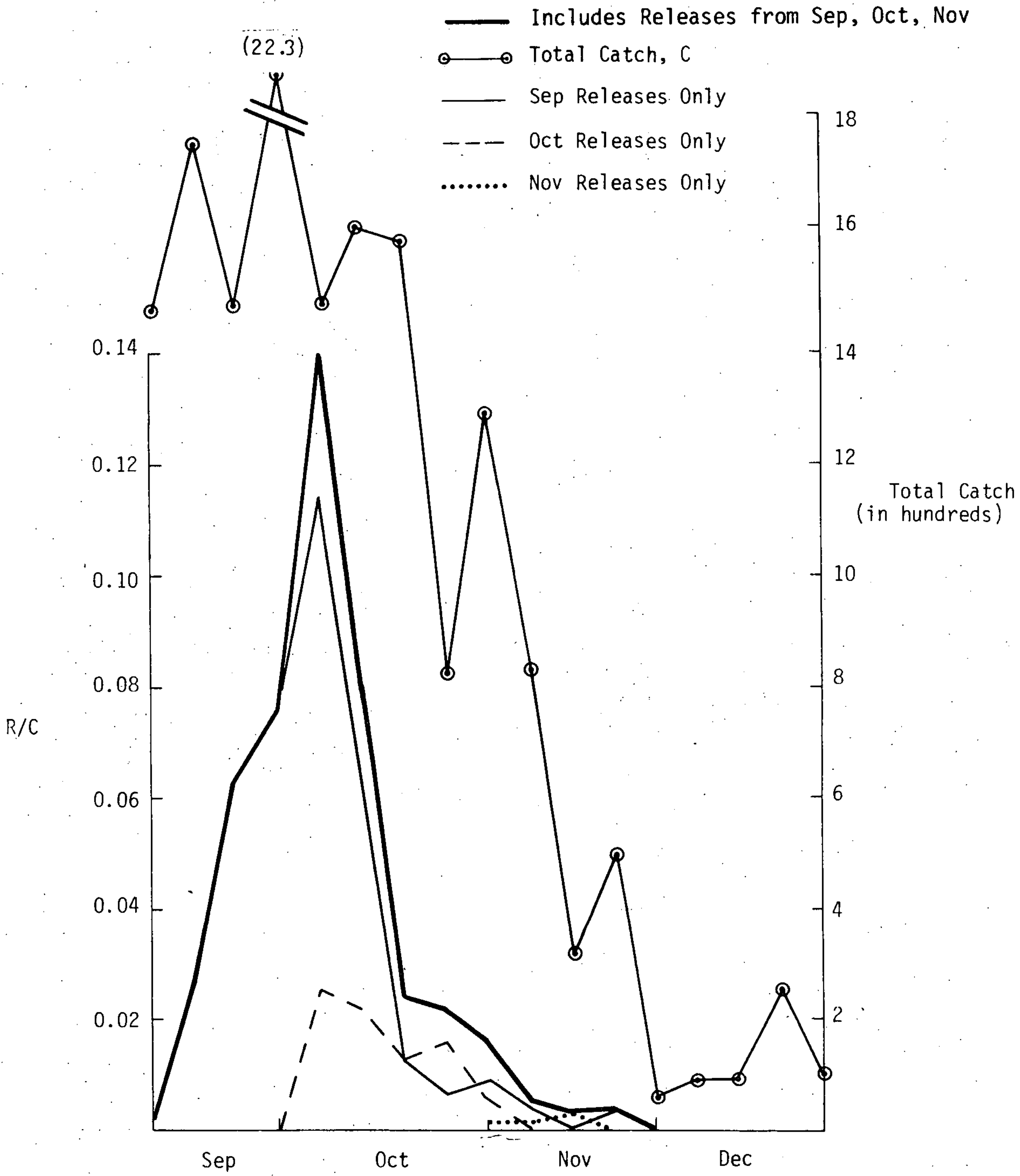

Figure IV-12. Observed Fraction of Marked Juvenile Striped Bass in Catch (R/C) and Sampling for September-December 1976. Sampling Included TI Field and Impingement Collections (Data are Presented in Appendix Table B-7).

could not be used for the 1976 year class since no marked fish were recaptured after December 1976. The lack of recaptures was unexpected since sampling in the fall of 1976 produced a higher recapture rate than in previous years (Table IV-8). Differences in timing or intensity of emigration may have resulted in a smaller than normal fraction of the fish marked in the fall being available for recapture in the following year. Therefore, estimates of the size of the juvenile striped bass population in the late summer and fall of 1976 were based on density extrapolations.

Table IV-8

Recaptures Rates for Finclipped Striped Bass Released August-November, 1974-1976, in Hudson River Estuary (Mark-Recapture Data for 1976 are Presented in Appendix Table B-8)

Date	Number Released	Number Recaptured through December	Fall Recapture Rate	Number Available January 1	Recaptures January-June	Spring Recapture Rate
Sept 1976	4226	617	0.1460	3609	0	0.0000
Aug-Sept 1975	8520	588	0.0690	7932	2	0.0003
Aug-Sept 1974	4731	101	0.0213	4630	1	0.0002
Oct 1976	2256	115	0.0510	2141	0	0.0000
Oct 1975	3551	171	0.0482	3380	13	0.0038
Oct-Nov 1974	3427	146	0.0426	3281	10	0.0030
Nov 1976	1635	5	0.0030	1630	0	0.0000
Nov 1975	2398	21	0.0088	2377	11	0.0046

(2) Density Extrapolation

Although the fall decline was more abrupt in 1976, the combined standing crops of juvenile striped bass in 1976 Figure IV-13a) were similar to those of 1974 and 1975. The peak standing crop of 9.4 million occurred in the week of August 15 to 21. Subsequently the standing crop declined sharply until early November when it stabilized near 0.5 million fish. Throughout July, August, and September, the greatest portion of the standing crop appeared to be in the shoals and bottom strata (Appendix Table B-9). After October the shore zone contributed the greatest part. The standing crop in the channel stratum was a substantial part of the total only during the week of July 4 to 10.

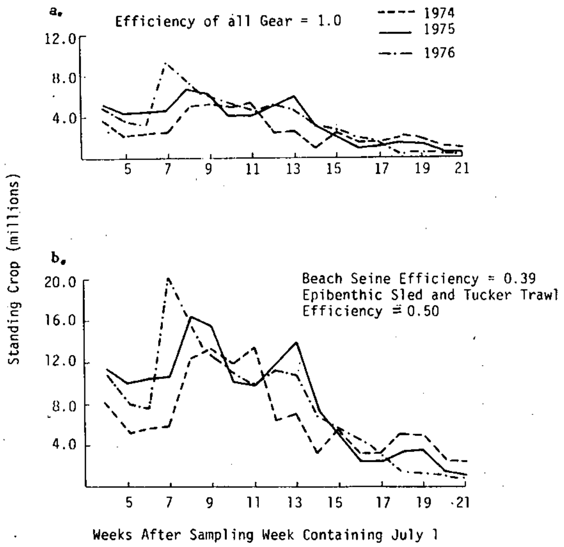

Figure IV-13. Combined Standing Crop of Juvenile Striped Bass in Hudson River Estuary, 1974-1976, Based Upon Beach Seine, Epibenthic Sled, and Tucker Trawl Sampling with (b.) and without (a.) Efficiency Adjustments. (Standing Crops before adjustments for gear efficiency are presented in Appendix Table B-9).

These standing crops must be viewed with caution as they represent only observed fish densities in the regions and strata that were sampled. No adjustments were made specifically for net avoidance or for portions of the river that were not sampled (i.e., after 14 August only beach seine sampling was conducted above RM 76 [KM 122] and the channel stratum was not sampled at all; after December 11 only beach seine sampling was conducted).

A study conducted during fall 1977 showed that daytime shore zone density estimates from 100-ft beach seine sampling averaged only 39% of the actual density (TI 1978b). While the daytime shore zone densities were considerably underestimated, it was not known whether increased night catches were due to increased sampling efficienty (i.e. - less net avoidance) or increased density caused by movement from deep to shallow water. If higher catches at night were due solely to less net avoidance, no further adjustment beyond the night-day catch ratio, R, are necessary. If higher night catches are due to distributional phenomena, then an efficiency correction would be appropriate. Since empirical evidence on night seining efficiency is currently unavailable, the daytime efficiency (39%) was applied to the shore zone standing crops previously calculated as an estimate of bias due to net avoidance.

Net avoidance also occurs with other sampling gear although empirical estimates of its magnitude were not available. The differences in length-frequency distributions of fish collected in beach seines and in the Ichthyoplankton Survey suggested that larger individuals were avoiding the epibenthic sleds and Tucker trawls (Appendix Figure B-1). When the switch from the Longitudinal River Survey to the Fall Shoal Survey occurred, a larger mesh net was used (3000-μ) and tow speeds were increased. Differences in length-frequency distributions disappeared and estimates of standing crop rose sharply (Figure IV-12).

However, the agreement in the length-frequency distributions and the rise in standing crops do not mean that net avoidance is no longer present only that it is not so distinctly size-related. Kjelson and Colby (1977) have reported catch efficiencies for towed nets ranging from 10% to 90%. The relatively small size of the epibenthic sleds and Tucker trawls, when compared to other towed gear, suggests that efficiency would probably not be in the higher end of that range. Thus an efficiency of 50% was assumed as an estimate of bias due to net avoidance.

Standing crops adjusted for catch efficiency (Figure IV-13b) exhibited patterns of abundance and decline similar to unadjusted standing crops (Figure IV-13a), although the adjusted standing crops were distinctly higher that the unadjusted estimate. The highest standing crop occurred in mid-August of 1976 (approximately 20 million). Peak standing crops for 1974 (13 million) and 1975 (16 million), adjusted for catch efficiency, occurred slightly later than in 1976. Empirically derived estimates of catch efficiency are desirable for all gear; however, these adjusted standing crops should be closer to the true standing crops than unadjusted estimates. Standing crop values near the period of peak abundance should be the best estimates of absolute population size since size related avoidance is no longer obvious and bias due to emigration is less severe than in later sampling periods.

The decline in standing crop through the fall was due to a combination of emigration and mortality and possibly to a movement to habitats that were sampled less effectively. Data were insufficient to determine how much each of these factors contributed to the observed decline. Emigration appeared to be the most likely factor although direct evidence was sparse. Recaptured fish did not show a high frequency of seaward movement although downriver movements were generally more frequent than upriver movements. Young-of-the-year striped bass, presumably from the Hudson River, have been found in the Long Island Sound in early August (Byron Young, NYSDEC, personal communication), thus emigration appeared to begin in late summer. The fraction of marked fish in the recapture samples and the total catch (Figure IV-12) declined very sharply after September which indicated either a rapid movement out of effectively sampled strata or emigration from the river.

3) Population Estimates Age Three and Older

The size of the age three and older (called older) striped bass population was an important element in determining stock-recruitment relationships, survival rates, and egg deposition estimates. These older (subadult and adult) striped bass were available to sampling gear primarily during the spring and early summer spawning run when they were taken in gill nets and haul seines. The spawning run caused a concentration of most adult striped bass within the estuary and separation of Hudson River stock from striped bass spawned in other river systems. On this basis, an estimate of population size was made during the spring and early summer spawning run.

a) Methods

Mark-recapture methods were chosen as the best means of estimating the older striped bass population size. Striped bass greater than 350 mm total length, marked with internal anchor tags from March 15 through June 5, 1976, were used for the population estimates. The sampling effort extended from RM 24 to 61 (KM 38 to 98) and was conducted with 4-in. to 8-in. (stretch mesh) gill nets and haul seines. Since the fishing gear used in the stratified random sampling programs (i.e. 100-ft beach seines, epibenthic sleds, Tucker trawls) caught very few adult striped bass, the density extrapolation techniques used for juveniles were not considered appropriate for estimating the older striped bass population size.

The Schumacher-Eschmeyer Multiple Census Technique was used to calculate the population estimate. This estimate required many of the same assumptions and was subject to the same types of errors as the Petersen estimates used for juveniles (Subsection IV.B.3.1b). The assumptions for the two mark recapture techniques are basically the same (i.e. - marks must be readily identifiable, there must be random mixing of marked and unmarked, and no emigration). We chose the Schumacher-Eschmeyer technique because there were not enough recaptures after the marking period was complete (the Peterson estimate requires this). The Schumacher-Eschmeyer method has simultaneous mark and recapture time periods. The Schumacher-Eschmeyer Estimate was calculated as follows:

$$1/\hat{N} = \frac{\Sigma R_i M_i}{\Sigma(C_i M_i^2)}$$

where

$\hat{N}$ = the estimated population

C_i = the total catch during time interval i

M_i = the total number of marked fish available for recapture during time interval i

R_i = the number of recaptured fish in C_i

A 90% confidence interval for N was found from:

$$\Sigma R_i M_i \pm t_{k-2}\,(0.05)\left[S^2 \Sigma\left(C_i M_i^2\right)\right]^{1/2}$$

where

$t_{k-2}(0.05)$ = t value for k sampling intervals at the
α = 0.10 level; specifically $t_{7-2}(0.05)$
= 2.015

$$S^2 = \frac{\Sigma \frac{R_i^2}{C_i} - \frac{\Sigma(R_i M_i)^2}{\Sigma C_i M_i^2}}{k-2}$$

The Schumacher-Eschmeyer Estimate is a weighted linear regression of R_i/C_i as a function of M_i with the restriction that the regression line must pass through the origin. The model is $R_i/C_i = \beta M_i + e_i$ where β is the slope of the regression line, is equal to $1/\hat{N}$ and e_i is a random error term with a mean of 0 (Seber 1973). When the values of R_i/C_i are weighted by the catch (C_i), the estimate for $1/\hat{N}$ equals the slope β.

b) Results and Discussion

(1) Analysis of Error

Type A error (Subsection IV.B.3.1.) was assumed to be negligible even though no tagging survival tests or quality control procedures for tag recognition were conducted. Only fish in good condition were marked and released and the tags were checked for correct implantation to minimize immediate tag loss. Since all fish were either tagged and released or taken to the laboratory for additional analysis, it is unlikely that any recaptured fish went unrecognized.

Type B error (Subsection VI.B.3.1a), if present, probably was the result of emigration of fish marked early in the season from the study area. Type B error was probably small early in the season but by the end of sampling, could have become sizeable, as indicated by the number of fish recaptured outside the Hudson River (Appendix Table C-23). Other sources of Type B error, including continuous, long-term tag loss or mortality of marked fish, were considered negligible.

As with juvenile striped bass, Type C error appeared to be the most severe due to delayed mixing of marked and unmarked fish. In an attempt to identify the Type C error and find a subset of the recaptured fish which might be randomly distributed (R'_i, Marten 1970 in Seber 1973:151), the relationship of the fraction of marked fish in the catch (R_i/C_i) to the total number of marked fish available (M_i) was examined for fish at large for different lengths of time.

When marked fish are randomly distributed, R_i/C_i increases in direct proportion to M_i. An inverse relationship between R_i/C_i and M_i would indicate either a Type B or Type C error. If the inverse relationship is apparent for all values of M_i, Type C error is suggested. Since Type B error generally increases with time, it was not expected to be severe for the earliest samples which had the smallest values of M_i. Type B error could, however, be at least partially responsible for error in later samples. If the inverse relationship occurs only for intermediate and high values of M_i, then Type B error is more likely to be the cause. An inverse relationship was evident when all recaptured fish or fish at large for at least one day were used to calculate R_i/C_i (Figure IV-14). If fish at large for at least 2 or 3 days were used, the Type C error was greatly reduced, although not entirely eliminated.

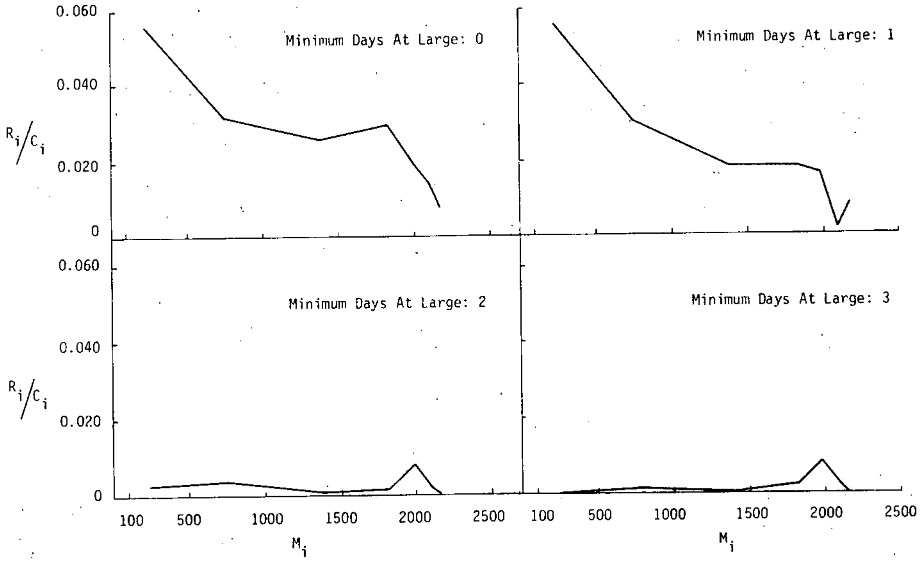

Figure IV-14. Fraction of Marked Fish in Sample R_i/C_i vs M_i when Recaptured Fish at Large Less than Minimum Number of Days Are Excluded

(2) Population Estimate

The steps to reduce Type C error also reduced the number of recaptured fish available for a population estimate to 16 (Table IV-9). The estimate N based on fish at large for 2 days or more was 513,000 with a 90% confidence interval of 282,000 to 2,819,000. A graphical representation of the data showed that the fit to the calculated regression line of R_i/C_i on M_i was relatively poor (Figure IV-15). Thus, the estimate of $(^1/N)$ was imprecise and confidence intervals were wide. The large deviations of the data points above the line for the first two sampling periods (those with the smallest values of M_i) suggested that Type C error could still be substantial. These points should be much closer to the regression line if marked fish were randomly distributed during the sampling period.

Table IV-9

Schumacher-Eschmeyer Population Estimate of Adult Striped Bass in Hudson River during Spring 1976

Period	M_i*	C_i	R_i'†	$R_i'M_i$	$C_iM_i^2$	$R_i'C_i$
1	235	725	2	470	40,038,125	0.00276
2	758	1325	5	3790	761,297,300	0.00377
3	1392	1414	2	2784	2,739,856,896	0.00141
4	1831	634	1	1831	2,125,523,674	0.00158
5	1986	582	5	9930	2,295,522,072	0.00859
6	2102	375	1	2102	1,656,901,000	0.00267
7	2170	233	0		1,097,173,700	---
Total			16		10,716,313,270	

$$\beta = \frac{\Sigma(R_iM_i)}{\Sigma(C_iM_i^2)} = \frac{2.0907 \times 10^4}{1.071631327 \times 10^{10}} = 1.951 \times 10^{-6}$$

$\hat{N} = \beta^{-1} = 513{,}000$

90% Confidence Interval 282,000 - 2,819,000

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*Total marked fish at large at middle of period

†Fish at large for 2 days or more

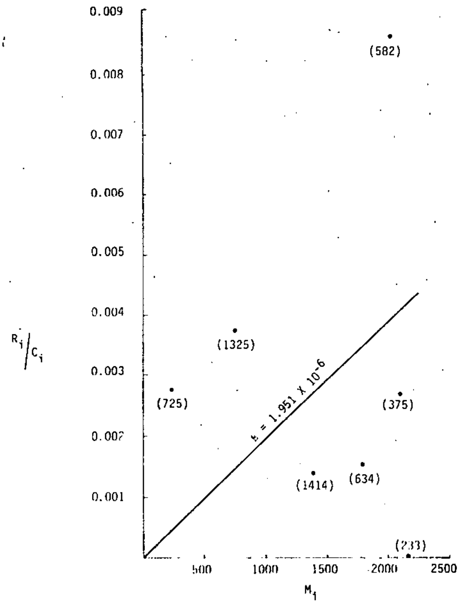

Figure IV-15. Weighted Linear Regression through Origin of R_i'/C_i M_i. R_i Includes Only Fish at Large for 2 Days or More (Weights for Each Point, C_i, Are Shown in Parentheses)

The population estimate of 513,000 represented fish greater than 350 mm total length (approximately age III and older) in the lower Hudson River estuary during the spawning season. Even though some age III fish are not mature, especially females, the inclusion of these fish did not seriously bias $\hat{N}$ as an estimate of the spawning stock. Much more serious biases were the Type C error still inherent in the data and the increasing Type B error in the later time periods. While the Type C error was greatly reduced by restricting R_i' to fish at large 2 days or more, an inverse relationship of R_i'/C_i and M_i was still suggested when data were examined graphically. The choice of a 2-day minimum was a compromise between eliminating Type C error and having sufficient recaptures to make an estimate. The magnitude of the Type B error could not be evaluated from the R_i'/C_i graphs since decreasing Type C error and increasing Type B error would produce similar trends. Thus, 513,000 is likely to be an underestimate of age III and older fish since the values of R_i'/C_i associated with small values of M_i (Type C error present) are weighted more heavily than values associated with large M_i (Type B error present); Type C errors would cause an underestimate of population size and Type B errors an overestimate as observed for this population.

b. Mortality

1) Early Life Stages

Striped bass is a fish of high reproductive potential (McFadden 1977:10.34) and exhibits a correspondingly high mortality rate, particularly during the early life stages. Within this period minor changes in mortality, both density independent and density dependent, can result in wide variations in year-class strength.

This section presents estimates of mortality rates for larvae and juveniles from the 1976 year class of striped bass. Striped bass spawned over a longer time period in 1976 than in 1975 (Section V, Figure V-2). Mortality rate estimates for 1976 are less precise than those for 1975. Several life stages with different mortality rates were present in the estuary at the same time due to an extended spawning in 1976.

a) Methods

Estimates of standing crops of larval and/or juvenile striped bass were available for each week from the start of spawning season (early May) through mid-December 1976. Standing crops of larvae were estimated from ichthyoplankton data (Subsection III-B) and represent populations in the shoals, channel, and bottom strata throughout the entire estuary. Juvenile standing crops were estimated from data collected by several types of sampling gear (Subsection IV-B.3a.). These values represent the estuary-wide population in the shore zone and the population in the shoal and bottom strata in the Yonkers through Poughkeepsie regions.

Mortality rates were estimated from the time of peak yolk-sac larval abundance (June 13 to 19) through October 2. After early October, increased emigration of striped bass from the sampling area would result in an overestimation of juvenile mortality. The period June 13 to October 2 was then divided into phases of apparent constant mortality. Daily instantaneous mortality rates were estimated for each phase from the following linear regression:

$$\ln(N_t) = A + Z(X_t)$$

where

Z = estimated daily instantaneous mortality rate

X_t = number of days from 1 May to the midpoint of sample week t

N_t = estimated standing crop of striped bass larvae and juveniles for week t

A = constant = $\ln(N_o)$

Estimates of daily instantaneous mortality rate (Z) were then converted to daily mortality rates as follows:

$$\text{daily mortality rate} = 1-e^{-Z}$$

To investigate the relative survival of various sizes of striped bass larvae, weekly length frequency histograms were prepared from ichthyoplankton length data for 1976 provided by LMS. These data were collected during transect sampling near the Bowline, Lovett, Roseton, and Danskammer generating stations.

b) Results and Discusssion

Estimates of standing crops were based on a combination of estimates for three distinct life stages; yolk-sac larvae, post yolk-sac larvae and juveniles. Yolk-sac larvae were present from June 13 through July 3, post yolk-sac larvae from June 13 through July 17, and juveniles were present from June 27 through the end of the year (Table IV-10). Graphical presentation of these standing crops suggests that the period June 13 through October 2 can be divided into two phases of constant mortality rate: June 13 through July 13, the time of yolk-sac and post yolk-sac larval abundance, and July 14 through October 2, the period of juvenile abundance (Figure IV-16). The extended spawning period observed in 1976 precluded division into finer time intervals as was possible with 1975 data (McFadden 1977); (Table IV-11).

Table IV-10

Striped Bass Standing Crop Estimates* in Hudson River Estuary during 1976 Used to Calculate Larval and Juvenile Mortality Rates

Time Interval	Yolk-sac Larvae	Post Yolk-Sac Larvae	Juveniles	Time
6/13 - 6/19	152,272,000	242,065,000		394,337,000
6/20 - 6/26	15,034,000	184,805,000		199,839,000
6/27 - 7/3	260,000	47,211,000	375,000	47,846,000
7/4 - 7/10		8,320,000	1,900,000	10,220,000
7/11 - 7/17		1,863,000	4,176,000	6,039,000
7/18 - 7/24			4,868,000	4,868,000
7/25 - 7/31			4,923,000	4,923,000
8/1 - 8/7			3,722,000	3,722,000
8/8 - 8/14			3,222,000	3,222,000
8/15 - 8/21			9,400,000	9,400,000
8/22 - 8/28			7,405,000	7,405,000
8/29 - 9/4			5,919,000	5,919,000
9/5 - 9/11			5,063,000	5,063,000
9/12 - 9/18			4,510,000	4,510,000
9/19 - 9/25			4,915,000	4,915,000
9/26 - 10/2			4,835,000	4,835,000

* with catch efficiency of sampling gear assumed to be 100 percent

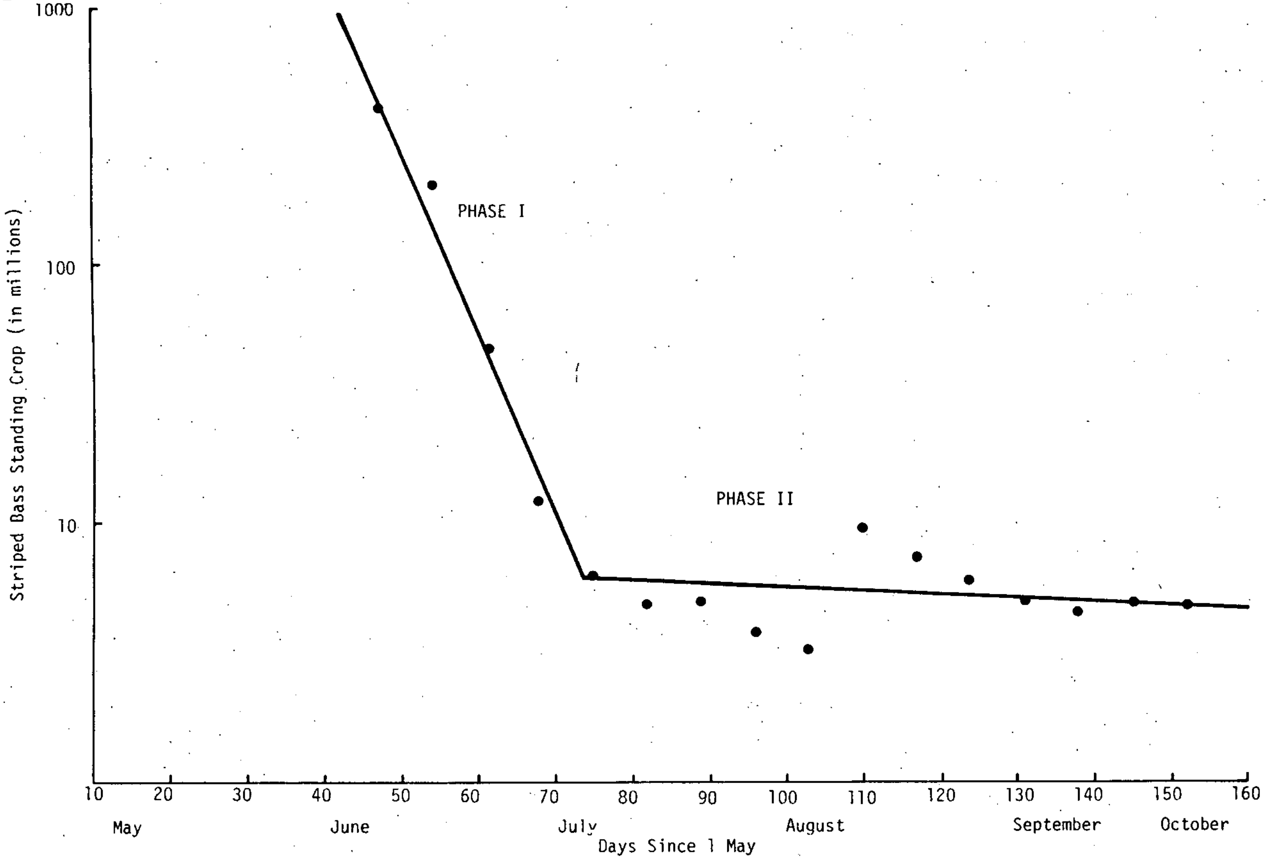

Figure IV-16. The Relationship Between Population Size and Time for 1976 Year Class of Striped Bass during Larval and Juvenile Stages in Hudson River Estuary

Daily mortality rates declined from almost 15% per day in phase I to 0.3% per day in phase II. These rates are similar to those estimated for phase II (May 23 through June 24) and phase IV (July 26 through December 31) of the 1975 year class (Table IV-11).

Temporal patterns in the abundance of eggs, yolk-sac larvae, and post yolk-sac larvae indicate that survival within each life stage varied during the season (Figure IV-17). There were two distinct peaks each for egg and yolk-sac larvae abundance. However there was only one peak for post yolk-sac larvae coincident with the second peak of the yolk-sac larvae. The two distinct peaks of egg abundance and the resultant two peaks in yolk-sac larvae abundance can be attributed to the temperature variation during the time of spawning in 1976 (Figure IV-18). The temperature increased from 12° to 15°C in early May, initiating a large spawn at this time. The temperature

Table IV-11

Daily Mortality Rate Estimates for Striped Bass Larvae and Juveniles in Hudson River Estuary during 1975 and 1976

1976

Phase	Time Interval	Daily Mortality Rate
I	Jun 13 - Jul 13	14.9%
II	Jul 14 - Dec 31	0.3%

1975

Phase	Time Interval	Daily Mortality Rate
II	May 31 - Jun 24	17.5%
III	Jun 25 - Jul 26	5.1%
IV	Jul 27 - Dec 31	0.5%

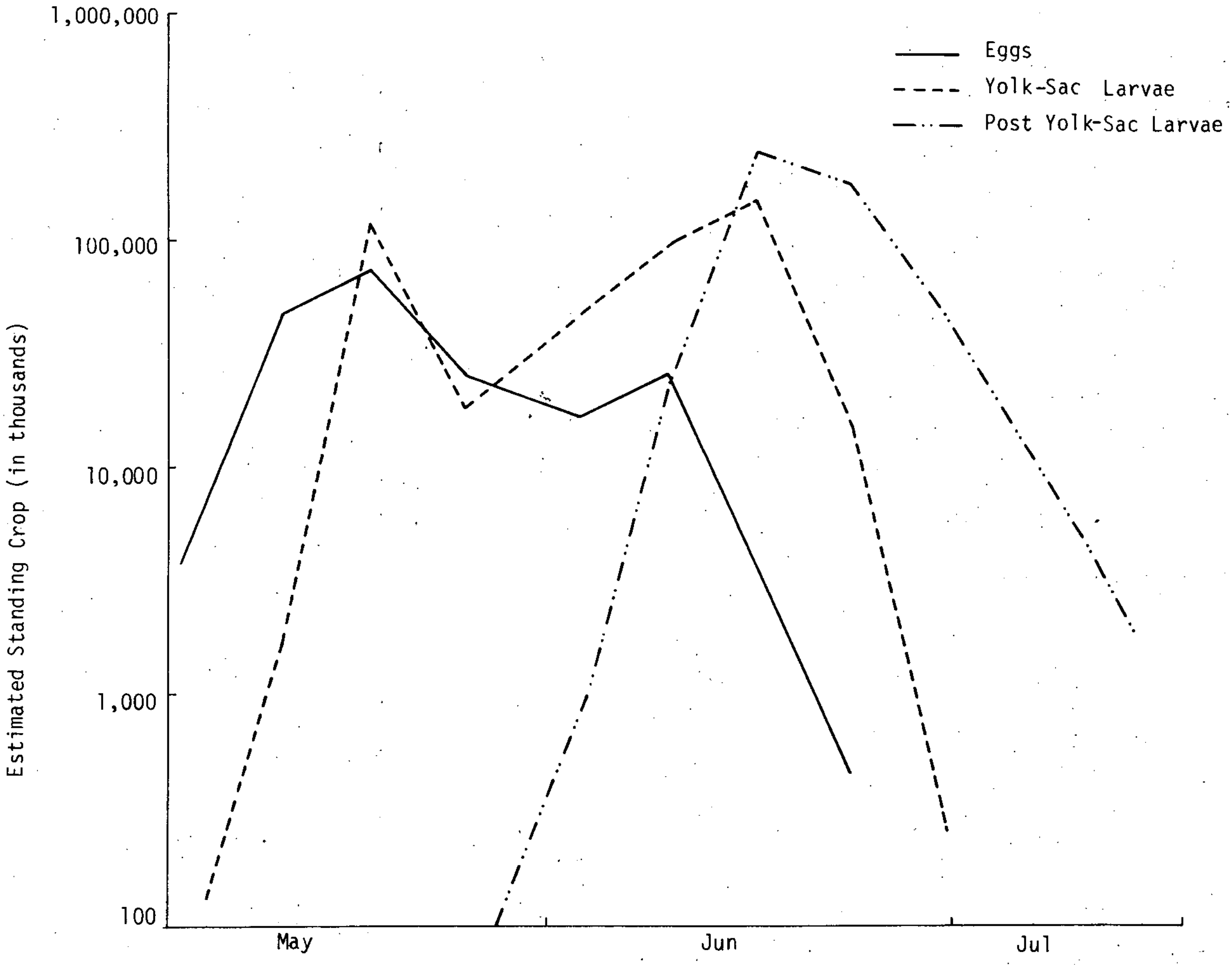

Figure IV-17. Standing Crops of Eggs, Yolk-Sac Larvae, and Post Yolk-Sac Larvae of 1976 Year Class of Striped Bass in Hudson River Estuary then dropped to 12°C and the egg abundance declined suggesting a cessation of spawning. In early June the temperature rapidly increased again and initiated a second, apparently smaller spawn. The pattern of succession of life stages suggests that the first spawn, followed by the subsequent temperature drop, produced some yolk-sac larvae but contributed little to the post yolk-sac larval population.

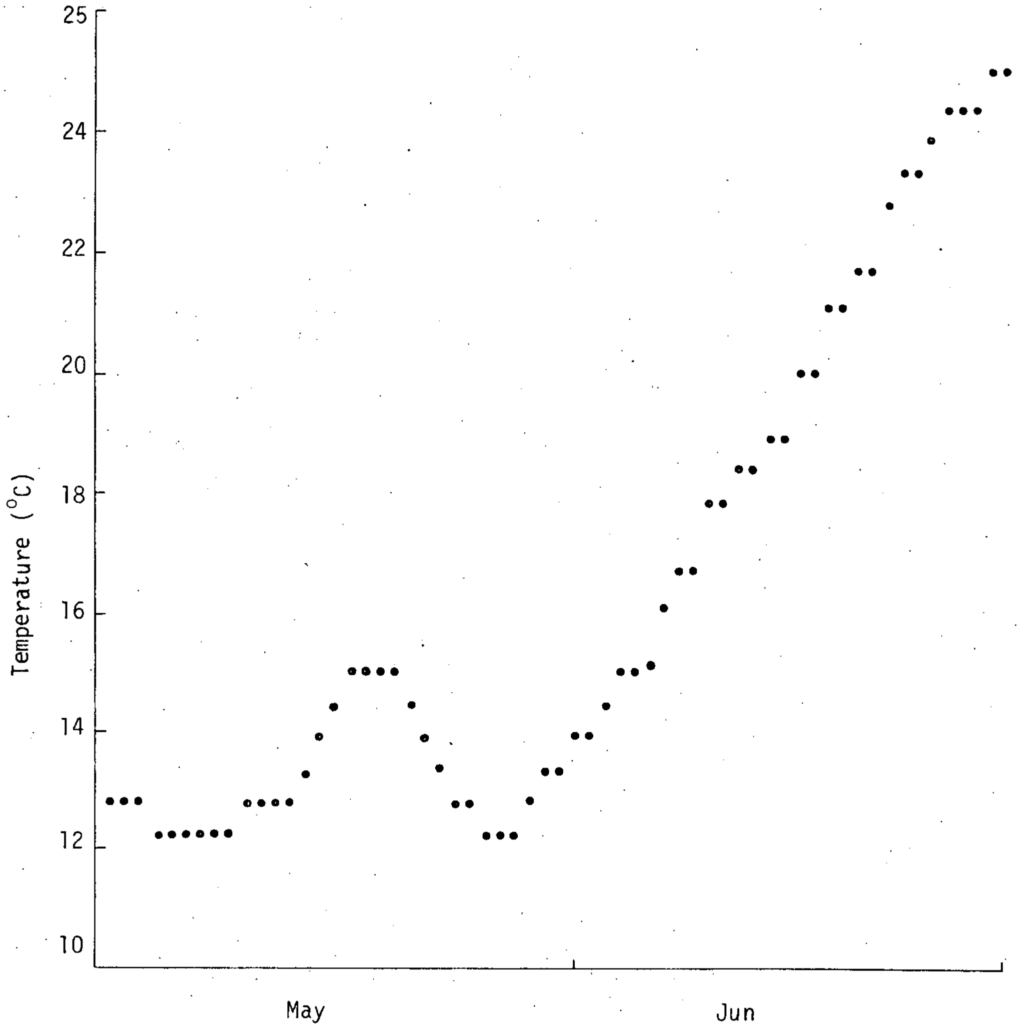

Figure IV-18. Water Temperatures during May and June 1976 in Hudson River Estuary, Poughkeepsie, New York

Weekly length-frequency histograms for striped bass larvae suggested a similar temporal pattern of abundance (Figure IV-19). The first spawn entered the larval population at 2 to 4 mm during the week of May 9 through 15. They grew until they were 6 to 7 mm long by May 23 through 29. In the following week, June 1 through 5, individuals from the initial spawn were no longer evident and smaller individuals (2 to 5 mm), presumably hatched from eggs deposited during the second spawn, predominated in the samples. The length-frequency distribution remained unimodal through the rest of the year. Such patterns in length frequency indicated that few individuals from the first spawn survived to grow larger than 7 mm. This size corresponds roughly to the transition from the yolk-sac to the post yolk-sac stage when striped bass larvae develop functional mouth parts and intestinal tracts and begin to feed.

One can hypothesize that the low survival of the first spawn at the time of transition to the post yolk-sac larval stage in 1976 resulted from lack of food of the type or size required by the developing larvae. This lack of food could be related to the temperature decline during the previous two weeks. Following the second spawn, temperatures continued to rise as in previous years, presumably producing a better synchronization of striped bass larval and food organism abundance.

These observations suggest that a "critical period" may be operating in the striped bass population. Availability of food during and immediately following this period of first feeding has been suggested by several authors (e.g. Hjort 1929, Gulland 1965, May 1974) as a major factor regulating year-class strength in fish populations. During these periods of high mortality, minor changes in mortality rates, either density-dependent or density-independent, will result in major changes in the abundance of later life stages.

Recent studies (Eldridge et.al. 1977) indicate that striped bass larvae do not exhibit the classic "point-of-no-return" response to starvation typical of many pelagic marine species. At first appearance, these results seem to argue against the existence of a critical period in striped bass. However, limited growth of larvae which did not feed could increase their

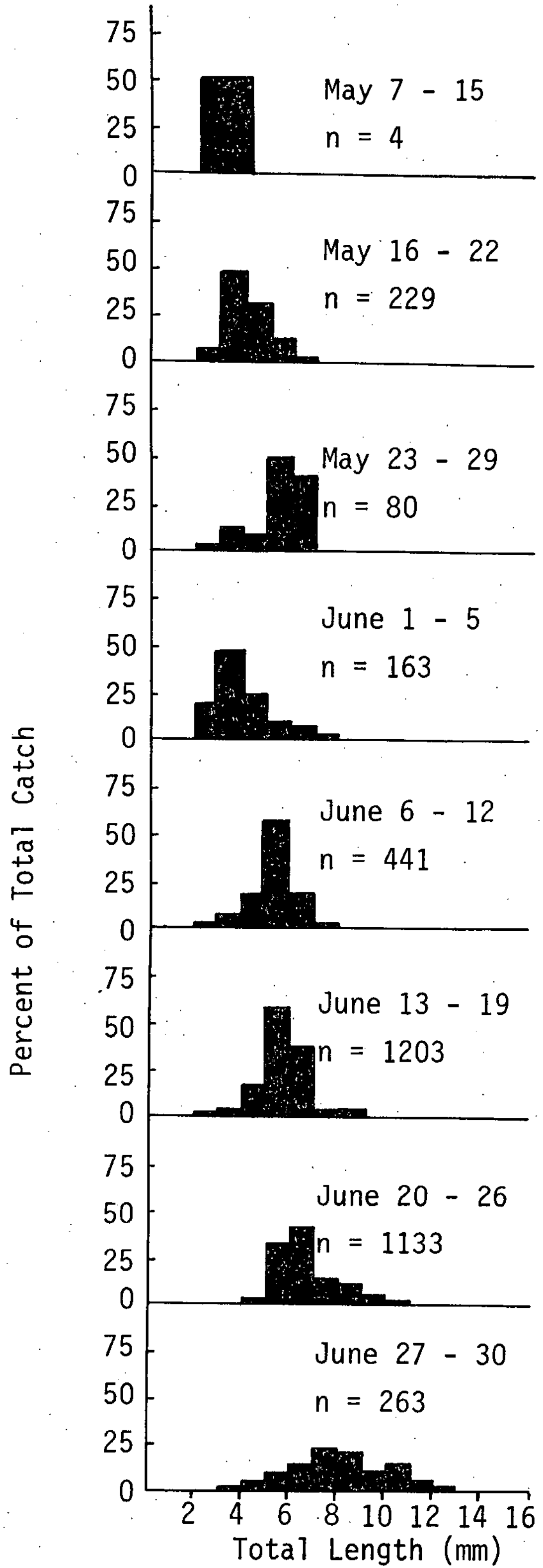

Figure IV-19. Weekly Length-Frequency of Striped Bass Larvae Collected by LMS in River Transect Sampling near Bowline, Lovett, Roseton, and Danskammer Power Plants, Hudson River Estuary, 1976 vulnerability to size-related sources of mortality such as predation (Cushing and Harris 1973). Additionally, during periods of limited food availability, larvae which had successfully fed would be larger and therefore able to out-compete larvae which had not previously fed. Thus, as noted by Miller (1977), "In all likelihood, the (striped bass) larvae that abstains (or is prevented) from feeding on one occasion is predisposed to abstinence in the future".

c. Feeding Interactions of Striped Bass and White Perch

Feeding interactions of striped bass and white perch were examined to determine if overlap occurred in their diets, which would suggest potential competition. Pianka (1973) devised an index to measure the overlap in diet between two species occupying the same habitat. The index value ranges from 0 (when there is no overlap in diet) to 1.0 (where there is complete overlap and the samples are identical with respect to proportional food category composition). The index values are influenced by three nonbiological factors: sample size, method of recording the feeding habits, and precision of identification of the food organisms (Moyle 1977). Interpretation of dietary overlap indices must take these nonbiological factors into account, especially when inferring any limiting influence one species may exert upon the other.

1) Methods

Striped bass and white perch were collected between river miles 39 and 46 (KM 62 and 74) in beach seines during April through November 1974. Sampling in 1974 provided the only data on white perch and striped bass feeding habits for which the length of each fish examined was available. Detailed descriptions of the feeding habits for each species are provided in Subsections IV.B.2.a.1 for striped bass and IV.C.2.a. for white perch. These same data are used to determine overlap in diets for striped bass (young-of-the-year, yearling and older) and white perch (young-of-the-year, yearling and older) less than 270 mm in length.

To facilitate analysis, all countable food items consumed were grouped into 15 taxonomic categories (Table IV-12). Categories were established by selecting classes, orders or phyla which contained the majority of food items consumed. Food items consumed in very large amounts, such as Gammarus, were classified separately while food items eaten infrequently were placed in "other" categories. The mean percent frequency of each category was calculated on a monthly basis for four length groups (less than or equal to 75 mm, 76-150 mm, 151-200 mm, 201-270 mm) and for all length groups combined [see Subsection IV.B.2.a.1. or IV.C.2.a. for mean percent frequency ($\bar{f}_i$) formula]. This analysis was done separately for striped bass and white perch.

Pianka's index of dietary overlap (1973) was calculated for those months and length groups in which at least ten stomachs from each species (striped bass and white perch) contained at least one countable food item. The formula used was:

$$a_{ij} = \frac{\Sigma P_{ih} P_{jh}}{\sqrt{\Sigma P_{ih}^2 \ \Sigma P_{jh}^2}}$$

where

a_{ij} = Dietary overlap index of species i and species j

P_{ih} = proportion (mean percent frequency) of food item h (taxonomic category) in the diet of species i

P_{jh} = proportion (mean percent frequency) of food item h (taxonomic category) in the diet of species j

2) Results and Discussion

Gammarus was present in the diets of both striped bass and white perch from April to November, while other amphipods, dipterans, isopods, and copepods were present in the diets of at least one of the species throughout the sampling season (Figure IV-20 and Appendix Table B-10). Some food categories (other insects, decapods, Corophium, Neomysis, and Osteichthyes) were not consumed until June and July. The consumption of different invertebrates

Table IV-12

Food Items Used in Analysis of White Perch and Striped Bass Dietary Overlap during April-November 1974

Taxonomic Group	Food Items
Order Diptera	*Chaoborus* (larvae)
	Chironomid (larvae)
	Chironomid (pupae)
	Diptera (larvae)
	Diptera (pupae)
	Diptera (adult)
Other Insecta	Odonata (juvenile)
	Coleoptera (juvenile)
	Trichoptera (juvenile)
	Homoptera (unidentified)
	Corixidae (unidentified)
	Adult insect remains
	Thysanoptera
	Lepidoptera (pupae)
Suborder Decapoda	*Crangon*
	Palaemonetes pugio
	Rhithropanopeus sp.
	Decapoda
Gammarus spp.	*Gammarus* spp.
Corophium spp.	*Corophium* spp.
Other Amphipoda	*Monoculodes* spp.
	Leptocheirus spp.
	Amphipoda
Suborder Isopoda	*Chirodotea* spp.
	Cyathura spp.
	Cassidina spp.
	Lironeca ovalis
	Isopod (unid)
Neomysis spp.	*Neomysis* spp.
Subclass Copepoda	Harpacticoida
	Cyclopoida
	Calanoida
Other Crustaceans	Cladocera (unid)
	Balanus sp.
Phylum Annelida	Oligochaeta
	Polychaeta
	Hirudina (unid)
Other	Nemertea (unid)
Class Osteichthyes	Fish remains
	Bay anchovy
	Banded killifish
	Mummichog
	Blueback herring
	Striped bass
	Atlantic tomcod
	Clupeid (unid)
	Morone (unid)
	Centrarchid (unid)
	American eel
Phylum Mollusca	*Congeria* sp.
	Gastropoda
Fish eggs	White perch
	Percidae
	Clupeidae
	Unidentified fish eggs

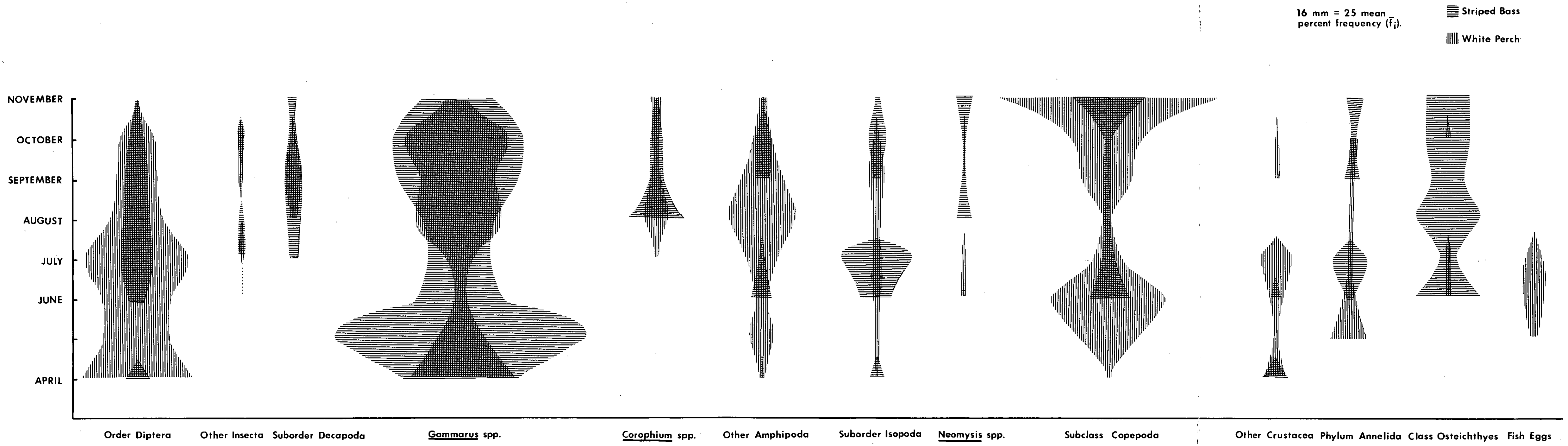

Figure IV-20. Mean Percent Frequencies of Taxonomic Categories of Food Items Consumed by Striped Bass and White Perch Collected in Beach Seines, April-November 1974 by white perch and striped bass during June and July was related to seasonal changes in the invertebrate resource base at Indian Point (RM 39-46). These changes in invertebrate species compositions are attributable to salt front intrusion in the Indian Point region and life history of the species (NYU 1977). Neomysis, Monoculodes, Corophium and Chaoborus were dominant during periods of high salinity (June-July) and Gammarus, oligochaetes and polychaetes became dominant during periods of lower salinity (NYU 1977). Feeding patterns of the more frequently eaten food items will be discussed by taxonomic groups.

Gammarus spp.

Gammarus was the food item most frequently consumed by striped bass from April-November. The mean percent frequency ($\bar{f}_i$) of Gammarus was 45 or more during April, September, and October. White perch fed on Gammarus to a lesser extent from April to November, except during August, when slightly more were consumed by white perch than by striped bass. Combined utilization of Gammarus by both species was lowest during June and July.

Order Diptera

Dipterans were present in the diets of white perch from April to November and in striped bass diets during April and June to November. White perch consumed considerably larger proportions of dipternas than striped bass, which corresponds with Taub's (1966) finding that dipterans were the most important insect consumed by all age groups of white perch in Quabbin Reservoir, Massachusetts. Dipterans were most important in the diet of both species during July.

Subclass Copepoda

Copepods were consumed by white perch from April to November, and by striped bass in April and June to November. The absence of copepods from the striped bass diet in May may be an artifact of the low sample size (n = 5). Striped bass ate copepods most frequently in April and November. White perch consumed copepods in June when their consumption of Gammarus and other amphipods was low. Fewer copepods were eaten during July and August when consumption of Gammarus and other amphipods increased. During November copepods again became the most common food item for white perch.

Other Amphipoda

Other amphipods, such as Monoculodes and Leptocheirus, were consumed by white perch from April to November and by striped bass to a lesser extent in April, June, July, and September to November. Amphipod consumption again reached a peak during August for white perch, corresponding to August peaks for Gammarus and Corophium consumption. White perch dominated the use of this resource from July through September.

Suborder Isopoda

Isopods, such as Cyathura and Chirodotea, were consumed in consistently small proportions by white perch from April to October. Isopods were consumed sporadically in larger proportions by striped bass during June and July, and in small proportions during October and November. Isopods do not appear to be particularly important in white perch diets. However, the larger proportions of isopods consumed by striped bass during June and July indicates their importance to this fish species at a time when they may be substitutes for other food items which are less abundant during this same period (such as Gammarus spp.).

Class Osteichthyes

Bony fishes (Osteichthyes) were consumed by striped bass during June-November. Striped bass ate more fish during June and August; however, fish were an important part of the diet throughout the season for yearling striped bass (see Subsection IV.B.2.a.1). Only three white perch stomachs contained fish remains during June, July, and October. In contrast to Taub's (1966) findings, fish does not appear to be an important food item for white perch in the Hudson River estuary.

Fish Eggs

Fish eggs were only consumed by white perch during May to July. Eggs were not identified to species for this study. However during 1973, fish eggs consumed by white perch during May were identified as alewife and blueback herring eggs (TI 1973).

Pianka's (1973) indices of dietary overlap are presented in Table IV-13 for striped bass and white perch by month and length group. Dietary overlap was greater than 0.5 for fish collected during July through October, indicating similar feeding habits. Dietary overlap was highest for those

Table IV-13

Index of Dietary Overlap between White Perch and Striped Bass from Selected* Months and Length Groups during 1974, Hudson River Estuary (Data Presented in Appendix Table B-11)

Month	Length Group (mm)	Index of Dietary Overlap
June	76-150	0.3792
July	76-150	0.5523
August	76-150	0.7677
September	≤ 75	0.5906
September	76-150	0.9081
October	≤ 75	0.7648
October	76-150	0.9168
April-November Combined	≤ 75	0.5909
April-November Combined	76-150	0.6516
April-November Combined	151-200	0.2053

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*Only those months and length groups in which at least 10 stomachs for each species contained at least one countable food item were used.

fish 76 to 150 mm (TL) collected in September (0.9081) and October (0.9168). During that time, Gammarus was the principal food item for both striped bass and white perch (Tables IV-1 and IV-25). Chironomid larvae and pupae, other amphipods, decapods, copepods, and isopods were also common food items. Dietary overlap increased from June through October for fish 76 to 150 mm (TL). Fish less than 75 mm (TL) also exhibited an increase in dietary overlap between September and October. For all months combined, dietary overlap increased slightly between fish less than 75 mm and 76-150 mm (TL). As fish became larger (greater than 150 mm TL) the diets of the two species diverged. Striped bass became more piscivorous and white perch continued to eat smaller food items.

Seasonal trends in dietary overlap indicated that during the spring and early summer (April, May, and June) striped bass and white perch both fed primarily on dipterans, Gammarus, other amphipods, and copepods. Striped bass fed primarily on Gammarus, while copepods, other amphipods, and dipterans were eaten most often by white perch. During the summer and early fall (July, August, and September), the diet of both species was dominated by dipterans, Gammarus, other amphipods, isopods, copepods, and fish. Dipterans and Gammarus were heavily preyed upon by both striped bass and white perch. Fish were consumed almost entirely by striped bass. Other amphipods and copepods were eaten more often by white perch. During the fall (October and November), Gammarus, copepods, dipterans, other amphipods and fish were preyed upon by both species. White perch primarily ate dipterans, Gammarus, and copepods, while striped bass fed primarily on Gammarus and fish.

In summary, striped bass and white perch diets overlapped in certain taxonomic categories, however, both species had diversified diets and seemed to utilize any food items readily available to them. Dietary overlap does not necessarily imply that competition for food items was occurring. Lacking knowledge of the relative abundance and spatiotemporal distribution of these food items, it is difficult to estimate what influence diet has on the survival and abundance of each species. To date, the data indicates that both striped bass and white perch had a sufficient food supply for survival despite overlap in diet, and their nonselective feeding habits allowed them to adapt to periods of low abundance of any particular food item.

d. Factors Affecting Growth of Early Life Stages

An analysis of factors affecting growth is important to an understanding of the response of the young-of-the-year striped bass population to changes in environmental conditions. For many fish species, size and mortality rates are closely related; therefore, many of the factors affecting growth will also have an effect on survival (Gerking 1957). Factors potentially affecting the first year growth of striped bass in the Hudson River estuary are examined in this section. Factors of primary interest are water temperature, freshwater flow into the estuary, and abundance of juveniles during midsummer.

1) Methods

Estimates of growth of juvenile striped bass for the July and August period were derived from beach seine data collected by NYU, Raytheon, and TI over the years 1965-1970, 1972-1976 (see Subsection IV-B.3a for a description of this data base). Weekly estimates of mean length for juveniles were calculated for each year. From these data, instantaneous growth rates (Ricker 1975) were estimated for each year using the following linear regression:

$$\ln(\overline{L_t}) = \ln(\overline{L_o}) + \beta(x_t)$$

where

$\overline{L_t}$ = mean length at time t

x_t = number of days since July 1 for time t

β = estimated instantaneous growth rate

$\overline{L_o}$ = estimated mean length on July 1

The advantage of using linear regression over other techniques to estimate instantaneous growth is that all data collected during the July and August time period can be incorporated into the estimation procedures. Other techniques would require the selection of specific time intervals, uniform across years, for growth estimation, and the specific estimates could vary depending upon the time intervals chosen.

Estimates of instantaneous growth rate during July and August of each year were compared using partial correlation analyses to juvenile striped bass abundance during July and August (Subsection IV-B.3a), mean water temperature during July and August, and the average freshwater flow into th estuary during July and August as measured at the Green Island Dam. Partial correlation analysis ermits investigation of linear relationships between selected variables while holding the effects of other variables constant (Snedecor and Cochran 1967).

In order to investigate the effects of environmental factors on larval and juvenile growth before the July through August time period, mean length of juveniles on August 1 was predicted from estimates of L_o and for the July through August time period as follows:

$$\bar{L}_A = \exp [\ln (\bar{L}_O + \beta (A)]$$

where

$\bar{L}_A$ = predicted length on August 1

A = number of days from July 1 to August 1 (= 31 days)

The choice of August 1 for a time of predicted length is based on two considerations. First, this date is the midpoint of the time period over which the regression coefficients were estimated; thus, at this time, the predictive value of the regression should be best. Second, differences among years in the length of fish in August appeared to remain constant through the end of the year (Subsection IV-B.2b). Therefore, factors related to August length will also be related to length at the end of the juvenile stage. These estimates of size on 1 August are related to the environmental data from the spawning period (early May) through July. Using partial correlation analyses, the relationships of mean May through July water temperature and average May through July freshwater flow at Green Island Dam to predicted length on 1 August were examined.

2) Results and Discussion

Weekly estimates of mean length for the years 1965 through 1976 (excluding 1971) show July through August to be a period of rapid growth for juvenile striped bass (Appendix Table B-12). This period corresponds to the rapid growth phase demonstrated for larvae and juveniles in 1973 through 1976 (Subsection IV-B.2b). Instantaneous growth rates derived from these weekly estimates of mean length varied from 0.0085 in 1970 to 0.0253 in 1967 (Table IV-14), a three-fold difference. Correlation coefficients of the natural log of mean length with time were greater than 0.90 for all years except 1968, supporting the applicability of linear regression to estimate instantaneous growth.

Estimates of instantaneous growth during July and August showed little relationship with mean temperature, mean freshwater flow, or juvenile abundance during that time period (Figure IV-21). The strongest partial correlation was between growth and abundance ($r = -0.23$); however, this relationship was not significant ($\alpha = 0.05$; Table IV-15). A strong negative relationship between both incremental and relative growth and juvenile abundance for

Table IV-14

Results of Linear Regression of the Natural Log of Mean Length with Time for Juvenile Striped Bass during July-August 1965-1976 in Hudson River Estuary

Year	Instantaneous Growth (Slope)	Intercept	Correlation Coefficient	Sample Size n
1965	0.0161	3.478	0.994	4
1966	0.0179	3.386	0.940	8
1967	0.0253	2.948	0.948	6
1968	0.0093	3.674	0.579	4
1969	0.0096	3.634	0.901	8
1970	0.0085	3.641	0.964	6
1972	0.0152	3.376	0.908	8
1973	0.0192	3.286	0.965	4
1974	0.0174	3.554	0.989	9
1975	0.0153	3.354	0.973	9
1976	0.0157	3.334	0.960	4

striped bass has been demonstrated (TI 1978c). While the relationship between instantaneous growth and abundance in this report was not significant, the correlation was negative. Although direct evidence for density independent growth in juvenile striped bass is limited, there has consistently been an inverse relationship between growth and abundance in all analyses.

Backiel and LeCren (1967) discuss density-dependent growth in fish populations and conclude that while a negative relationship between growth and abundance probably exists for many species, demonstration of this relationship is difficult due to the wide variation in fish growth rates in response to density-independent environmental factors. The limited number

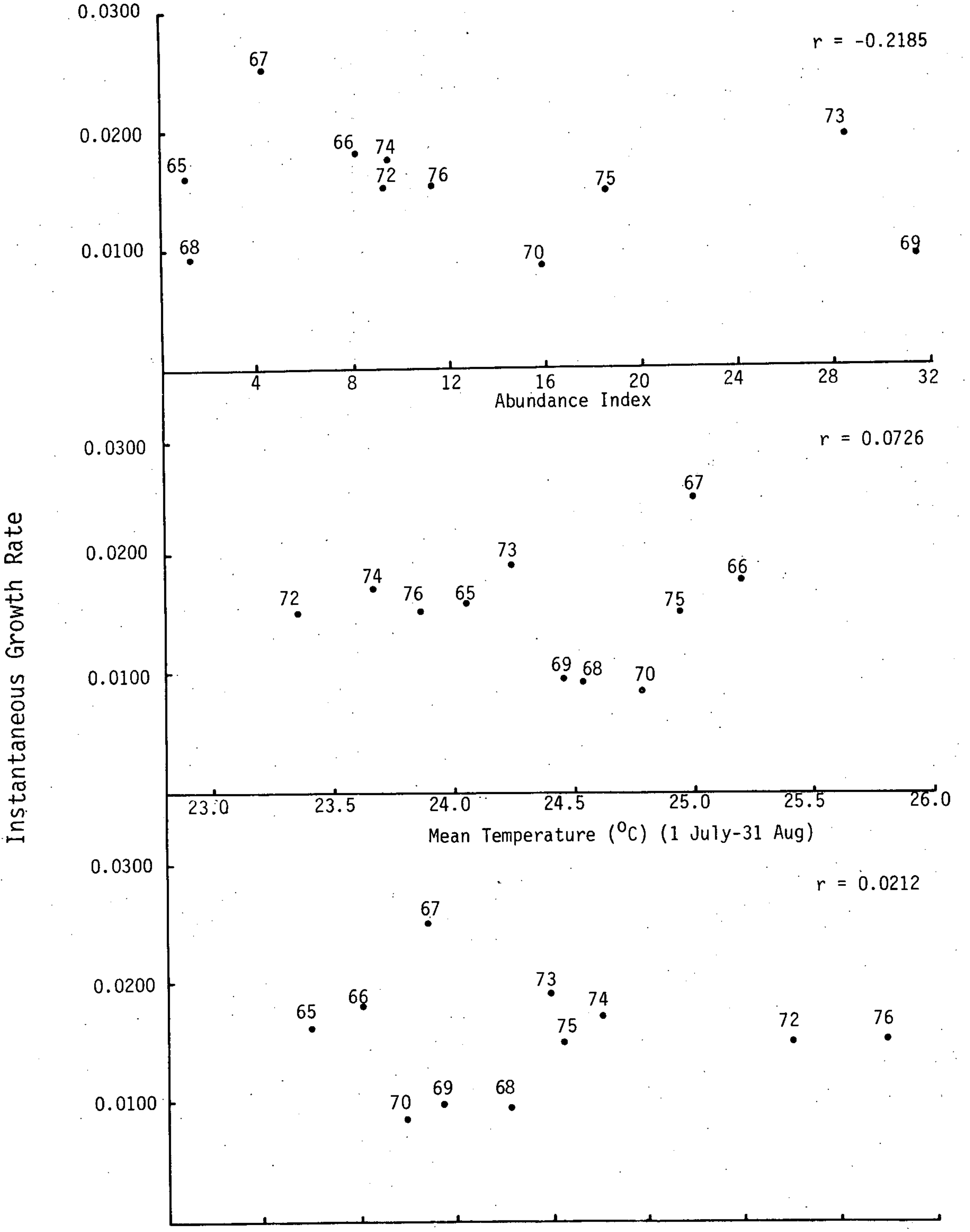


Figure IV-21. Relationship between Instantaneous Growth Rate of Striped Bass Juveniles and Juvenile Abundance, Mean Water Temperature and Mean Freshwater Flow during July-August, 1965-1976 (Excluding 1971) in Hudson River Estuary (Data in Appendix Table B-13)

Table IV-15

Partial Correlation Analysis of Instantaneous Growth Rate of Striped Bass Juveniles versus Juvenile Abundance, Mean Water Temperature, and Mean Freshwater Flow during July-August, 1965-1976 (Excluding 1971) in Hudson River Estuary

Variable Correlated with Striped Bass Juvenile Instantaneous Growth Rate	Variables Held Constant through Partial Correlation	Partial Correlation Coefficient
Juvenile Abundance Index	Mean Freshwater Flow Mean Water Temperature	-0.2349(p*=.49)
Mean Freshwater Flow	Juvenile Abundance Index Mean Water Temperature	0.1213(p*=.72)
Mean Water Temperature	Juvenile Abundance Index Mean Freshwater Flow	0.1402(p*=.68)

*Probability value for the correlation

(11) of estimates of striped bass growth available for the Hudson River and the large number of density-independent factors potentially affecting growth compound the problem of identifying significant relationships between growth and abundance.

The mean length of juvenile striped bass on 1 August, as predicted from the linear regression of length and time varied from 41.8 mm in 1967 to 56.2 mm in 1975 (Table IV-16). The predicted mean length on 1 August showed a strong positive relationship with the mean May through July water temperatures and a weak negative relationship with the mean May through July freshwater flow (Figure IV-22). The partial correlation between temperature and size was highly significant ($\alpha = 0.01$) while the partial correlation between freshwater flow and size (Table IV-17) was not significant (P is greater than 0.05).

Table IV-16

Predicted Mean Total Length of Juvenile Striped Bass Population on August 1, 1965-1976 (Excluding 1971) in Hudson River Estuary

Year	Predicted Mean Total Length (mm) on 1 August
1965	53.4
1966	51.5
1967	41.8
1968	52.6
1969	51.0
1970	49.6
1972	47.0
1973	48.5
1974	49.1
1975	56.2
1976	45.6

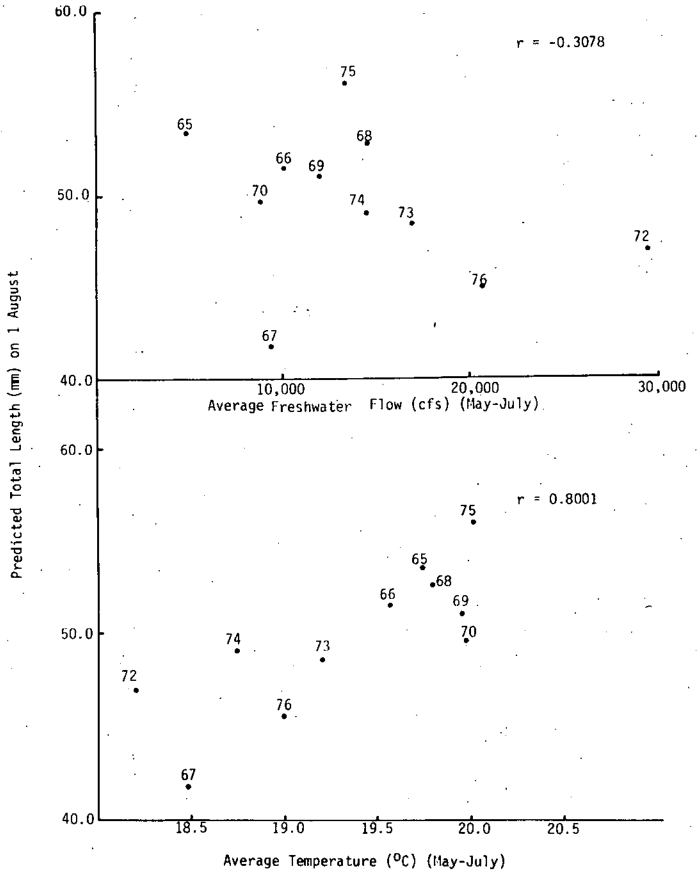


Figure IV-22. **Relationship between Predicted Total Length of Striped Bass Juveniles on 1 August and Mean May-July Water Temperature and Mean May-July Freshwater Flow for 1965-1976 (Excluding 1971) in Hudson River Estuary (Data in Appendix Table B-14)**

Table IV-17

Partial Correlation Analysis of the Predicted Total Length of Juvenile Striped Bass on 1 August versus Mean May-July Water Temperature and May-July Freshwater Flow during 1965-1976 (Excluding 1971) in Hudson River Estuary

Variable Correlated with the Predicted Length Striped Bass Juveniles on 1 August	Variable held Constant through Partial Correlation	Partial Correlation Coefficient
May-July Water Temperature	Mean May-July Freshwater Flow	0.7987(P=.004)*
Mean May-July Freshwater Flow	Mean May-July Water Temperature	-0.2987(P=.38)*

*Probability value for the correlation

As previously discussed (Subsection IV-B.2b), temperature patterns during May 1976 apparently reduced the length of the growing season from effective spawning to 1 August. Temperatures during June have also been demonstrated to affect growth during the yolk-sac stage (McFadden 1977). Therefore, the significant correlation between size on August 1 and temperature during May hrough July could reflect the effects of temperature on both survival and growth during May through July.

e. Environmental Factors Influencing Year-Class Abundance

The relationship between juvenile striped bass abundance (dependent variable) during July and August, 1965 to 1976 (excluding 1971) and various environmental factors (independent variables) was analyzed using latent root regression (Webster, Gunst, and Mason 1974). Latent root regression can detect linear dependencies among the independent variables and adjust for those which lead to bias in ordinary least squares regression (McFadden 1977). Regression analysis is useful in identifying variables that significantly influence year-class abundance, differentiating their effects from changes in abundance caused by power plant impact, and quantifying the effect of these variables. However, the use of any multiple linear regression technique to develop a predictive model from the present data base is restricted by both the complex relationships among the independent variables and the small number of observations (11) compared with the number of independent variables being tested (6). As Ricker (1975) observed, each of several environmental variables may be important in regulating a fish population, depending on the magnitude of that variable in any one year. Over the 11 years of data, several factors may have influenced striped bass year-class strength. Furthermore, it is unlikely that the same set of factors has been important every year. Therefore, statistical significance between environmental factors and juvenile striped bass abundance will, predictably, be difficult to demonstrate.

Multiple regression analysis is useful, however, as an inductive model and a reasoning tool. The effect of combinations of variables on year-class abundance can be demonstrated with multiple regression, but this is seldom a simple "additive" effect of the separate linear correlations. Multiple regression is also useful in supplying "negative" information, i.e. indicating those variables that are least likely to affect year-class abundance by eliminating them from the regression.

1) Selection of Independent Variables

Guidelines recommended by Ricker (1975) were used in selecting independent variables from the large number of available environmental factors. These guidelines give preference to factors most likely to affect the species directly (as determined from previous studies) and to factors for which accurate quantitative measurements are available over all 11 years of juvenile abundance indices. Factors evaluated for inclusion in the regression analysis included physical factors (freshwater flow and ambient water temperature), biological factors (predators and competitors), and the potential amount of water used by power plants for cooling purposes (as an index of entrainment and impingement mortality).

Freshwater flow has been noted as important in determining striped bass abundance in other systems (Sommani 1972, Turner and Chadwick 1972). Hudson River flow data were available in biweekly segments for all months of the year (based on USGS records of mean daily freshwater flow at Green Island

Dam, Troy, New York), but only the months from November (of the previous year) through June were considered to have a possible effect on July through August juvenile abundance. A relatively large proportion of the November through June flow occurs during April, so average flow rate for this month was evaluated separately from November through June flow variable. Seasonal flows in the Hudson are characteristically low through the summer and early fall months of July through October, but increase substantially in November.

Temperature may also influence striped bass reproduction (Talbot 1966, Farley 1967, Bayless 1972). With a July through August abundance index for juveniles, pertinent temperature effects on the survival of eggs, larvae, and early juveniles are probably limited to April, May, and June. Correlation revealed no significant relationships between juvenile abundance and biweekly mean temperatures during that period. However, if maximum spawning activity always occurs within the same narrow temperature range (Calhoun et al 1950, Talbot 1966, Farley 1967), then rate of temperature change or the duration of temperatures within a certain range could be the more important factors (Bannister et al 1974, Pinus 1974).

The rate of temperature rise for two ranges 12^{o} to 16^{o} and 16^{o} to 20^{o}C, corresponding to the peak catch-per-unit-effort of eggs and yolk-sac larvae, were entered in a latent root regression analysis previously performed (McFadden 1977). The degree rise per day during the 16^{o} to 20^{o}C range was selected by this analysis as significantly ($\alpha = .05$) influencing juvenile striped bass abundance, while the rate of increase during the 12^{o} to 16^{o} range was not correlated with year-class abundance. Therefore, only the days to span from 16^{o} to 20^{o} was entered into this regression (Table IV-18). Temperature values were taken from the records of the Poughkeepsie Water Works Department, which provides a more consistent temperature data base than the data from several USGS stations used in prior reports (TI 1975a, McFadden 1977).

The amount of cooling water withdrawal at power plants was entered as an index of entrainment and impingement mortality. Volumes used were maximum possible daily water withdrawal for all operating units combined at the

Table IV-18

Variables Entered into Latent Root Regression Analysis of Juvenile Striped Bass Abundance in Hudson River Estuary

Year	Juvenile Striped Bass* Abundance	April** Flow (ft ^{3}/sec)	Average Flow** Nov-June (ft ^{3}/sec)	Days to Span 16 - 20^0	Power Plant+ Water Withdrawal (m^{3}x10^3/day)	Predator* Index	Juvenile White Perch* Abundance
1965	1.19	19,284	8,010	13	3,143	0.52	12.69
1966	8.20	15,627	13,311	9	3,712	0.03	18.56
1967	4.20	30,937	12,371	10	3,712	0.18	34.33
1968	1.31	18,299	15,498	21	4,529	0.18	11.91
1969	30.72	40,730	17,943	19	5,183	0.38	24.21
1970	15.91	39,347	15,622	22	5,183	1.87	22.19
1972	9.23	37,963	22,951	15	5,183	5.22	4.33
1973	28.55	30,957	25,108	8	12,019	1.96	20.08
1974	9.51	30,167	19,750	26	14,113	7.33	6.81
1975	18.27	25,583	19,654	9	15,873	3.59	25.96
1976	11.28	36,757	25,349	9	20,616	4.43	25.28

*Derived from beach seine catch-per-unit area (river-wide samples) from mid-July through August.

**Mean daily freshwater inflow at Green Island Dam, Troy (United States Geological Survey).

+Based on maximum daily water withdrawal with all units (Lovett, Bowline, Indian Point, Danskammer, and Roseton) operating at 100% capacity.

Bowline (RM 37; KM 59), Lovett (RM 41; KM 66), Indian Point (RM 42; KM 67), Danskammer (RM 66; KM 106), and Roseton (RM 65; KM 104), power plants assuming the volume of water withdrawn was directly proportional to capacity (Table IV-18).

Cannibalism and predation could also be involved in the regulation of the juvenile striped bass population. In the Sacramento-San Joaquin River system of California, cannibalism of juveniles by both yearlings and adults was demonstrated (Stevens 1966, Thomas 1967). Another potentially important predator in the Hudson is the bluefish (Pomatomus saltatrix), an active piscivore (Bigelow and Schroeder 1953). Abundance indices for bluefish and yearling and older striped bass were based on the same beach seine samples collected during July and August from which the juvenile striped bass abundance index was derived, except for 1972 when the predator index was based on river-wide unadjusted collections. Cannibalism was considered to be a special type of predation and bluefish and yearling and older striped bass to be part of a predator complex. A combined predator index equivalent to the sum of catch-per-unit-area indices of abundance for bluefish and yearling and older striped bass was entered in an earlier regression (McFadden 1977) and found to be nonsignficant. However, predation may affect juvenile striped bass abundance only during certain years, and the influence may not be apparent with limited data. Therefore, the predation index was again entered as a variable in the regression (Table IV-18).

Juvenile white perch abundance was also included as a variable. The two Morone species have overlapping distributions and similar morphometry, especially as early juveniles. This could result in the species utilizing the same food sources and being subject to the same predators (Subsection IV.B.2.a).

An index of striped bass spawning stock abundance had been used as a variable in a previous latent root regression analysis (McFadden 1977), but the index was not selected as a significant influence on juvenile abundance. The spawning stock index was based on commercial fishery yield (pounds) per effort. This fishery was closed in early 1976 due to the levels of PCB (polychlorinated biphenyls) in the body tissues of striped bass, and since no equivalent yield-per-effort statistics were available for 1976, spawning stock abundance was not entered as a variable in this latent root regression.

2) Results and Discussion

Three factors selected by latent root regression as influencing the abundance of juvenile striped bass were April freshwater flow (positive), average freshwater flow from November through June (positive), and the predator index (negative) (Table IV-19). Since nonpredictive correlations did not exist among the independent variables, the latent root regression is the same as the ordinary least squares regression. When the relationship between an independent variable and the dependent variable demonstrated a "t" statistic greater than 1.0 in the regression routine, that independent variable was retained. None of the independent variables selected was significant at α = .05, but such results were expected with the relatively small data set

Table IV-19

Results of Latent Root Regression Analysis of Six Selected Environment Factors (see Table IV-18) on Juvenile Striped Bass Abundance, Hudson River Estuary, 1965-1976 (Excluding 1971)

Source	Degree of Freedom	Sum of Square	Mean Square	F	P	R^2
Regression	3	541.8	180.6	2.79	> .10	0.544
Error	7	453.9	64.8			
Total	10	995.7				

Regressor	Modified t Statistic
April freshwater flow	1.30
Mean freshwater flow (Nov-June)	1.78
Predator index	-1.57

Prediction Equation Using Standardized Regressors:

$$Y = -16.66 + 0.00044X_1 + 0.0012X_2 - 2.09X_3$$

where:

Y = Predicted juvenile striped bass abundance
X_1 = April freshwater flow
X_2 = Mean freshwater flow, (Nov-Jun)
X_3 = Predator index

(Ricker 1975). The three factors combined explain 54.4% of the variation in striped bass year class strength. This R^2 value (0.544) indicates that important environmental factors are influential but have not yet been tested or that some of the tested factors influence abundance in a nonlinear fashion.

The effect of the rate of the 16 to 20°C degree rise was not found to be important in this analysis. Previous reports (McFadden 1977, McFadden and Lawler 1977) indicated that this variable was significantly correlated with juvenile abundance. The Poughkeepsie Water Works data were used to generate rates of temperature rise for this report instead of previous measures of water temperatures at different times and places. Hence, use of this new data set, more comparable across years, resulted in a smaller correlation coefficient with juvenile striped bass abundance (r = -0.083) than reported in previous reports.

Although the regression was not significant at $\alpha = .1$, the selected variables represent those environmental factors most likely to affect year-class strength and may become statistically significant when more years of data are available for analysis. The predation index had a low correlation coefficient, but it was retained by the regression. The simple correlation coefficient for this variable was positive (Appendix Table B-15), although it appears in the predictive equation as a negative influence. Such a change of sign and importance is consistent with the mechanisms of this variable. If the negative effect of predation occurs only in certain years (see next section), this effect would be revealed only when the predator index was analyzed in conjunction with other important variables. A direct comparison of striped bass and bluefish juvenile abundance over the entire time period can obscure the true relationship and result in a weak correlation or a correlation with a different sign.

3) Possible Mechanisms of Selected Variables

Spring and summer flow patterns have been shown to influence striped bass year-class abundance in other systems. Survival of young striped bass up to 3.8 cm long was initially related to summer river flow in the Sacramento-San Joaquin estuary of California (Turner and Chadwick 1972). Sommani (1972) and Stevens (1977) used independent methods to show a significant positive relationship between June and July delta outflow and striped bass juvenile abundance in this same system. A survey by the Maryland Department of Natural Resources (Joe Boone, personal communication, and California Department of Fish and Game et al. 1974) revealed that catch-per-seine-haul of juvenile striped bass in the Potomac River was significantly correlated with mean April and May flow (r = +.86 for 1961 to 1971).

April flow could affect striped bass year class strength through a number of mechanisms. Since spawning occurred in early May in all years of study (1973-1976), it is doubtful that the effect is directly on survival of early life stages. More likely, April flow may have an effect on the adult population, either directly or through its effect on temperature, by cueing gonad maturation. Increased April flow may also indirectly affect the survival of larval striped bass by providing the prey organisms a sufficient detrital food base and thereby increasing food availability when larval feeding begins. Large November through June freshwater flows may function to increase the detrital food base or dissolved nutrient levels. These could increase the amount of food available to and therefore the abundance of zooplankton on which the post yolk-sac larvae and early juveniles feed, thereby increasing their survival rates.

Bluefish and yearling and older striped bass are known to prey on juvenile striped bass (Thomas 1967, TI 1976d). The combined predator variable should be a good index of the amount of predation pressure by bluefish and striped bass in an area of juvenile striped bass abundance. However, whether this reflects actual predation on juvenile striped bass depends upon the relative abundance of other prey species. In years when juvenile striped bass are relatively abundant (and other prey species are relatively scarce), this predation factor could influence the abundance of juvenile striped bass. In other years, the striped bass may be buffered from this factor. Therefore predation would only affect striped bass year class strength in certain years and should only show a relationship with juvenile abundance when examined in combination with those factors which determine the abundance and distribution of prey species.

Cannibalism is an important source of mortality for striped bass in the Sacramento-San Joaquin River system of California, where concentration of juveniles overlap with concentrations of subadults and adults (Stevens 1966, Thomas 1967). Like most predators, adult striped bass are opportunistic, however, and feed on the most readily available species (Thomas 1967). In the Hudson River, yearling and older striped bass are caught infrequently with juveniles. This is reflected in the predator index, which is usually dominated by bluefish (Appendix Table B-16). Both the predator index and the striped bass juvenile index were derived from the same beach seine data base (mid-July through August).

Therefore, our working hypothesis of mechanisms influencing striped bass year-class abundance includes the following:

- April freshwater flow regulates the timing and synchronization on gonadal development and the spawning migration.
- Large freshwater flows from November through June increase the available food base through input of detritus and dissolved nutrients.
- During those years of high juvenile striped bass abundance (relative to other potential prey species) and high predator abundance, predation is an important mortality factor and will reduce year class strength of striped bass.

4. Compensation in Striped Bass Population

Compensation refers to the dependency of birth and/or death rates on population density such that as a population varies in numbers, birth rates vary inversely and/or death rates directly (McFadden 1977). Without density-dependent birth and death rates, the rate of increase is random with respect to density, and population numbers go either to zero or to unreasonably high values through random walk (Slobodkin 1973). Random walk is a series of numbers n_i such that the magnitude of the changes (n_i-n_i-1) is random.

Density-dependent regulation of population numbers has been the source of considerable controversy in the past, but now it is almost universally accepted by ecologists. Slobodkin (1973) summarized a symposium on stock and recruitment saying the general acceptance of density-dependence was among the more important results of the symposium. Royama (1977) initiated a discussion of density-dependent regulation with:

> A basic concept in many theories to explain the persistence of animal populations is the notion of density-dependent regulation, which is now widely accepted in spite of much controversial literature during the last half century.

Compensation is a term applied to exploited fish populations and is used to indicate the potential for counterbalancing additional mortality through an increase in survival rates of remaining fish. The existence of compensation implies that the impact of power plants on fish populations is probably less than that indicated by the conditional mortality rates due to entrainment and impingement (McFadden 1977).

There are at least two general ways to demonstrate the existence of compensation operating in natural populations. First, density-dependent birth, death, and growth rates will generate a specific relationship between stock and recruit biomass. These relationships have been examined and the results generally support the concept of compensation operating in the Hudson River striped bass population (McFadden 1977). Second, in the absence of compensation, an increase in the mortality rate will generate a decline in stock size.

The following discussion of compensation will address declines in yield-per-unit effort and changes in the age composition of striped bass in the Hudson River estuary.

a. Predicted Decline in Yield-Per-Effort in the Absence of Compensation

Any source of mortality will cause a decline in numbers if compensation does not exist within a population. The potential decline in striped bass numbers due to entrainment and impingement at Danskammer (which started oprations in 1951) and Lovett (which started operation in 1949) was calculated as an exercise based on four assumptions:

The first assumption of this exercise is that the population has no compensatory ability, and the removal of a certain percentage of young will result in an equivalent reduction in the adult population. This assumption is being tested in this exercise. If the assumption is false, then the decline in numbers calculated in this exercise should be conspicuous when compared to actual abundance trends. The second assumption is that the one year of data (1973) for conditional mortality rates at these two plants is a reasonable estimate of the mean conditional mortality rates from 1949 to present. Obviously, if the mean is underestimated, the decline will also be underestimated, the decline will also be underestimated, and if the mean is overestimated, then the decline will be overestimated. The third assumption is that conditional mortality rates calculated with respect to total flow rates are proportional to conditional mortality rates for individual unit maximum flow rates (Table IV-20), as represented by the following formula:

$$\frac{M_t}{M_i} = \frac{F_t}{F_i}$$

where

M_t = Conditional mortality rate calculated for all units

M_i = Conditional mortality rate for unit i

F_t = Total maximum flow rate for all units combined

F_i = Total maximum flow rate for unit i

The fourth assumption is that no major influx of striped bass has occurred during the time period covered in the exercise (1949-1976). If striped bass from other estuarine populations (e.g. the Chesapeake Bay) are replacing those removed by entrainment and impingement, then no decline in numbers would be expected; available data indicate that the probability that this assumption is true is very high. Impingement and entrainment mortality rates were taken from TI (1975a). Impingement mortality rates are given as expectation of death from impingement

$$u_i = N_i/N_t$$

where

u_i = Expectation of death from impingement

N_i = Number of fish impinged

N_t = Total number of fish at the beginning of the impingement period

This value can be converted to a conditional mortality rate by:

$$m_i = 1 - \frac{1-q_t}{1-q_n}$$

where

m_i = Conditional mortality rates due to impingement

q_t = Total mortality rate

q_n = Mortality from natural causes

Table IV-20

Percent Flows (Cooling Water Withdrawals) of Individual Units at Lovett and Danskammer and Associated Impact on Striped Bass Based on 1973 Entrainment and Impingement Data

Power Plant	Unit	Year Operation began	Cumulative Proportion Maximum Flow	Direct * Impact
Lovett	I	1949	0.08	0.0019
Lovett	II	1951	0.16	0.0037
Lovett	III	1955	0.29	0.0068
Lovett	IV	1966	0.62	0.0144
Lovett	V	1969	1.00	0.0233
Danskammer	I	1951	0.13	0.0069
Danskammer	II	1954	0.26	0.0138
Danskammer	III	1959	0.60	0.0319
Danskammer	IV	1967	1.00	0.0532

---

* Direct impact is equal to the conditional mortality rate in the absence of compensation

Total mortality (q_t) was calculated to be .8 in McFadden (1977). Natural mortality (q_n) can be calculated:

$$q_n = (1-q_t)^{[1-(u_i/q_t)]}$$

Entrainment mortality is calculated directly as conditional mortality. Values used here assume 80, 60, and 70 percent mortality for eggs, yolk-sac larvae, and post yolk-sac larvae respectively. Values of .5 for withdrawal and .1 for recirculation were used as in McFadden and Lawler (1977). The combined impact of these two mortality rates can be calculated:

$$\text{combined mortality} = m_i + m_e - (m_i m_e)$$

where

m_i = Conditional mortality rate due to impingement

m_e = Conditional mortality rate due to entrainment

With no compensation present, each year the year class would be reduced by the conditional mortality rate. The expected behavior of such a population starting with 100 fish is shown in Table IV-21.

Table IV-21

Expected Behavior of a Hypothetical Population of Striped Bass with No Ability to Compensate for Additional Mortality from Danskammer and Lovett Power Plants

Year	Population Size	Proportion Surviving Impact	Conditional Plant Mortality at Danskammer	Conditional Plant Mortality at Lovett
1949	100	0.9981	------	0.0019
1950	99.81	0.9981	------	0.0019
1951	99.62	0.9894	0.0069	0.0037
1952	98.56	0.9894	0.0069	0.0037
1953	97.52	0.9894	0.0069	0.0037
1954	96.49	0.9826	0.0138	0.0037
1955	94.81	0.9795	0.0138	0.0068
1956	92.86	0.9795	0.0138	0.0068
1957	90.96	0.9795	0.0138	0.0068
1958	89.10	0.9795	0.0138	0.0068
1959	87.27	0.9615	0.0319	0.0068
1960	83.91	0.9615	0.0319	0.0068
1961	80.68	0.9615	0.0319	0.0068
1962	77.57	0.9615	0.0319	0.0068
1963	74.59	0.9615	0.0319	0.0068
1964	71.71	0.9615	0.0319	0.0068
1965	68.95	0.9615	0.0319	0.0068
1966	66.30	0.9542	0.0319	0.0144
1967	63.26	0.9332	0.0532	0.0144
1968	59.04	0.9332	0.0532	0.0144
1969	55.09	0.9247	0.0532	0.0233
1970	50.94	0.9247	0.0532	0.0233
1971	47.11	0.9247	0.0532	0.0233
1972	43.56	0.9247	0.0532	0.0233
1973	40.28	0.9247	0.0532	0.0233
1974	37.25	0.9247	0.0532	0.0233
1975	34.44	0.9247	0.0532	0.0233
1976	31.85	0.9247	0.0532	0.0233

This simulation, indicates that a 68% decline in the striped bass population should have resulted since 1949 from the operation of these two plants alone if no compensation exists (Table IV-21). A 66% decline would have occurred since 1955. The catch-per-effort of the Hudson River fishery shows no decline over the years 1955 through 1975, a period when gear use is comparable McFadden 1977). Young-of-the-year indices are available since 1965 (Subsection IV.B.3.). Under these assumptions, a 54% decline should be evident in these data, but the young-of-the-year indices show no decline. If the impacts of commercial fishing and additional power plants were included in this exercise, the population decline would be even greater and the population should be very small or even extinct at the present time. The lack of any decline in yield per effort indices indicates that some compensatory mechanism is operating.

b. Changes in Age Composition

Another method of detecting population changes is through changes in the age structure. Declining stocks typically show a declining average age (Rounsefell 1975). Age composition of the Hudson River spawning stock has been estimated from samples collected by commercial fishermen using gill nets (McFadden et. al. 1978). Although gill nets are size selective, preliminary analysis of haul seine data (a nonselective gear) indicates the commercial fishery samples broadly the spawning run and commercial gill net data are not seriously biased. Since gill nets select for smaller fish, any bias would be toward a younger age distribution.

The age composition of the Hudson River spawning stock is compared to data from other sources in Table IV-22. Sixty-eight percent of the Hudson River commerical catch are 5 years old or older, but the majority of other stocks are 3 years old or younger. The Hudson River stock shows no indication of over-exploitation when its age structure is compared to these other stocks.

The fish in the Chesapeake Bay system are probably persisting under higher exploitation rates than the Hudson River population. Chesapeake Bay striped bass have younger age distributions which suggests that these populations may be compensating for additional mortality by maturing at a younger age.

Table IV-22

Age Composition of Striped Bass Spawning Stocks in Several Estuarine Systems

	Age Composition (%)								
System	II	III	IV	V	VI	≥VII	N[**]	Source	Gear
Chesapeake Area	13	43	13	22	[→]	4	93	Tiller 1950	Pound Nets
James River	53	18	9	3	4	12	429	Grant 1974	Pound and Fyke Nets
York River	66	19	6	3	2	5	210	Grant 1974	
Rappahannock River	64	19	6	2	1	8	324	Grant 1974	
Hudson River	[*]	15	17	33	23	12	1221	Modified from McFadden et.al., 1978	Commercial Gill Nets

[→] In the Chesapeake area, age VI fish were included in the ≥VII age group.

[*] Less than 1%.

[**] Sample size.

Hudson River fish are not 100% mature until age IX while age VII is the latest maturing of other stocks (Table IV-23). Caution is advised where making comparisons across geographical regions because southern populations tend to mature earlier than northern populations in general (Scott and Crossman 1973). However, if earlier age at maturity does represent a compensatory response, the Hudson River stocks still have considerable flexibility in the adjustment of their age at maturity and should be able to compensate for a considerable amount of additional mortality.

c. Fecundity as an Estimate of Compensatory Capability

Cushing (1971) related an index of compensatory capabilities to the cube root of fecundity. This relationship was later updated (Cushing and Harris 1973) using the term $-\beta\bar{P}$ from Ricker's (1975) stock recruitment equation. In past reports, α has been used because the reduction in equilibrium

Table IV-23

Percentage of Mature Striped Bass Females by Age Reported in Different Study Areas

Study Area	Age III	IV	V	VI	VII	VIII	IX+	Reference
California	--	35	87	98	100	100	100	Scofield 1931
New England States	--	27	74	93	100	100	100	Merriman 1941
Oregon	18	68	100	100	100	100	100	Morgan and Gerlach 1950
North Carolina*	3	78	100	100	100	100	100	Lewis 1962
North Carolina*	4	94	100	100	100	100	100	Lewis 1962
Maryland	44	79	99	100	100	100	100	Jones et al 1977
Hudson River	4	7	19	43	86	89	100	**McFadden and Lawler 1977**

*Two-year study

population size due to power plant mortality can be calculated if α is known (McFadden 1977). The term $-\beta\overline{P}$ was converted to α through the identity:

$$\alpha = e^{\beta\overline{P}}$$

where

α = coefficient of density independent mortality

β = coefficient of density dependent mortality

$\overline{P}$ = average stock size

This identity holds true when recruit biomass equals parental stock biomass, which happens at the average population size, $\overline{P}$. The α term correlated well with the fecundities reported by Cushing (1971) ($r = 0.62$, $P < 0.01$) (Table IV-24). The relationship is described by the equation

$$\alpha = 0.81 + 0.067\ \overline{F}^{1/3}$$

where

$\overline{F}$ = average fecundity for each species

Table IV-24

Relationship between Fecundity and Density Dependence for Different Fish Stocks

Species	$\bar{F}$*	$-\beta\bar{P}$**	$\bar{\alpha}$***	$\bar{F}^{1/3}$****
Pink salmon				
Kodiac	1,754	1.00	2.72	12.1
Puget	1,754	0.41	1.51	12.1
Red salmon				
Nushagak	4,011	1.00	2.72	15.90
Skeena	3,273	0.53	1.70	14.85
Karluk	3,199	0.61	1.84	14.73
Chum salmon	2,890	1.13	3.10	14.24
Atlantic herring				
Dogger	70,000	0.61	1.84	41.20
Buchan	80,000	0.48	1.62	43.08
Pacific herring				
Kodiac	20,000	2.10	8.17	27.14
British Columbia North	20,000	0.67	1.95	27.14
British Columbia Lower East	16,000	1.03	2.80	25.20
Sakhalin	45,000	0.86	2.36	35.57
California sardine	33,000	1.14	3.13	32.08
Flatfish				
Plaice	140,000	1.01	2.75	51.92
Petrale sole	100,000	0.48	1.62	46.41
Halibut (2)	210,000	1.26	3.53	59.44
Halibut (3)	210,000	1.34	3.82	59.44
Gaddoids				
North Sea haddock	250,000	1.03	2.80	63.00
Georges Bank haddock	250,000	1.44	4.22	63.00
St. Lawrence cod	1,100,000	2.70	14.89	103.23
Artic cod	1,500,000	1.85	6.36	114.47

*Average fecundity taken from Cushing (1971).
**Index to density dependent mortality taken from Cushing & Harris (1973).
***Index to density independent mortality.
****Cube root of the average fecundity.

Cushing (1971) generally calculated fecundity by using length-fecundity relationships combined with the average length of the fish in the spawning stock. This method would give the fecundity of fish contributing most to the spawn. For striped bass, a fecundity of 740,000 eggs per female was used representing an average of five, six, and seven-year-old females which contribute 55% of the spawn (McFadden and Lawler 1977). A weighted average of fecundity would have given a higher value, but would not have been consistent with the methodology used in most cases by Cushing (1971). This value for striped bass fecundity is a conservative estimate.

Using this equation and the fecundity of 740,000, the calculated alpha value for striped bass is 6.87 (95% confidence interval of .74 to 13.00). The alpha value represents the relative production of recruits at very low densities and indicates the maximum ability of a stock to compensate for the additional mortality. The alpha value generated for the Hudson River striped bass stock was exceeded by only two fish stocks analyzed by Cushing (1971) and indicates a comparatively high potential for compensation (Table IV-24) in Hudson River striped bass. An alpha value of 4 has been estimated from striped bass stock-recruitment relationships (McFadden 1977). Therefore, the estimation of alpha through fecundity relationships indicates 4 is a rather conservative estimate.

C. WHITE PERCH (Morone americana)

1. General Life History

The white perch, an euryhaline member of the family Percichthyidae, occurs naturally in Atlantic coastal and near-coastal waters of North America from the Miramichi River in the Maritime Provinces of Canada to South Carolina. White perch, similar in body form to striped bass, are smaller as adults (Figure IV-23). They are primarily estuarine throughout the southern end of their range, occur more frequently as land-locked freshwater populations towards the northern end, and become uncommon in marine waters north of Cape Cod (Bigelow and Schroeder 1953). In the central portion of their range, white perch are one of the most abundant species in the lower estuarine reaches of both the Hudson River (TI 1976a) and the Connecticut River (Marcy 1976). Since 1950, the range of the white perch has been extended, probably as a result of dispersal through the New York State Barge Canal system, to include the lower Great Lakes (Figure IV-24). Within nine years of their initial appearance, the white perch populations grew to become the dominant species in the commercial fishery of Lake Ontario. This lake is the likely source of the first recorded occurrences of white perch from the St. Lawrence Seaway (Scott and Christie 1963). Sizable catches of white perch reported in 1975 from Lake Erie suggest this lake now also supports reproducing populations and that further expansion to the upper Great Lakes is probable (Busch et al 1977). White perch are often successful when introduced to landlocked ponds and lakes. Many New England freshwaters have developed populations (often large populations of stunted individuals) from stocked fish (Thoits 1973) and ponds as small as one-quarter acre (0.1 ha) contain breeding populations (Stroud 1955).

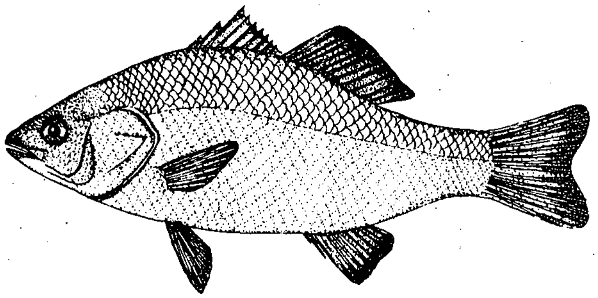
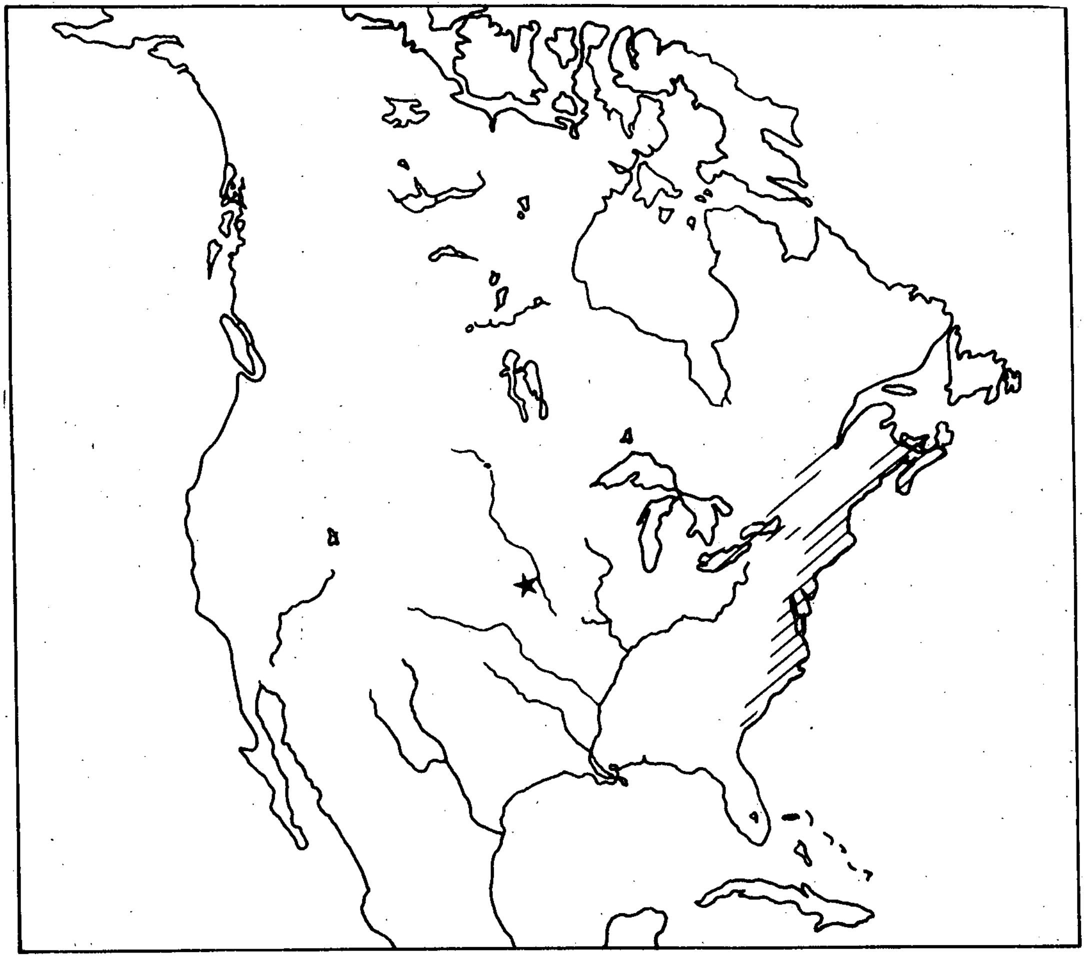


Figure IV-23. White Perch (Morone americana), Euryhaline Member of Percichthyidae Family



★ Sport fishery established by stocking hatchery reared fry, natural reproduction occurring.

Figure IV-24. Distribution of White Perch in North America as of 1976 (Adapted from Hergenrader and Bliss [1971] and Scott and Crossman [1973])

White perch commonly exhibit seasonal patterns in distribution. Coastal populations overwinter in the deeper waters of mid and lower estuaries (Mansueti 1957; Markle 1976; TI 1976a). Upstream migrations from these areas toward brackish and tidal freshwater spawning grounds may commence as early as March in North Carolina (Hardy 1978) or as late as July at the northern end of their range (Mansueti 1964). Males migrate first and are usually more numerous than females throughout the spawning period. Spawning runs may be as extensive as 45 miles (72 km) (Mansueti 1957) and the spawning run in any river may extend over a month or more (Mansueti 1964; Smith 1971). There are few observations of the spawning act. It is generally accepted that large schools congregate over shoals or in tributary streams, where several males will follow a single female, fertilizing the eggs she has developed and released (AuClair 1956; Mansueti 1957). After the spawning run, adult white perch generally return to the lower reaches of estuaries and movements are limited for the duration of the year (Mansueti 1957; TI 1976a).

White perch begin to enter the spawning population at age II when faster growing individuals mature. In the Patuxent River, all males are mature at that age but in the Hudson River, some males do not mature until age IV. Females in the Patuxent and Hudson Rivers may not mature until age IV and V respectively (Mansueti 1957, McFadden et. al. 1978). Egg production varies with size and age, with fecundity reportedly ranging from 20,000 to 321,000 eggs (Scott and Crossman 1973). During the first hour after fertilization when eggs water-harden, they are adhesive and will adhere to any substrate they contact. Eggs that do not settle may be found floating free in the water column (Mansueti 1964). Depending on water temperature hatching occurs in 1.5 to 6 days, with the eggs developing faster at higher temperatures (Mansueti 1964).

Newly hatched yolk-sac larvae, 1.7 to 3.0 mm in length, remain on or near the bottom for 3 to 5 days as the yolk is absorbed. At 3.5 to 4.0 mm in total length (TL), the fry enters the post yolk-sac stage and begins to move about actively and feed (Mansueti 1964). The juvenile stage begins when the young perch develops the adult fin complement, which occurs within approximately one month after hatching when the fish are about 20 mm TL (TI 1975a). At 20 to 25 mm TL, juveniles begin to move to shoal and shore zone areas (Mansueti 1964). The diet of the young white perch is predominantly zooplankton such as copepods, cladocerans and amphipods and when they reach a length of 61 to 100 mm TL, their diet becomes dominated by benthic forms including crustaceans, dipteran larvae and annelids (Taub 1966; Marcy 1976). During late summer and fall, juvenile white perch move shoreward and downstream through the nursery area, eventually entering the overwintering areas (TI 1976a). Yearling and adult fish are polyphagous, consuming fish, fish eggs, crustaceans, insects, and aquatic plants to different degrees depending upon location (Taub 1966; TI 1976a).

2. Population Characteristics

a. Diet

The stomach contents of juvenile (young-of-the-year), yearling and older white perch were examined and the data were analyzed to determine the food habits of the fish. Data were collected to allow comparison with food habits of striped bass (Subsection IV.B.3.c) and to determine the frequency of cannibalism or predation on striped bass.

1) Methods

Stomach contents of fish collected by beach seines near Indian Point (RM 39-46) [KM 62-74] in 1974 were used for these analyses since both white perch and striped bass were present in these samples. Fish were processed as described for striped bass, and the mean percent frequency of each countable food item was similarly calculated (Subsection IV.B.2.a.).

2) Results and Discussion

A total of 603 stomachs from juveniles, yearling and older white perch were examined. Ninety-one (15%) of these fish had empty stomachs and 24 (4%) had consumed only uncountable food items (filamentous algae, plant and animal remains and detritus). A complete listing of food items is presented in Tables IV-25 and Appendix Table B-17.

Small fish [less than or equal to 75 mm (total length)] from April to July and September through November were analyzed (no sample was available in August for white perch ≤75 mm TL). During April, dipterans and cladocerans were the main food items (Table IV-25). In May, calanoid copepods replaced dipterans as the most common organism eaten and they continued to be the major food eaten during June. During July, white perch ate approximately equal amounts of harpacticoid and calanoid copepods and unidentified fish eggs. In 1973, eggs of alewife and blueback herring were identified in white perch stomachs. During September through November, copepods, Gammarus, and chironomid larvae were the major items eaten.

Table IV-25

Comparison of Major Countable Food Items of White Perch by Mean Percent Frequency, April-November, 1974

	APRIL			MAY			JUNE		
Length Group (mm)	Sample Size	Food Item	Mean Percent Frequency	Sample Size	Food Item	Mean Percent Frequency	Sample Size	Food Item	Mean Percent Frequency
≤ 75	2	Diptera (L)	50.00	7	Calanoida	51.21	31	Calanoida	48.68
		Cladocera (unid)	34.62		*Leptocheirus*	17.55		Chironomid (L)	12.17
		Gammarus	7.69		Chironomid (L)	11.94		Polychaeta	10.23
		Chironomid (L)	3.85		Harpacticoida	7.25		*Leptocheirus*	8.70
		Cyclopoida	3.85		Cyclopoida	5.38		Cladocera (unid)	7.86
					Polychaeta	2.78		Harpacticoida	7.05
					Gammarus	1.78		Fish eggs (unid)	2.84
					Chironomid (P)	1.64		Chironomid (P)	1.01
76-150	4	Chironomid (L)	68.00	21	Chironomid (L)	24.53	93	Calanoida	37.70
		Gammarus	21.28		Calanoida	19.90		Chironomid (L)	25.93
		Cladocera (unid)	10.71		*Gammarus*	15.02		Chironomid (P)	7.35
					Leptocheirus	11.81		Fish eggs (unid)	6.58
					Chironomid (P)	11.25		*Gammarus*	4.82
					Polychaeta	6.47		Cladocera (unid)	3.86
					Fish eggs (unid)	4.76		Polychaeta	3.27
					Cyclopoida	2.40		Harpacticoida	3.16
151-200	8	*Gammarus*	63.79	8	*Gammarus*	45.47	9	*Cyathura*	24.44
		Chironomid (L)	16.02		Polychaeta	35.81		Chironomid (L)	23.15
		Diptera (L)	12.82		Chironomid (L)	16.95		Calanoida	14.81
		Cyathura	2.58		Chironomid (P)	1.49		Chironomid (P)	11.85
		Monoculodes	1.70		Oligochaeta	0.28		*Leptocheirus*	11.67
		Leptocheirus	1.14					Fish eggs (Clupeidae)	10.[illegible]5
		Chirodotea	0.98					*Gammarus*	2.87
		Chaoborus (L)	0.96					Harpacticoida	0.16
201-270		No sample		1	*Gammarus*	100.00		No sample	

Unid = Unidentified
L = Larvae
P = Pupae

Table IV-25 (Contd)

Length Group (mm)	JULY Sample Size	Food Item	Mean Percent Frequency	AUGUST Sample Size	Food Item	Mean Percent Frequency	SEPTEMBER Sample	Food Item	Mean Percent Frequency
≤75	4	Fish eggs (unid)	24.35		No sample		33	Harpacticoida	31.98
		Harpacticoida	21.43					*Gammarus*	19.81
		Calanoida	21.13					Chironomid (L)	14.04
		Chironomid (L)	14.91					*Leptocheirus*	9.22
		Adult Insect Remains	8.33					*Monoculodes*	8.87
		Diptera (P)	8.33					Calanoida	3.52
		Chironomid (P)	1.28					*Cyathura*	3.39
		Gammarus	0.16					Chironomid (P)	2.39
		Cyathura	0.07						
76-150	101	Chironomid (L)	36.51	53	*Gammarus*	36.60	41	*Gammarus*	40.38
		Cladocera (unid)	13.88		*Leptocheirus*	25.65		Chironomid (L)	13.98
		Leptocheirus	11.21		Chironomid (L)	18.61		*Rhithropanopeus*	11.89
		Gammarus	10.52		*Corophium*	10.38		*Corophium*	7.10
		Chironomid (P)	6.14		*Rhithropanopeus*	2.70		*Leptocheirus*	6.73
		Calanoida	4.18		*Cyathura*	1.98		*Monoculodes*	5.45
		Cyathura	4.01		Monoculodes	1.63		*Cyathura*	3.30
		Harpacticoida	2.79		Chironomid (P)	1.27		Chironomid (P)	3.09
151-200	2	Chironomid (L)	90.35	2	*Leptocheirus*	48.90	5	*Leptocheirus*	37.88
		Leptocheirus	7.89		Chironomid (L)	22.91		*Cyathura*	28.10
		Chironomid (P)	0.88		*Cyathura*	9.56		*Gammarus*	27.14
		Cyathura	0.88		Polychaeta	5.71		*Corophium*	3.65
					Corophium	3.85		Chironomid (L)	1.94
					Chironomid (P)	2.86		Chironomid (P)	0.65
					Gammarus	2.86		Polychaeta	0.65
					Monoculodes	1.92			
					Cyclopoida	1.43			
201-270		No sample			No sample			No sample	

Table IV-25 (Contd)

	OCTOBER			NOVEMBER		
Length Group (mm)	Sample Size	Food Item	Mean Percent Frequency	Sample Size	Food Item	Mean Percent Frequency
≤ 75	26	*Gammarus*	36.59	5	Calanoida	73.02
		Harpacticoida	29.98		Harpacticoida	14.71
		Chironomid (L)	10.79		*Corophium*	8.00
		Polychaeta	6.32		*Gammarus*	4.00
		Calanoida	4.06		Chironomid (L)	0.15
		Leptocheirus	3.67		*Monoculodes*	0.13
		Gastropoda	2.56			
		Monoculodes	1.15			
76-150	25	*Gammarus*	45.93	4	Calanoida	79.24
		Calanoida	14.61		*Gammarus*	15.66
		Chironomid (L)	12.70		Harpacticoida	4.70
		Leptocheirus	7.26		Cyclopoida	0.21
		Corophium	5.73		Chironomid (L)	0.11
		Monoculodes	3.63		*Monoculodes*	0.03
		Harpacticoida	3.16		Gastropoda	0.02
		Cyathura	2.83		*Leptocheirus*	0.02
151-200	3	*Gammarus*	43.39		No sample	
		Chironomid (L)	33.33			
		Corophium	11.64			
		Lepidoptera (P)	11.11			
		Cyathura	0.26			
		Leptocheirus	0.26			
201-270		No sample			No sample	

White perch 76 to 150 mm TL were sampled from April through November. Chironomid larvae and Gammarus were predominant throughout this period (Table IV-25). During June, calanoid copepods became the most frequently consumed food item while fish eggs (unidentified) were consumed in relatively small numbers during May and June. In general, a variety of organisms were consumed and white perch 76 to 150 mm TL appeared to be eating the same food as smaller individuals (≤ 75 mm). Chironomid larvae and copepods were consumed frequently; however, Gammarus were eaten in larger proportions by fish 76 to 150 mm TL.

Larger white perch (151 to 200 mm TL) were collected from April-October but sample sizes were small (less than or equal to 9 per month) in this length group (Table IV-25). Throughout the season Gammarus and chironomid larvae were the most common items in white perch diet, and other organisms, including Cyathura and Leptocheirus were important food items in their diet during certain months. Fish eggs (clupeid) appeared only in June.

Previous studies (Taub 1966; Webster 1942/1943) found dipterans to be of major importance in the diet of juvenile, yearling and older white perch. Data from 1974 indicate that dipterans, especially chironomid larvae, are frequently eaten by all sizes of white perch in the Hudson River throughout the sampling season. Mean percent frequencies of chironomid larvae were very high in May, June, and July in the stomachs of white perch. Gammarus and copepods become increasingly important later and often had the highest percent frequencies in the stomachs of white perch during September, October and November. Taub (1966) also found cladocerans, copepods, and amphipods common food items for juvenile white perch in the Quabbin Reservior in Massachusetts. Juveniles in the Hudson River contained all of these food items, and the most common organisms eaten by fish in all length groups after August were copepods and amphipods. Unlike Taub's (1966) findings, fish and fish eggs were not predominant food items in yearling and older white perch, although fish eggs were consumed by white perch during May through July. Most fish eggs were not identified further except for clupeid eggs eaten during June by white perch 151 to 200 mm TL.

From the large variety of food items consumed by juveniles, yearlings and older white perch in the Hudson River, it is apparent that white perch are opportunistic feeders. Dipterans and crustaceans were the most common food items consumed (Table IV-25 and Appendix Table B-17). Few fish were consumed by white perch captured in beach seines during 1974 and there was no evidence of cannibalism or predation upon striped bass. However, during 1972, some white perch greater than 100 mm (TL) contained young-of-the-year white perch and striped bass (TI 1976c). White perch also preyed upon striped bass eggs during the 1972 spawning season (TI 1976c).

b. Growth

1) Early Life Stages

In this section, growth of young white perch during 1976 is described and compared to that of the 1975 year class. Since white perch spawn over an extended period of time (Subsection V.C.1.b.), changes in mean length used to evaluate growth in this section are affected by continuing recruitment of small fish. However, growth can still be evaluated by examining changes in mean length if cognizance is taken of this influence.

a) Methods

Growth of young white perch was evaluated with methods identical to those used for the 1973 to 1976 year classes of striped bass (Subsection IV-B.a.b.; McFadden 1977). Mean lengths of larvae were provided by LMS from their river transect sampling and were used together with data on juvenile length from the TI Beach Seine, Fall Shoals, and Interregional Bottom Trawl Surveys to estimate the mean length of individuals for each week. Such data were available from the time of first spawning (early May) until mid-December. Curves were fitted by eye for the young-of-the-year white perch population.

b) Results and Discussion

Growth of young white perch in both 1975 and 1976 produced a S-shaped curve when plotted against time (Figure IV-25). A similar pattern has been described for young striped bass (Subsection IV.B.2.b.). During

May and early June of 1976, growth was slow; it increased during late June and this rate continued through July. Growth rate decreased during August and little growth occurred from September through the end of the season. This pattern during 1976 was like that described for the 1976 year class of striped bass (Subsection IV.B.2.b.).

The 1975 year class of white perch grew more rapidly during the early growth phase than it did the 1976 year class. As a result, the mean length of the 1975 year class was 4 to 8 mm greater than that of 1976 year class during comparable periods. Differences in growth during early 1975 and 1976 may be related to differences in water temperature during this period. There is evidence to suggest that larvae hatched later in the season survived better than those hatched earlier (Subsection IV.C.3.b.). Most of the larvae contributing to the 1976 year class seem to have been from eggs spawned two to three weeks later than those of the 1975 year class. Thus, the apparent mean daily growth rate during early 1976 was depressed by the later appearance of relatively large numbers of young larvae. The same phenomenon affected a difference in the size of striped bass between the 1975 and 1976 year classes (Subsection IV.B.2.b.).

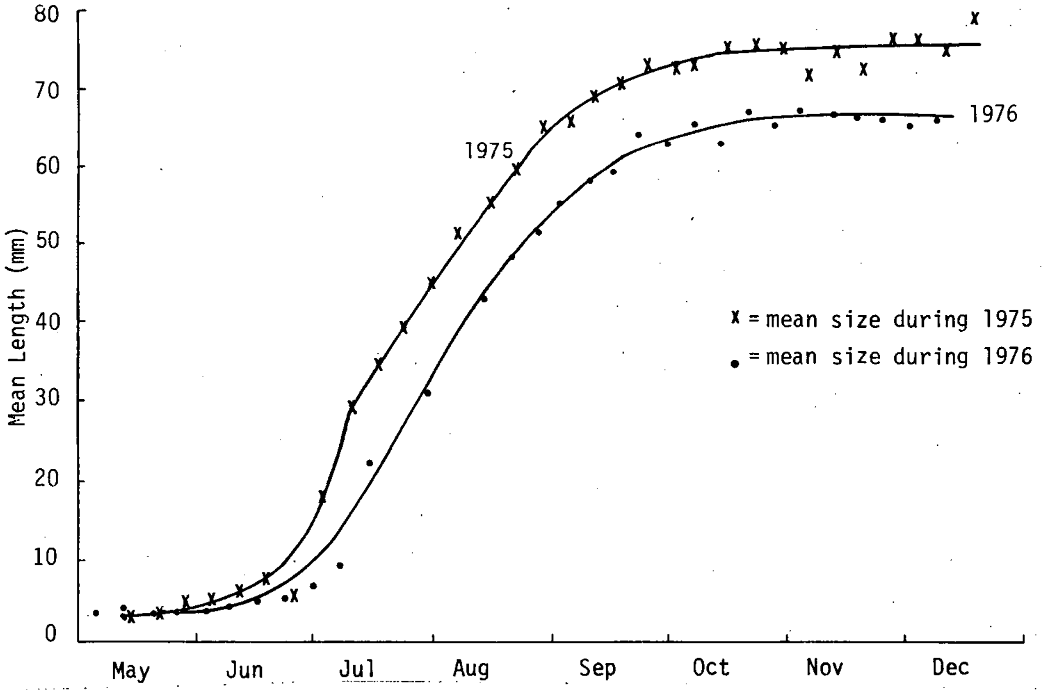


Figure IV-25. Estimates of Mean Total Length and Growth Curves for Larvae and Juveniles of 1975 and 1976 Year Classes of White Perch in Hudson River Estuary

During the succeeding phase of rapid growth, daily rates were similar in 1975 and 1976 but the difference of 4-8 mm in average length was maintained. However, the rapid growth phase continued later into the summer in 1975 than in 1976. White perch growth decreased during August of 1976, probably as a result of declining temperatures (Table IV-4). During this period the 4 to 8 mm length difference increased to 7 to 12 mm and this difference was maintained through the rest of the year. At the end of 1975, young-of-the-year white perch averaged 77 mm TL, whereas the average length at the end of 1976 was only 67 mm TL. Thus white perch growth was influenced by the length of the growing period and the temperature during that time.

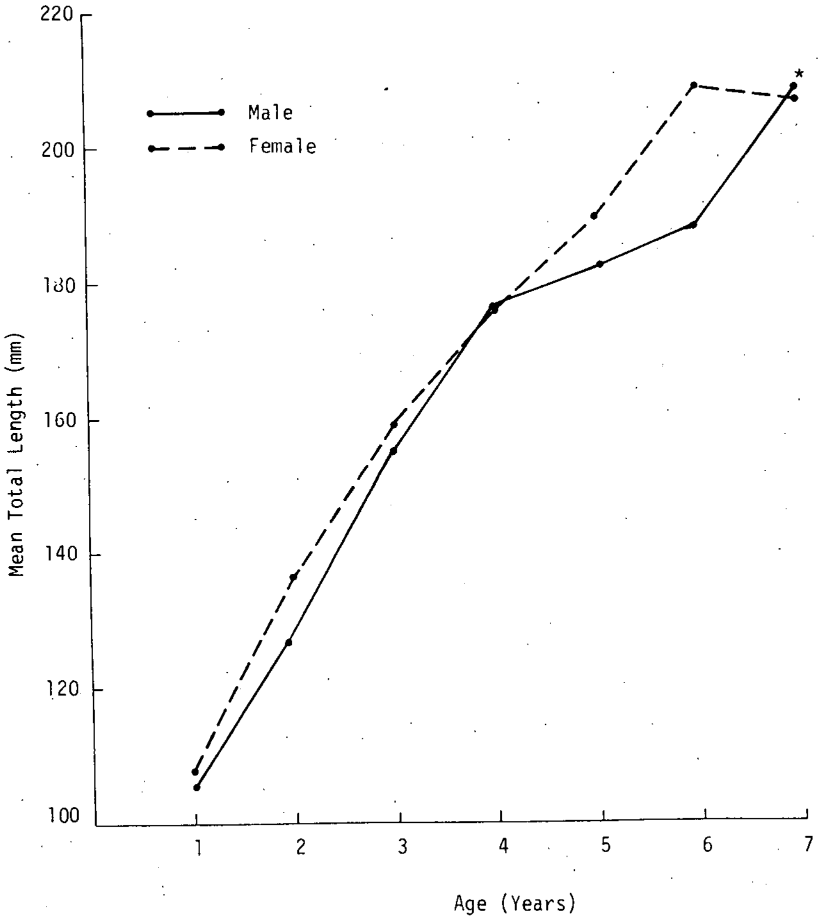
2) Adults

White perch were collected in the Hudson River estuary during May, June, and July in beach seines and bottom trawls and the length and weight of each fish were recorded and scales taken for subsequent age determination. The sex of randomly subsampled individuals was also determined. Length at the time of capture was plotted against age to evaluate growth of white perch in the Hudson River.

Generally, female white perch are significantly larger than males at a given age ($t = 2.60$; $P < 0.05$) (Figure IV-26; Table IV-26). Females attain a length of 208.1 mm (TL) compared to 188.1 mm (TL) for males by age VI (Table IV-26).

Several other studies (Taub 1966; AuClair 1956; Mansueti 1961b) have also shown that female white perch have a higher growth rate than males. Such sexual differences do not appear until age II in the Quabbin Reservoir, Mass. (Taub 1966) and age III in Sebasticook Lake, Me. (AuClair 1956). Taub (1966) attributed sexual differences in growth rate to the time of maturation; "Earlier maturing males utilize food conversion for gonad development at the expense of somatic growth at least one year before females. Consequently, females mature at least one year later than males and have an additional year of unrestricted somatic growth which contribute to the sexual difference" AuClair (1956) supported this position. This may also explain growth differences for white perch in the Hudson where males mature earlier than females (Subsection IV.e.2.d.).

To determine the annual growth rate for any age, the time of annulus formation must be known. The time is variable and occurs from mid-June to mid-July in Quabbin Reservoir (Taub 1966) to late March in Albermarle Sound, N.C. and the lower Roanoke River, N.C. (Conover 1958). The timing in the Hudson River is not known, but some spawning occurs in early to mid-summer, therefore the first annulus is probably not formed until the following summer. Therefore, fish collections in May through June were compared to other populations (Table IV-27) in making comparisons of the time of annulus formation.



*This point (i.e. 7 year old males) collected in April

Figure IV-26. Mean Length of White Perch Collected in Hudson River Estuary, May-July, 1976 Plotted against Age at Time of Capture

Table IV-26

Mean Total Length (mm) of White Perch Collected in Hudson River Estuary, May-July, 1976

Age	Male	Number	Female	Number
I	105.1	7	108.0	5
II	126.0	26	135.7	29
III	153.2	38	157.9	44
IV	174.0	30	175.6	41
V	179.3	42	188.7	33
VI	188.1	18	208.1	8
VII	207.5*	2	206.0	1
XI	——	NS	303.0*	1

*Fish collected in April

NS = No sample

Table IV-27

Mean Total Length (mm) at Annulus Formation for White Perch Collected from Various Locations (Male, Female and Unsexed Fish are Combined). Ranks for Friedman analysis are shown in parentheses ($X_r^2 = 15.7$, $P<0.001$).

AGE	HUDSON*	CONNECTICUT**	DELAWARE***	ROANOKE[†]	PATUXENT[‡]
I	87 (3)	87 (4)	83 (2)	69 (1)	89 (5)
II	128 (2)	179 (5)	134 (3)	106 (1)	137 (4)
III	154 (2)	225 (5)	158 (3)	146 (1)	164 (4)
IV	175 (2)	255 (5)	174 (1)	177 (3)	183 (4)
V	183 (1)	278 (5)	186 (2)	203 (4)	198 (3)
VI	194 (1)	308 (5)	196 (2)	227 (4)	219 (3)
Sum ranks	(11)	(29)	(13)	(14)	(23)

[†] Standard lengths (SL) from Marcy, 1976 were converted to total lengths (TL) for comparison using the equation: $TL = 1.57 + 1.2\ SL$.

*Texas Instruments current study

**Marcy (1976)

***Wallace 1971 (from Marcy 1976)

[†] Conover 1958 (from Marcy 1976)

[‡] Mansueti 1961 (from Marcy 1976)

There is a significant difference in the size attained at a given age for white perch from several estuarine systems (Table IV-27, $X^2r = 15.7$, $P < 0.001$). As Marcy (1976) noted, white perch from the Connecticut River grow faster than other populations. Hudson River fish tended to be intermediate in the size attained at a given age although age V and VI fish are smaller than fish of these ages in other systems. These differences could be related to food supply, water temperature, or unknown factors.

c. Sex Ratio and Age Composition

1) Sex Ratio

a) Methods

The sex of white perch greater than 150 mm TL was determined from subsamples of the catch from beach seines (shore zone) and bottom trawls (offshore) at standard stations near Indian Point from April through December (Section III) of 1975 and 1976. Additionally, during May, June, and July of 1975 and 1976, the sex of white perch greater than 100 mm TL was also determined from subsamples from the same gear types. The data were grouped by age (II through VI) within each gear type and by all ages combined within each gear type for each year.

The hypothesis of a 1:1 sex ratio, was tested with the following model (Steel and Torrie 1960):

$$Z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}}$$

where

$$\hat{p} = \frac{n_1}{n}$$

$$p = 0.5$$

$$q = 1-p$$

$$n = n_1 + n_2 \ (n_1 = \text{no. males};\ n_2 = \text{no. females})$$

b) Results and Discussion

The sex ratio of adult white perch, by age and all ages combined (in the shore zone) was not significantly different ($\alpha = 0.05$) from 1:1 during 1975 or 1976 (Table IV-28). The sex ratio for all ages combined from deeper offshore areas was not significantly different from 1:1 during 1976; however, during 1975 there were significantly fewer males than females caught in the offshore areas. The sex ratio of white perch caught by bottom trawl during 1975 was significantly different from 1:1 for all ages except age V. The 1976 bottom trawl data indicated significantly fewer males than females for age II and significantly more males than females for age VI. The sex ratios for ages III through V were not significantly different from 1:1. There is presently no explanation for the unequal sex ratio from the 1975 bottom trawl data. Other studies reported that the sex ratio of Hudson River white perch was approximately 1:1 (O and R 1977, and CHG and E 1977). In conjunction with the data from this study, these observations lead to the conclusion that the sex ratio of the Hudson River adult white perch population was not significantly different from 1:1.

2) White Perch Age Composition

a) Methods

White perch collected from standard station beach seines and bottom trawls during April through December were used to determine the age composition of the 1976 population. Scale samples for age determinations were removed from subsamples of yearling and older white perch (Subsection III.c.2.). No scales were removed from fish less than 50 mm TL which were assumed to be young-of-the-year. The data were grouped by gear and month for analysis.

b) Results and Discussion

The majority of white perch captured by beach seines in the shore zone during May and June were age I (Table IV-29). In July, large numbers of age 0 fish appeared in the shorezone, and from July through November these dominated beach seines catches. A generally decreasing trend of

Table IV-28

Test for Significant Differences in Percentage of Male White Perch by Age Group and Gear Type, 1975-1976

	1975								1976							
	Bottom Trawl				Beach Seine				Bottom Trawl				Beach Seine			
Age	Percent Male	Sample Size	Z	P†	Percent Male	Sample Size	Z	P†	Percent Male	Sample Size	Z	P†	Percent Male	Sample Size	Z	P†
2	32	146	-4.35	<0.0001*	45	87	-0.93	0.1762	34	87	-2.98	0.0014*	55	40	0.63	0.2643
3	37	120	-2.85	0.0022*	36	22	-1.31	0.0951	47	135	-0.70	0.2420	48	44	-0.26	0.3974
4	31	209	-5.49	<0.0001*	50	28	0	0.5000	50	111	0	0.5000	41	22	-0.84	0.2005
5	41	111	-1.90	0.0287	23	13	-1.95	0.0256	55	74	0.86	0.1949	44	16	-0.48	0.3156
6	30	23	-1.92	<0.0274*					75	24	2.45	0.0071*				
Combined	34.2	609	-7.90	<0.0001*	43	150	-1.71	0.0436	48	431	-0.83	0.2033	48	122	-0.44	0.3300

[†] Probability (P) of obtaining a more significant (higher) Z value than the calculated Z value (Steele and Torrie 1960:355)

*Indicates significant difference from 50% males at α = 0.05.

Table IV-29

Percentage Age Composition of White Perch Captured by Standard Station Beach Seine and Bottom Trawl during April—December 1976, Hudson River Estuary

	Age	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottom Trawl	0	—*	—	—	23.8	20.0	9.4	46.0	53.5	40.5
	1	72.8	66.9	23.4	16.2	26.7	20.9	25.4	34.6	43.1
	2	8.6	5.4	10.1	10.3	13.3	33.4	19.9	7.2	10.4
	3	12.2	5.8	19.0	16.6	21.3	20.5	5.4	3.0	4.9
	4	4.8	10.4	16.6	7.9	16.0	11.0	2.8	1.4	0.8
	5	1.3	10.0	20.3	14.2	—	4.7	0.5	0.3	0.3
	6	0.2	1.5	10.5	9.4	2.8	—	—	—	—
	7	0.2	—	—	1.6	—	—	—	—	—
Number Aged		379	179	122	72	75	126	344	372	340
Beach Seine	0	—	—	—	53.8	93.0	82.9	83.3	97.1	33.3
	1	13.3	65.7	75.8	40.4	6.4	14.7	13.9	1.0	33.3
	2	26.7	14.9	10.0	3.1	0.2	1.3	1.4	1.0	33.3
	3	26.7	9.0	8.3	1.9	0.3	0.7	1.4	—	—
	4	13.3	3.0	4.0	0.2	—	0.3	—	1.0	—
	5	6.7	6.0	2.0	0.3	—	0.2	—	—	—
	6	—	1.5	—	0.2	—	—	—	—	—
	7	6.7	—	—	—	—	—	—	—	—
	11	6.7	—	—	—	—	—	—	—	—
Number Aged		15	66	338	402	451	474	177	97	3

*Dashes indicate no fish aged.

occurrence for older white perch in the shore zone was apparent as the season progressed (Table IV-29). From April through June, age V and older white perch consistently appeared in the beach seine catches; however, from August through December, age V fish appeared only in September; age IV perch only in September and November, and age III fish occurred only through October. This suggests a movement by older white perch from the shore zone and presumably to deeper offshore areas.

From April through June, age I white perch predominated in bottom trawl catches. Young-of-the-year (age 0) white perch were caught in bottom trawls from July through December; however, the percentage of age 0 white perch remained low relative to beach seine catches (Table IV-29). Older white perch were consistently caught in the deeper, offshore areas sampled by bottom trawls. Except during August, age V fish were captured throughout the sampling season and age VI fish were captured from April through August.

In general, it appears that age 0 fish move to the shore zone in July and remain in large numbers relative to other age groups until November. During the latter part of the sampling season, older fish were less abundant in the shallow water and more abundant in the deeper, offshore areas than age 0 fish.

d. White Perch Age at Maturity

The age at which white perch mature was determined from subsamples of beach seine and bottom trawl catches collected during May and June of 1975 and 1976 (Subsection III.c.2.). Both the ratio of gonad weight to body weight and visual examination of the gonads were used to estimate maturity. Age was determined from scales and the data were grouped by age for each year.

The results indicate that male white perch mature faster than females (Table IV-30). An average of 1975 and 1976 data indicates by age II, 18% of females and 37% of the males were sexually mature. By age III approximately 83% of the females were mature, 95% by age IV, and 100% by age V. Approximately 76% of the males were mature by age III and 100% by age IV. These results are similar to earlier results (TI 1976c: V-32,33).

Table IV-30

Percentage and Number by Age of Sexually Mature Male and Female Hudson River White Perch, 1975-1976

		Age											
		II			III			IV			V		
Sex	Year	Percent Mature	Number Examined	Number Mature	Percent Mature	Number Examined	Number Mature	Percent Mature	Number Examined	Number Mature	Percent Mature	Number Examined	Number Mature
Male	1975	32	50	16	80	20	16	100	38	38	100	32	32
	1976	46	28	13	74	38	28	100	27	27	100	49	49
Average		37			76			100			100		
Female	1975	18	60	11	78	23	18	95	43	41	100	43	43
	1976	18	33	6	88	25	22	95	21	20	100	15	15
Average		18			83			95			100		

e. White Perch Fecundity

1) Methods

White perch from bottom trawl and beach seine catches during the months of May and June 1975 and 1976 were used to estimate fecundity. The fish were measured to the nearest gram (g) of total body weight and millimeter (mm) of total length. Both ovaries were removed, stored in 10% formalin, and later drained on paper towels and weighed to the nearest 0.01 g. Then a wedge-shaped sample weighing approximately 0.1 g was removed from a transverse section of the ovary taken midway along the long axis; the apex of the wedge approximated the central axis of the ovary. The sample was immediately weighed to the nearest 0.01 g and the eggs were manually separated from the ovarian connective tissue and counted. Since the minimum size at which eggs are likely to mature during a spawning season is unknown, eggs ≥0.2 mm diameter, as measured with an ocular micrometer, were assumed to be maturing and were included in fecundity estimates. The choice of 0.2 mm diameter was based on preliminary examination of frequency of egg diameters from ovary samples collected in May and June.

For each fish, the total number of eggs greater than or equal to the minimum diameter (0.2 mm) for each fish was estimated using the equation:

$$E = \frac{c}{w} W$$

where

E = estimated number of eggs greater than or equal to 0.2 mm in both ovaries

c = number of eggs in sample greater than or equal to 0.2 mm

w = weight of sample

W = weight of both ovaries

The $\log_{10}$ of the estimated number of eggs for each fish was regressed on the $\log_{10}$ of the total length (mm), on $\log_{10}$ of the total weight (g), or on age as follows:

$$\log_{10} E = \alpha + \beta \text{ (x)}$$

where

α and β are constants

$x = \log_{10}$ total length (mm) or
$\log_{10}$ total weight (g) or
Age of fish i

Pairwise comparisons (May versus May and June versus June) were made between years for the fecundity-length data sets and within each year (May versus June) for the fecundity-weight of fecundity-age data sets. Monthly regressions were compared since fecundity-length regressions from May and June 1975 were found to be significantly different ($\alpha = 0.05$; TI 1978a). Data were tested for homogeneity of group variance with Levene's test (Brown and Forsythe 1975) and for differences between regressions lines with analysis of variance (ANOVA).

2) Results and Discussion

No significant difference ($\alpha = 0.05$) was found for either the group variance or regression lines between the May 1975 and 1976 fecundity-length data sets. A significant difference ($\alpha = 0.05$) was found in group variances between the June data sets for the two years making a comparison of the June regression lines invalid. Therefore, the best available data on fecundity for Hudson River white perch are based on the regression using pooled data from May 1975 and May 1976 (Appendix Table B-18).

Fecundity estimates from Hudson River white perch have been made since 1972, however, differences in methodology precluded use of data prior to 1975. Holsapple and Foster (1975) reported on white perch fecundity data collected in 1972 for this study but egg counts included diameters greater than 0.1 mm as opposed to 0.2 mm used for later (1973-1976) estimates for this study. Fecundity estimates from 1973 and 1974 data used 0.2 mm as the minimum egg diameter to be counted, but an ocular micrometer was not used for all samples; therefore, estimates from 1973 and 1974 may not have been as accurate as the 1975 and 1976 estimates, for which an ocular micrometer was used for all samples.

Fecundity-length regression from this and other studies were not compared since observed differences in fecundity estimates may only reflect the minimum egg diameter chosen to estimate fecundity. Sheri and Power (1968) reported three distinct egg sizes in white perch from Lake Ontario. Taub (1969), working with white perch in Massachusetts, found a significant difference ($\alpha = 0.05$) among fish in the number of eggs per unit of weight. Taub attributed this to differences in egg size among fish and his only quantitative statement on egg size was that they were less than 1 mm. This study and Holsapple and Foster (1975) recognized a gradation in egg diameters and identified minimum diameters for inclusion to estimate fecundity.

An accurate estimate of fecundity for white perch must include all viable eggs that will be spawned by an individual during a spawning season. This is difficult to estimate with the data presently available. The current working hypothesis developed from this study (TI 1978a) provides that a mass of ova are activated for the approaching spawning season. However, only a portion of the ova mature and the majority are inhibited from maturation by a hormonal feedback mechanism. When the mature eggs are shed, a second group of ova begin to mature and the hormonal feedback mechanism is restarted. This cycle of maturation-inhibition may continue throughout the spawning season. There is evidence that a single female can ovulate over a period of at least 10 days (Mansueti 1964) which tends to support this hypothesis.

Fecundity as predicted by age was significantly ($\alpha = 0.05$) different for the months of May and June 1975. The fecundity-age relationship could not be tested for the same months of 1976 and because of differences in group variance, neither could the 1975 and 1976 fecundity-weight relationships.

Regressions of fecundity on age are not as desirable as regressions of fecundity on length for predicition of white perch fecundity. Wallace (1971) has shown length to be a poor index of age for white perch, indicating that age would be a poor indicator of fecundity.

The regressions of fecundity on weight can be misleading since a portion of the weight on which fecundity is regressed is the weight of the eggs. This in effect regresses eggs on their own weight, causing the correlation to be spurious (Bagenal 1967).

3. Population Dynamics

This section describes the population dynamics of larval, juvenile and older white perch collected in the Hudson River estuary. Estimates of the relative and absolute abundance and mortality rates for white perch during 1976 are presented. In addition, factors, both density-dependent and density-independent, affecting growth and abundance of juvenile white perch are investigated.

a. Abundance Trends and Population Estimate

1) Juvenile Abundance Trends

Trends in the juvenile white perch population from 1965 through 1976 were examined using a yearly index of abundance. This index is a relative measure of year-class strength over a 12-year period. Estimates of the actual numbers of juvenile white perch are discussed in Section IV.C.3.a.2. Factors which may affect abundance of juvenile white perch are examined in Section IV.C.3.d.

a) Methods

The catch per 10,000 ft^2 swept in beach seines from mid-July through August was used as the index of abundance for the years 1965 through 1976 (excluding 1971). A similar index covering more months of the year was calculated for the years 1969 through 1976. Statistical analyses of this alternate index provided the basis for judging the accuracy of trends evident in the 1965 through 1976 abundance index. Also, comparisons were made between yearling white perch abundance and juvenile abundance in the previous year.

(1) Calculation of Eleven-Year Abundance Index

The abundance index was calculated for juvenile white perch by the same technique used to calculate the juvenile striped bass index (Subsection B.3.a). Beach seine net sizes varied from 50 to 100 ft over the years for which the index was calculated (Appendix Table B-2). In order to standardize the catch among these gear, the catch-per-unit-area swept (scaled to 10,000 ft^2) was used as the index of year class abundance. The method for determining the area swept by each beach seine tow is given in Subsection IV.B.3.a. The mid-July through August period was chosen for the index, since juvenile white perch catches in seines increase about the middle of July (Figure V-46) and August was the latest month sampled consistently from 1965 through 1976 (excluding 1971 [Figure IV-27]). For each of the years 1969, 1970, and 1972 when sampling was not riverwide (Table IV-5), all available beach seine data were used to calculate the indices. No adjustments to the 1969, 1970, and 1972 data to approximate a more river wide estimate were made for the white perch abundance index as was done with the striped bass index because of the distribution patterns of white perch in the river. White perch juveniles were more evenly distributed in the river than striped bass, with high catches in the Tappan Zee through Croton-Haverstraw and Saugerties through Catskill regions, and moderate to low catches in the rest of the estuary (Figure V-44). Therefore, numbers of white perch taken in the lower half of the estuary should reflect trends throughout the estuary and preclude the need for an adjustment of 1969, 1970, and 1972 data.

(2) Seven-Year Alternate Index

Catches of juvenile white perch in beach seines remained high after the mid-July through August period used for the index (Figure V-45), so a July through October index (catch-per-unit-area) was calculated for the years 1969-1976 (excluding 1971). Beach seine sampling did not continue through October in years prior to 1969 (Figure IV-27). The July through October index was compared to the mid-July through August index to determine if the trends were similar. Statistical analysis of the differences among years using the mid-July through August data was impaired by the limited number of biweekly samples that were taken during the period covered by the index. However, the July through October index provided nine biweekly periods per

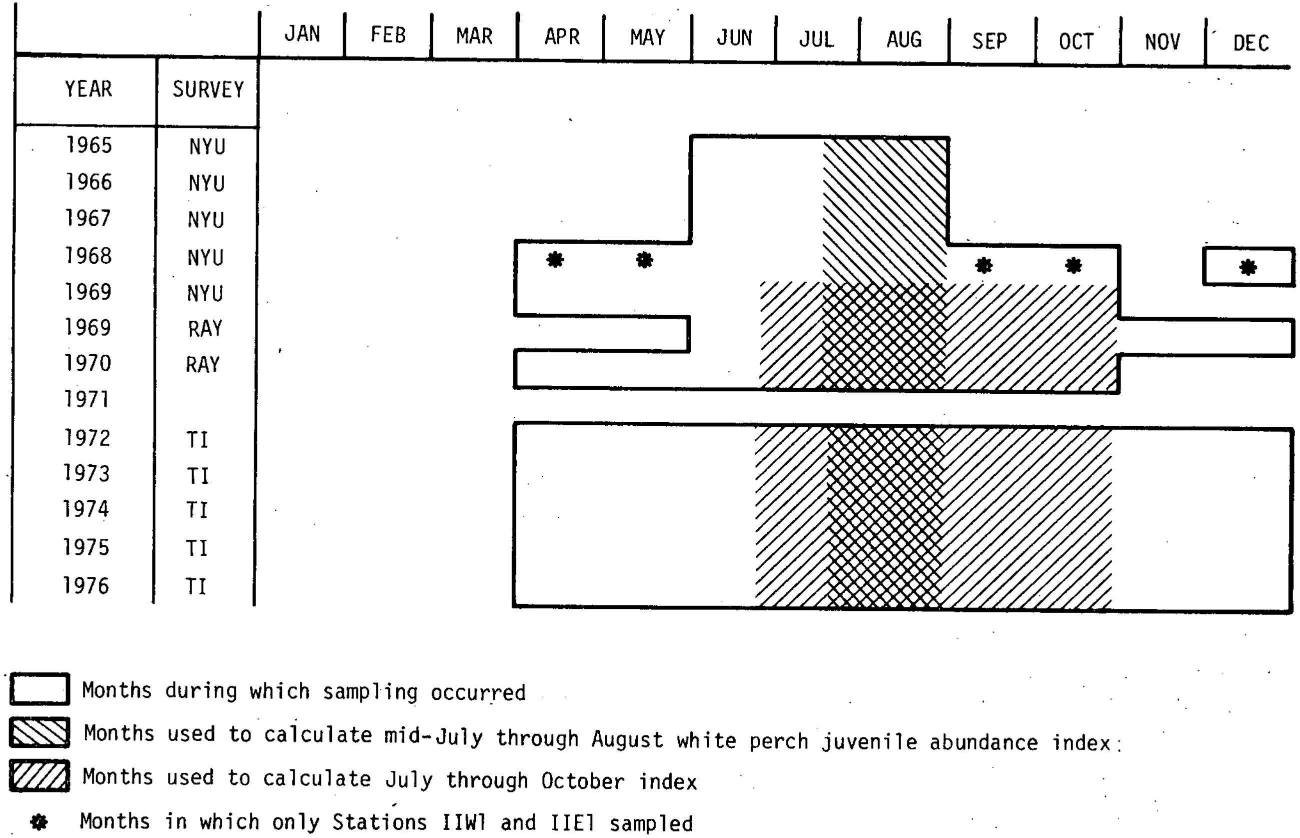


Figure IV-27. Beach Seine Sampling of Hudson River Estuary from 1965-1976

year and permitted the use of a Friedman analysis and multiple comparisons test (Appendix Tables B-19 and B-20, [Hollander and Wolfe 1973]) in the analysis of the index data.

(3) Juvenile Abundance versus Yearling Abundance in the Following Year

Juvenile white perch abundance over three years (1973-1975) was compared to the yearling abundance in each following year (1974-1976). Yearling abundances indices (CPUA) were calculated in the same manner and using the same time periods as were the juvenile abundance indices. This analysis was restricted to three data points because 1974 through 1976 were the only years when yearling catches were recorded separately from older age groups. Older white perch do not leave the river system and would contribute an unknown and varying number of individuals to the index, confounding the comparison of juvenile abundance and the yearling abundance in each following year.

b) Results and Discussion

(1) Juvenile Abundance Index (Eleven Years)

The juvenile white perch abundance index (Table IV-31) varied by a factor of 8.0, showing less variability over the eleven years than the striped bass index. Seven strong year classes (1966, 1967, 1969, 1970, 1973, 1975, and 1976), two intermediate (1965 and 1968), and two weak year classes (1972 and 1974) were evident (Figure IV-28), indicating a fairly stable level of annual juvenile abundance during the eleven years analyzed.

Table IV-31

Beach Seine Data Used to Calculate a Riverwide Index of Abundance (Catch per 10,000 ft^2) for Juvenile White Perch, Hudson River Estuary, 1965-1976 (excluding 1971)

Year	Survey	Sample Dates	Number Caught	Area Swept (ft^2)	Index of Abundance
1965	NYU	7/19-8/17	288	227,000	12.7
1966	NYU	7/13-8/24	661	356,225	18.6
1967	NYU	7/17-8/21	944	275,000	34.3
1968	NYU	7/15-8/19	464	389,700	11.9
1969	NYU & RAY	7/13-8/30	319	131,750	24.2
1970	RAY	7/12-8/29	946	426,272	22.2
1972	TI	7/16- 9/2	131	302,451	4.3
1973	TI	7/15- 9/8	4308	2,145,892	20.1
1974	TI	7/14- 9/7	1943	2,853,116	6.8
1975	TI	7/13- 9/6	9343	3,599,092	26.0
1976	TI	7/11- 9/4	9502	3,758,944	25.3

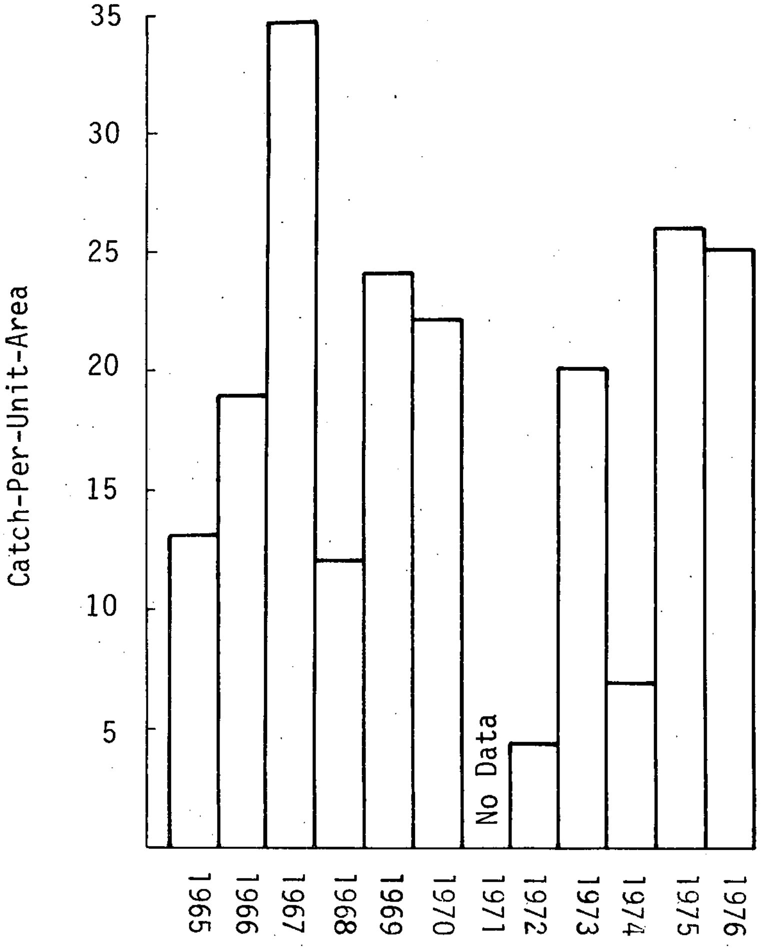


Figure IV-28. Juvenile White Perch Abundance Indices (Catch-Per-Unit-Area in Beach Seines), Mid-July through August, 1965-1976, Hudson River Estuary

(2) Alternate Index (Seven Years)

The two years of low white perch abundance (1972 and 1974) identified with the mid-July through August index were also reflected in the indices developed from catches during the period July through October (Figure IV-29). The Friedman distribution-free multiple comparisons analysis calculated from July through October data over the seven years 1969 through 1976 (excluding 1971 [Appendix Tables B-19 and B-20]) showed that the low abundance index in 1974 was significantly different (α=0.05) from 1969, 1970, and 1973 indices while the index in 1972 was significantly different (α=0.05) from 1969 and 1973 indicies. The 1972 and 1974 indices were not significantly different from the 1975 and 1976 indices (Figure IV-30). The similarity in trends between the two sets of indices supported the use of the mid-July through August time period to determine juvenile white perch abundances from 1965 through 1976 (excluding 1971).

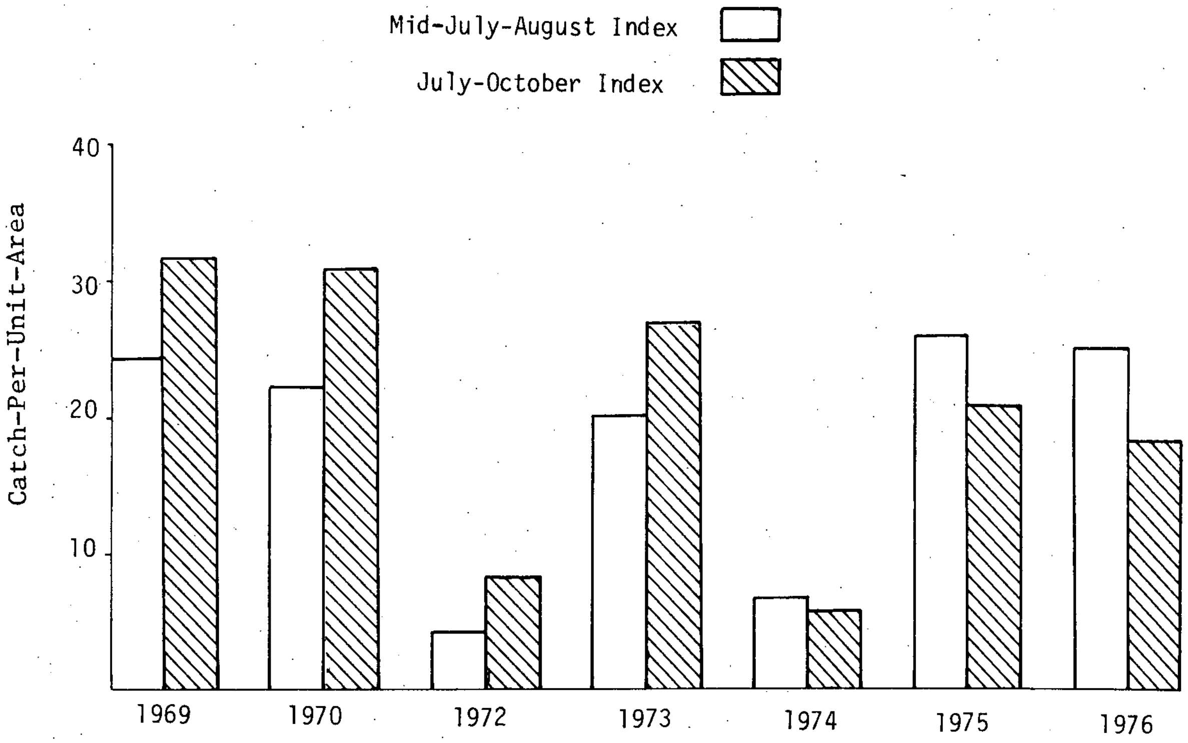


Figure IV-29. Comparison of Mid-July through August and July through October Indices of Juvenile White Perch Abundance (Catch-per-unit-area) in Hudson River Estuary 1969-1976 (excluding 1971)

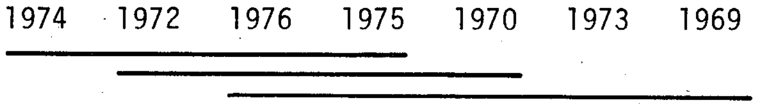


Figure IV-30. Results of Multiple Comparison Test of July-October Index of Abundance for Juvenile White Perch, 1969-1976 (excluding 1971), Hudson River Estuary (Those years between which no significant [$\alpha = 0.05$] difference exists are underlined)

(3) Juvenile Abundance versus Yearling Abundance in the Following Year

Years of high juvenile abundance (1973 and 1975) were followed by years of high yearling abundance and the year of low juvenile abundance (1974) was followed by relatively low yearling abundance (Table IV-32). This limited data set suggests that year-class strength is established during the juvenile life stage before the mid-July through August period.

2) Juvenile Population Estimates

In order to estimate the actual abundance of young-of-the-year white perch, the same basic sampling programs and analytical techniques used for striped bass (Subsection IV.B.3.a.) were applied. The two species are closely related and many aspects of their life histories are similar, but differences exist between their distributions, both among and within the sampling regions. The following sections examined the effects of these differences on the assumptions of the estimation procedures.

a) Methods

Both mark-recapture and density extrapolation methods were used to estimate juvenile white perch abundance. Sampling programs and procedures were identical to those described for striped bass (Subsection IV.B.3), but the night/day adjustment, 14-day survival rates, and beach seine efficiency adjustment were calculated specifically for white perch. A detailed discussion of biases in mark-recapture estimates of population size was presented in Subsection IV.B.3.

Table IV-32

Comparison of Juvenile and Yearling White Perch Annual Abundance Indices (Catch-per-unit-area) from Beach Seine Samples Collected from mid-July through August, 1973-1976, Hudson River Estuary

Year t	Juvenile CPUA	Year t + 1	Yearling CPUA
1973	20.1	1974	21.0
1974	6.8	1975	9.9
1975	26.0	1976	15.1

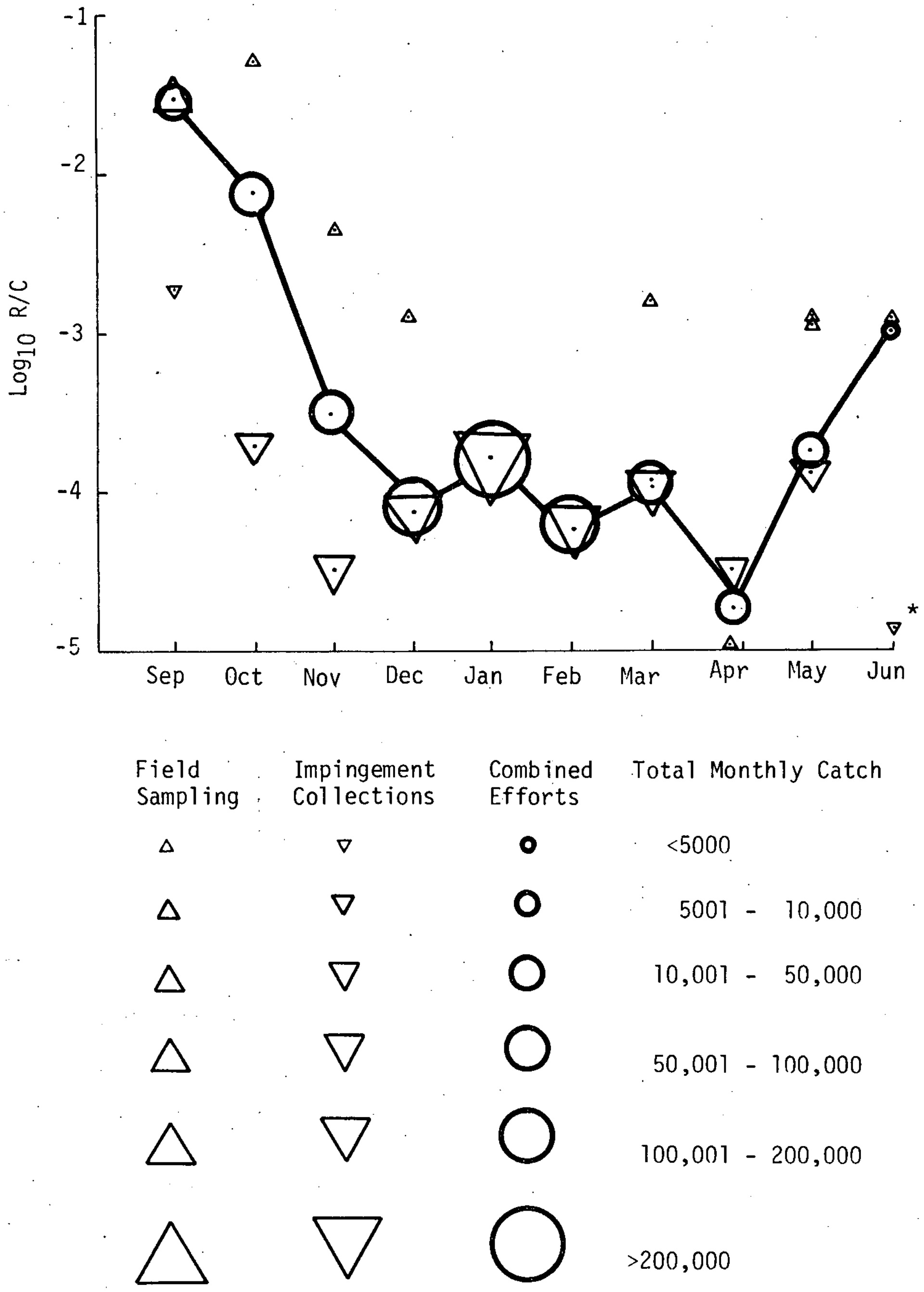
b) Results and Discussion

(1) Mark-Recapture

Corrections for Type A error (errors in intercept) in the mark-recapture data were also necessary for white perch (Appendix Table B-41). Survival adjustments, based on 14-day survival tests, were 1.0 for September and 0.95 for October and November (Appendix Table B-21). Other adjustments for Type A error (i.e. non-reporting of recaptured fish) were not considered necessary since only samples specifically examined for marked fish by TI and LMS were used for population estimation.

Type B error (incorrect slope) was not apparent but could have been present. The most likely source of error would be a higher than normal mortality of marked fish. However, a decline in R/C values caused by increased mortality of marked fish could not be distinguished from dispersal. Two other sources of Type B error, regeneration and emigration, were not likely. Regeneration was not seen as a significant problem since the recapture effort was concluded before July of the next year. Also, emigration of marked fish from the sampling area was not considered a problem since emigration had not been observed for juvenile white perch.

As with striped bass, Type C error (time-related distributional anomalies) was the most severe problem. The R/C (fraction of marked fish in the sample) values rose rapidly through September, then declined just as rapidly in October and November (Figure IV-31). The combined R/C ratio stabilized at 0.0001 through the winter months when impingement collections represented almost 100% of the combined sample. The stabilization of the R/C ratio indicated that mixing may have sufficiently reduced Type C error. Movement data derived from recaptured fish also indicated that mixing occurred during the winter months (Subsection V.C.4. and 5.). Fish captured in impingement collections during the winter (marked in fall) had moved into the Indian Point region from other regions in the middle estuary (RM 24-77 [KM 38-123]). Movement matrices for fish recaptured from January through June 1977 indicated that fish marked in September were dispersed relatively



* R/C = 0.00

Figure IV-31. Observed Fraction of Marked Juvenile White Perch in Sample (R/C) for September 1976 through June 1977. (Recaptures and total catch from TI field sampling and Indian Point impingement collections in 1976. For 1977 [January through June], impingement collections at Bowline, Lovett, Roseton, and Danskammer power plants are also included [Data from Appendix Table B-22]) well (Table IV-33). The recapture rates, R/M, for fish released in September were approximately equal (Table IV-33), which suggested that fish released in all five regions were being sampled with the same intensity. All recaptures occurred in only two regions. This was not unusual, since the vast majority of the catch occurred in impingement collections in regions 2 and 3. Fish released in October and November (Tables IV-34 and IV-35) exhibited wider variations in recapture rates, and the recapture sample was not considered to be random with respect to these groups of releases. As a result, the September releases were used for the population estimate.

Table IV-33

Mark-Recapture Data for Juvenile White Perch Released in September 1976 and Recaptured January-June 1977 in Hudson River Estuary (Recapture effort included all TI field sampling programs and impingement collections at Bowline*, Lovett*, Indian Point, Roseton, and Danskammer power plants)

	Recovery Region (j)							
Release Region (i)	(1) RM 12-23 KM 19-37	(2) 24-38 38-61	(3) 39-46 62-74	(4) 47-76 75-122	(5) 77-152 123-243	R_i	M_i	R_i/M_i
(1) 12-23 19-37	--	--	1	--	--	1	40	0.0250
(2) 24-38 38-61	--	2	24	--	--	26	9227	0.0028
(3) 39-46 62-74	--	--	14	--	--	14	3107†	0.0045
(4) 47-76 75-122	--	1	6	--	--	7	2126	0.0033
(5) 77-152 123-243	--	--	--	--	--	0	468	0.0000
R_j	0	3	45	0	0			
C_j	149	32336	620806	17743	353			
R_j/C_j	0.000	0.00009	0.00007	0.000	0.000			

R_i = number of fish marked in region i that were recovered Jan through Jun 1977

M_i = number of fish marked in region i that were available for recapture on Jan 1 1977

R_j = number of marked fish recovered in region j Jan through Jun 1977

C_j = number of fish examined for marks in region j Jan through Jun 1977

*Samples from which yearling and older fish were not differentiated were not included in these analyses.

†Some fish with the Sep Region 3 fin clip combination were actually released in Region 2. These fish have been included in the M_i value for Region 2 (RM 24-38)

Table IV-34

Mark-Recaptue Data for Juvenile White Perch Released in October 1976 and Recaptured January-June 1977 in Hudson River Estuary (Recapture Effort Included all TI Field Sampling Programs and Impingement Collections at Bowline*, Lovett*, Indian Point, Roseton, and Danskammer Power Plants)

	Recovery Region (j)							
Release Region (i)	(1) RM 12-23 KM 19-37	(2) 24-38 38-61	(3) 39-46 62-74	(4) 47-76 75-122	(5) 77-152 123-243	R_i	M_i	R_i/M_i
(1) 12-23 19-37	-	-	-	-	-	0	38	0.0000
(2) 24-38 38-61	-	3	7	-	-	10	3009	0.0033
(3) 39-46 62-74	-	-	6	-	-	6	2886	0.0021
(4) 47-76 75-122	-	1	5	-	-	6	509	0.0118
(5) 77-152 123-243	-	1	-	-	-	1	202	0.0050
R_j	0	5	18	0	0			
C_j	149	32336	620806	17743	353			
R_j/C_j	0.000	0.00015	0.00003	0.000	0.000			

R_i = Number of fish marked in region i that were recovered Jan through Jun 1977
M_i = Number of fish marked in region i that were available for recapture on Jan 1 1977
R_j = Number of marked fish recovered in region j Jan through Jun 1977
C_j = Number of fish examined for marks in region j Jan through Jun 1977

*Samples from which yearling and older fish were not differentiated were not included in these analyses.

Table IV-35

Mark-Recapture Data for Juvenile White Perch Released in November 1976 and Recaptured January-June 1977 in Hudson River Estuary (Recapture Effort Included all TI Field Sampling Programs and Impingement Collections at Bowline*, Lovett*, Indian Point, Roseton, and Danskammer Power Plants)

	Recovery Region (j)							
Release Region (i)	(1) RM 12-23 KM 19-37	(2) 24-38 38-61	(3) 39-46 62-74	(4) 47-76 75-122	(5) 77-152 123-243	R_i	M_i	R_i/M_i
(1) 12-23 19-37	-	-	6	-	-	6	55	0.1091
(2) 24-38 38-61	-	1	2	-	-	3	299	0.0100
(3) 39-46 62-74	-	-	10	-	-	10	1653	0.0060
(4) 47-76 75-122	-	-	1	-	-	1	36	0.0278
(5) 77-152 123-243	-	-	1	-	-	1	13	0.0769
R_j	0	1	20	0	0			
C_j	149	32336	620806	17743	353			
R_j/C_j	0.000	0.00003	0.00003	0.000	0.000			

R_i = Number of fish marked in region i that were recovered Jan through Jun 1977
M_i = Number of fish marked in region i that were available for recapture on Jan 1 1977
R_j = Number of marked fish recovered in region j Jan through Jun 1977
C_j = Number of fish examined for marks in region j Jan through Jun 1977

*Samples from which yearling and older fish were not differentiated were not included in these analyses.

+Some fish with the Nov region 3 fin clip combination were actually released in region 2. These fish have been included in the M_i value for region 2 (RM 24-38 [KM 38-61])

A Petersen Population Estimate of juvenile white perch in the Hudson River estuary was calculated based on a September 1976 release period and January through June 1977 recapture period. Recapture samples were taken from TI field collections and impingement collections at Bowline, Lovett, Indian Point, Roseton and Danskammer power plants. The following equation was used:

$$\hat{N} = \frac{M \cdot C}{R}$$

where

M = number of marked fish available for recapture = 14,968

C = number of fish examined for marks = 671,000

R = number of marked fish recaptured = 48

$\hat{N}$ = estimated population = 209.2×10^6

The 95% confidence interval (Poisson Method, Ricker 1975) is $157.9 \times 10^6 - 284.6 \times 10^6$. This population estimate is much higher than previous mark-recapture estimates for juvenile white perch (TI 1978b). The estimate for the 1976 year class applies to September, while estimates for other year classes were based upon fish marked in October and November.

A population estimate as large as 209 million juvenile white perch was checked by converting the estimate to a measurement of biomass per surface area. If the 209 million white perch were multiplied by 2.75 gm, the mean weight of juveniles in September 1976 (TI 1978a), and the result divided by the surface area of the river (RM 12-152) in hectares ($\sim$29,200), the biomass is 20 kg/ha. When compared to densities of other perciform fishes (Table IV-36), this estimate does not seem unreasonable even though densities, expressed as biomass per surface area, are generally higher for ponds and small lakes than for large lakes and rivers. If the species listed are comparable to white perch, the standing crop of 20 kg/hectare for juvenile white perch in the Hudson lies within the ranges for lakes and streams in North America. Hence, the estimate of 209 million juvenile white perch in September 1976 is reasonable.

Table IV-36

Biomass of Centrarchid Fishes Reported in Handbook of Freshwater Fishery Biology (Carlander 1977)

Species	Location	Biomass (kg/ha)	Primary Source
Lepomis macrochirus	Ill. - ponds	112-194	Buck and Thoits 1970
	Ore. - ponds	101-260	Buck and Thoits 1970
	Ky. - ponds	353-744	Buck and Thoits 1970
	Mich.- Mill R.	49	Schneider 1973
	Ind. - Wyland L.	98 (June) 72 (annual ave.)	Gerking 1962
L. megalotis	Ind. - White R	21.4 - 53.9	Benda and Proffitt 1974
L. microlophus	Okla.- ponds	5.3	Whiteside and Carter 1973
Micropterus dolomieu	Lakes	11-342 20-40 (most frequent value)	Haines 1973
	Ill. - ponds	29.6-189.4	Buck and Thoits 1970
	N.Y. - ponds	51 - 163	Regier 1962
	Wisc.- streams	3.7-82.9	Paragamian and Coble 1975
	Ohio - streams	3.3-13.5	Paragamian and Coble 1975
	Ill. - streams	32.8	Paragamian and Coble 1975
	Mo. - streams	8.6-8.9	Paragamian and Coble 1975
	Md. - streams	17.9	Paragamian and Coble 1975
M. punctulatus	Ind. - White R.	39.1-82.2	Benda and Proffitt 1974
M. salmoides	North America, lakes and rivers	16.8 (mean)	Bennett 1971
	Mich.-Third Sister L.	14.2	Brown and Ball 1943
	Mich.-Wintergreen L.	53.9	Fetterolf 1952
	Mich.-Lakes	0.2-21.3	Ball 1948
	Okla.-L. Carl Blackwell	1.4	Zweiacker 1972
	Ga. - L. Lanier	4.9-12.6	Heman et al 1969
Pomoxis annularis	Ind. - White R.	29.8-38.5	Benda and Proffitt 1974
	Tex. - Meridian L.	36.5	Rutledge and Barron 1972

(2) Density Extrapolation

The density extrapolation method produced a combined standing crop estimate of 11 million juvenile white perch in mid-August (Figure IV-32). After mid-August, the standing crop declined until mid-October when shoal and bottom standing crops climbed to over 6 million. The shift in distributing from the shore zone to shoal and bottom in late October was evident in the standing crop estimates.

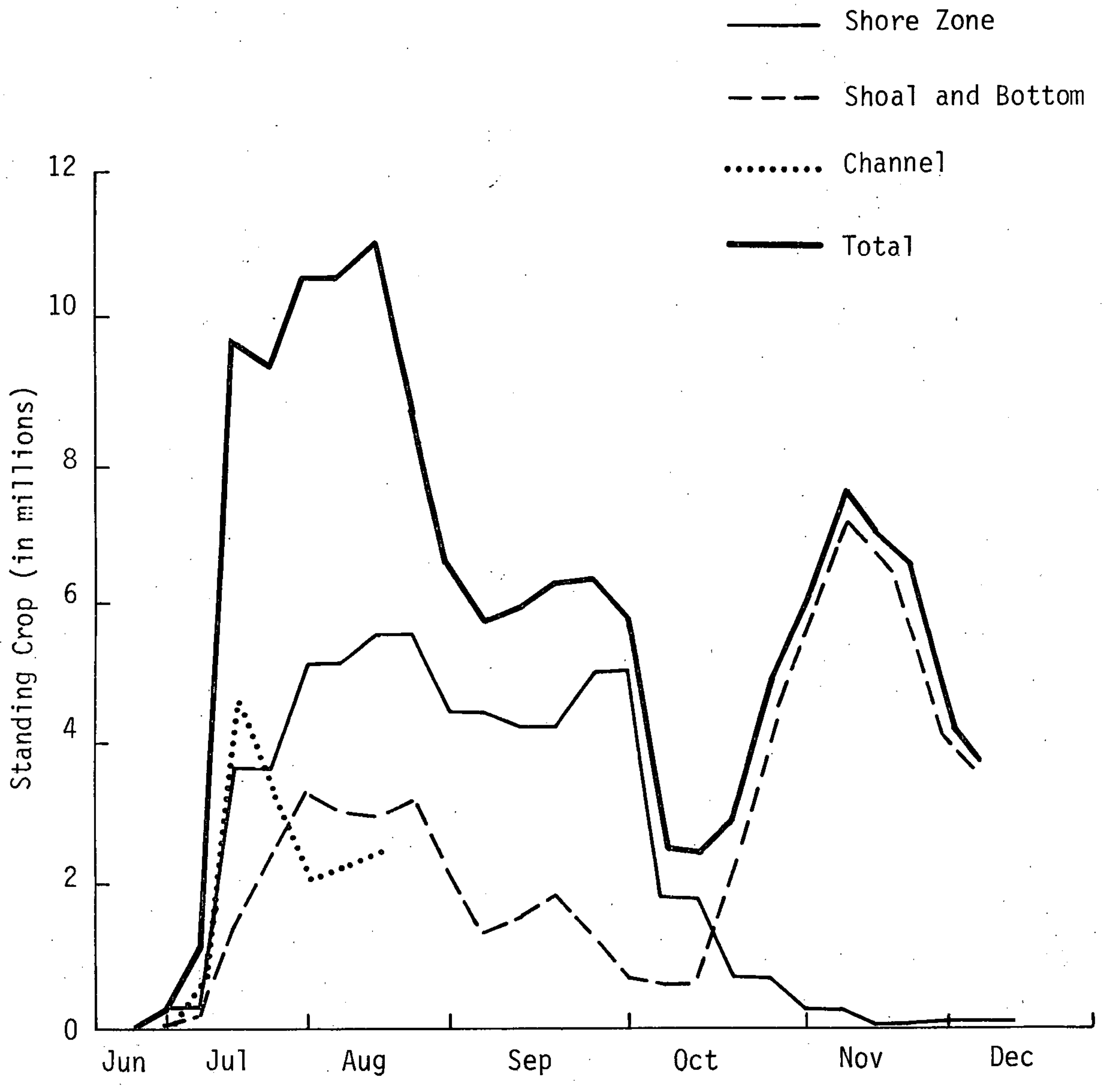


Figure IV-32. Combined Standing Crops of Juvenile White Perch in Hudson River Estuary, June through December 1976 (Data from Appendix Table B-23)

By comparison with the estimates of population size from the mark-recapture study, the combined (unadjusted) standing crops are of limited value as an absolute estimate of population size for juvenile white perch. The rapid decline in standing crops immediately after the change in sampling programs (Aug 15-21) suggested that large numbers of juvenile white perch were present in the areas that were no longer being sampled (i.e. above RM 77 and in the channel stratum). The channel standing crops were larger than 2 million fish when channel sampling was discontinued.

A test of efficiency of the 100-ft (30.5-m) beach seine was conducted during September through November 1977 (TI 1978b) and showed that shore zone standing crop estimates based upon daytime sampling averaged less than 7% of the true population size there. If increased nighttime densities are due to distributional phenomena and not increased sampling efficiency, the shore zone standing crops could be approximately 14-fold higher than estimated. At present, no data are available on the catch efficiency of the epibenthic sled and Tucker trawl, but the assumption of 50% efficiency used for striped bass (Subsection IV.B.3) may also be reasonable for white perch. Using these assumptions about sampling gear efficiency, the estimate of peak standing crop for juvenile white perch (August 8-14) would increase from 11 million to 93 million. This is still substantially less than the mark-recapture estimates, possibly due to the large portions of the estuary that are unsampled after mid-August (offshore areas upstream from the Poughkeepsie region). Thus the density extrapolation methods are at best an estimate of only a portion of the population of juvenile white perch in the Hudson River estuary.

b. Mortality Estimates

1) Early Life Stages

White perch spawn for an extended time period throughout the Hudson River estuary (Subsection V.C.1.a.). Accurate estimates of the absolute abundance of white perch larvae and early juveniles have proven difficult to obtain (Subsection IV.C.3.a.). As a result, estimates of mortality rates through an analysis of temporal patterns in abundance are unreliable. In this section, patterns in the abundance of white perch larvae and juveniles during 1976 are discussed and estimates of mortality between juvenile (young-of-the-year) and yearling stages previously presented (TI 1977f) are reviewed.

a) Methods

The abundance of larvae and juveniles during 1976 was estimated by combining larval standing crops from the Ichthyoplankton Survey with the combined juvenile standing crops (Subsection IV.C.3.a.). The juvenile standing crops reflect populations in the shore zone throughout the estuary, but shoal and bottom standing crops were estimated only for the Yonkers through Poughkeepsie regions. White perch, unlike striped bass, are abundant throughout the estuary (Subsection V.C.1.a.), and since a portion of the estuary (shoal and channel strata) is unsampled after mid-August, these combined standing crops are probably underestimates of the white perch 1976 year class (Subsection IV.C.3.c.). Despite this problem, changes in the standing crops over time can provide insight into the patterns of mortality in the early life stages of white perch. To investigate the relationship between size and survival in white perch larvae, weekly length-frequency histograms were calculated using data from river transect sampling provided by LMS.

b) Results and Discussion

Standing crops of white perch larvae and juveniles during 1976 (Table IV-37) declined from more than 2 billion in late June to approximately 4 million at the end of the first year (Figure IV-33). As noted earlier, these standing crops may be substantial underestimates. Based on these declines in standing crops, mortality rates were highest during the larval stages and declined through the juvenile stage. Assuming the same distribution and relative catchability from all sizes of larvae and juveniles, the rate of decline from the period of peak abundance (late June) through mid-December was 3.6% day^{-1}.

Temporal patterns in the abundance of eggs, yolk-sac larvae, and post yolk-sac larvae indicated that, as with striped bass, survival within each life stage differed through the season (Figure IV-34). There were two distinct peaks for both white perch egg and yolk-sac larval abundance. The

Table IV-37

Standing Crops* of White Perch Larvae and Juveniles, 1976, Hudson River Estuary

Week	Yolk-Sac Larvae	Post Yolk-Sac Larvae	Juveniles	Total
4/25-5/1	6,235,000	13,000		6,248,000
5/2-8	25,977,000	1,134,000		27,111,000
5/9-15	85,486,000	12,326,000		97,812,000
5/16-22	292,892,000	77,372,000		370,264,000
5/23-29	83,922,000	137,918,000		221,840,000
5/30-6/5	60,098,000	30,207,000		90,305,000
6/6-12	116,627,000	442,733,000		559,360,000
6/13-19	149,997,000	1,708,436,000		1,858,433,000
6/20-26	17,723,000	2,080,263,000		2,097,986,000
6/27-7/3	663,000	675,509,000	282,000	676,454,000
7/4-10	279,000	205,945,000	1,059,000	207,283,000
7/11-17		189,160,000	9,512,000	198,672,000
7/18-24		30,729,000**	9,214,000	39,943,000
7/25-31		4,992,000	10,444,000	15,436,000
8/1-7		787,000**	10,484,000	11,271,000
8/8-14		124,000	10,962,000	11,086,000
8/15-21			8,708,000	8,708,000
8/22-28			6,662,000	6,662,000
8/29-9/4			5,749,000	5,749,000
9/5-11			5,963,000	5,963,000
9/12-18			6,238,000	6,238,000
9/19-25			6,367,000	6,367,000
9/26-10/2			5,842,000	5,842,000
10/3-9			2,550,000	2,550,000
10/10-16			2,458,000	2,458,000
10/17-23			3,146,000	3,146,000
10/24-30			4,948,000	4,948,000
10/31-11/6			6,072,000	6,072,000
11/2-13			7,651,000	7,651,000
11/14-20			7,063,000	7,063,000
11/21-27			6,681,000	6,681,000
11/28-12/4			4,402,000	4,402,000
12/5-11			3,627,000	3,627,000

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*With catch efficiency of sampling gear assumed to be 100 percent.

**Geometric mean interpolation from two adjacent weeks

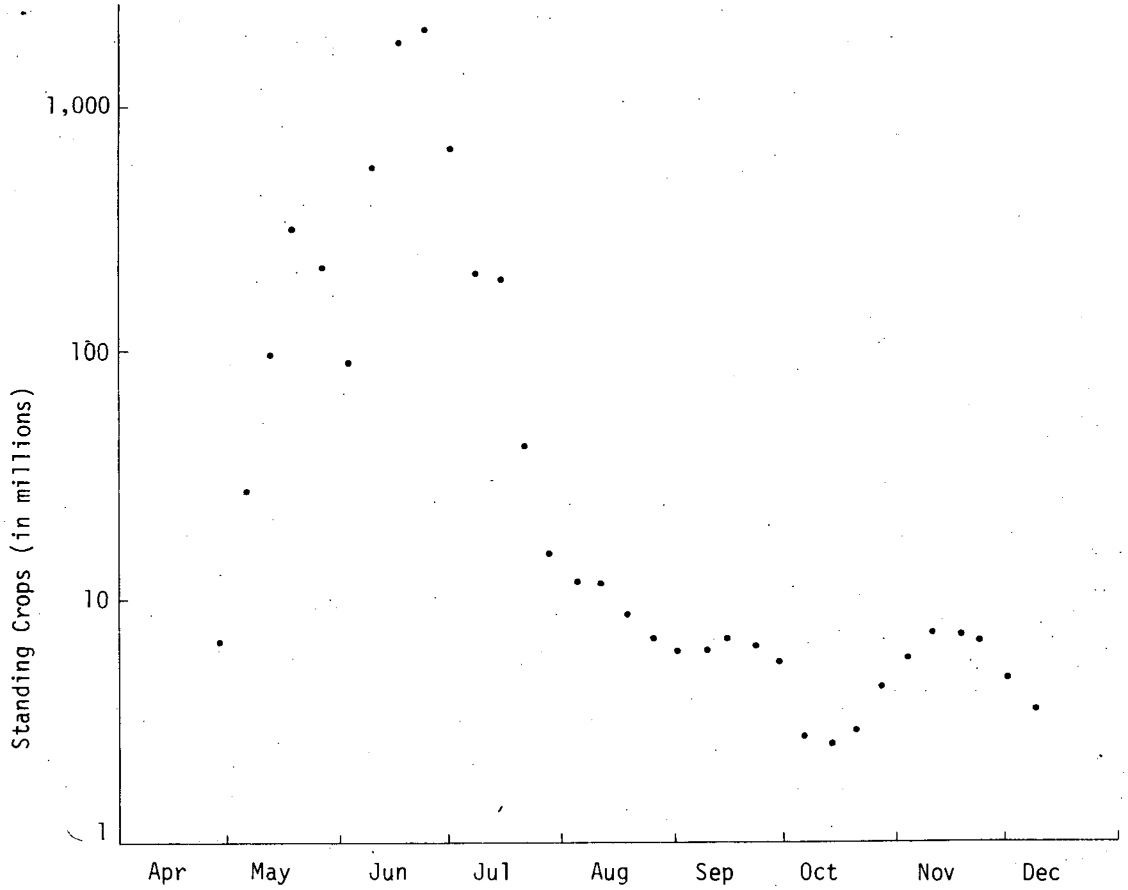

Figure IV-33. Relationship between Estimated Population Size and Time for 1976 Year Class of Hudson River White Perch during Larvae and Juvenile Stages

bimodal pattern in the abundance of eggs and yolk-sac larvae suggests two distinct spawning periods that can be related to the water temperatures during this period, a pattern discussed in detail for striped bass (Subsection IV.B.3.b.). White Perch post yolk-sac larval abundance showed a small increase slightly after the first peak in yolk-sac larval abundance but most post yolk-sac larvae were collected following the second peak in yolk-sac larval abundance. This pattern suggests that larvae from the first spawn experienced high mortality during the yolk-sac stage and that most of the individuals surviving to the post yolk-sac stage were from the second spawn.

Weekly length-frequency histograms for larvae provided further evidence of high mortality following the first peak in spawning (Figure IV-35). During the period May 2 through 29, few larvae greater than 5 mm were evident even though large numbers of white perch eggs were collected during that period. This suggests that the temperature drop to 12°C during this period was lethal to the developing larvae. In June, when water temperatures rose steadily and many individuals greater than 5 mm were collected, only a unimodal length-frequency distribution was evident.

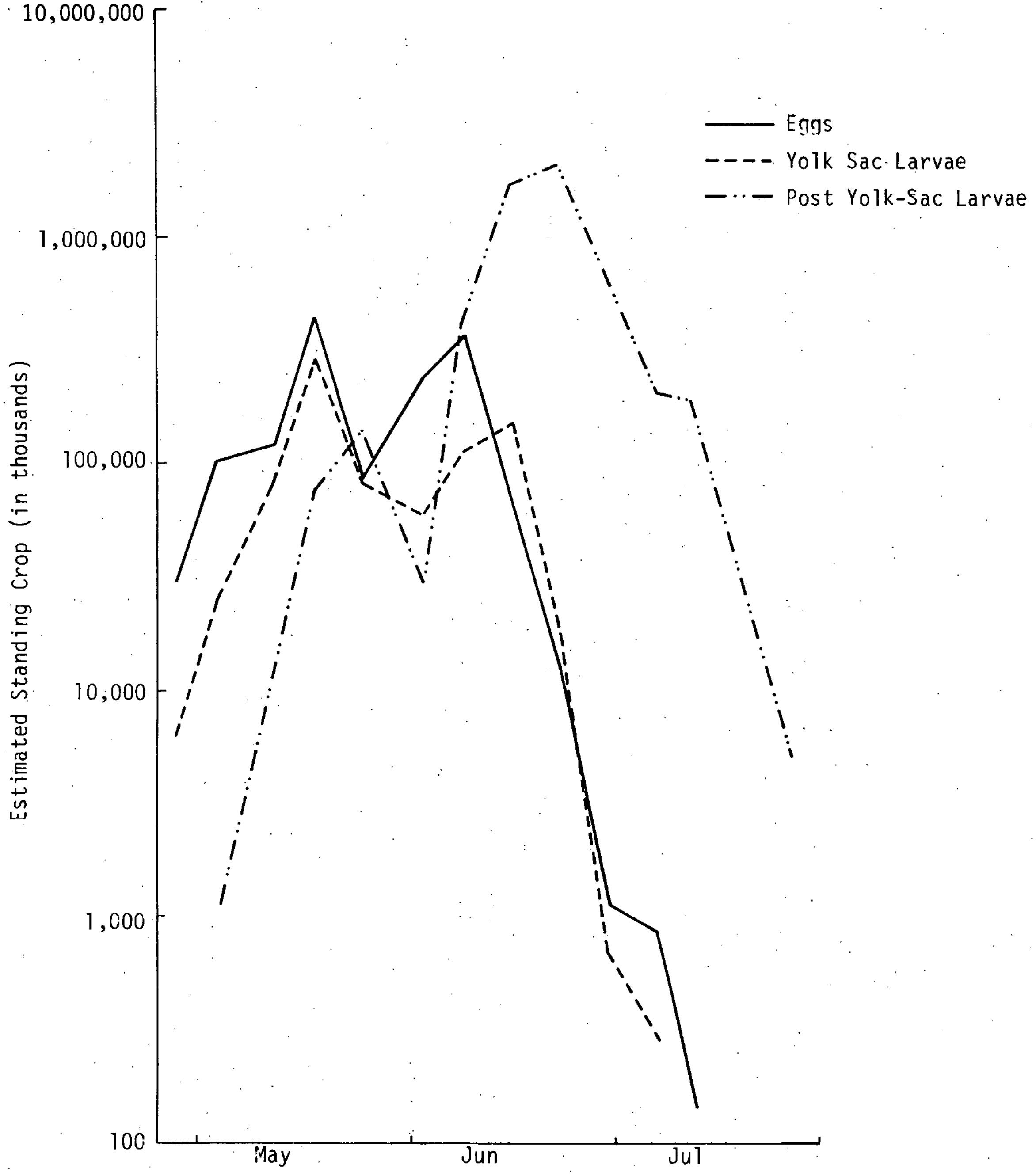

Figure IV-34. Standing Crops of Eggs, Yolk-Sac Larvae, and Post Yolk-Sac Larvae of 1976 Year Class of White Perch in Hudson River Estuary

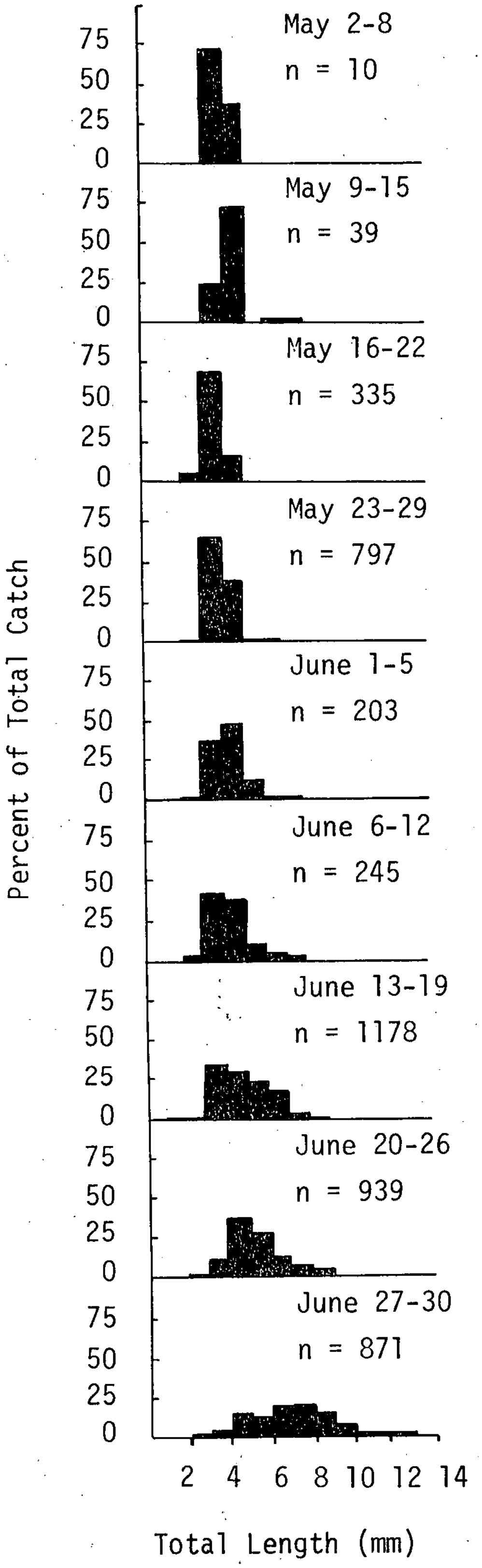

Figure IV-35. Weekly Length-Frequency of White Perch Larvae Collected by LMS in River Transect Sampling near Bowline, Lovett, Roseton and Danskammer Power Plants, 1976

The pattern in the weekly length-frequency distributions for young white perch in May and June of 1976 was similar to that described for striped bass (Subsection IV.B.3.c.). However, the size at which mortality apparently occurred was greater for striped bass (7 mm) than for white perch. Since the transition from the yolk-sac to the post yolk-sac stage in white perch occurs at a smaller size ($\sim$4 mm) than in striped bass (McFadden 1977), this decline in relative abundance by size apparently coincided in both species with the transition from yolk-sac to post yolk-sac stage and first feeding. Thus, the "critical period" hypothesized by May (1974) could have occurred at this time, and the extreme mortality experienced by white perch could have been related to lack of available food due to low temperatures. This hypothesis is further discussed in Subsection IV.C.3.b.

Estimates of white perch mortality from the end of the juvenile stage (October through December) to end-of-the-yearling age (October through December of the next year) were presented in an earlier report (TI 1977f). In that report, an annual mortality rate of 89% (0.6% day^{-1}) was obtained using catch curve analysis. While mortality rates based on catch-curve analysis can be severely affected by differences in relative year-class strength and catchability between two age groups (Ricker 1975), this mortality estimate is similar to the estimate of 75% (0.4% day^{-1}) presented in Central Hudson (1977). The 89% value is also similar to the juvenile mortality rate (0.5% day^{-1}) for striped bass (Subsection IV.B.3.b.), a closely related species.

2) Adults (Yearling and Older Age Groups)

a) Methods

Total annual mortality of yearling and older white perch during 1976 was estimated by catch-curve analysis of age-composition data collected in bottom trawls (16-mm mesh liner in cod-end) from October to December at the Indian Point standard stations (Section III). The age composition of each sample was weighted by the total catch of each sample and summed over the three months.

A least squares regression technique described the linear relationship

$$\ln N_i = \alpha - \beta t$$

where

N_i = number of age-i individuals collected

α, β = constants

t = age in years

From this regression, total annual mortality was determined as follows:

$$A = 1-e^{-i}$$

where

A = total annual mortality

e = 2.71828..., base of natural logarithm

i = slope (β) = instantaneous mortality rate from linear regression $\ln N_i = \alpha - \beta(t)$ (see above)

The data for the three years were tested for homogeneity of variance (Brown and Forsythe 1974) and a common regression line ($\alpha_1 = \alpha_2 = \alpha_3$, $\beta_1 = \beta_2 = \beta_3$) using analysis of variance (ANOVA).

b) Results

The annual mortality estimate for the common regression line was calculated to be 0.66 (Table IV-38). The null hypothesis of a common variance and regression line, as tested by ANOVA, for the three years of white perch catch-curve data (Appendix Table B-40) was not rejected (α = 0.05; F = 2.68 for variance, F = 1.96 for regression). A discussion relating 1974 and 1975 white perch mortality estimates (Table IV-38) from this study to estimates from other studies was presented in an earlier report (TI 1978a). The mortality estimates from TI's 1976 study are generally higher than estimates reported from the Delaware River (0.54 for males and 0.58 for females) by Wallace (1971), estimates reported from the Patuxent River estuary (0.55 for both sexes) by Mansueti (1961b), and other estimates

Table IV-38

Regression Analysis and Annual Mortality Estimates for White Perch Caught during October-December in Bottom Trawls, 1974-1976, Hudson River Estuary

Parameter	1974	1975	1976	Three Years Combined
Intercept (α)	6.08442	6.01005	7.06477	6.31172
Slope (β)	-1.17955	-0.97459	-1.17655	-1.07822
Correlation Coefficient (r)	-0.91755	-0.97800	-0.98939	-0.93401
Annual Mortality (A)	0.6926	0.6227	0.6917	0.6598

reported from the Hudson River estuary (0.56) by O and R (1977). A reanalysis of the data from Wallace (1971:210) on a monthly basis (to coincide with times of capture in this study), however, showed that the mortality rates are similar (0.70 for Wallace vs 0.65 to TI's study [TI 1977g, 1978a]). Differences in mortality estimates can reflect differences in methodology as well as real differences in population behavior. The methodology used for TI's study is preferred because it considers the seasonal change in the distribution of yearling and older white perch. There is an apparent consolidation of yearling and older white perch in deep water during the fall and winter and this is the best time to sample the population (see Subsection IV.C.2.d.) to estimate mortality rates with catch-curve analysis.

c. Factors Influencing Juvenile Growth

This section presents the analysis and discussion of factors influencing growth of white perch juveniles in the Hudson River estuary. Since growth and mortality are often interrelated, analysis of factors influencing growth can provide insight into the mechanisms regulating juvenile white perch abundance. Estimates of growth for juveniles are discussed and related to water temperature, freshwater flow, and abundance of juveniles during mid-summer.

1) Methods

The procedures used for the analysis of factors influencing juvenile white perch growth are identical to those used for juvenile striped bass presented earlier (Subsection IV.B.3.d.). Weekly mean total lengths determined from the beach seine data base for the years 1965 through 1976 (excluding 1971) were regressed against time to estimate instantaneous growth rates for the July through August period. These estimates of instantaneous growth rate were related to juvenile white perch abundance, mean water temperature and mean freshwater flow during July and August using partial correlation analysis.

To investigate the effect of environmental factors on larval and juvenile growth before July and August, estimates of the mean total length of juveniles on August 1 were predicted from the linear regression of size and time. These estimates of August mean length were related to mean water temperature and mean freshwater flow for May through July using partial correlation analysis.

2) Results and Discussion

Instantaneous growth rates derived from weekly mean total lengths for July and August varied from a low of 0.0034 in 1972 to a high of 0.0222 in 1973 (Table IV-39), more than a six-fold difference. The weekly mean total lengths of July and August (Appendix Table B-24) cover the period of rapid growth for juvenile white perch as demonstrated in the assessment of larval and juvenile growth rates during 1975 and 1976 (Subsection IV.C.2.b.). While the correlation coefficients for the natural log of the mean length versus time for white perch were substantially lower than those for striped bass, the coefficients were greater than 0.80 in eight years of the eleven year study period (Table IV-39).

Table IV-39

Results of Linear Regression of Natural Log of Mean Total Length and Time (instantaneous growth) for Juvenile White Perch during July-August, 1965 through 1976 (excluding 1971), Hudson River Estuary

Year	Instantaneous Growth (Slope β)	Intercept (α)	Correlation Coefficient (r)	N (Sample Size)
1965	0.0154	3.390	0.976	4
1966	0.0164	3.138	0.886	6
1967	0.0160	2.964	0.730	5
1968	0.0133	3.174	0.793	7
1969	0.0118	3.475	0.968	7
1970	0.0129	3.387	0.948	7
1972	0.0034	3.436	0.568	5
1973	0.0222	2.909	0.992	4
1974	0.0204	2.940	0.989	8
1975	0.0177	3.237	0.986	9
1976	0.0181	2.982	0.992	4

As with striped bass, the instantaneous growth rates of juvenile white perch during July and August showed little relationship with either mean temperature, mean freshwater flow, or juvenile abundance during the same period (Figure IV-36). The strongest partial correlation was between growth and abundance (Table IV-40; $r = 0.27$); however this relationship was not significant ($\alpha = 0.05$). This weak, positive correlation between abundance and growth is opposite the pattern described for striped bass although neither correlation was strong. These results offer no evidence for density dependent growth in white perch juveniles during July and August. A discussion of the difficulty in detecting significant relationships between growth and density was presented in Subsection IV.B.3.c.

The mean length of the juvenile white perch population on 1 August predicted from the linear regression of length and time varied from a low of 31.8 mm (TL) in 1967 to a high of 47.8 mm (TL) in 1965 (Table IV-41). The predicted mean length on August 1 showed a strong positive relationship with

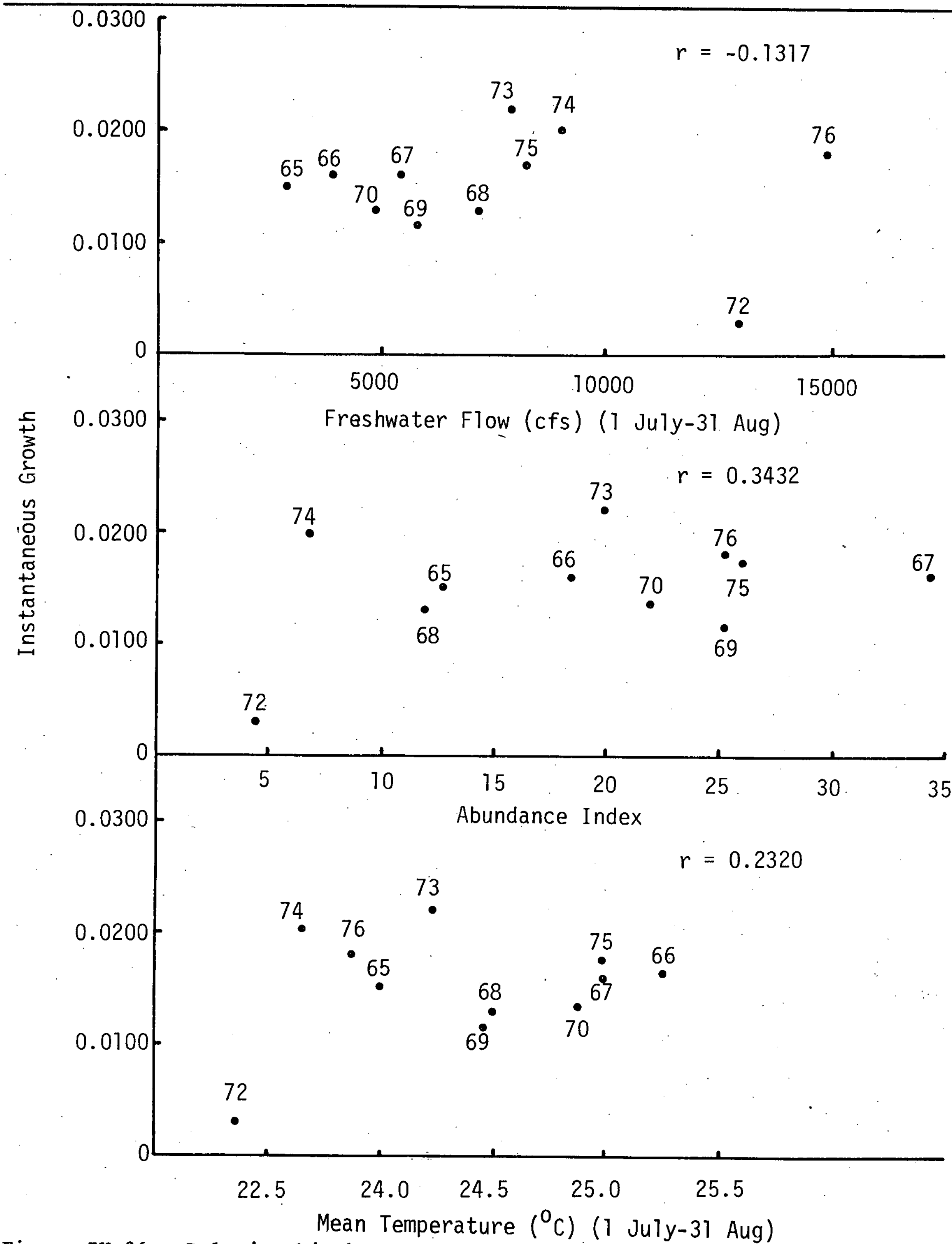

Figure IV-36. Relationship between Instantaneous Growth Rate of Juvenile White Perch and Juvenile Abundance, Mean Water Temperature and Mean Freshwater Flow during July-August of 1965-1976 (excluding 1971) in Hudson River Estuary (Data presented in Appendix Table B-25)

Table IV-40

Partial Correlation Analysis of Juvenile White Perch Instantaneous Growth Rates Versus Juvenile Abundance, Mean Water Temperature and Mean Freshwater Flow during July-August, 1965-1976 (excluding 1971), Hudson River Estuary

Variable Correlated with White Perch Juvenile Instantaneous Growth Rate	Variable held constant Through Partial Correlation	Partial Correlation Coefficient (r)
Juvenile Abundance Index	Mean Freshwater Flow Mean Water Temperature	0.2696 (P=0.43)
Mean Freshwater Flow	Juvenile Abundance Index Mean Water Temperature	-0.0739 (P=0.83)
Mean Water Temperature	Juvenile Abundance Index Mean Freshwater Flow	-0.0321 (P=0.92)

Table IV-41

Predicted Mean Total Length of Juvenile White Perch Population on 1 August, 1965-1976 (Excluding 1971), Hudson River Estuary

Year	Predicted Mean Total Length (mm) on 1 August	Year	Predicted Mean Total Length (mm) on 1 August
1965	47.8	1970	44.1
1966	38.3	1972	34.5
1967	31.8	1973	36.5
1968	36.1	1974	35.6
1969	46.6	1975	44.1
		1976	34.6

mean May through July water temperatures and a negative relationship with mean May through July freshwater flow (Figure IV-37). The partial correlation between mean length and temperature was highly significant ($P < 0.01$); however the partial correlation between freshwater flow and mean length was not significant at $\alpha = 0.05$ (Table IV-42). The relationships between environmental factors and growth in juvenile striped bass and white perch were quite similar during late spring and summer; both showed strong positive relationships between mean size on August 1 (reflecting growth during May through July) and temperature during the early life stages. Because of these similar patterns and because the two species are closely related, it is reasonable to hypothesize similar explanations for both white perch and striped bass (Subsection IV.B.3.d.). We propose that the time at which the surviving white perch larvae were spawned was affected by water temperatures during May (Subsection IV.C.2.b) resulting in a shorter growing season and smaller juveniles in 1976 than in 1975. Since growth of striped bass was enhanced by elevated temperatures during June 1975, it is reasonable to assume a similar effect on white perch. Therefore, the significant correlation between mean length on August 1 and temperature during May through July for juvenile white perch could reflect the effects of temperature on both survival and growth during May through July.

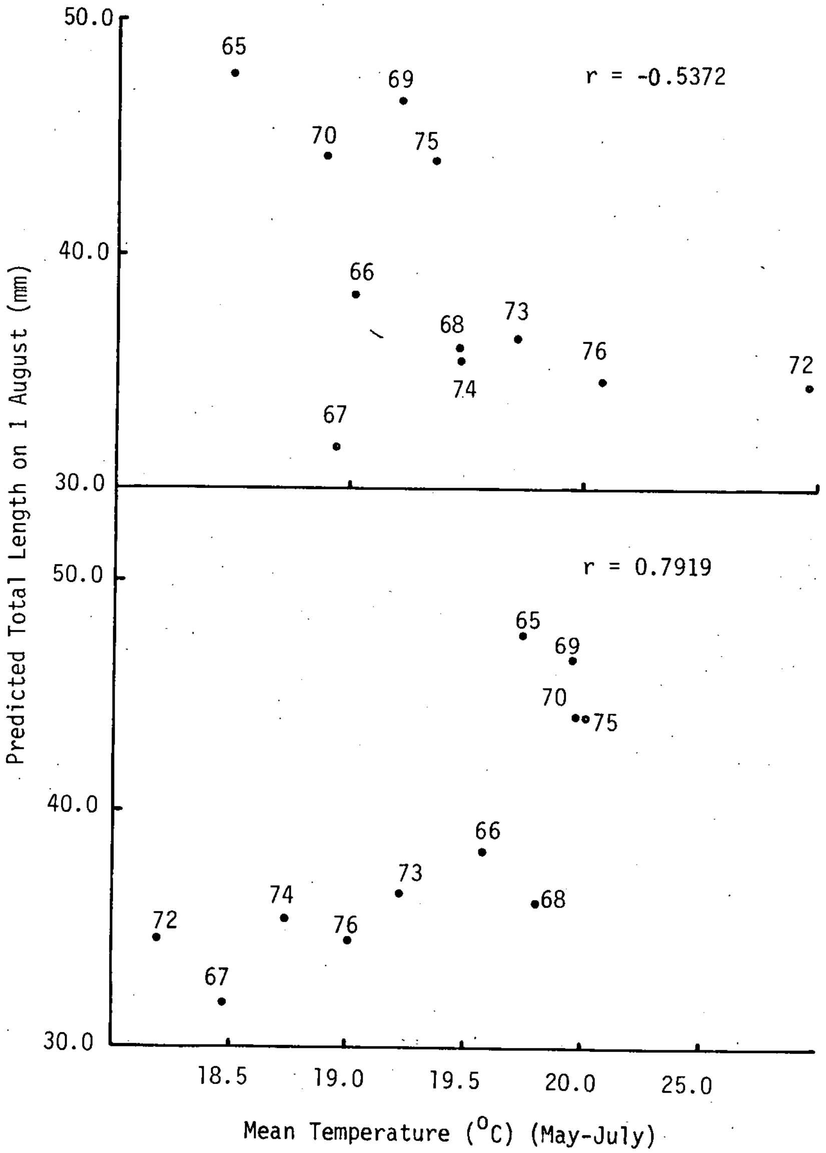

Figure IV-37. Relationship between Predicted Total Length of Juvenile White Perch on 1 August and May through July Mean Water Temperature and Freshwater Flow, for 1965 through 1976 (Excluding 1971), Hudson River Estuary (Data in Appendix Table B-26)

Table IV-42

Partial Correlation Analysis of the Predicted Total Length of White Perch on August 1 Versus Mean Water Temperature and Mean Freshwater Flow during May-July, 1965-1976 (excluding 1971), Hudson River Estuary

Variable Correlated with the Predicted Total Length of White Perch Juveniles on 1 August	Variable Held Constant through Partial Correlation	Partial Correlation Coefficient
Mean May-July Water Temperature	Mean May-July Freshwater Flow	0.7007 (P=0.02)
Mean May-July Freshwater Flow	Mean May-July Water Temperature	-0.1727 (P=0.61)

d. Factors Influencing Year-Class Abundance

The relationship between juvenile white perch abundance during July and August in 1965-1976 (excluding 1971) and various environmental factors was analyzed using latent root regression (Webster, Gunst, and Mason 1974). Latent root regression is a variation of ordinary least squares linear multiple regression, a technique commonly used to assess the relationships among a dependent variable and several independent variables (Ricker 1975). Factors influencing white perch year-class strength were previously analyzed by latent root regression (TI 1978a). The advantage of latent root regression over ordinary least squares regression (the ability to correct for linear dependencies among the environmental factors) was explained in earlier reports (McFadden 1977; TI 1978a). The benefits of latent root regression as an inductive tool and the restrictions limiting its use as a predictive model are further explained in Subsection IV.B.3.d. of this report.

1) Selection of Independent Variables

The large number of potentially important independent variables was reduced by prior selection to maintain an adequate number of degrees of freedom with 11 years of available data (i.e., a total of 11 observations). Ricker (1975) suggested that when selecting independent variables, preference be given to those most likely to affect the species directly (as determined from previous studies) and to those for which accurate quantitative measurements are available over the time period being studied. Factors evaluated for entry in the regression included physical factors (freshwater flow and ambient temperatures), biological factors (predators and competitors), and the quantity of water used by power plants for cooling purposes (as an index of potential entrainment and impingement mortality).

An initial selection of environmental variables was made in the 1975 Year-Class Report (TI 1978a) and the rationale for the original choice of these variables was also discussed therein. The data sets for the variables entered into that regression, plus the 1976 data points, are presented in Table IV-43. Latent root regression on data collected through 1975 retained four variables as important influences on juvenile white perch abundance: striped bass juvenile abundance, May freshwater flow, July freshwater flow, and degree rise per day between 16 and 20°C. Of the three remaining variables, two (bluefish abundance and June freshwater flow) had relatively high simple correlation coefficients ($r = -0.514$ and -0.486 respectively) with juvenile white perch abundance (TI 1978a), but were not retained by the latent root regression.

These six variables were chosen again for examination in latent root regression with the 1976 data points included. The seventh variable, power plant water withdrawal (an index of potential entrainment and impingement mortality), was also entered into the regression, since this report concerns potential effects of power plants on Hudson River fish species.

2) Results and Discussion

Four factors were selected by latent root regression as influencing the abundance of juvenile white perch: May freshwater flow (negative), June freshwater flow (negative), striped bass juvenile abundance (positive), and the days to span 16 to 20°C (negative; Table IV-44). These factors in combination explained 51.8% of the variation in juvenile white perch annual abundance. The factors selected are the same as those chosen using ordinary least squares regression, although the weights in the predictive equation are different (Appendix Table B-27).

Table IV-43

Juvenile White Perch Abundance (Dependent Variable) and Environmental Factors (Independent Variables) Entered in Latent Root Regression

Year	Juvenile White Perch*	Juvenile Striped Bass*	Bluefish Index*	May Flow** (ft^3)	June Flow** (ft^3)	July Flow** (ft^3)	Days to Span 16°-20°C	Power Plant Water Withdrawals (m^3 x 10^3/day)
1965	12.69	1.19	0.26	8309	3573	3082	13	3143
1966	18.56	8.20	0.00	18406	8270	3674	9	3712
1967	34.33	4.22	0.07	17061	6197	5075	10	3712
1968	11.91	1.31	0.15	18487	15707	9795	21	4529
1969	24.21	30.72	0.08	20913	9995	5430	19	5183
1970	22.19	15.91	0.77	14546	6387	5997	22	5183
1972	4.33	9.23	3.70	40522	29630	18379	15	5183
1973	20.08	28.55	1.28	27603	13053	10390	8	12019
1974	6.81	9.51	4.71	22965	8791	11784	26	14113
1975	25.96	18.27	2.97	19999	12973	7464	9	15873
1976	25.28	11.28	3.41	31800	15223	15277	9	20616

*Based on beach seine catch per unit area for riverwide samples from mid-July through August.

**Mean daily freshwater inflow at Green Island Dam, Troy, New York, according to the United States Geological Survey records.

Table IV-44

Results of Latent Root Regression Analysis of Six Selected Environmental Factors* on Juvenile White Perch Abundance in Hudson River Estuary, 1965-1976 (excluding 1971)

Source	Degree of Freedom	Sum of Square	Mean Square	F	R^2
Regression	3	422.37	140.79	2.51	0.518
Error	7	392.45	56.06		
Total	10	814.82			

Regressor	Modified T Statistic
Juvenile Striped Bass Abundance	1.27
May Freshwater Inflow	-2.02
June Freshwater Inflow	-1.50
Days to Span 16°-20°C	-1.95

Prediction Equation Using Standardized Regressors:

$$Y = 32.38 + 0.30X_1 - 0.00028X_2 - 0.00027X_3 - 0.73X_4$$

where

Y = Predicted White Perch Juvenile Abundance
X_1 = Striped Bass Juvenile Abundnace
X_2 = May Freshwater Inflow
X_3 = June Freshwater Inflow
X_4 = Days to Span 16°-20°C

Although over one half of the variability can be explained by the four factors mentioned, some random error will always remain. The R^2 value (0.518) and the nonsignificant F statistic (2.51) indicate that either all important environmental factors were not tested, or that some of the variables tested influenced abundance in a non-linear fashion.

Three of the four variables selected were the same as those previously chosen for the previous 10 years of data (TI 1978a). July flow, previously retained by the regression using ten years of data, was replaced by June flow. The simple correlation coefficent between July flow and juvenile white perch abundance declined from -0.626 with ten years of data to -0.444 with eleven years of data (Appendix Table B-28). The simple correlation coefficients for the three freshwater flow variables are still quite high (r = +0.881 for May versus June, + 0.911 for May versus July, and + 0.852 for June versus July; Appendix Table B-29). Since May, June and July flows all have a negative relationship with juvenile abundance, and since they are highly correlated, these late-spring/early-summer flows are probably interchangeable in their value for predicting year-class strength in white perch.

The two variables deleted from the regression were power plant water withdrawal and bluefish abundance. Power plant water withdrawal was removed artificially because of the positive relationship for which no biological mechanism was evident. Also, the simple correlation coefficient between power plant water withdrawal and juvenile white perch abundance was quite low (r = +0.135) (Appendix Table B-28), and the sign for it had changed since the regression was run with data only through 1975 (r = -0.011; TI 1978a). These results indicate that the amount of water withdrawn by power plants was not related to juvenile white perch abundance.

Bluefish juvenile abundance had a lower simple correlation coefficient with juvenile white perch abundance after the addition of 1976 data (r = -0.394 through 1976, Appendix Table B-28; r = -0.514 through 1975, TI 1978). Apparently, bluefish have influence both on weak and occasional white perch. Bluefish predation pressure would undoubtedly vary from year to year depending upon the relative abundance of available species within the bluefish prey species complex and upon bluefish abundance.

3) Possible Mechanisms for Observed Influences of Selected Variables

May, June, and July freshwater flow could affect white perch year-class abundance through the same mechanism or mechanisms each month, or through different mechanisms operating during different time periods. For example, a direct effect would occur if increased turbidity impaired sight feeding by post yolk-sac larvae and juveniles. If one lifestage was more sensitive to turbidity (e.g. post yolk-sac larvae), the negative influence would be exerted mainly during the peak abundance of that stage. However, another mechanism (such as siltation and smothering of eggs) may have overlapping influences with peaks at a different time. Also, if the time of spawning varies between years due to temperature (which is interrelated with flow), then a particular life stage (and the maximum flow rate effect) could occur in different months during different years. Freshwater flow could also have an indirect effect by influencing the abundance or distribution of food organisms. This indirect effect could work simultaneously with the direct effects. Mansueti (1961b) noted a negative relationship between February through May rainfall and the growth of juvenile white perch in the Patuxent estuary, Maryland. The negative correlation in the Hudson River probably occurs later because white perch in the Hudson spawn at a higher temperature and at a later date than in Maryland waters (TI 1978a).

The positive relationship between rate of temperature increase from 16 to 20°C and juvenile white perch abundance is the opposite of temperature-juvenile abundance correlations noted for some oceanic species; for the latter, low temperatures and a slow rate of warming are positively correlated with large year classes (Bannister, et al 1974, Pinus 1974). For tiulka (Clupeonella delicatula), Pinus states that in years when the water remained between 15 and 18°C for 18 to 22 days, year classes were larger. In years of rapid warming (about 10 days duration for the 15 to 18°C range) low abundance resulted; however, 15 to 18°C is the optimum temperature range for tiulka egg survival, and Pinus postulated that a warming beyond this range would increase egg mortality. Bannister, et al (1974) postulated reduced predation intensity at low temperatures, or a better synchronization of larvae with food-organism cycles. However, for larval white perch in the Hudson River, rapid warming between 16 to 20°C probably accelerates growth and thereby shortens the yolk-sac developmental period. This, in turn, could result in reduced exposure to predation and therefore increased larval survival. A rapid rise in spring temperature could also help synchronize food organism cycles with the transition by white perch from the yolk-sac to the post yolk-sac stage, when the larvae first begin to feed.

The positive relationship which exists between the abundance of striped bass and white perch juveniles could represent either a direct interaction between the two species, or a common response to a third variable or set of variables. One potential direct interaction would occur if the two species formed part of a prey species complex for predators such as bluefish. In this instance, high abundance of one species would tend to buffer predation on the other, increasing the survival rate for the latter. Indirect mechanisms could include physical or chemical factors which aid the survival of both species, or the abundance of a food organism eaten by both species. The early juvenile stages of these two species are very similar; thus common food sources would be expected (Subsection IV.B.3.c.).

A working hypothesis for the operation of key factors influencing white perch year-class strength includes the following: large freshwater flow during May and June reduces the numbers of juvenile white perch through siltation and smothering of eggs, through inhibition of sight feeding by larvae and juveniles, and by decreasing the abundance of available food organisms. A rapid temperature rise from 16 to 20°C shortens the yolk-sac larval period and reduces the duration of exposure to predation. A rapid increase in temperature could also synchronize increases in invertebrate food organisms with the development of juvenile white perch. Large year classes of striped bass could buffer juvenile white perch from common predators and increase survival. Years of high or low abundance are the result of the interaction of these mechanisms and others not yet tested.

4. Compensation

The white perch population in the Hudson River Estuary appears to be compensating for power plant mortality. Three arguments are presented for compensation in Hudson River white perch: (1) density-dependent growth, (2) the potential decline in stock size due to mortality induced by the Danskammer and Lovett plants, and (3) analysis of age structure and age at maturity. Finally, the alpha-fecundity relationship described in Subsection IV.B.4. is used to estimate compensatory capabilities in white perch.

Density-dependent growth has been documented in white perch by Mansueti (1961b) who found large year classes exhibiting less growth than smaller year classes in the Patuxent River estuary, in Maryland. Texas Instruments has not described a similar relationship in Hudson River white perch, possibly because environmental variation easily obscures the relationship. However, density-dependent growth may play a role in mitigating losses in white perch populations in the Hudson River, because Dew (1977b) described a negative relationship between juvenile white perch abundance and growth from samples collected in the nearfield areas of the Bowline and Roseton power plants.

The potential decline in population size from mortality imposed by Danskammer and Lovett power plants was calculated for white perch as done in Subsection IV.B.4. for striped bass. A total mortality of 0.8 was assumed during the period of impingement. Direct impact (conditional mortality rates) for individual units at Danskammer and Lovett are shown in Table IV-45 and are derived from previously published data (TI 1975a). Table IV-46 shows the behavior of the white perch population with no compensation occurring. A 46% decline in stock size would be expected in the absence of compensation as a result of the operation of these two power plants alone from 1949 to 1976. The yield per effort data from the commercial fishery show a decline, but the data are confounded with yellow perch catches and declining market value (TI 1975a) so the results of this exercise are somewhat obscured. No decline of abundance is obvious from juvenile abundance indices since 1965 (Subsection IV.C.). However, without compensation the population should have shown a continuous decline of 34% from that time till 1976 as a result of Danskammer and Lovett-induced mortality.

Table IV-45

Proportion of Maximum Cooling Water Flow of Individual Units at Lovett and Danskammer and Associated Impact Based on 1973 Entrainment and Impingement Data for White Perch

Plant	Unit	Year Operation Began	Cumulative Proportion of Maximum Flow for Each Plant	Direct Impact
Lovett	I	1949	0.08	0.0013
Lovett	II	1951	0.16	0.0026
Lovett	III	1955	0.29	0.0047
Lovett	IV	1966	0.62	0.0101
Lovett	V	1969	1.00	0.0163
Danskammer	I	1951	0.13	0.0033
Danskammer	II	1954	0.26	0.0066
Danskammer	III	1959	0.60	0.0152
Danskammer	IV	1967	1.00	0.0254

Table IV-46

Expected Behavior of a Hypothetical Population of White Perch with No Ability to Compensate for Additional Mortality due to Entrainment and Impingement at Danskammer and Lovett

Year	Population Size	Proportion Surviving Impact	Conditional Plant Mortality at Danskammer	Conditional Plant Mortality at Lovett
1949	100	0.9987	----	0.0013
1950	99.87	0.9987	----	0.0013
1951	99.74	0.9941	0.0033	0.0026
1952	99.15	0.9941	0.0033	0.0026
1953	98.57	0.9941	0.0033	0.0026
1954	97.99	0.9908	0.0066	0.0026
1955	97.08	0.9887	0.0066	0.0047
1956	95.99	0.9887	0.0066	0.0047
1957	94.90	0.9887	0.0066	0.0047
1958	93.83	0.9887	0.0066	0.0047
1959	92.77	0.9802	0.0152	0.0047
1960	90.93	0.9802	0.0152	0.0047
1961	89.13	0.9802	0.0152	0.0047
1962	87.37	0.9802	0.0152	0.0047
1963	85.64	0.9802	0.0152	0.0047
1964	83.94	0.9802	0.0152	0.0047
1965	82.28	0.9802	0.0152	0.0047
1966	80.65	0.9749	0.0152	0.0101
1967	78.63	0.9648	0.0254	0.0101
1968	75.86	0.9648	0.0254	0.0101
1969	73.19	0.9587	0.0254	0.0163
1970	70.17	0.9587	0.0254	0.0163
1971	67.27	0.9587	0.0254	0.0163
1972	64.49	0.9587	0.0254	0.0163
1973	61.83	0.9587	0.0254	0.0163
1974	59.27	0.9587	0.0254	0.0163
1975	56.82	0.9587	0.0254	0.0163
1976	54.48	0.9587	0.0254	0.0163

Analysis of age composition and age at maturity demonstrates the compensatory reserve in white perch populations as in Subsection IV.B.4. Hudson River white perch have a substantial number of older fish (Subsection IV.C.2), indicating no great stress on the population. Only one study has data on age at maturity of white perch from other systems (Mansueti 1961b); these data show that white perch females mature in 4 years in the Chesapeake region compared to five years in the Hudson River population (Subsection IV.C.2.d). This comparison is subject to the same confounding with the north-south gradient in the age at maturity discussed in Subsection IV.B.4. However, at least physiologically, white perch can mature earlier than they do in the Hudson River. Age at first reproduction (maturity) is an important factor in determining the potential for increase of a population. A population with a lower age at first reproduction can withstand greater exploitation.

Alpha, the measure of the population's ultimate ability to compensate for additional mortality was calculated as in Subsection IV.B.4. A value of 53,647 was used for average fecundity, representing the average fecundity of 3- and 4-year old fish in 1975-1976 (TI 1977f). Alpha for this fecundity, derived from the alpha-fecundity relationship presented in Table IV-24 is 3.34, representing a moderate potential for increase, exceeded by 6 of the 21 stocks analyzed by Cushing (1971).

To date, the white perch population has been able to compensate for the additional mortality due to power plant operation. The expected decrease in stock size of 46% is not evident and analysis of age structure and age at maturity show the population to have the capability to compensate for additional mortality.

D. ATLANTIC TOMCOD Microgadus tomcod (Walbaum)

1. General Life History

The Atlantic tomcod (Figure IV-38) belongs to the codfish family (Gadidae), resembles the Atlantic cod and grows to a maximum size of approximately 15 inches in (381 mm) total length (Bigelow and Schroeder 1953). An anadromous, inshore, bottom-dwelling species, the Atlantic tomcod inhabits coastal and brackish waters from southern Labrador to Virginia and exists landlocked in several freshwater lakes of coastal Canada. The Hudson River is the most southern major spawning area for Atlantic tomcod and details concerning the biology of the species are lacking for much of its range (Scott and Crossman 1973).

Adult tomcod usually ascend estuaries and coastal rivers during mid-winter to spawn in shallow fresh or brackish water, although some may spawn in salt water (Scott and Crossman 1973). Fecundities for tomcod spawning in the Hudson River during the years 1973 to 1976 averaged from 14,000 to 20,000 eggs per female (Section IV.D.2.e). Eggs are about 1.5 mm in diameter, demersal (sinking) and nonadhesive (Mather 1887, 1889). Several reports describing eggs as adhesive probably resulted from the stripping of unripe or over-ripe eggs or from misidentification (Mather 1886). Length of incubation varies with water temperature; at a mean of 3.5°C, hatching occurs in 36 to 42 days (Hardy and Hudson 1975).

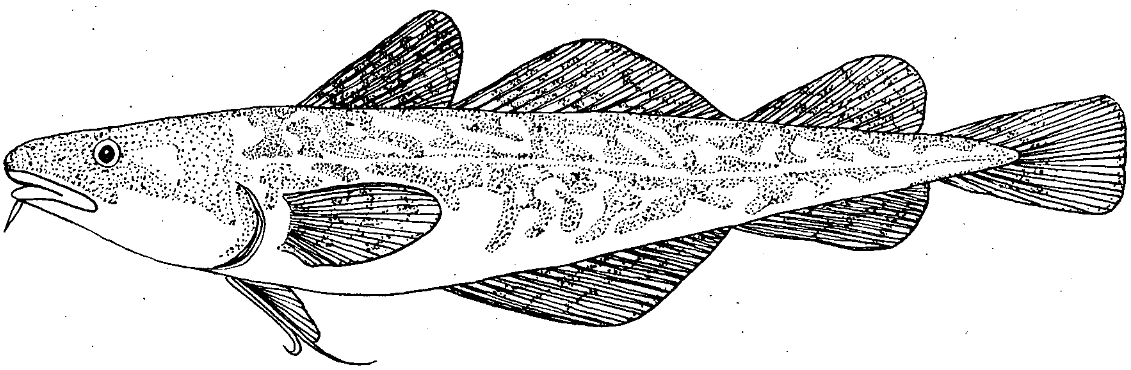

Figure IV-38. Atlantic Tomcod (Microgadus tomcod), Anadromous Member of Family Gadidae

At hatching, yolk-sac larvae (prolarvae) are approximately 5-mm long and swim in brief bursts towards the surface, falling back head first between bursts. By the time they reach 7-mm in length (probably 1-2 weeks after hatching), the gas bladder is inflated, the mouth and gut are functional, and the yolk-sac is fully absorbed (Booth 1967). Post yolk-sac larvae (postlarvae) feed on zooplankton and apparently drift downstream from the spawning areas, as indicated by relatively high population densities detected in the channel stratum of the lower Hudson estuary during late winter and early spring (McFadden 1977).

By mid-spring, most young-of-the-year tomcod have attained the juvenile form and continue moving downstream, although many are also found in the deeper portions of the middle Hudson River estuary (McFadden 1977). Having evolved as a cold water species, tomcod grow rapidly during early spring, feeding mainly on copepods and Gammarus (TI 1976c). Juveniles grow to approximately 74 mm (TL) by early summer, and then grow little, if at all, until water temperature declines in the fall (TI 1975b). During the summer, juvenile tomcod may move to deeper, cooler water, (McFadden 1977) which coincides with the upstream intrusion of the salt front (TI 1975b).

With the onset of fall, a general downstream movement occurs (TI 1977f), and rapid growth is resumed. Juvenile diets may include a variety of benthic organisms and small fish, but mainly the crustaceans Gammarus and Neomysis (TI 1977b). Hudson River juveniles almost double their summer length by early winter when they most become sexually mature adults. After maturity, the adults migrate upstream during late December (when they are classified as young-of-the-year) or January (when they are classified as yearlings) to spawn in the shore zone of the middle estuary (TI 1978a). Since few older fish are collected, the spawning migration is followed by what appears to be a final downstream migration for most Hudson River tomcod, since approximately 95% of the following year's spawning stock is composed of individuals completing their first year of life (TI 1977f).

The mortality rate appears to be high for Hudson River tomcod during their first two years of life with mortality being highest in the first year (McFadden 1977). Predation by striped bass (Boyle 1969 and juvenile bluefish (TI 1967d) may account for substantial mortality. Survival of Atlantic tomcod is also reported to be seriously limited by chemical pollution and low oxygen levels created by waste discharge (Scott and Crossman 1973). Tomcod are harvested commercially and for sport mainly in Canada where they are fairly popular in certain regions.

2. Population Characteristics

a. Growth of Juveniles

1) Methods

Samples of juvenile Atlantic tomcod during May through November 1976 were collected at approximately two week intervals from bottom trawls. The mean weight of all young-of-the-year tomcod in a subsample (Subsection III.C.1) was used for determining instantaneous growth rates with the following formula:

$$G = \frac{Ln_e W_f - Ln_e W_i}{t}$$

where

G = instantaeous growth rate

W_f = final mean weight

W_i = initial mean weight

t = elapsed time (approximately 14 days)

2) Results and Discussion

During 1976, the instantaneous growth rate for juvenile Atlantic tomcod was highest in May, declined through the summer and increased in the fall (Figure IV-39). A similar pattern occurred in 1974 and 1975 with the greatest instantaneous growth occurring in the spring and the lowest occurring in the summer (TI 1976c). This pattern of growth is the result of the inverse relationship between temperature and incremental growth found for the 1974 and 1975 juvenile tomcod (TI 1978a). Mean lengths observed during December for the 1974-75, 1975-76, and 1976-77 spawning seasons indicate that juvenile growth during these years was similar (i.e. mean total lengths were within 10 mm for all years; (subsection IV.D.2.b.2).

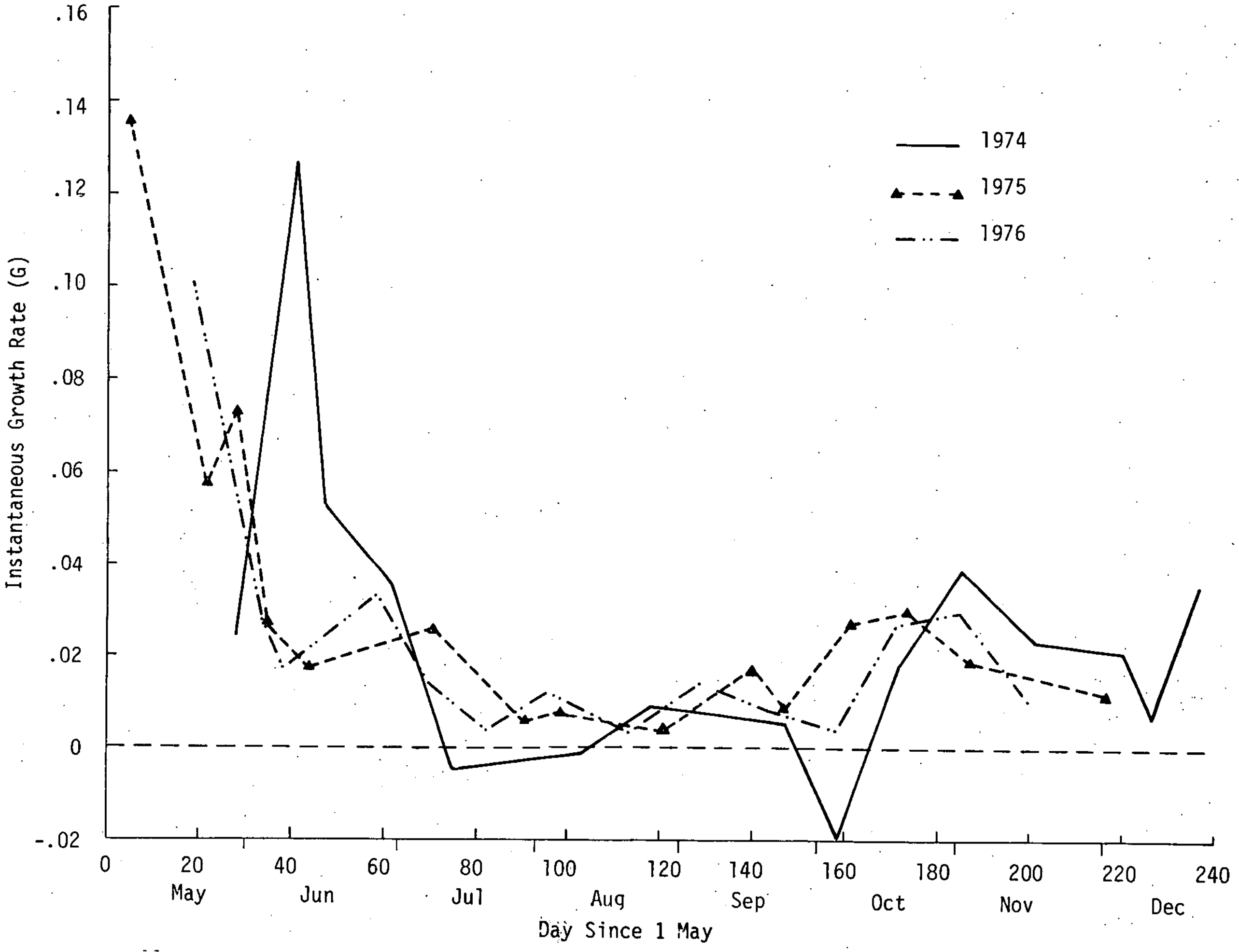

Figure IV-39. Instantaneous Growth Rates for Juvenile Atlantic Tomcod, Hudson River Estuary, 1974-1976

b. Sex Ratio

1) Methods

The sex ratio of juvenile Atlantic tomcod was determined from samples of bottom trawl (Subsection III.C.2.) catches collected approximately weekly from June through September. The data were grouped by month, and a Z-value (Steel and Torrie 1960) was calculated to test if the proportion of males was different from 0.5 as follows:

$$Z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}}$$

where

$\hat{p} = \frac{n_1}{n}$

$p = 0.5$

$q = 1-p$

$n = n_1 + n_2$ (n_1 = no. males; n_2 = no. females)

During the 1974-75, 1975-76 and 1976-77 spawning seasons (December through February) the sex ratio of spawning tomcod was also determined on a weekly basis from box trap (Subsection III.C.1.) catches delivered to the lab for biological processing. Only data from the river miles 47-56 (KM 75-90), the region with the largest catch-per-trap hour (Subsection V.D.2.) were used for analysis of adult sex ratio.

2) Results and Discussion

From June through September of all years examined, males tended to be more abundant than females with the average representation by males being 54.0% for all years during this period (Table IV-47). Only during June (44.5%) and August (48.5%) of 1976 were males less abundant than females. During 1974 and 1975, the highest percentage of males occurred in June (59.6% and 60.0% respectively) and the percentage decreased through September. However, this trend was not observed during 1976 when June had

Table IV-47

Percentages of Juvenile Male Atlantic Tomcod in Bottom Trawl Catches in Hudson River Estuary, 1974-1976 (Z Values and Probability that the Percentage of Males Was Greater than that of Females Each Month)

	1974				1975				1976				All Years Combined			
	% ♂	n‡	Z†	p‡	% ♂	n‡	Z†	p‡	% ♂	n‡	Z†	p‡	% ♂	n‡	Z†	p‡
Jun	59.6	554	4.52	<0.0001*	60.0	70	1.67	0.0475	44.5	236	-1.69	0.0455	55.5	860	3.23	0.0006*
Jul	53.2	1096	2.12	0.0170	57.5	153	1.86	0.0314	57.2	437	3.01	0.0013*	54.6	1686	3.78	<0.0001*
Aug	54.0	855	2.34	0.0096	53.8	80	0.68	0.2483	48.5	235	-0.46	0.3228	52.9	1170	1.98	0.0239*
Sep	55.2	426	2.15	0.0158	51.3	226	0.39	0.3483	50.8	242	0.25	0.4013	53.0	894	1.79	0.0367
Comb	54.9	2931	5.30	<0.0001*	54.6	529	2.12	0.0170	51.5	1150	1.02	0.1539	54.0	4610	5.43	<0.0001*

† $Z = \frac{\hat{p}-p}{\sqrt{\frac{pq}{n}}}$ where $\hat{p} = \frac{n_1}{n}$, $q = 1-p$, $n = n_1+n_2$, $p = 0.5$, n_1 = no. males, n_2 = no. females

‡ p = Probability of obtaining a more significant (higher) Z value than the calculated Z Value (Steel and Torrie, 1960:434)

‡ n = Sample size

* Significant at $\alpha = 0.05$

the lowest percentage (44.5%) of males. In spite of the variability which occurred in 1976, these data suggest that male tomcod may slightly outnumber females as the spawning season approaches.

During the spawning period from December through February, the ratio of male to female adult tomcod taken in boxtraps has followed the same pattern during the last three seasons (1974-75, 1975-76 and 1976-77). In early December males far outnumbered females (Figure IV-40) and the percentage of females increased from early December (approx. 5%) until early or mid-January to almost 50% after which percentages of females decreased sharply to approximately 5% again by late January. In 1974-75 and 1976-77, females represented 50 to 60% of the catch during their period of greatest relative abundance. However, in 1975-76, females did not exceed 40% of the catch before their percentages began to decline. The relationship between catch per hour and sex ratio of the catch is presented in Subsection V.D.2.

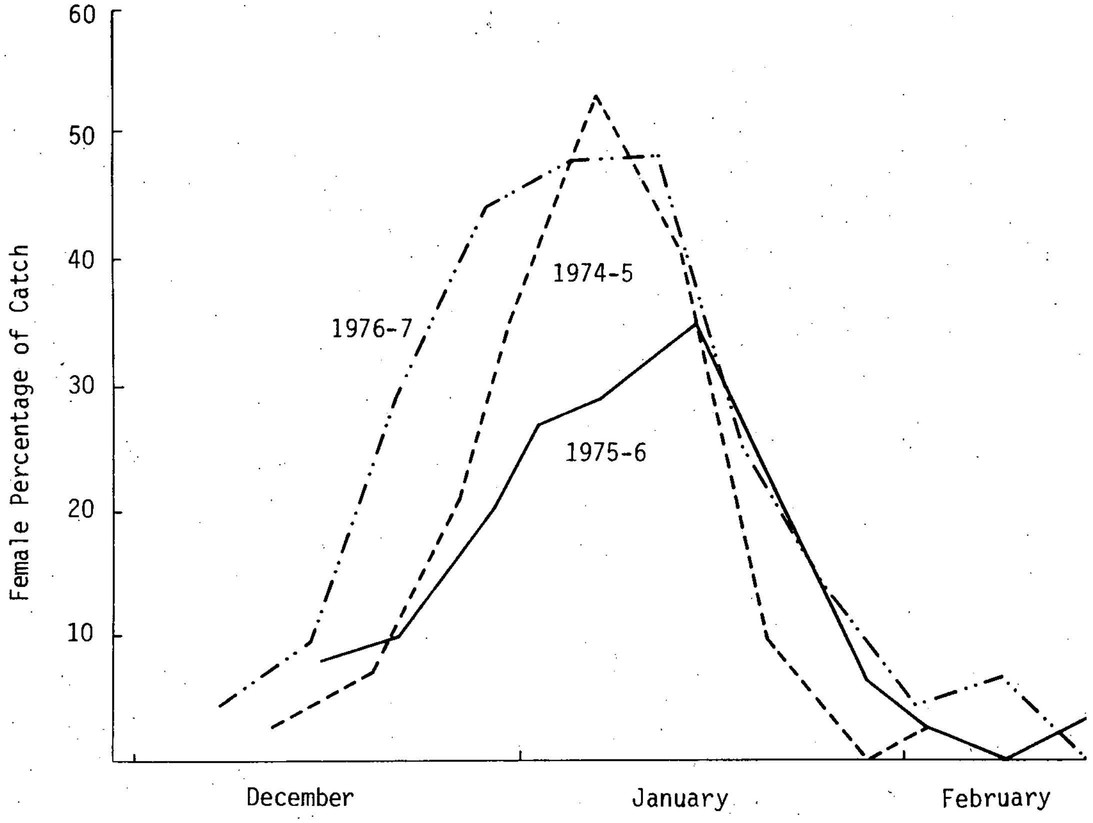

Figure IV-40. Percentage of Atlantic Tomcod Captured in Box Traps in West Point Region (RM 47-56), Hudson River Estuary, during 1974-75, 1975-76, and 1976-77 Spawning Seasons

The rapidly changing sex ratio in box trap catches during the spawning season is probably due to different timing of movements onto the spawning grounds by the two sexes. Males apparently arrive first and are followed in about two weeks by the females. Although no direct evidence is available, it is believed that a female spends about a week on the spawning grounds before leaving. This notion is supported by the short period during which females are very abundant (Figure IV-40) and by observations of the relative abundance of females considered "ripe running", "partially spent", or "spent". Males seem to both arrive earlier and remain longer than females.

An accurate estimate of the sex ratio within the spawning population is required to estimate the number of eggs spawned during a spawning season. Direct estimates of that sex ratio fluctuated so much through the spawning season that this estimate was judged unreliable. Direct estimates of the juvenile sex ratio fluctuated less, so the mean juvenile sex ratio (June through September) was used as a best estimate of the spawning population sex ratio (TI 1978a). This method provided sex ratios which corresponded in general with the maximum percentage of females observed during the spawning period (Figure IV-39). The sex ratio of juvenile tomcod in September was selected as the best estimate of the sex ratio of the spawning population since it showed the least deviation over the three years. The September sex ratios were not statistically different from 1:1. However, if the downward trend in proportion of males which appeared to occur from June through September continued into December, the proportion of females present in the spawning population may be underestimated by the September sex ratios.

c. Age and Length Composition

1) Methods

During the 1976-77 spawning season (December through February), otoliths were removed from subsamples of tomcod greater than or equal to 150 mm TL (Subsection III.C.1. for subsampling criteria) and used to determine age. All fish were captured in box traps between RM 24 and 76 (KM 38 and 22) (Subsection III.C.1.). Fish were divided into length catagories and the percentage of each age represented in each category was calculated and compared to the length frequency distribution of tomcod tagged and released to determine the age composition.

2) Results and Discussion

The 1976 year class (age I) represented 91.6% of the 1976-77 spawning population; the 1975 year class (age II) contributed 8.4% and the 1974 year class (age III) contributed 0.01% (Table IV-48). During the 1975-1976 spawning season, 96.7% of the spawning population was composed of age I fish (1975 year class) and the remaining 3.3% of the fish were age II (1974 year class) (TI 1977f). Prior to the 1976-77 spawning season, no age III tomcod had been collected. The higher percentage of age II tomcod and larger population size estimated to have spawned in 1976-77 (Subsection IV.D.3.) can be explained by a higher survival rate for the 1975 and 1976 year classes.

Table IV-48

Percentage Length Frequency and Age Composition of Atlantic Tomcod Captured in Box Traps during the 1976-77 Spawning Season

Total Length Class (mm)	LENGTH FREQUENCY (% of total)				AGE COMPOSITION* (% of total)		
	Dec 1976	Jan 1977	Feb 1977	Three Months Combined	Age I	Age II	Age III
61-70	0.02			0.01	100		
71-80	0.01			0.01	100		
81-90	0.01			0.01	100		
91-100	0.02	0.11	0.21	0.06	100		
101-110	0.63	1.53	2.83	1.03	100		
111-120	4.07	7.67	13.46	5.69	100		
121-130	11.77	16.18	22.80	13.73	100		
131-140	18.90	20.68	23.80	19.71	100		
141-150	20.19	17.79	16.36	19.25	100		
151-160	15.81	13.03	9.06	14.59	100		
161-170	9.79	8.86	4.18	9.19	100		
171-180	5.10	5.21	1.77	4.95	97.52	2.48	
181-190	2.81	2.96	0.85	2.74	89.68	10.32	
191-200	1.87	1.57	1.49	1.76	58.04	41.96	
201-210	1.91	1.00	0.92	1.58	19.70	80.30	
211-220	1.88	0.67	1.13	1.47	11.01	88.99	
221-230	1.71	0.71	0.64	1.34		100	
231-240	1.03	0.55	0.28	0.84		100	
241-250	0.85	0.51	0.14	0.71		100	
251-260	0.71	0.47	0.07	0.60		100	
261-270	0.51	0.31		0.42		100	
271-280	0.26	0.11		0.20		100	
281-290	0.10	0.09		0.09		100	
291-300	0.04			0.03		77.78	22.22
301-310	0.01			0.01		100	
311-320							
Sample Size	15930	7498	1412	24840	639	678	2
Mean Total Length (mm)	154.5	149.9	139.0	152.3			

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* 3 months combined; Age I = 11-14 months, Age II = 23-26 months and Age III = 35-38 months assuming January 1 spawning.

d. Age at Maturity

1) Methods

Gonads were removed from juvenile Atlantic tomcod captured during July through November of 1976 and stored in 10% formalin. The gonads were later weighted to the nearest 0.01 gram and the percentage of total body weight represented by gonads was calculated, by sex, for each sample and plotted against time of capture.

2) Results and Discussion

Gonad maturation was first observed in both sexes during October for the 1976 year class and continued through November when gonads composed about 18% of the total body weight (TI 1977f). Data collection into December of 1974 (TI 1975b) indicated a loss of gonad weight which corresponded to advanced maturity. It was concluded that the loss of fluid from the gonads was resulting in erroneous estimates of the gonad weight/body weight index used to determine age at maturity. Therefore, it was concluded that data collected through November adequately indicated that age at maturity was 11 to 13 months. This was similar to results from during 1974 and 1975 data (TI 1976c).

e. Fecundity

1) Methods

Atlantic tomcod collected from box traps during the spawning seasons (December through February) of 1973-74, 1974-75, 1975-76 and 1976-77 were examined to determine fecundity. During 1973-1974, whole fish with body wall cut on one side were preserved in 10% formalin. During the following three spawning seasons, tomcod were subsampled by a stratified random sampling of length groups (Subsection III.C.1.). Ovaries were removed from fresh fish and preserved in Simpson's modified version of Gilson's fluid (Bagenal 1971).

The fecundity of each fish was estimated by freeing the egg mass of ovarian tissue, allowing it to drain and weighing the egg mass to the nearest 0.01 g. A sample of approximately 2 g was removed, weighed to the nearest

0.01 g, and the eggs counted. The total number of eggs per fish was then estimated as for white perch (Subsection IV.C.2.c.).

Fecundity estimates ($\log_{10}$) were regressed on the total lengths ($\log_{10}$). The data were tested for homogeneity of group variance with Levene's test (Brown and Forsythe 1974) and for common regression lines with analysis of variance (ANOVA). Fecundity estimates ($\log_{10}$) were also regressed on the total weights ($\log_{10}$). The average number of eggs per female tomcod during the 1973-74 spawning season was determined from the following:

$$\bar{F} = {}^1/_n \sum_{i=i}^{n} aL_i^b$$

where

$\bar{F}$ = estimated mean number of eggs per female

a,b = estimates of α, β from length-fecundity relationship: $\log_{10} F = \log_{10} \alpha + \beta \log_{10} L$

n = number of females examined during the spawning season

L_i = length of ith female

During the 1974-75, 1975-76, and 1976-77 spawning seasons, a stratified random subsample was used (Subsection III.C.1.) and the average number of eggs per female per length group was determined from the following:

$$F_i = {}^1/_{m_i} \sum_{j=1}^{m^1} aL_{ij}^b$$

where

F_i = estimated mean fecundity for length group i for an individual sample

m_i = number of females measured in length group i for an individual sample

L_{ij} = length of jth females from ith length group for an individual sample

a,b = estimates of α , β from length-fecundity relationship: $\log_{10} F = \log_{10}\alpha + \beta \log_{10} L$

The weighted average number of eggs per female tomcod combined overall length groups for each sample was then determined by:

$$\bar{\bar{F}} = \frac{\sum_{i=1}^{8} P_i \bar{F}_i}{\sum_{i=1}^{8} P_i}$$

where

F = weighted mean fecundity

n = total number of fish caught in the sample

P_i = proportion of females measured in length class i; number of females measured in length class i/number of fish measured of fish measured in length class i

Since the total number of females per length class was counted rather than estimated during the 1975-76 and 1976-77 spawning season, N_i, the number of female tomcod in length class i replaces P_i in the above equation for those years.

The simple average of the weighted mean fecundities over all samples was then determined to estimate the overall mean fecundity for each of the latter three spawning season (1974-75, 1975-76, 1976-77) as follows:

$$F = \frac{1}{k} \sum \bar{\bar{F}}$$

where

F = overall mean fecundity

k = number of samples containing females

F = weighted mean fecundity for an individual sample

2) Results and Discussion

No significant difference ($\alpha = 0.05$) between group variances for the four years of fecundity-length data was found but, the four regression lines (Figure IV-41) were significantly different from a common line. Pairwise comparisons of regression lines between years demonstrated that 1973-74 versus 1976-77 and 1974-75 versus 1976-77 did have common lines ($\alpha = 0.05$; Table IV-49). Thus, for the four spawning seasons analyzed, the 1976-77 regression appears to be a reasonable estimate of the relationship between fecundity and length for Hudson River Atlantic tomcod.

The fecundity-weight relationship for the 1976-77 spawning season had the highest correlation coefficient ($r = 0.95$) of the four spawning seasons analyzed (Table IV-50). Fecundity and weight data are difficult to interpret when regressed upon each other because a portion of the total weight is derived from the eggs, resulting in the number of eggs being regressed on their own weight.

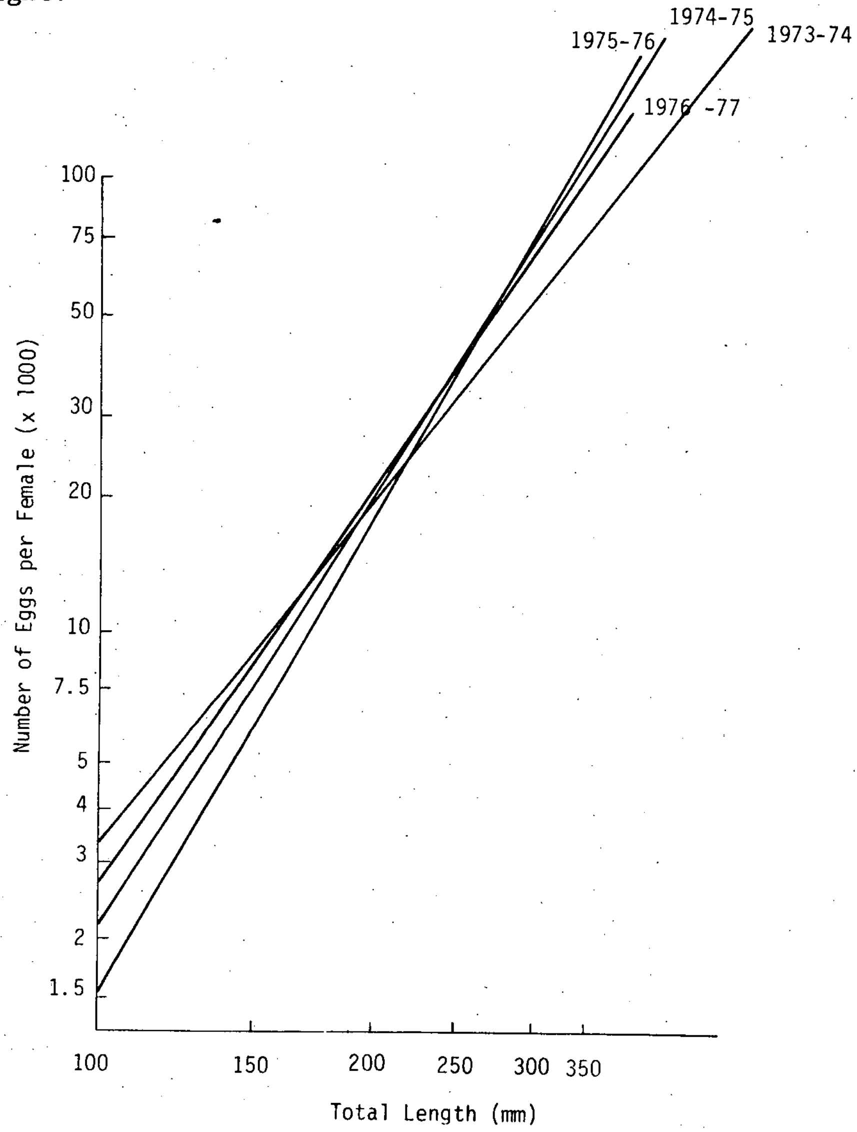

Figure IV-41. Regressions of Log_{10} Fecundity on Log_{10} Total Length for Atlantic Tomcod from Hudson River, 1973-74, 1974-75, 1975-76, and 1976-77 Spawning Season

Table IV-49

Probability Levels† from Levene's Test for Homogeneity of Group Variance and ANOVA Test for Common Line of Hudson River Atlantic Tomcod Log_{10} Fecundity Data Regressed on Log_{10} Length Data, 1973-74, 1974-75, 1975-76, and 1976-77 Spawning Seasons

Pairwise Comparisons	Group Variance	Common Line
1973-1974 vs 1974-1975	0.231	0.976*
1975-1976	0.108	1.000*
1976-1977	0.910	0.942
1974-1975 vs 1975-1976	0.111	0.983*
1976-1977	0.849	0.940
1975-1976 vs 1976-1977	0.857	1.000*
1973-1974 - 1976-1977	0.608	1.000*

†Probability of obtaining a less significant value; if the probability level ≤ 0.95 then the two lines are not significantly different at the $\alpha = 0.05$ level

*Significant at $\alpha = 0.05$

Table IV-50

Regression Results from Log-Transformed Fecundity Versus Weight Data for Atlantic Tomcod during the 1973-1974, 1974-1975, 1975-1976 and 1976-1977 Spawning Seasons, Hudson River Estuary

Spawning Season	Sample Size	y Intercept (a)	Slope (b)	Correlation Coefficient (r)	Coefficient of Determination (r^2)
1973-1974	49	2.67727	0.851652	0.899010	0.808220
1974-1975	115	2.34134	1.01361	0.908166	0.824766
1975-1976	80	2.28524	1.01741	0.937570	0.879038
1976-1977	109	2.52544	0.937932	0.953702	0.909547

The average fecundities for the four spawning seasons (Table IV-51) indicated that during the 1973-74 and 1974-75 seasons, the mean fecundity estimates were very similar (20,226 and 20,053 respectively) but considerably larger than the 1975-76 and 1976-77 seasons (14,228 and 16,850 respectively). Due to the improvement of laboratory and sampling methodologies as well as increased sample size, the estimates for the latter two seasons were considered to be more accurate than for the first two seasons.

The literature contains little information on Atlantic tomcod fecundity. Schaner and Sherman (1960) reported fecundity estimates for tomcod caught along the coast of Massachusetts (Table IV-52). TI's estimates for Hudson River tomcod are close to the December estimates of Schaner and Sherman, exclusive of one fish 208-mm long (assumed to be total length) from Massachusetts which had a low fecundity estimate relative to the rest of the sample. Scott and Crossman (1973) reported fecundity estimates made by Vladykov, which are much lower than those presented by TI (Table IV-52). The estimates of Vladykov were from Quebec and, with the other fecundity estimates, may indicate an inverse relationship between fecundity and latitude for a given fish length. Similar relationships have been found by Paulson and Smith (1977) for Pacific herring, and by Carscadden (1966) for American shad, where the number of eggs for a female of a given size decreases in more northern latitudes.

Table IV-51

Mean Fecundities and Mean Total Lengths of Female Atlantic Tomcod Collected during Four Spawning Seasons, 1973-1974, 1974-1975, 1975-1976 and 1976-1977 in Hudson River Estuary

Spawning Season	Mean Fecundity	Sample Size	Mean Total Length (mm)	Sample Size
1973-1974	20,226	83	198.0	77
1974-1975	20,053*	116	155.7	229
1975-1976	14,228*	80	172.3	608
1976-1977	16,850*	112	165.9	1,164

*Weighted mean fecundity.

Table IV-52

Comparison of Atlantic Tomcod Fecundity Estimates (Eggs Per Female) from Hudson River, Massachusetts and Quebec

Total Length* (mm)	Hudson River (TI)**				Massachusetts*** Schaner & Sherman[†] (1960)	Quebec*** Scott & Crossman (1973)
	(1973-1974)	(1974-1975)	(1975-1976)	(1976-1977)		
180	14,701	13,946	12,165	14,936		6,000
210	21,744	22,781	20,814	23,407	24,752	
220	24,470	26;417	24,476	26,806	31,640	
221	24,754	26,802	24,866	27,163	29,707	
225	25,907	28,377	26,469	28,621	19,470	
230	27,394	30,433	28,576	30,514		14,000
355	82,468	121,172	129,637	108,110		65,780

*Lengths for Hudson River data are total lengths; lengths reported in other studies are assumed to be total lengths

**Estimates from linear regressions: 1973-1974, α = -1.55910, β = 2.53914; 1974-1975, α = -3.03479, β = 3.18332; 1975-1976, α = -3.77224, β = 3.48399; 1976-1977, α = -2.39857, β = 2.91442

***Each fecundity estimate based on one fish

[†] One reported fish (208 mm) not included since fecundity estimate (5,075) was low relative to other fish in report.

3. Population Dynamics

This section describes the population dynamics of larval, juvenile and adult Atlantic tomcod collected in the Hudson River estuary. Estimates of the relative and absolute abundance and mortality rates for Atlantic tomcod during 1976 are presented. In addiiton, factors affecting growth and abundance are investigated.

a. Abundance Trends and Population Estimates

1) Juvenile Abundance Trends

A relative abundance index was developed to determine the fluctuations in annual abundance of juvenile Atlantic tomcod. In previous reports (TI 1978a), this index was developed from bottom trawl data collected at four standard station sites in the Indian Point area by Raytheon Company and Texas Instruments from 1969-1976 (excluding 1971). Atlantic tomcod are regularly caught in the Indian Point region in interregional bottom trawls operated by TI; thus standard station trawls were believed to be a representative sample of the juvenile Atlantic tomcod population. However, in 1976, a comparison of the standard station samples with those taken from the interregional trawl which collected samples from RM 24 to 61 (KM 38-98) indicated that the use of the standard station data underestimated the abundance of the juvenile tomcod. Therefore, all available bottom trawl data were considered for the calculation of the abundance index.

a) Methods

(1) Selection of Index

From 1973 through 1976, interregional trawl samples were collected from the Tappan Zee through Cornwall regions. However, in 1969, 1970, and 1972, sampling was primarily restricted to the Croton-Haverstraw and Indian Point regions (Table IV-53). To determine if a representative abundance index could be derived from these three years of restricted sampling, a juvenile tomcod index using bottom trawl catch data collected between July and September in the Croton-Haverstraw and Indian Point regions in 1973-1976 were compared to catch data collected between July and September in the Tappan Zee through Cornwall regions (Table IV-54). For both data sets, rankings of the annual abundance indices were the same, i.e., from low to high, 1974, 1973, 1975, 1976. Bottom trawl data from the Croton-Haverstraw and Indian Point regions (RM 34-46 [KM 54-74]) for all years 1969-1976 (except 1971) were therefore used for the abundance indices. This extended the data set to seven years of sampling.

(2) Calculation of Index

For July through September of each year, the catch per tow for bottom trawl samples collected from RM 34-46 (KM 54-74) was used to calculate the annual index of juvenile Atlantic tomcod abundance. No adjustments were made for differences in tow speed or duration across years for reasons explained in an earlier report (TI 1977b). Adjustments were made, however, to the catch-per-tow value calculated for the years 1972 and 1973, when there was no cod-end cover or liner in the trawl net (Table IV-55). Catches in these two years were adjusted to maximize comparability with other years.

Table IV-53

Geographic Regions of Hudson River Estuary Sampled with Bottom Trawls by Raytheon Company and Texas Instruments, 1969-1976 (excluding 1971)

	Geographic Region (River Miles)					
Year	YK (12-23)	TZ (24-33)	CH (34-38)	IP (39-46)	WP (47-55)	CW (56-61)
1969			*	*	*	
1970			*	*	*	
1972		*	*	*		
1973		*	*	*	*	*
1974	*	*	*	*	*	*
1975		*	*	*	*	*
1976		*	*	*	*	*

*Regions sampled

Table IV-54

Comparison of Abundance Indices (Catch per Tow) in Different Sampling Segments Calculated from Bottom Trawl Data Collected from July-September, 1973-1976, Hudson River Estuary

Year	CH-IP Regions	TZ-CW Regions
1973	31.0	18.5
1974	9.2	7.8
1975	44.6	30.1
1976	78.1	76.0

CH = Croton-Haverstraw Region
IP = Indian Point Region
TZ = Tappan Zee Region
CW = Cornwall Region

Table IV-55

Bottom Trawl Information from Ecological Survey Subsets of Hudson River Historical Data Analyzed to Calculate Annual Juvenile Atlantic Tomcod Abundance, 1969-1976 (Excluding 1971)

			GEAR		DEPLOYMENT			SAMPLING STATION		
Survey	Year	Month Sampled	Dimensions	Mesh Size	Tow Speed	Tow Duration	Tow Direction	Identification Number	RM	(km)
Raytheon (RAY) studies in vicinity of Indian Point	1969	Jun	25-ft (8-m) semiballoon bottom trawl; doors 36-in. long X 17-in. wide	1.25-in. stretch mesh with 0.25-in. stretch mesh nylon liner	About 3 knots (5.1 fps)	10 min until 8 Aug when changed to 7 min	Against the flow	3	35	(56)
		Jul						4	35	(56)
		Aug						5	36	(58)
		Sep						6	38	(61)
		Oct						7	38	(61)
		Nov						8	39	(63)
		Dec						9	40	(64)
								10	42	(68)
								11	42	(68)
								12	44	(71)
								13	45	(72)
								14	47	(76)
								15	40	(64)
								16	41	(66)
	1970	Mar	25-ft (8-m) semiballoon bottom trawl; doors 36-in. long X 16-in. wide	1.25-in. stretch mesh with 0.25-in. stretch mesh nylon liner	About 3 knots (5.1 fps)	7 min	Against the flow	3	35	(56)
		Apr						4	35	(56)
		May						5	36	(58)
		Jun						6	38	(61)
		Jul						7	38	(61)
		Aug						8	39	(63)
		Sep						9	40	(64)
		Oct						10	42	(68)
								11	42	(68)
								12	44	(71)
								13	45	(72)
								14	47	(76)
								15	40	(64)
								16	41	(66)
Texas Instruments (TI) Hudson River Ecology Study	1972	Apr	25-ft (8-m) semiballoon bottom trawl; doors 30-in. long X 16-in. wide	1.50-in. stretch mesh cod end, no liner	3-4 fps	10 min	Against the flow	0-1	35	(56)
		May						0-2	33	(53)
		Jun						0-3	32.5	(52)
		Jul						0-4	31	(50)
		Aug						0-5	30	(48)
		Sep						1	43	(69)
		Oct						2	43	(69)
		Nov						3	42	(68)
		Dec						4	42	(68)
								5	41	(66)
								6	39	(63)
								7	40	(64)
								15*	38	(61)
								16*	38	(61)

*Sampled Sep - Dec only

Table IV-55 (Contd)

						DEPLOYMENT			SAMPLING STATION		
Survey	Year	Month Sampled	Gear	Dimmensions	Mesh Size	Tow Speed	Tow Duration	Tow Direction	Identification Number	RM	(km)
Texas Instruments (TI) Hudson River Ecological Study	1973	Mar Apr May Jun Jul Aug Sep Oct Nov Dec		25-ft (8-m) semiballoon bottom trawl	1.50-in. stretch mesh cod end, no liner			Against the flow			
			Standard Stations	doors 30-in. long x 16-in. wide		3-fps	10 min		1 2 3 4 5 6 7	43 43 42 42 41 39 40	(69) (69) (68) (68) (66) (63) (64)
			Interregional Trawls	doors 48-in. long X 30-in. wide		4-fps	5 min		RM 24-61 (38-98)		
	1974	Mar Apr May Jun Jul Aug Sep Oct Nov		25-ft (8-m) semiballoon bottom trawl				Against the flow			
			Standard Stations	doors 30-in. long X 16-in. Wide	1.50-in. stretch mesh cod end and 0.5-in. stretch mesh liner	3-fps	10 min		1 2 3 4 5 6 7	43 43 42 42 41 39 40	(69) (69) (68) (68) (66) (63) (64)
			Interregional Trawls	doors 48-in. long X 30-in. wide	1.50-in. stretch mesh cod end and 0.50-in. stretch mesh cod-end cover	4-fps	5 min		RM 12-61 (19-98)		
	1975	Mar Apr May Jun Jul Aug Sep Oct Nov Dec		25-ft (8-m) semiballoon bottom trawl				Against the flow			
			Standard Stations	doors 30-in. long X 16-in. wide	1.50-in. stretch mesh cod end and 0.50-in stretch mesh liner	3-fps	10 min		1 2 3 4 5 6 7	43 43 42 42 41 39 40	(69) (69) (68) (68) (66) (63) (64)
			Interregional Trawls	doors 48-in. long X 30-in. wide	1.50-in. stretch mesh cod end and 0.5-in. stretch mesh cod-end cover	4-fps	5 min		RM 24-61 (38-98)		
	1976	Mar Apr May Jun Jul Aug Sep Oct Nov Dec		25-ft (8-m) semiballoon bottom trawl				Against the flow			
			Standard Stations	doors 30-in. long X 16-in. wide	1.50-in. stretch mesh cod end and 0.5-in. stretch mesh liner	3-fps	10 min		1 2 3 4 5 6 7	43 43 42 42 41 39 40	(69) (69) (68) (68) (66) (63) (64)
			Interregional Trawls	doors 48-in. long X 30-in. wide	1.50-in. stretch mesh cod end and 0.5-in. stretch mesh cod-end cover	4-fps	5 min		RM 24-61 (38-98)		

Monthly adjustment factors applied to juvenile tomcod catches in 1972 and 1973 were estimated from comparisons of 1974-1976 interregional bottom trawl catches of juvenile tomcod in the cod end portion of the gear versus cod-end cover. The monthly adjustment ratios were calculated as follows:

$$\text{monthly ratio} = \frac{\text{monthly catch in cod end plus cod-end cover}}{\text{monthly catch in cod end}}$$

The ratios calculated from the two biweekly samples within each month (July, August, September) were averaged for 1974, 1975, and 1976 (Appendix Table B-30) to generate mean monthly adjustment factors that were assumed to be estimates of the proportional increase in 1972-1973 abundance. July catches were multiplied by 3.90, August catches were multiplied by 2.33 and September catches were multiplied by 1.87. The total adjusted catch per tow from July through September was used as the index of juvenile tomcod abundance for 1972 and 1973.

(3) Statistical Analysis of Index

Significant differences in abundance among years were determined using a Friedman distribution-free multiple comparison test (Hollander and Wolfe 1973). Catch-per-tow for six biweekly intervals from July-September were ranked over seven years and the yearly rank sums were compared (Appendix Tables B-31 and 32).

b) Results and Discussion

(1) Abundance Index

Juvenile tomcod abundance varied over the seven years, 1969-1976 (excluding 1971), by a factor of 14 (Table IV-56). After a relatively strong year class occurred in 1970, abundance indices sharply decreased to relatively weak year classes in 1972, 1973 and 1974, followed by a recovery trend through 1976 (Figure IV-42). Environmental factors influencing the abundance of juvenile tomcod are discussed in Subsection IV.D.3.d.

Table IV-56

Juvenile Atlantic Tomcod Abundance Index (Catch per tow) from Bottom Trawl Collections, RM 34-46, in July-September, 1969-1976 (Excluding 1971) Hudson River Estuary

Year	Survey	Time Period	No. of Tows	Abundance Index
1969	RAY	6/29-9/27	130	76.6
1970	RAY	6/28-9/26	176	125.4
1972	TI	7/3-9/25	98	29.8*
1973	TI	7/1-10/6	99	31.0*
1974	TI	6/29-10/4	80	9.2
1975	TI	7/13-10/4**	73	44.6
1976	TI	6/27-10/2	98	78.1

*Adjusted for trawl used without a fine mesh cod end liner or a cod end cover

**No sampling during the first half of July

RAY = Raytheon Company

TI = Texas Instruments Incorporated

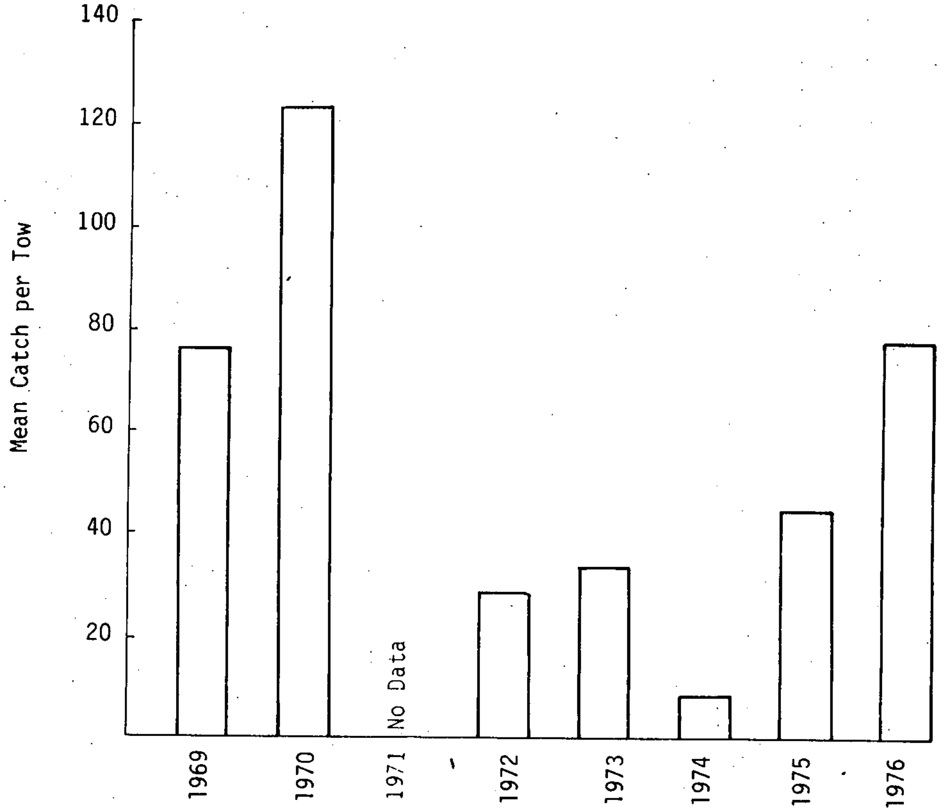

Figure IV-42. Annual Abundances Indices (Mean Catch Per Tow) for Juvenile Atlantic Tomcod in July-September, 1969-1976, Hudson River Estuary

(2) Statistical Analysis of Index

The results of the Friedman multiple comparison test showed a significant ($\alpha = 0.05$) difference between the strong 1970 year class and the weak 1973 and 1974 year classes (Table IV-57). No other significant ($\alpha = 0.05$) differences were obtained.

Table IV-57

Results of Multiple Comparison Test of the July-September Annual Indices of Abundance for Juvenile Atlantic Tomcod, 1969-1976 (excluding 1971), Hudson River Estuary (Those years between which no significant ($\alpha = 0.05$) difference exists are underscored by the same line)

1974	1973	1972	1975	1969	1976	1970

2) Population Estimates

Atlantic tomcod normally spawn in the middle portions of the Hudson River estuary (primarily West Point to Poughkeepsie regions) during December and January. During this period, the population is relatively concentrated and conditions in the river prevent the use of boats to sample this population. As a result, passive fishing gear (box traps) used during the mark-recapture program provided the data for the population estimates.

a) Methods

Marking effort in 1976-77 was conducted entirely from 3 x 3 x 6-ft (1 x 1 x 2-m) box traps set at selected sites from RM 24 (KM 38) to RM 77 (KM 123) [Subsection II.C.4]. The trap sites were grouped into four regions RM 24-38 [KM 38-61], 39-46 [62-74], 47-61 [75-98], and 62-77 [99-123] for marking purposes. Fish were marked from November 15 through March 15 with either fin clip combinations (unique to each region-time period stratum) or with Carlin tags (Appendix Table B-33). Marked fish recaptured in samples from box trap and impingement collections were recorded.

The Schaefer estimate for stratified populations (Schaefer 1951) was used in this study to estimate the size of the tomcod spawning population. This method was developed for Pacific salmon spawning stocks to eliminate certain type B (increasing through time) and C (decreasing through time) errors (Subsection IV.B.3.) commonly encountered when estimating migratory fish populations. A migrating population may be accessible for sampling at only a few places along the migration route and unless the entire popuation travels together, there will be a continual emigration of marked and unmarked fish from a sampling site, and a continual recruitment of unmarked fish during the spawning run. In this case, emigration and recruitment would combine to produce a serious type B error, while incomplete mixing in the immediate vicinity of the sampling site may produce type C error. As the fish mix, the type C error decreases but type B error becomes more severe so an unbiased estimate is difficult with standard single or multiple census estimates. If the population can be sampled at some point further along its route, mixing may be sufficient and type C error can be eliminated. The emigration and recruitment problems are overcome by estimating populations in the release and recapture regions through time, therefore, marks must be identifiable as to time of release.

Using this technique the tomcod population was estimated as:

$$\hat{N} = \sum \left(R_{ij} \cdot \frac{M_i}{R_i} \cdot \frac{C_j}{R_j} \right)$$

where

$\hat{N}$ = estimated population size

M_i = number of fish marked in the ith marking period

C_j = number of fish caught and examined in the jth recovery period

R_{ij} = number of fish marked in the ith marking period and recaptured in the jth recovery period

R_i = total number of fish marked in the ith marking period which are subsequently recovered

R_j = total number of fish recaptured in the jth recovery period.

A method of calculating the standard error of $\hat{N}$ was developed by TI and is presented in Appendix Table B-34.

To avoid an inherent positive bias, the assumption that individual fish are available for marking or recapturing during only one time period must be met, i.e. fish available for marking or recapture sampling during one time period will not be available in subsequent periods. A correction for violations of this assumption was developed by calculating a "resident fraction" for marked fish remaining in the release region. The resident fraction, P_{ij}, which is analagous to estimates of survival rates from portions of an age series (Ricker 1975:31), is given by:

$$P_{ij} = \frac{\sum_{j=j}^{k} R'_{ij}}{\sum_{j=1}^{k} R'_{ij}}$$

where

P_{ij} = fraction of fish marked in period i which remain in the marking region in recovery period j

R'_{ij} = number of fish marked in period i which are recovered in the marking region in recovery period j

k = number of recovery periods

Therefore, for any release group, the resident fraction for a particular time period is the number of fish recaptured in the release region during or subsequent to that time divided by the total number of recaptures summed over all time periods.

The mean resident fraction for each group of releases during the following recapture period was multiplied by the population $\hat{N}_i$ in the release area during the release period to estimate the number of fish which remained in the release area. This number was then subtracted from the population in the following period, $\hat{N}_i+1$, so that only fish arriving in the release area during the interval are being estimated. The adjusted estimate can be expressed as:

$$\hat{N} = \sum_{i=1}^{m} \left[\hat{N}_i - P_{(i-1)j} \cdot \hat{N}_{i-1} \right]$$

for j = i and

m = number of release periods

b) Results and Discussion

For the purposes of the Schaefer population estimate, release and recapture regions were defined as RM 47-77 (KM 75-123) and RM 24-46 (KM 38-74) respectively. These regions were similar to those used for the size estimates of the 1975-76 and 1974-75 spawning populations (TI 1978b), therefore, some difficulty in interpreting the population estimate could result since fish were moving both upriver and downriver through these regions. However, the majority of fish were caught in the West Point and Poughkeepsie regions in 1976-77, i.e., within the marking region. They were not readily caught during the upriver migration.

As in past years, factors contributing to Type A (constant proportional bias; see Subsection IV.B.3.) errors were not a problem with Atlantic tomcod. Results of 14-day marking mortality tests revealed no increase in mortality for fish marked with either Carlin tags or finclips. Therefore, survival adjustments were not necessary and immediate tag loss was not evident. Type A error due to incomplete reporting of recaptured fish was also considered negligible since recapture samples were taken only from collections examined by environmental technicians employed by contractors. Tags are bright yellow and are highly visible. Finclips are also easily recognized on mature tomcod and unreported recaptures were probably minimal.

Type B errors, other than those already discussed, were not readily apparent. Higher mortality of marked fish was not indicated since the two marking methods, tags and finclips, had similar recapture rates for almost all release periods (Appendix Table B-35). Since the recapture rates of the two marking methods were equal it is unlikely that either one caused any significant mortality (Ricker 1975). Type II tag loss and fin regeneration were not recognized as problems since few fish (3) were caught with tag wounds and the short duration of the spawning season kept fin regeneration to a minimal level.

The Type C error (incomplete mixing) was eliminated by using the separate marking and recovery zones and the Schaefer estimate. The fraction of the catch which is marked (R/C) was similar for impingement and box trap collections in the recovery area, so mixing was assumed to be sufficient. A new Type C error was introduced, because the assumption of temporally distinct populations was violated, i.e. individual fish remained available for marking or recapture over several time periods (Appendix Table B-36). In this case, the fish were, in effect, "counted" more than once and a positive bias was introduced. The error caused by failure of this assumption was reduced by adjusting the estimates of fish in the marking region for "residence" time within that region. The resident fraction for each release period declined continuously although substantial numbers of fish remained in the release region for several weeks (Figure IV-43), especially for the earlier release periods. The mean value during a recapture period of the resident fraction for the previous release period (Appendix Table B-37) was used to adjust the marking region population estimates.

Both the unadjusted Schaefer estimate (16.2 million) and the adjusted estimate (10.4 million) for the 1976-77 spawning population were much higher than mark-recapture population estimates for spawners in previous years (Tables IV-58, 59). These 1976-77 estimates agree with the higher index of abundance for the 1976 year class derived from bottom trawl data (Subsection IV.D.3.), the higher box trap catch-per-hour and the wider distribution of the spawning stock (Subsection V.D.2.). Thus, all abundance estimate procedures indicated that the 1976-77 tomcod spawning population was the largest observed in the estuary since 1974. Estimates for the two previous years, using the unadjusted Shaefer estimate were 3.36 million for 1974-75 and 3.50 million for 1975-76 (TI 1978b). The 1976-77 spawning population represented an apparent increase of at least a 3.1 fold over 1974-75 (adjusted 1976-77: unadjusted 1974-75) and a 3.0 fold over 1975-76.

b. Mortality Estimates

1) Method

The annual mortality rate for Hudson River Atlantic tomcod during 1976 was estimated by catch-curve analysis. This analysis determines the rate of change in the logarithm of the estimated number of individuals (the standing crop) by age (day number). The 1976 mortality estimates were

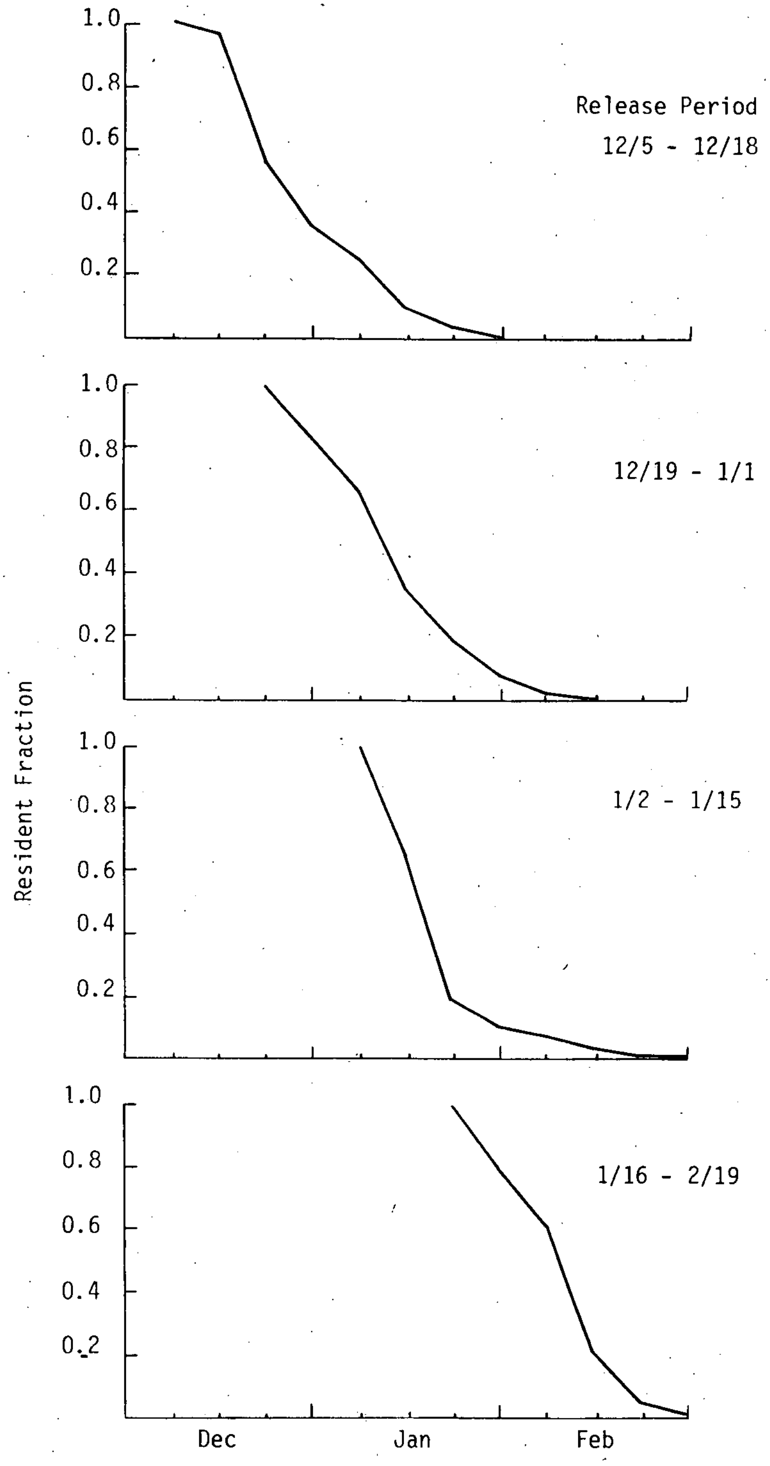

Figure IV-43. Resident Fractions (P_{ij}) for Tomcod Marked in RM 46-77 during Each Release Period, December 1976-February 1977, Hudson River Estuary

Table IV-58

Recoveries of Atlantic Tomcod Marked from RM 47-77 and Recovered from RM 24-46 Stratified by Marking Period and Recovery Period, 1976-77, Hudson River Estuary

Recovery Period (j)	Release Period (i)				Total Fish Recaptured	Total Fish Examined	
	1 12/05-12/18	2 12/19-01/01	3 01/02-01/15	4 01/16-02/19	R_j*	C_j*	C_j/R_j
1 12/05-12/18	3				3	3860	1287
2 12/19-1/1	11	13			24	7400	308
3 1/2-1/15	3	7	1		11	3551	323
4 1/16-2/19	3	1	3	1	8	1345	168
Total Fish Recaptured R_i*	20	21	4	1	46	16156	
Total Fish Marked M_i	13747	17678	17289	7167	55881		
M_i/R_i	687	842	4322	7167			

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*Includes fish captures in TI field sampling and impingement collections at Bowline, Lovett, and Indian Point Power Plants.

derived using a two phase method, in contrast to the single phase method used to estimate mortality during 1974 and 1975 (TI 1978a). Phase I of the two phase method included the population standing crop on January 1, 1976 as eggs and the population standing crop in May 1976 as larvae and early juveniles. Phase II included the ichthyoplankton standing crop estimates from early May through mid-August and the adult population estimate during the 1976-77 spawning season (December-February).

Egg deposition was estimated by multiplying the 1975-1976 spawning population estimate (Subsection IV.D.3.) by the percentage of juvenile females in the population during September 1975 (Subsection IV.D.2.b.1. for discussion) and by the mean fecundity estimate for the 1975-1976 spawners (Subsection IV.D.2.d.). The spawning population estimate was not adjusted for the age II tomcod (3.3% of total) in the 1975-1976 spawning population (TI 1977f). Standing crops of larvae and juveniles prior to May were not used because of either incomplete recruitment of eggs to the gear or the occurrence of yolk-sac and post yolk-sac larvae outside of the sampling

Table IV-59

Estimate of Number of Atlantic Tomcod in Release Region (RM 47-77)
during the 1976-77 Spawning Season (in thousands)
Based on Schaefer Method

Recovery Period (j)	Release Period (i)			
	1	2	3	4
1	2652			
2	2328	3371		
3	666	1904	1396	
4	346	141	2178	1204
Total $\hat{N}_i$	5992	5416	3574	1204

$$\hat{N} = \Sigma \hat{N}_i = 16{,}186{,}000$$

Standard error of $\hat{N}$ = 2,608,000

Adjusted Schaefer Estimate

$$\begin{array}{rl} \hat{N} = & [5{,}992{,}000 - \qquad\qquad\qquad 0] \\ + & [5{,}416{,}000 - 0.46 \cdot 5{,}992{,}000] \\ + & [3{,}574{,}000 - 0.505 \cdot 5{,}416{,}000] \\ + & [1{,}204{,}000 - 0.08 \cdot 3{,}574{,}000] \\ \hline & 10{,}409{,}000 \end{array}$$

area, which would result in underestimates of the early lifestages (Subsection V.D.1.). The 1976-1977 tomcod spawning population estimate discussed in Subsection IV.D.2.d. consists of more than one year class. However, the 1976 year class of tomcod comprised 91.6% of that spawning stock (Subsection IV.D.2.b.). Therefore, 91.6% of the spawning stock estimate was used as an estimate of the 1976 year class population size.

A mortality estimate for phase I and phase II (separate) was determined using the formula:

$$A_j = 1-e^{-b_j T_j}$$

where

A_j = mortality estimate for phase j

b_j = instantaneous mortality rate for period j

T_j = time in days encompassed in phase j

e = 2.71828

Instantaneous mortality estimates (b) were calculated by regressing standing crop (Appendix Table B-38) on time as follows:

$$\log_e \hat{N}_t = a + b(t)$$

where

$\hat{N}_t$ = estimated standing crop at time t

a = estimate of intercept

b = estimate of slope; the absolute value of b is the estimate for instantaneous mortality rate.

t = number of days from January 1

Total annual mortality was estimated using the formula:

$$A_T = 1-(1-A_I)\ (1-A_{II})$$

where

A_T = annual mortality estimate

A_I, A_{II} = mortality estimates for phase I and II respectively

2) Results and Discussion

The mortality rate of Atlantic tomcod during phase I was 99.92%; during phase II there was a major shift and the mortality rate was reduced to 57.80% (Figure IV-44, Table IV-60). The total annual mortality rate was 99.96% which is very similar to the results of single phase estimates of total annual mortality from 1974 and 1975 (99.97% and 99.99% respectively [TI 1978a]).

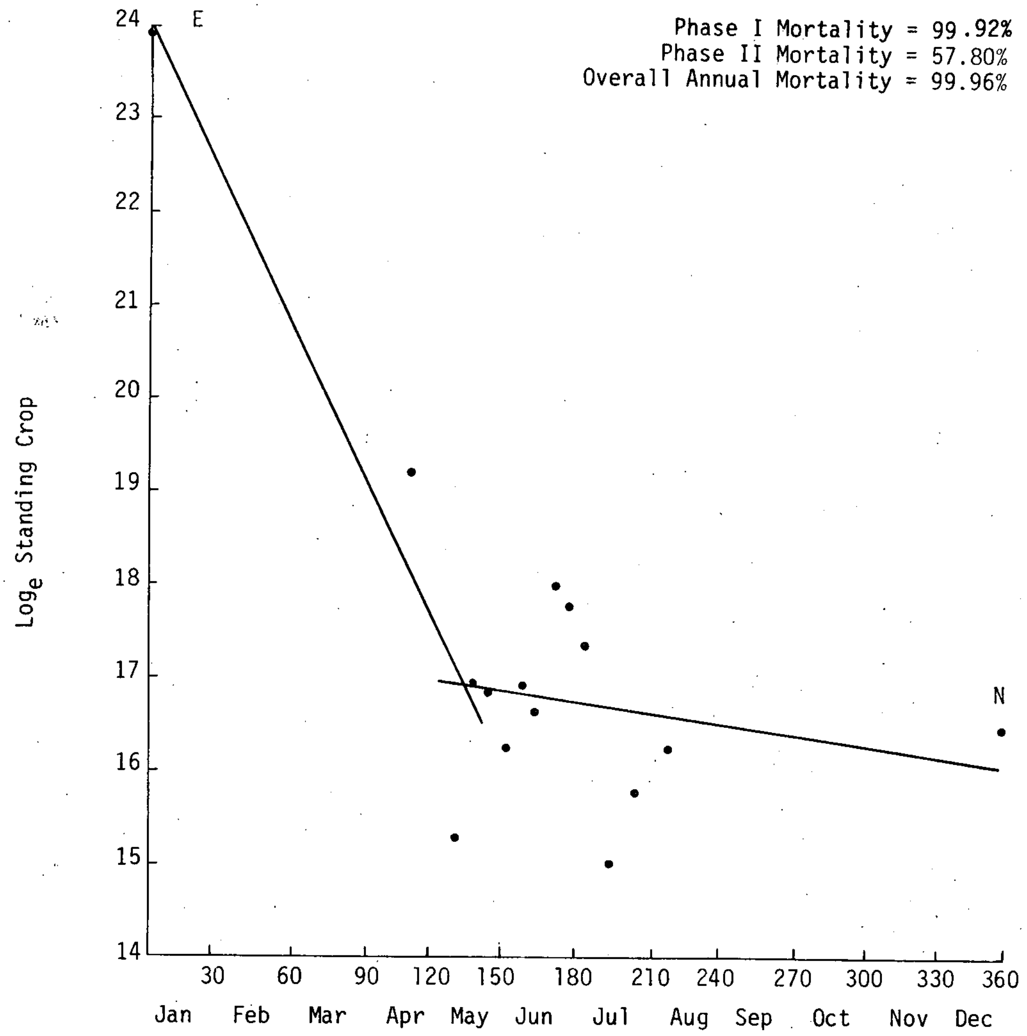


Figure IV-44. Survivorship Curves Based on Standing Crops of Hudson River Atlantic Tomcod during 1976. Phase I = January through May and Phase II = May through December. (E is predicted egg deposition for the 1975-76 spawning season; N is the population estimate for 1976-77 spawning season)

The ichthyoplankton standing crops (May 1 to mid-August) were highly variable and in all instances the majority of the tomcod population was found in the two downriver sampling regions, Yonkers and Tappan Zee (Figure III-1). Since the Yonkers region is only sampled in the shoal areas (Subsection V.D.1.) and since tomcod prefer the bottom of deeper areas (TI 1977b), ichthyoplankton standing crops are probably underestimates of true population size. An underestimate would result in a reduced mortality rate for phase I and an increased mortality rate for phase II; however, the total annual mortality would not be expected to change significantly.

Table IV-60

Regression Analysis and Mortality Rate Estimates for Phases I, II and Overall Annual (both phases) for Hudson River Atlantic Tomcod, 1976

Parameter	Phase I (January-May)	Phase II (May-December)	Overall Annual Mortality Rate
Intercept (α)	23.98935	17.434784	
Slope (β)	- 0.051958	- 0.003767	
Correlation Coefficient (r)	- 0.9333	- 0.213589	
Mortality (q)	0.99915	0.57797	0.99964

The two phase method used here is biologically realistic since higher mortality rates would be expected to occur during early lifestages (i.e. egg, post yolk-sac) and lower mortality rates would be expected for the juvenile to adult stages. The total annual mortality for tomcod was estimated to be 99.96% and the mortality rates for each phase, while not believed to correspond to precise time intervals, simulate the expected decrease in the mortality rate for older fish.

c. Factors Influencing Growth

An analysis of factors influencing growth is important since growth and mortality are often interrelated. Factors of primary interest include freshwater flow into the estuary and water temperature. Therefore, analysis of these factors can provide insight into mechanisms regulating the Atlantic tomcod population.

1) Methods

Mean total lengths of juvenile Atlantic tomcod on July 1, 1969-1970 and 1972-1976, was estimated from available bottom trawl data and used as an index of annual growth. July 1 was chosen because early season growth is completed by this date (TI 1977g) and the mean length at this time reflects larval and early juvenile growth patterns. Also, length data for late summer and fall were not available for all years since 1969.

Mean daily water temperatures (°C) for January through March and April through June and mean daily freshwater flow (CFS) at Green Island Dam for January through March and April through June were each compared using partial correlation analysis to the estimates of mean tomcod length on July 1 for the years 1969-1970 and 1972-1976. Partial correlation analysis allows for the investigation of linear relationships between variables while holding the effects of other related variables constant (Snedecor and Cochran 1967).

2) Results and Discussion

The mean length of Atlantic tomcod on 1 July showed a direct relationship with April through June flow, an inverse relationship with January through March temperature, and a weak inverse relationship with April through June temperatures (Figure IV-45). January through March freshwater flow showed no relationship with mean length on 1 July so this factor was eliminated from further analysis.

While none of the partial correlation coefficients were significant ($\alpha = 0.05$), both April through June flow and January through March temperatures showed a strong enough relationship with juvenile growth to warrant further consideration (Table IV-61). The positive partial correlation between April through June flow and growth could be explained by high spring run off with increased nutrient loading causing a corresponding increased food availability in the estuary. The relationship between January through March temperatures (time period encompassing egg and yolk-sac stages) and July 1 length does not correspond to any easily discernible direct mechanisms.

d. Factors Influencing Year-Class Abundance

The juvenile tomcod annual abundance indices were compared to quantitative variations within a selected group of environmental factors in order to delineate which of these might influence the survival (or production) of young-of-the-year fish. Since the abundance index was derived from a slightly different data base than that described in previous reports (Subsection IV.3.a.), all potentially important variables for which data were available were screened to determine their potential influences on the abundance of juvenile tomcod.

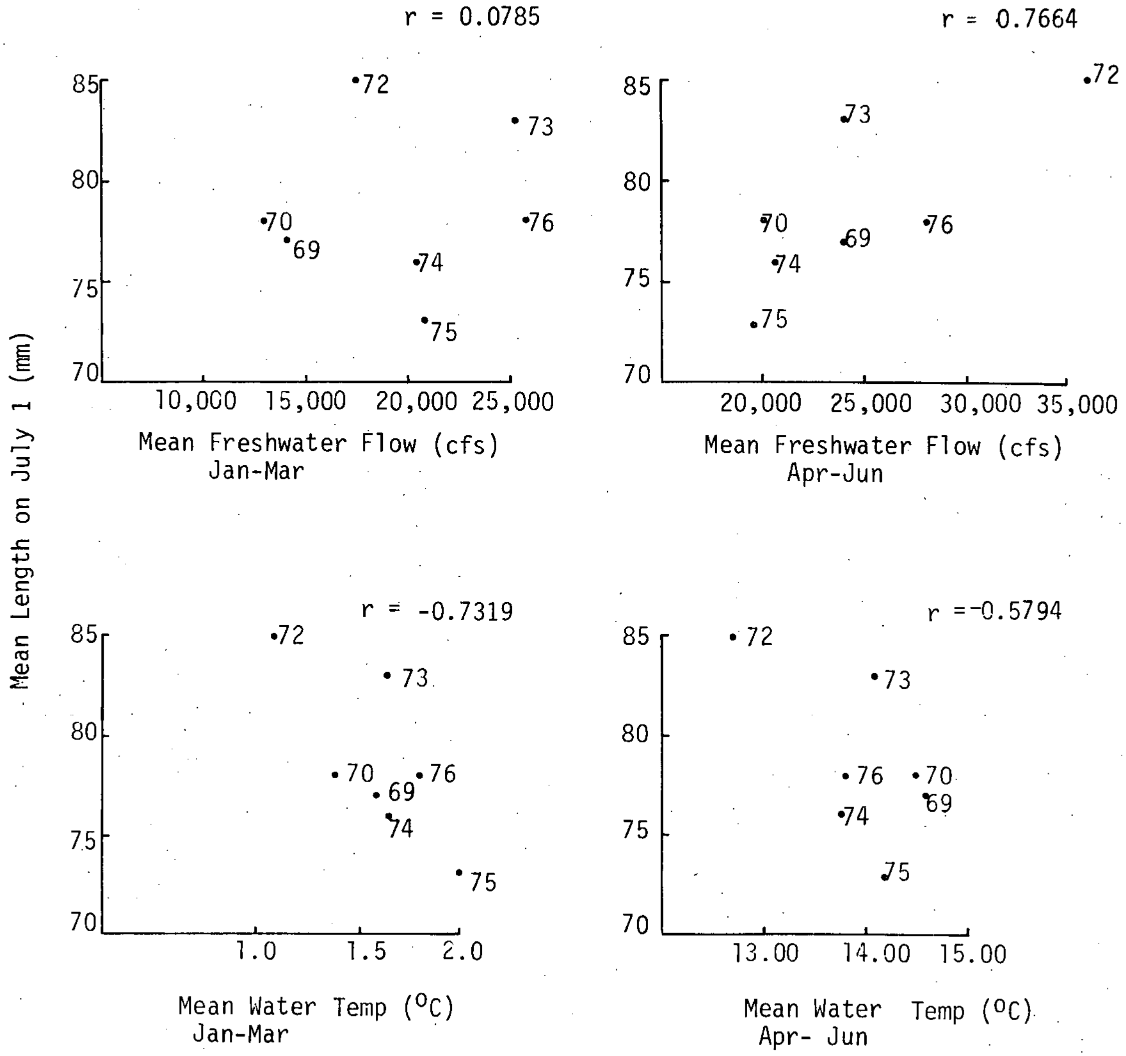


Figure IV-45. Relationship Between the Mean Length of Atlantic Tomcod Juveniles on 1 July and Mean January-March and April-June Freshwater Flow and Mean January-March and April-June Water Temperature, Hudson River Estuary, 1969-1976 (excluding 1971)

Table IV-61

Partial Correlation Analysis of Mean Total Length of Atlantic Tomcod on 1 July and Mean April-June Freshwater Flow, January-March and April-June Water Temperatures during 1969-1976, Hudson River Estuary

Variable Correlation with the mean length of Atlantic Tomcod on July 1	Variable held constant through Partial Correlation	Partial Correlation Coefficient
April-June freshwater flow	January-March water temperature April-June water temperature	0.5062 (P = 0.28)
January-March water temperature	April-June water temperature April-June freshwater flow	-0.5219 (P = 0.26)
April-June water temperature	April-June freshwater flow January-March water temperature	0.1313 (P = 0.74)

1) Methods

Seven years of observations (1969-1976; excluding 1971) were considered too few to attempt multiple regression analysis. Therefore, the environmental variables (Table B-39) were examined graphically, and by simple linear correlation with juvenile abundance. Correlations of r ≥ 0.75 at $P \leq 0.05$ were considered significant. Correlations of $0.75 \geq r \geq 0.5$ and $P \leq 0.25$ were considered to be potentially important and are listed in the Appendix as relationships that deserve consideration as additional years of data are obtained. Since this report concerns effects of power plants upon Hudson River fish stocks, the graph and correlation between power-plant water withdrawal and Atlantic tomcod juvenile abundance are also presented (Appendix Figure B-6).

Physical variables examined included mean daily temperature and freshwater flow during selected months. Temperature records were obtained from the Poughkeepsie Water Works and freshwater flows were recorded at Green Island Dam, Troy, New York, by the U.S.G.S. Freshwater flow rates and temperatures were examined for December, January, and February because of their potential impact upon spawning migration, gonad maturations, egg survival, and yolk-sac larvae survival (Subsection IV.D.1.). March through August temperatures and flows were examined for effects upon the larval and juvenile lifestages. Temperature and freshwater flow during September, October, and November were not analyzed, since variables during these months were considered too late to affect an abundance index taken during July through September (Subsection IV.D.3.a) and too early to affect spawning which starts in late December (Subsection V.D.2.a.).

Two other variables were also correlated with juvenile tomcod abundance. As previously mentioned, the maximum daily water withdrawal from the five power plants combined was used as an index of impingement and entrainment mortality. Bluefish abundance was also analyzed since the species is a predator on juvenile tomcod in the Hudson River (TI 1976d) and can influence tomcod year-class abundance.

2) Results and Discussion

Only two of the 20 factors analyzed had significant ($\alpha = 0.05$) relationships with juvenile Atlantic tomcod abundance. December and January freshwater flows were negatively correlated ($r = -0.816$, $p = 0.025$; $r = -0.783$, $p = 0.037$ respectively) with the annual abundance index (Figures IV-46 and 47). The relationships appeared to be curvilinear, therefore correlation coefficients were calculated using natural log (ln) of both December freshwater flow ($r = -0.852$) and January freshwater flow ($r = -0.840$) as the independent variable. These correlation coefficients support the hypothesis that December and January freshwater flows had a negative exponential relationship with Atlantic tomcod year-class strength.

Atlantic tomcod spawn during December and January in the Hudson River (Subsection V.D.2.a.). Although ice conditions prevented sampling for eggs, peak abundance probably occurred during January. Therefore, freshwater flows during December and January could influence year-class strength either by affecting the spawning success of the adults or the survival of the eggs. Mechanisms for the former could include influences in the timing of gonad

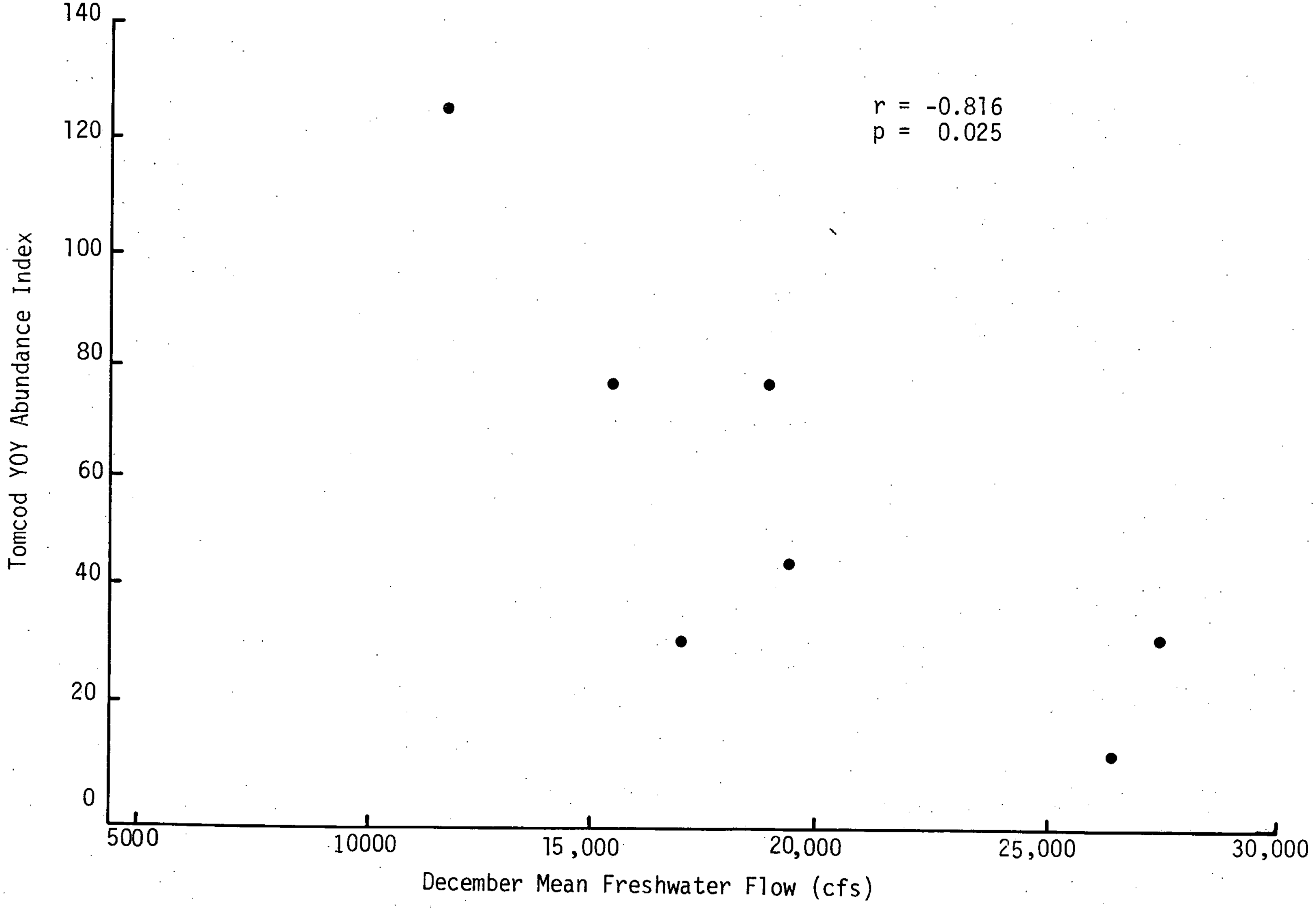


Figure IV-46. Relationship between Atlantic Tomcod Juvenile (YOY) Abundance (1969-1976, excluding 1971) and Preceeding December Freshwater Flow, Hudson River Estuary

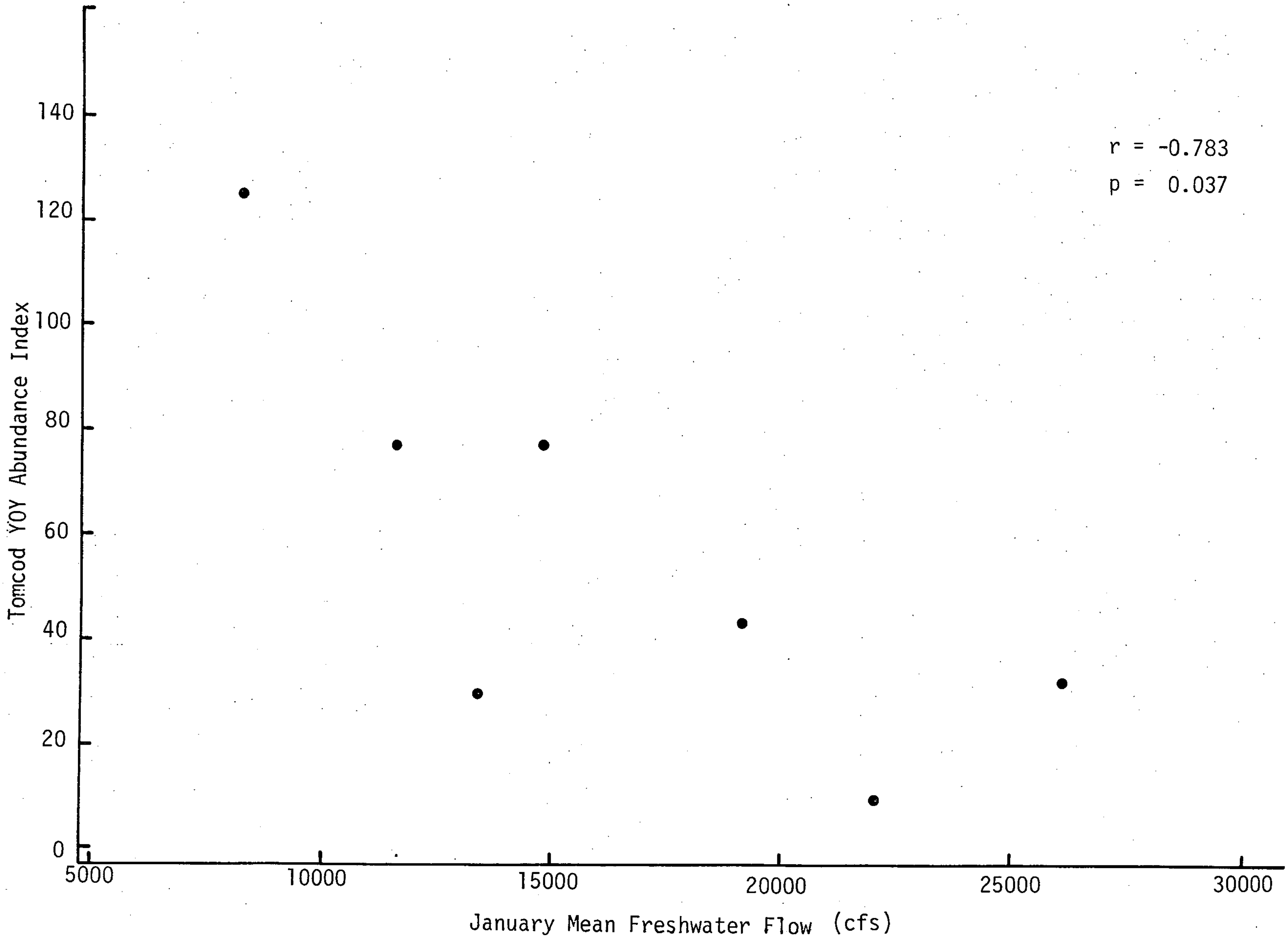


Figure IV-47. Relationship between Atlantic Tomcod Juvenile (YOY) Abundance and January Freshwater Flow, Hudson River Estuary (1969-1976;excluding 1971) maturation or the spawning run, influences causing reductions in the fertilization percentage through mechanical or ionic interference, or influences affecting spawning location and thus the location of larvae within the estuary.

Evidence for a relationship between freshwater flows, spawning location, and year-class strength was obtained by comparing the distribution of tomcod during four spawning seasons (1973-74 through 1976-77) (TI 1978a [Subsection V.B.2.e.] and Subsection V.D.2.b.). During the 1973-1974 season when December and January freshwater flows were highest of the four (Appendix Table B-39), the tomcod population spawned farther downstream than in 1974-1975 and 1975-1976 (TI 1978a [Subsection V.B.2.e.]). This downstream spawning location in 1973-1974 corresponded to a very low abundance of juveniles in 1974 (Subsection IV.D.3.a.). The 1976-1977 population spawned farther upriver than either of the two previous years, and much farther upriver than in 1973-1974 (Subsection V.D.2.b.). If spawning location is determined by freshwater flow, then the December 1976 and January 1977 mean freshwater flows should be lower than those of the three previous years. Provisional data from the Poughkeepsie Water Works recorded these mean flows as 14,078 ft^3/sec and 7,956 ft^3/sec respectively, which is considerably lower than the December and January flows for the three previous years (Appendix Table B-39). These data are consistent with a hypothesis that adult tomcod tend to spawn some distance above the salt wedge, and if high January freshwater flow causes a downstream displacement of spawning, then larvae may not be in an optimal habitat when they hatch, and subsequent survival and year-class strength may be low.

High freshwater flow could affect egg survival through smothering by siltation, or by displacing the eggs downstream. Since tomcod eggs are non-adhesive when ripe (Subsection IV.D.1.), they can be transported by the current and larval development, in some years, may occur downstream in perhaps less suitable habitats.

Variables which were potentially important (r less than or equal to 0.75 and greater than or equal to 0.5) to juvenile tomcod abundance included February temperature ($r = +0.619$, $p = 0.138$), April freshwater flow ($r = +0.612$, $p = 0.144$), June temperature ($r = +0.615$, $p = 0.142$), and bluefish abundance (r = -0.637, p = 0.124) (Appendix Figures B-2 through B-5). These relationships may become significant as additional years of data become available for analysis. All the other environmental variables tested had correlation coefficients of r less than 0.500 and p >0.250. Power plant water withdrawal was apparently not related to annual juvenile tomcod abundance (r = -0.264, p = 0.567) (Appendix Figure B-6).

4. Compensation in Atlantic Tomcod

Virtually no population studies on Atlantic tomcod are available for comparison with the Hudson River population. In the Hudson, the population may be viewed as an annual crop with few fish surviving to the second year (Subsection IV.D.). All females mature in the first year of life, so changes in age at maturity cannot realistically be considered a potential compensatory mechanism in Atlantic tomcod.

Impact due to impingement and entrainment of tomcod at Danskammer and Lovett has not been estimated, therefore, no analysis of predicted decline comparable to the analyses completed for striped bass and white perch is possible (Subsections IV.B.4. and IV.C.4. respectively). Entrainment impact estimation is not possible because tomcod spawn in winter when ichthyoplankton sampling is impossible. Potential impact of these two power plants (without compensation) is probably on the same order as the values calculated for striped bass and white perch (Subsections IV.B.4. and IV.C.4.), particularly at Danskammer in 1973, for example, where Atlantic tomcod represented 76% of the total number of fish impinged (LMS 1973).

Analysis of relative compensatory abilities through the fecundity-alpha relationship (Table IV-24) revealed that tomcod, with an average fecundity of 15,539 eggs per female (average of the 1975-1976 and 1976-1977 values) (Subsection IV.D.a.) had an alpha of 2.48, the lowest of the three species examined. This value of alpha may be misleading in not reflecting the ability of the tomcod population to compensate for additional mortality. Eberhardt (1977) has shown that

$$\alpha = e^r$$

where

r = the maximum intrinsic rate of increase

Cole (1954) has demonstrated that age at maturity is an important component of the intrinsic rate of increase. The relationship between alpha and fecundity described in Table IV-24 ignores the contribution of that component (age at maturity). As stated previously, Atlantic tomcod mature in their first year of life, so the fecundity alpha is not directly comparable to striped bass and white perch, which mature at later ages. Therefore, using the fecundity-alpha approach with Atlantic tomcod probably underestimates the true alpha as an estimate of compensatory ability.

SECTION V

DISTRIBUTION, MOVEMENTS AND EXPOSURE TO POWER PLANT IMPACT

A. INTRODUCTION

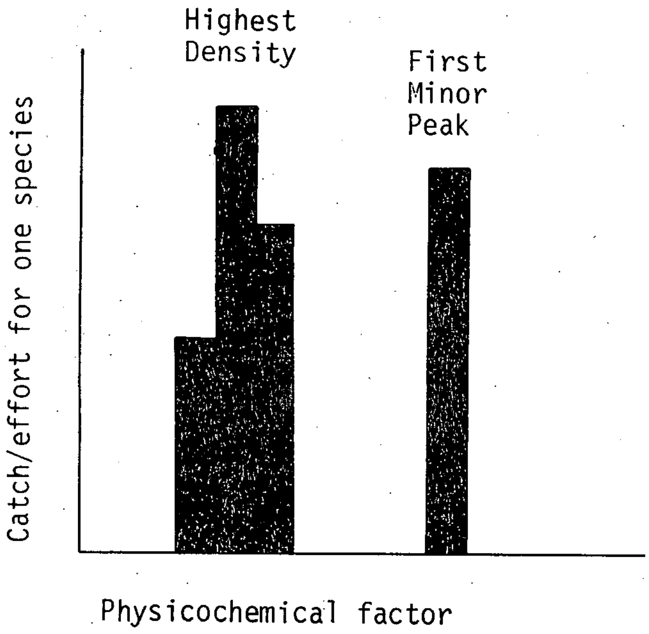
The distribution and movements of the early life stages of striped bass, white perch, and Atlantic tomcod in the Hudson River estuary affect the exposure (vulnerability) of these species to entrainment and impingement at the power plants. The term exposure is used herein to describe the susceptibility of a population to mortality due to the effects of power plant operation. The power plants (Bowline, Lovett, Indian Point, Roseton, Danskammer) are located between River Mile (RM) 37 and 66 and (Kilometer [KM] 59 and 106).

Sampling programs were conducted from RM 12 to 152 (KM 19 to 243) to determine locations and sizes of fish populations. If a large proportion of a population inhabit an area near a power plant, the exposure of that population to the influence of the plant can be high, depending on other factors which affect the likelihood that individuals of the population would be entrained or impinged. If a small proportion exist near a plant, exposure of the population to entrainment and impingement is low. The behavior and characteristics of each life stage, migration within or through the study area, and the location of plant intakes (relative to flow characteristics in the cooling water body) are examples of other variables that must be considered in assessment of exposure. If exposure assessments were based solely on distribution without considering these factors, actual exposure could be over or underestimated. The purpose of this section is to review the distribution of striped bass, white perch, and Atlantic tomcod in the estuary and to assess the exposure of these species to entrainment and/or impingement at the five power plants.

Since juvenile and/or yearlings represent the overwhelming majority of fish impinged, the exposure of two-year-old and older fish is not discussed, but distribution and movements of these life stages are described.

Data collected by Texas Instruments (TI) and presented in this section were gathered during the Atlantic Tomcod, Ichthyoplankton, Fall Shoals, Beach Seine, Winter Box Trap, and Interregional Bottom Trawl surveys, as well as the Adult Striped Bass Stock Assessment Program. Each survey was designed for a specific purpose, and some surveys are more relevant than others in discussions of the distribution of different species and life stages. Data concerning the egg and larval stages of striped bass, white perch, and Atlantic tomcod were collected during the Atlantic Tomcod and Ichthyoplankton surveys. Juvenile and yearling striped bass and the older stages of white perch and Atlantic tomcod were collected in the Beach Seine, Fall Shoals, and Interregional Bottom Trawl surveys. Data on the distribution of two-year-old and older striped bass were collected during the Stock Assessment Program. Additional data concerning spawning migrations of mature Atlantic tomcod were gathered during the Winter Box Trap Survey when other collection methods were impractical. Sampling methods are described in detail in Section III.

The distribution of striped bass, white perch and Atlantic tomcod eggs, larvae, and juveniles in relation to temperature, conductivity, and dissolved oxygen (D.O.) was examined using data collected from 1974-1976. These physicochemical variables were measured concurrently with each sample (Subsection III.E and Appendix Figures C-2 and C-3). Catch data, separated by life stage and gear, were analyzed with respect to the corresponding water quality variables in two ways: the range of physicochemical values in which each life stage occurred and the values at which the greatest catch/effort (highest density) was made. Other values of the same physicochemical factor in which high larvae catches occurred are not necessarily distributed symmetrically around this highest density; therefore, it is only an indication of where the highest catch/effort of the fish occurred in a range of values for a parameter. In some instances, catches at the highest density are slightly higher than catches occurring at another, separate value within a range. Instances in which the second highest density peak is at least 25% as large as the highest density have been designated a "first minor peak" as:



Data collected by TI and other contractors (New York University; Ecological Analysts Incorporated; Lawler, Matusky, and Skelly Engineers) in the immediate vicinity of the power plants (nearfield data) are presented in discussions of vulnerability of the three key species to entrainment and impingement at the plants. Data from nearfield studies are compared with TI estimates to determine whether the abundance of fish in the immediate area of the plants varies from abundance within the expanded plant regions defined by TI.

Discussions of the general distribution of egg and larval stages are divided into two or three sections: geographic (spatial) distribution, temporal distribution, and distribution and movements in the Indian Point plant region. The geographic and temporal distribution subsections are short discussions of the estimated regional standing crops and densities for each life stage of striped bass, white perch, and Atlantic tomcod. Included in the discussions are the geographic range and time span occupied by each species and life stage as well as the regions and sampling periods containing the highest standing crops or densities. Since the species and life stages within each species differ in abundance in the estuary, terms such as "high" and "low" are relative and their use in reference to each is based on density, catch-per-effort, and standing crop estimates (Appendix Tables C-1,2, 4,5,7,8,10-17,29-32,34,35,37-45,48,56-70). Additional information on the length frequency of striped bass post yolk-sac larvae and juveniles is presented in Appendix Tables C-18 and C-19.

The estuary was divided into upriver, middle, and downriver areas (McFadden 1977) for distribution discussions. The Hyde Park through Albany regions represent the upriver area RM 77-152 (KM 123-243), the Yonkers through Croton-Haverstraw regions represent the downriver area RM 14-38 (KM 22-61), and the Indian Point through Poughkeepsie regions represent the middle area RM 39-76 (KM 62-122). For river mile boundaries of the sampling regions see Figure III-1.

Trends in distribution of striped bass and white perch from 1974 through 1976 and Atlantic tomcod from 1975 and 1976 are discussed in terms of distribution indices. The indices were computed by summing estimated standing crops for a time period or region, dividing the sum by the total of the estimated standing crops for all sampling periods and regions, and multiplying by 100. The higher the resulting index value, the more abundant the organisms were in a particular region or sampling period relative to the surrounding regions or sampling periods during the same year.

Distribution and movement of eggs and larvae in the Indian Point area were analyzed using analysis of variance techniques (Appendix Tables C-3,6,9,33,36) on data collected by New York University during 1976 at seven standard (Figure V-3) stations between River Mile 39 and 44 (Km 62 and 70). Significant effects and interactions were broken down into their components to facilitate interpretation through use of Newman-Keuls test (Miller 1966). These analyses did not include striped bass post yolk-sac larvae because the statistical model failed to explain a significant proportion of the observed distributional variation. White perch eggs and all life stages of Atlantic tomcod were not collected in sufficient numbers for analysis.

The movements of juvenile and older fish within the estuary are also described. Special attention is given to movements to and from the shore zone, movements associated with spawning activity, and other seasonal migration up and downriver. Movement between regions is analyzed from the results of mark-recapture programs.

Descriptions of exposure are based primarily on the abundance of each life stage within each of five plant regions, defined as the areas 6.5 miles up and downriver from each power plant since maximum tidal excursion in the estuary is about 6.5 miles. An exposure index was developed to illustrate trends in exposure of eggs, yolk-sac, and post yolk-sac larvae using data collected in 1974, 1975, and 1976. The index was computed by summing the standing crops of a given life stage and species within each plant region over selected sampling periods during a given year. This sum was then divided by the total of riverwide standing crops for the same periods. Only those sampling periods in which the life stage in question was abundant were included in the analysis.

Data collected by other contractors near the power plants are also considered in assessment of exposure. Discussion of juvenile and older fish is augmented with impingement data collected at each of the plants. Other data, literature, and observations are included in exposure discussions when they are relevant to the species and power plant being discussed. Overall exposure of each life stage of each species is assessed in view of all these considerations.

B. STRIPED BASS

1. General Distribution and Movements of Early Life Stages

a. Eggs

1) Geographic Distribution

a) Distribution during 1976

Striped bass eggs were collected from all 12 river regions during 1976. Densities over 50 eggs/1000 m^3 (in most instances, regional densities were less than 10 eggs/1000 m^3) were encountered in the Indian Point, West Point, Hyde Park, Kingston, and Albany regions, indicating dispersed spawning activity by striped bass. Most spawning occurred in or near the Indian Point and West Point regions because the highest proportion of the estimated standing crops of eggs was found in either of these two regions during most sampling periods (Table V-1). Considerable spawning activity may also have

Table V-1

Percentage of Total Standing Crops of Striped Bass Eggs in Twelve Geographic Regions of Hudson River Estuary during Each of Eight Sampling Periods, May-June 1976

	Sampling Date							
Geographic Region	May 3 - May 5	May 10 - May 13	May 17 - May 19	May 24 - May 26	Jun 1 - Jun 4	Jun 7 - Jun 11	Jun 14 - Jun 17	Jun 21 - Jun 24
YK	*		<0.1	0.4				
TZ			0.7	0.5				
CH		3.1	8.5	1.1	0.7	0.1		
IP	51.5	39.5	26.5	46.5	10.4	2.8	7.5	19.1
WP	48.0	54.1	13.6	19.7	57.9	29.0	40.4	78.3
CW	0.4	0.9	2.9	1.1	6.2	33.4	6.2	2.6
PK		1.2	4.5	2.5	2.1	9.0	31.1	
HP		0.9	13.5	1.1	6.3	0.7	10.4	
KC		0.3	19.4	2.1	12.8	1.7		
SG			0.4			6.7		
CS			1.6	22.3	2.7	16.5	4.3	
AL			8.4	2.7	0.9			
Total (%)	99.9	100.0	100.0	100.00	100.00	99.9	99.9	100.0
Total Standing Crops (Thousands)	3756	48459	76139	25558	17295	26191	3282	460

*No entry indicates no eggs collected

occurred in the seven regions upriver from West Point. Those seven regions contained over 30% of the standing crops during the mid-May through mid-June periods, while the regions below Indian Point contained less than 10%.

b) Trends in Distribution (1974, 1975, 1976)

Patterns in the geographic distribution index of striped bass eggs (Figure V-1) were similar from 1974 through 1976, though some variation occurred between years. The distribution index for each of the three years was highest in the Indian Point and West Point regions, and declined in the regions immediately up and downriver. During 1974 and 1976, secondary peaks were present in the Kingston region, and in 1976, a third peak occurred farther upriver in the Catskill region. The highest index values for any

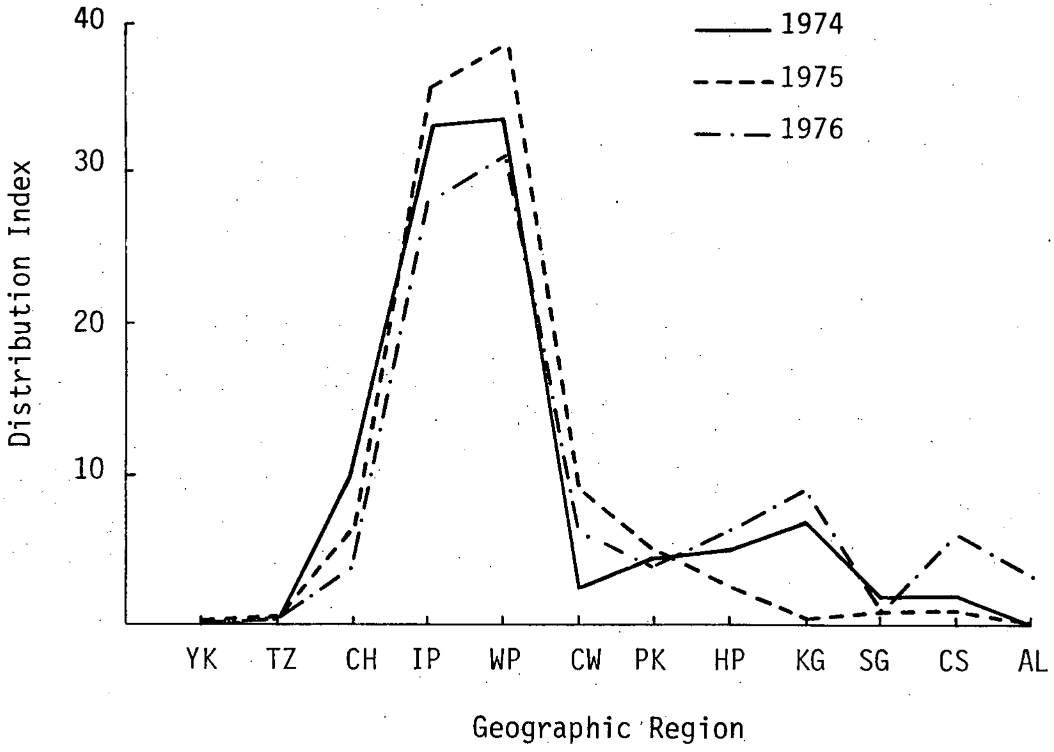


Figure V-1. Trends in the Geographic Distribution of Striped Bass Eggs in Hudson River Estuary, 1974-1976

year were found during 1975 in the Indian Point and West Point regions indicating that eggs were more concentrated in those regions during that year than either 1974 or 1976.

2) Temporal Distribution

a) Distribution during 1976

Eggs were collected from early May through late June. Standing crops of eggs increased to over 75 million two weeks after the first eggs were collected and then declined gradually until spawning ceased in late June (Table V-1). Densities were greatest during the three sampling periods between May 10 and May 26 when most spawning occurred.

b) Trends in Distribution (1974, 1975, 1976)

The highest temporal distribution index occurred in mid-May during 1974, 1975, and 1976, but distribution varied between years in other respects (Figure V-2). Since the points in Figure V-2 represent the midpoint of each

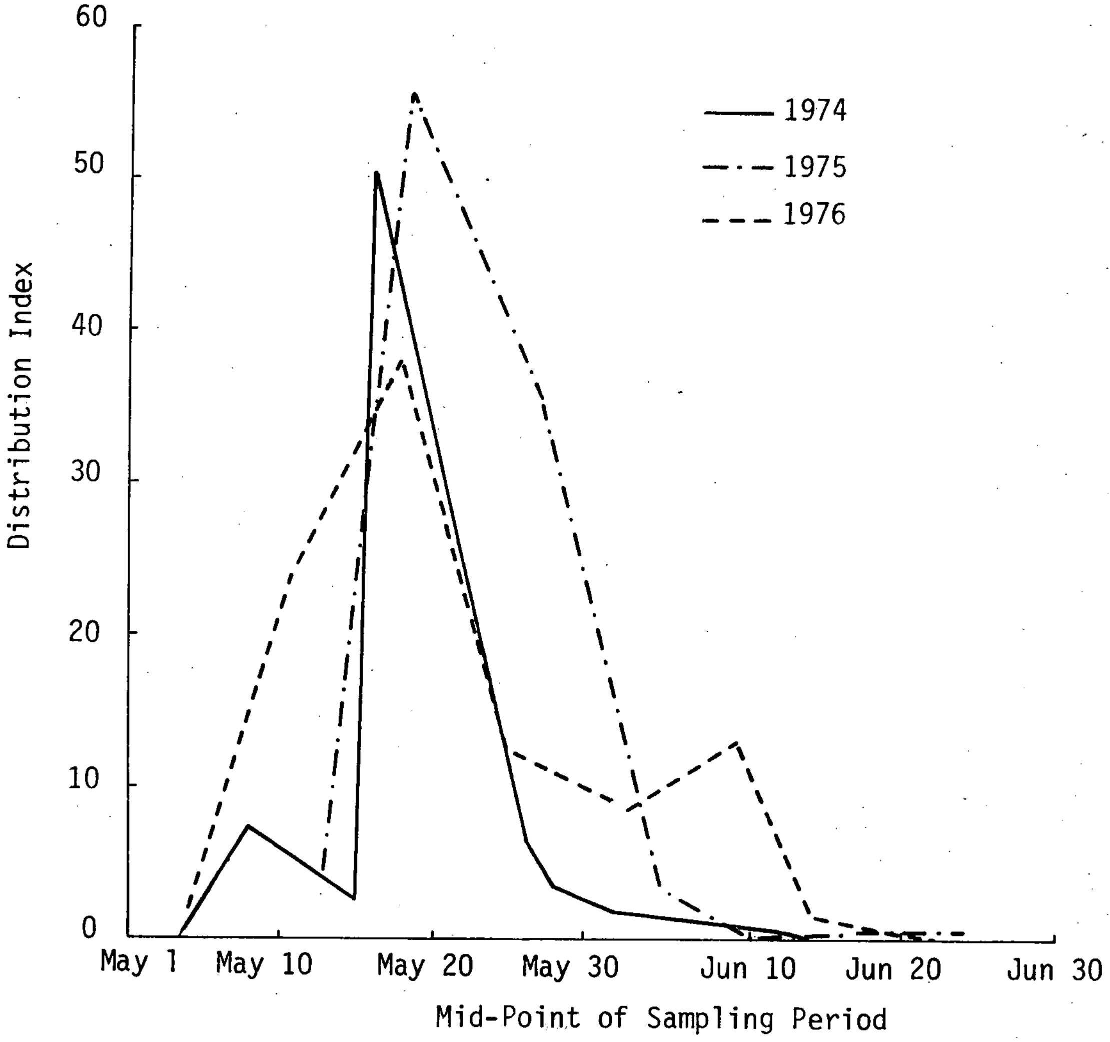


Figure V-2. Trends in Temporal Distribution of Striped Bass Eggs in Hudson River Estuary, 1974-1976

sampling period, and since sampling was not continuous (most sampling periods lasted three or four days and the next period began three or four days later), the precise date of the peak spawning periods may vary from that shown. No striped bass eggs were collected before the end of April or after the end of June during the three years. Indices from 1974 and 1975 have only a mid-May peak, and in 1976, a secondary peak occurred in early June. Most spawning activity during 1974 and 1975 was compressed into a short time period compared to 1976.

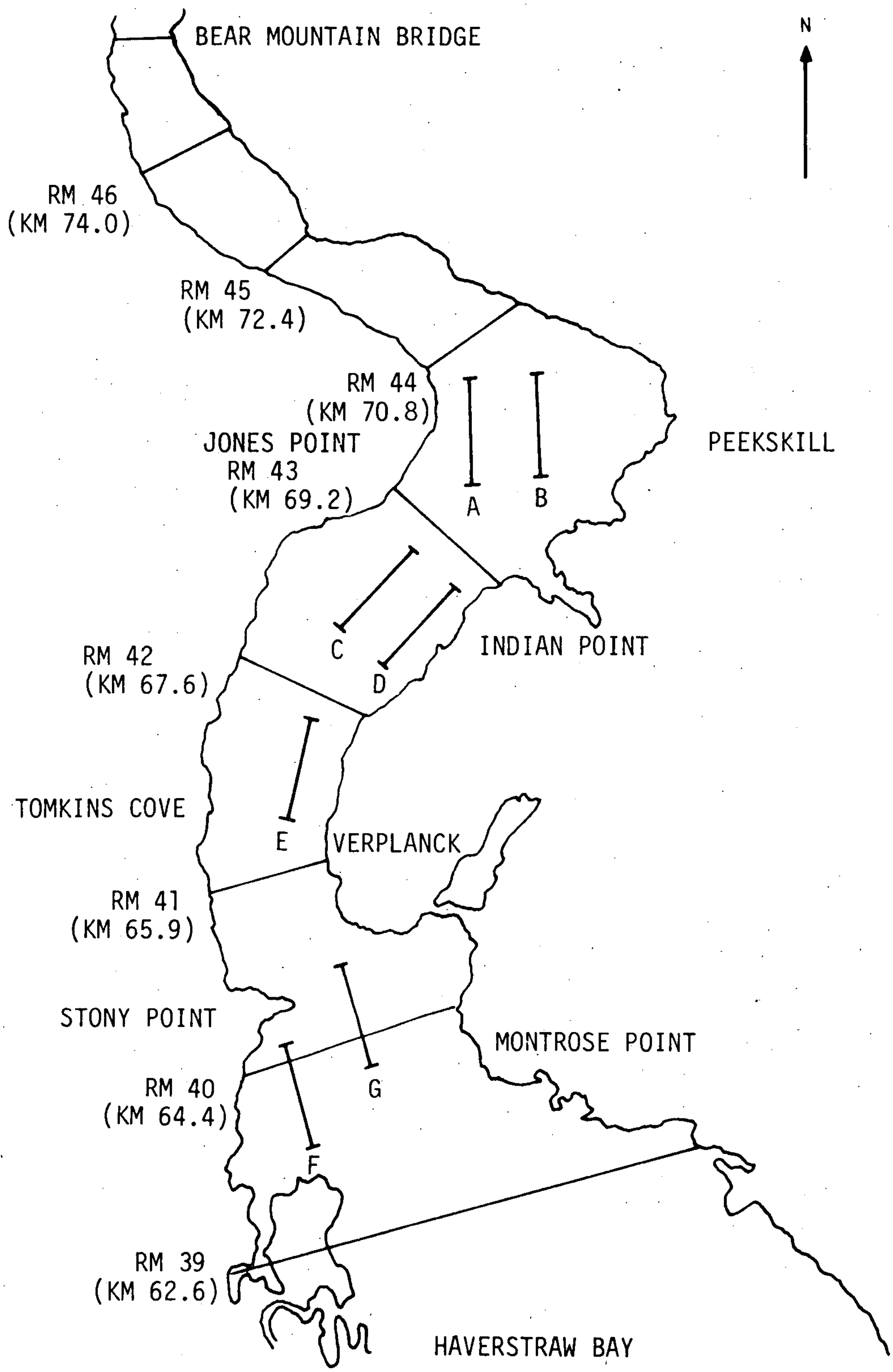


Figure V-3. New York University Indian Point Nearfield Study Sampling Sites during 1975

3) Distribution and Movements in Indian Point Area, 1976

Analysis of variance of the distribution of striped bass eggs in the Indian Point area during one sampling period (Appendix Table C-3) detected differences (P less than or equal to 0.05) due to the depth and sampling station. Analysis of the sampling station effect indicated no overall pattern in egg densities (Figure V-4); densities at station A (farthest upstream) were significantly higher than at station F (farthest downstream). The difference may have been due to tidal action, local currents, or the proximity of station A to areas of spawning activity. Egg density was higher near the bottom than near the surface, but the density at mid-depth was not significantly different from surface and bottom densities (Figure V-5). This analysis confirms the observations described in earlier reports (McFadden 1977) that striped bass eggs tend to be distributed near the bottom.

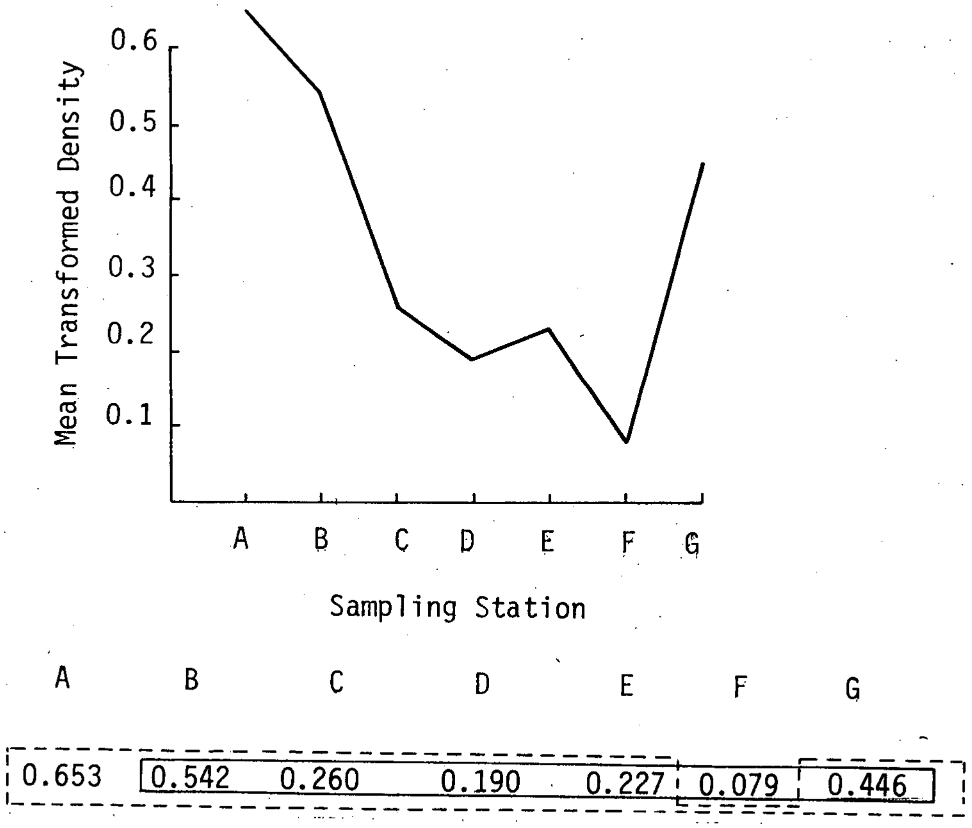


Figure V-4. Distribution of Striped Bass Eggs among Seven Sampling Stations in Indian Point Area and Results of Newman-Keuls Test (No Significant Difference [p greater than 0.05] Exists between Any Two Members of a Grouping; Values Are Mean Transformed [$\sqrt{X}$] Densities, Indian Point Study, New York University, 1976)

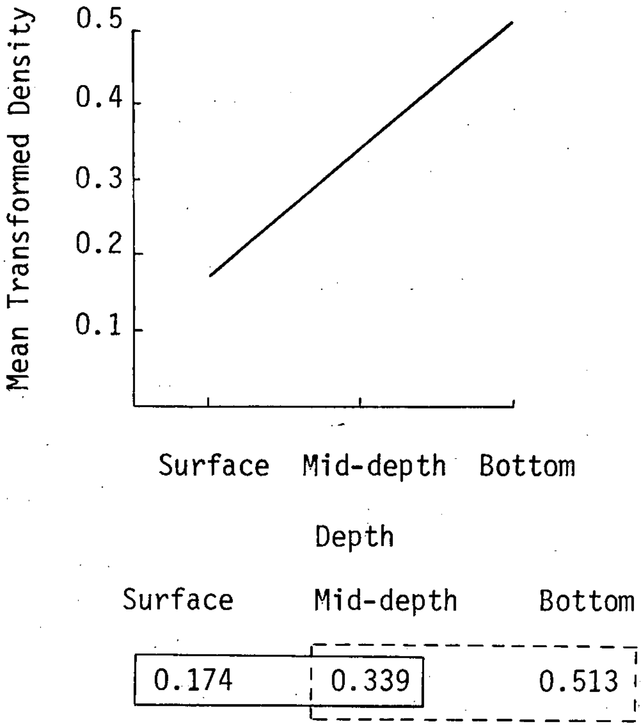


Figure V-5. Depth Distribution of Striped Bass Eggs in Indian Point Area and Results of Newman-Keuls Test (No Significant Difference [p greater than 0.05] Exists between Any Two Members of a Grouping; Values Are Mean Transformed [$\sqrt{X}$] Densities, Indian Point Study, New York University, 1976)

b. Yolk-Sac Larvae

1) Geographic Distribution

a) Distribution during 1976

Striped bass yolk-sac larvae were collected in every region within the study area but were never abundant in the farthest upriver region (Albany) or the farthest downriver region (Yonkers). Densities greater than 100 yolk-sac larvae/1000 m^3 (in most instances, regional densities were less than 30 yolk-sac larvae/1000 m^3) were found during at least one sampling period in the regions from Indian Point through Hyde Park (RM 39-85 [KM 62-136]). During the three sampling periods (May 17-19, June 7-11, and June 14-17) when standing crops for the study area were greater than 100 million yolk-sac larvae, the largest proportions of the standing crops occurred in the Indian Point, West Point, and Poughkeepsie regions (Table V-2).

Table V-2

Percentage of Total Standing Crops of Striped Bass Yolk-Sac Larvae in 12 Geographic Regions of Hudson River Estuary during Each of 10 Sampling Periods, May-June 1976

Geographic Region	Sampling Date May 3 - May 5	May 10 - May 13	May 17 - May 19	May 24 - May 26	Jun 1 - Jun 4	Jun 7 - Jun 11	Jun 14 - Jun 17	Jun 21 - Jun 24	Jun 28 - Jul 1	Jul 26 - Jul 29
YK	*		0.5	3.2						
TZ		3.4	18.3	46.0	0.8	2.0		1.1		100.0
CH		25.4	8.3	19.9	3.1	2.8	2.3	0.6		
IP		19.7	33.7	20.8	18.8	14.7	17.0	23.2	20.4	
WP		7.6	20.4	7.7	12.0	16.9	23.7	74.0	68.1	
CW	100.0	11.9	6.7	1.6	11.5	11.2	11.1	1.1	11.5	
PK		30.6	10.6	0.9	43.5	35.2	22.7			
HP		1.4	0.9		6.0	8.4	14.6			
KG			0.5		3.6	2.0	4.6			
SG					0.7	6.3	2.6			
CS						0.4	1.4			
AL			<0.1							
Total (%)	100.0	100.0	99.9	100.1	100.0	99.9	100.0	100.0	100.0	100.0
Total Standing Crops (Thousands)	59	1733	116399	18150	47796	100651	152272	15034	260	33

*No entry indicates no yolk-sac larvae collected

b) Trends in Distribution (1974, 1975, 1976)

The geographic distribution indices of striped bass yolk-sac larvae showed minor differences from 1974 through 1976 (Figure V-6). The geographic indices for 1975 and 1976 were similar, exhibiting a broad peak in the Indian Point and West Point regions, but a second peak in the Poughkeepsie region was more pronounced in 1976 than in 1975. During 1974, the Indian Point-West Point peak was absent and the Poughkeepsie peak predominated. The index value was greater than ten (in most instances the index value was less than five) in only the Indian Point through Poughkeepsie regions, indicating only limited displacement of yolk-sac larvae from the areas of peak egg concentration.

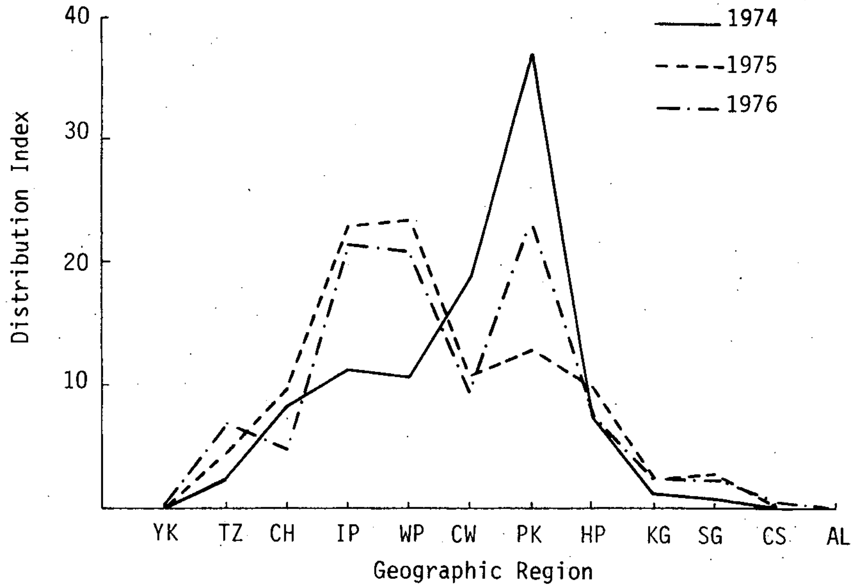


Figure V-6. Trends in Geographic Distribution of Striped Bass Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

2) Temporal Distribution

a) Distribution during 1976

Yolk-sac larvae were first collected in early May and most had transformed to the post yolk-sac stage by early July. Two peaks in larval abundance occurred during the season, one in mid-May, and the other in mid-June; standing crops in the study area were greater than 100 million yolk-sac larvae during these periods. As expected, peaks in the abundance of yolk-sac larvae occurred concurrently with or shortly after peaks in the abundance of striped bass eggs, but the major mid-June peak in the standing crop of yolk-sac larvae followed a minor peak in egg abundance.

b) Trends in Distribution (1974, 1975, 1976)

The temporal distribution index of yolk-sac larvae differed from year to year (Figure V-7). The 1974 index exhibited three peaks, two in late-May and the last in mid-June. In contrast, the 1975 index showed one predominant peak in late May, then declined precipitously in early June. During 1976, the index peaked twice, earlier in May and later in June than either 1974 or 1975. These differences may be due to environmental factors,

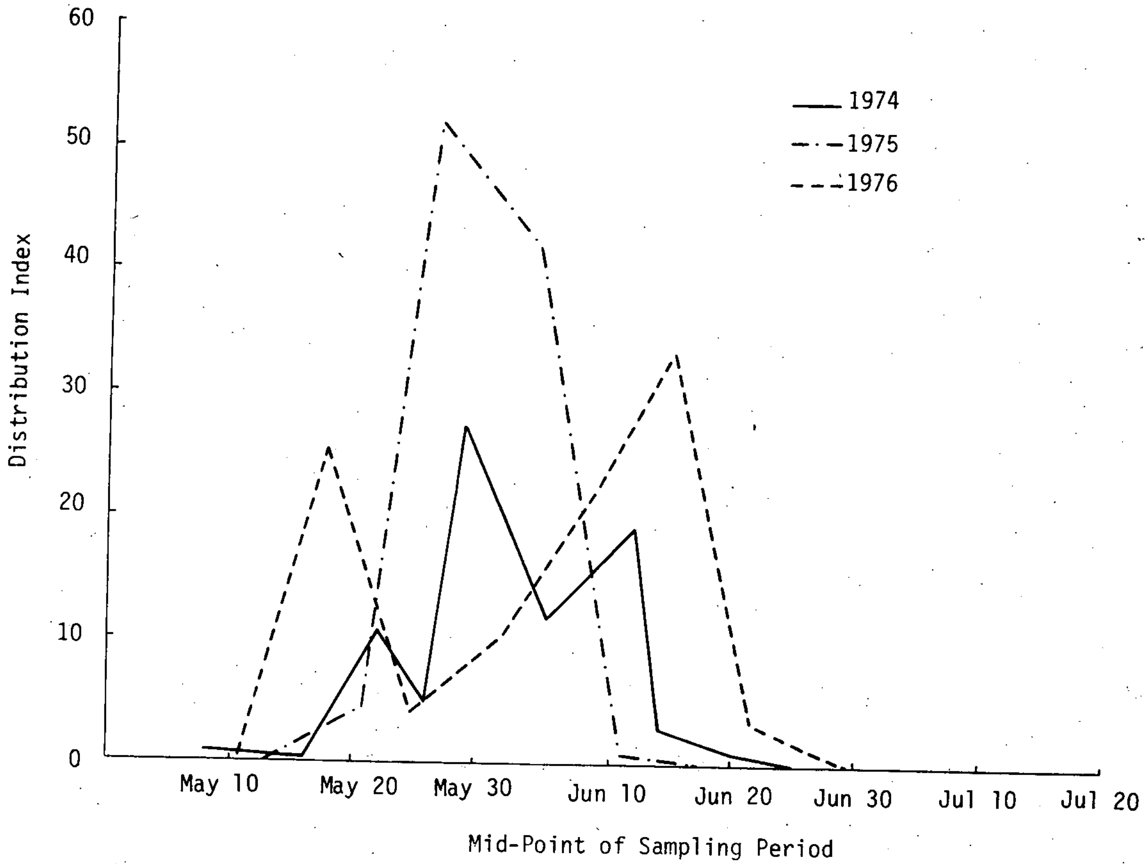
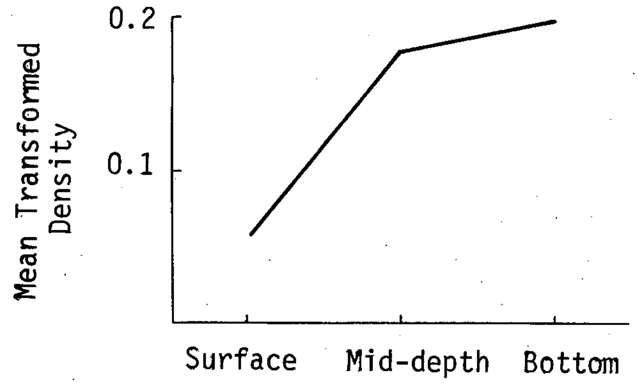


Figure V-7. Trends in Temporal Distribution of Striped Bass Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

particularly water temperature which affects spawning activity and rate of development. The lag which existed between the May peak in the temporal index of egg distribution and the June peak in the temporal index of yolk-sac larval distribution during 1976 may indicate the loss of large numbers of yolk-sac larvae to some unknown source of mortality in late May (Subsection IV.B.3.b.). The minor early June peak in the temporal distribution index for striped bass eggs (Figure V-2) apparently led to the observed major peak of yolk-sac larvae in mid-June.

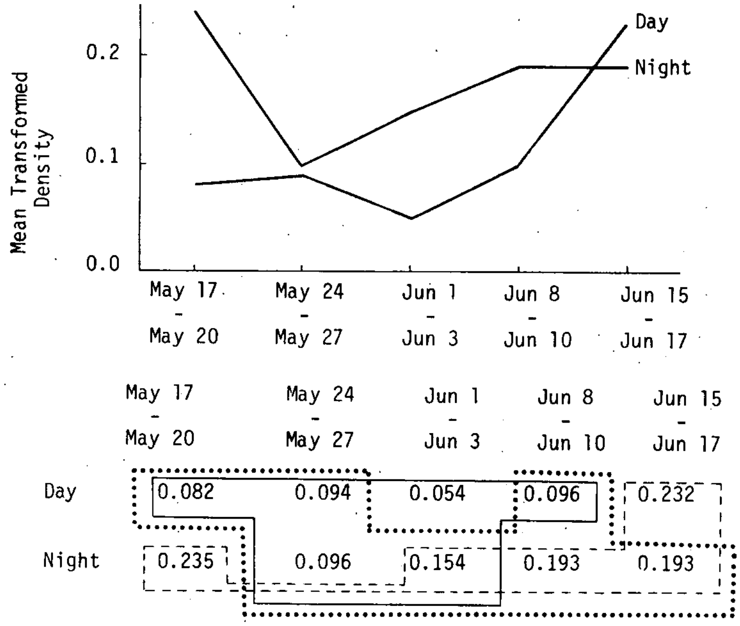
3) Distribution and Movements in Indian Point Area

One effect (relative depth) and two interactions (day/night x sampling period and station x sampling period) were significant in the analysis of variance (Appendix Table C-6) of the distribution of striped bass yolk-sac larvae in the Indian Point area during 1976. Like eggs, the yolk-sac larvae were more numerous near the bottom than near the surface (Figure V-8). Analysis of 1975 data (McFadden 1977) showed a day/night difference in depth distribution which was not evident in 1976. The day/night x sampling period interaction (Figure V-9) showed that more yolk-sac larvae were usually collected at night than during the day, suggesting avoidance of the 0.5-m nets during daylight. In three of the five sampling periods, the differences between day and night densities were not significant. Analysis of a second interaction, station x sampling period (Figure V-10), showed that the only difference was in the fifth sampling period (June 15-17) at Station A where the density of yolk-sac larvae was greater than at any other combination of sampling period and station. The reasons for this result are unknown but could have been related to tide and current conditions.



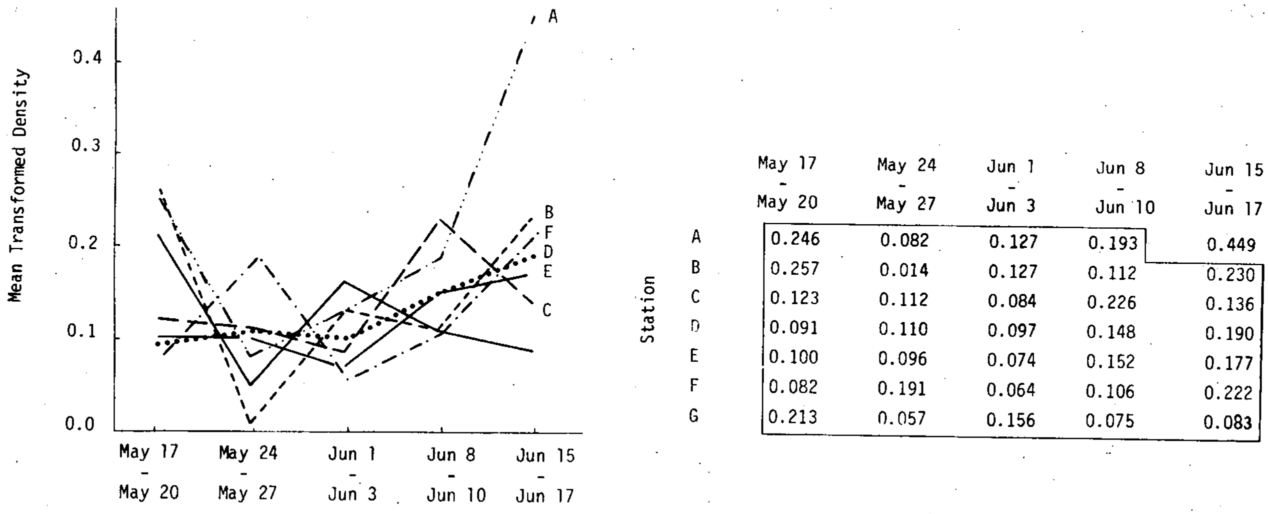
Surface	Mid-depth	Bottom
0.057	0.175	0.196

Figure V-8. Depth Distribution of Striped Bass Yolk-Sac Larvae in Indian Point Area and Results of Newman-Keuls Test (No Significant Difference [p greater than 0.05] Exists between Any Two Members of a Grouping; Values Are Mean Transformed [$\sqrt{X}$] Densities, Indian Point Study, New York University, 1976)



	May 17 - May 20	May 24 - May 27	Jun 1 - Jun 3	Jun 8 - Jun 10	Jun 15 - Jun 17
Day	0.082	0.094	0.054	0.096	0.232
Night	0.235	0.096	0.154	0.193	0.193

Figure V-9. Day/Night Distribution of Striped Bass Yolk-Sac Larvae during Five Sampling Periods in Indian Point Area and Results of Newman-Keuls Test on the Day/Night x Sampling Period Interaction (No Significant Difference [p greater than 0.05] Exists between Any Two Members of a Grouping; Values Are Mean Transformed [$\sqrt{X}$] Densities, Indian Point Study, New York University, 1976)



	May 17 - May 20	May 24 - May 27	Jun 1 - Jun 3	Jun 8 - Jun 10	Jun 15 - Jun 17
A	0.246	0.082	0.127	0.193	0.449
B	0.257	0.014	0.127	0.112	0.230
C	0.123	0.112	0.084	0.226	0.136
D	0.091	0.110	0.097	0.148	0.190
E	0.100	0.096	0.074	0.152	0.177
F	0.082	0.191	0.064	0.106	0.222
G	0.213	0.057	0.156	0.075	0.083

Figure V-10. Distribution of Striped Bass Yolk-Sac Larvae during Five Sampling Periods at Seven Stations in Indian Point Area and Results of Newman-Keuls Test on Station x Sampling Period (No Significant Difference [p greater than 0.05] Exists between Any Two Members of a Grouping; Values are Mean Transformed [X] Densities, Indian Point Study, New York University, 1976)

c. Post Yolk-sac Larvae

1) Geographic Distribution

a) Distribution during 1976

Striped bass post yolk-sac larvae were collected in the Yonkers through Catskill regions but were scarce in the Yonkers region and upriver from the Hyde Park region. Densities greater than 100 post yolk-sac larvae/ 1000 m^3 (in most instances, densities were less than 20 larvae/1000m^3) were found in every region from Croton-Haverstraw through Hyde Park during at least one sampling period. During the two periods (June 14 through 17 and June 21 through 24) when standing crops within the study area were highest, the largest proportions of these standing crops were found in the Croton-Haverstraw, Indian Point, and West Point regions (Table V-3). The geographic distribution of post yolk-sac larvae differed from that of yolk-sac larvae. The Croton-Haverstraw region contained a larger portion of the standing crop of the post yolk-sac larvae than yolk-sac larvae, and yolk-sac larvae were more concentrated upriver in the Poughkeepsie region.

Table V-3

Percentage of Total Standing Crops of Striped Bass Post Yolk-Sac Larvae in Twelve Geographic Regions of Hudson River Estuary during Each of Eight Sampling Periods, May-June 1976

Geographic Region	Sampling Date							
	May 24 - May 26	Jun 1 - Jun 4	Jun 7 - Jun 11	Jun 14 - Jun 17	Jun 21 - Jun 24	Jun 28 - Jul 1	Jul 6 - Jul 9	Jul 12 - Jul 15
YK	*				0.2	0.3	9.4	
TZ	100.0	18.3	12.2	6.4	3.4	12.5	28.6	56.0
CH		35.3	5.4	5.9	24.2	18.8	20.1	4.0
IP		34.3	5.1	23.7	36.0	46.8	9.0	3.1
WP		4.1	7.8	22.2	21.4	8.0	15.8	8.2
CW			3.5	12.2	6.3	2.9	2.9	8.2
PK		8.0	61.5	15.0	5.6	6.5	5.2	6.7
HP			4.1	11.4	1.1	2.9	4.8	10.4
KG			0.4	2.7	1.4	0.9	3.6	
SG				0.6	0.1	0.3	0.6	
CS					0.1			3.7
AL								
Total(%)	100.0	100.0	100.0	100.1	99.8	99.9	100.0	100.3
Total Standing Crops (Thousands)	47	804	24191	242065	184805	47211	8320	1863

*No entry indicates no post yolk-sac larvae collected

b) Trends in Distribution (1974, 1975, 1976)

Only minor differences occurred in the geographic distribution index for striped bass post yolk-sac larvae in 1974, 1975, and 1976 (Figure V-11). The indices were highest in the Indian Point region, followed by the West Point, Poughkeepsie, Croton-Haverstraw, and the Cornwall regions indicating that post yolk-sac larvae were abundant over a larger area than yolk-sac larvae or eggs.

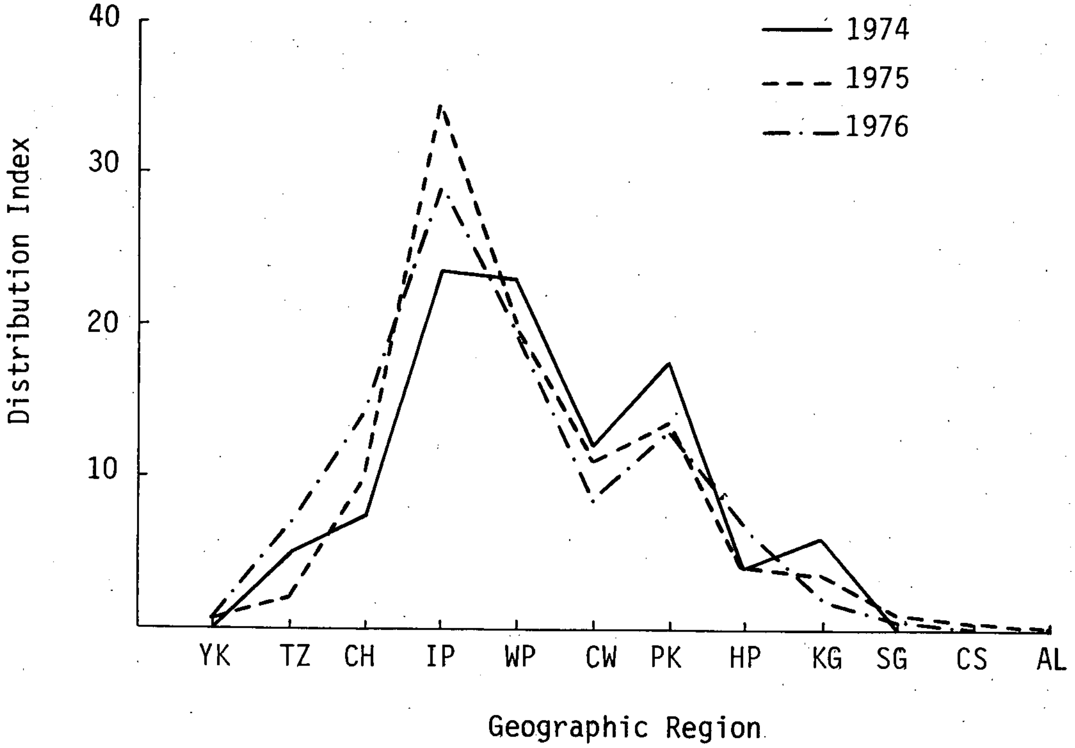


Figure V-11. Trends in Geographic Distribution of Striped Bass Post Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

2) Temporal Distribution

a) Distribution during 1976

Striped bass post yolk-sac larvae were present in the study area from late May through mid-July with a distinct peak in abundance from mid- to late June. The peak was simultaneous with the mid-June peak in the abundance of yolk-sac larvae. Standing crops during the two sampling periods of highest abundance (June 14 through 17 and June 21 through 24) were greater than 180 million post yolk-sac larvae.

b) Trends in Distribution (1974, 1975, 1976)

The temporal distribution index attained its highest value for the year on June 20 in 1974, on June 4 in 1975, and on June 15 in 1976 (Figure V-12). The 1976 peak coincides with the peaks in the temporal index for yolk-sac larvae (Figure V-7), but the 1974 and 1975 peaks of post yolk-sac larval abundance occurred a week later than the peaks for the yolk-sac stage during those years. The early peak in 1975 was probably due to the same factors that caused the early peak in the 1975 temporal distribution index of yolk-sac larvae. The temporal distribution of striped bass post yolk-sac larvae clearly differed among the three years indicating that environmental variables can cause variation in the timing of periods of peak abundance.

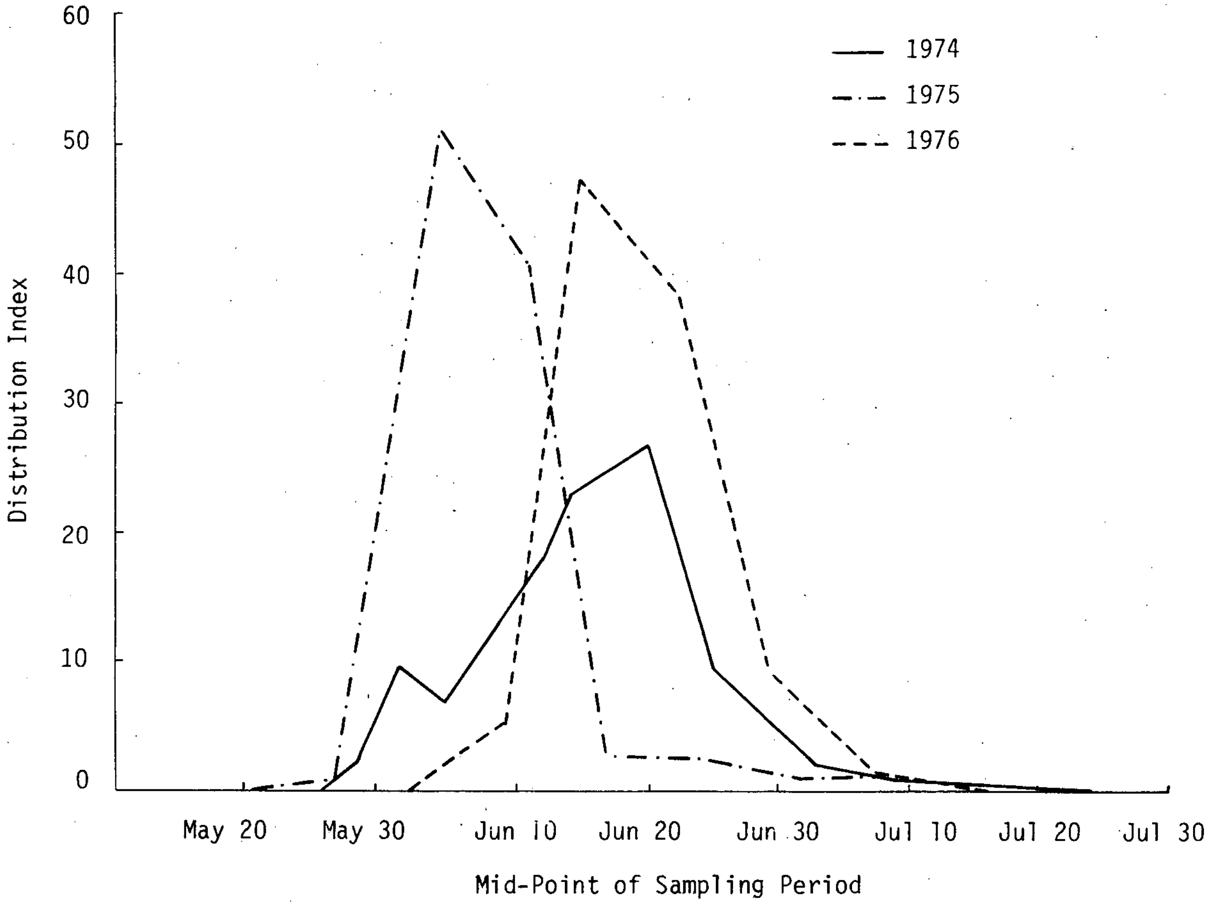


Figure V-12. Trends in Temporal Distribution of Striped Bass Post Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

d. Juveniles

1) Geographic and Temporal Distribution during 1976

In the offshore bottom waters, juvenile striped bass were collected in almost every regions from their first appearance during mid-June through early July (Appendix Tables C-10, 11). They were most abundant in the Croton-Haverstraw and Tappan Zee regions, but during July large numbers of juveniles were found in the Hyde Park through Saugerties regions. Highest standing crops of juveniles occurred in the Croton-Haverstraw and Tappan Zee regions during August. During late October and continuing through mid-December, standing crops in the offshore bottom waters declined.

Striped bass quickly migrate to shore zone areas after they gain motility in the late post yolk-sac larval stage or as early juveniles (McFadden 1977). Juvenile striped bass were collected in almost every region from their first appearance in the shore zone during late-June and early-July. Most of the population was in the Croton-Haverstraw or Tappan Zee regions (Table V-4; Appendix Table C-14). Distribution indices were relatively low from the Poughkeepsie through Albany regions. Shore zone standing crops were highest during mid-July and mid-August and later declined. No juveniles were collected in the shore zone from mid-October to December in the Hyde Park through Albany regions, therefore, indicating a general downstream movement.

Visual inspection of the 1976 data by gear type indicates that juvenile striped bass were most abundant in the Croton-Haverstraw and Tappan Zee regions in both the shore zone and deeper waters during most of the sampling season. However, during July in the Hyde Park through Saugerties regions, many juvenile striped bass were in the deeper waters while few were in the shore zone. During the late fall, juvenile striped bass were dispersed between Yonkers through Poughkeepsie in the shoals and the shore zone (see Section IV). By late November, few juveniles were in the shore zone.

Table V-4

Percentage of Total Standing Crop of Juvenile Striped Bass in 12 Regions of Hudson River Estuary during Each of 12 Beach Seine Survey Sampling Periods, June - December 1976

	Sampling Date											
Geographic Region	Jun 27 - Jul 10	Jul 11 - Jul 24	Jul 25 - Aug 7	Aug 8 - Aug 21	Aug 22 - Sep 4	Sep 5 - Sep 18	Sep 19 - Oct 2	Oct 3 - Oct 16	Oct 17 - Oct 30	Oct 31 - Nov 13	Nov 14 - Nov 27	Nov 28 - Dec 11
YK	0.2	5.5	8.9	7.3	10.1	14.0	13.4	12.5	25.3	34.2	75.2	NS**
TZ	48.4	22.5	27.0	46.2	47.2	31.9	38.0	38.4	47.5	32.8	21.6	
CH	6.7	39.7	25.0	19.2	26.4	33.4	38.1	37.4	21.2	24.7	2.1	79.9
IP	5.0	3.5	8.5	6.5	3.3	5.5	3.4	4.4	2.3	6.4	1.1	16.9
WP	21.2	2.1	2.7	0.6	3.6	2.0	1.5	1.1	0.6			3.2
CW	7.9	14.6	13.7	5.5	3.8	4.7	1.5	3.0	0.8	0.7		
PK	0.5	1.7	1.0	2.4	1.2	0.6	0.5	0.8	2.0	1.2		NS
HP	*	0.8	0.9	0.2	0.2	0.2			0.2			NS
KG	6.3	7.6	2.1	0.2	1.8	0.9		0.6				NS
SG	3.8	1.2	7.0	6.7	1.5	3.5						NS
CS		0.7	3.0	4.3	0.6	2.0	3.0	1.2				
AL			0.3	0.9	0.2	1.3	0.5	0.5				
Total (%)	100.0	99.9	100.1	100.0	99.9	100.0	99.9	99.9	99.9	100.0	100.0	100.0
Total Standing Crop (Thousands)	172	1022	720	1045	809	670	900	460	486	151	105	10

*No entry indicates no juveniles collected.
**NS = No Sample

2) Trends in Distribution (1974, 1975, 1976)

The geographic distributions of juvenile striped bass in the shore zone was similar during 1974, 1975, and 1976 (Figure V-13). Geographic distribution indices calculated from beach seine standing crops indicated that most juvenile striped bass were present in the Croton-Haverstraw or Tappan Zee regions and few were found in other regions.

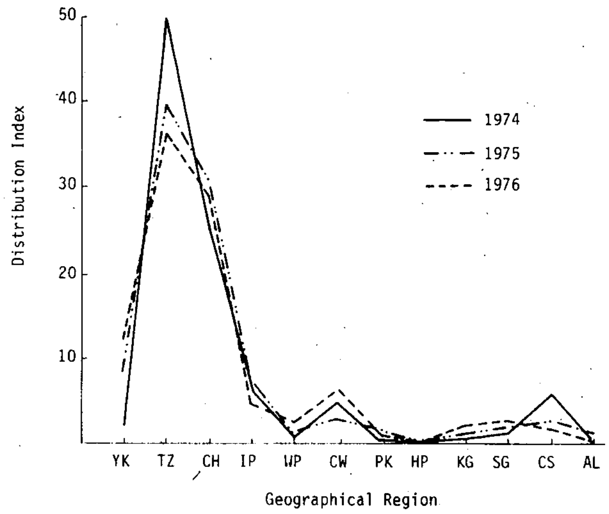


Figure V-13. Trends in Geographic Distribution of Juvenile Striped Bass Collected in Beach Seines in Hudson River Estuary, 1974-1976

The temporal distribution pattern of juvenile striped bass varied considerably over the three year period from July through September (Figure V-14). The percentage of juveniles in the shore zone during July and most of August 1976 was higher than during July and most of August in both 1974 and 1975. However, from late August through most of September in 1974 and 1975, the percentage of juveniles in the shore zone increased, while during 1976, shore zone percentages decreased. By late September, the percentages of juveniles in the shore zone were similar for all three years and decreased except for brief increases during late October or early November. By late November, few juvenile striped bass appeared in the shore zone.

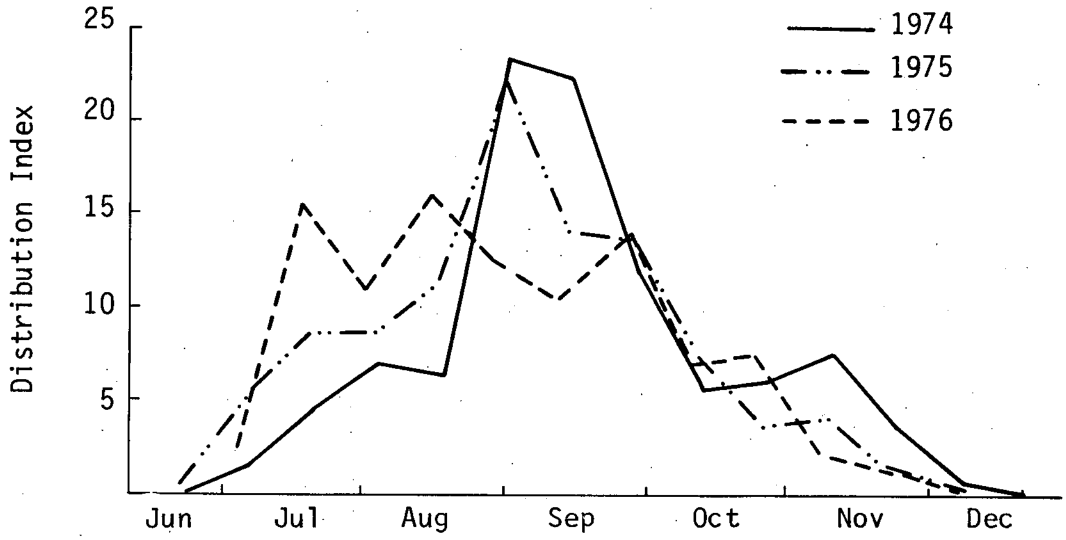


Figure V-14. Trends in Temporal Distribution of Juvenile Striped Bass Collected in Beach Seines in Hudson River Estuary, 1974-1976

Juvenile striped bass were more concentrated in shoal areas during 1976 in the Croton-Haverstraw and Tappan Zee regions than during 1975 when they were most abundant between the Indian Point and Poughkeepsie regions. The trend observed in the shore zone (Figure V-14) was similar in the shoals, i.e., highest standing crops occurred during August in 1976, and during late September through early October in 1975.

During 1976, the population of juvenile striped bass was concentrated farther downstream in both the offshore and in the shore zone than during 1974 or 1975. The juveniles also moved into these lower river regions earlier in 1976 than in either 1974 or 1975.

3) Interregional Movements during 1976-1977

Over 8,000 juvenile striped bass were finclipped during the fall of 1976 (Table V-5). Fall recaptures showed very little movement between regions (Figure V-15 and Appendix Table C-21). Almost all recaptures occurred in the region of original release and this pattern of limited interregional movement was also observed in previous studies (TI 1977b, 1978a). Of the few juvenile striped bass that did move between regions, eight moved downriver while four moved upriver. Only long range movements could be detected by the study because of the large size of the marking regions and the short time interval between release and recapture. However, tagging studies of yearling striped bass suggest that there is a limited home range for young striped bass (Subsection e.5).

Table V-5

Mark-Recapture Regions and Number of Finclipped Striped Bass Released in Each Region during September-November 1976

Region	River Mile		Number of Fin Clips Released*
1	12-23		1,704
2	24-38		3,556
3	39-46		2,354
4	47-76		470
5	77-152		33
		Total	8,117

*Adjusted for 14-day mortality

	Recapture Region				
Release Region	1	2	3	4	5
1	90	2			
2	1	482	2		
3		2	120		
4		2	3	9	
5					

Movement		
Upriver	4	(1%)
Same region	701	(98%)
Downriver	8	(1%)

Figure V-15. Release-Recapture Matrix for Juvenile Striped Bass Finclipped during September-November 1976 and Recaptured from September-December, 1976

No juvenile striped bass finclipped during the fall of 1976 were recaptured during January through June 1977 and only one of the 749 striped bass finclipped in the spring of 1977 was recaptured during that period. That fish was released and recaptured in Region 2.

No consistent pattern of movement was evident from the recapture of juvenile striped bass finclipped in 1976, despite other evidence that juvenile striped bass do appear to emigrate from the river during the fall (TI 1977c). Undetected downriver movements may occur offshore in the channel or on the shoals where the striped bass are less vulnerable to recapture.

4) Movements to and from the Shore Zone during 1976

Data from the Beach Seine Survey and the Fall Shoals Survey for the Yonkers through Poughkeepsie regions were examined for indications of movement by juvenile striped bass between the shore zone and deeper water. During mid-August, most juveniles were in areas with depths of 20 ft or less (Figure V-16). During September, the juvenile population briefly shifted to areas deeper than 20 ft and then back into shallower depths. A fluctuating pattern then occurred as the fish appeared to move freely between the shore zone and shoal areas, but by late October, most juveniles were in the shore zone, a trend which continued through early November. Movement to deeper

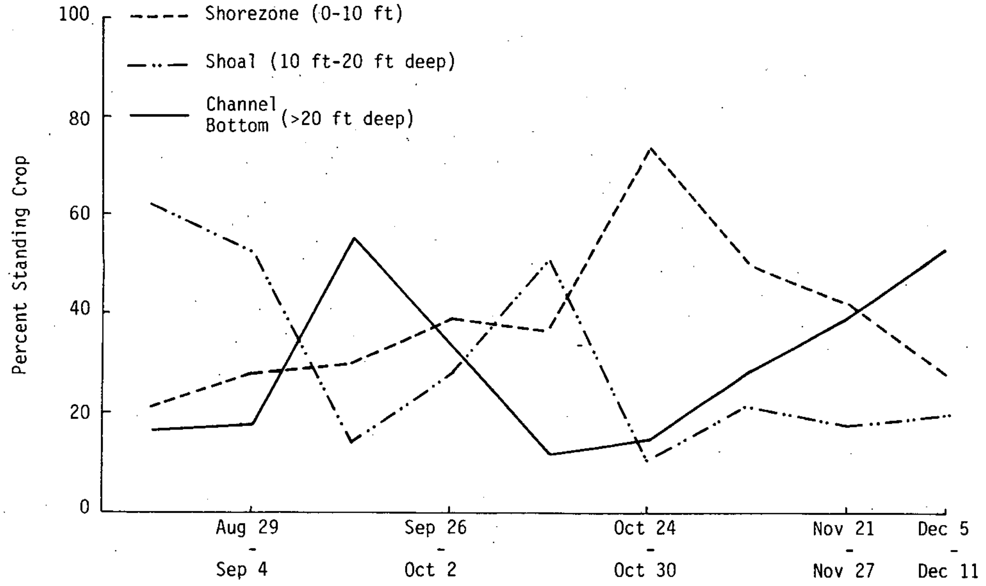


Figure V-16. Depth Distribution of Juvenile Striped Bass in Hudson River Estuary, August-December, 1976

water was observed during October and November of 1976, although some juvenile striped bass remained in shallow areas until the early winter. This pattern differs considerably from the pattern observed during 1975 (McFadden 1977) when movements to the shore zone were more dramatic in September.

e. Yearlings

1) Geographic and Temporal Distribution during 1977

During the first half of 1977, yearling striped bass from the 1976 year class were present in the shore zone from the beginning of the sampling season in April, although standing crops were relatively low compared to later months (Appendix Tables C-15-17). The standing crops in the shore zone increased gradually during May when yearlings were most abundant in the Tappan Zee and Croton-Haverstraw regions and none were taken above Indian Point during this time. By June they had become widespread throughout the estuary, although most of the population still appeared in the Tappan Zee and Croton-Haverstraw regions. By late June, yearling numbers began to decline in the shore zone as they apparently moved offshore.

2) Trends in Distribution (1974, 1975, 1976 Year Classes)

An examination of beach seine data indicated most yearling striped bass of the 1974, 1975, and 1976 year classes were located in the Tappan Zee region, few were present in the Indian Point through Saugerties regions and, depending on the year, numbers increased slightly in the upriver Catskill or Albany regions (Figure V-17). Yearling striped bass were common in shorezone areas from April through June or July, depending on the year. During the spring of 1977, yearling striped bass were more abundant than the previous two years. During 1976, few yearling striped bass were caught in the lower Hudson, few were collected after July, and by mid-November, most had moved away from the shore areas (Figure V-18).

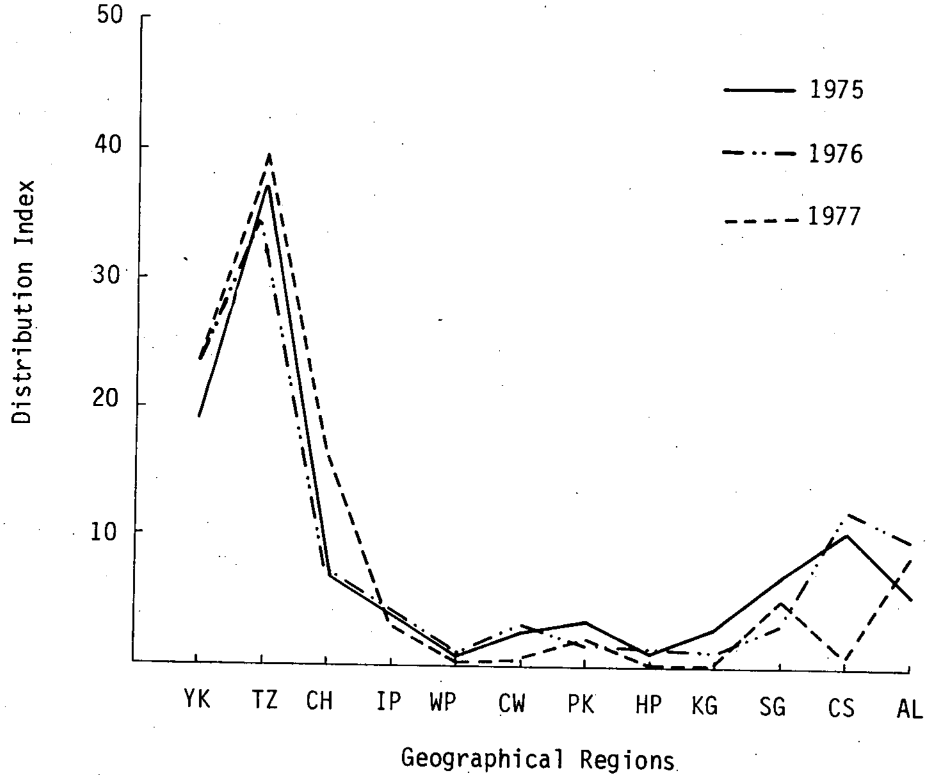


Figure V-17. Trends in Geographic Distribution of Yearling Striped Bass Collected in Beach Seines in Hudson River Estuary, 1975-1977

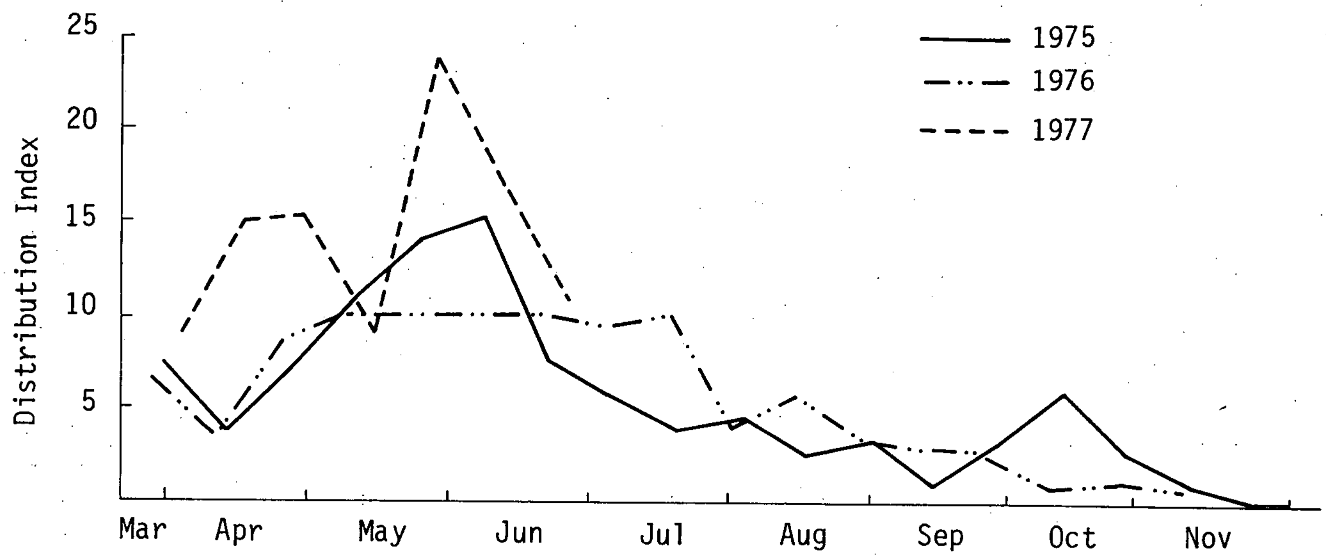


Figure V-18. Trends in Temporal Distribution of Striped Bass Yearlings Collected in Beach Seines in Hudson River Estuary, 1975-1977

3) Interregional Movements

Fifty-four yearling and two-year-old striped bass were tagged and recaptured during the fall of 1976; only three moved away from the site of release (Appendix Table C-20). One yearling tagged in September at RM 38 (KM 61) was recaptured that month at RM 39 (KM 62). Two others recaptured in November showed greater movement: one tagged in October at RM 35 (KM 56) was recaptured at RM 13 (KM 21), the other tagged at RM 42 (KM 67) in November and caught by a sport fisherman at RM 9 (KM 14). During the period September to October, 16 fish were released and recaptured more than once; one as many as seven times. None of the 16 fish moved away from the river mile of release.

Seven striped bass tagged as yearlings in 1976 and recaptured from January through July 1977 moved greater distances (Table V-6). Three moved downriver an average of 38 miles. One exhibited no movement. The other three moved upriver: 23, 33 and 92 miles. Movement was upriver as well as downriver; therefore, emigration from the river was not clearly indicated.

Table V-6

Striped Bass Marked with Fingerling Tags during 1976 and Recaptured from January-July 1977, Hudson River Estuary

Tag Number	Release			Recapture				
	Date	River Mile	Total Length (mm)	Date	River Mile	Days at Large	Movement (mi)	Direction
5-40117	9/24/76	57	175	2/23/77	3	151	54	Downriver
5-44240	10/25/76	42	213	3/12/77	3	137	39	Downriver
5-37400	9/7/76	60	176	6/8/77	38	273	22	Downriver
5-46939	11/9/76	42	169	6/18/77	75	220	33	Upriver
5-40585	9/27/76	60	218	7/1/77	152	276	92	Upriver
5-39381	9/20/76	60	217	7/27/77	60	309	0	No movement
5-46932	11/9/76	42	218	7/27/77	65	259	23	Upriver

The lack of movement during September and October suggests that some striped bass restrict their movements to a limited area until reaching a certain age or size or receiving some environmental cue to migrate. Data from 1975 recaptures of yearling and older striped bass also support a home range hypothesis for striped bass in effect until a certain time of year or maturity (TI 1978a).

f. Distribution of Striped Bass in Relation to Physicochemical Factors

1) Objectives

The range of and highest density for each life stage were compared for each year from 1974 through 1976 in order to determine general associations between life stage distribution and physicochemical factors.

2) Results and Discussion

Spawning activity of striped bass was related to conductivity, temperature, and dissolved oxygen (Table V-7). Striped bass spawned in areas of low conductivity [less than 0.3 m S/cm (0.3 mmhos/cm) or about 0.17 $^{o}/oo$ salinity at 25°C] during the three years (1974 through 1976) studied. Spawning began when temperatures reached 12°C and peaked at temperatures between 16 and 20°C, depending on the year studied. Striped bass spawned as long as the temperature remained over 12°C, however temperatures may influence incubation success (Bayless 1972). Most eggs were collected at slightly higher temperatures in 1975 and 1976, thus hatching time should have been shorter in those years. Most eggs occurred in areas where dissolved oxygen (D.O.) levels were greater than 7. O'Malley and Boone (1972) reported that eggs exposed to D.O. concentrations between 4.9 and 9.8 mg/l developed normally, so egg survival in the Hudson River then was probably not influenced by dissolved oxygen levels in 1974 through 1976.

The range of temperature and conductivity at which yolk-sac larvae occurred was similar to that observed in previous years. They were found in temperatures of 12 to 26°C during 1974 through 1976 (Table V-7). As observed for eggs, peak yolk-sac larvae densities occurred at higher temperatures in 1975 and 1976 compared to 1974, but all temperature ranges were within the limits for larval survival (McFadden 1977). Some larvae occurred in areas where conductivity was greater than 0.3 mS/cm, but most were still found at or just above the saltfront (i.e., the freshwater/saltwater interface, which is defined by TI as 0.3 mS/cm). Since striped bass larvae reared at salinities of 4 to 14 ^{o}/oo (7 to 23 mS/cm) had higher survival and growth rates than those reared in freshwater (Doroshev 1970), conditions for Hudson River larvae may have been less than optimal if the survival and growth observations in the laboratory apply to larvae under natural conditions. However, other factors such as food availability or competition may have led to the presence of larvae at lower salinities than would be predicted by Doroshev's study (1970).

Yolk-sac larvae were collected over a wide range of dissolved oxygen concentrations in 1974 and 1976, with peaks in 1975 and 1976 over 6 mg/l; many were taken at higher levels. In 1974, larvae were collected in areas where D.O. was less than 2 mg/l. The survival of larvae subjected to concentrations of 2 mg/l was probably low, but this is dependent upon the length of exposure and the physical condition of the larvae.

There are two major changes in striped bass distribution as they enter the post yolk-sac stage. Although the water temperatures at highest densities of eggs and yolk-sac larvae differed for 1975-76 from 1974, and

Table V-7

Ranges of Physicochemical Factors and Values at Highest Densities (Greatest Catch/Effort) Associated with Striped Bass Eggs and Larval Distribution

		Eggs			Yolk-Sac Larvae			Post Yolk-Sac Larvae		
Parameter		1974	1975	1976	1974	1975	1976	1974	1975	1976
Temperature (°C)	Range	10-24	12-24	12-24	12-26	12-26	12-24	14-28	16-30	14-26
	Highest Density	14-16	18-20	14-16	16-18	18-20	18-20	20-22	20-22	20-22
Conductivity (m S/cm)	Range	<0.3-0.6	<0.3-3	<0.3-5	<0.3-7	<0.3-11	<0.3-17	<0.3-17	<0.3-19	<0.3-15
	Highest Density	<0.3	<0.3	<0.3	<0.3-0.6	<0.3	<0.3	0.3-1	1-3	0.3-0.6 (3-5)
Dissolved Oxygen (mg/ℓ)	Range	1-13	6-11	7-13	1-13	6-11	5-13	1-13	4-11	4-12
	Highest Density	9-10	8-9	9-10	0-2 (12-13)*	9-10	8-9	12-13 (8-9)	8-9	8-9

*Values in parenthesis are first minor peaks

changed substantially during the three years, the greatest densities for striped bass post yolk-sac larvae occurred first at 20°C in all years (Appendix Table C-22 and Figure V-19). By the third lifestage, mechanisms such as the rate of larval development through earlier stages, changes in larval mortality, and shifts in distribution patterns have led to the highest densities of post yolk-sac larvae first appearing at 20°C. The action of these factors in leading to highest densities at a consistent temperature over a period of years can be referred to as a synchronization of the larval populations with the temperature regimes found during the spring and summer. Evidence that the first of these mechanisms is important can be seen in the 1976 data. Individuals forming the first catch of yolk-sac larvae in that year died off before they could develop into post yolk-sac larvae, possibly due to temperatures below 12°C after the first occurence of yolk-sac larvae (Subsection V.B.1.c.3 and Appendix Tables C-22). In other years and at the time of the occurrence of the second peak of yolk-sac larvae, 1976 temperatures were within the range necessary for survival (McFadden 1977).

A second important change in distribution of post yolk-sac compared to yolk-sac larvae and eggs is that the post yolk-sac larvae were found in areas of higher conductivity - highest densities are at 0.3 up to 5 mS/cm

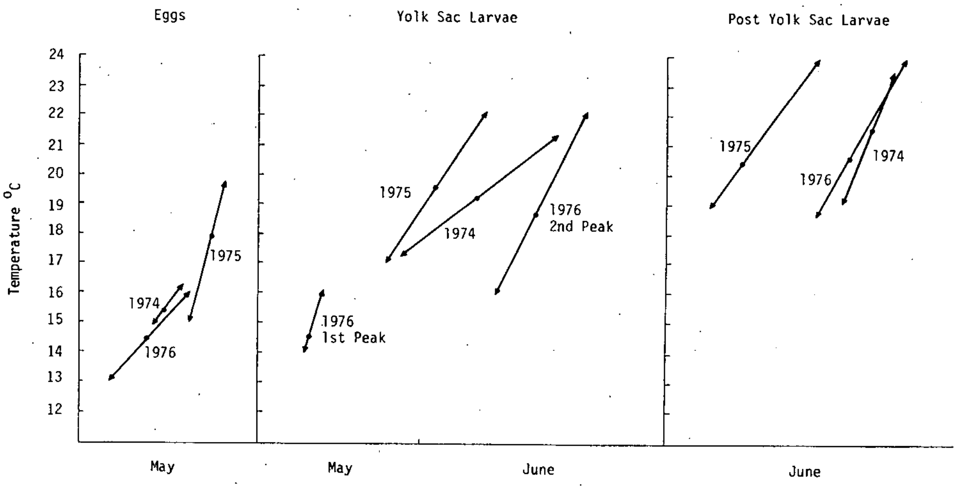


Figure V-19. Temperatures in Hudson River Occurring during Egg and Larval Life Stages of Striped Bass, 1974-1976 (Maximum, Minimum, and Mean (Dot) Temperatures Are Shown)

(Table V-7). Since salinities of 4 to 14 $^{o}/oo$ (about 7 to 23 mS/cm) improved survival among hatchery-reared larvae (Doroshev 1970, Bayless 1972), this change apparently reduces mortality. Whether the occurrence in waters of higher conductivity is due to active selection or passive drift with the net downstream movement is unknown. This distributal change is not related to dissolved oxygen levels, since larvae occurred in D.O. greater than 5 mg/l in 1974-1976.

Most striped bass juveniles are found in waters with conductivities of 5 to 23 mS/cm, thus continuing the trend seen with post yolk-sac larvae. This reflected in the trend for net downstream movement seen in the longitudinal distribution (Subsection V.B.1.d.3). Highest densities of striped bass were found in areas below the saltfront and while densities of white perch were found in areas above the saltfront (Subsection V.C.1.c.). Juvenile distribution was not limited by dissolved oxygen. Most fish were caught where dissolved oxygen levels ranged from 4 to 10 ppm (Table V-8).

Juvenile striped bass were found over a wide range of temperatures, from 2 to 32°C (Table V-8). They showed a movement to the shore zone and beaches (Subsection V.B.1.d.3) as water temperatures reach summer maximas (Table V-7). Peak catches of juveniles were found between 28 and 32°C in

Table V-8

Range of Physicochemical Parameters and Values at Highest Densities (Greatest Catch/Effort) Associated with Striped Bass Juvenile Distribution (Values in Parentheses are First Minor Peak)

Parameter		Beach Seine			Fall Shoals			Plankton			Bottom Trawl		
		1974	1975	1976	1974	1975	1976	1974	1975	1976	1974	1975	1976
Temperature (°C)	Range	2-32	4-32	2-32	4-28	4-26	–	18-28	22-28	22-26	4-26	4-28	6-26
	Highest Density	30-32	30-32	26-28	22-24	18-20	–	26-28	24-26	24-26	8-10 (4-6)*	20-22	24-26
Conductivity (m S/cm)	Range	<0.3-27	<0.3-19	<0.3-25	<0.3-19	<0.3-15	–	<0.3-17	<0.3-15	<0.3-13	<0.3-25	<0.3-13	<0.3-13
	Highest Density	5-7	15-17	21-23	5-7	9-11	–	0.6-1	11-13	9-11	23-25	<0.3	<0.3
Dissolved Oxygen (mg/ℓ)	Range	4-16	3-16	3-15	2-13	4-13	–	5-10	5-10	5-10	4-11	4-13	4-13
	Highest Density	12-13	3-4	3-4	6-7	4-5	–	7-8	6-7	8-9	4-5	6-7	6-7

*Values in parenthesis are first minor peaks

the three years studied. As the temperatures declined, fewer juveniles were found in beach seine catches (Subsection V.B.1.d.1); they first moved out to shoals (where peak densities occurred at 18 and 24°C) and then to other areas.

2. General Distribution and Movements of Two-Year Old and Older Fish

During the period 1972 through 1976, a tagging program was used to examine the migratory patterns of two-year old and older striped bass in and around the Hudson River estuary. Striped bass were tagged and released between RM 25 and RM 61, an area that includes much of the spawning ground within the Hudson River. The program was intensified during 1976; therefore, the resuts from that year are described in greater detail.

a. Movements During 1972-1975

The recapture of 71 tagged fish over the years 1972 through 1975 conclusively demonstrated that the migrations of Hudson River striped bass are not limited entirely to the vicinity of the Hudson River. Tagged fish were recovered from as far away as Boston Harbor, but none were recovered south of Rockaway, Long Island (McFadden 1977). Most (72%) of the 1,792 striped bass tagged and released during 1972 through 1975 were <300 mm TL. The movements of these small fish appeared to be confined to the Hudson

River, western Long Island Sound, and the southwestern shore of Long Island. Ten striped bass >800 mm TL, however, traveled an average of 343 km northeastward toward New England. Because of the limited data on the movement of intermediate size striped bass, the initial conclusion was that the distance migrated was positively related to the size of the fish; i.e. large fish migrate farther than small fish (McFadden 1977). One objective of the subsequent tagging in 1976 was to examine this possible phenomenon by obtaining more information on fish of intermediate size.

b. Movements During 1976

From 8 March through 30 June 1976, 2,406 Hudson River striped bass were captured (primarily by gill nets and haul seines), marked with nylon internal anchor tags (Floy FD-67C), and released in the river (Tables V-9 and V-10). Tag number, total length, date, time, location, and capture gear were recorded for each fish tagged and released. A scale sample was taken from each fish for age determination by the annulus method (Mansueti 1961a). The sex of the fish was recorded upon release if readily discernible. Most fish (87%) were released between RM 30-48 (KM 48-77); 93% of the fish were between 301 and 700 mm TL. Tagged fish were recovered by TI sampling efforts, other environmental contractors, and commercial and sport fishermen in the Hudson River and along the Atlantic coast. The tag number, date, method and area of capture were the information provided from a recaptured striped bass. However, areas of movement, timing of movements, days at large, sex, age, distance from the mouth of the river at time of recapture, and the extent to which various size groups undergo a migration from the river were all examined by matching the recapture with the release information.

From March - December 1976, 312 tagged striped bass were recovered (Appendix Table C-23) for a 13.0% recovery rate. Fish recovered near their released location less than 2 days after release (156 fish) were eliminated from further analysis. Of the remaining 156 recaptures, 149 had been released during 1976 (Figures V-20, V-21) and 7 had been released in previous years. Tagged striped bass were recaptured throughout the Hudson River estuary (north to Troy Dam, RM-152) and as far north along the Atlantic

Table V-9

Distribution of Total Lengths by Time Period of Striped Bass (Greater than 250 mm Total Length) Tagged and Released in Hudson River Estuary during 1976

Total Length (mm)	Time Period								
	Mar 15 - Mar 28	Mar 29 - Apr 11	Apr 12 - Apr 25	Apr 26 - May 9	May 10 - May 23	May 24 - Jun 6	Jun 7 - Jun 20	Jun 21 - Jun 30	Total
250-300	0	1	6	0	3	15	9	1	35
301-400	28	48	107	30	24	38	1	0	276
401-500	369	395	442	116	48	21	8	3	1402
501-600	74	129	98	43	14	19	8	4	389
601-700	11	26	60	11	23	22	4	2	159
701-800	0	6	6	4	14	11	3	1	45
801-900	1	0	9	7	7	13	4	0	41
901-1000	0	1	2	7	16	13	8	0	47
>1000	0	0	1	1	1	5	1	1	10
No length recorded	1	0	0	1	0	0	0	0	2
Total	484	606	731	220	150	157	46	12	2406

Table V-10

Number of Tagged Striped Bass (greater than 250 mm Total Length) Released in Hudson River Estuary during 1976

	Date of Release								
River Mile (km)	Mar 15 - Mar 28	Mar 29 - Apr 11	Apr 12 - Apr 25	Apr 26 - May 9	May 10 - May 23	May 24 - Jun 6	Jun 7 - Jun 20	Jun 21 - Jun 30	Total
<30 (48)	100	109	21	13	3	1	7	1	255
30-48 (48-77)	384	497	710	184	140	145	28	11	2099
>48 (77)	0	0	0	23	7	11	11	0	52
Total	484	606	731	220	150	157	46	12	2406

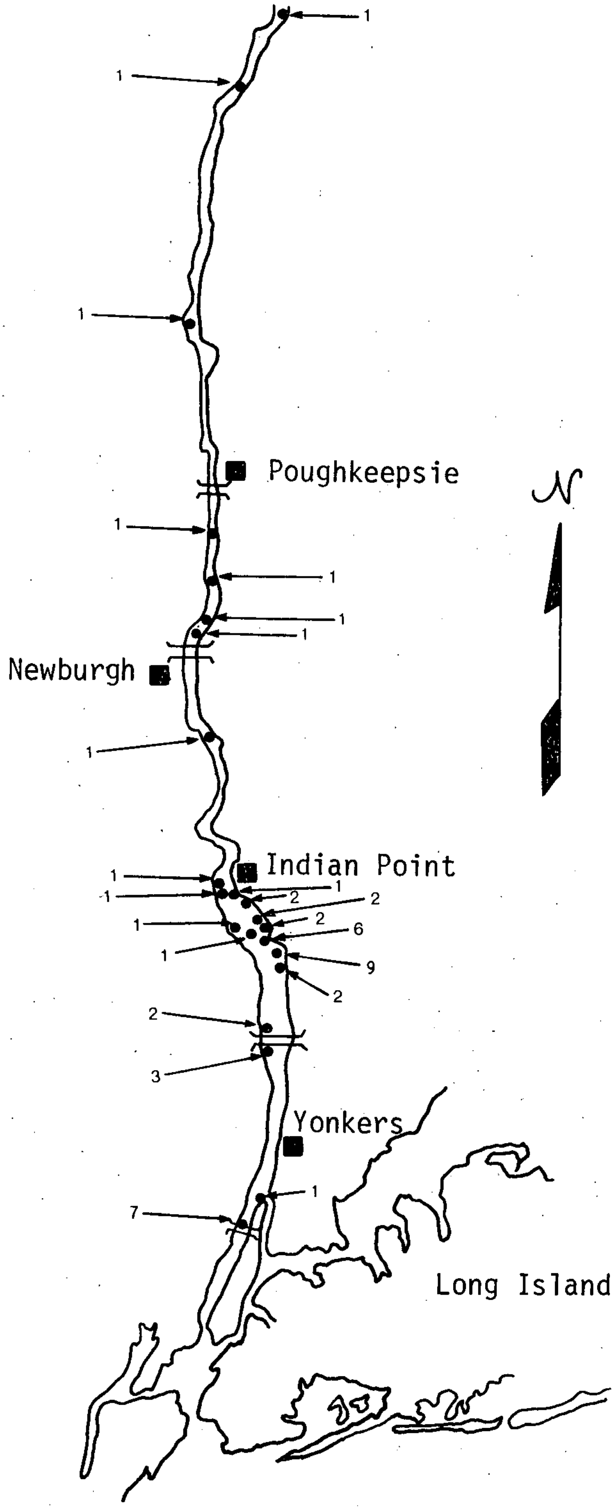


Figure V-20. Numbers and Recapture Locations of Adult Striped Bass Tagged and Released by TI and Recaptured in 1976 in Hudson River Estuary

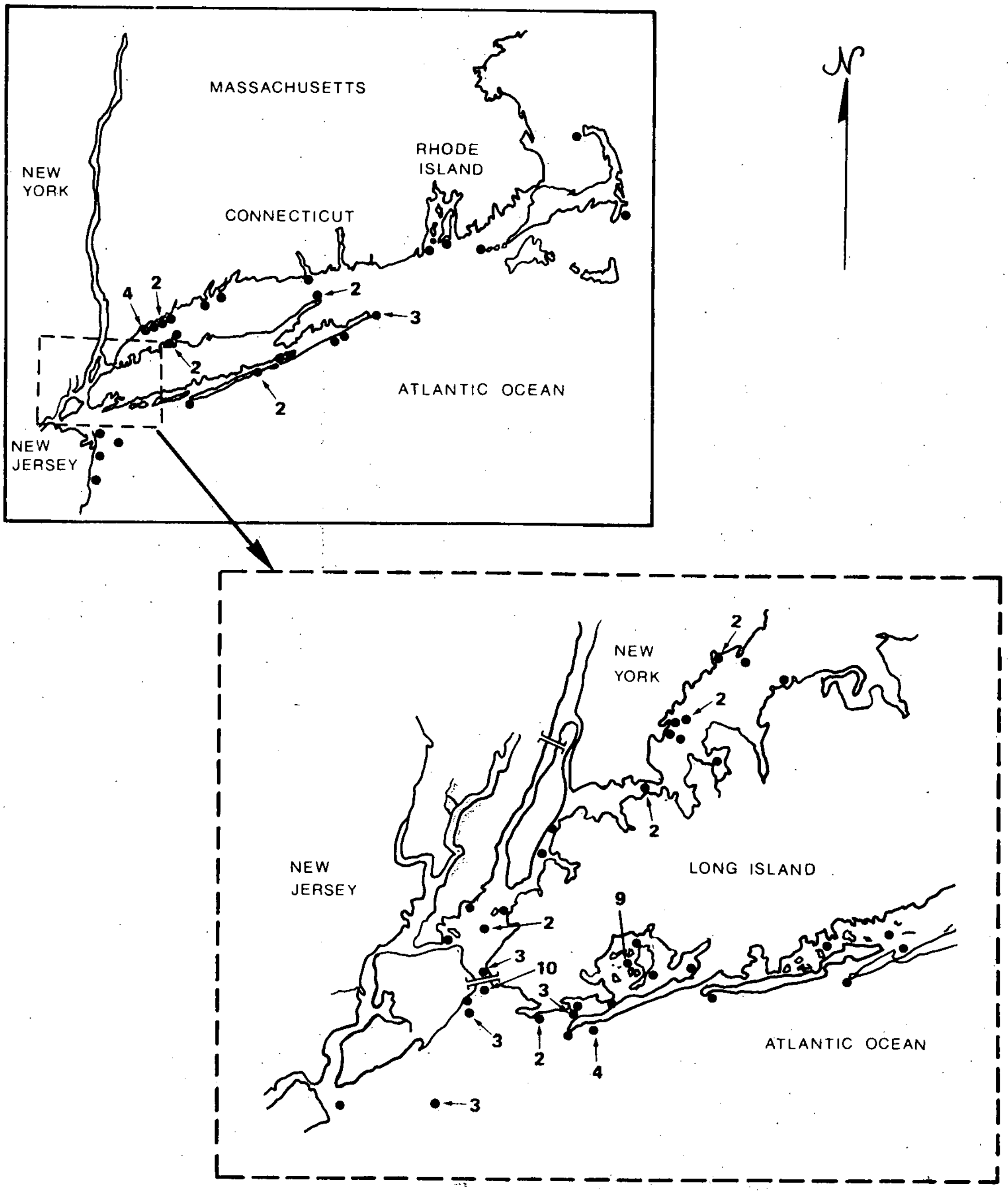


Figure V-21. Numbers and Recapture Locations of Adult Striped Bass from Areas outside Hudson River during 1976 (All Fish Were at Large Two or More Days). Single recaptures are denoted by unlabeled dots.

seaboard as the northern tip of Cape Cod. Most were recaptured near the mouth of the river, but those captured outside the river had generally traveled northeastward, results similar to earlier accounts of striped bass movements along the Atlantic Coast (Merriman 1941, Vladykov and Wallace 1938, 1952, Alperin 1966, Raney 1952, Raney 1954, Raney 1972, Raney et al. 1954, Massman and Pacheco 1961, Chapoton and Sykes 1961, and Nichols and Miller 1967). Of the 104 tagged fish recovered outside the Hudson River, 26 were caught in Long Island Sound, 5 off New Jersey, 35 off the south shore of Long Island, 4 in the East River, 26 in the Upper and Lower New York Bay region, and 8 from Montauk, New York to Chatham, Massachusetts.

There was no significant difference in the size of striped bass recaptured by commercial fishermen, sport fishermen and TI sampling ($X^2 = 8.31$, $p > .05$) (Table V-11). There was also no significant relatinship between the days at large and the distance moved (Figure V-22) by the fish ($r = .142$, $p > .05$), so all recaptures were used to describe movement patterns.

Table V-11

Number of Tagged Hudson River Striped Bass at Large at Least Two Days and Recaptured during 1976

	Total Length Interval (mm)				All Length Intervals
	250-400	401-600	601-800	801-1000	
Commercial	0	13	2	0	15
Sports Fishermen	14	84	16	6	120
Other Firms and TI Sampling	3	10	6	2	21
Total	17	107	24	8	156

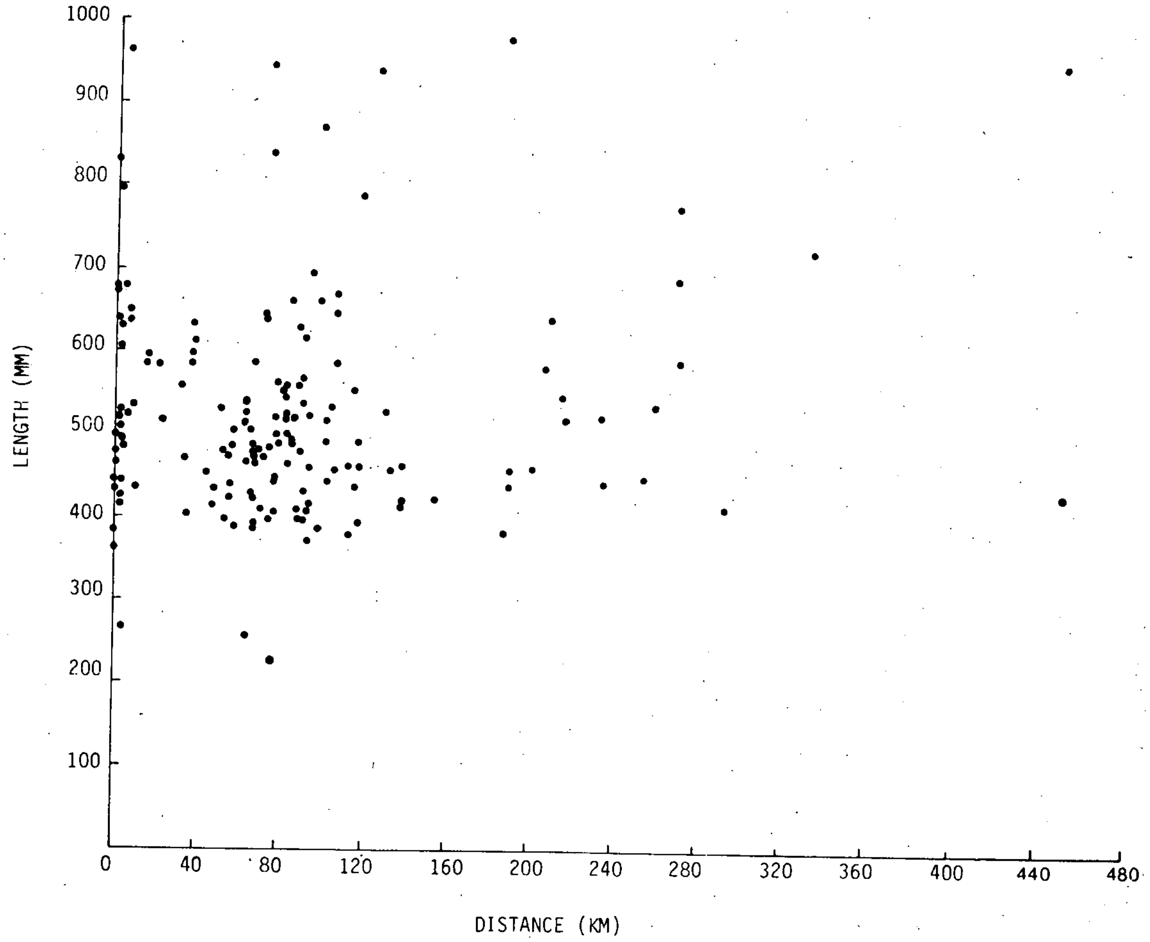


Figure V-22. Total Length vs Distance Traveled for 1976 Recaptured Adult Striped Bass (at Large Two or More Days) Tagged and Released in Hudson River Estuary

There appear to be at least two types of movement patterns for striped bass tagged and released in the Hudson River: a) individuals that remain in or near the river and do not migrate at all and b) individuals that undergo more extensive migrations soon after spawning. These groups contained roughly equal-sized fish in 1976, since there was no significant relationship ($r = .133$, $p > .05$) between the distance moved and the size of the fish (Figure V-23). Of all the recoveries, 75% were within 100 km of the release point (Table V-12). What causes the striped bass to become part of the resident group or the migratory group is unknown. We might hypothesize that this is due to sex, genetic background, or the speed at which the fish recover from spawning activities, but data are presently not available to test these hypotheses.

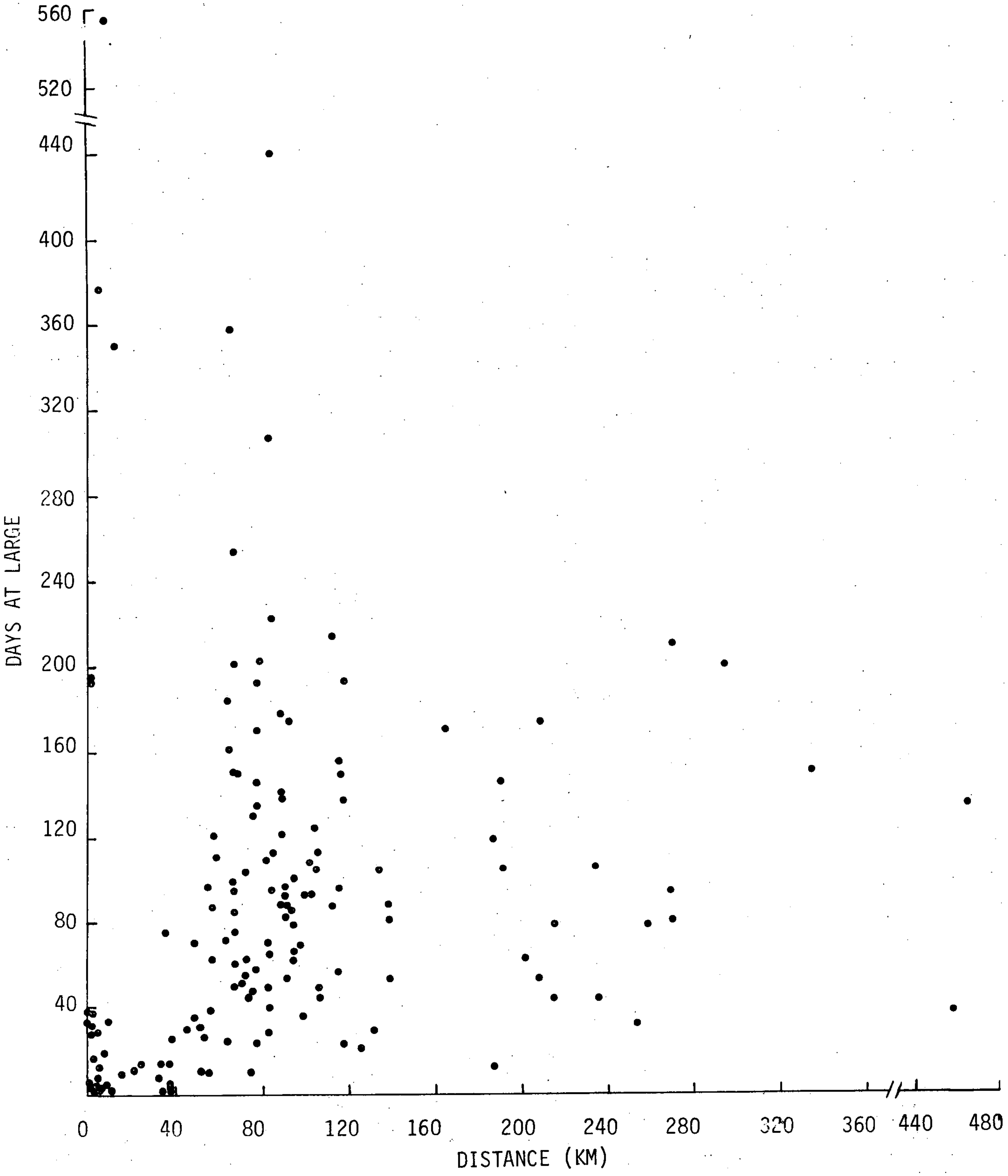


Figure V-23. Days at Large vs Distance Traveled for 1976 Recaptured Adult Striped Bass (at Large Two or More Days) Tagged and Released in Hudson River Esturay

Table V-12

Recaptures of Striped Bass by Length Group during 1976 within and outside Hudson River (Tagged and Released in Hudson River 1976)

		Early Season Releases (March/April)				Mid-Season Releases (May)				Late Season Releases (June)				Other Releases			
	Length(mm)	250-400	401-600	601-800	801-1000	250-400	401-600	601-800	801-1000	250-400	401-600	601-800	801-1000	250-400	401-600	601-800	801-1000
Distance from Release Point	Recaptures																
0-50 km	In	1	22	8	1	1	2	1	1					1	3	1	
	Out		2														
	Total	1	24	8	1	1	2	1	1					1	3	1	
51-100 km	In	1	4														
	Out	5	38	5		2	6	2	3					3		1	
	Total	6	42	5		2	6	2	3					3		1	
101-150 km	In		2														
	Out	2	12	2			1						1				
	Total	2	15	2			1						1				
151-200 km	In	1	1														
	Out		3										1				
	Total	1	4										1				
201-250 km	In																
	Out		5					1									
	Total		5					1									
>250 km	In																
	Out		4	1				2			1		1				
	Total		4	1				2			1		1				

3. Exposure of Early Life Stages to the Effects of Power Plants

a. Eggs

1) Distribution within Power Plant Regions

Striped bass began spawning in early May. Although eggs were observed within all power plant regions by May 10, the longest duration of exposure occurred at Lovett and Indian Point (May 3 to June 24), followed by Roseton and Danskammer (May 10 to June 17) and Bowline (May 10 to June 11 [Figure V-24]). Peak egg abundance occurred during May 17 to 19. The largest standing crop estimates within the Bowline, Lovett, and Indian Point plant regions occurred during this time, while the largest values for the Roseton and Danskammer plant regions occurred later in the season (June 6 to June 11) (Appendix Table C-24).

The percentage of the total river standing crop found within any plant region (Figure V-25) shows that the highest values for Bowline, Lovett, and Indian Point occurred either prior to or directly after the period of peak egg deposition and then declined sharply. The decrease in percentage values seen during May 17 to 19 indicates that during this period of peak egg abundance, spawning was not concentrated within any particular plant region. The percentage of eggs within the plant regions of Roseton and Danskammer remained consistently low throughout May and then increased sharply in early June. This pattern is reflected in geographic distribution indices, which showed secondary peaks for eggs occurring in the Kingston and Catskill regions late in the season.

During the period of striped bass egg abundance (May 10 to June 11), total percentages within plant region were highest for Indian Point and Lovett, respectively. Bowline was intermediate and Roseton and Danskammer both showed relatively low percentages.

2) Trends in Exposure

Trends in the exposure of striped bass eggs based on longitudinal distribution, were similar from 1974 through 1976 (Figure V-26). Exposure was consistently higher in the three downriver plant regions with the highest

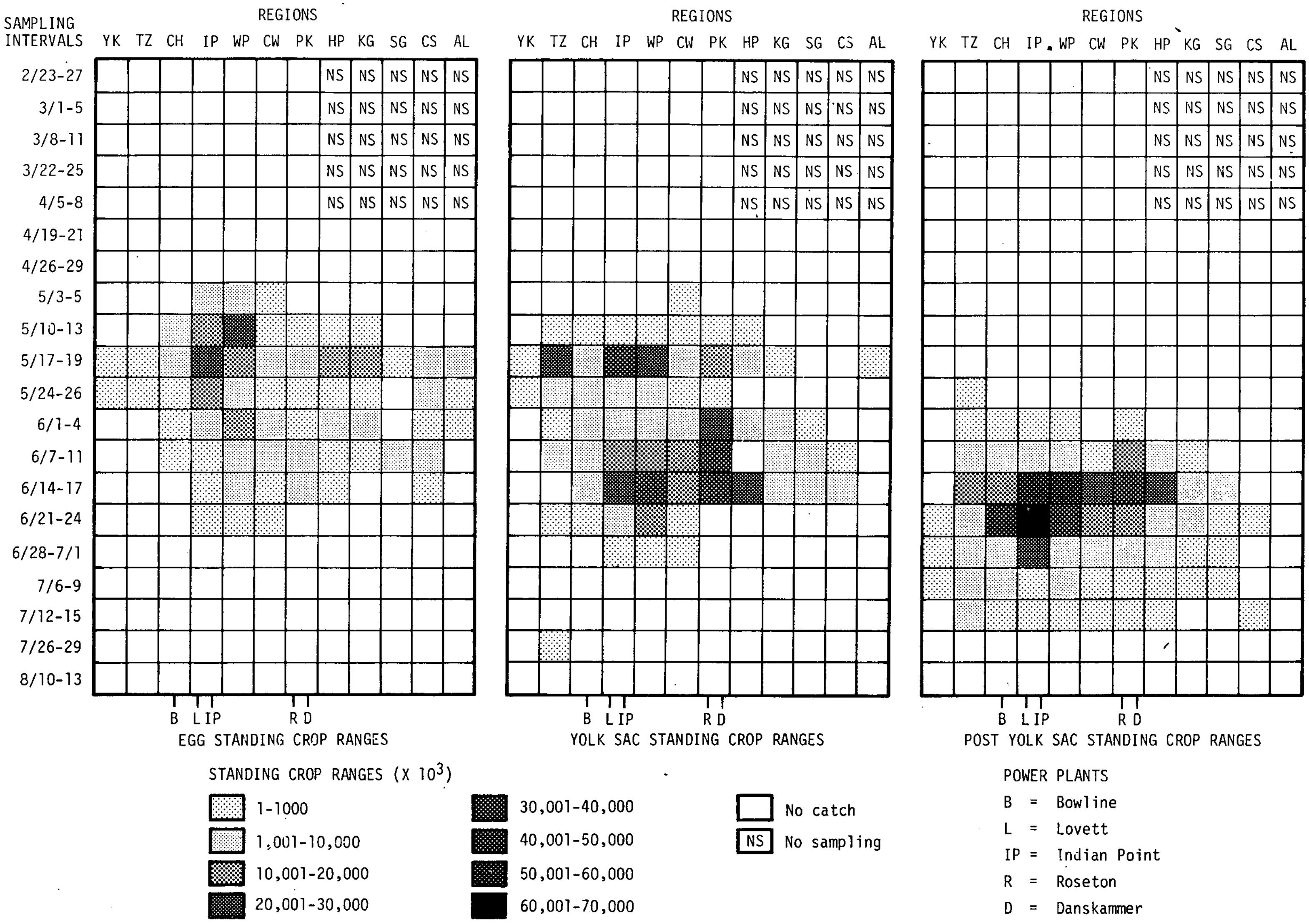


Figure V-24. Exposure Matrix of Striped Bass Eggs, Yolk-Sac and Post Yolk-Sac Larvae Collected during 1976 Ichthyoplankton Survey

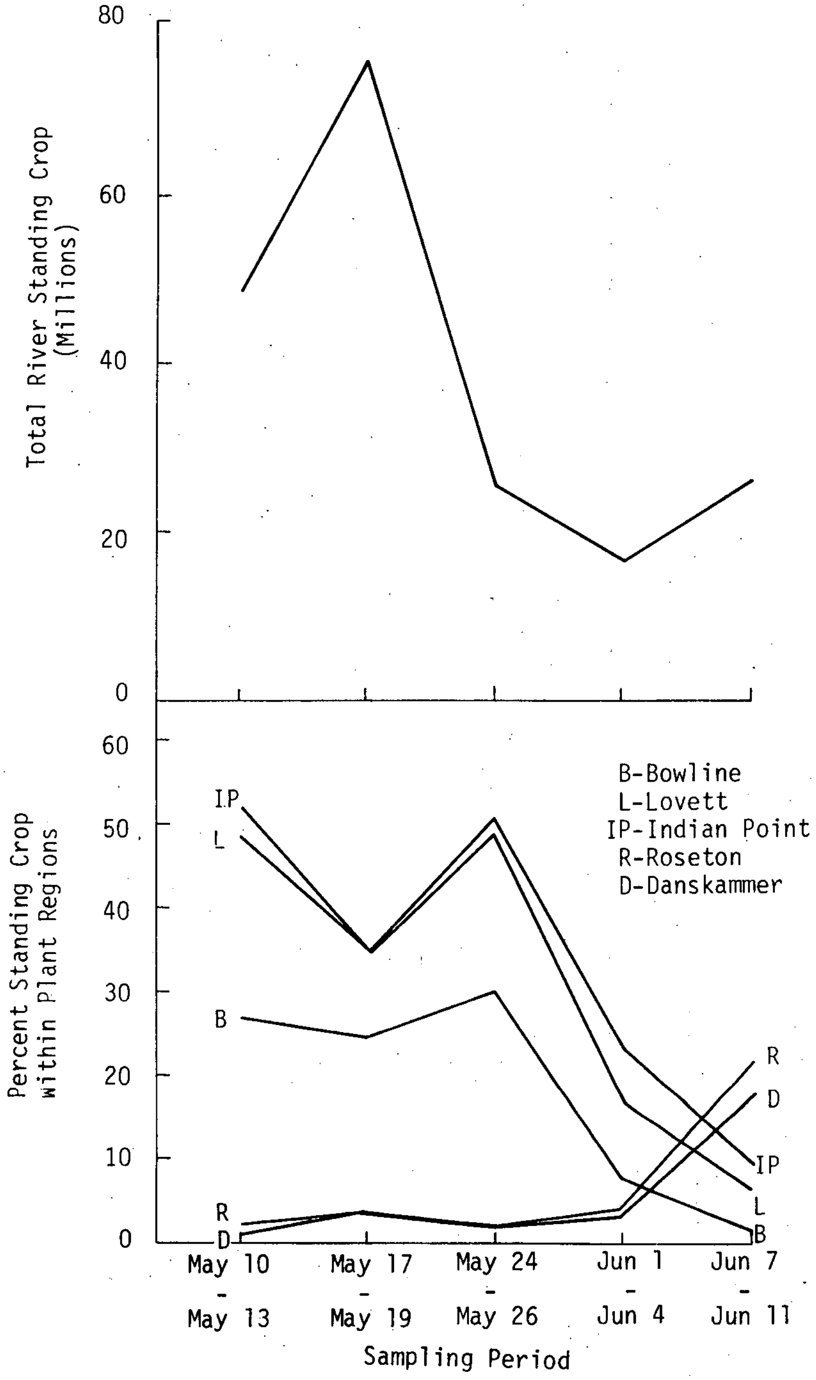


Figure V-25. Comparison of Total River Standing Crop of Striped Bass Eggs with Percent Standing Crop Found within Plant Regions during Selected Periods in 1976

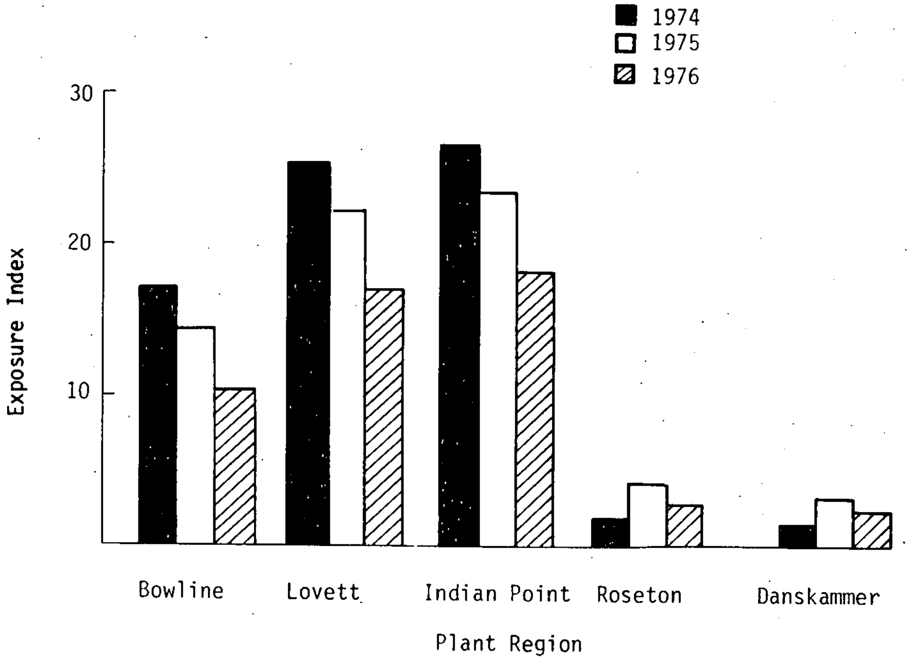
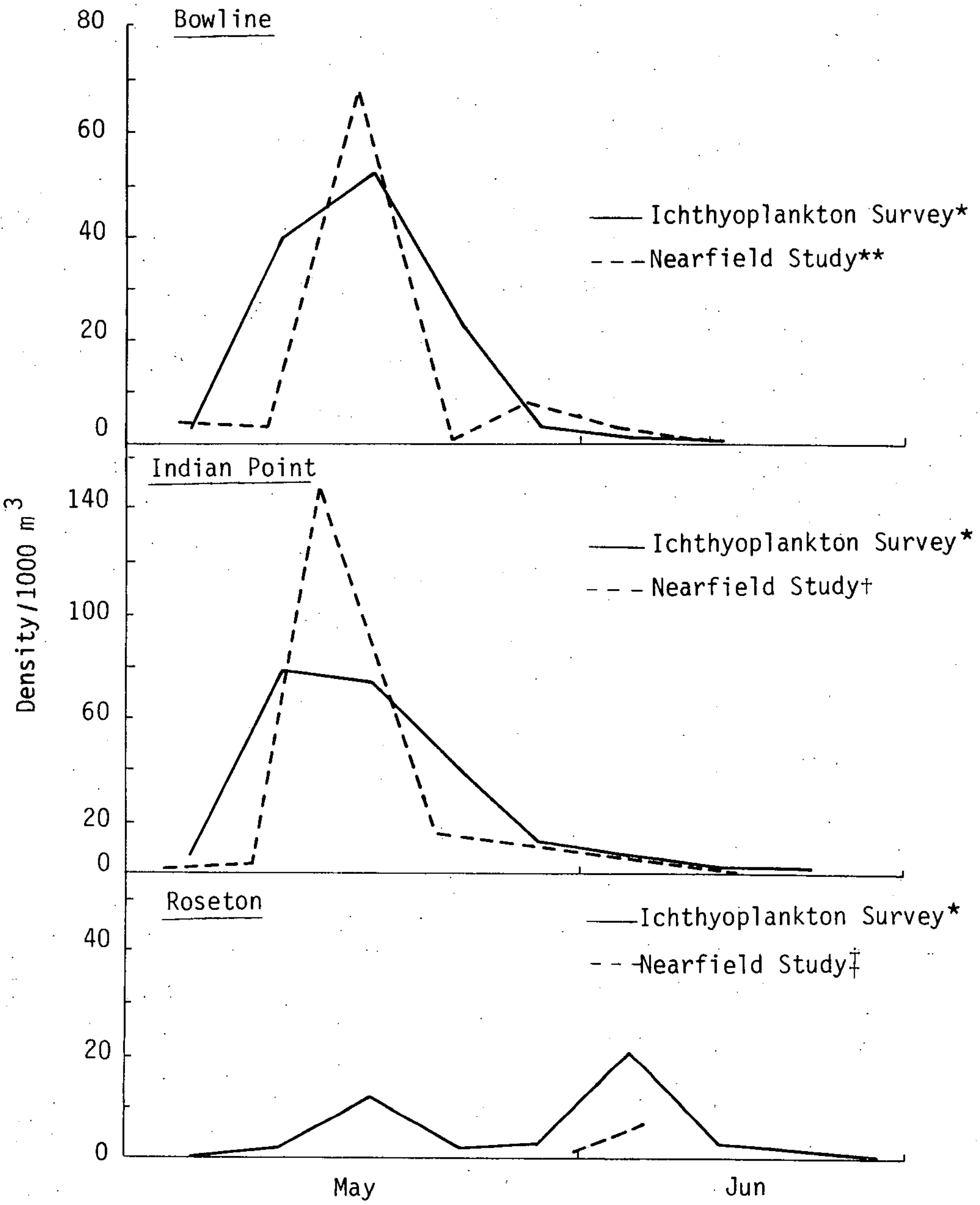


Figure V-26. Exposure (Vulnerability) Indices of Striped Bass Eggs for Power Plant Regions during Selected Periods from 1974 to 1976

seen at Indian Point during each year. Roseton and Danskammer had the lowest exposure during all three years, although slightly higher in 1975 than in 1974 or 1976. Exposure at Bowline, Lovett, and Indian Point was highest in 1974 and declined in 1975 and 1976, indicating a decrease in the proportion of striped bass eggs found within these plant regions during the three-year period.

3) Comparison with Near Field Density Estimates

Far Field Ichthyoplankton Survey (TI) and near field study densities of striped bass eggs showed similar temporal distributions within the Bowline (LMS-stations BE, BCH and BW transects) and Indian Point (NYU) plant regions (Figure V-27). While near field densities at Bowline and Indian Point showed higher peaks occurring in mid-May, ichthyoplankton estimates showed a more gradual decline in egg density during the periods directly after peak egg abundance. Near field and ichthyoplankton estimates at these two plants were similar during the month of June, when striped bass egg densities were low.



*Density estimates prior to June reflect daytime sampling efforts; nighttime sampling efforts after June 1.
**Mean river concentration based on day and night sampling.
†Corresponding photoperiods to those of ichthyoplankton survey.
‡Corresponding photoperiods to those of ichthyoplankton survey during selected periods.

Figure V-27. Comparison of Density Estimates of Striped Bass Eggs at Bowline, Indian Point, and Roseton Plant Regions during 1976

Since comparable data for the Roseton plant region are limited, discrepancies in density values between the two studies may reflect variability associated with sample location rather than actual egg density differences.

4) Other Factors Affecting Exposure

Striped bass eggs, yolk-sac and post yolk-sac larvae are susceptible to entrainment during the period of growth between spawning and juveniles about 40 mm in total length (McFadden 1977). The physical characteristics and duration of each life stage are important factors when assessing exposure.

The diameter of a freshly deposited egg measures 1.3 mm (Lippson and Moran 1974) and is characterized as being nonadhesive and semibuoyant (Mansueti 1958). Following a process of water hardening, requiring from 1 to 1.5 hours (Mansueti 1958), the diameter of the new egg is about 3.4 mm and firm to the touch (Lagler et al 1962). In general, hatching time lasts from 1.5 to 3 days depending on temperature (McFadden 1977). Albrecht (1964) found that suspension of eggs within the water column was important to their development. While eggs are found throughout the water column in rapidly flowing water, they do tend to settle and concentrate near the bottom (McFadden 1977).

Studies conducted in the Cornwall and Indian Point regions indicated that eggs were usually more abundant in the bottom strata than in surface layers (McFadden 1977).

5) Overall Exposure Assessment

Striped bass eggs, yolk-sac, and post yolk-sac larvae are susceptible to entrainment during the period of growth between spawning and juveniles about 40 mm in length (McFadden 1977). In general, hatching time for eggs lasts from 1.5 to 3 days depending on temperature. While eggs are found throughout the water column in rapidly flowing water, they do tend to settle and concentrate near the bottom (McFadden 1977).

The major factor contributing to the exposure of striped bass eggs is their distribution. Overall, eggs are most exposed to the Indian Point and Lovett plants, while exposure to Roseton and Danskammer is generally low. Because of the Bowline plant location on a tidal pond, striped bass eggs are probably actually less exposed to this plant than egg distributions indicate.

b. Yolk-Sac Larvae

1) Distribution within Power Plant Regions

The transition of egg to yolk-sac larvae for striped bass began during early May of 1976 and larvae were found within all power plant regions by May 10. The longest duration of exposure for yolk-sac larvae occurred at Lovett and Indian Point (May 10 to July 1) followed by Bowline (May 10 to June 24) and Roseton and Danskammer (May 10 to June 17) (Figure V-24). Two peaks in yolk-sac abundance were seen during the sampling period: one in mid-May, the other in mid-June. Highest standing crops values within the Bowline, Lovett, and Indian Point plant regions occurred during the initial peak while highest values for Roseton and Danskammer coincided with the major second peak later in the season (June 14 to 17) (Appendix Table C-25).

The exposure of yolk-sac larvae, based on the percentage of organisms found within each plant region, was highest for Lovett and Indian Point early in the season (May 17 to 19) and declined until mid-June (Figure V-28). The highest exposure within the Bowline plant region occurred during May 24 to 26; but the total river standing crops during this time was low. Thereafter, most yolk-sac larvae were found above the Bowline plant region. Overall, exposure to Roseton and Danskammer was highest when the total river standing crops were increasing after May 24. However, when peak abundance of yolk-sac larvae was reached in mid-June, the exposure to each plant was similar.

During the period of striped bass yolk-sac abundance, May 17 through June 17, total percentages within plant region were highest for Indian Point and Lovett, respectively. Exposure to Roseton was intermediate and relatively low to Danskammer and Bowline.

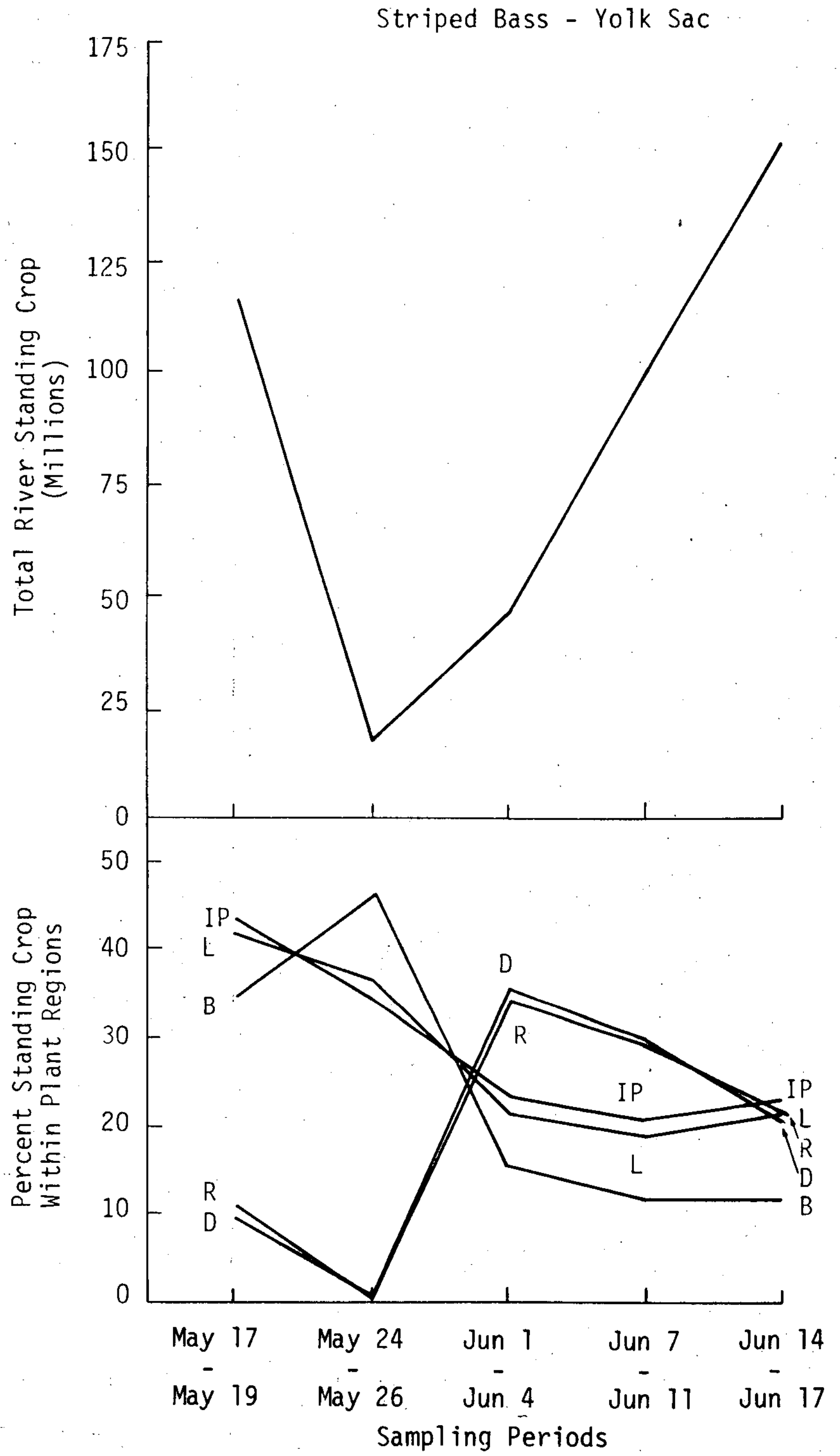


Figure V-28. Comparison of Total River Standing Crop of Striped Bass Yolk-Sac Larvae with Percent Standing Crop Found within Plant Regions during Selected Periods in 1976

2) Trends in Exposure

The exposure of striped bass yolk-sac larvae to power plants in 1974 differed markedly from that of 1975 or 1976 (Figure V-29). In 1974, exposure was highest to the upriver Roseton and Danskammer plants. In 1975 and 1976, exposure was highest to Indian Point.

The 1975 and 1976 yolk-sac exposure indices followed the patterns observed for striped bass eggs. The high exposure seen at Roseton and Danskammer in 1974 was also consistent with the geographic distribution index of larvae, which showed a predominant peak within the Poughkeepsie region. Overall, depending on a number of environmental factos, exposure may vary markedly between years.

3) Comparison with Near Field Density Estimates

Density estimates of yolk-sac and post yolk-sac larvae will be discussed as combined life stage.

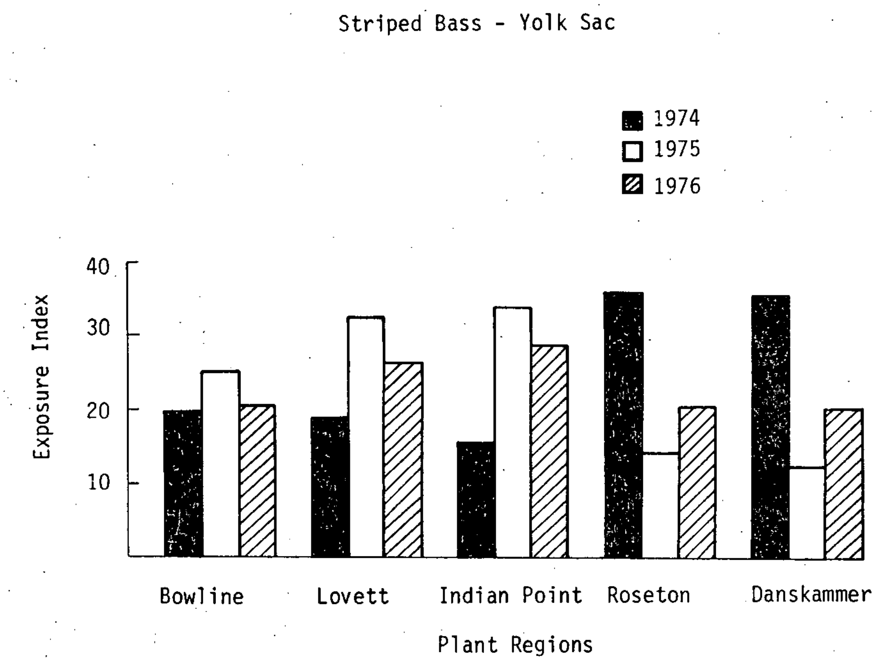


Figure V-29. Exposure Indices of Striped Bass Yolk-Sac Larvae for Power Plants during Selected Periods from 1974-1976

4) Other Factors Affecting Exposure

Since the duration of the yolk-sac life stage is brief, yolk-sac larvae are exposed to entrainment for only a short time. At hatching, the larvae are 2.0 to 3.7 mm in length (Bayless 1972; Mansueti 1958), each possessing a large yolk-sac with a well defined oil globule. The rate of development is temperature dependent and usually lasts from 4 to 6 days at 19 to 21°C (Mansueti 1958; Bayless 1972). Yolk-sac larvae are capable of irregular swimming movements and appear to disperse throughout the water column at night; distribution during the day is similar to eggs, with the highest concentrations near the bottom (McFadden 1977). The dispersal of yolk-sac larvae may reduce densities within immediate zones of water withdrawal, thereby, reducing the actual number entrained.

5) Overall Exposure Assessment

The striped bass yolk-sac life stage usually lasts from 4 to 6 days at 19 to 21°C (Mansueti 1958, Bayless 1972) with larvae capable of making irregular swimming movements. The relatively short life stage duration and increased mobility associated with yolk-sac larvae may be viewed as favorable factors in avoiding entrainment.

The exposure of striped bass yolk-sac larvae to entrainment in 1976 was similar at all plants but differed from the exposure of eggs. During 1974 exposure to Roseton and Danskammer was high in comparison to 1975 and 1976. During 1975 and 1976 exposure to Lovett and Indian Point was highest. Overall, striped bass yolk-sac larvae appear to be exposed to all the power plants, though the intake location on a tidal pond at Bowline may reduce larval exposure there.

c. Post Yolk-Sac Larvae

1) Distribution within Power Plant Regions

Post yolk-sac larvae were collected as early as May 24 but were not found within all plant regions until June 1 (Figure V-24). Larval occurrence within all plant regions lasted until mid-July. Peak riverwide abundance of post yolk-sac larvae occurred in mid-June, at which time Roseton and Danskammer plant regions had their highest standing crops values (Appendix Table C-26). Highest values for Bowline, Lovett, and Indian Point occurred in the following week (June 21-24) as total river standing crops began to decline.

The percentage of total river standing crop of post yolk-sac larvae within the three downriver plant regions (Figure V-30) shows similar patterns with values increasing in the period between mid-June and the beginning of July. During this time, total river standing crops estimates declined. Exposure indices at Bowline, Lovett, and Indian Point were always higher than at Roseton and Danskammer, reflecting the geographic distribution which showed a high proportion of post yolk-sac larvae in the Croton-Haverstraw region.

During the period of striped bass post yolk-sac abundance (June 14 to July 1), total within plant region percentages were highest for Lovett and Indian Point, respectively. Exposure to Bowline was intermediate and exposure to Roseton and Danskammer was relatively low.

2) Trends in Exposure

In general, the exposure of post yolk-sac larvae to power plants was similar in 1975 and 1976 with the highest exposure to in the Lovett and Indian Point plant regions and the lowest upriver at Roseton and Danskammer (Figure V-31). Although Indian Point had the highest exposure in 1974, indices within other plant regions were similar, indicating that post yolk-sac larvae were more widely dispersed that year than in either of the following two years. Overall, the trends in exposure concur with those of the geographic distribution which showed only minor differences from 1974 through 1976.

3) Comparison with Near Field Density Estimates

Far-Field Ichthyoplankton surveys (TI) show minor peaks in striped bass yolk-sac and post yolk-sac densities within all plant regions in mid-May, and major peaks in mid-June (Figure V-32). In general, near field

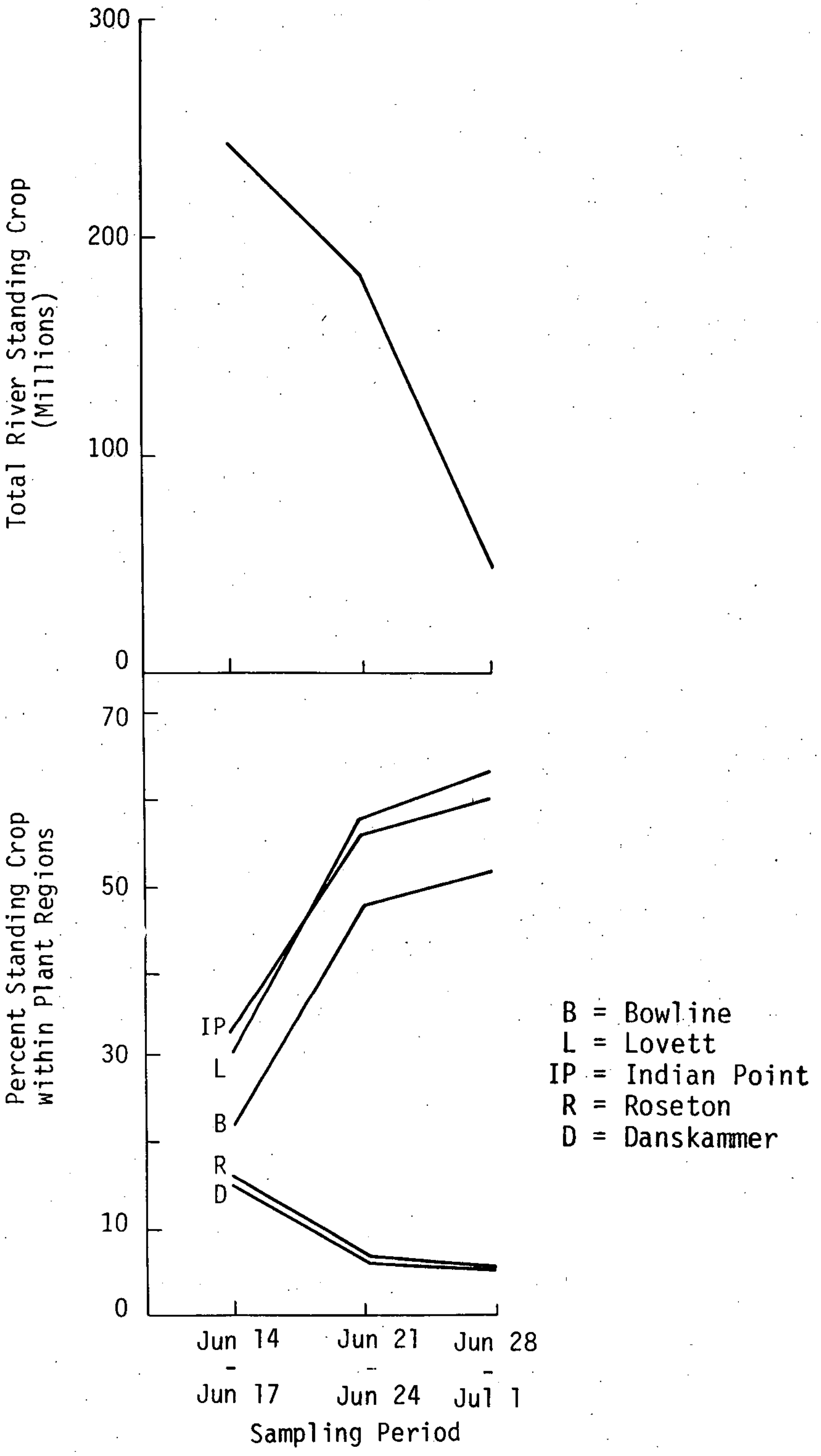


Figure V-30. Comparison of Total River Standing Crop of Striped Bass Post Yolk-Sac Larvae with Percent Standing Crop Found within Plant Regions during Selected Periods in 1976

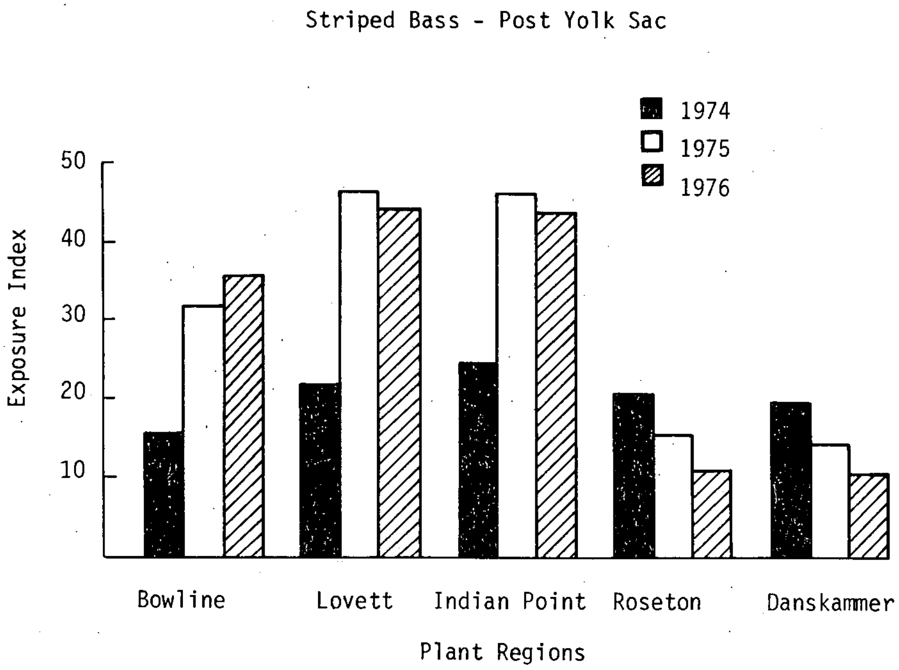
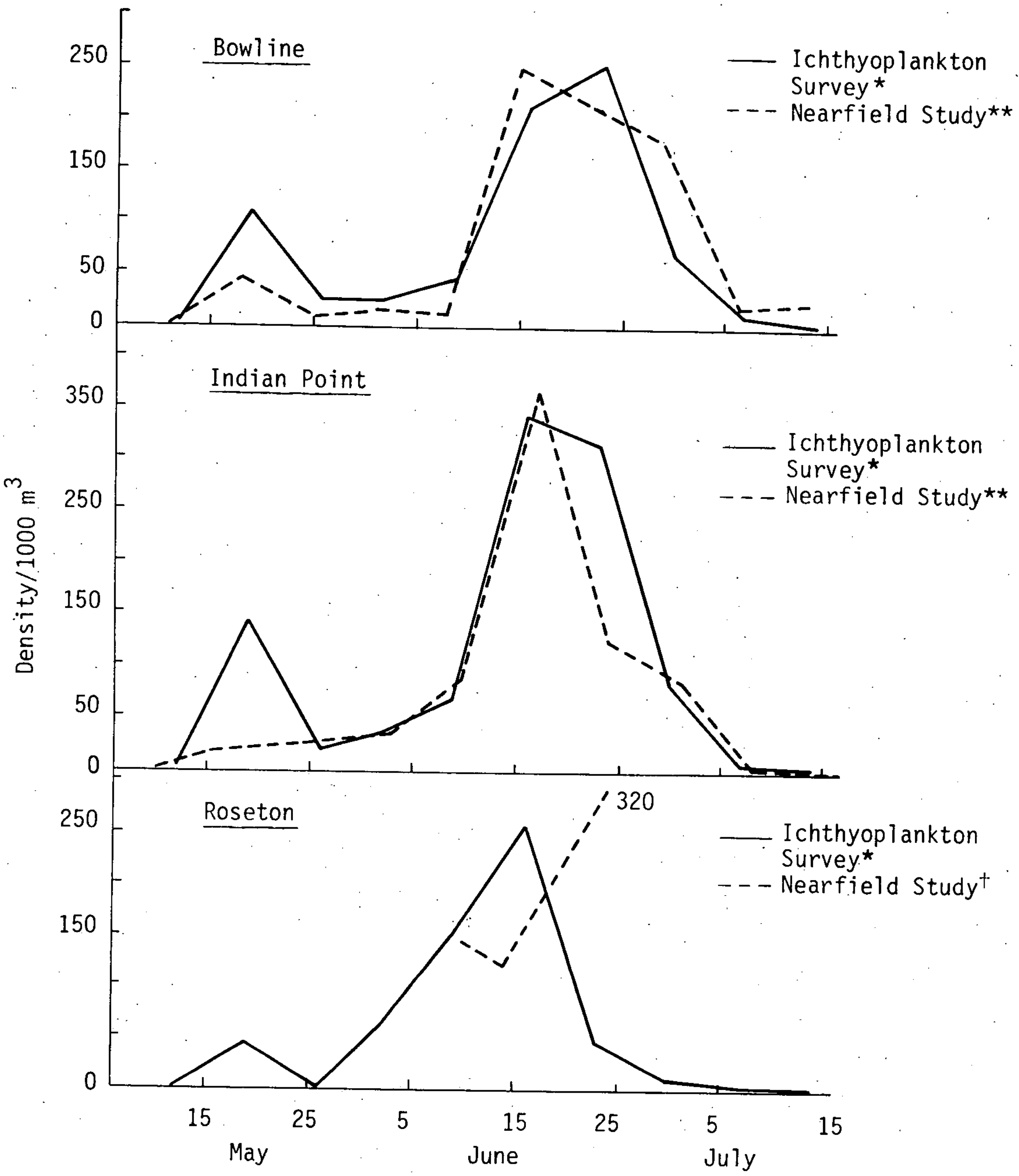


Figure V-31. Exposure (Vulnerability) Indices of Striped Bass Post Yolk-Sac Larvae for Power Plant Regions during Selected Periods from 1974 through 1976

densities within the Bowline (LMS) and Indian Point (NYU) plant regions showed similar temporal distribution patterns to those of the Far-Field Ichthyoplankton surveys. However, while the peak densities for both studies were similar in value, nearfield estimates in mid-May were lower. Since density estimates for both studies reflect corresponding day/night sampling efforts, the May differences cannot be explained by diel migrations of the larvae. They can, however, reflect differences in either gear type (and resultant gear avoidance) or sample location. Similar considerations may explain the differences observed for the available data within the Roseton plant region.

4) Other Factors Affecting Exposure

Life stage duration for post yolk-sac larvae is longer than that for either egg or yolk-sac larvae and the capability of post yolk-sac larvae for making strong directional movements is important when assessing overall exposure. Transformation from the yolk to post yolk-sac stage occurs 4 to 6 days after hatching when larval size is from 5 to 6 mm long (Mansueti 1958; Bayless 1972). Rogers et al (1976) found the duration of the post yolk-sac



*Density estimates prior to June reflect daytime sampling efforts; nighttime sampling efforts after June 1.

**Corresponding photoperiods to those of Ichthyoplankton Survey.

†Corresponding photoperiods to Ichthyoplankton Survey during selected periods.

Figure V-32. Comparison of Density Estimates of Striped Bass Yolk-Sac and Post Yolk-Sac Larvae at Bowline, Indian Point, and Roseton Plant Regions during 1976 stage was about 31 days at 21°C with transformation to juveniles occurring when larvae were about 16 mm. Studies of Hudson River post yolk-sac larvae showed a length of 16 mm was attained 20 to 30 days after hatching (McFadden 1977). While post yolk-sac life stage duration increases exposure time to entrainment, their ability to make directional movements can reduce their exposure relative to other life stages.

5) Overall Exposure Assessment

The duration of the post yolk-sac stage is about 31 days at 21°C with transformation to juveniles occurring when larvae are about 16 mm (Rogers et al 1976). Studies of Hudson River post yolk-sac larvae showed a length of 16 mm was attained 20 to 30 days after hatching, with larvae capable of making strong directional movements (McFadden 1977). While exposure may be viewed as high in terms of life stage duration, the capability of making strong swimming movements may be an important factor in entrainment avoidance.

Striped bass post yolk-sac larvae were generally most exposed to the Lovett and Indian Point plants, although some variation occurred between years. Overall exposure was low to moderate to Bowline, Roseton, and Danskammer.

d. Juveniles

1) Distribution within the Power Plant Regions

Juvenile striped bass were concentrated in the Croton-Haverstraw and Tappan Zee regions during 1976 (Figure V-33). Consequently, most of the population was either downriver or within the near field regions of the three lower river power plants. Juvenile striped bass were exposed to those plants, especially the Bowline plant, from July through October. At the Roseton and Danskammer plants, juvenile striped bass were not exposed from June through late November as most of the population was concentrated below the two plants (Appendix Table C-27). During November, most fish occurred downriver of all five power plants.

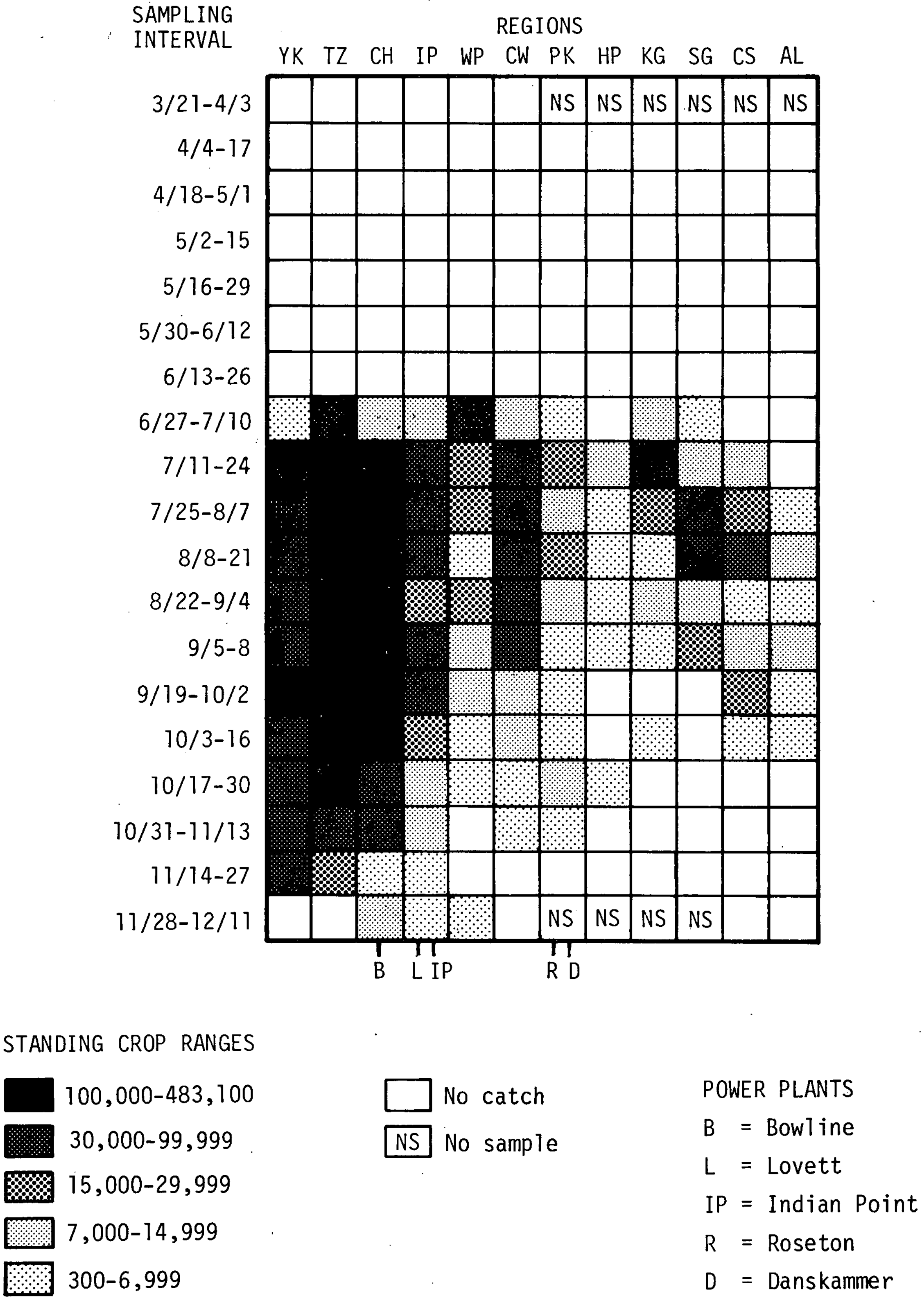


Figure V-33. Exposure Matrix of Juvenile Striped Bass Collected during the 1976 Beach Seine Survey

2) Trends in Exposure (1974, 1975, 1976)

Although some variation did occur (Figure V-33b), the exposure of juvenile striped bass was similar from 1974 through 1976. During 1975, juveniles appeared in the plant regions earlier than during 1974 and 1976. During July through October in all three years, a large portion of the population was exposed to the power plants, especially Bowline, Lovett and Indian Point.

At the Roseton and Danskammer units, juveniles were not exposed except during July and August. During November and December, estimated standing crops declined as the fish moved downstream, and during 1974 and 1975, the proportion of the population within the plant regions decreased as well (Figure V-33b). However, during 1976 juvenile striped bass appeared to be exposed during December as a high percentage of the population appeared within the lower three plant regions.

3) Comparison of Distribution in the Power Plant Regions to Impingement

Although juvenile striped bass were in the vicinity of one or more of the five power plants from July through October, few were impinged until October (Figure V-34). Generally, at all the plants, nearfield abundance estimated as catch-per-unit-effort of bottom trawls showed considerable variation. Few juvenile striped bass appeared to be in the areas sampled by the bottom trawls. The data does indicate however, that when the fish were common in trawls, they were not impinged or rates were low. Impingement rates increased through the fall into the winter at Bowline, Lovett, and Indian Point, while trawl catches dropped. At Roseton and Danskammer, trawl catches were low through the entire season with peaks in July and September. Impingement at these two plants was also low, although it did increase as striped bass moved downstream in the fall. Impingement of juvenile striped bass, mostly occurring from October through December was highest at Indian Point, Lovett, and Bowline.

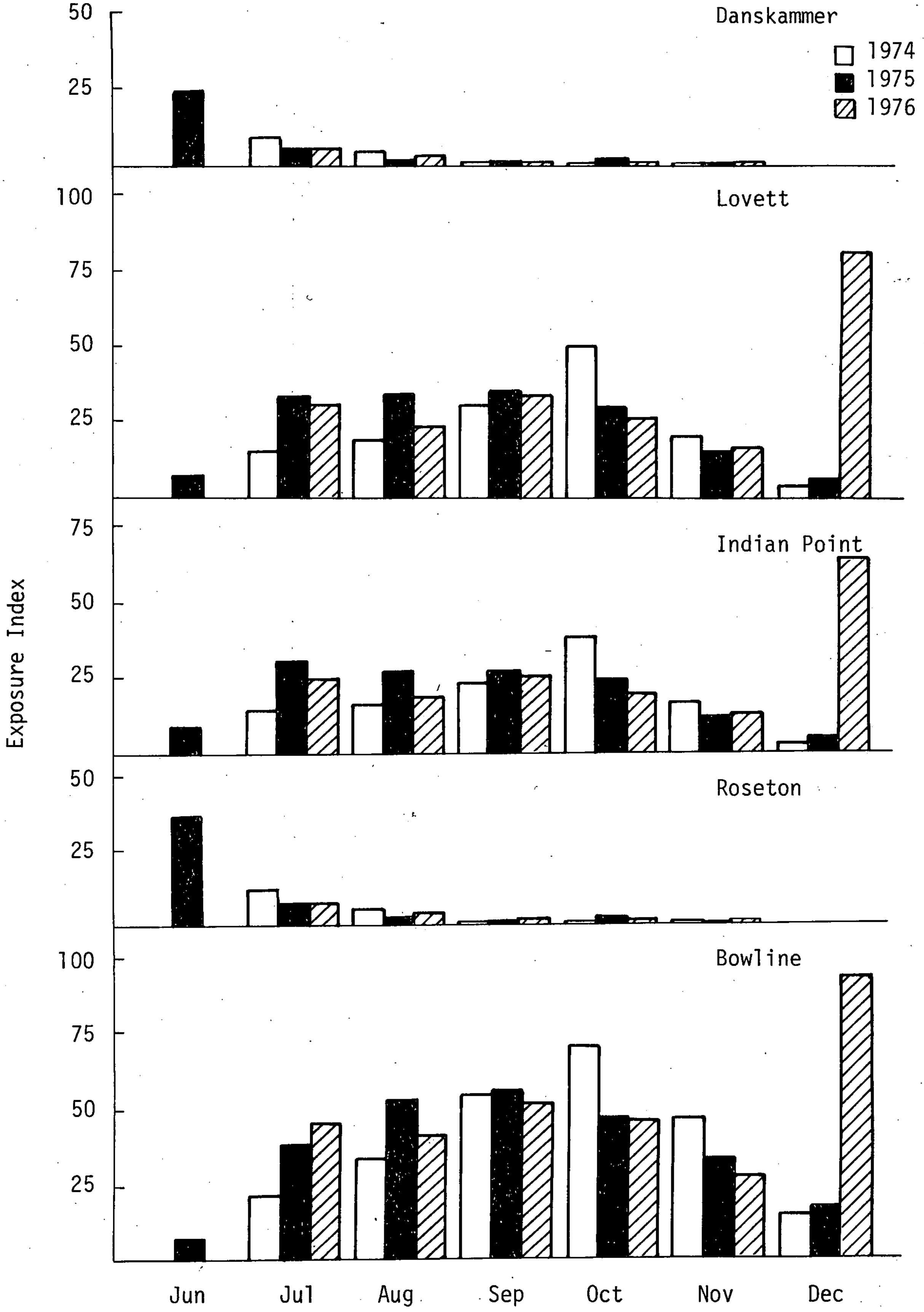


Figure V-33b. Exposure Indices of Juvenile Striped Bass for Power Plant Regions during June-December 1974-1976

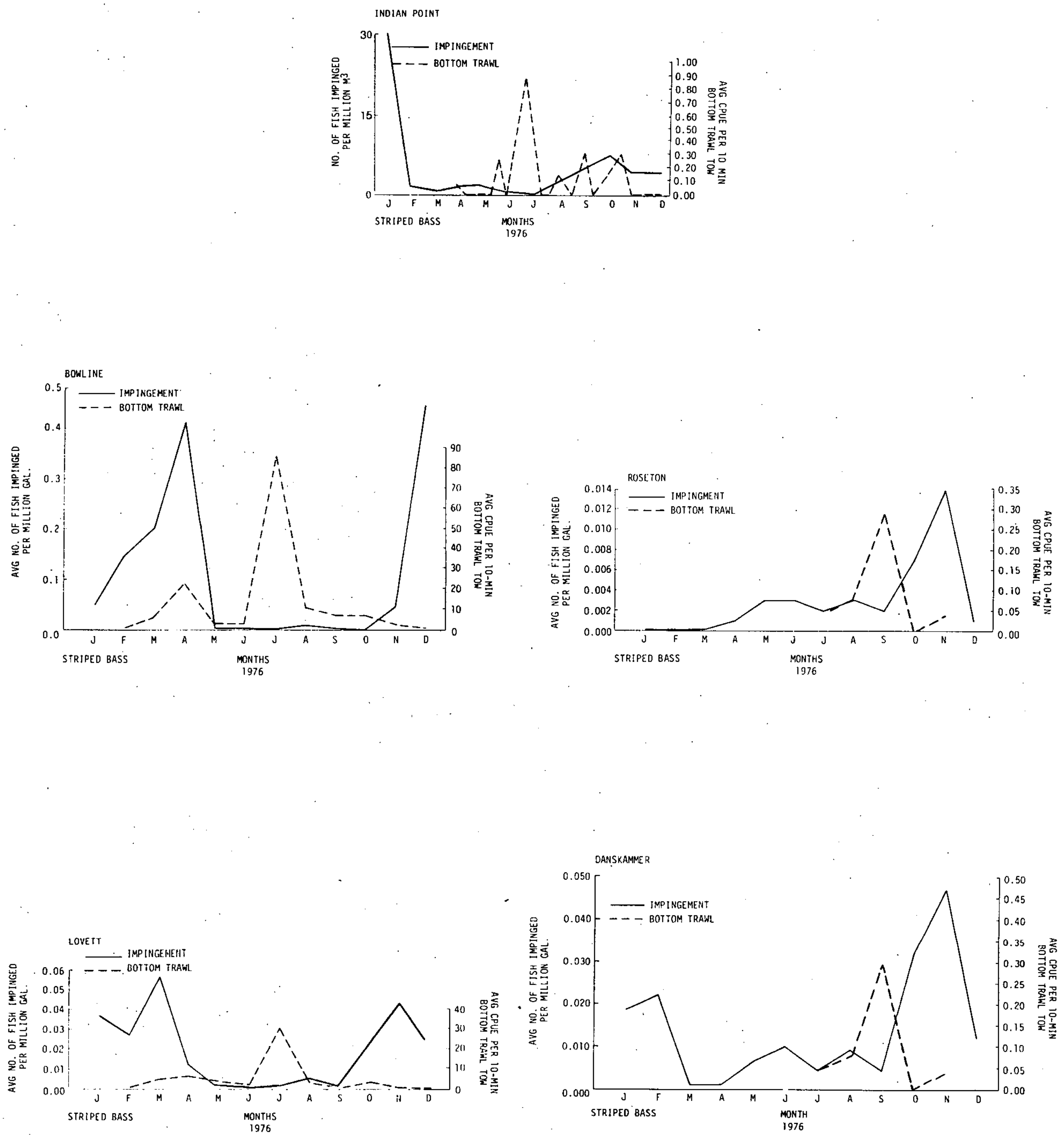


Figure V-34. Monthly Impingement Rates and Near-Field Bottom Trawl CPUE of Striped Bass (Juveniles and Older) for Five Power Plants on Hudson River Estuary during 1976. Impingement rate and catch per tow by bottom trawl at Bowline, Lovett, Roseton, and Danskammer supplied by or compiled from data supplied by Lawler, Matusky, and Skelly Engineers, Inc.

4) Other Factors Affecting Exposure

The prime factor affecting exposure is the distribution of juvenile striped bass in relation to the power plants throughout the year (McFadden 1977). The life history, behavioral traits, habitat preferences of the fish, tides and currents as well as sudden salinity and temperature changes in the estuary are also presumably several important factors (McFadden 1977). An important life history or behavioral trait of juvenile striped bass is day/night patterns of movement (Muessig and Mayercek 1976; McFadden 1977) which can interact with specific salinity and temperature conditions to increase impingement rates at night particularly during the winter (Clark and Brownell 1973; Muessig and Mayercek 1976). Muessig and Mayercek (1976) noted that young striped bass were abundant in shore zone areas during summer nights and that few were impinged at Indian Point during the summer. However, during the fall and winter, when the young fish presumably move to deeper water, they observed that striped bass impingement increased substantially between 2200 and 0600 hours at Indian Point.

5) Overall Exposure Assessment

Most of the population occurred in the lower estuary, so juvenile striped bass were most exposed to impingement at the Bowline, Lovett, and Indian Point plants in 1976. They were not especially exposed to impingement at either Roseton or Danskammer. During the late summer, impingement rates of juvenile striped bass at these two plants increased briefly as the fish moved downstream. Exposure and impingement also increased at the three lower plants during the late summer and continued to increase through the fall and winter. Few striped bass were impinged compared to the white perch and Atlantic tomcod. A number of factors such as behavior, tides, currents, and sudden changes in temperature and salinity during the fall and winter in addition to distribution, could have influenced their exposure to impingement.

e. Yearlings

1) Distribution within the Power Plant Regions

Few yearling striped bass of the 1976 year class were collected during the spring of 1977. Those collected were taken in the Yonkers through Croton-Haverstraw regions from April through mid-May. Their exposure to the plants was low through this period. From late May through late June, yearlings were more abundant throughout the estuary and their exposure increased at Indian Point, Bowline, and Lovett. Yearling striped bass were not particularly exposed to Roseton and Danskammer through time because most of the population was downriver from these plants.

2) Trends in Exposure

The exposure of yearling striped bass fluctuated considerably (Figure V-35) from 1974 (1973 year class) through 1976 (1977 year class), and yearlings were most exposed to Lovett and Bowline during December 1975 (1974 year class) and July 1977 (1976 year class). Yearling striped bass did not appear to be exposed to the Indian Point plant except during July 1977 (1976 year class) and December 1975 (1974 year class). From September through November 1975 (1974 year class) and September through December 1976 (1977 year class), only a small portion of the yearling population occurred in the vicinity of Indian Point. They were not exposed to Roseton and Danskammer during all three years.

3) Comparison of Distribution in Power Plant Regions to Impingement Rates

Yearling striped bass were generally impinged from January through May of each year. The higher impingement rates occurred in January through March, especially at the Indian Point, Lovett and Danskammer plants (Figure V-34). Distribution of yearlings in power plant regions as shown by near-field trawl data indicates that few yearlings were present in deeper waters during April through June. Data presented earlier (Subsection V.A.e.1.) indicate yearlings are common in the shore zone and appear to be exposed during the summer. Yearlings were apparently within the plant regions through the late winter and spring, before sampling began, so the index of exposure did not accurately predict impingement rates of yearling striped bass.

4) Overall Exposure Assessment

Yearling striped bass were exposed to impingement only during the winter and early spring at Bowline, Lovett, or Indian Point. Little

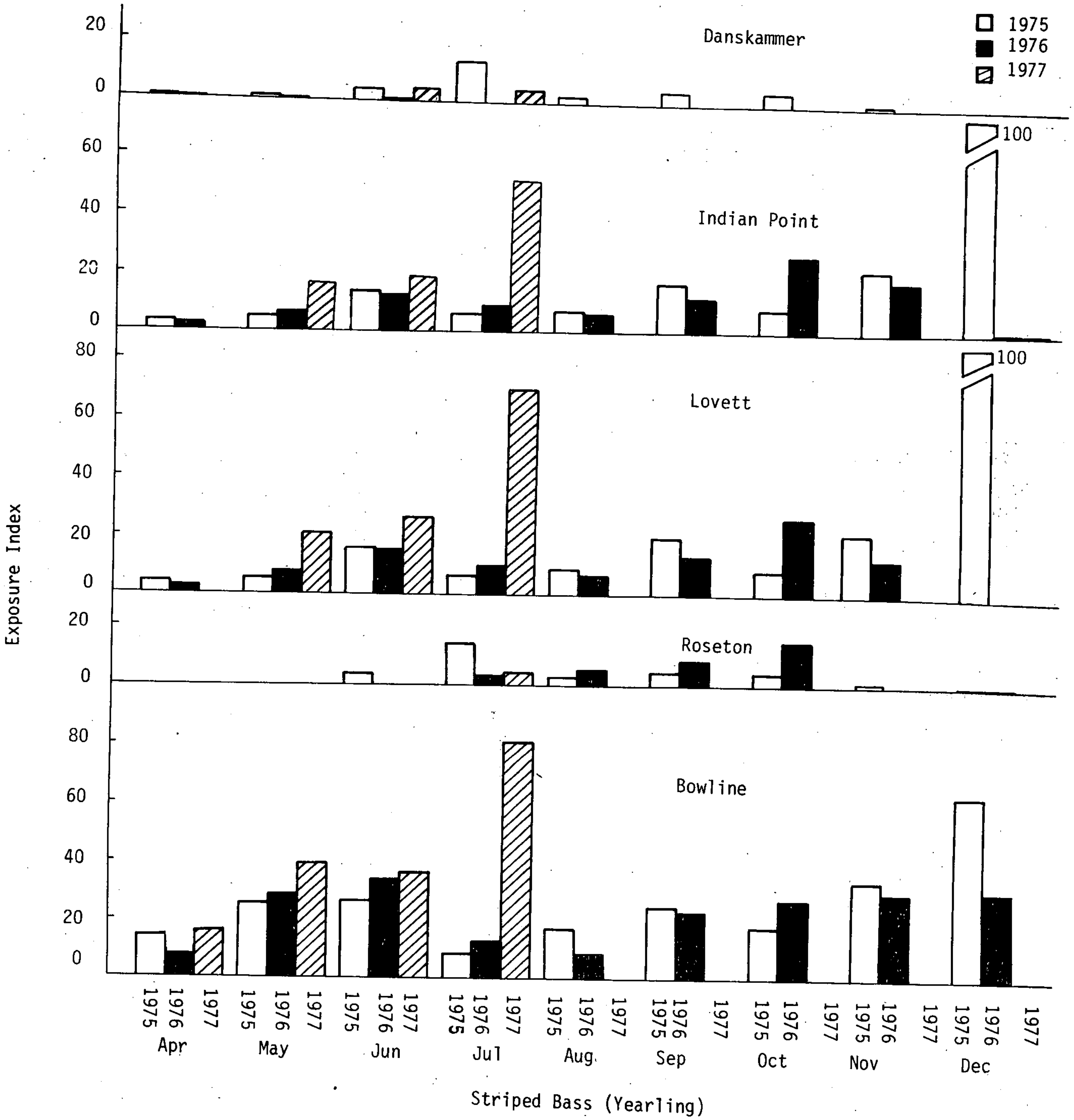


Figure V-35. Exposure of Yearling Striped Bass to Each Power Plant during April-December 1975 and 1976, and April-July 1977 impingement of yearlings occurred at Roseton and Danskammer during the year. Factors such as behavior, tides, currents, and sudden changes in temperature and salinity during the winter which influence exposure of juvenile striped bass to impingement may also influence the exposure of the yearlings as well.

C. WHITE PERCH

1. General Distribution and Movements of Early Life Stages

a. Eggs

1) Geographic Distribution

a) Distribution during 1976

White perch eggs were collected from the Tappan Zee through Albany regions but were most abundant in the upriver portions (Poughkeepsie through Albany) of the study area. Densities greater than 200 eggs/1000 m^3 were found in the Hyde Park through Catskill regions during at least one of the sampling periods; the Saugerties and Catskill regions held densities greater than 1000 eggs/1000 m^3. During periods when eggs were most abundant (May 17 through 19, June 1 through 4, June 7 through 11), the greatest proportion of the standing crops was usually found in the Saugerties and Catskill regions (Table V-13) but a few eggs (10% or more of the standing crops) were collected in regions downriver from Saugerties during several sampling periods.

Because the Ichthyoplankton Survey was designed to place most sampling in areas where striped bass were abundant, relatively small numbers of samples were collected in the upriver regions where the highest densities and standing crops of white perch were encountered. These standing crop estimates for white perch eggs and larvae must be viewed with caution since small sample sizes could have resulted in overestimated or underestimated standing crops in the upriver regions. The demersal and adhesive nature of white perch eggs is another characteristic that would cause underestimation of egg abundance.

Table V-13

Total Standing Crops of White Perch Eggs and Percentage of Total in 12 Regions during Each of 13 Sampling Periods, April-July 1976

Regions	Sampling Dates												
	Apr 19-21	Apr 26-29	May 3-5	May 10-13	May 17-19	May 24-26	Jun 1-4	Jun 7-11	Jun 14-17	Jun 21-24	Jun 28 Jul 1	Jul 6-9	Jul 12-15
YK	*												
TZ		0.1	<0.1	0.1	0.9	1.7	12.3	2.9	9.7	3.7	34.9	100.0	
CH			7.2	3.2	0.6	32.5	0.4	0.8	0.2	12.3	51.7		
IP			0.1	0.2	0.2	0.4	1.2	0.3	1.1	6.9	8.8		
WP	40.0	0.1	0.1	1.3	0.9	0.7	4.6	1.9	4.1	10.1			
CW	60.0	0.1	0.1	0.1	<0.1	16.3	2.1	0.8	18.1	0.5			
PK		2.7	32.8	17.2	0.6	22.5	8.6	2.1	45.1	40.4			
HP			34.1	3.5	3.1	0.6	2.3	0.7	6.7	3.6			
KG		0.5	1.1	11.9	11.2	5.5	2.1	7.1	0.9	3.3			
SG		89.8	1.1	16.5	31.9	18.3	4.9	74.2	6.1	16.2			
CS		0.9	22.9	37.4	49.4	0.6	53.3	8.9	6.5	1.9	4.5		
AL		5.8	0.4	8.5	1.1	0.9	8.2	0.2	1.5	1.1			100.0
Total	100.0	100.0	99.9	99.9	99.9	100.0	100.0	99.9	100.0	100.0	99.9	100.0	100.0
Total standing crop (thousands)	25	31375	103753	118939	436759	83164	243047	375801	62523	13028	1144	888	142

*No entry indicates no eggs collected

b) Trends in Distribution (1974, 1975, 1976)

Adult white perch spawn throughout the study area above the Yonkers region, as reflected in the geographic distribution of eggs in 1974 through 1976 (Figure V-36). The 1974 distribution index peaked in the Croton-Haverstraw region and the 1976 index peaked in the Saugerties and Catskill regions. The 1975 index was never as high as the highest points in 1974 and 1976, but three lesser peaks were evident in Tappan Zee, Poughkeepsie and Catskill regions.

2) Temporal Distribution

a) Distribution during 1976

Eggs were collected from mid-April through mid-July with highest densities and standing crops found from mid-May to mid-June. The May 17 through 19, June 1 through 4, and June 7 through 11 sampling periods resulted

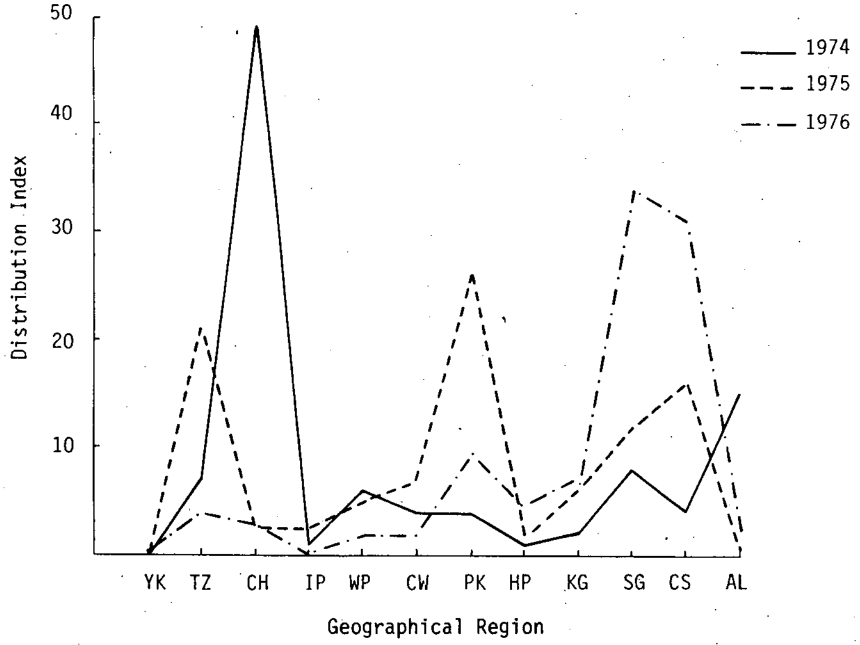


Figure V-36. Trends in Geographic Distribution Index of White Perch Eggs in Hudson River Estuary, 1974-1976

in egg standing crops greater than 200 million. Standing crops were less than 35 million eggs for every sampling period before May 3 and after June 17.

b) Trends in Distribution (1974, 1975, 1976)

The temporal distribution index of white perch eggs showed one distinct peak in late May of 1975 and lesser peaks from mid-May to mid-June in 1974 and 1976 (Figure V-37). Late April marked the earliest collection of eggs (1976) and early July was the latest. In 1974 and 1975, no eggs were collected before early May.

b. Yolk-sac Larvae

1) Geographic Distribution

a) Distribution during 1976

White perch yolk-sac larvae were widely distributed; densities greater than 50 yolk-sac larvae/1000 m^3 were estimated during at least one sampling period in every region within the study area except Yonkers. Highest densities (greater than 250 yolk-sac larvae/1000 m^3) were encountered in the

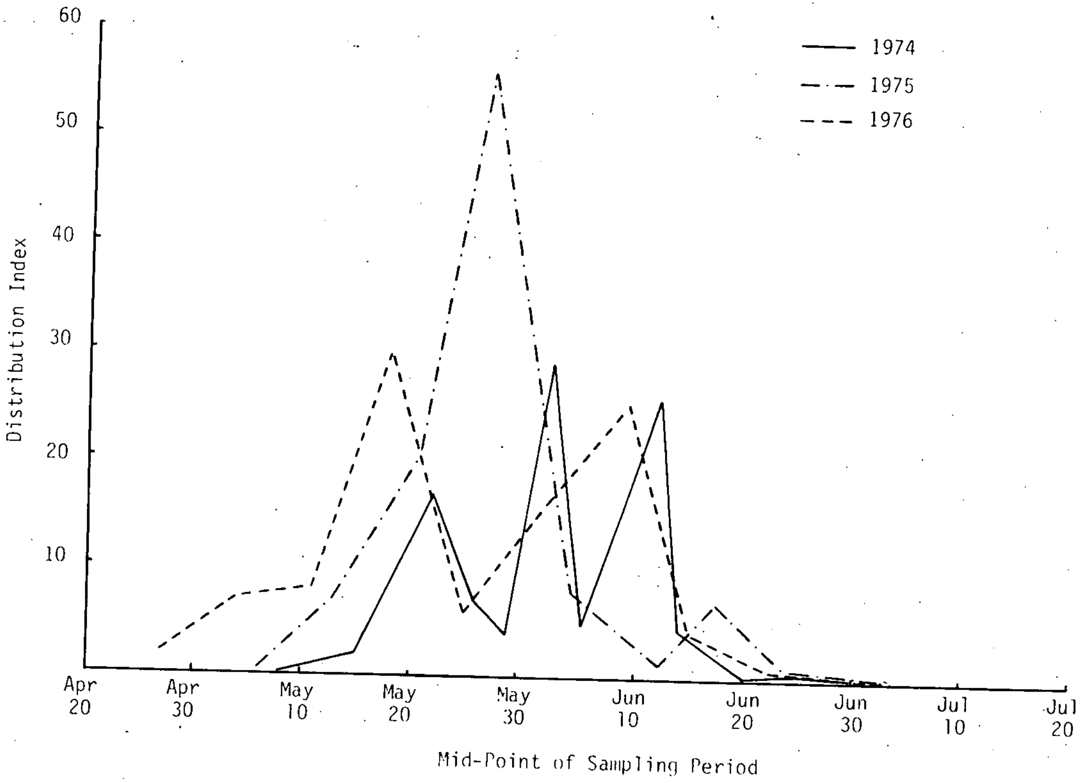


Figure V-37. Trends in Temporal Distribution Index of White Perch Eggs in Hudson River Estuary, 1974-1976

Hyde Park, Kingston, Catskill, and Albany regions. High percentages of the estimated standing crops of yolk-sac larvae occurred in these regions and in the Poughkeepsie and Saugerties regions (Table V-14) during the periods when larvae were most abundant (May 17 through 19, June 7 through 11, and June 14 through 17). These results must be interpreted with the same cautions concerning small sample sizes in the upriver regions that were discussed for eggs in Subsection V.C.1.

Although the upriver regions (Poughkeepsie through Albany) contained a large proportion of the standing crops, yolk-sac larvae were widely distributed within the study area, especially during May. The only region that never contained more than 15% of the standing crops during at least one sampling period was the Yonkers region, at the downriver extreme of the study area. This widespread distribution is characteristic of white perch in the Hudson River estuary.

Table V-14

Total Standing Crops of White Perch Yolk-Sac Larvae and Percentage of Total in 12 Regions during Each of 11 Sampling Periods, April-July 1976

Regions	Sampling Dates										
	April 26-29	May 3-5	May 10-13	May 17-19	May 24-26	June 1-4	June 7-11	June 14-17	June 21-24	June 28-Jul 1	July 6-9
YK	*	0.4	0.2	<0.1	1.1			<0.1			
TZ	0.3	0.1	15.0	10.6	10.3	2.7	2.1	5.5		19.5	
CH		0.3	15.1	2.9	15.6	2.4	2.1	0.9	1.7	30.0	3.2
IP	3.3	2.3	5.8	2.2	21.4	1.2	0.4	0.8	2.5	17.0	2.5
WP	2.4	17.0	7.2	6.3	29.3	0.8	0.7	0.9	4.9		
CW	1.8	18.1	17.7	11.2	7.4	1.0	1.1	2.3	1.1		
PK	0.7	29.5	12.3	18.9	5.6	3.6	2.2	6.1			
HP	4.7	15.4	5.8	19.8	1.1	5.2	1.3	9.7	0.7		
KG	38.6	10.3	7.0	9.1	2.8	7.0	5.5	23.7	5.9	6.3	
SG	22.2	1.3	10.0	6.6	2.0	18.2	17.6	16.4	20.2		
CS	26.1	3.3	3.4	9.6	2.8	36.4	44.7	29.3	9.9	27.3	18.6
AL		1.9	0.6	2.7	0.5	21.5	22.3	4.6	53.3		75.6
Total	100.1	99.9	100.1	99.9	99.9	100.0	100.0	100.2	100.2	100.1	99.9
Total standing crop (thousands)	6235	25977	85486	292892	83922	60098	116627	149997	17723	663	279

* No entry indicates no yolk-sac larvae collected

b) Trends in Distribution (1974, 1975, 1976)

The geographic distribution of yolk-sac larvae varied from 1974 through 1976. In 1975 the distribution index peaked in the Tappan Zee region, where the 1974 and 1976 indices showed only minor peaks (Figure V-38). The 1974 index peaked in the Hyde Park region, then declined slightly in Kingston and Saugerties. The 1976 index peaked in the Catskill region.

2) Temporal Distribution

a) Distribution during 1976

White perch yolk-sac larvae were collected from late April through early July. Standing crops were greater than 100 million during three sampling periods: one in mid-May and two in mid-June. The mid-May period (May 17 through 19) yielded an estimate of nearly 300 million yolk-sac larvae within the study area. Estimates for the two June (June 7 through 11 and 14 through 17) periods were between 100 and 150 million. These peak periods either coincided with or closely followed periods of highest egg abundance. Yolk-sac larvae were relatively scarce before mid-May and after mid-June.

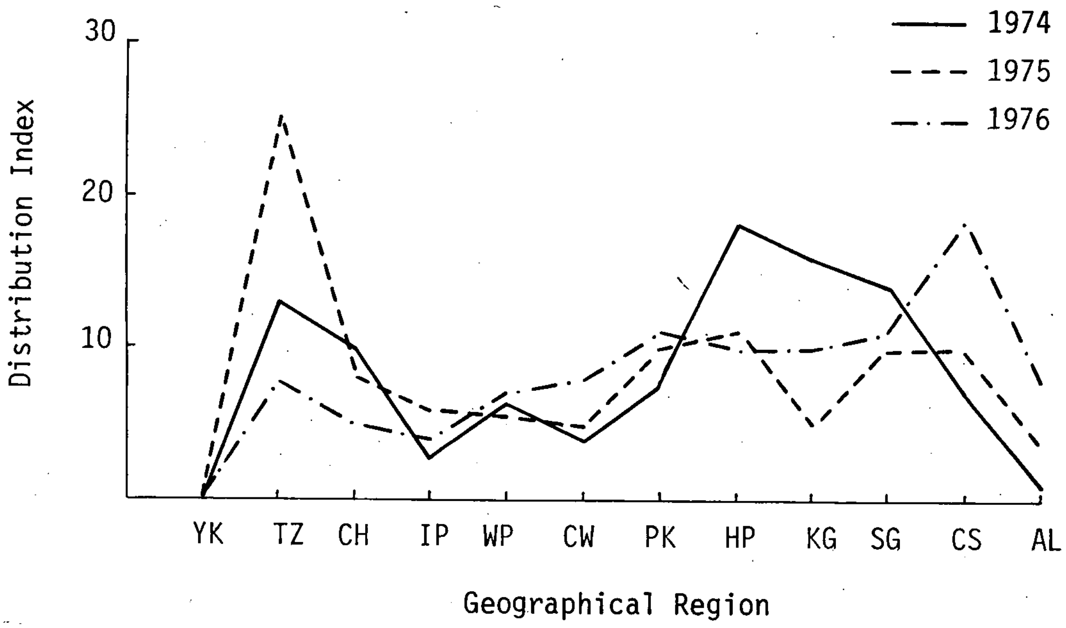


Figure V-38. Trends in Geographic Distribution Index of White Perch Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

b) Trends in Distribution (1974, 1975, 1976)

The temporal distribution index for all three years peaked about May 20 (Figure V-39). In 1974, secondary peaks developed in late May and mid-June; the 1976 index showed a secondary peak in early June. Yolk-sac larvae first appeared in late April or early May and disappeared by early July during the three years.

3) Distribution and Movements in the Indian Point Area

The density of white perch yolk-sac larvae in the Indian Point area was higher near the bottom than near the surface during 1976 (Figure V-40); densities at mid-depth were intermediate. Analysis of 1975 data (TI 1978a) yielded similar conclusions although the relationships were more complex. No strong evidence for vertical dispersion at night was found during either year.

Densities varied between stations depending on time of day (Figure V-41) although no meaningful pattern was evident. Variations were probably due to local current patterns and tidal influence but assessment of these

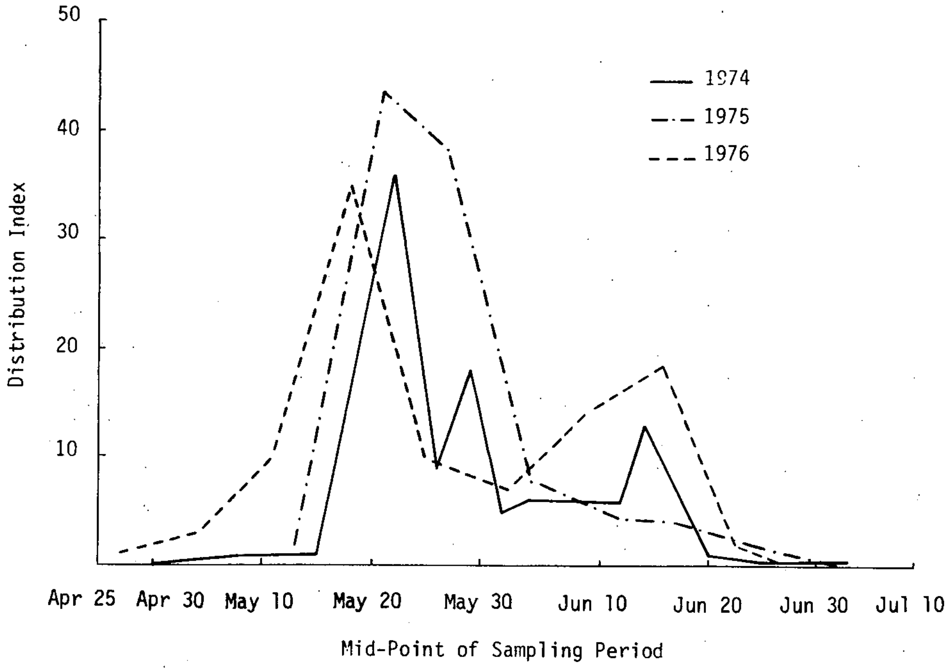


Figure V-39. Trends in Temporal Distribution Index of White Perch Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

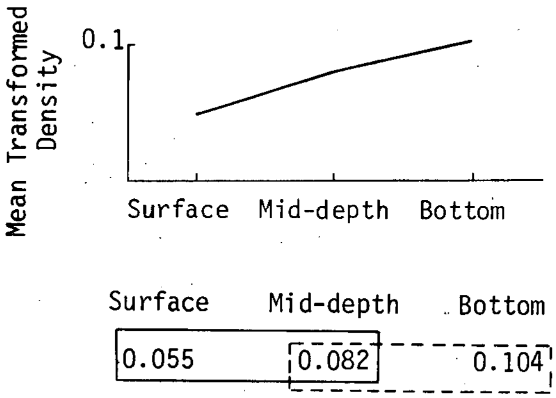
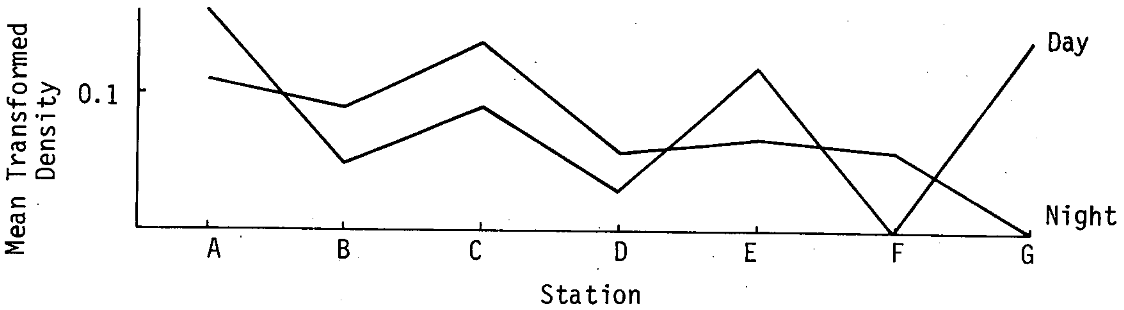


Figure V-40. Depth Distribution of White Perch Yolk-Sac Larvae in Indian Point Area and Results of Newman-Keuls Test on Depth Effect (No Significant Difference [p greater than 0.05] Exists Between Any Two Members of a Grouping; Values Are Mean Transformed [$\sqrt{x}$] Densities, Indian Point Study, 1976)



	A	B	C	D	E	F	G
Day	0.156	0.054	0.086	0.026	0.122	0.0	0.141
Night	0.111	0.090	0.137	0.062	0.074	0.062	0.0

Figure V-41. Diel Distribution of White Perch Yolk-Sac Larvae at Stations A through G in Indian Point Area and Results of Newman-Keuls Test on Day/Night x Stations Interactions (No Significant Difference [p greater than 0.05] Exists between Any Two Members of A Grouping; Values And Mean Transformed [$\sqrt{x}$] Densities, Indian Point Study, 1976)

factors was not included in the study design. Overall, the distribution of yolk-sac larvae was fairly uniform among the seven stations regardless of the time of day.

c. Post Yolk-sac Larvae

1) Geographic Distribution

a) Distribution during 1976

The distribution of white perch post yolk-sac larvae was similar to that of yolk-sac larvae; they were collected throughout the study area and the highest densities occurred in upriver regions. Densities greater than 1000 post yolk-sac larvae/1000 m^3 were estimated for the Poughkeepsie through Catskill regions, and every region upriver from Yonkers contained an estimated 100 larvae/1000 m^3 or more during at least one sampling period. The highest proportions of the standing crops during the two sampling periods when standing crops within the study area were greater than 1.5 billion

(June 14 through 17 and 21 through 24) occurred in the Poughkeepsie through Catskill regions (Table V-15). Earlier in the year, the post yolk-sac larvae were more concentrated downriver in the Tappan Zee through Indian Point regions.

b) Trends in Distribution (1974, 1975, 1976)

The geographic distribution indices for 1974 through 1976 reflected the widespread distribution of white perch post yolk-sac larvae in the study area (Figure V-42). The 1974 and 1975 indices show several high points from Croton-Haverstraw through Catskill, but the 1976 index was distinctly higher in the Hyde Park through Catskill regions than in the other regions. The value of the index in the Yonkers and Albany regions was low in all three years.

Table V-15

Total Standing Crops of White Perch Post Yolk-Sac Larvae and Percentage of Total in 12 Regions during Each of 14 Sampling Periods, April-August 1976

Region	Sampling Date													
	April 26-29	May 3-5	May 10-13	May 17-19	May 24-26	June 1-4	June 7-11	June 14-17	June 21-24	June 28 July 1	July 6-9	July 12-15	July 26-29	August 10-13
YK	*			1.6	2.1						0.2	0.1	3.1	
TZ			5.9	37.9	26.2	13.0	0.2	1.2	0.3	1.5	3.0	2.3	0.3	
CH		1.3	27.3	4.0	26.7	20.7	0.3	0.4	1.0	2.7	5.8	1.2		
IP			27.8	13.1	26.6	30.5	1.2	0.5	1.6	18.6	4.8	0.6	0.8	8.1
WP		0.9	14.5	13.7	16.0	17.9	0.7	0.7	3.1	17.3	11.0	2.8	4.8	
CW	100.0	8.7	6.8	12.7	1.9	7.0	0.6	1.1	6.1	11.0	6.5	1.8	16.5	22.6
PK		60.2	6.2	11.3	0.4	7.3	5.9	8.5	25.6	10.3	12.2	11.6	16.8	69.4
HP			2.8	4.6	0.1	2.4	26.6	25.3	15.2	18.2	25.3	57.0	32.3	
KG		2.4	3.4	1.0	0.1	0.4	33.0	21.2	26.7	10.3	26.0	17.9	17.0	
SG		8.0	4.2	<0.1		0.4	21.4	21.0	11.2	7.7	4.5	4.1	4.9	
CS			1.2			0.4	9.8	18.9	8.1	2.3	0.7	0.6	3.4	
AL		18.6					0.3	1.2	1.0	0.1	0.1			
Total Standing crop (thousands)	13	1134	12326	77372	137918	30207	442733	1708436	2080263	675509	205945	189160	4992	124

*No entry indicates no post yolk-sac larvae collected.

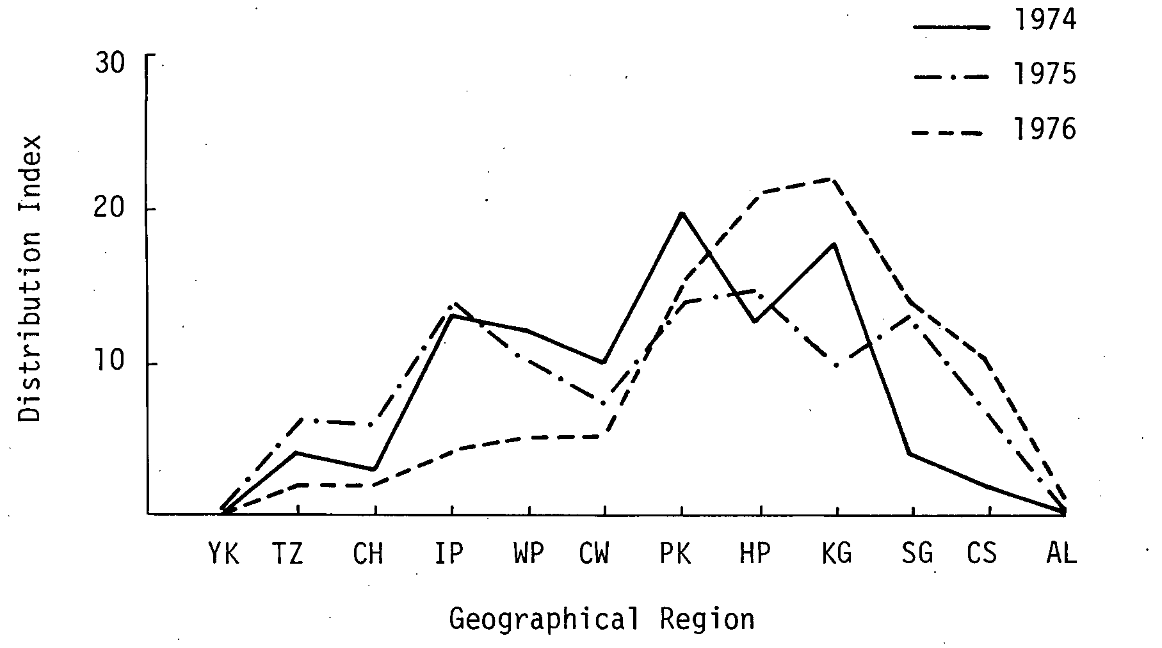


Figure V-42. Trends in Geographic Distribution Index of White Perch Post Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

2) Temporal Distribution

a) Distribution during 1976

Post yolk-sac larvae were present in the study area from late April through the end of the ichthyoplankton survey in mid-August. Densities increased slowly until early June, peaked in mid and late June, and decreased by mid-July. The sampling periods with the highest standing crops (June 14 through 17 and 21 through 24) followed the last two periods of greatest yolk-sac larval abundance (Subsection V.C.2). The reason for the lack of an earlier peak following the first peak of yolk-sac abundance (May 17 through 19) may be related to water temperature patterns during this time of the year (Section IV.C.3.b).

b) Trends in Distribution (1974, 1975, 1976)

Peaks in the 1974 through 1976 temporal distribution indices occurred from early to late June (Figure V-43). Variation in the approximate date of the peak is probably due to environmental conditions, especially water temperature. Post yolk-sac larvae were collected earliest in 1976 (late April) and usually lasted through late July.

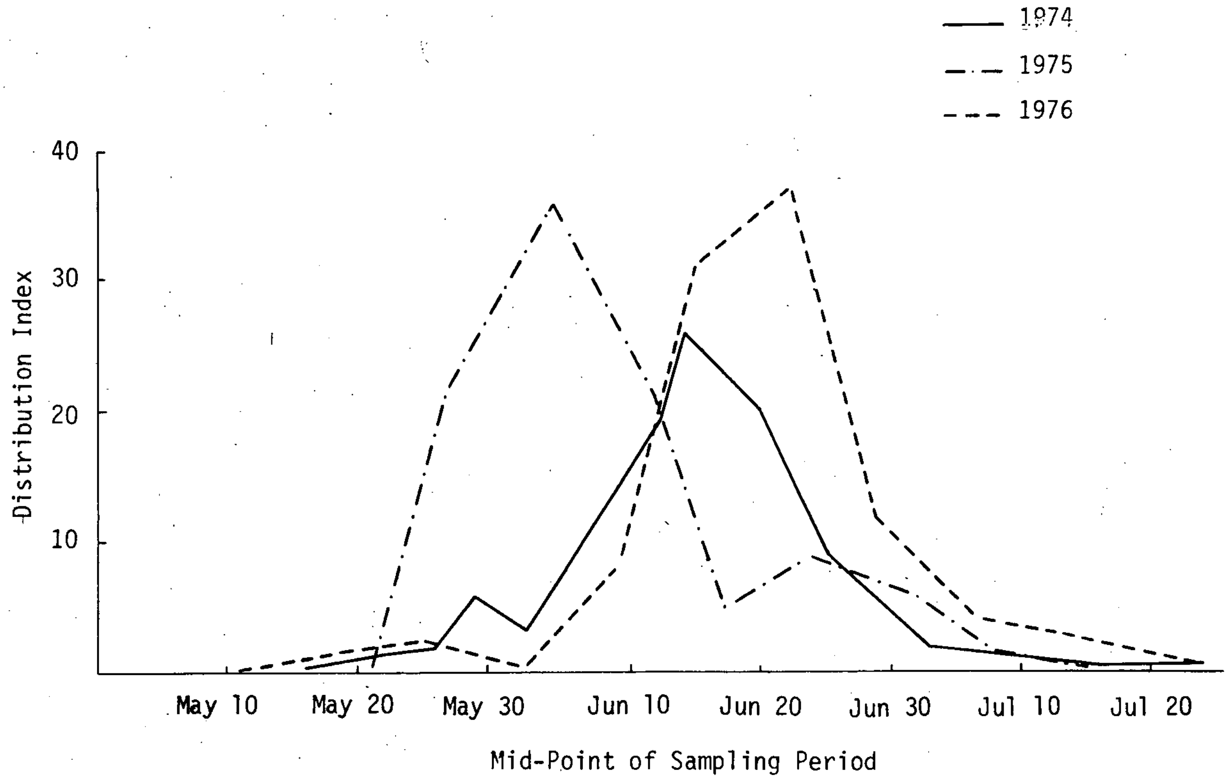


Figure V-43. Trends in Temporal Distribution Index of White Perch Post Yolk-Sac Larvae in Hudson River Estuary, 1974-1976

3) Distribution and Movements in the Indian Point Area

Analysis of variance (Appendix Table C-36) of the distribution of white perch post yolk-sac larvae in the Indian Point area resulted in two significant interactions involving day/night and depth effects. The results of the Newman-Keuls Test on the significant day/night x depth x station interaction are presented in Appendix Figure C-3. Analysis of the day/night x depth x sampling period interaction (Figure V-44) did not reveal any consistent pattern of diel migrations, although on two occasions (May 21 through 24, June 8 through 10) larval density near the surface was significantly higher at night than during the day. Generally, the highest densities were found at mid-depth and near the bottom, demonstrating a tendency for the larvae to occupy the lower half of the water column.

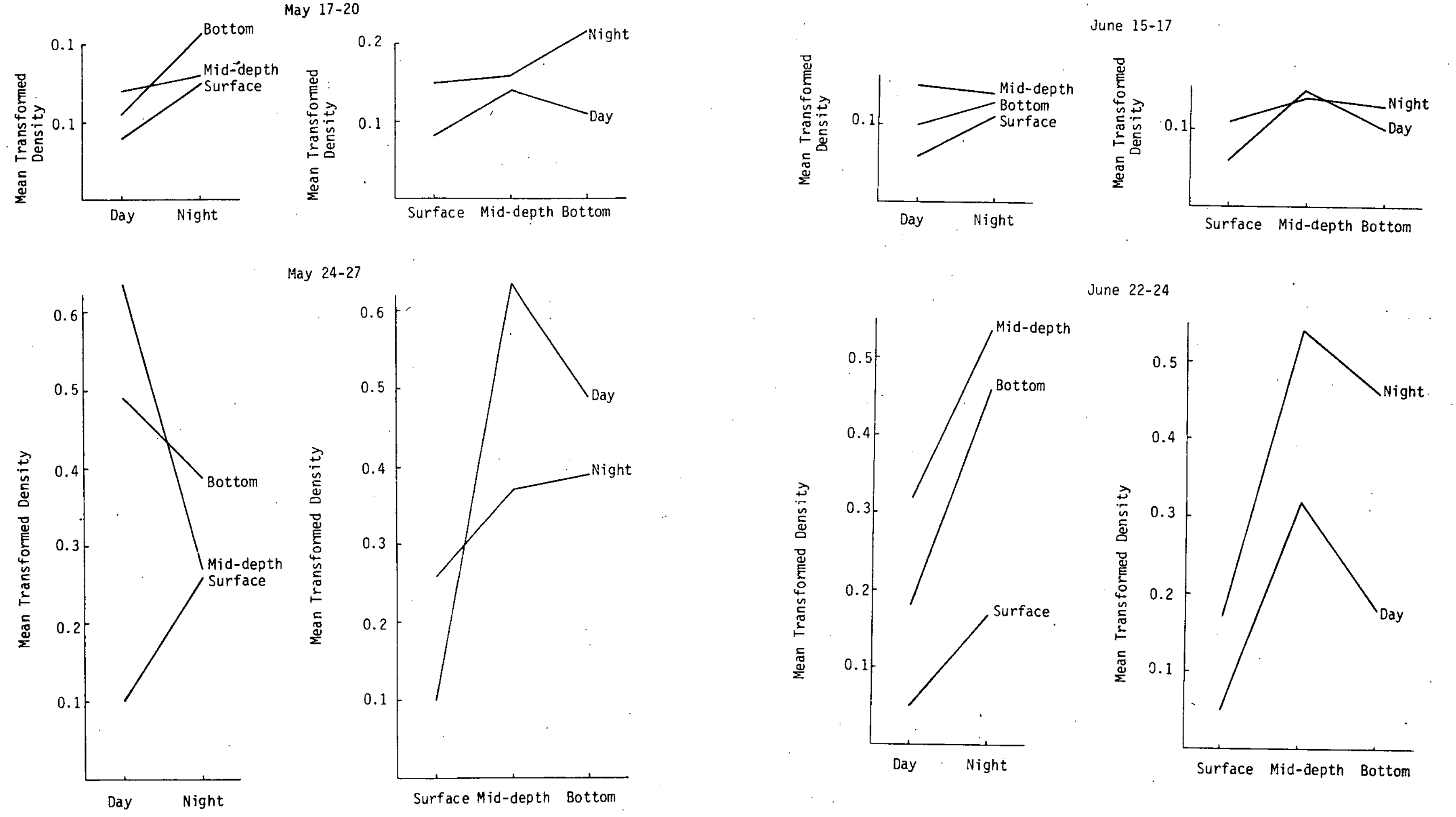
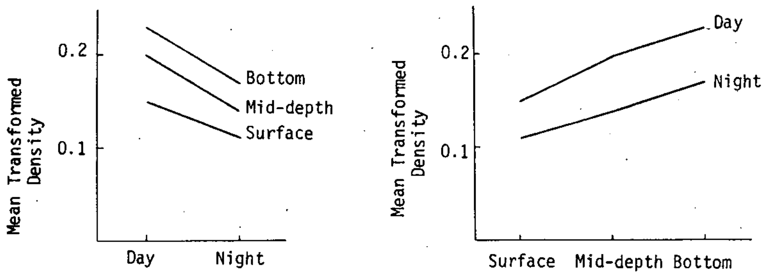
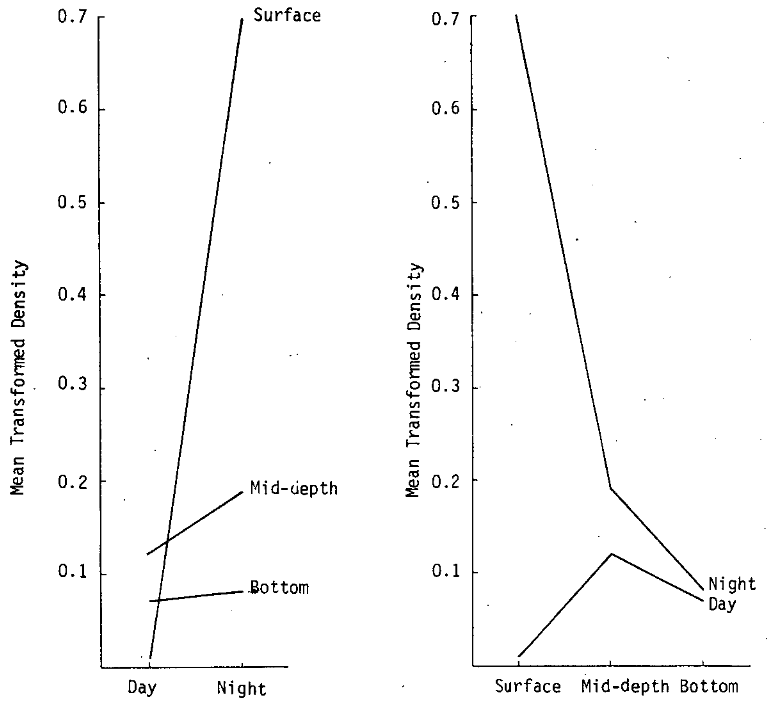


Figure V-44. Day/Night Depth Distribution of White Perch Post Yolk-Sac Larvae during Seven Sampling Periods in Indian Point Area and Results of Newman-Keuls Test on Day/Night x Depth x Sampling Period Interaction (No Significant Difference [p Less Than 0.05] Exists between Any Two Members of a Grouping; Values and Mean Transformed [$\sqrt{X}$] Densities, Indian Point Study, 1976)

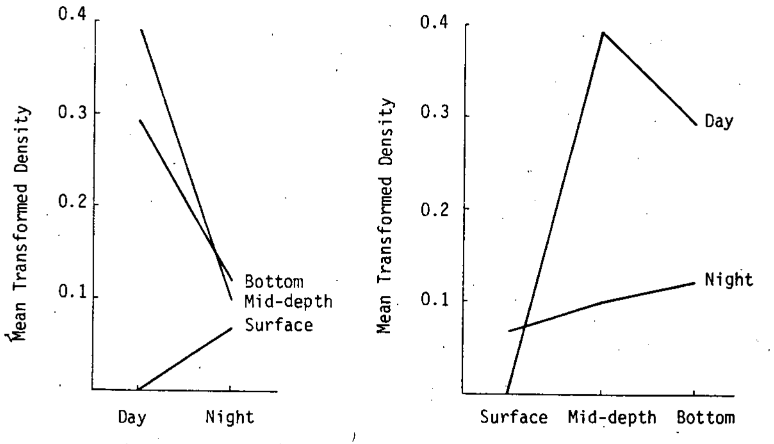
June 1-3



June 8-10



June 29-July 1



May 17-20

	Surface	Mid-depth	Bottom
Day	0.079	0.144	0.108
Night	0.150	0.158	0.215

May 21-24

	Surface	Mid-depth	Bottom
Day	0.102	0.636	0.493
Night	0.263	0.373	0.387

June 1-3

	Surface	Mid-depth	Bottom
Day	0.148	0.196	0.229
Night	0.112	0.144	0.169

June 8-10

	Surface	Mid-depth	Bottom
Day	0.011	0.125	0.071
Night	0.700	0.190	0.083

June 15-17

	Surface	Mid-depth	Bottom
Day	0.066	0.153	0.102
Night	0.112	0.145	0.133

June 22-24

	Surface	Mid-depth	Bottom
Day	0.049	0.318	0.182
Night	0.169	0.540	0.459

June 29-July 1

	Surface	Mid-depth	Bottom
Day	0.0	0.386	0.286
Night	0.073	0.097	0.117

Figure V-44 (Contd)

d. Juveniles

1) Geographic and Temporal Distribution during 1976

Juvenile white perch first appeared in the deeper offshore areas during mid-June (Table V-16; Appendix Table C-38). By mid-July, they were dispersed through the offshore waters of nearly every region of the estuary, with highest standing crops occurring in the Hyde Park region. Standing crops remained high through mid-August from the Tappan Zee through Catskill regions. In the Tappan Zee through Poughkeepsie regions during late August and through mid-October, juvenile abundance declined, then increased to the highest levels of abundance of the year in mid-November. Throughout this period, juveniles were abundant in the Tappan Zee and Croton-Haverstraw regions and continued to be abundant in offshore waters through December, especially in the Tappan Zee and Indian Point regions.

Most post yolk-sac larvae and early juveniles begin to move into shore zone areas during late June (McFadden 1977). This pattern occurred during 1976 as juvenile white perch first appeared in the shore zone throughout much of the estuary during late June. The highest proportion of the total shore zone standing crops occurred in the Kingston or Saugerties regions from late June through mid-August. From late August through October, most white perch juveniles were found either in these regions or in the Tappan Zee and Croton-Haverstraw regions. After October, most juveniles occurred in the Tappan Zee or Croton-Haverstraw regions and standing crops in the shorezone of the middle and upper estuary (Cornwall through Albany regions) declined to zero.

Generally during 1976, juvenile white perch were most abundant in the Tappan Zee, Croton-Haverstraw regions or the Kingston through Catskill regions. During June through mid-July, juveniles were most common in the offshore waters, but beginning in late July, most of the population started moving to shore zone areas. Juveniles remained abundant in the shore zone until mid-October where they began to move away into the shoals or deeper areas (Section IV).

Table V-16

Total Standing Crops of Juvenile White Perch and Percentage of Total Standing Crops in 12 Regions during Each of 12 Beach Seine Survey Sampling Periods, June-December, 1976

Region	Sampling Dates											
	6/27 - 7/10	7/11 - 7/24	7/25 - 8/7	8/8 - 8/21	8/22 - 9/4	9/5 - 9/18	9/19 - 10/2	10/3 - 10/16	10/17 - 10/30	10/31 - 11/13	11/14 - 11/27	11/28 - 12/11
YK	*	2.3	1.7	0.9	0.7	0.3	0.1	0.7	3.5	5.3	34.1	32.5
TZ	5.0	12.3	17.6	19.2	25.7	32.4	5.3	8.5	28.3	26.9	28.7	61.7
CH	5.9	2.5	9.8	11.2	30.5	18.5	16.5	10.6	20.2	9.1	10.4	1.9
IP	1.3	3.0	7.1	5.2	9.0	9.6	6.6	6.2	2.2	6.8	4.4	3.9
WP	8.4	3.2	4.9	2.2	4.4	3.5	4.0	3.3	3.6	2.3	6.1	
CW	12.5	15.0	7.1	6.2	7.8	3.7	3.1	5.1	4.4	0.5		
PK	15.2	8.8	6.1	2.5	1.4	3.6	0.1	0.5	2.5	10.4	16.4	NS**
HP	12.2	2.6	4.0	0.8	0.7	0.1	0.4	0.2	1.3	0.6		NS
KG	34.0	26.4	10.6	4.2	9.5	3.9	1.9		3.0	25.2		NS
SG	3.9	21.1	24.0	38.2	4.5	19.0	31.1	9.0	9.3	12.9		NS
CS	1.6	1.5	6.3	8.7	5.3	1.7	30.8	54.3	20.8			
AL		1.4	0.9	0.6	0.5	3.8	0.1	1.7	0.9			
Total Standing Crop (thousands)	114	1452	2062	2234	1777	1755	2021	730	284	102	22	28

*No entry indicates no juveniles collected.

**NS = No Sample

2) Trends in Distribution (1974, 1975, 1976)

Three years of beach seine survey data indicated that juvenile white perch in the shore zone were consistently distributed throughout the estuary with two areas of concentration: the Croton-Haverstraw and Tappan Zee regions, and the Saugerties and Catskill regions (Figure V-45). Both areas have extensive shoal with macrophyte beds or riprap which offer excellent habitat for food and shelter. Patterns of abundance varied among the three years. During 1974 and 1976, the geographic distribution index in the Saugerties-Catskill regions equaled or exceeded the indices for the Croton-Haverstraw and Tappan Zee regions, but in 1975 this pattern was reversed.

Juveniles were most abundant in the shore zone during late August through late September (Figure V-46). However, during 1974, the highest standing crops value occurred during mid-November. All three years juveniles usually moved away from the shore zone by late November.

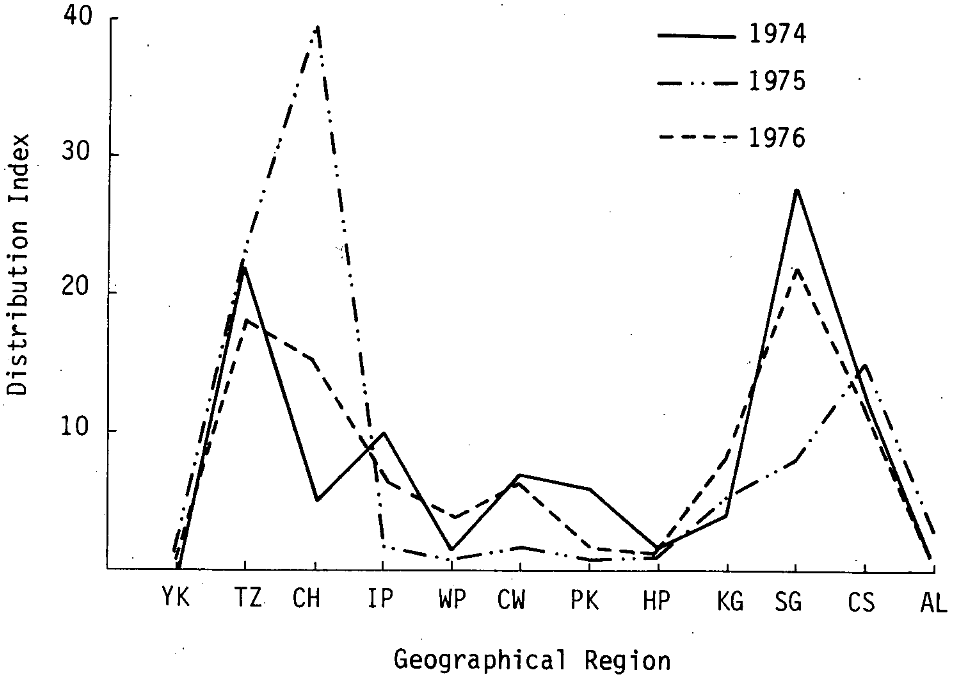


Figure V-45. Trends in Geographic Distribution Index of Juvenile White Perch Collected in Beach Seine, in Hudson River Estuary, 1974-1976

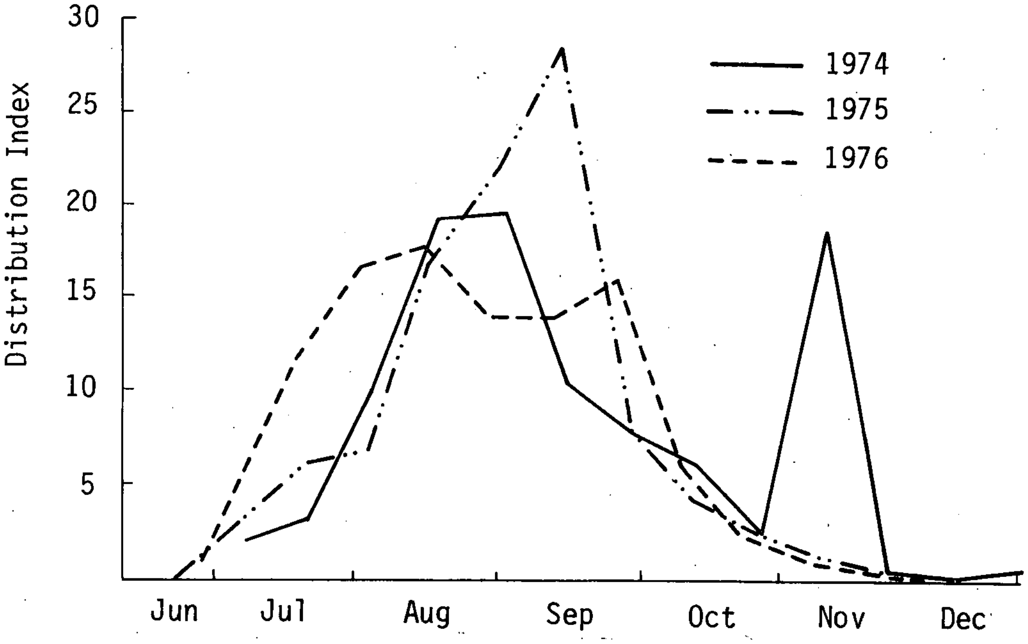


Figure V-46. Trends in Temporal Distribution Index of Juvenile White Perch Collected in Beach Seines, Hudson River Estuary, 1974-1976

3) Interregional Movements

Over 22,000 juvenile white perch were finclipped from September through November 1976; approximately 19,000 were released in regions 2 and 3 (Table V-17). Most recapture effort was applied in regions 2 and 3, thus fish that were marked in regions 2 and 3 and moved into regions 1, 4, and 5 would have a lower chance of recapture than those that remained in regions 2 and 3; therefore movement into regions 1, 4, and 5 could be underestimated. Also, finclipped fish from regions 1, 4, and 5 that moved into regions 2 and 3 would have a greater chance of being recaptured in regions 2 and 3 than those remaining in regions 1, 4, and 5, resulting in an overestimation of movement from regions 1, 4, and 5 into regions 2 and 3.

Mark-recapture data for juveniles finclipped from September to November and recaptured through December 1976 indicated that after moving into the shore zone during the summer, most juveniles remained in the same region during the fall. Almost all of the recaptured fish (97%) were collected in the region of release (Figure V-47). This pattern of limited movements was also evident in the fall of 1975 (TI 1978a). Three percent of the recaptures moved downriver; most (23 of 30) moved from the Indian Point region (region 3) into the Croton-Haverstraw region (region 2). Eleven fish moved into region 3 from other regions, (one from region 1, four from region 2, four from region 4, and two from region 5).

Table V-17

Marking Region and Number of Finclipped White Perch Released from September-November 1976, Hudson River Estuary

Region	RM	KM	*Number Released
1	12-23	19-37	129
2	24-38	38-61	11,572
3	39-46	62-74	7,405
4	47-76	75-122	2,340
5	77-152	123-243	607
Total			22,053

*Adjusted for mortality

Recapture Region

Release Region	1	2	3	4	5
1	2		1		
2		711	4		
3		23	222		
4			4	32	
5		1	2		1

Movement

Upriver	5	1%
None	968	97%
Downriver	30	3%

Figure V-47. Release-Recapture Matrix for White Perch Finclipped September-November, 1976 and Recaptured September-December 1976

A larger percentage of the juveniles marked from September through November 1976 and recaptured from January through June 1977 showed interregional movement. Only 40% were recaptured in the region of release (Figure V-48). Approximately 57% of the recaptures had moved into the Indian Point region. This high percentage was partially caused by the limited recapture effort in other regions due to cessation of river sampling during the winter. The only sources of recaptures during the winter were the impingement samples from the five power plants, hence only the Croton-Haverstraw, Indian Point, and Poughkeepsie regions (marking regions 2, 3, and 4) were represented and the movement patterns may be distorted. Furthermore, impingement collections are made daily only at the Indian Point Plant, so more recaptures would be expected from the Indian Point marking region.

About one quarter (22%) of the juveniles that were finclipped and recaptured during April through June 1977 showed interregional movement (Figure V-49). Only 7% of the finclipped fish from the 1975 year class

Recapture Region

Release Region	1	2	3	4	5
1			7		
2		7	33		
3			30		
4		2	12		
5		1	1		

Movement

Upriver	40	43%
None	37	40%
Downriver	16	17%

Figure V-48. Release-Recapture Matrix for White Perch Finclipped from September-November 1976 and Recaptured from January-June 1977

Recapture Region

Release Region	1	2	3	4	5
1	*				
2		32	10		
3		1	28	1	
4			5		
5					

Movement

Upriver	11	14%
None	60	78%
Downriver	6	8%

*Anomalies (naturally missing anal fins) prevented the analysis of movement from this region.

Figure V-49. Release-Recapture Matrix for White Perch Finclipped and Recaptured from April-June 1977 moved between regions. Most movement was again into the Indian Point region. Of the 15 fish recaptured there, 10 had moved upriver and 5 moved downriver.

Overall, the results indicated little interregional movement by juvenile white perch during the fall after moving into the shore zone during the summer. Over the winter and during the next spring they moved more extensively both upriver and downriver.

4) Movements to and from the Shore Zone

During 1976, juvenile white perch first appeared in samples taken in mid-July in shore zone and deeper offshore areas of the Tappan Zee through Cornwall regions (Figure V-50). Bottom trawl samples taken in deeper offshore areas indicated that most juveniles were offshore in mid-July. Juveniles began to move to the shore zone with increasing water temperatures and the development of macrophyte beds (which are extensive in the Croton-Haverstraw and Tappan Zee regions) during mid-August.

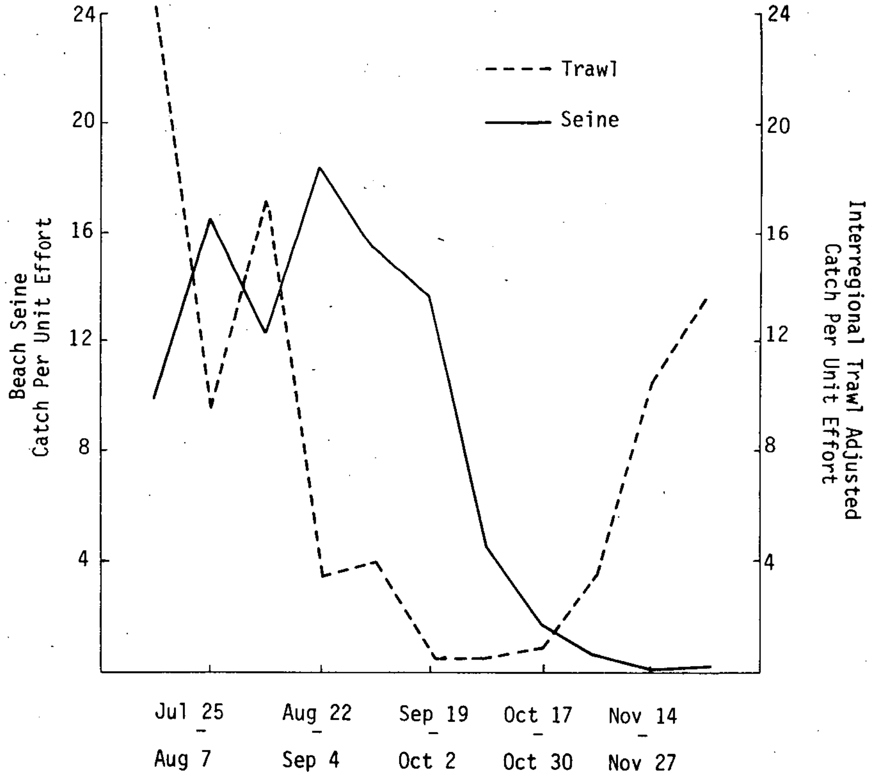


Figure V-50. Comparison of Catch-Per-Unit-Efforts between Seine and Trawl Collections of Juvenile White Perch Taken between the Tappan Zee-Cornwall Regions of Hudson River Estuary, July-December 1976

Beach seine catches began to fall sharply in early October after a late summer buildup (Figure V-50) indicating that the juveniles moved out of shore zone areas. This trend is confirmed by the rise in bottom trawl catches in mid-October. Trawl catches were low during September when beach seine catches were highest. These offshore movements in October may be related to water temperature changes as was shown for white perch in several Chesapeake Bay area rivers by Markle (1976). By November, movement from the shore zone of the Hudson River was apparently complete because both fall shoals and bottom trawl catches increased (Appendix Table C-40 and C-42).

e. Yearlings

1) Geographic and Temporal Distribution

During the first half of 1977, white perch yearlings of the 1976 year class were present in beach seine collections from the beginning of the sampling season in (April), although Riverwide standing crops in the shore zone were low. Abundance increased in May, and yearlings were concentrated in the Croton-Haverstraw, Tappan Zee, and Kingston through Catskill regions (Appendix Table C-45), with a distribution pattern similar to juvenile white perch. Standing crops were highest during June, but then began to decline, a trend that probably continued throughout the remainder of the year. This decline in beach seine catches could be attributed to mortality and/or possible movement away from the shore zone areas.

2) Trends in Distribution (1975, 1976, 1977)

White perch yearlings from the 1974, 1975 and 1976 year classes were present in the shore zone in April (at the beginning of each sampling season). Two abundance peaks were consistently evident: one in the Tappan Zee and Croton-Haverstraw regions and the other in the Kingston through Catskill regions. Yearlings from the 1974 year class were most abundant in the Tappan Zee and Croton-Haverstraw regions, but yearlings from the 1975 year class were most abundant further upriver in the Kingston through Catskill regions. Yearlings from the 1976 year class were distributed in a pattern similar to that of 1974 and 1975 (Figure V-51). Few yearlings were collected in the shore zone during any year from the Indian Point through Hyde Park regions. In these regions, standing crops were consistently higher

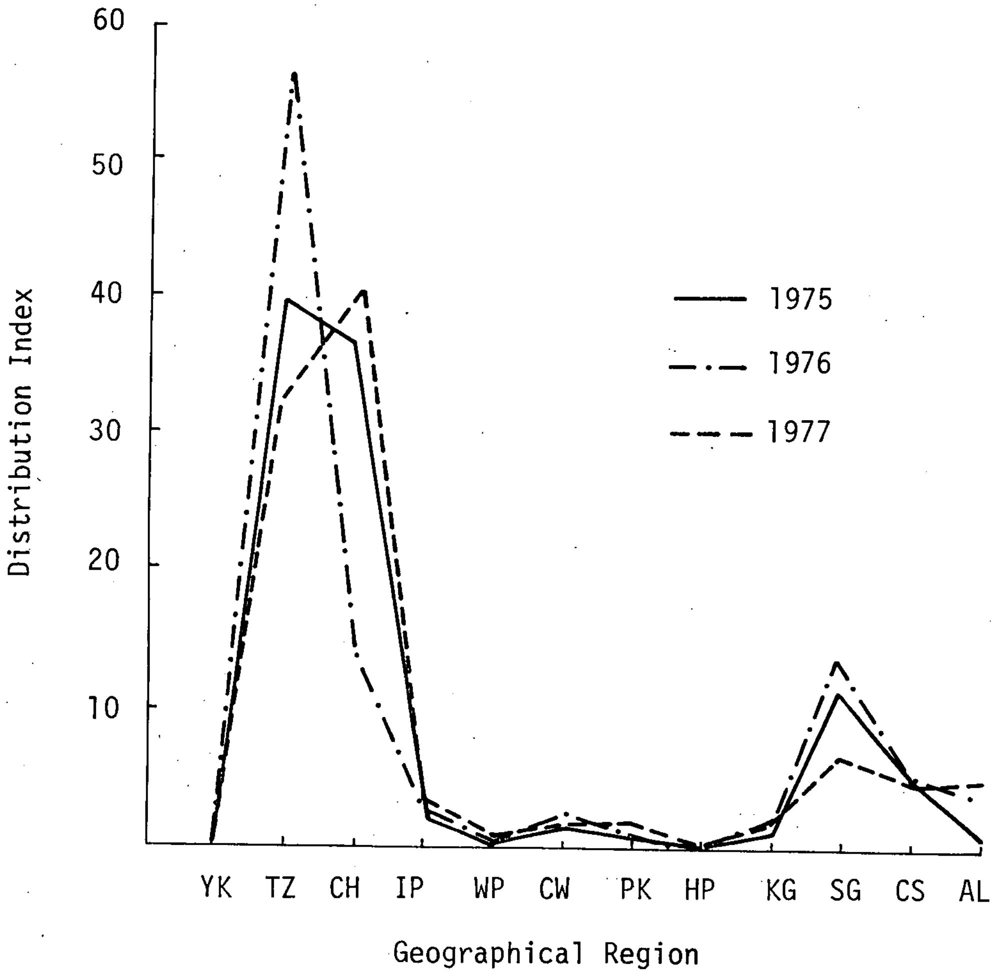


Figure V-51. Trends in Geographic Distribution Index of Yearling White Perch Collected in Beach Seines in Hudson River Estuary, 1975-1977

in the deeper, offshore areas. White perch yearling were common during May through August (Figure V-52), and by September, most had moved away from the shore zone areas.

f. Distribution of White Perch in Relation to Physicochemical Factors

1) Objectives

The range and highest density for each life stage in 1974-1976 were examined in order to determine general associations between life stage distribution and physicochemical factors (Appendix Table C-47).

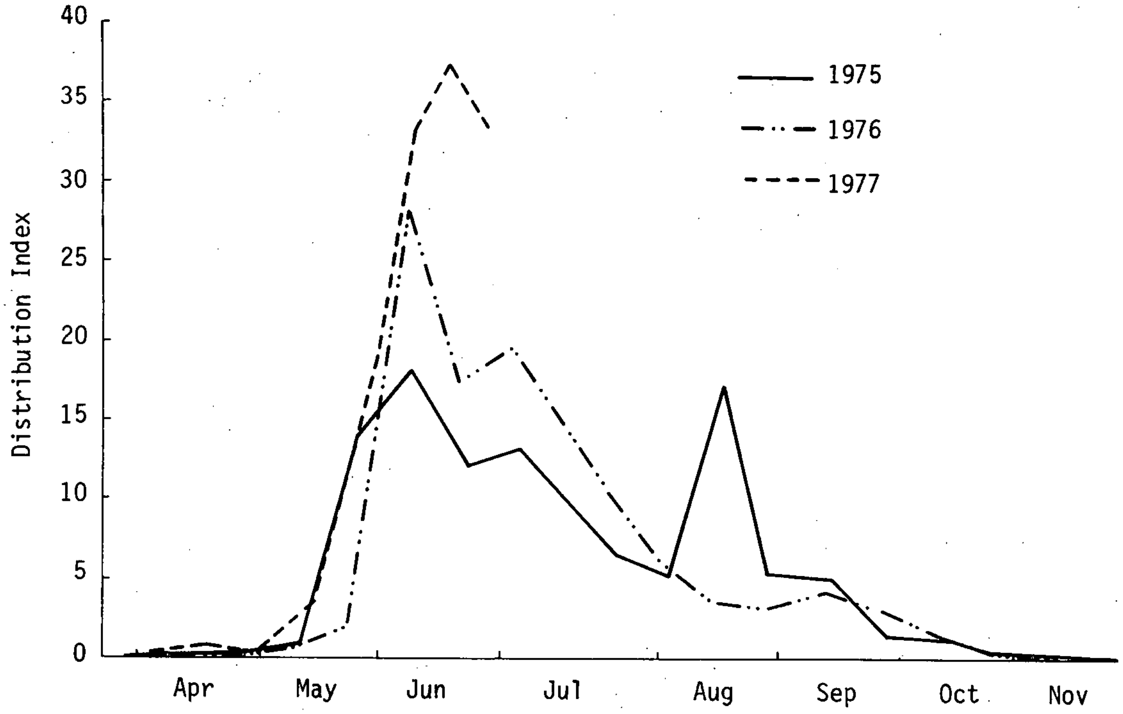


Figure V-52. Trends in Temporal Distribution Index of Yearling White Perch Collected in Beach Seines in Hudson River Estuary, 1975-1977

2) Results and Discussion

White perch spawning activity was weakly related to temperature and conductivity. Eggs were collected over a wide range of temperatures (10 to 28°C) in 1974 through 1976 with the highest densities observed at 14 to 20°C (Table V-18). These peak densities occurred at higher temperatures in 1974 than in 1975 and 1976. Highest densities of eggs were found at conductivities of <0.3 to 3.0 mS/cm. Spawning occurred at higher temperatures in the Hudson River than reported for the Chesapeake Bay region, where spawning in tidal, fresh, and brackish water occurred at temperatures ranging from 10 to 15°C (Mansueti 1961b; 1964). Since there is a large variation in the temperature at which white perch spawning occurred in the Hudson, temperature seems to be a minor factor controlling the timing of spawning. Spawning activity in freshwater tributaries was reported for white perch populations from the Delaware River (Wallace 1971) and from the James and York Rivers of Virginia (St. Pierre and Davis 1972). The potential role of tributary streams to the Hudson River estuary as spawning areas for white perch has not been investigated.

Table V-18

Ranges of Physicochemical Factors and Values at Highest Densities Associated with White Perch Egg and Larval Distribution, (Values in Parentheses are First Minor Peaks)

	Eggs			Yolk-Sac Larvae			Post Yolk-Sac Larvae		
Parameter	1974	1975	1976	1974	1975	1976	1974	1975	1976
Temperature									
Range	12-26	10-24	10-26	12-26	12-24	10-26	12-28	16-30	10-28
Highest Density	18-20	18-20	14-16	16-18	16-18	14-16	20-22	20-22	20-22
Conductivity									
Range	<0.3-11	<0.3-11	<0.3-7	<0.3-9	<0.3-13	<0.3-15	<0.3-27	<0.3-15	<0.3-21
Highest Density	1-3	<0.3-0.6	<0.3	0.6-1	<0.3	<0.3	0.6-1	1-3	<0.3
Dissolved Oxygen									
Range	1-13	6-11	5-13	1-13	5-11	5-13	1-13	4-11	5-13
Highest Density	10-11	9-10	9-10	10-11	9-10	9-10	1-2 (7-8)	8-9	8-9

Spawning activity is associated with dissolved oxygen (D.O.) concentration. Most eggs were found in areas of high oxygen content; peak densities were observed at 9 to 11 mg/l.

The densities of yolk-sac and post yolk-sac larvae were highest at water temperatures of 14 to 22°C and in primarily fresh or brackish (less than 1 mS/cm) water (Table V-18). Dissolved oxygen levels during the larval periods ranged from 5 to 11 mg/l, highest catches generally occurred in areas with D.O. concentrations between 8 and 11 mg/l, except in 1974 when the highest densities of post yolk-sac larvae occurred at D.O. levels of 1 to 2 mg/l. Dissolved oxygen levels greater than 3 to 5 mg/l are suitable for survival and growth for most freshwater fishes (Doudoroff and Shumway 1970). The effect of the low levels in 1974 on post yolk-sac larvae would depend on the duration of exposure and the physical condition of the larvae.

Associations of post yolk-sac larvae with conductivity and temperature are different for white perch and striped bass. First, a few white perch occurred in areas of higher salinity (greater than 3 mS/cm) as they reached the post yolk-sac stage. Second, temperature is not as important in the development of yolk-sac larvae to the post yolk-sac stage as it is with striped bass (see Subsection V.B.1.f, Figure V-53, Table C-49).

The distribution of juvenile white perch collected was influenced by temperature (Table V-19). After transformation from the post yolk-sac larval stage in mid- to late July, juvenile white perch apparently began to move into the shorezone (Section V.C.d.1) as water temperatures increased. Juveniles remained in the shorezone through August and then began to move offshore again in September or October as water temperatures decreased. Beach seine catches declined rapidly at temperatures below 12°C (catches peak at 18 to 28°C), but epibenthic sled (fall shoal) catches in the offshore area increased to a peak at temperatures of 6 to 14°C and then declined in late fall (Table V-19). Thus, the catch data from several gear confirmed that juvenile white perch moved offshore in the fall as temperatures declined.

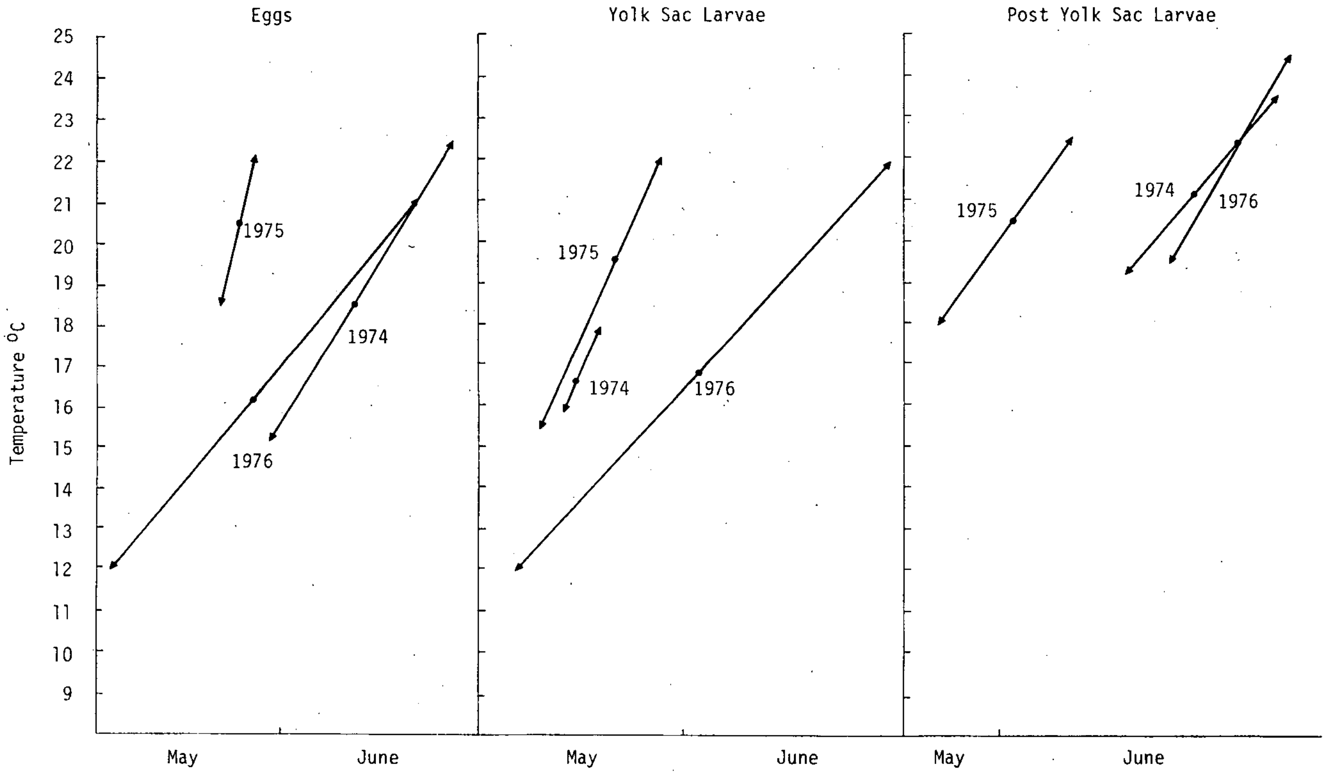


Figure V-53. Temperatures in Hudson River during Egg and Larval Life Stages of White Perch, 1974-1976

Table V-19

Ranges of Physicochemical Factors and Values at Highest Densities Associated with White Perch Juvenile Distribution (Values in Parentheses Are First Minor Peaks)

	Beach Seine			Fall Shoals			Plankton			Bottom Trawl		
Parameter	1974	1975	1976	1974	1975	1976	1974	1975	1976	1974	1975	1976
Temperature												
Range	2-32	6-32	2-30	2-28	4-26	-	18-28	22-28	20-26	2-26	4-28	4-26
Highest Density	26-28	18-20	26-28	6-8	12-14	-	26-28	24-26	22-24	2-4	12-14	24-26 (6-8)
Conductivity												
Range	<0.3-27	<0.3-17	<0.3-25	<0.3-15	<0.3-11	-	<0.3-9	<0.3-13	<0.3-21	<0.3-17	<0.3-9	<0.3-15
Highest Density	0.3-0.6	3-5	0.3-0.6	<0.3-0.6	1-3	-	0.3-0.6	0.3-1	7-9	0.3-0.6	1-3	1-3
Dissolved Oxygen												
Range	4-16	4-16	3-16	4-14	4-13	-	4-10	5-9	5-10	4-14	4-14	3-13
Highest Density	15-16	8-9	14-15	11-12	11-12	-	6-7	7-9	8-9 (6-7)	13-14	5-6	5-6

Longitudinal distribution of juvenile white perch was related to salinity and dissolved oxygen. Catches were highest in all samples collected in fresh or brackish (less than 9 mS/cm) water area (Table V-19). Highest densities were associated with conductivities representative of the saltfront. Few juvenile white perch were collected in areas containing dissolved oxygen of less than 5 mg/l although a wide range occurred (Table V-19).

2. Age Two and Older White Perch

a. Geographic and Temporal Distribution during 1976

Two year old and older (2 yr +) white perch were widely dispersed along the shore zone throughout the estuary from April through early December 1976 (Table V-20). They were abundant in the Tappan Zee and Croton-Haverstraw regions, and from the Kingston through Catskill regions; the regions of peak abundance depended upon the month. Few were collected in the shore zone between West Point and Hyde Park.

Standing crops for 2 yr+ white perch peaked during late May although the fish were relatively abundant from May through early October.

Table V-20

Total Standing Crops of Two Year Old and Older White Perch and Percentage of Total Standing Crops in 12 Regions of Hudson River Estuary during Each of 19 Beach Seine Survey Sampling Periods, March-December 1976

	Sampling Date																		
Region	3/21 - 4/3	4/4 - 4/17	4/18 - 5/1	5/2 - 5/15	5/16 - 5/29	5/30 - 6/12	6/13 - 6/26	6/27 - 7/10	7/11 - 7/24	7/25 - 8/7	8/8 - 8/21	8/22 - 9/4	9/5 - 9/18	9/19 - 10/2	10/3 - 10/16	10/17 - 10/30	10/31 - 11/13	11/14 - 11/27	11/28 - 12/11
YK	2.6	0.6	2.3	0.2	0.1	0.2	1.1	0.7	0.9	1.6	0.4	0.8	3.1	3.1	3.6	3.9	1.7	2.4	*
TZ	42.6	19.6	12.6	3.5	0.9	12.4	16.2	36.4	40.4	65.5	42.1	64.8	38.1	30.6	55.5	54.1	35.0	52.9	77.6
CH	31.7	35.1	11.5	7.0	1.5	10.5	12.3	13.2	22.4	16.9	7.0	15.5	45.0	43.2	15.4	15.2	7.9	8.2	16.4
IP	19.0	0.2	24.7	0.7	0.2	1.2	3.6	2.2	3.9	5.1	1.7	2.2	1.7	3.9	6.9	1.2	0.5	0.7	4.6
WP		0.6	0.9	0.2	0.2	1.4	1.1	0.4	0.1	0.1	0.6	0.2	0.2	0.2	0.5	0.4	5.9	4.3	1.3
CW	4.0	2.4	10.5	3.9	4.5	5.3	3.9	2.6	3.3	2.4	3.7	1.8	0.3	0.9	3.8	1.0			
PK	NS**	30.2	17.3	10.1	7.1	NS	27.5	4.9	3.4	0.8	0.5	0.5	0.8	0.7	0.3	1.2	4.5		NS
HP	NS		0.1	7.3	3.7	6.3		0.4	0.5	0.4	0.2	0.4	0.1		0.7				NS
KG	NS	9.0	2.4	40.1	29.8	38.2	0.5	4.3	3.3	1.1	3.2	3.4	1.5	1.0		1.2		31.5	NS
SG	NS		2.4	25.7	39.9	17.7	19.8	18.4	12.6	4.2	10.0	5.7	6.7	3.7	3.8	9.8	44.6		NS
CS	NS	2.3	15.3	1.3	6.2	2.1	12.5	9.6	7.3	1.4	9.0	4.0	2.2	12.4	8.9	11.0			
AL	NS				5.8	4.6	1.4	6.8	2.0	0.6	21.7	0.8	0.4	0.3	0.7	1.0			
Total	99.9	100.0	100.0	100.0	99.9	99.9	99.9	99.9	100.1	100.1	100.1	100.1	100.1	100.0	100.1	100.0	100.1	100.0	99.9
Total Standing Crops (Thousands)	48	191	359	1912	3282	1261	1703	1455	1319	1383	1005	1368	2105	1345	349	359	39	27	12

*No entry indicates no juveniles collected.

**NS = No sample.

August, then increased during early September. Most of the population was in the Croton-Haverstraw and Tappan Zee regions during June, July and August. From mid-September through October, few fish appeared in the shore zone above Poughkeepsie, but during November a substantial percentage of the standing crops was found in the Kingston and Saugerties regions. By late November, when the total standing crops dropped to 11,000, 2 yr+ perch were rarely captured in the shore zone.

b. Trends in Distribution (1974, 1975, 1976)

Two year old and older white perch were widely dispersed throughout the shore zone of the estuary during all of 1974, 1975 and 1976 (Figure V-54). They were most abundant in two areas: the Tappan Zee and Croton-Haverstraw regions, and the Kingston through Catskill regions. During all three years, most older white perch were located in the Tappan Zee and Croton-Haverstraw regions, with fewer collected between Kingston and Catskill. During 1975 and 1976, 2 yr+ fish were more abundant in the Kingston through Catskill regions than during 1974.

Periods of high abundance varied over the three years, with peak standing crops occurring from late May through late June (Figure V-55). Peaks of secondary standing crops occurred in August and early September during 1974 and 1976 respectively. Standing crops began to decline by late September in all thre years as the fish moved from the shore zone.

c. Interregional Movements

Two recapture periods have been used to assess the movement of white perch tagged in 1976: July through December 1976 and January through June 1977. Movement of fish marked with fingerling tags was also compared with fish marked with internal anchor tags to see if movement and size of the fish were related.

A higher percentage of fish recaptured from January through June 1977 moved between regions than those recaptured from July through December 1976. Of the white perch less than 150 mm total length (TL), 88% of the

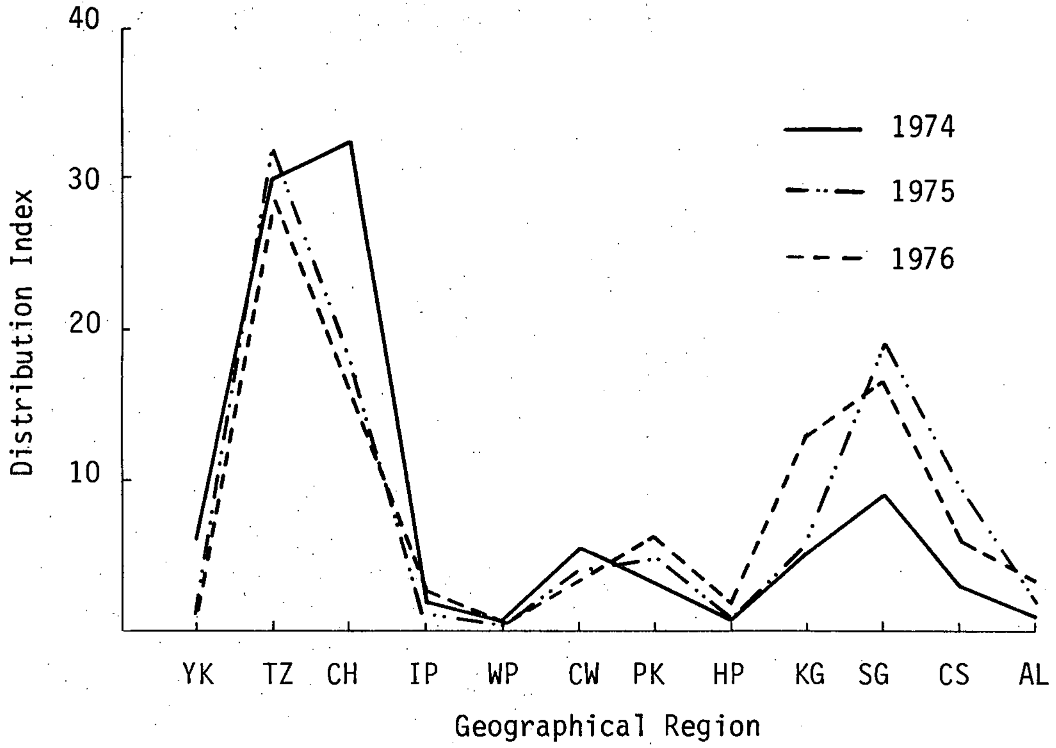


Figure V-54. Trends in Geographic Distribution Index of Two Year Old and Older White Perch Collected in Beach Seines in Hudson River Estuary, 1974-1976

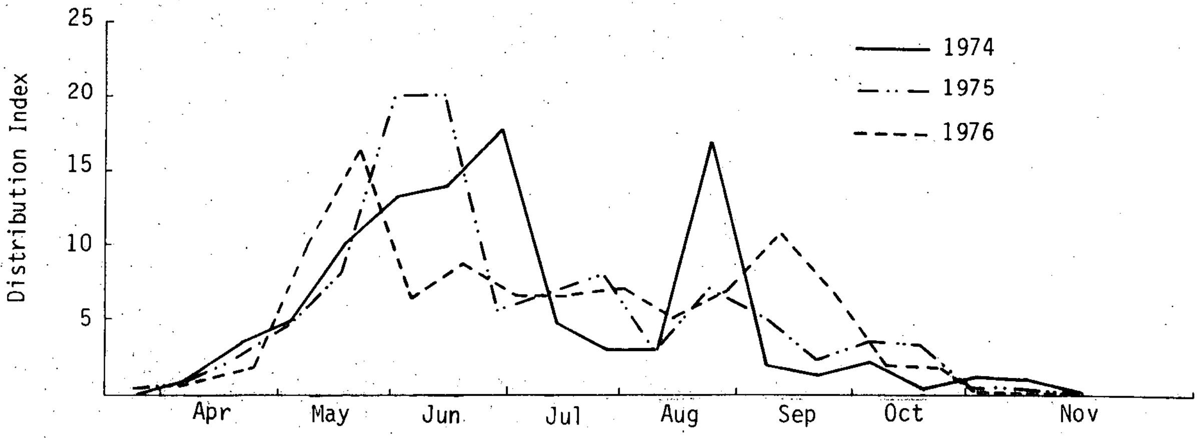


Figure V-55. Trends in Temporal Distribution Index of Two Year Old and Older White Perch Collected in Beach Seines in Hudson River Estuary, 1974-1976 fish recaptured July through December were collected in the region of release compared to 54% of the January through June recaptures (Figure V-56 and V-57). For the larger white perch (greater than 150 mm TL) 83% of the July through December recaptures exhibited no interregional movement compared to 50% of the January through June recaptures (Figure V-58 and V-59). These differences are mostly a function of the time between release and recapture; no truly sedentary period existed although less movement was apparent from late September through November (Appendix Tables C-49 and C-50).

Movement of the fish recaptured from January through June was mostly into the Indian Point area from both upriver and downriver regions; 40% of the fingerling tag recaptures and 42% of the internal anchor tag recaptures were of fish that moved into that region (Figures V-57 and V-59). Due to limited sampling in other regions of the estuary, the movement of marked fish into the Indian Point area exaggerated the population movements.

Fish greater than 150 mm (TL) appeared to move further, both upriver and downriver than those less than 150 mm (TL), although movements by all white perch were generally limited. Four white perch tagged with internal anchor tags in region 1 were recaptured in region 4, while several fish tagged in region 5 were recaptured in regions 2, 3, or 4. Of the white perch tagged with fingerling tags and released in region 1, one was recaptured in region 2 and one in region 3; of those fish released in region 5, recaptures occurred in two other regions (3 and 4). White perch of both size classes tended to remain in the same location for a long time. Some fish were recaptured at the same location after as many as 350 days at large.

Movements were both upriver and downriver, and occurred throughout the length of the estuary and into surrounding waters. One white perch was recaptured in Eastchester Bay 473 days after being tagged at RM 40 (KM 64) on May 22, 1975. Another fish tagged at RM 34 (KM 54) was recaptured at the mouth of the river (RM 0 [KM 0]) after being at large 119 days. One fish moved upriver from RM 14 (KM 22) to RM 66 (KM 106) in 13 days, another from RM 15 (KM 24) to RM 66 (KM 106) in 249 days, and another from RM 40 (KM 64) to RM 99 (KM 158) in 198 days.

Recapture Region

Release Region	1	2	3	4	5
1	2				
2	4	195	15		
3		6	76		
4		5	3	1	
5			1	2	1

Movement

Upriver	15	5%
None	275	88%
Downriver	21	7%

Figure V-56. Release-Recapture Matrix for White Perch Tagged with Fingerling Tags during 1976 and Recaptured from July-December 1976

Recapture Region

Release Region	1	2	3	4	5
1		1	1		
2	1	73	67		
3		9	40	1	
4			14	5	
5			7	1	3

Movement

Upriver	70	31%
None	121	54%
Downriver	32	14%

Figure V-57. Release-Recapture Matrix for White Perch Tagged with Fingerling Tags during 1976 and April-June 1977 and Recaptured from January-June 1977

Recapture Region

Release Region

	1	2	3	4	5
1	22				
2	2	190	17		
3		4	28		
4	1	2	6	9	1
5		6	10	3	2

Movement

Upriver	18	6%
None	251	83%
Downriver	34	11%

Figure V-58. Release-Recapture Matrix for White Perch Tagged with Internal Anchor Tags during 1976 and Recaptured from July-December 1976

Recapture Region

Release Region

	1	2	3	4	5
1	10	1	2	4	
2	3	86	79	1	
3	1	3	34	1	2
4		5	18	1	1
5			13		1

Movement

Upriver	91	34%
None	132	50%
Downriver	43	16%

Figure V-59. Release-Recapture Matrix for White Perch Tagged with Internal Anchor Tags from January 1976-June 1977 and Recaptured from January-June 1977

In conclusion, 2 yr+ white perch moved more extensively than juveniles (Subsection V.C.1), although the patterns were similar with less movement in the fall and movement into the Indian Point region in the winter from both upriver and downriver regions (movement into other regions was probably underrepresented due to limited sampling outside the area of Indian Point during the winter). Fish greater than 150 mm (TL) moved further than fish less than 150 mm (TL). Some white perch were recaptured at the same location where they were released after hundreds of days at large. Movement was in both directions over the entire estuary indicating a single, continuous population even though the geographic distribution showed upper river and lower river groups (Subsection V.C.2.a.).

3. Exposure of Early Life Stages to the Effects of Power Plants

a. Eggs

1) Distribution Within Power Plant Regions

White perch eggs were first collected in mid-April and found within all plant regions by May 3. Peak egg abundance occurred during mid-May and mid-June primarily in the Saugerties and Catskill regions, north of the power plant regions (Figure V-60). Highest standing crops values within the Roseton and Danskammer plant regions occurred in early May, prior to the periods of peak egg deposition (Appendix Table C-51). The Bowline, Lovett and Indian Point plant regions showed highest values in late May, after the mid-May peak and before the mid-June peak in egg abundance.

The highest percentage of white perch eggs within all plant regions was observed during periods of low river standing crops (Figure V-61). In general, the largest proportion of organisms were consistently found upriver from the plant regions, indicating that major spawning activity occurred north of the plants.

During the period of white perch egg abundance, total within plant region percentages were highest for Danskammer and Roseton. Bowline had an intermediate value, while Lovett and Indian Point had the lowest percentages.

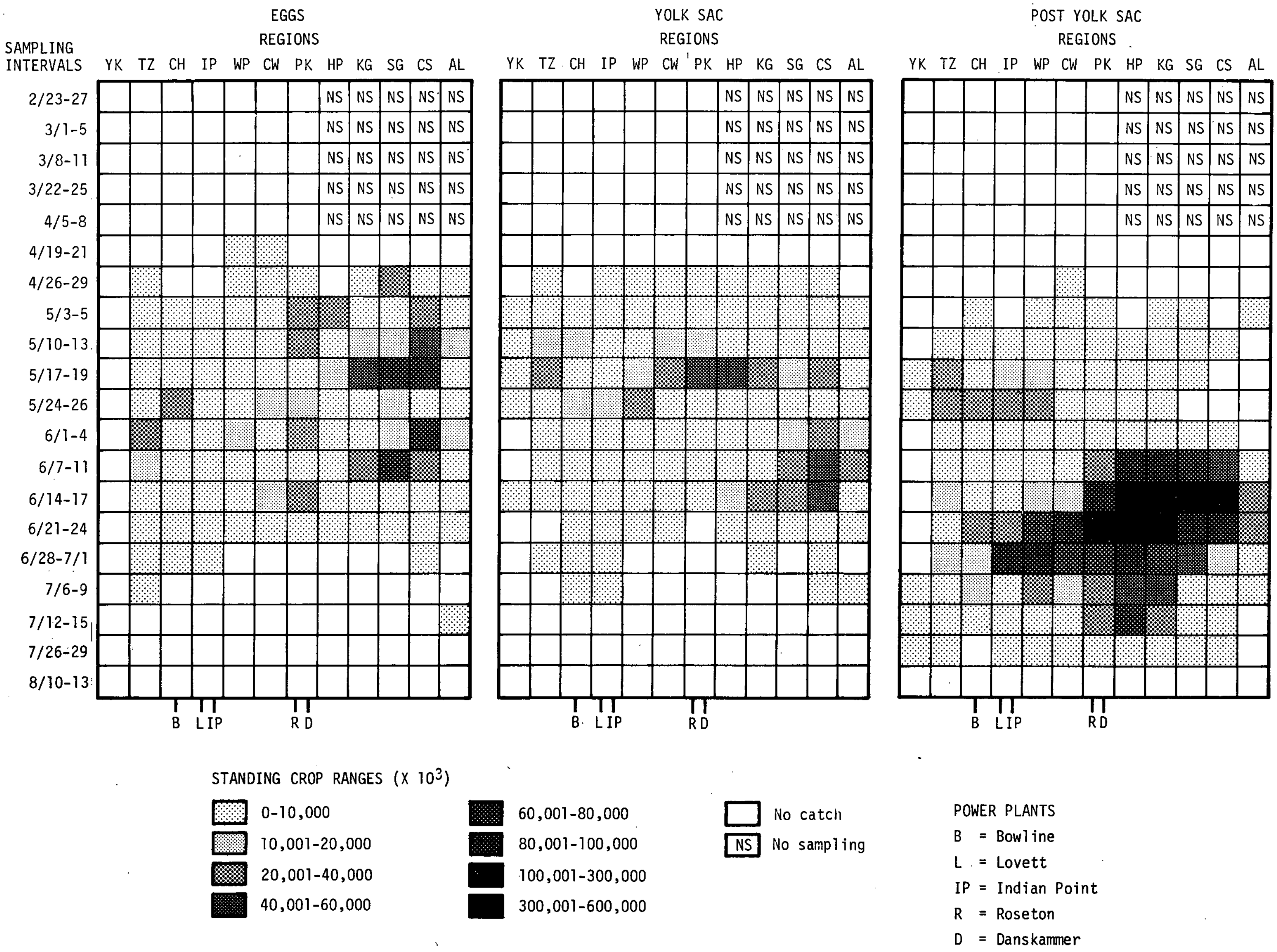


Figure V-60. Exposure Matrix of White Perch Eggs, Yolk-Sac and Post Yolk-Sac Collected during 1976 Ichthyoplankton Survey

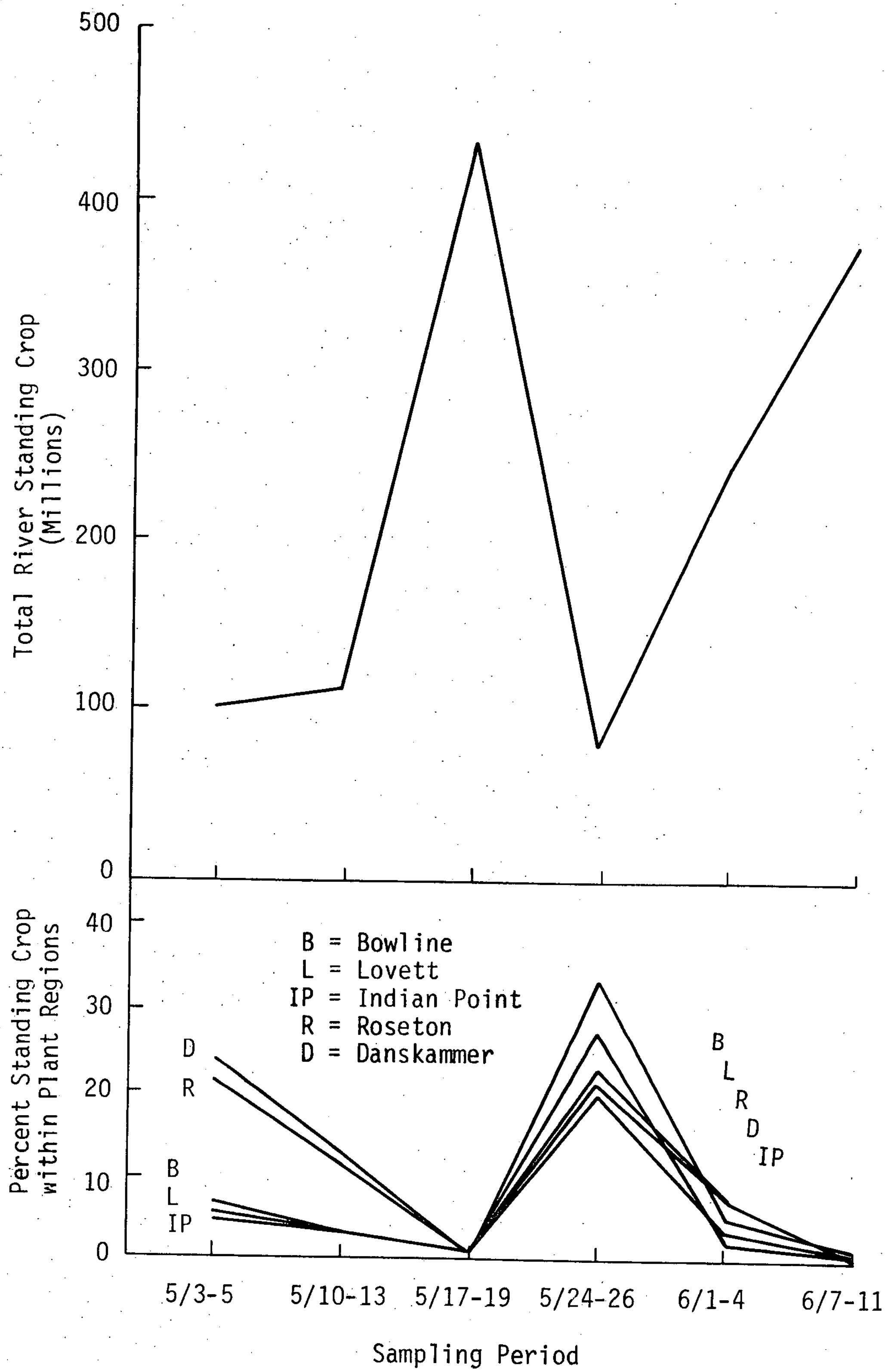


Figure V-61. Comparison of Total River Standing Crops of White Perch Eggs with Percent Standing Crops Found within Plant Regions during Selected Periods in 1976

2) Trends in Exposure

In 1974, white perch eggs showed no distinct differences in vul- exposure to the five power plant regions, although exposure of eggs was slightly higher to Bowline (Figure V-62). Exposure was similar to Bowline, Lovett, and Indian Point in 1975, but much higher to Roseton and Danskammer. These higher values reflect the 1975 geographical distribution indices which showed a large proportion of eggs within the Poughkeepsie and Catskill region, areas adjacent to and upriver from Roseton and Danskammer. In 1976, exposure of eggs was again similar to all plants and less than in previous years.

3) Comparison with Near-Field Density Estimates

Far-Field Ichthyoplankton and Near-Field Study surveys within the Bowline plant region showed a difference in temporal distribution of white perch egg densities (Figure V-63). Density estimates in the Bowline plant region based on the Far-field Survey peaked in late May when near-field study densities were low; then nearfield values peaked in early June as far-field densities declined. This difference cannot easily be explained by either gear or time of sampling effort. However, since the peak nearfield density estimate (June 8) represents only samples taken from a channel station in which the highest densities were found in the bottom layer (Central Hudson Gas and Electric Corp. 1977), the June 8 value may reflect the demersal nature of white perch eggs observed in the ichthyoplankton estimates during the previous period.

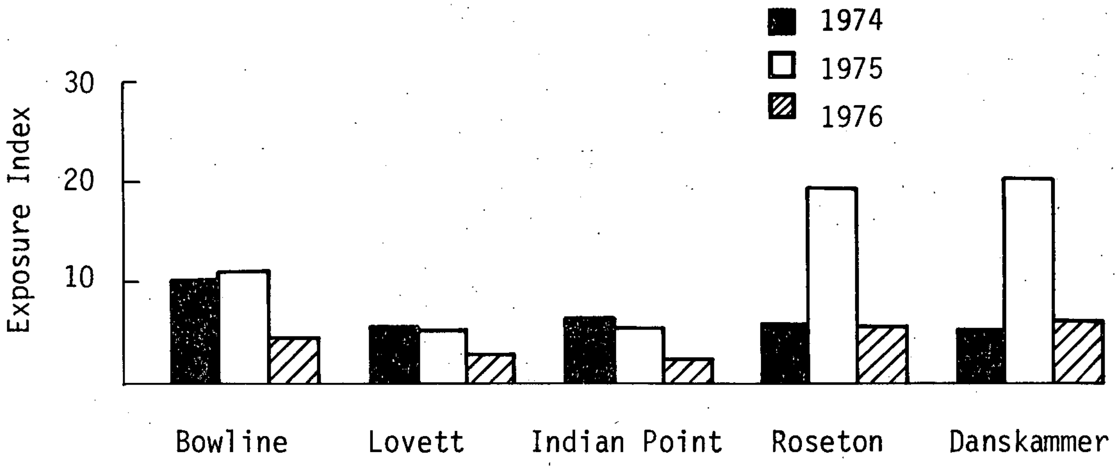
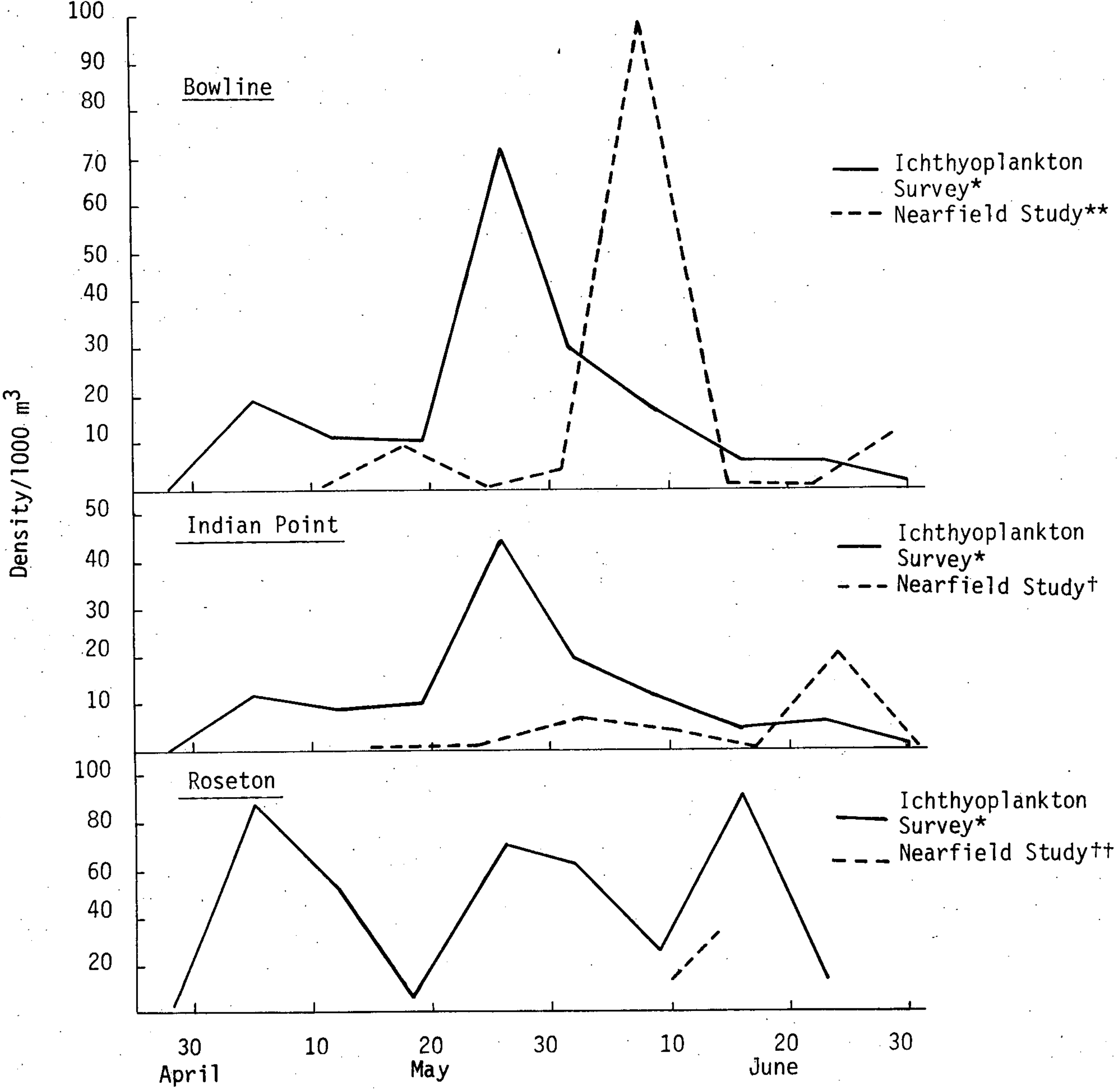


Figure V-62. Exposure Indices of White Perch Eggs for Power Plant Regions during Selected Periods from 1974-1976



*Density estimates prior to June reflect daytime sampling efforts; nighttime sampling efforts after June 1.

**Mean river concentration based on day and night sampling.

†Corresponding photoperiods to those of Ichthyoplankton Survey.

††Corresponding photoperiods to Ichthyoplankton Survey during selected periods.

Figure V-63. Comparison of Density Estimates of White Perch Eggs at Bowline, Indian Point, and Roseton Plant Regions during 1976

Density estimates within the Indian Point plant region based on the Far-Field Survey followed a pattern similar to the one found at Bowline, but, the nearfield densities at Indian Point remained low throughout May and most of June, with a slight peak late in the season. In the Roseton plant region, Far-Field Survey density estimates were higher overall, but little comparison with nearfield densities was possible.

4) Overall Exposure Assessment

Two factors make white perch eggs relatively invulnerable to the power plants. The spawned eggs sink to the bottom and because of their adhesive nature, stick to each other and to substrates that they contact (Mansueti 1964). They presumably remain stationary at the bottom until they hatch which occurs from 1.5 to 6 days and is temperature dependent (McFadden 1977). Another factor is that most eggs are found outside the plant regions, especially upriver at Roseton and Danskammer, therefore, any eggs found outside the plant regions are unlikely to be entrained.

b. Yolk-Sac Larvae

1) Distribution Within Power Plant Regions

The transition of egg to yolk-sac larvae occurred in late April during 1976 and larvae were found within all power plant regions by May 3. The longest duration of exposure of yolk-sac larvae in power plant regions occurred at Lovett and Indian Point (April 26 through July 9) followed by Bowline (May 3 through July 9) and Roseton and Danskammer (April 29 through June 17) (Figure V-60). Two peaks in yolk-sac abundance occurred during sampling; one in mid-May and the other in mid-June (Figure V-64). Highest standing crop values within the Roseton and Danskammer plant regions occurred during the initial peak, although a large proportion of organisms were observed from the plant regions at this time. This indicates a widely distributed yolk-sac abundance throughout the study area (Appendix Table C-52). Bowline, Lovett, and Indian Point plant regions had the highest values in late May prior to the second peak in yolk-sac abundance, with the largest proportion of organisms found upriver from these plant regions.

The exposure of yolk-sac larvae, based on the percentage of the total standing crops within plant regions (Figure V-64), showed the highest values during the last half of May. The percentages declined, within all plant regions after June 1 as total river standing crops increased. During the period of white perch yolk-sac abundance, May 10 through June 17, total within plant region percentages were highest for Roseton and Danskammer, respectively. These two plants were followed by Bowline with an intermediate value while Lovett and Indian Point had the lowest percentages.

2) Trends in Exposure (1974, 1975, 1976)

The exposure of white perch yolk-sac larvae did not vary greatly among the five power plants from 1974 through 1976 (Figure V-65). The highest exposure in 1975 occurred to the downriver plants (Bowline, Lovett and Indian Point); exposure in 1976 was slightly higher to Roseton and Danskammer. These higher values reflect peaks in the geographic distribution indices of yolk-sac larvae seen in the Tappan Zee and Catskill regions during 1975 and 1976, respectively. Overall, the similarities of exposure to all power plants indicates a rather wide dispersion of yolk-sac larvae throughout the estuarine study area.

3) Comparison with Nearfield Density Estimates

Density estimates of yolk-sac and post yolk-sac larvae will be discussed as combined life stages.

4) Overall Exposure Assessment

The life stage duration of yolk-sac larvae is about three to five days (McFadden 1977) and exposure would seem low in terms of this duration. Studies conducted on the Hudson River showed that higher yolk-sac densities were found in the channel than in the bottom strata (McFadden 1977). Overall, exposure of white perch yolk-sac larvae to entrainment was low because most larvae occur outside the plant regions.

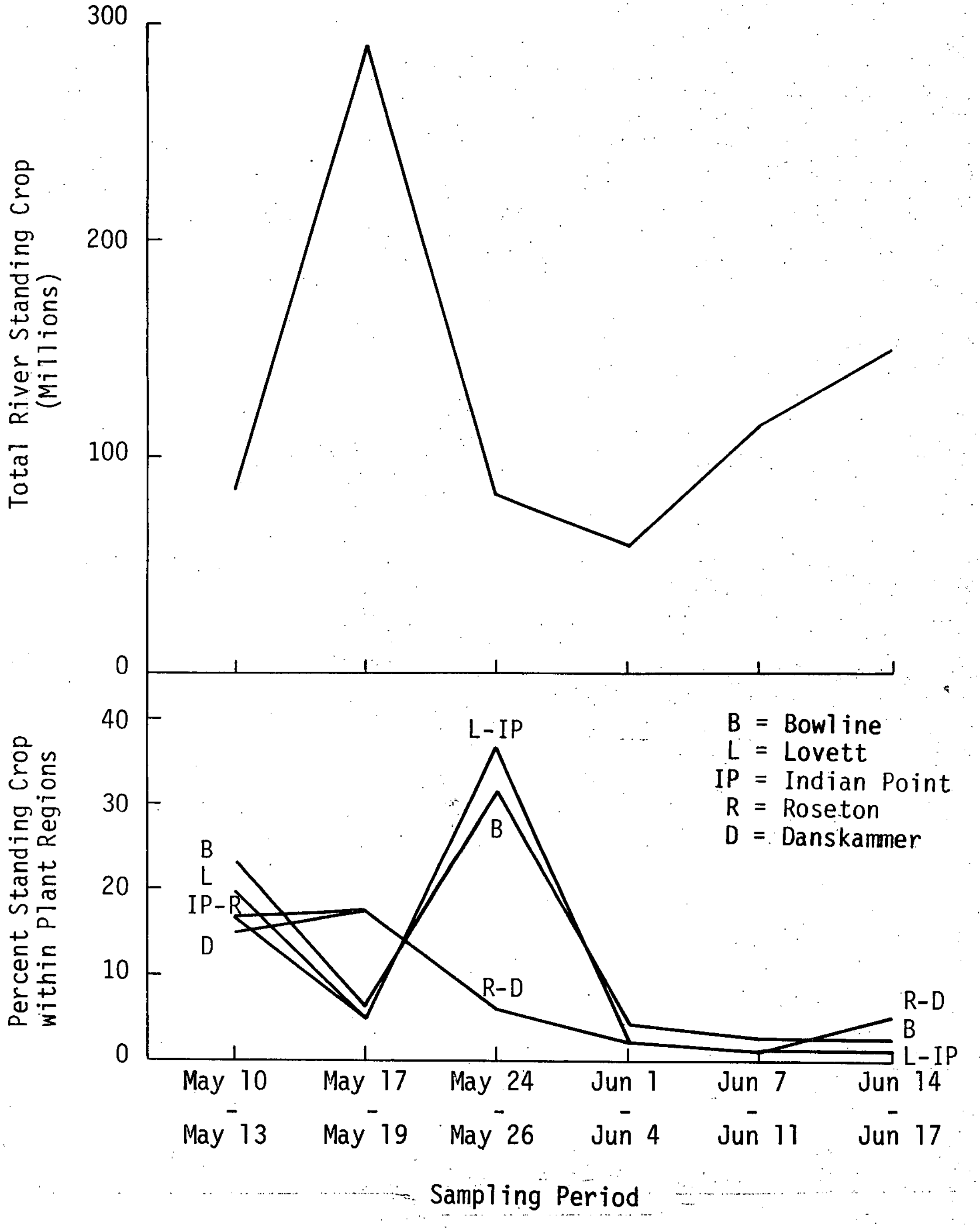


Figure V-64. Comparison of Total River Standing Crops of White Perch Yolk-Sac Larvae with Percent Standing Crops Found within Plant Regions during Selected Periods in 1976

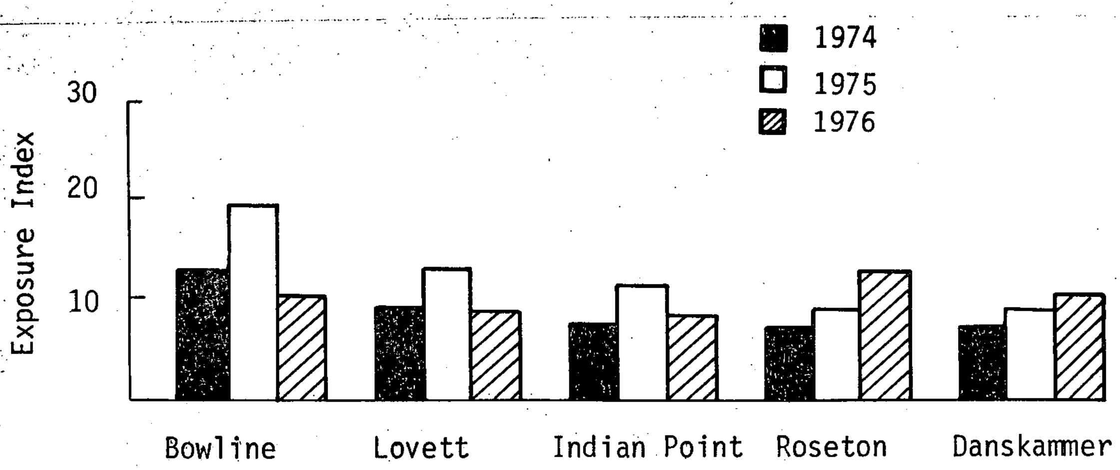


Figure V-65. Exposure Indices of White Perch Yolk-Sac Larvae for Power Plant Regions during Selected Periods from 1974-1976

c. Post Yolk-Sac Larvae

1) Distribution within Power Plant Regions

Post yolk-sac larvae were first collected as early as April 26 but not found within all plant regions until mid-May (Figure V-60), and remained within these regions until the latter part of July. Peak abundance of post yolk-sac larvae occurred during the third week in June, when the highest standing crops values were found in the Roseton and Danskammer plant regions (Appendix Table C-53). Highest values for Bowline, Lovett, and Indian Point occurred during the following week (June 28 to July 1) as total river standing crops began to decline.

The percentage of organisms within the three downriver plant regions had similar patterns, with values increasing in late June (Figure V-66). Roseton and Danskammer plant regions had increasing values through the third week in June, then declined and exhibited the pattern of the total river standing crops. By early July, values within all plant regions were similar, with the largest proportion of organisms found above the plant regions. This indicates an upriver distribution of post yolk-sac larvae, similar to that observed for the geographic distribution.

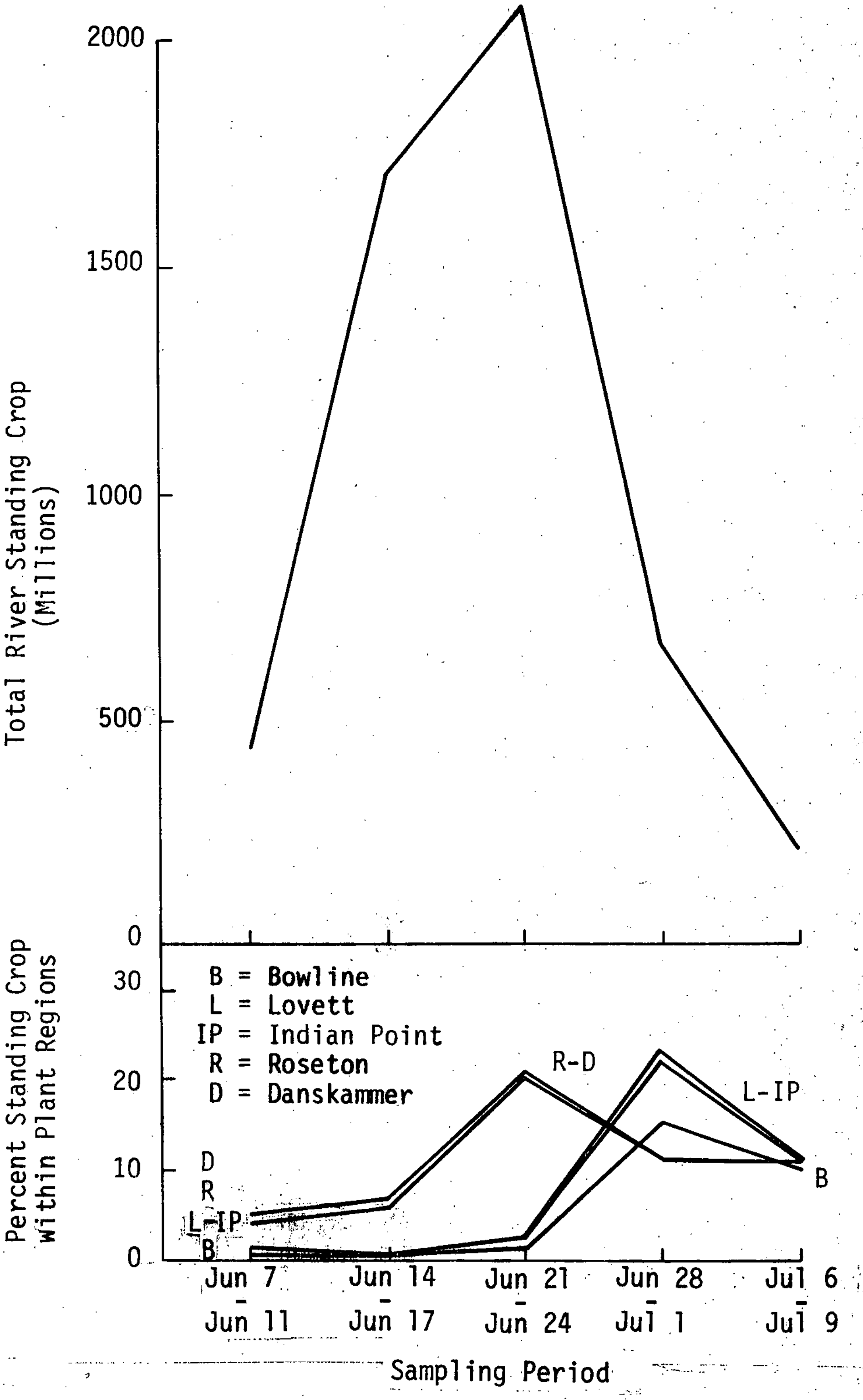


Figure V-66. Comparison of Total River Standing Crops of White Perch Post Yolk-Sac Larvae with Percent Standing Crops Found within Plant Regions during Selected Periods in 1976

During the period of white perch post yolk-sac abundance (June 7 through July 9), total within plant region percentages were highest for Danskammer and Roseton, followed by Bowline, Lovett, and Indian Point, in decreasing order.

2) Trends in Exposure (1974, 1975, 1976)

Except for being slightly lower at Bowline, exposure of post yolk-sac larvae was similar to all plants in 1974 (Figure V-67). The exposure patterns follow those observed for yolk-sac larvae in the same year. In 1975, exposure to Bowline, Lovett, and Indian Point remained approximately the same as in 1974, but decreased at Roseton and Danskammer. During 1976, exposure to Roseton and Danskammer varied little from 1975 but was much lower at Bowline, Lovett, and Indian Point than in either 1974 or 1975.

The different patterns in exposure over the three year period reflect the geographic distribution indices that showed widespread distribution of post yolk-sac larvae in the study area from 1974 to 1976.

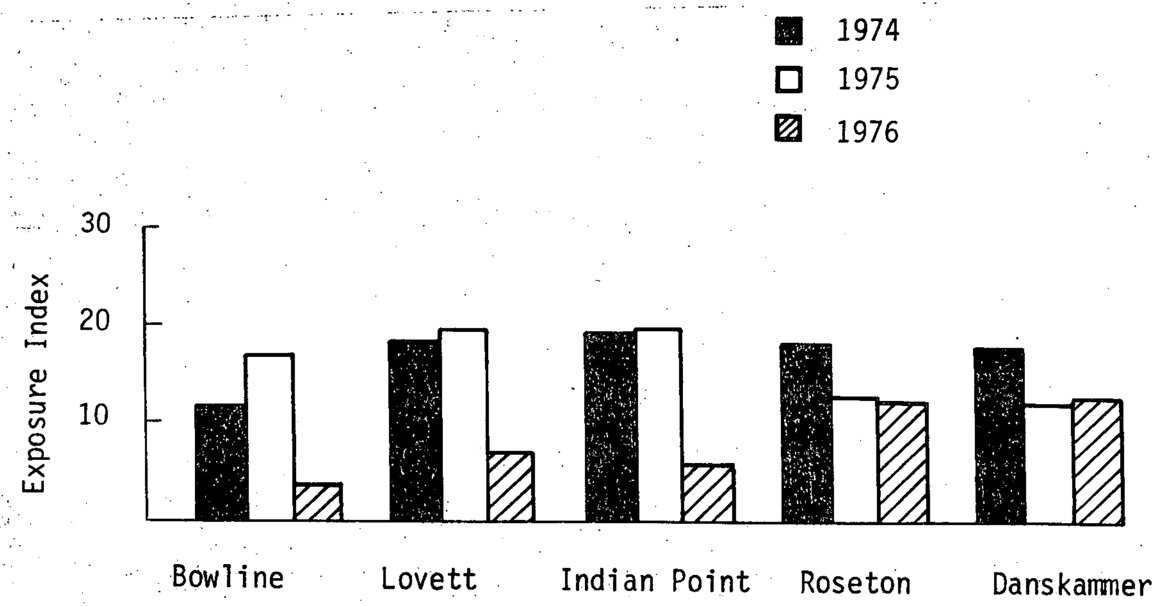


Figure V-67. Exposure Indices of White Perch Post Yolk-Sac Larvae for Power Plant Regions during Selected Periods from 1974-1976

3) Comparison with Nearfield Density Estimates

Farfield Ichthyoplankton surveys revealed minor peaks in white perch yolk-sac/post yolk-sac densities within all plant regions in the second half of May, and major peaks in late June (Figure V-68). In general, density estimates from the Nearfield Survey in these plant regions showed similar temporal distribution patterns to those of the Farfield Ichthyoplankton surveys. Peak density estimates for the two surveys within the Bowline (LMS) plant region were almost identical. While ichthyoplankton (TI) and nearfield density values at Indian Point (NYU) correspond well during the initial peak in May, nearfield estimates in June were much lower.

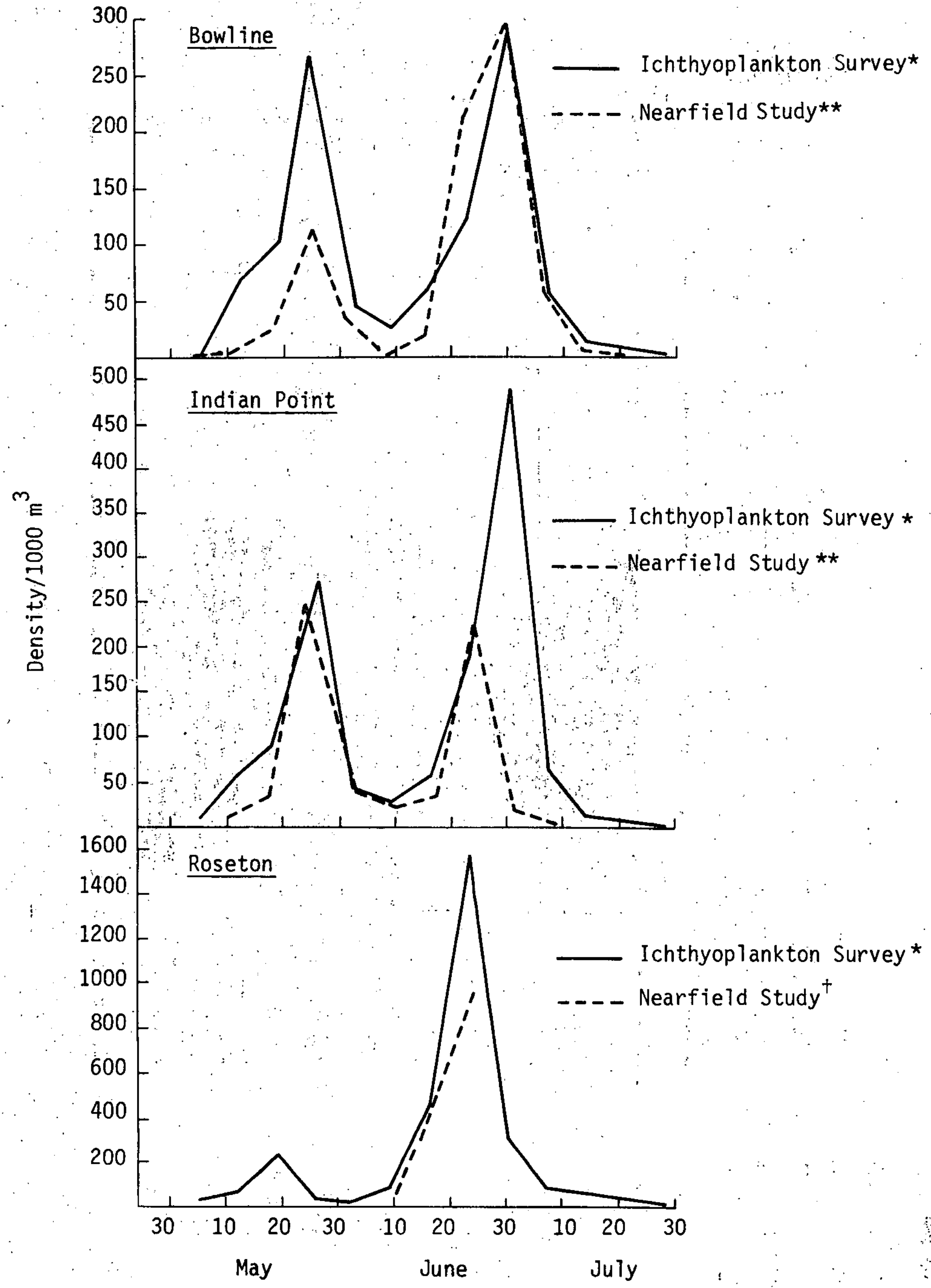
4) Overall Exposure Assessment

Transformation from the yolk-sac to post yolk-sac stage occurs about 4 to 11 days after hatching (McFadden 1977) and from the post yolk-sac to juvenile stage approximately one month after hatching (TI 1975b). Although exposure of post yolk-sac larvae may be greater than either egg or yolk-sac larvae in terms of life stage duration, the increased mobility of the post yolk-sac larvae may be favorable in avoiding entrainment. Overall, the riverwide distribution of this species results in much of the population being outside the area of influence of the plants causing exposure to entrainment to be low to moderate.

d. Juveniles

1) Distribution within Power Plant Regions

Juvenile white perch in the shore zone appeared to be increasingly exposed (Figure V-69) to the three lower river plants (Bowline, Lovett, Indian Point), especially Bowline from late July through early October. During late October through November exposure increased slightly as a higher percentage of the total population appeared in the vicinity of those plants. The areas of highest concentration were either upriver or downriver from the Roseton and Danskammer plant (Figure V-69). Consequently juvenile white perch were not exposed to either plant during most of the year.



*Density estimates prior to June reflect daytime sampling efforts; nighttime sampling efforts after June 1.

**Corresponding photoperiods to those of Ichthyoplankton Survey.

†Corresponding photoperiods to Ichthyoplankton Survey during selected periods.

Figure V-68. Comparison of Density Estimates of White Perch Yolk-Sac and Post Yolk-Sac Larvae at the Bowline, Indian Point and Roseton Plant Regions during 1976

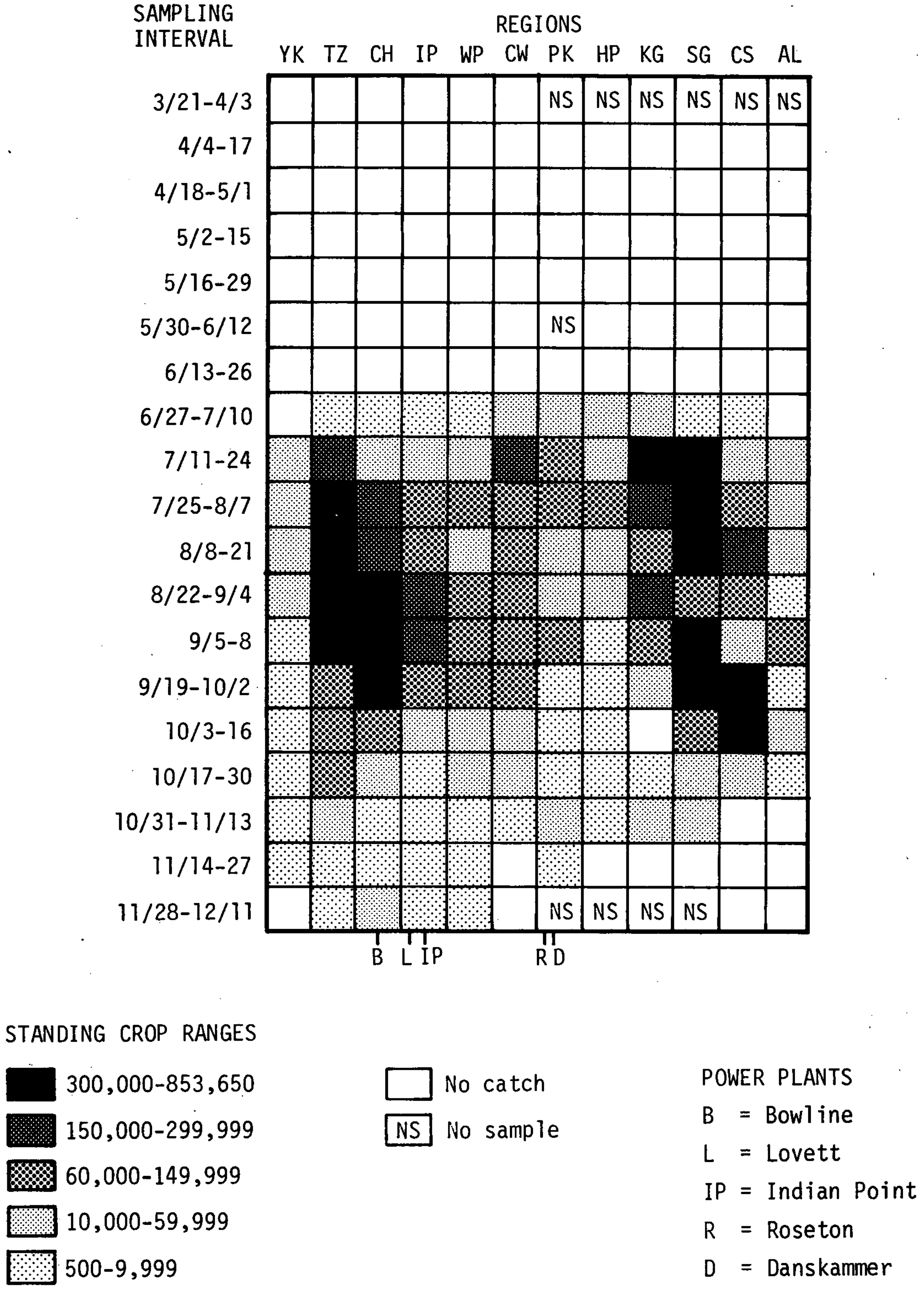


Figure V-69. Exposure Matrix for Juvenile White Perch Prepared from Beach Seine Survey Data during 1976

2) Trends in Exposure (1974, 1975, 1976)

The exposure of juvenile white perch to power plants was variable from 1974 through 1976 (Figure V-70). Like juvenile striped bass, juvenile white perch appeared in the plant regions earlier in 1975 than in 1974 and 1976. During August through November, a large proportion of the population was exposed to the three downriver plant regions, especially Bowline. In December 1974 and 1975, the percent of the population near the plants decreased, but during 1976, it remained high within the lower three plant regions. At Roseton and Danskammer, juvenile white perch were relatively non exposed except during 1975.

3) Comparison of Distribution in Power Plant Regions to Impingement Rates

Although juvenile white perch were in the vicinity of the power plants from August through early October, few were impinged until late October (Figure V-71). Near-field abundance patterns based on catch-per-unit effort data were similar to impingement patterns at the Bowline and Indian Point plants, but nearly opposite at Lovett, Roseton and Danskammer. At Bowline and Indian Point, impingement rates of juvenile white perch began to increase during October and continued through the winter. Bottom trawl catches of juveniles also increased during this period, noticeably at Bowline. At Lovett, Roseton and Danskammer, bottom trawl catches were usually highest when impingement rates were low and decreased when impingement rates increased in the fall and early winter. Only at Bowline and Indian Point does bottom trawl data give a reasonably good indication of when impingement rates will increase. At the other plants, trawl data were not as useful in predicting impingement for juvenile white perch.

4) Overall Exposure Assessment

Many of the factors discussed in the striped bass section (Subsection III.4.d.) are equally applicable to the juvenile white perch. Juvenile white perch also exhibit day/night patterns of movements (Muessig and Mayercek 1976) which could possibly interact with a combination of salinity and temperature conditions to make them susceptible to impingement. During the winter,

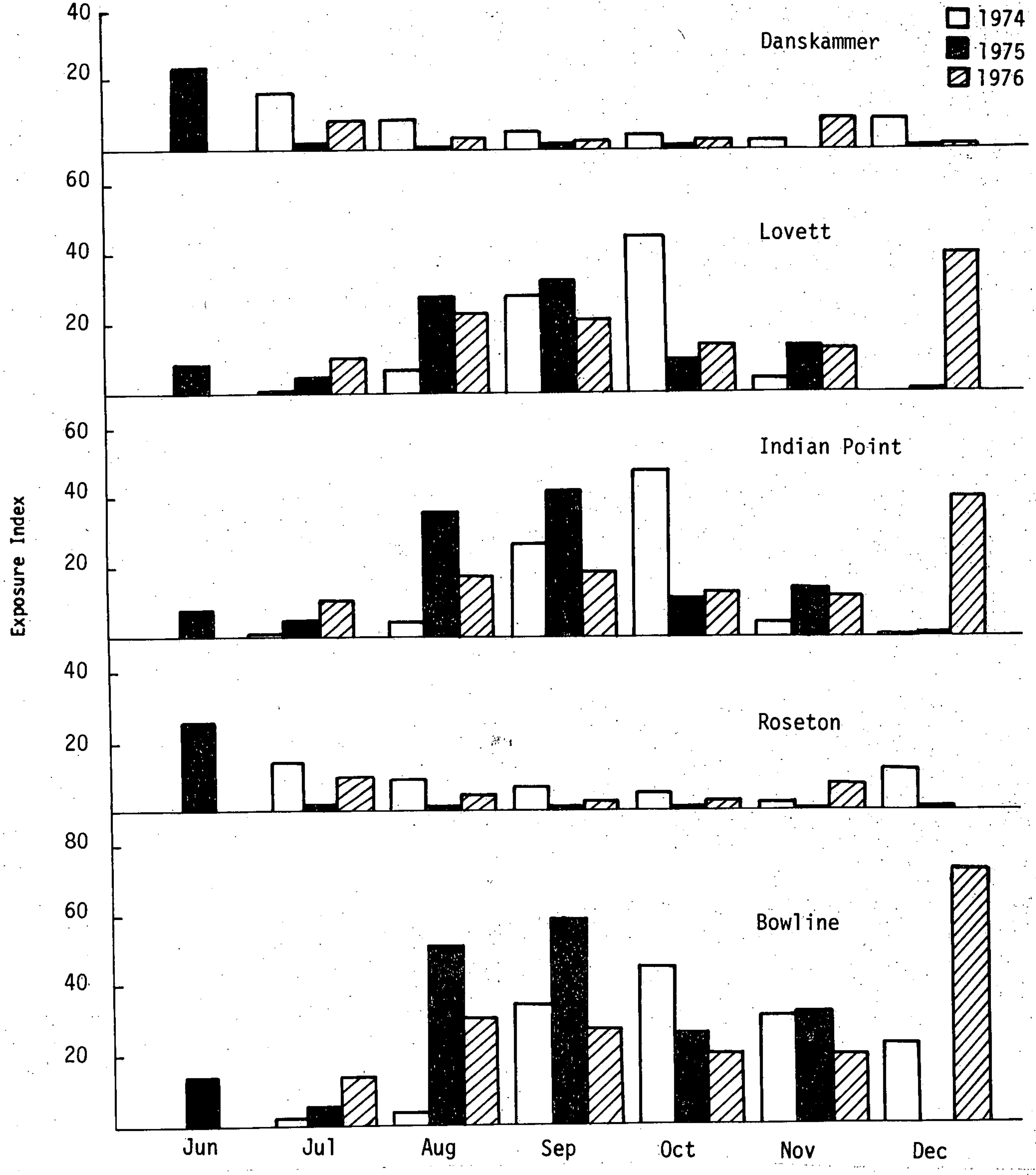


Figure V-70. Exposure Indices of Juvenile White Perch for Power Plant Regions during June-December, 1974-1976

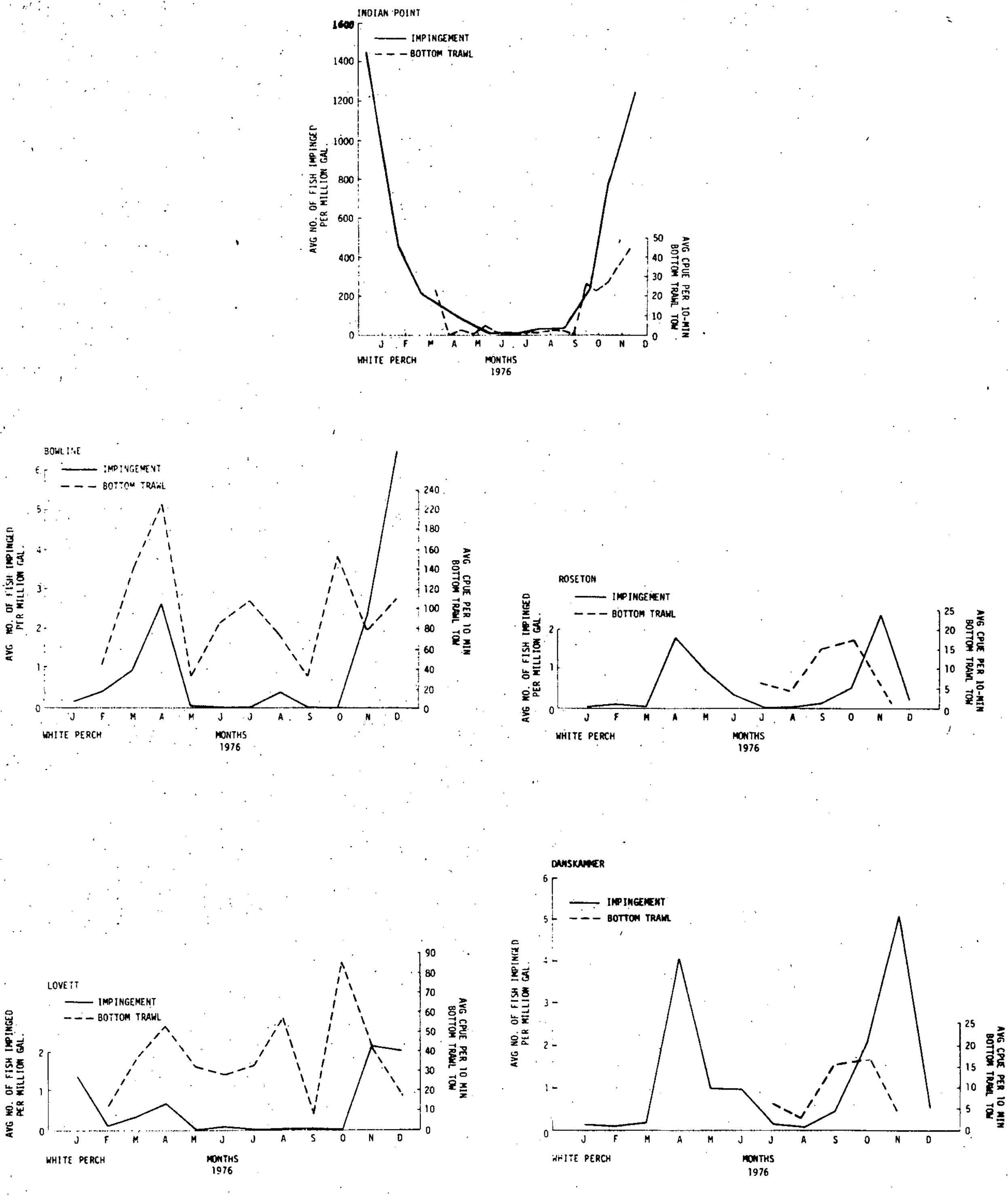


Figure V-71. Comparison of Monthly Impingement Rates and Nearfield Bottom Trawl CPUE of White Perch (Juvenile and Older Fish) at Five Power Plants, Hudson River Estuary, 1976. Impingement rate and catch per tow by bottom trawl at Bowline, Lovett, Roseton, and Danskammer supplied by or compiled from data supplied by Lawler, Matusky, and Skelly Engineers, Inc.

juvenile white perch that inhabited the Croton-Haverstraw and Tappan Zee regions in late fall could have moved upstream to the deep water area between Stony Point and Peekskill Bay. Also during the winter, impingement of juvenile white perch is high and may occur when the discharge plume is in the vicinity of the intakes (Parkinson and Goulet 1976).

Juvenile white perch appeared to be most exposed to impingement at the Bowline, Lovett, and Indian Point plants because a substantial portion of the population was found in the region of each plant. Roseton and Danskammer plant regions were between the areas of population abundance so juveniles were not especially exposed. Juvenile white perch did not become exposed to impingement until the late summer. Exposure increased, as did impingement rates, from the late fall through the winter. Juveniles are more exposed to impingement when they move into the channel or during the time when certain temperature and salinity combinations are present. A number of factors such as behavior, tides, currents, and sudden changes in temperature and salinity during the fall and winter, in addition to distribution, appear to influence exposure to impingement.

e. Yearlings

1) Distribution within Power Plant Regions

Few yearling white perch of the 1976 year class were collected during the spring of 1977, but most occurred between the Yonkers and Indian Point regions (Appendix Table V-55). They were not especially vulnerable to any of the plants except Bowline. Yearlings were abundant in the Croton-Haverstraw, Tappan Zee, and Saugerties regions during late spring and summer. Exposure increased at the three plants in the lower estuary and was highest at Bowline during late June and early July when over 80% of the population was in this region of this plant. Exposure was low to the Roseton and Danskammer plants as most of the population was either upriver or downriver from these plants.

2) Trends in Exposure (1975, 1976, 1977)

The exposure of yearling white perch from 1974 through 1976 was variable (Figure V-72). Yearling white perch were most exposed to the three lower estuary plants, especially Bowline, from July through September. Exposure was similar at Bowline, Lovett and Indian Point in all three years. Yearling white perch were not exposed to Roseton and Danskammer during any month of the two and a half year period (Figure V-72).

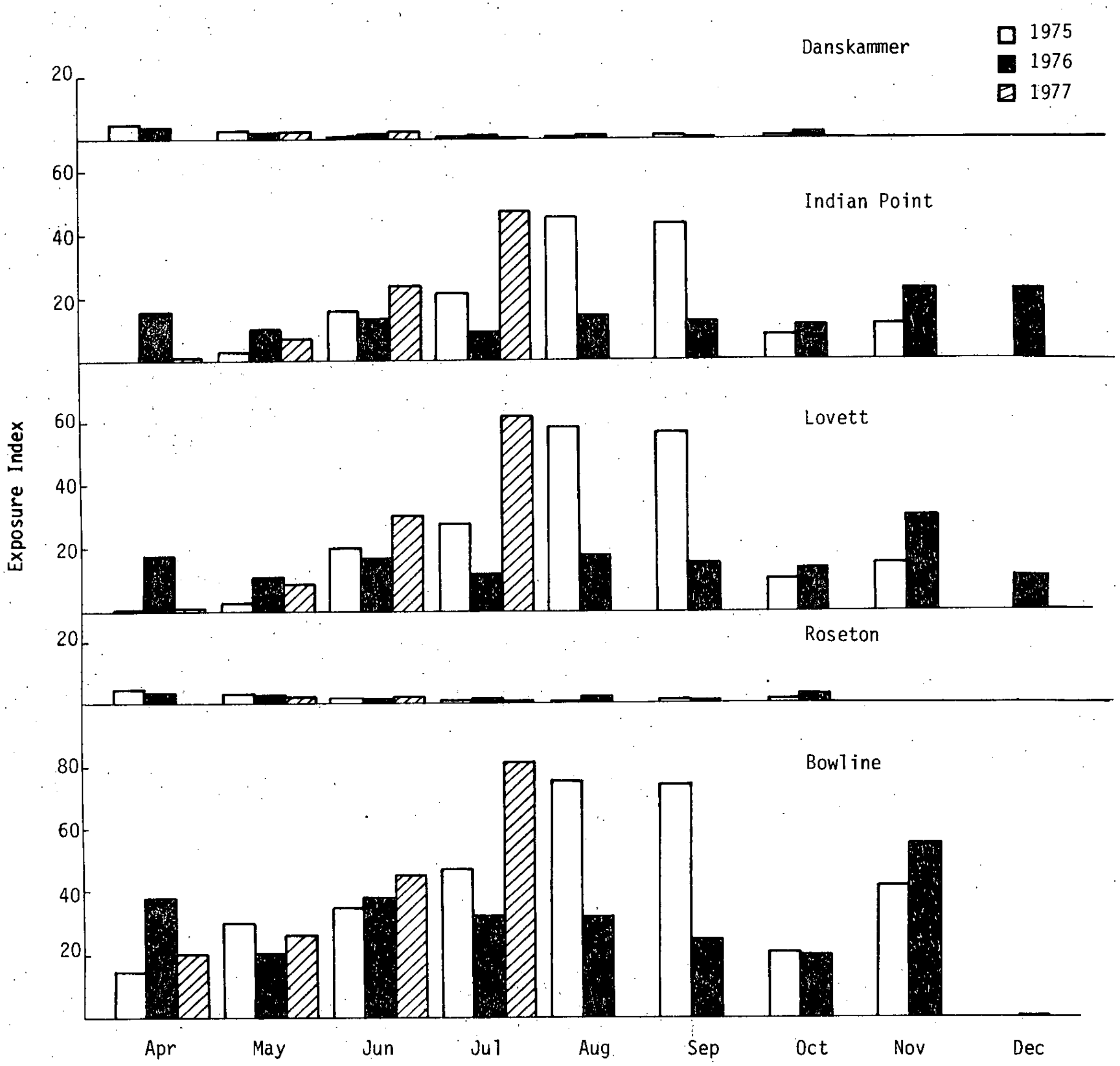


Figure V-72. Exposure Index of Yearling White Perch for Power Plant Regions during April-December 1975 and 1976, and April-July 1977

3) Comparison of Distribution in Power Plant Regions to Impingement Rates

Most yearling white perch are impinged from January through May, depending upon the plant. Nearfield abundance estimates from bottom trawl data generally matched yearling white perch impingement rates at Bowline and Indian Point; however, abundances and impingement did not match at Roseton, Danskammer, and Lovett. Bottom trawl data is useful for predicting impingement rates of yearling white perch at the Bowline and Indian Point plants, but is not as useful for the other three plants.

4) Overall Exposure Assessment

Yearling white perch were most exposed to impingement during the winter and early spring at all the plants and especially so at Bowline and Indian Point. During the remainder of the year, impingement rates were rather low. The factors affecting the exposure of juvenile white perch to impingement affect the exposure of yearlings as well. Yearling white perch are probably influenced by the same factors of behavior, tides, currents and sudden changes in salinity and temperatures which affect juvenile white perch (Subsection V.C.3.d.3).

D. ATLANTIC TOMCOD

1. General Distribution and Movements of Early Life Stages

a. Eggs

1) Geographic Distribution

a) Distribution during 1976

Very few eggs (21) were collected in 1976, probably because most spawning was completed by late February when sampling began. Eggs were found in the West Point and Cornwall regions only.

b) Trends in Distribution

Eggs had never been collected in the Atlantic tomcod survey until 1976 because weather conditions usually prohibit sampling in mid winter when tomcod spawn.

2) Temporal Distribution

Almost all eggs (95%) were collected during the first sampling period, February 23 to 27.

b. Yolk-sac Larvae

1) Geographic Distribution

a) Distribution during 1976

Tomcod yolk-sac larvae were collected in all seven regions (Yonkers through Poughkeepsie) sampled during the tomcod survey. Densities greater than 300 yolk-sac larvae/1000 m^3 were estimated for the Tappan Zee through Indian Point regions with the highest proportion of the estimated standing crops usually occurring in the Tappan Zee region (Table V-21).

Table V-21

Total Standing Crop of Atlantic Tomcod Yolk-Sac Larvae and Percentage of Total in 12 Regions during Each of Five Sampling Periods, February through April 1976

	Sampling Dates				
Region	Feb 23 - Feb 27	Mar 1 - Mar 5	Mar 8 - Mar 11	Mar 22 - Mar 25	Apr 5 - Apr 8
YK	26.8	2.4	7.3	23.4	100.0
TZ	28.6	19.7	31.4	41.5	*
CH	11.1	12.6	25.6	14.4	
IP	18.6	20.6	17.9	16.2	
WP	12.2	20.9	11.1	2.8	
CW	1.6	9.3	3.9	0.8	
PK	1.2	14.5	2.8	0.8	
Total	100.1	100.0	100.0	99.9	100.0
Total Standing Crops (Thousands)	87,035	125,144	357,707	154,760	22

*No entry indicates no yolk-sac larvae collected.

b) Trends in Distribution (1975, 1976)

Since the late winter tomcod survey was first conducted in 1975, only two years of data were available for comparison. The geographic distribution indices (Figure V-73) were similar in 1975 and 1976 and the highest values occurred in the Tappan Zee and Croton-Haverstraw regions.

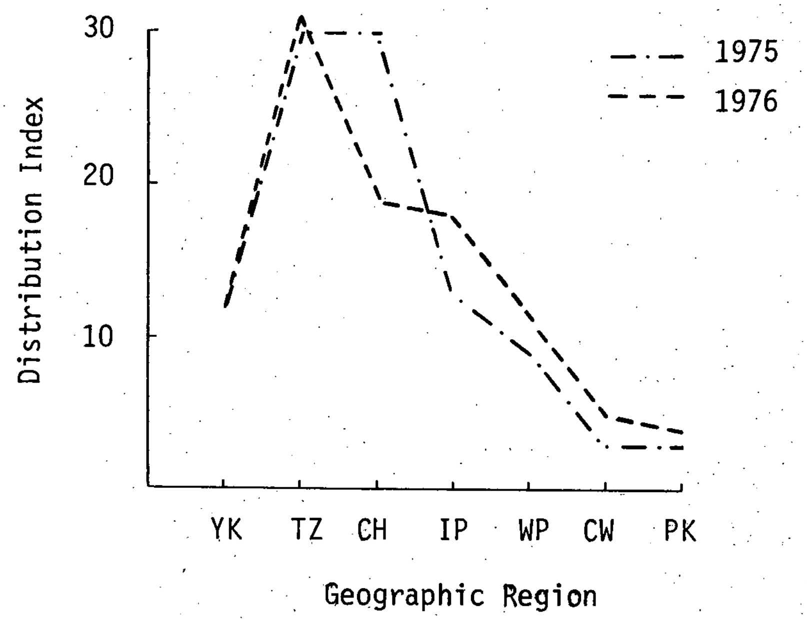


Figure V-73. Trends in the Geographic Distribution Index of Atlantic Tomcod Yolk-Sac Larvae in Hudson River Estuary, 1975-1976

The tomcod survey does not include the area upriver from the Poughkeepsie region, so the distribution of tomcod larvae there is unknown. Only during the second sampling period (March 1 to 5) was a relatively large proportion of the standing crop (14.5%) found in the Poughkeepsie region, indicating that upriver regions probably contained relatively few tomcod yolk-sac larvae.

2) Temporal Distribution

a) Distribution during 1976

Yolk-sac larvae were collected from the beginning of the tomcod survey in late February until early April, although larvae were probably present in the estuary before sampling began. The highest standing crops occurred March 8 to 11.

b) Trends in Distribution (1975, 1976)

Sampling did not start until March 10 in 1975 and the first sampling period yielded the highest value for the temporal distribution index for that year (Figure V-74). The 1976 index peaked at about the same date. Yolk-sac larvae were not present after early April in either year. No yolk-sac larvae were collected in 1974 because sampling began in early April.

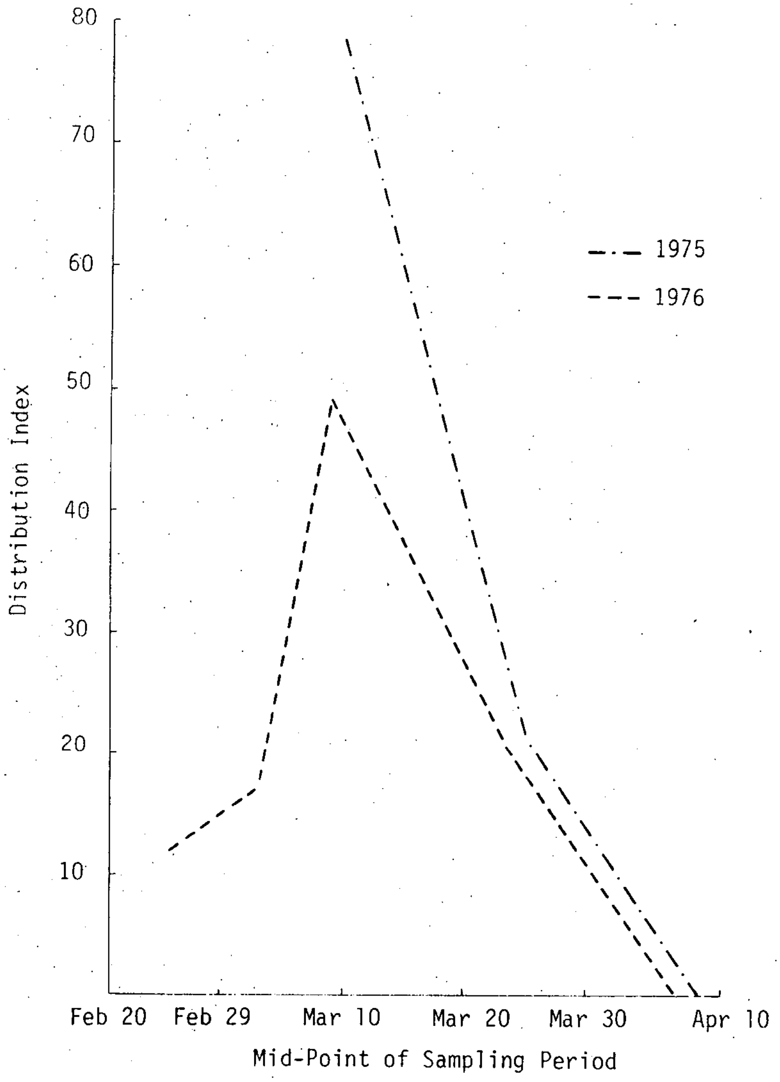


Figure V-74. Trends in Temporal Distribution Index of Atlantic Tomcod Yolk-Sac Larvae in Hudson River Estuary, 1975-1976

c. Post Yolk-sac Larvae

1) Geographic Distribution

a) Distribution during 1976

Atlantic tomcod post yolk-sac larvae were collected during both the tomcod and ichthyoplankton surveys from the Yonkers through Poughkeepsie regions. The Tappan Zee region (Table V-22) held the highest proportions of the estimated standing crops during the periods of peak abundance (April 19 to 21 and 26 to 29). Tappan Zee and its adjacent regions (Yonkers and Croton-Haverstraw) contained densities greater than 200 post yolk-sac larvae/ 1000 m^3 during at least one of the sampling periods.

Table V-22

Total Standing Crops of Atlantic Tomcod Post Yolk-Sac Larvae and Percentage of Total in Twelve Regions during Each of Twelve Sampling Periods, February through June 1976

	Sampling Date											
Region	Feb 23 - Feb 27	Mar 8 - Mar 11	Mar 22 - Mar 25	Apr 5 - Apr 8	Apr 19 - Apr 21	Apr 26 - Apr 29	May 3 - May 5	May 10 - May 13	May 17 - May 19	May 24 - May 26	Jun 1 - Jun 4	Jun 7 - Jun 11
YK	*	0.4	81.0	18.0	1.2	<0.1	2.2	14.3				
TZ	41.2	62.1	17.9	77.0	87.4	51.2	95.9	85.7	100.0	78.5		100.0
CH	27.6	34.9	0.7		10.1	29.2	0.3					
IP		2.6	0.2		1.2	19.5	0.2			20.0	33.3	
WP	15.2	<0.1	0.3		0.1	<0.1	0.9					
CW	15.9		<0.1	4.9	<0.1	0.1					66.7	
PK						<0.1	0.3					
HP	NS**	NS	NS	NS								
KG	NS	NS	NS	NS			0.1					
SG	NS	NS	NS	NS								
CS	NS	NS	NS	NS								
AL	NS	NS	NS	NS								
Total	99.9	100.0	100.1	99.9	100.0	100.0	99.8	100.0	100.0	98.5	100.0	100.0
Total Standing Crops (Thousands)	728	28454	65505	122	80308	105658	40033	544	613	65	21	2754

*No entry indicates no post yolk-sac larvae collected.

**No sample.

b) Trends in Distribution

The geographic distribution index of tomcod post yolk-sac larvae was highest in the Yonkers and Tappan Zee regions during 1975 and 1976 (Figure V-75). The index was lowest upriver of the West Point region. Most post yolk-sac larvae were collected downriver of the areas occupied by eggs (Subsection V.D.1.a.) and showed a smaller downriver shift from areas inhabited by yolk-sac larvae (Subsection V.D.1.b.). Post yolk-sac larvae were more concentrated than yolk-sac larvae in the downriver regions (Yonkers and Tappan Zee).

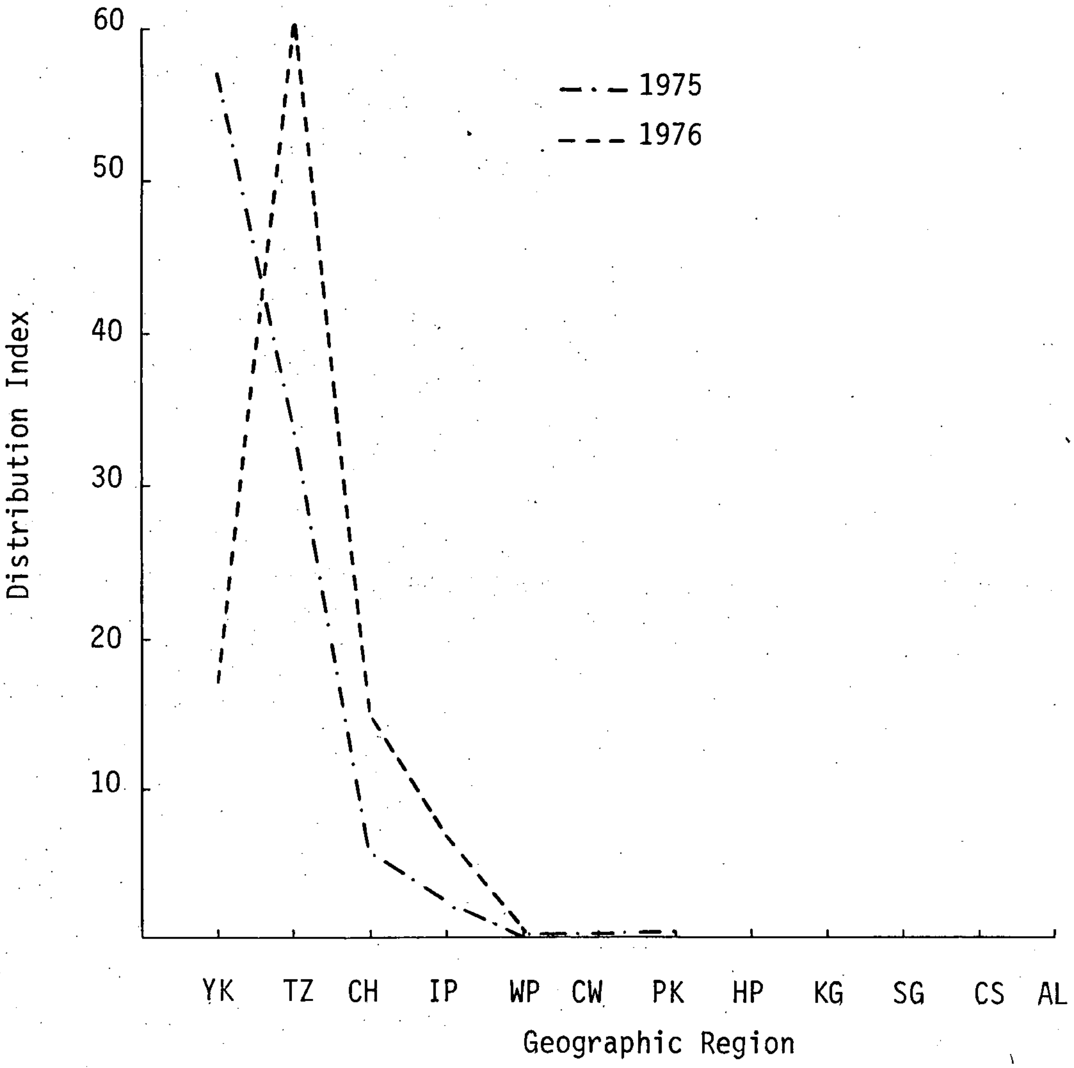


Figure V-75. Trends in the Geographic Distribution Index of Atlantic Tomcod Post Yolk-Sac Larvae in the Hudson River Estuary, 1975-1976

2) Temporal Distribution

a) Distribution during 1976

Tomcod post yolk-sac larvae were present in the study area from late February when the tomcod survey began until mid-June, though they were relatively rare before mid-March and after mid-May. Highest standing crops were encountered in late March and late April, and were separated by a period of low standing crops in early April.

b) Trends in Distribution (1975, 1976)

The temporal distribution indices showed one peak in 1975 in early April while the 1976 index peaked once in late March and once in late April (Figure V-76). Post yolk-sac larvae were present during the first sampling period in both years but were nearly absent after mid-May. No post yolk-sac larvae were collected in 1974.

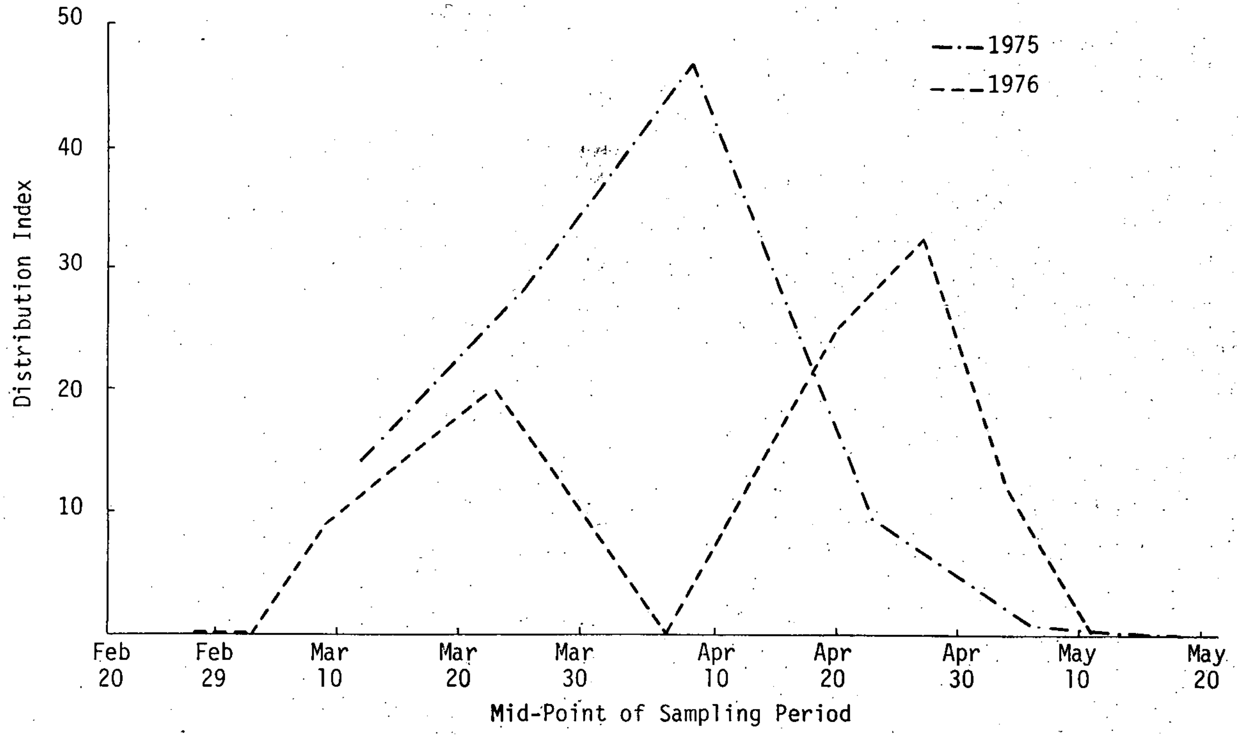


Figure V-76. Trends in Temporal Distribution Index of Atlantic Tomcod Post Yolk-Sac Larvae in Hudson River Estuary, 1975-1976

d. Juveniles

1) Geographic Distribution

a) Distribution during 1976

Juvenile Atlantic tomcod were first collected in the Croton-Haverstraw region during early March. However, they did not become widely distributed until early May when they were present in ichthyoplankton samples from the Yonkers through Saugerties region (RM 14-106 [KM 22-170]). While juvenile tomcod were found in every region except Catskill and Albany during 1976, they were concentrated in the most downriver regions. At least 85% of the standing crops (based on ichthyoplankton sampling) always was found from the Yonkers through West Point regions (RM 14-55 [KM 22-88]) (Table V-23).

Table V-23

Percentage of 1976 Standing Crop of Atlantic Tomcod Juveniles within 12 Geographical Regions of Hudson River Estuary (Based on Ichthyoplankton Data)

	Region											
Time Period	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-2/27	*							NS**	NS	NS	NS	NS
3/01-3/05								NS	NS	NS	NS	NS
3/08-3/11			100					NS	NS	NS	NS	NS
3/22-3/25								NS	NS	NS	NS	NS
4/05-4/08								NS	NS	NS	NS	NS
4/19-4/21							100					
4/26-4/29		61.2	35.5	3.2								
5/03-5/05	1.1	96.5	1.4	0.5	0.3	0.1	0.1					
5/10-5/13	9.0	83.2		2.7		1.0			4.1			
5/17-5/19	10.0	73.2	1.0	5.2	0.3	4.2	2.2	1.2	2.6	0.2		
5/24-5/26		92.6		5.8	0.3	0.9	0.2	0.2				
6/01-6/04	26.8	29.1	5.6	10.1	22.2	4.0	1.2	0.7	0.3			
6/07-6/11	41.3	37.7	12.3	3.7	0.4	1.2	2.8	0.4	0.3			
6/14-6/17	3.0	56.9	24.5	4.6	4.1	4.1	2.4	0.2	0.2			
6/21-6/24	0.6	92.6	4.0	2.7	0.02	0.02	0.1	0.03				
6/28-7/01	75.3	13.5	4.5	3.7	1.2	1.8						
7/06-7/09	23.6	67.7	5.1	3.0	0.5	0.1						
7/12-7/15	4.9	76.6	3.2	7.1	4.8	3.5						
7/26-7/29	5.3	41.8	21.4	13.7	10.1	7.3	0.4					
8/10-8/13	4.7	24.0	3.8	34.1	29.4	2.1	1.6			0.3		

* No entry indicates no juveniles collected

** NS = No Sample

Juvenile Atlantic tomcod were rare in the shore zone except during May and June, the period of peak abundance (Figure V-77 and Appendix Table C-67). The presence of Atlantic tomcod juveniles in the shore zone during this time (the period of peak abundance) may have been due to extremely high densities and the resulting competition for space which may have forced some individuals into marginal habitats.

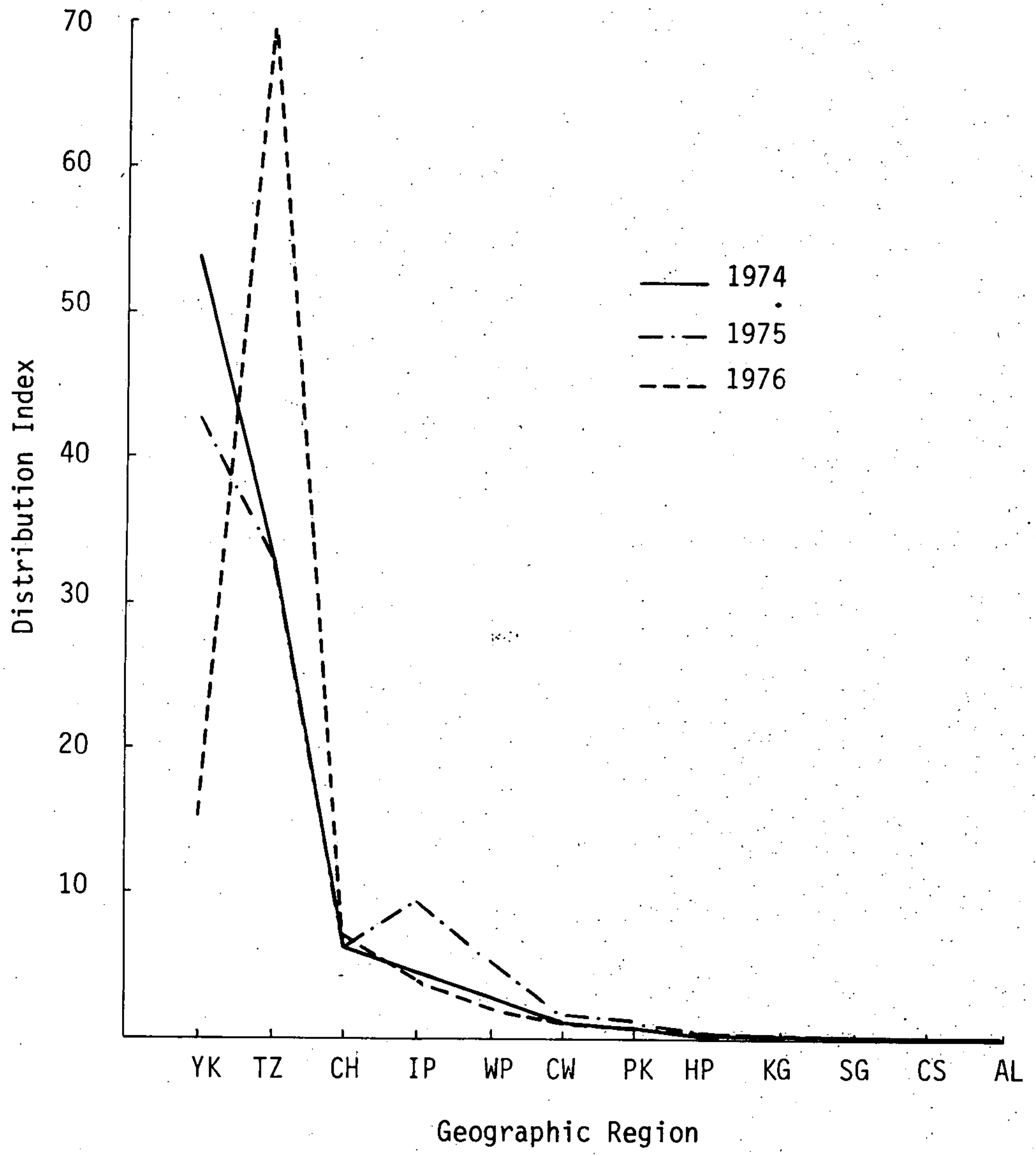


Figure V-77. Trends in the Geographic Distribution Index for Juvenile Atlantic Tomcod in the Hudson River Estuary 1974-1976, Based on Ichthyoplankton Data

Since Atlantic tomcod were concentrated in the regions farthest downriver, an unknown portion of the population probably existed below the study area (RM 12-153). Dew and Hecht (1976) collected both larvae and juveniles in the Hudson River below the George Washington Bridge in 1973, 1974, and 1975. Large catches of juvenile tomcod in Little Neck Bay (western Long Island Sound) and in lower New York Bay (off Staten Island) were reported by TI (1977c) for late May and early June of 1975. It is likely that these fish were of Hudson River origin since the peak period of juvenile tomcod abundance in the Hudson came in late May of 1975 and the region where they were most abundant was Yonkers (TI 1978a). Larvae and juveniles were also collected by TI near New Jersey's proposed Liberty Island State Park (in upper New York Bay) in the spring and summer of 1976 (TI 1976e). The proportion of the population existing below the study area may change during the year producing fluctuations in the standing crops estimates within the study area.

The distribution of Atlantic tomcod has been reported to be associated with the salt front (TI 1976b). Dew and Hecht (1976) collected 85% of their larvae and juveniles where the conductivity was 3000 to 17,200 mS/cm. The concentration of juvenile tomcod in the lower part of the study area is probably the result of their preference for brackish or slightly saline water (Subsection V.D.1.e.).

Conductivity (a measure of the salinity of water) appears to be the main factor which characterizes not only the geographic distribution of juvenile Atlantic tomcod but their vertical distribution as well. Tomcod are a demersal fish and were reported to be more abundant in the bottom stratum (depths greater than 20 ft) than the shoal stratum (depths less than 20 ft, Appendix Table C-66) (TI 1977b). Conductivity was also stratified vertically; and higher conductivities occurred with increasing depth (TI 1976b). Thus, the higher densities of tomcod in the deeper areas of the river could be explained by a preference for brackish water.

b) Trends in Geographic Distribution (1974, 1975, 1976)

The overall geographic distribution of juvenile tomcod showed little change from 1974 through 1976 (Figure V-77). Juveniles were concentrated in the most downriver regions of the estuary (Yonkers and Tappan Zee) where the post yolk-sac larvae had been most numerous. After the period of peak abundance, juveniles dispersed upriver.

Juvenile tomcod were abundant only in the lower regions (Yonkers through Poughkeepsie) of the study area, although a few were collected upriver as far as the Saugerties region in 1975 and 1976 and the Albany region in 1974. In 1974 and 1975, the distribution index was highest for the Yonkers region and in 1976, the highest value was calculated for the Tappan Zee region. Since the bottom stratum was not sampled in the Yonkers region (see Section III) and Atlantic tomcod are demersal fish, their numbers may have been underestimated in the Yonkers region. Values for the Indian Point and West Point regions were larger in 1975 than in 1974 and 1976, however, for all years, a trend of decreasing abundance from Tappan Zee upriver is evident.

The geographic distribution index based on standing crops estimates from the Fall Shoal Survey indicates marked differences in the distribution of juveniles in the lower geographic regions (Yonkers through Poughkeepsie; the only regions sampled during that survey) during the fall of 1974, 1975, and 1976 (Figure V-78). The highest values for 1974 and 1975 were in the Indian Point-West Point regions, indicating that juvenile Atlantic tomcod were concentrated more upriver in 1974 and 1975 than in 1976. Examination of bottom trawl catches also indicates that during the fall, juveniles were distributed farther upriver in 1974 and 1975 than in 1976 (Appendix Tables C-69 and C-70). Even though they occupied the lower estuary in the fall during all years, their distribution within this area changed substantially.

2) Temporal Distribution

a) Distribution during 1976

Juvenile Atlantic tomcod were first collected by ichthyoplankton gear in early March, but they were not found in large numbers (densities greater than 50/1000 m^3) until late April. The largest standing crops (based on ichthyoplankton collections) occurred in early May (Table V-23). Standing crops declined immediately afterward but increased again in late June. This bimodal pattern in the temporal distribution of juveniles is

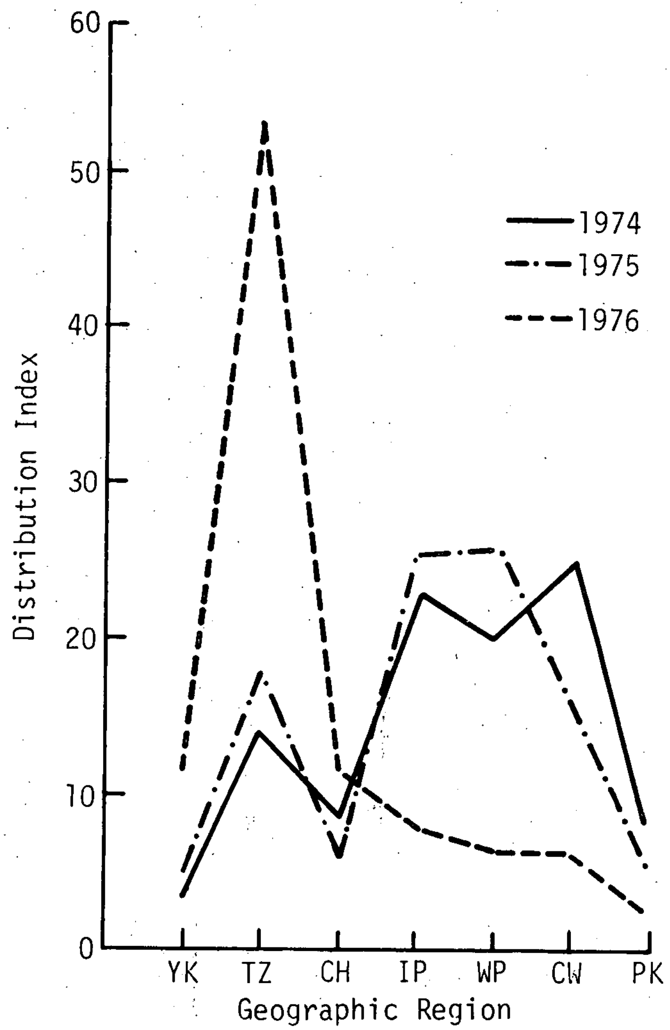


Figure V-78. Trends in Geographic Distribution Index for Juvenile Atlantic Tomcod in Hudson River Estuary 1974-1976, Based on Fall Shoals Survey Data

similar to that for post yolk-sac larvae. The first peak for juvenile tomcod followed the first peak for post yolk-sac larvae by about 42 days and the second peaks in post yolk-sac larvae and juvenile abundance were about 56 days apart. From July through December, the standing crops estimates were greatly reduced from the early-May and late-June highs. This reduction in standing crops estimates is likely to be caused by a high mortality rate (Subsection IV.3.D) and a dispersion from the river into the lower bays.

Catches of juvenile Atlantic tomcod by beach seine and bottom trawl first occurred in mid-May. Juvenile Atlantic tomcod were rare in the shore zone except during May and June, the period of peak abundance (Figure V-79 and Appendix Tables C-67 and 68). Bottom trawl catches peaked in late-July to early-August and remained high through September. By mid-October juveniles had virtually disappeared from bottom trawl catches (Table V-24 and Figure V-79). Standing crops estimated from Fall Shoals Survey data were also lowest during October. Atlantic tomcod may have left the river briefly during this period and then returned in November and December to spawn. Bottom trawl catches increased in November and early December as did the Fall Shoals Survey estimated standing crops (Appendix Tables C-64 and 65). These increases presumably reflect the beginning of the spawning run, since Atlantic tomcod mature in about 11 months and spawn during their first winter (Subsection IV.D.).

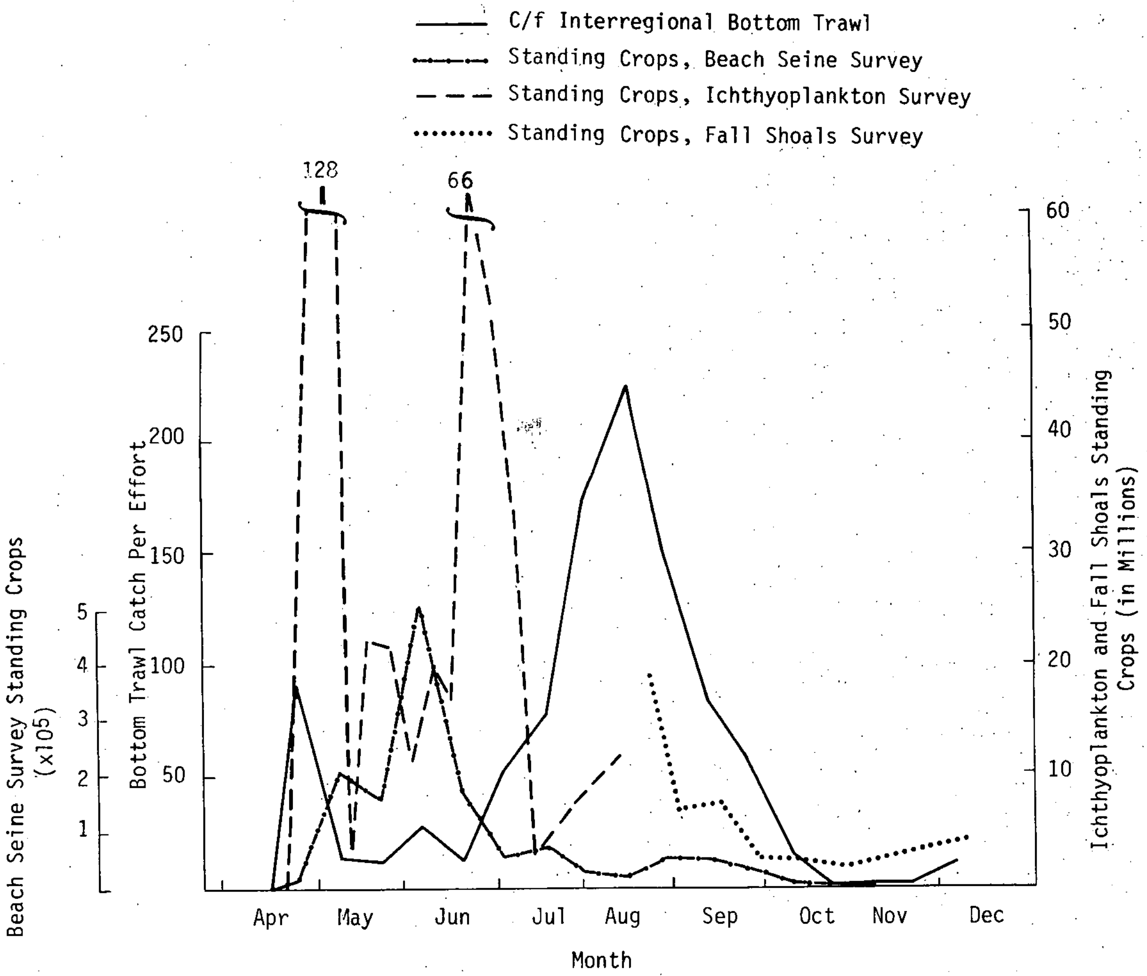


Figure V-79. Standing Crop Estimates of Juvenile Atlantic Tomcod from Ichthyoplankton, Fall Shoals Surveys, and Beach Seine Surveys, and Catch-Per-Effort (C/f) by Interregional Bottom Trawl, Hudson River Estuary, 1976

Table V-24

Catch-Per-Tow of Juvenile Atlantic Tomcod during 1976 Interregional Bottom Trawl Survey

Time Period	Region				
	TZ	CH	IP	WP	CW
4/14- 4/17	0	0	0	0	0
4/18- 5/01	280.66	12.31	1.54	0	0
5/02- 5/15	5.77	0.51	18.18	32.31	0
5/16- 5/29	18.27	0.51	10.49	14.62	3.08
5/30- 6/12	51.35	1.03	40.56	36.31	15.69
6/13- 6/26	20.19	0	14.27	10.46	0.62
6/27- 7/10	69.23	3.08	71.75	61.54	2.15
7/11- 7/24	316.92	0	24.34	32.00	0
7/24- 8/07	314.43	11.28	171.19	229.67	0.31
8/08- 8/21	366.73	0.51	328.81	126.15	0
8/22- 9/04	1.73	0	215.95	480.61	4.92
9/05- 9/18	28.65	1.54	133.98	192.00	3.69
9/19-10/02	0	0	119.86	91.69	0
10/03-10/16	19.04	0	14.55	33.84	0
10/17-10/30	0	0	1.40	0.62	0
10/31-11/13	0.38	0	2.38	0.92	0
11/14-11/27	0.77	1.54	1.82	0.62	5.54
11/28-12/11	14.81	0.51	13.43	9.23	2.77

b) Trends in Temporal Distribution (1974, 1975, 1976)

The temporal distribution indices calculated from the Atlantic Tomcod Survey and Longitudinal River Survey standing crop estimates indicate a similar pattern of abundance through time for 1974 and 1976 (Figure V-80). Peak abundance occurred in early May; thereafter, the index dropped sharply. In 1975, the peak period did not occur until mid-May. The 1974 index remained at a relatively low level after the peak period, but in 1975 and 1976, the index values fluctuated somewhat after the peak period. The temporal distribution indices for fall shoals again showed 1974 and 1976 to be similar (Figure V-81). During these years, the indices declined rapidly from August to October. In 1976, the index gradually increased in November and December, but did not in 1974. The 1975 index was highest in mid-August and declined immediately, but high values occurred again in mid-September and in late October to mid-November.

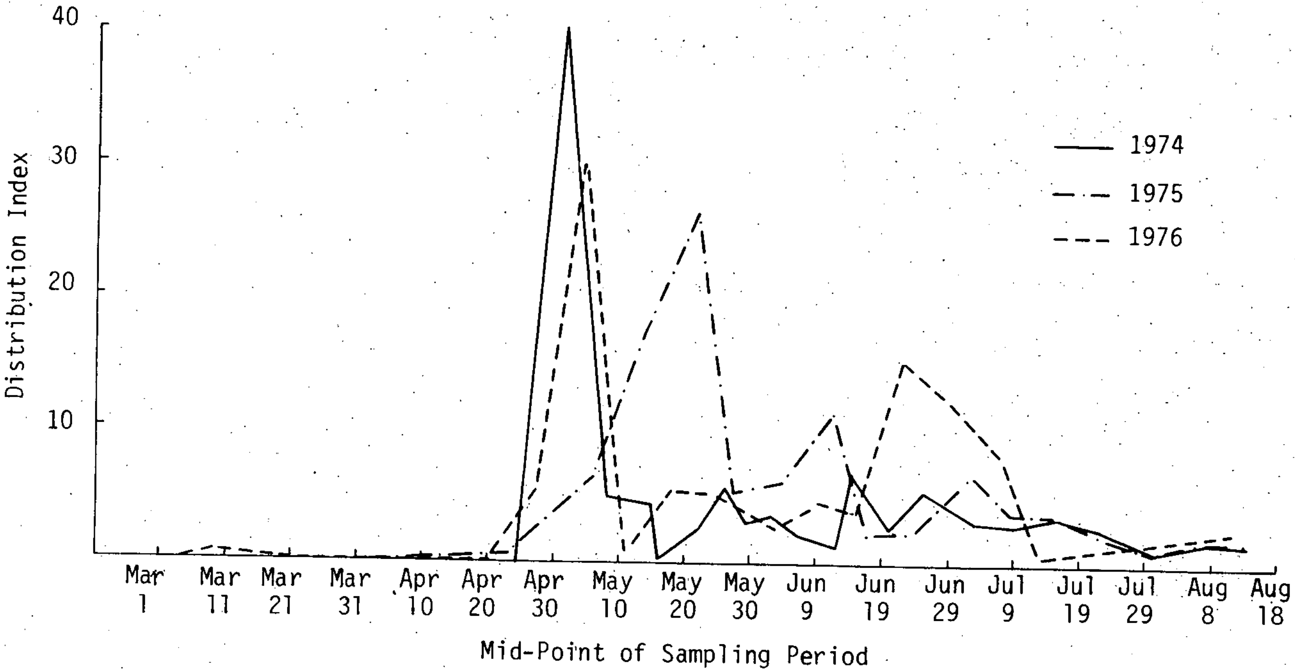


Figure V-80. Trends in the Temporal Distribution Index for Juvenile Atlantic Tomcod in Hudson River Estuary 1974-1976, Based on Ichthyoplankton Data

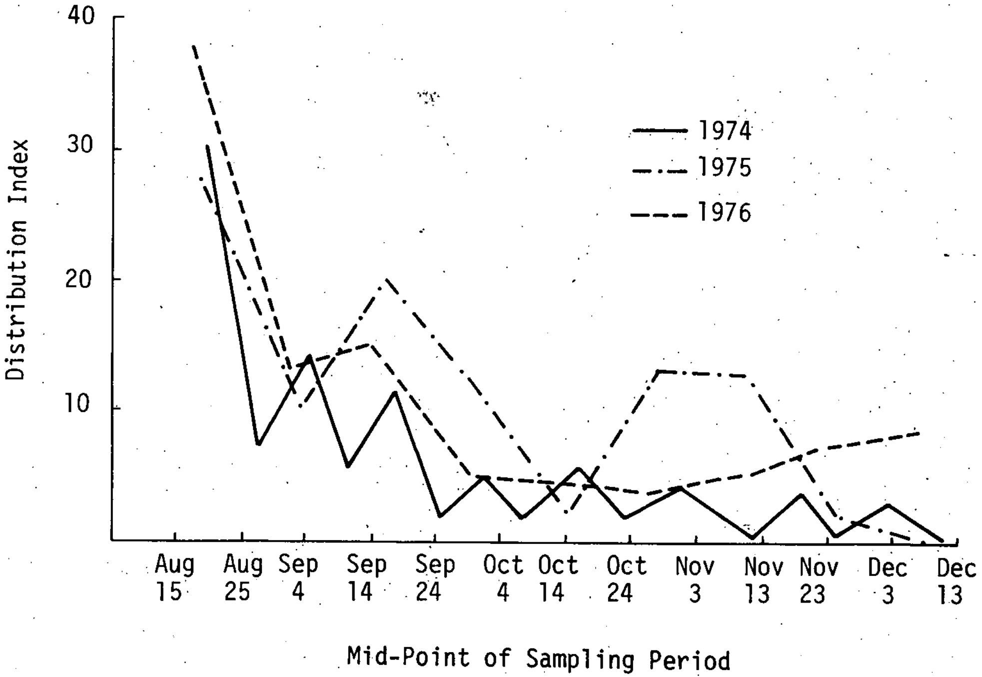


Figure V-81. Three-Year Trends in the Temporal Distribution Index of Juvenile Atlantic Tomcod in Hudson River Estuary 1974-1976, Based on Fall Shoals Survey Data

The decline in Atlantic tomcod standing crops through time can be attributed to a combination of mortality and emigration from the study area. Irregular fluctuations in standing crops estimates during the year are likely due to movement into and out of the study area.

e. Distribution of Atlantic Tomcod in Relation to Physicochemical Factors

1) Objectives

In order to determine general associations between life stage distribution and physicochemical factors, the range and highest density for each life stage in 1974-76 were examined.

2) Results and Discussion

Conductivity and dissolved oxygen were important factors influencing the distribution of Atlantic tomcod eggs. They were spawned in December through February at salinities <0.3 and 0.6 mS/cm (Table V-25) at a time when dissolved oxygen levels were high (12-13 mg/l). They apparently spawned in areas of similar conductivity (slightly brackish) in the Hudson River, as they do in other systems (Mckenzie, 1959).

Table V-25

Ranges of Physicochemical Factors and Values at Highest Densities (Greatest Catch/Effort) Associated with Atlantic Tomcod Egg and Larva Distribution

	Eggs			Yolk-Sac Larvae			Post Yolk-Sac Larvae		
Parameter	1974	1975	1976	1974	1975	1976	1974	1975	1976
Temperature									
Range	–	–	2-6	–	2-16	2-8	–	2-20	2-20
Highest Density	–	–	<2	–	2-4	2-4	–	6-8	10-12 (6-8)*
Conductivity									
Range	–	–	<0.3	–	<0.3-17	<0.3-25	–	<0.3-25	<0.3-25
Highest Density	–	–	<0.3	–	3-5	0.3-0.6	–	19-21 (3-5)	0.3-0.6
Dissolved Oxygen									
Range	–	–	12-13	–	10-13	8-14	–	7-13	8-14
Highest Density	–	–	12-13	–	11-12	12-13	–	11-12 (9-10)	11-12

*Values in parenthesis are first minor peak.

Atlantic tomcod spawn in the winter when water temperatures are 2 to 6°C. Highest densities of eggs occur in the lower part of this range <2° (Table V-26). They show marked contrast to striped bass and white perch in respect to the temperature at which they spawn, although salinity requirements seem to be similar to white perch (Subsection V.B.1.e.).

Table V-26

Range of Physicochemical Factors and Values at Highest Densities (Greatest Catch/Effort) Associated with Atlantic Tomcod Juvenile Distribution

	Beach Seine			Fall Shoals			Plankton			Bottom Trawl		
Parameter	1974	1975	1976	1974	1975	1976	1974	1975	1976	1974	1975	1976
Temperature												
Range	6-32	8-30	4-28	2-28	6-26	–	12-28	6-28	2-28	6-28	4-28	4-26
Highest Density	28-30	20-22	18-20	24-26	24-26	–	12-14 (16-18)	20-22 (16-18)*	12-14	22-24	18-20	24-26
Conductivity												
Range	<0.3-27	<0.3-19	<0.3-23	<0.3-21	<0.3-23	–	<0.3-27	<0.3-27	<0.3-25	<0.3-25	<0.3-19	<0.3-23
Highest Density	19-21	13-15	13-15	17-19	0.6-1	–	25-27 (15-17)	7-9	13-15	<0.3	9-11	9-11
Dissolved Oxygen												
Range	4-16	3-15	3-15	3-14	3-11	–	1-13	2-12	2-12	1-11	3-14	2-13
Highest Density	4-5	5-6	3-4	3-4	5-6	–	3-4	6-7	4-5	4-5	4-5	5-6

* Values in parenthesis are first minor peak.

Although the temperature range at which yolk-sac and post-sac larvae occurred was different for 1975 and 1976, there was an orderly progression of highest densities through temperature within each year. In 1975, peak yolk-sac larvae densities occurred at 2 to 4°C and peak post yolk-sac larvae at 6 to 8°C. In 1976, peak densities for eggs, yolk-sac and post yolk-sac larvae occurred at <2°C, 2 to 4°C, and 10 to 12°C, respectively (Table V-25). Hence, the absolute temperature for development is not rigid and development can occur within a wide range.

Highest densities of yolk-sac and post yolk-sac larvae occur at higher salinities than do eggs. These have moved farther downstream to areas where they develop in the higher salinity apparently due to passive drift (Table V-25). Leim (1924) observed tomcod eggs hatching in both fresh and saline waters but larvae surviving only under saline conditions (Scott and Crossman 1973). Thus, the movements of larvae to areas of higher salinity (0.6-21 mS/cm) may reduce mortality. Dissolived oxygen levels in this area are high (11 to 13 mg/l) and more than adequate for growth and survival of most fish (Dudoroff and Shumray 1970).

The distribution of juvenile tomcod is influenced by temperature and conductivity, but not by dissolved oxygen. Most juvenile tomcod are first caught at temperatures over 12°C (Table V-26) (in fall shoals and epibenthic sled/Tucker trawl) and catches remain high up to 26°C. They clearly prefer brackish water (with highest densities occurring over 10 mS/cm), although they are found over a wide range of conductivities. There was no apparent relationship between juvenile tomcod density and dissolved oxygen concentrations. Most catches in epibenthic sleds, Tucker trawls, and bottom trawls occurred over a dissolved oxygen range of 2 to 15 mg/l (Table V-26).

2. Distribution and Movements of Mature Fish

a. Geographic and Temporal Distribution

Atlantic tomcod mature in approximately 11 months (TI 1977f) and spawn when they are one year of age. Their longevity may be limited since approximately 90% of the spawning population is composed of fish in their first year of life (Subsection IV.3). Spawning generally occurs from December-January after which most adult Atlantic tomcod move downriver (Subsection b).

During the 1976-1977 spawning season, mature Atlantic tomcod (mostly the 1976 year class) were collected in shallow water using box traps (Section III). They were abundant in the Croton-Haverstraw, West Point, Cornwall, and Poughkeepsie regions. Peak abundance occurred in the West Point region during December 19 to 25 (Table V-27). After December, abundance declined in the West Point, Cornwall, and Poughkeepsie regions and increased in the Tappan Zee region, indicating that the spawning period was ending and fish were leaving the river. After January, tomcod were scarce in all regions.

Table V-27

Atlantic Tomcod Box Trap Catch-Per-Hour during November 1976-March 1977

Week	Tappan Zee (RM 24-33)	Croton-Haverstraw (RM 34-38)	Indian Point (RM 39-46)	West Point (RM 47-55)	Cornwall (RM 56-61)	Poughkeepsie (RM 62-76)
11/28 - 12/04	0.12	0.47	0.00	0.08	0.00	NS
12/05 - 12/11	0.54	3.50	0.01	1.97	0.13	2.71
12/12 - 12/18	0.74	3.55	0.00	13.76	5.51	8.18
12/19 - 12/25	NS	5.27	0.28	18.10	6.46	9.77
12/26 - 12/31	0.79	6.28	0.75	8.90	3.57	5.14
1/2 - 1/8	1.69	5.60	0.18	10.39	2.17	2.95
1/9 - 1/15	1.37	3.69	0.07	8.44	NS	3.35
1/16 - 1/22	0.50	1.66	0.17	5.01	0.35	3.19
1/23 - 1/29	0.24	0.32	0.10	1.62	NS	1.00
1/30 - 2/5	0.03	0.02	0.05	2.27	NS	0.71
2/6 - 2/12	0.02	0.00	0.00	0.81	NS	0.15
2/13 - 2/19	0.01	0.00	<0.01	0.31	NS	0.08
2/20 - 2/26	0.03	0.05	0.01	0.12	NS	0.04
2/27 - 3/5	NS	NS	NS	0.05	NS	0.01

NS = No sample

The first large catches of tomcod in December were predominately males, while the second period of large catches resulted from the movement of females into the area (Table V-28, Figure V-82). Most females were absent from catches by the end of January, but males were caught until early March. When large numbers of females moved into the spawning area in late December and early January, males and females approached equal proportions in contrast to earlier and later time periods when the proportion of males was much higher than females.

b. Trends in Distribution

Adult Atlantic tomcod were collected in large numbers further upriver during the 1976-1977 spawning season than during the previous two seasons. They were most abundant in the West Point region during all three years. In all years, the decline in abundance at the end of December and the increase in early January was also evident. The catch per trap hour in the Poughkeepsie region was much higher for the 1976-1977 run. The largest catch-per-trap-hour in the Poughkeepsie region was 0.29 and 0.06 in 1974-75

Table V-28

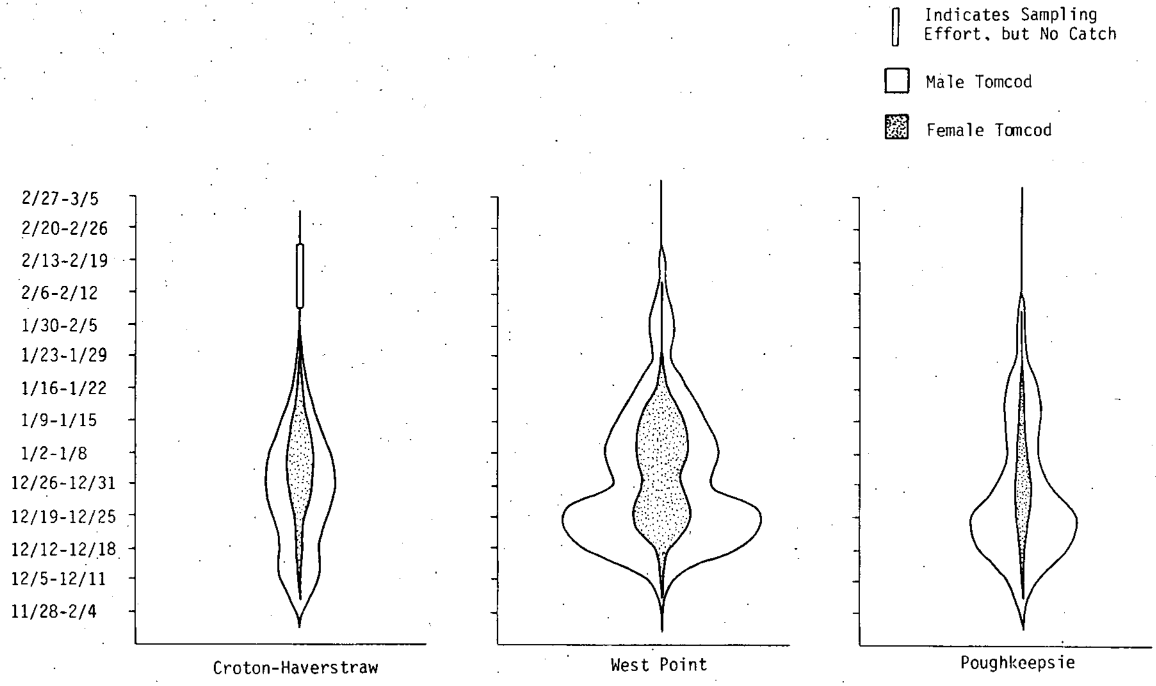
Catch-Per-Hour of Male and Female Atlantic Tomcod in Box Traps in the Croton-Haverstraw, West Point, and Poughkeepsie Regions during 1976-1977 Spawning Season

	Croton-Haverstraw (RM 34-38)		West Point (RM 47-55)		Poughkeepsie (RM 62-76)	
Week	Male	Female	Male	Female	Male	Female
11/28 - 12/04	*	*	*	*	NS	NS
12/05 - 12/11	3.39	0.11	1.88	0.09	2.63	0.08
12/12 - 12/18	3.18	0.37	12.70	1.06	7.69	0.49
12/19 - 12/25	4.26	1.01	12.74	5.36	8.49	1.28
12/26 - 12/31	4.15	2.13	5.06	3.84	3.66	1.48
1/2 - 1/8	3.31	2.29	5.61	4.78	1.18	1.14
1/9 - 1/15	2.31	1.38	4.37	4.07	2.85	0.50
1/16 - 1/22	1.23	0.43	3.73	1.28	2.80	0.39
1/23 - 1/29	0.25	0.07	1.44	0.18	0.93	0.07
1/30 - 2/5	*	*	2.16	0.11	0.67	0.04
2/6 - 2/12	NC	NC	0.76	0.05	*	*
2/13 - 2/19	NC	NC	0.31	0.00	0.08	0.00
2/20 - 2/26	*	*	0.10	0.02	*	*
2/27 - 3/5	NS	NS	*	*	*	*

NS = No sample

NC = No catch

* = Subsample size insufficient for sex ratio



Note: Width of diagrams scaled to catch-per-hour
see Table V-27 for actual catch-per-hour values

Figure V-82. Catch-Per-Hour of Male and Female Atlantic Tomcod in Croton-Haverstraw, West Point, and Poughkeepsie Regions in November-March 1976-1977 and 1975-76 respectively, but in 1976-1977, it was 9.77. This may have been due to a broadening of the preferred spawning area based on physicochemical factors or to the much larger spawning population that was present in 1976-1977 than in the previous two years (Subsection V.D.3). Catches in the Tappan Zee and Indian Point regions were generally low from the 1974-1975 through 1976-1977 seasons. However, Indian Point appeared to be the center of spawning activity during the 1973-1974 season (TI 1978a). Catch-per-hour in the Croton-Haverstraw region was higher in 1976-1977 than in the previous two seasons, and the Cornwall region had slightly lower catches in 1976-1977.

The duration of the spawning period was about seven to eight weeks for all years. In 1976-1977, large catches occurred earlier than the other two seasons (December 5 to 11 versus December 8 to 14 in 1974-1975, and December 14 to 20 in 1975-1976). The 1975-1976 spawning run peaked slightly later than the 1974-1975 spawning run.

In summary, the distribution of adult Atlantic tomcod was concentrated in the West Point region during the last three spawning seasons, 1974-75, 1975-76, and 1976-77. Unlike previous years, high catches occurred in the Poughkeepsie region during 1976-77. The bimodal pattern in catch per hour in the West Point region may have been due to a differential temporal distribution between male and female Atlantic tomcod. However, the lower catch per hour that occurred in all spawning runs during the last week of December may be due to a decrease in box trap efficiency due to longer duration between tendings.

c. Interregional Movements

Atlantic tomcod were marked with fin clips or Carlin tags during their winter spawning run (Subsection 3.). A majority of marked fish were released in regions 3 and 4 (RM 47 and 76 [KM 75 and 122]), the apparent spawning area, although some were also released in the Tappan Zee through Indian Point regions also (Table V-29).

Table V-29

Total Number of Atlantic Tomcod Marked with Finclips and Carlin Tags November 1976-March 1977, Hudson River Estuary

Release	Area	Number of Finclips	Number of Carlin Tags
1	RM 24-38	1,303	2,737
2	RM 39-46	4	304
3	RM 47-61	26,663	15,421
4	RM 62-76	7,465	6,481
	Total	35,435	24,943

In general, results of the marking study showed that the movements of the 1976-77 spawning run were similar to the two previous runs (Appendix Tables C-71 and C-72). Atlantic tomcod moved upriver to the spawning area (centered near Garrison during 1974-1975 and 1975-1976 but extending up to Poughkeepsie during 1976-1977) in November and December from the lower estuary and surrounding bays. Fish began leaving the spawning area mid- to late December in 1976-1977, and in early January during 1975-1976 (Subsection D.II.a). By March, most Atlantic tomcod had moved back downriver. The details of these movements are discussed in the following paragraphs.

Atlantic tomcod tagged during November and December and recaptured from December through January moved both upriver and downriver. However, prior to mid-December, most fish moved upriver into the spawning area (Figure V-83). Three fish moved from RM 34 (KM 54) to RM 51 (KM 82), one fish tagged at RM 36 (KM 58) was recaptured at RM 56 (KM 90) and another moved from RM 36 (KM 58) to RM 51 (KM 82). Another recapture showed that fish moved within the primary spawning area. After mid-December, Atlantic tomcod tagged in the spawning area (regions 3 and 4) were recaptured downriver (regions 1 and 2) while others continued to move upriver into the spawning area (Figure V-84). Six fish tagged in region 1 were recaptured in regions 3 or 4, 16 left the spawning area after being tagged there and were recaptured in regions 1 and 2.

		Recapture Region			
		1	2	3	4
Release Region	1	8		5	
	2				
	3			43	
	4			1	5

Figure V-83. Release-Recapture Matrix for Atlantic Tomcod Tagged and Recaptured from November through Mid-December 1976, Hudson River Estuary

		Recapture Region			
		1	2	3	4
Release Region	1	11		5	1
	2				
	3	3	11	112	6
	4		2	4	36

Figure V-84. Release-Recapture Matrix for Atlantic Tomcod Tagged during November and December 1976 and Recaptured from Mid-December through January 1977, Hudson River Estuary

Relatively few Atlantic tomcod were tagged in the lower marking regions so the recapture data did not reveal a mass upriver migration. The fish most likely traveled up the channel of the river until they reached the spawning area and then moved towards the shore. Hence they may have eluded the box traps set downriver and suddenly appeared en masse in the box traps set in the spawning area.

Recaptures of Atlantic tomcod tagged in January showed no movement upriver to the spawning area from the lower regions of the river. The only upriver movement occurred within region 4, with one fish moving from RM 67 (KM 107) to RM 71 (KM 114) and another from RM 71 (KM 114) to RM 72 (KM 115). Two fish moved downriver and out of the spawning area (Figure V-85).

Recapture Region

Release Region	1	2	3	4
1	2			
2				
3	2		25	
4				9

Figure V-85. Release-Recapture Matrix for Atlantic Tomcod Tagged and Recaptured during January 1977, Hudson River Estuary

After January, movements were downriver (Figure V-86 and V-87) except for one fish which moved from RM 36 (KM 58) to RM 37 (KM 59) (Appendix Table C-71). Atlantic tomcod apparently left the spawning area by moving back down the channel, since catches by the downriver traps remained small. By March, several tagged Atlantic tomcod were caught by sport fisherman near the mouth of the river. Six tags were returned from fish caught outside the river during April and May: 3 from the East River, 2 from upper New York Bay, and 1 from Gravesend Bay.

Recapture Region

Release Region	1	2	3	4
1				
2	1			
3	4	2	8	
4		1	1	8

Figure V-86. Release-Recapture Matrix for Atlantic Tomcod Tagged from December 1976 through February 1977 and Recaptured during February 1977, Hudson River Estuary

		Recapture Region			
		1	2	3	4
Release Region	1	1			
	2	1			
	3	8			
	4	2	1		1

Figure V-87. Release-Recapture Matrix for Atlantic Tomcod Tagged from December 1976 through February 1977 and Recaptured during March 1977, Hudson River Estuary

Movement of fin-clipped Atlantic tomcod was much like that of tagged fish (Figures V-88 and V-89). Most were recaptured in the region where they were marked. Fewer fish were finclipped than tagged in regions 1 and 2 (Table V-29), hence, none were recaptured and movement upriver from the spawning area was not evident for fin-clipped fish. Movement between regions 3 and 4 and downriver was however, much like the movement of the tagged fish.

3. Exposure of the Early Life Stages to the Effects of Power Plants

a. Eggs

1) Distribution in Power Plant Regions

The majority of Atlantic tomcod spawned before sampling began in late February (Figure V-90). Eggs were never collected within the Bowline plant region, although a small number of eggs were occasionally collected within the other plant regions during the period from February 23 to March 25 (Appendix Table C-73).

2) Trends in Exposure (1974, 1975, 1976)

The few tomcod eggs collected in late February 1976, did not permit evaluation of their exposure to power plants. No eggs were collected in 1974 and 1975.

Release Region	Carlin Tags Recapture Region				Recapture Month	Fin Clips Recapture Region			
	1	2	3	4		1	2	3	4
1	11		8	1	Nov and Dec	2			
2									
3	1	6	110	2			18	51	1
4		2	3	20				13	29
1	8		2		Jan	1			
2									
3	2	5	45	4		3	3	53	1
4			2	21				2	14
1					Feb				
2	1						None		
3	3	2							
4				2					
1	1				Mar				
2									
3	5*						1		
4	1**			1					
1					April through June				
2							None		
3	6†								
4	3††								

* Includes three recaptures from East River and one from RM 17.

** Includes one recapture from RM 3.

† Includes two recaptures from East River, one from Kill van Kull and one from RM 11.

†† Includes one recapture from RM 13 and one from RM 3.

Figure V-88. Release-Recapture Matrices for Atlantic Tomcod Marked in November and December 1976 and Recaptured through June 1977, Hudson River Estuary

		Carlin Tags Recapture Region				Fin Clips Recapture Region			
Recapture Month	Release Region	1	2	3	4	1	2	3	4
Jan	1	2							
	2								
	3	2		25		1	1	75	
	4				9	1		3	10
Feb	1								
	2								
	3	1		4		1		6	
	4		1	1	4				5
Mar	1								
	2								
	3	3*							
	4	1**	1			1			
April through June	1								
	2								
	3	9†					1		
	4	4††							

* Includes one recapture from RM 19, one from RM 13, and one from RM 3.

** Includes one recapture from RM 19.

† Includes one recapture from East River, one from Gravesend Bay, one from Upper New York Bay, one from RM 13 and one from RM 1.

†† Includes one recapture from Upper New York Bay and one from RM 10.

Figure V-89. Release-Recapture Matrices for Atlantic Tomcod Marked in January 1977 and Recaptured through June 1977, Hudson River Estuary

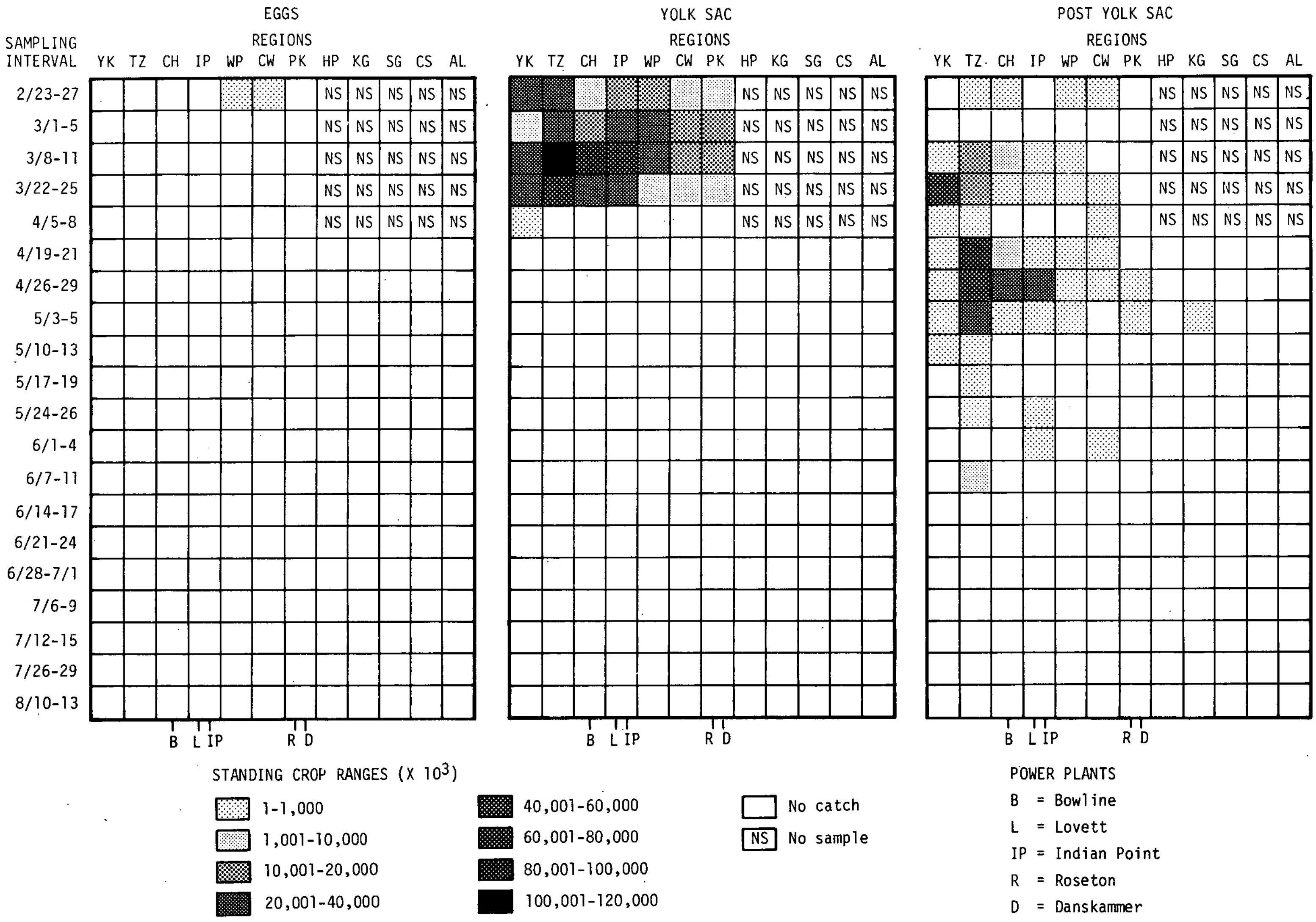


Figure V-90. Exposure Matrix of Atlantic Tomcod Eggs, Yolk-Sac, and Post Yolk-Sac Larvae Collected during the 1976 Ichthyoplankton Survey

3) Comparison of Near-field Density Estimates

The small number of eggs collected did not allow comparison of near-field density estimates with densities in the plant regions based on farfield sampling efforts.

4) Overall Exposure Assessment

Tomcod eggs are demersal and unlike either striped bass or white perch eggs which hatch within one week, tomcod eggs hatch in 24 to 30 days (McFadden 1977). Although exposure may increase as a result of this extended duration, the demersal nature of the eggs probably reduces their exposure to entrainment. Apparently, most spawning occurs in the area between the upriver (Roseton and Danskammer) and downriver (Bowline, Lovett, and Indian Point) plants, further reducing exposure.

b. Yolk-sac Larvae

1) Distribution Within Power Plant Regions

Yolk-sac larvae were present when sampling began in late February and were last collected in early April (Figure V-90). Peak standing crops occurred during March 8 to 11; exposure to the Bowline, Lovett, and Indian Point plants was also high at this time. The exposure of yolk-sac larvae to the Roseton and Danskammer plants was relatively high in early March, although the largest portion of the larval population was consistently found downriver from these plant regions.

In general, the exposure of yolk-sac larvae within the Bowline, Lovett, and Indian Point plant regions increased through early March and then declined (Figure V-91 and Appendix Table C-74). Exposure within the Roseton and Danskammer plant regions also had similar patterns, but highest values occurred prior to peak yolk-sac abundance.

Based on total standing crops percentages, the plant regions ranked from high to low as follows: Bowline, Lovett, Indian Point, Roseton, and Danskammer.

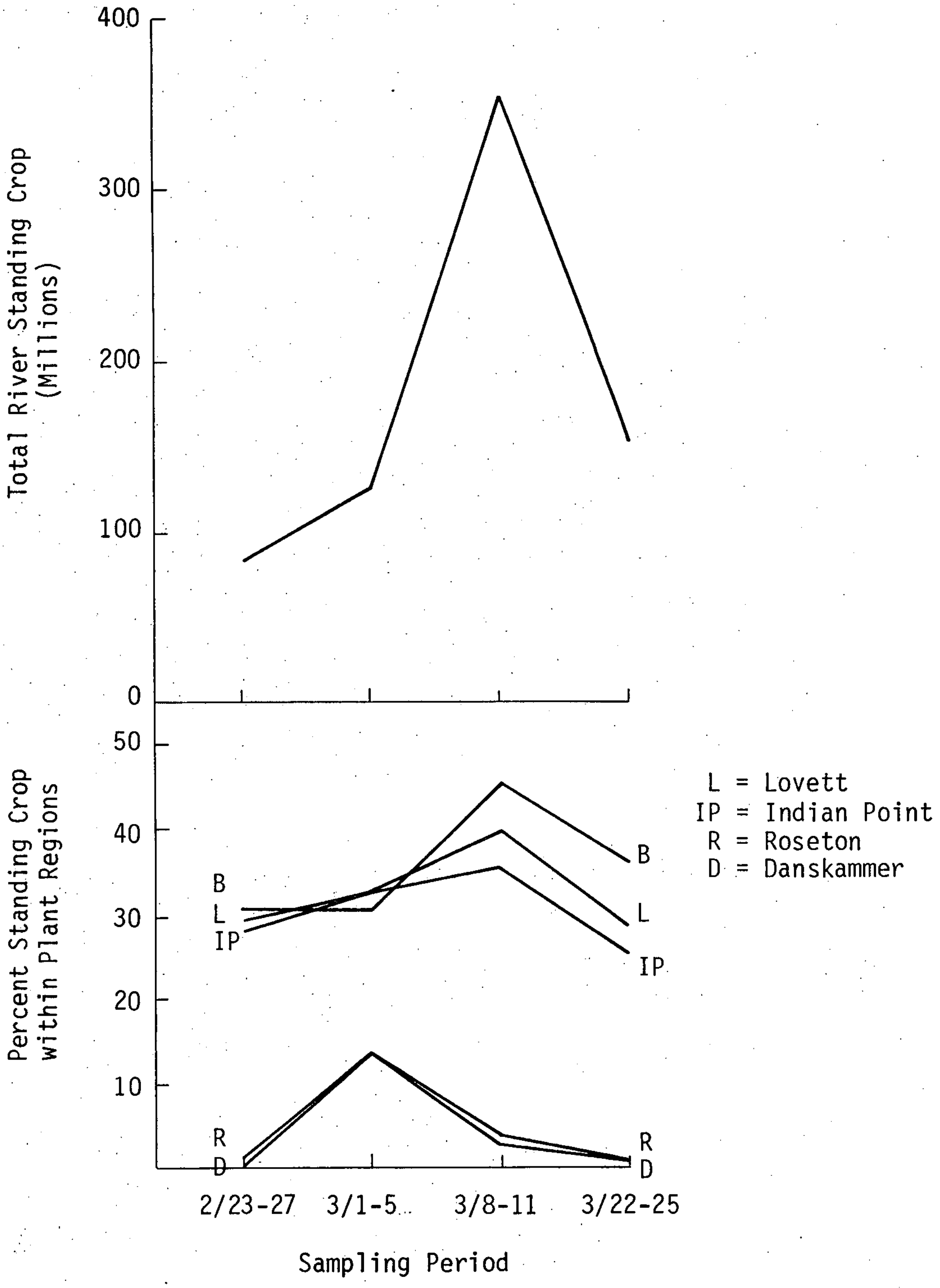


Figure V-91. Comparison of Total River Standing Crop of Atlantic Tomcod Yolk-Sac Larvae with Percent Standing Crop Found within Plant Regions during Selected Periods, 1976

2) Trends in Exposure (1975, 1976)

Yolk-sac larvae were most vulnerable to the downriver plants (Bowline, Lovett, and Indian Point) with descending values seen for each of these plant regions, respectively (Figure V-92). Indices in 1976 were similar in pattern and value to those of 1975. The geographic distribution indices in these years showed peak values in the Tappan Zee and Croton-Haverstraw regions reflecting the higher downriver exposure indices.

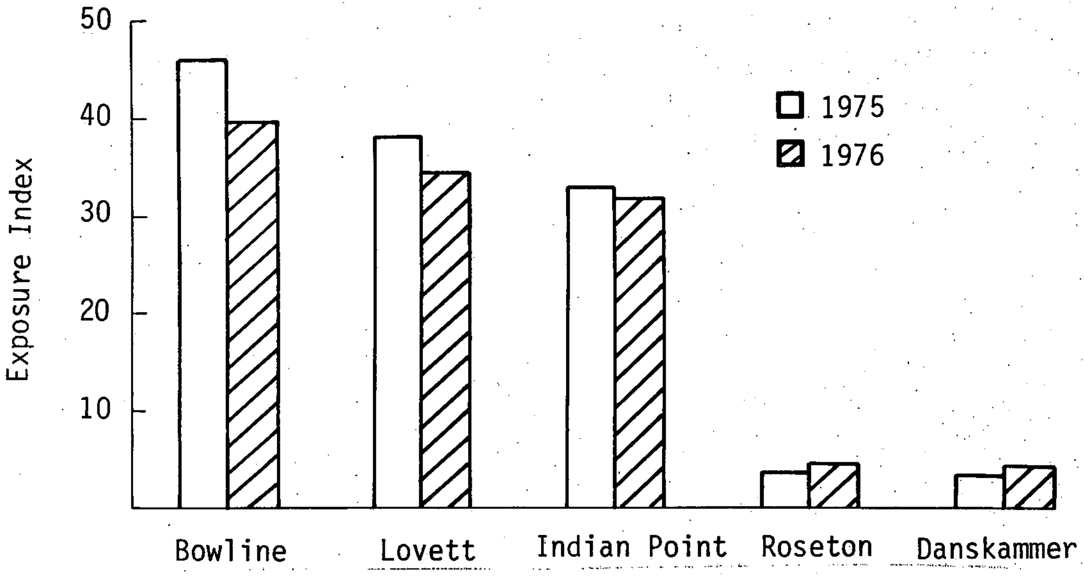


Figure V-92. Exposure Indices of Atlantic Tomcod Yolk-Sac Larvae for Power Plant Regions during Selected Periods in 1975 and 1976

3) Comparison With Nearfield Density Estimates

Density estimates of yolk and post yolk-sac larvae will be discussed jointly in Section V.C.3.).

4) Overall Exposure Assessment

Atlantic tomcod yolk-sac larvae are abundant in the vicinity of the three downriver plants and seem to be distributed throughout the water column. The overall exposure of yolk-sac larvae to entrainment may be high at Bowline, Lovett, and Indian Point. Yolk-sac larvae were not abundant near the Roseton and Danskammer plants so overall exposure to these plants was low.

c. Post Yolk-sac Larvae

1) Distribution Within Power Plant Regions

Post yolk-sac larvae were collected as early as February 23 and last observed in early June (Figure V-90). Exposure to the Bowline, Lovett, and Indian Point plants increased sharply as the post yolk-sac larvae reached peak abundance in late April (Appendix Table C-75). Exposure to Roseton and Danskammer remained consistently low throughout the entire sampling period, indicating that the primary nursery area occurred downriver from these regions.

The portion of the total river standing crops found within the Bowline, Lovett, and Indian Point plant regions shows sharp increases and decreases in the periods surrounding April 26 to 29 when peak larvae abundance occurred (Figure V-93). Shortly thereafter (May 3 to 6), post yolk-sac larvae were found only within the Bowline plant region, reflecting a downstream movement of tomcod post yolk-sac larvae at this time.

During the period of post yolk-sac abundance, March 22 to May 19, vulnerability was highest to Bowline and Lovett, respectively. Indian Point had an intermediate percentage; and Roseton and Danskammer both showed relatively low percentages.

2) Trends in Exposure (1975, 1976)

Exposure of post yolk-sac larvae showed similar patterns in 1975 and 1976, with the highest exposure occurring to the three downriver plant regions (Figure V-94). The highest exposure was observed in the Bowline plant region during each year. Exposure of post yolk-sac larvae was generally higher in 1976; however, exposure of post yolk-sac larvae was lower than yolk-sac larvae within all plant regions during corresponding years.

Examination of these values suggests that exposure may vary markedly between years depending on various environmental factors.

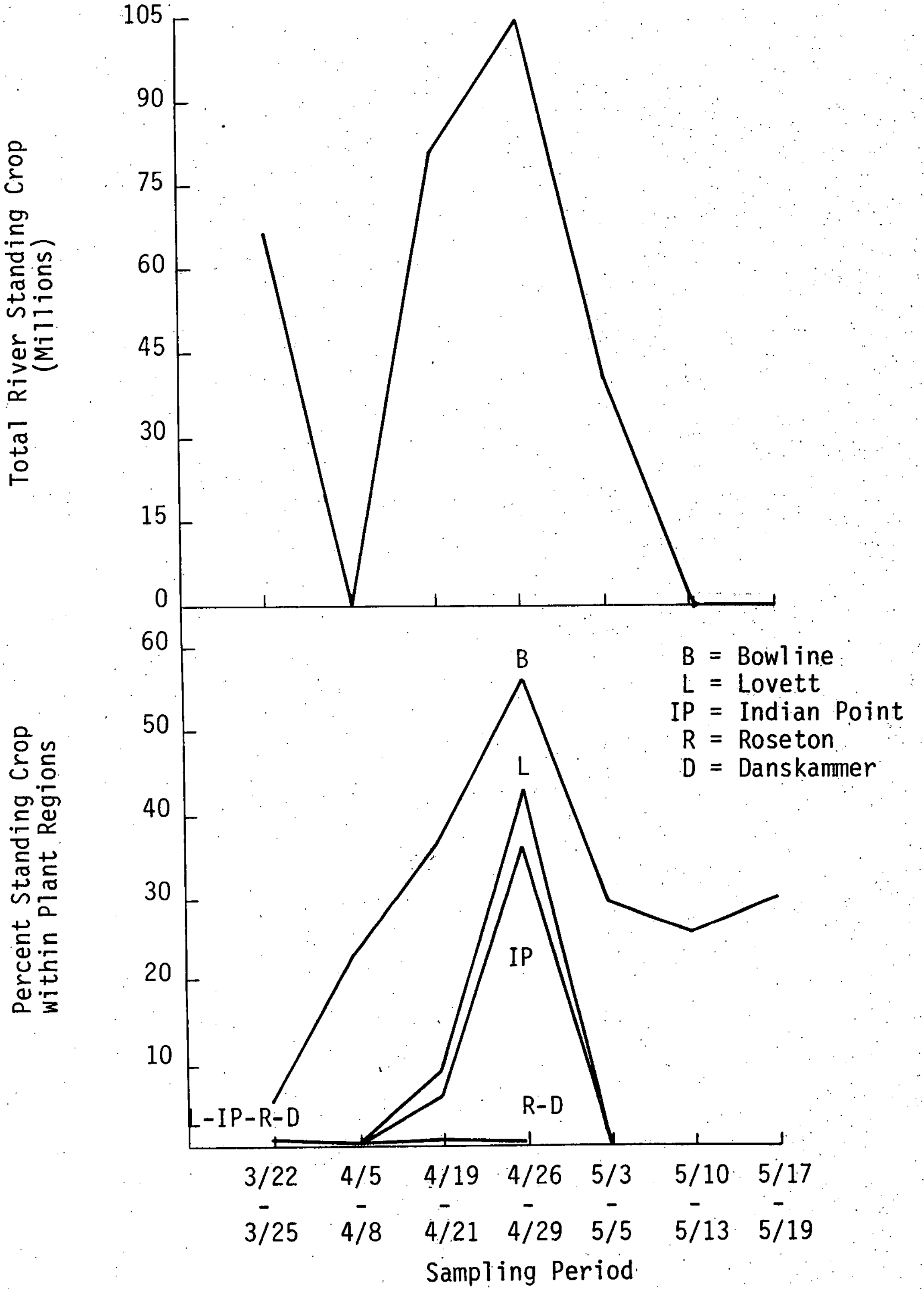


Figure V-93. Comparison of Total River Standing Crop of Atlantic Tomcod Post Yolk-Sac Larvae with Percent Standing Crop Found within Plant Regions during Selected Periods, 1976

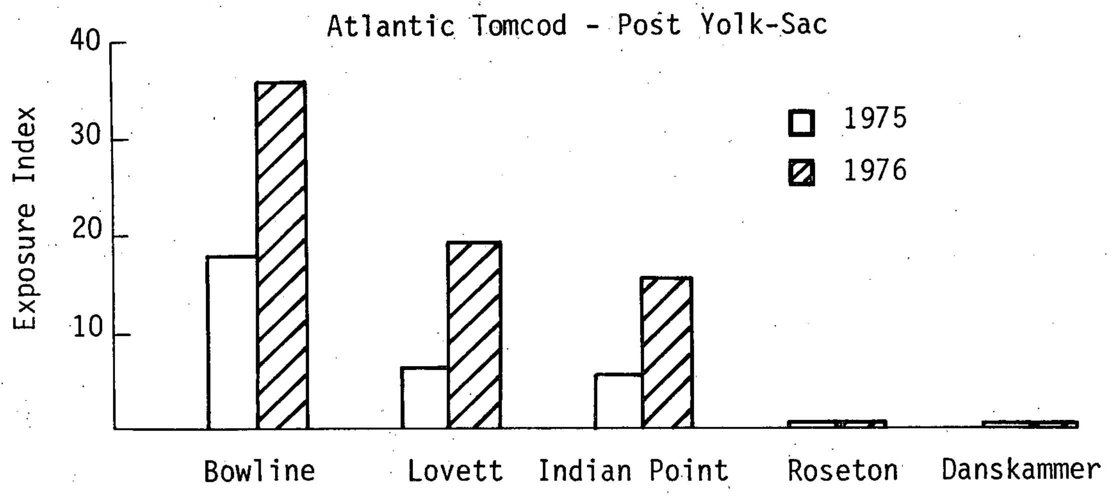


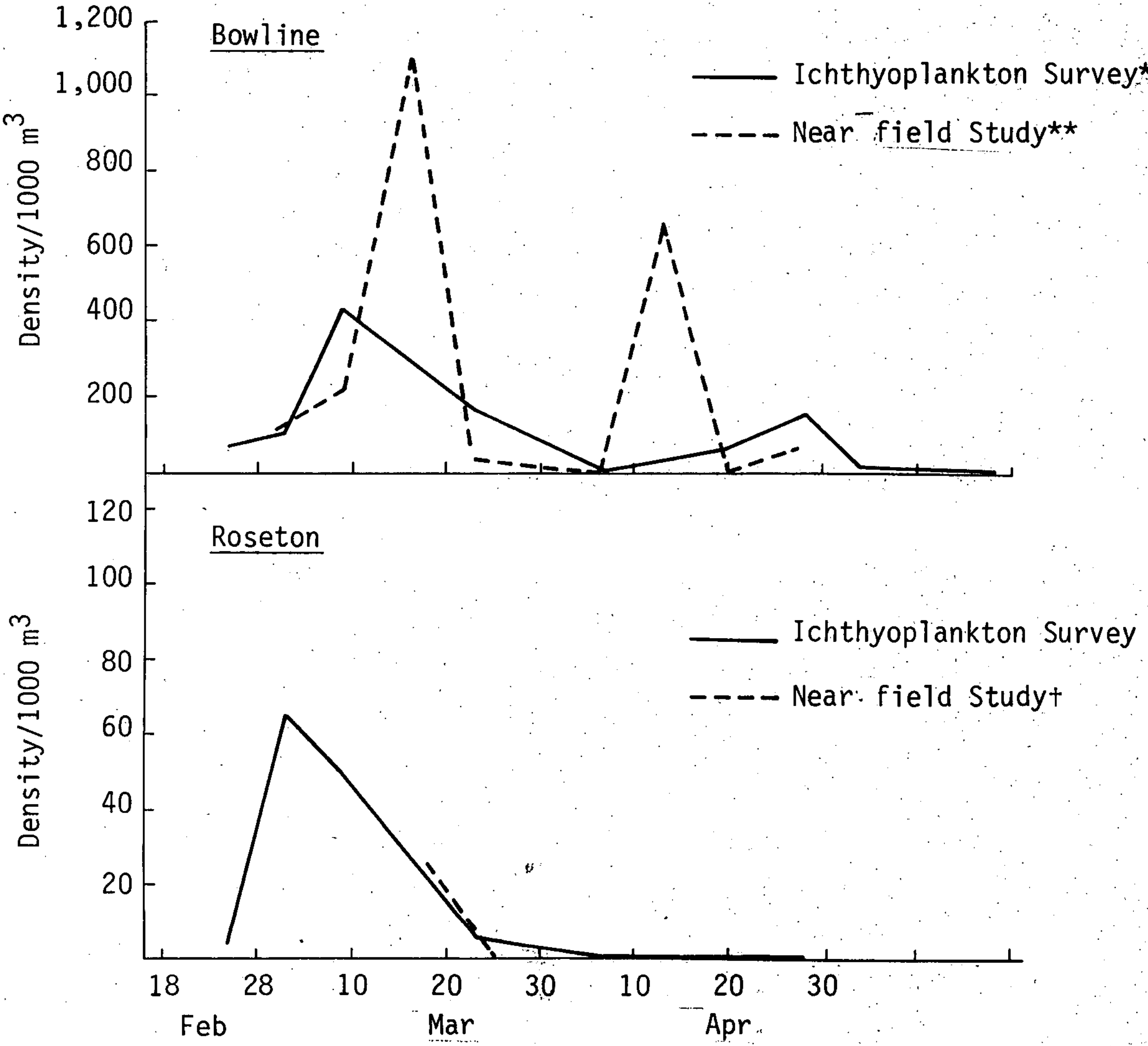
Figure V-94. Exposure Indices of Atlantic Tomcod Post Yolk-Sac Larvae for Power Plant Regions during Selected Periods in 1975 and 1976

3) Comparison With Near-field Density Estimates

Nearfield densities of yolk-sac and post yolk-sac larvae within the Bowline (LMS) plant vicinity peaked during mid-March and mid-April (Figure V-95). These peak values should be viewed with caution since they reflect samples taken only at one channel station. In addition, values for periods adjacent to either of these peak periods were considerably lower, and these densities were lower than Ichthyoplankton (TI) Survey estimates. Nearfield densities within the Roseton plant region, although available only during a short period in March, were similar to density estimates in the plant regions based on the Farfield Ichthyoplankton Survey.

4) Overall Exposure Assessment

Post yolk-sac larvae were concentrated more in the lower estuarine regions than either the egg or yolk-sac life stages. Overall exposure to entrainment was highest to Bowline, somewhat lower to Lovett and Indian Point, and negligible to Roseton and Danskammer.



*Yolk-Sac and post yolk-sac densities are combined for March 23. Values before this time reflect yolk-sac densities while those after reflect post yolk-sac densities.

**Combined yolk-sac and post yolk-sac larvae

†Combined yolk-sac and post yolk-sac larvae during selected periods

Figure V-95. Comparison of Density Estimates of Atlantic Tomcod Yolk-Sac and Post Yolk-Sac Larvae at the Bowline and Roseton Plant Regions during Selected Periods in 1976

d. Juveniles

1) Distribution Within Power Plant Regions

Atlantic tomcod juveniles were concentrated in the Yonkers and Tappan Zee regions throughout 1976. Thus, their exposure to power plants was usually low (Figures V-96 and V-97). Between 32 and 85% of the estimated standing crop (based on Ichthyoplankton and Fall Shoals surveys data) was always below all the power plant regions (Appendix Tables C-76, 77). During the period when the estimated standing crop of juvenile Atlantic tomcod was largest, less than 2% of the standing crop was within any of the plant regions except for Bowline (the plant farthest downriver) (Figure V-98). During the peak period of abundance, 31% of the estimated standing crops occurred within the Bowline plant region. By fall, the standing crops estimates were much smaller and juveniles were more evenly distributed in the lower regions of the estuary (Yonkers through Poughkeepsie); therefore, the percentages of the estimated standing crops within most plant regions increased (Figure V-99).

The Roseton and Danskammer plant regions consistently contained the smallest percentages of the juvenile population (0 to 14% for Roseton and 0 to 11% for Danskammer). The percentage of the estimated standing crops of juvenile Atlantic tomcod within the Indian Point plant region ranged from 2 to 25%. The Lovett plant region, being proximate to Indian Point, contained a similar percentage of the standing crops of juveniles; the range was 2 to 32%. The percentage ranged from 11 to 56% for the Bowline plant region. Thus exposure of juvenile Atlantic tomcod based on percentage of standing crop within a plant region was moderate to high at Bowline, low to moderate at Lovett and Indian Point, and low at Roseton and Danskammer. However, since Atlantic tomcod prefer deep water and the Bowline plant withdraws its cooling water from a shallow tidal pond, actual exposure to impingement at Bowline was probably less than the plant region density would indicate.

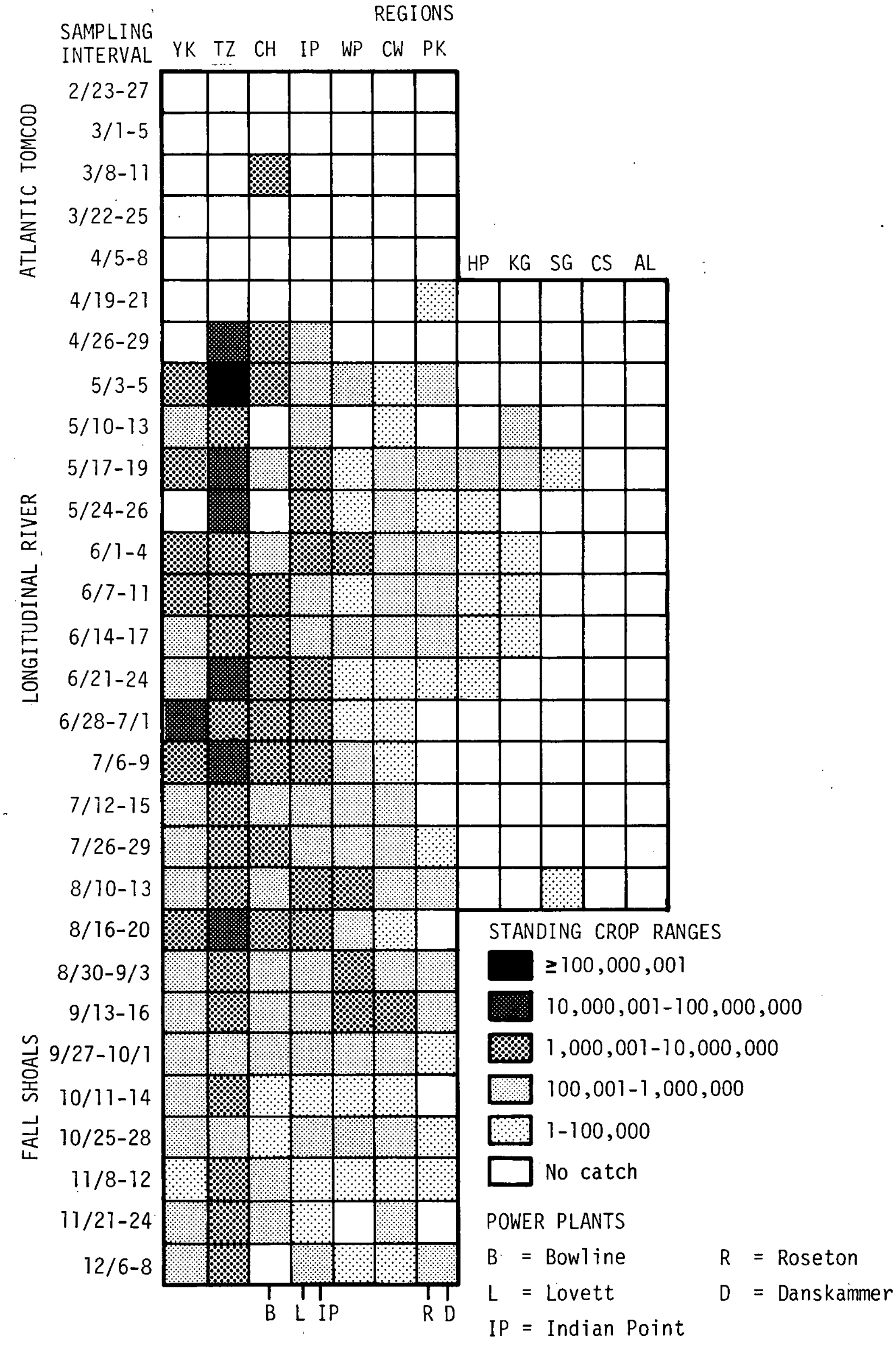


Figure V-96. Exposure Matrix of Juvenile Atlantic Tomcod Collected by Ichthyoplankton Gear, 1976

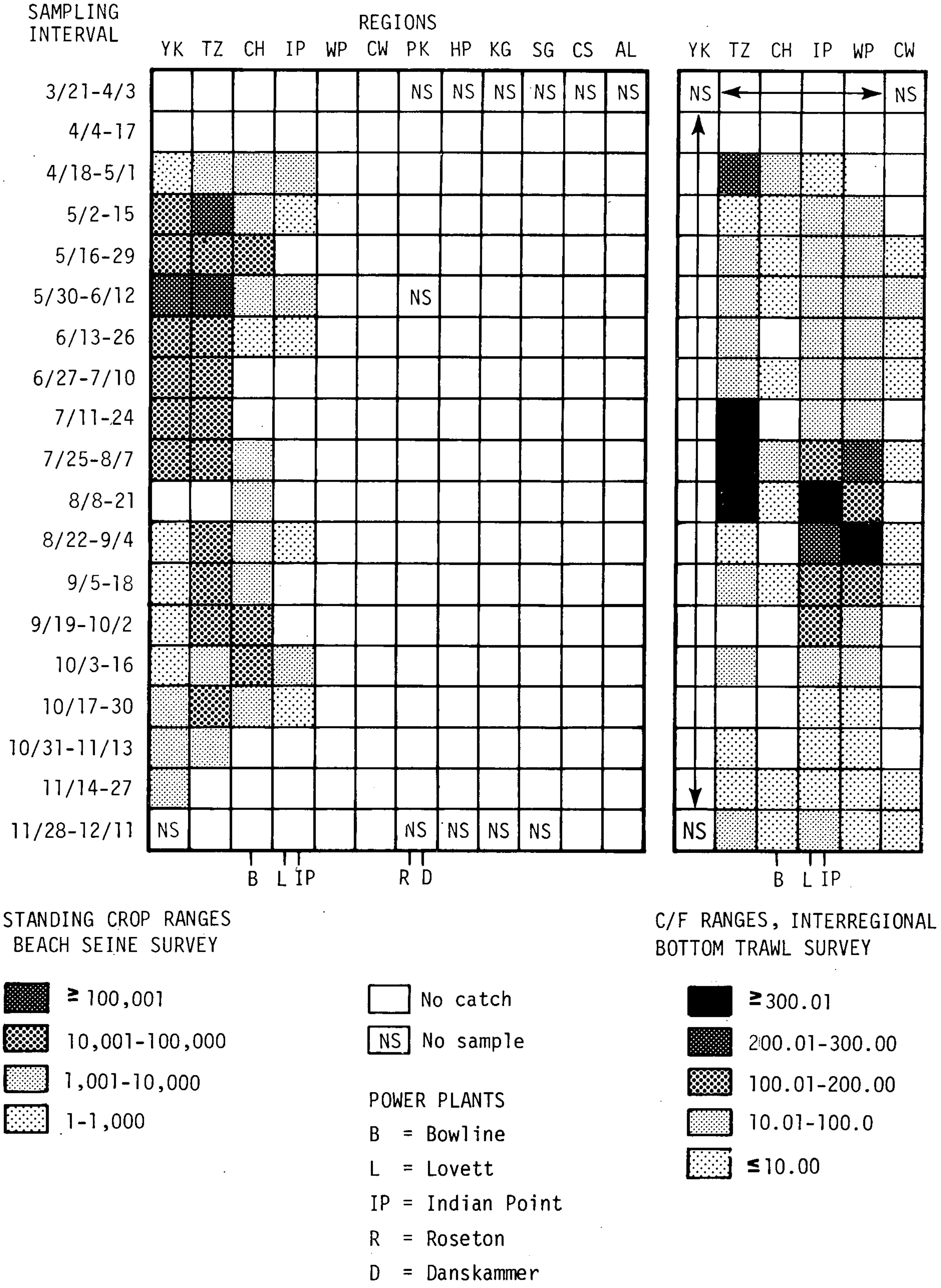


Figure V-97. Exposure Matrix of Juvenile Atlantic Tomcod Collected during the 1976 Beach Seine Survey and 1976 Interregional Bottom Trawl Survey

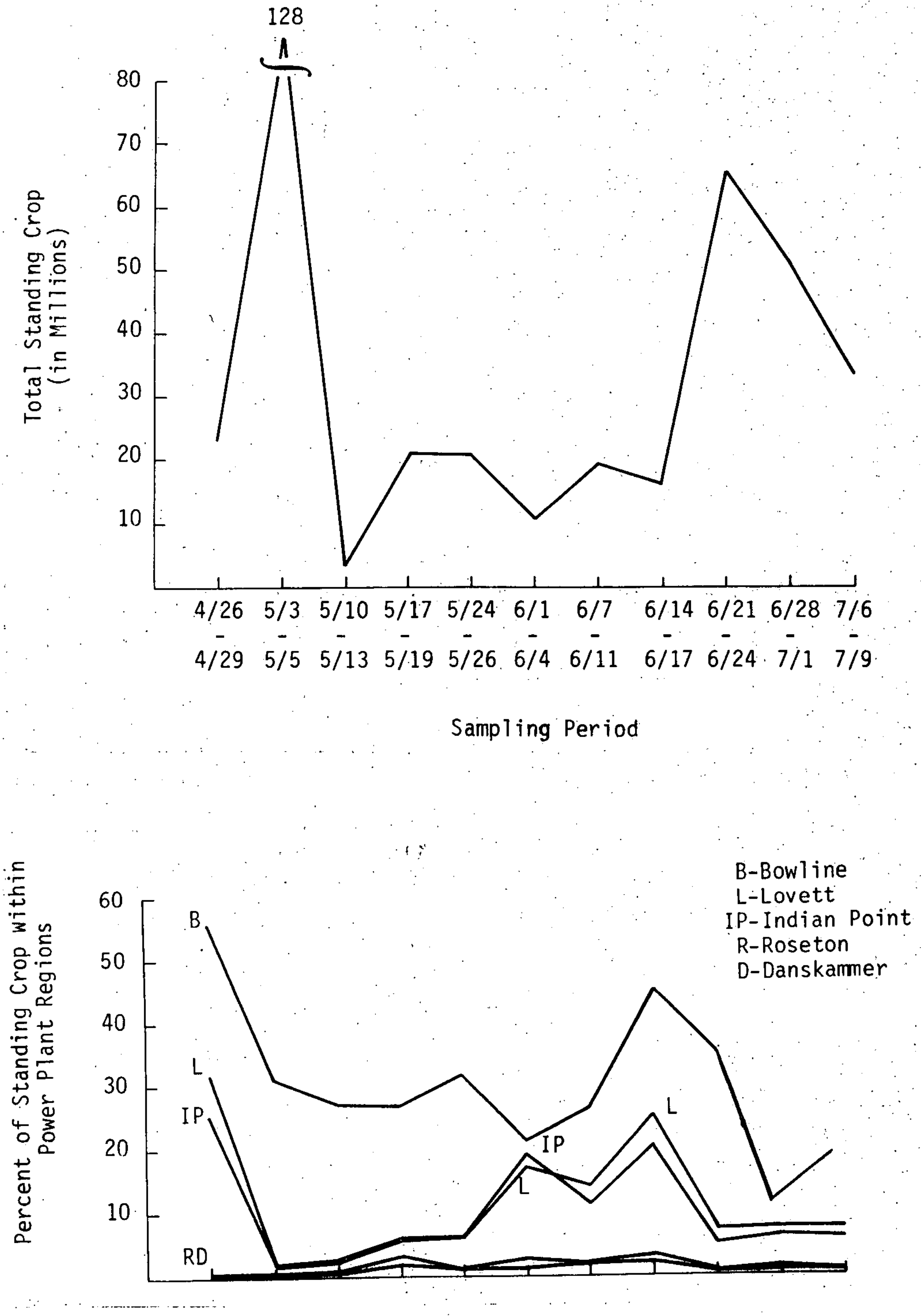


Figure V-98. Percentages of the Estimated Standing Crop of Juvenile Atlantic Tomcod within the Power Plant Regions and Total Standing Crop (Based on Ichthyoplankton Sampling, Late April-Early July 1976)

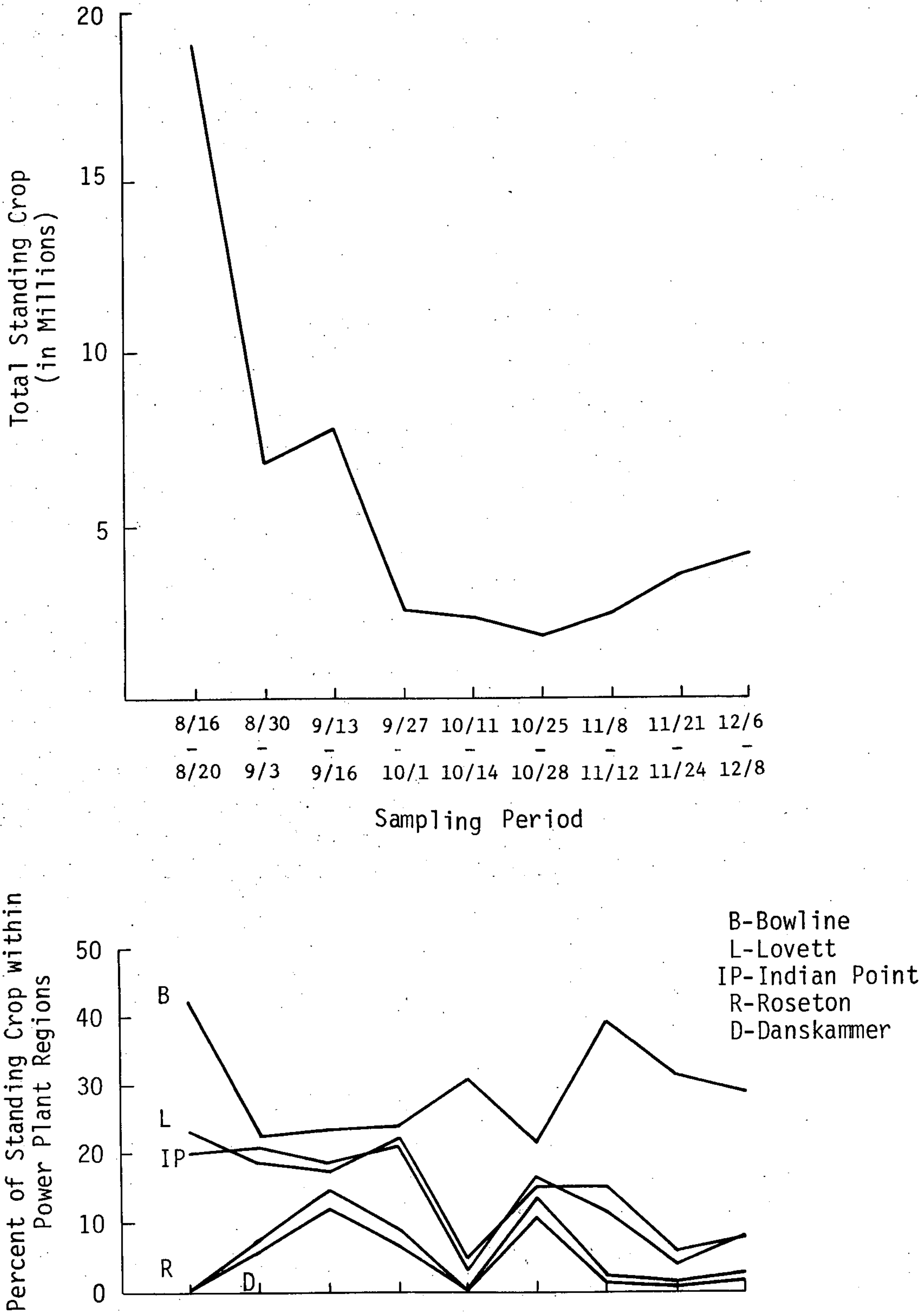


Figure V-99. Percentages of the Estimated Standing Crops of Juvenile Atlantic Tomcod within the Power Plant Regions and Total Standing Crop (Based on Fall Shoals Sampling, August-December, 1976)

2) Trends in Exposure (1974, 1975, 1976)

Spatial-temporal distribution of juvenile Atlantic tomcod in the power plant regions differed among years (1974-1976), because geographic distribution in 1974 and 1975 differed from that for 1976. When the estimated standing crops were largest (early or mid-May, based on Ichthyoplankton Survey Data), juvenile Atlantic tomcod were concentrated further downriver in 1974 and 1975 (Yonkers region) than in 1976 (Tappan Zee region). This resulted in higher percentages of the peak estimated standing crops being below all plant regions in 1974 and 1975 than in 1976 (91%, 92%, and 69% respectively). Vulnerability of juveniles to impingement at Bowline was thus higher in 1976. Thirty-one percent of the peak standing crops was within the Bowline plant region in 1976; 9% in 1974 and 4% in 1975. Percentages within the other plant regions were largest in 1975 although none were over 5% (Table V-30).

Table V-30

Percentage of the Peak Standing Crop of Juvenile Atlantic Tomcod within Each Plant Region, Based on Longitudinal River Survey Data during 1974, 1975, and 1976

Plant Region	Bowline	Lovett	Indian Point	Roseton	Danskammer
1974	9.4	<0.1	<0.1	0	0
1975	3.5	3.6	3.9	0.3	0.3
1976	30.6	1.7	1.4	0.1	0.1

In 1974 and 1975, after the period of greatest abundance, juvenile Atlantic tomcod dispersed upriver (and possibly out of the lower end of the study area also) so that eventually, a large percentage of the estimated standing crop was upriver in the Indian Point and West Point regions. In 1976, juveniles were most abundant in the Tappan Zee region throughout the year. This difference in distribution resulted in higher percentages of the estimated standing crops within the Lovett, Indian Point, Roseton, and Danskammer plant regions in 1974 and 1975 than in 1976 (TI 1978a). In 1976, the average percentage of the standing crop within the Lovett plant region was 11, in 1975 it was 20%, and in 1974 it was 16% (Table V-31). For Indian Point, percentages were 10% in 1976, 19% in 1975, and 15% in 1974. For

Table V-31

Average Percentages of Estimated Standing Crops of Juvenile Atlantic Tomcod within Each Plant Region Based on Longitudinal River Survey Data during 1974, 1975, and 1976

Plant Region	Bowline	Lovett	Indian Point	Roseton	Danskammer
1974	25	16	15	2	2
1975	29	20	19	3	3
1976	29	11	10	1	1

Roseton and Danskammer, the differences between 1976 and the two previous years were less; 1% in 1976, 3% in 1975, and 2% in 1974 for both Roseton and Danskammer. At Bowline, the percentages within the plant region were almost the same for all years, but during 1976, a large part of the standing crops was below the Bowline plant region while in 1975 and 1974, a large percentage of the standing crops was above it.

Exposure was much greater during 1974 and 1975 to Lovett and Indian Point and slightly higher to Roseton and Danskammer relative to 1976. For Bowline, exposure was higher in 1976 due to the large percentage of the peak standing crop within the plant region, even though the period of peak abundance was brief.

3) Comparison of Near-field Abundance to Impingement Rate

Impingement rates of Atlantic tomcod were compared to nearfield abundance at each plant to determine how well seasonal distribution relative to the power plants corresponded to numbers of tomcod impinged. Distribution based on regional or nearfield collections appeared to be a good indicator of impingement exposure at Bowline and Indian Point only. Factors such as micro-distribution (i.e. eastside versus westside of river, shore zone versus channel) and the design and operation of the power plants may be more important determinants of the number of fish impinged than nearfield distribution.*

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*Impingement rate and catch per tow by bottom trawl at Bowline, Lovett, Roseton, and Danskammer supplied by or compiled from data supplied by Lawler, Matusky, and Skelly Engineers, Inc.

At Bowline, the impingement rate paralleled the C/f of Atlantic tomcod by bottom trawl. Peak abundance in bottom trawl catches occurred during June when the impingement rate was also highest (Figure V-100). The impingement rate at Lovett was highest during the winter months, but bottom trawl catches were greatest during July (Figure V-101). Thus, mature tomcod are more likely to be impinged at Lovett than juveniles. At Indian Point, the impingement rate of Atlantic tomcod corresponded well to the C/f of juveniles by bottom trawl in the Indian Point area (Figure V-102). Thus, as at Bowline, most Atlantic tomcod impinged at Indian Point are likely to be juveniles. The general patterns of impingement and near field abundance (C/f by bottom trawl) was similar for Roseton and Danskammer (Figure V-103 and V-104). Both increased sharply from September-December, reflecting an influx of Atlantic tomcod prior to spawning.

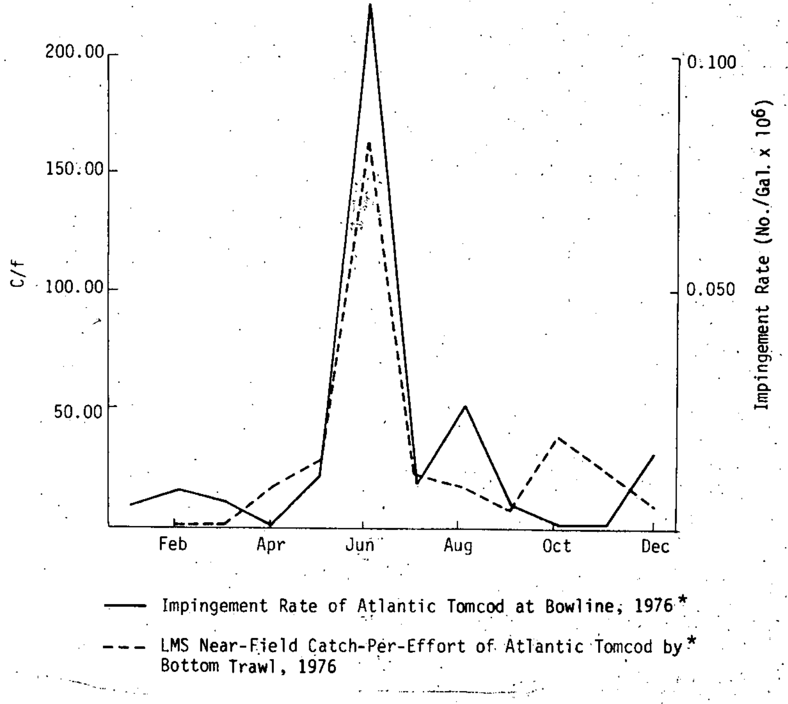

Figure V-100. Impingement Rate of Atlantic Tomcod at Bowline and Catch-Per-Effort of Atlantic Tomcod by Bottom Trawl near Bowling Point, 1976.

*Impingement rate and catch per tow by bottom trawl at Bowline, Lovett, Roseton, and Danskammer supplied by or compiled from data supplied by Lawler, Matusky, and Skelly Engineers, Inc.

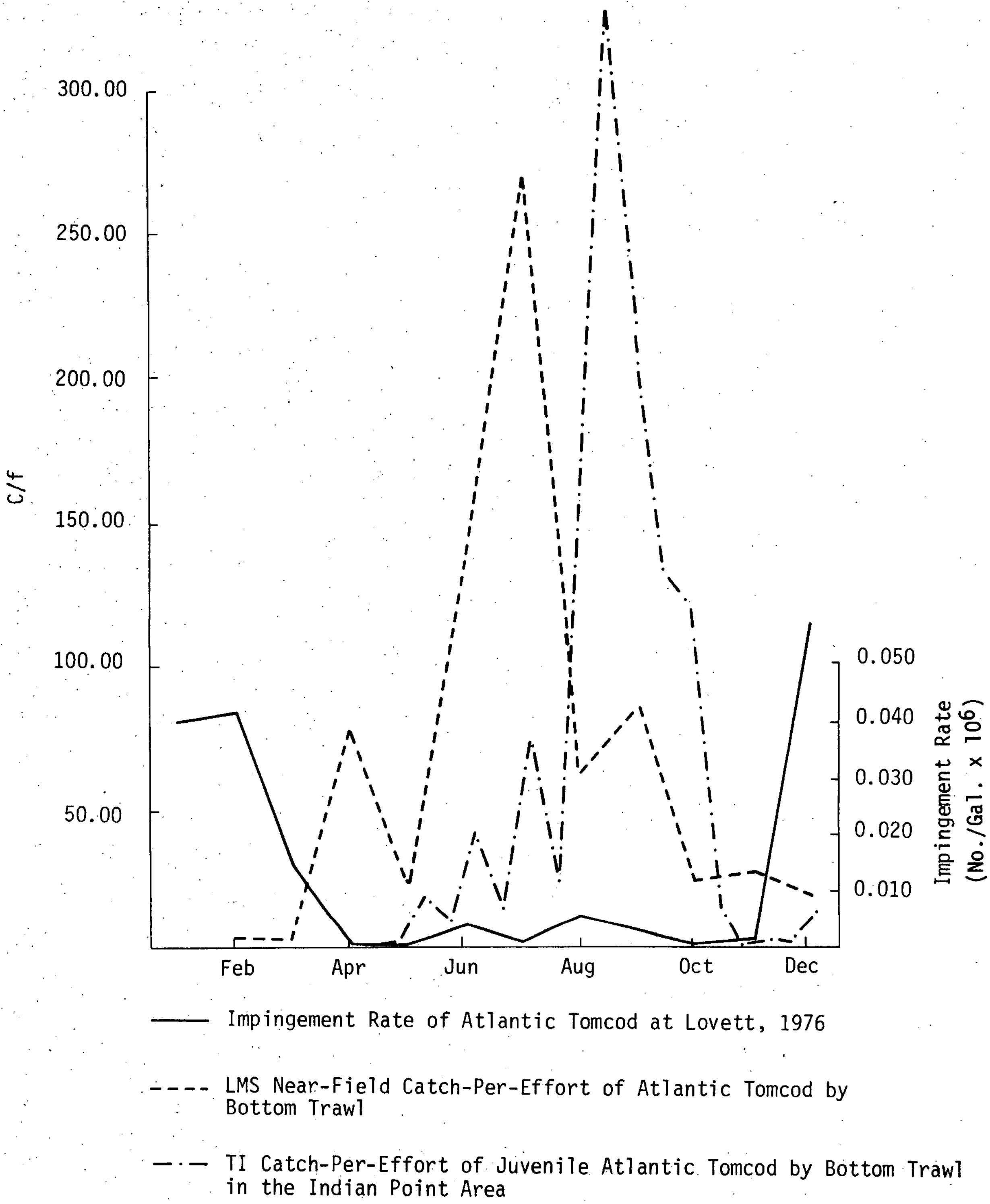

Figure V-101. Impingement Rate of Atlantic Tomcod and Catch-Per-Effort of Atlantic Tomcod by Bottom Trawl near Lovett and Catch-Per-Effort of Juvenile Atlantic Tomcod by Bottom Trawl in Indian Point Region, 1976

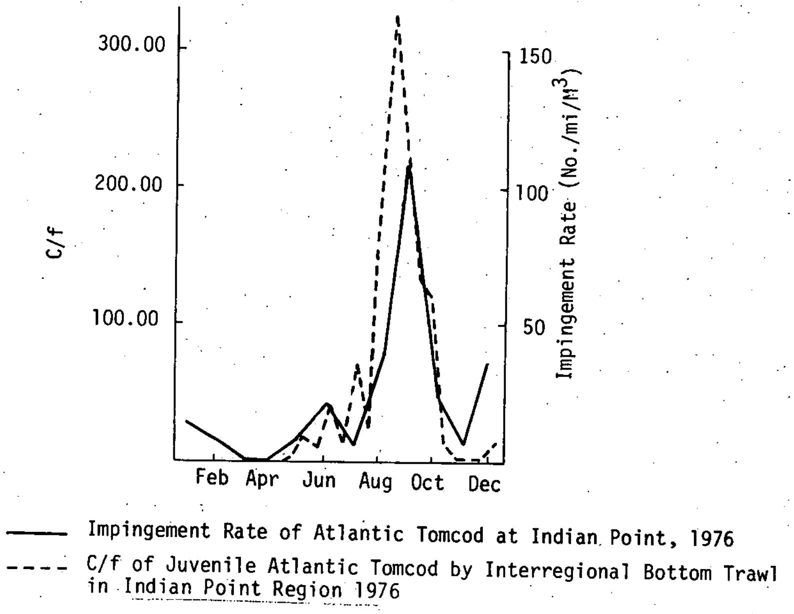

Figure V-102. Impingement Rate of Atlantic Tomcod at Indian Point and Catch-Per-Effort of Atlantic Tomcod by Bottom Trawl in Indian Point Region, 1976

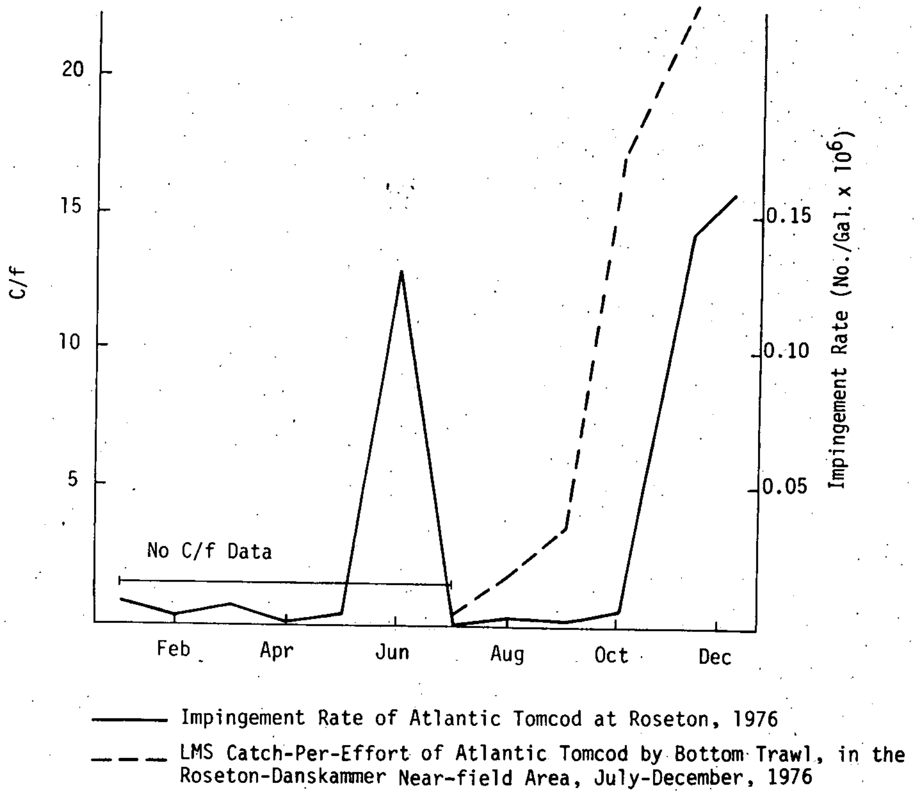

Figure V-103. Impingement Rate of Atlantic Tomcod at Roseton and Catch-Per-Effort of Atlantic Tomcod by Bottom Trawl, near Roseton, 1976

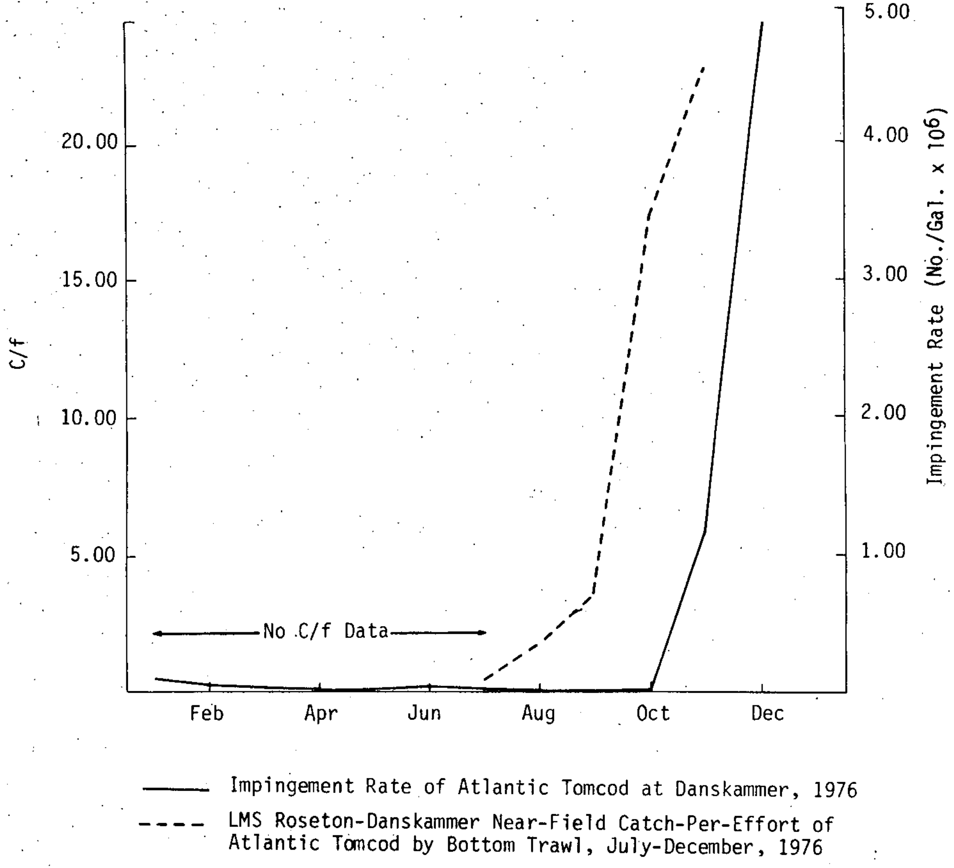

Figure V-104. Impingement Rate of Atlantic Tomcod at Danskammer and Catch-Per-Effort of Atlantic Tomcod by Bottom Trawl near Danskammer 1976

4) Overall Exposure

During their first year of life, juvenile and mature Atlantic tomcod exhibit movement patterns that affect their exposure to power plants. During the summer, most juveniles inhabit the lower river regions and thus are most exposed to the Bowline plant. Impingement rates at Bowline indicates a peak in impingement rates in June and during the fall. Bottom trawl catches increase near Indian Point in July and August and impingement of tomcod increases almost simultaneously. During the winter spawning run, impingement rises at all the plants, especially at Roseton and Danskammer with the highest impingement observed at the Danskammer plant in December. Impingement at Roseton does not increase to as high a level as it does at Danskammer, indicating that some factors other than distribution cause tomcod to be more susceptible to Danskammer than Roseton. Overall, exposure to impingement at Bowline and Indian Point in the summer and at Roseton and Danskammer during December is high, and exposure to Lovett is moderate from December through February. The increase in impingement during the winter at all the plants suggests that some behavioral change associated with either the spawning run or cold water temperatures, but unrelated to the actual location of the spawning areas, causes an increase in the exposure of maturing tomcod to the power plants.

4. Exposure of Mature Fish to Effects of Power Plants

a. Distribution Relative to Power Plants

Atlantic tomcod migrate upstream from the lower part of the Hudson River estuary and its surrounding bays to spawn during the winter months. The population is concentrated below most power plant regions during most of the year and not exposed to impingement. However, during the spawning run, they become exposed to impingement even at the power plants which were farthest upriver. Adults move through the Bowline, Lovett, and Indian Point plant regions to reach the spawning area and pass these plants again when they return to the lower bays. Box trap catches from regions below the spawning area suggest that the movement occurs in deep water (see Subsection V.D.2.). Therefore their exposure to impingement at the Bowline plant was less than that at the Lovett and Indian Point plants. The 1976-1977 spawning run extended upriver to at least the Poughkeepsie region exposing Atlantic tomcod vulnerable to impingement at both Roseton and Danskammer.

b. Trends in Exposure

The extension of the spawning area of Atlantic tomcod further upriver during 1976-1977 was the major difference in distribution among the three spawning runs (1974-1975, 1975-1976, and 1976-1977). Exposure to impingement at the Roseton and Danskammer plants was therefore greater during the 1976-1977 spawning period than the previous two. The impingement rate of Atlantic tomcod and the estimated total number impinged was higher in December 1976 than December 1974 and 1975 (Central Hudson 1977). Exposure to the other plants was similar for all years and differences in the actual numbers impinged at these plants probably reflect differences in the size of the spawning populations.

c. Overall Exposure Assessment

Due to the early maturation of Atlantic tomcod, the overall exposure of juvenile and older tomcod to power plants is discussed in Subsection D.1.4.

SECTION VI
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APPENDIX A

Appendix A contains details related to the field and laboratory procedures described in Section III.

APPENDIX A

QUALITY ASSURANCE AND CONTROL

Inspection of selected tasks was instituted for Consolidated Edison's Hudson River studies to afford protection from exceeding an acceptable quality level (AQL) designated by the client, and to provide the data necessary to signal introduction of unwanted variables. The ability to distinguish unusual variability, indicative of change in the process, from the typical variability of ordinary conditions, provides the stimuli for initiation of systematic actions directed toward returning the process to a state of control. If a process is in control, the application of an inspection plan will ensure an average outgoing quality level (AOQ) which is less than the average incoming defect rate (Duncan 1974).

Inspection and monitoring of incoming defect rates was accomplished through application of the following quality control (QC) systems.

- Single-level continuous sampling procedures and tables for inspection by attributes (MIL-STD 1235)
- 100 percent inspection of field-coded data sheets
- Zero fraction defective sampling by attributes

The latter can be described as an inspection system with a lot tolerance proportion defective (LTPD) set at zero with an AOQ limit of 5 percent. The MIL-STD (Military Standard) inspection system was applied with an AOQ limit of 10 percent. All field-coded data were inspected (100 percent) since volume and complexity were considered high and variable. All defects encountered throughout the program were corrected. Appendix Table A-1 indicates those tasks inspected during 1976.

Overall administration and surveillance of QC activity was conducted by a staff functioning in accordance with the intent and guidelines of 10 CFR 50 (NRC guide). In addition, TI's quality system was designed to comply with the requirement specified in MIL-Q-9858A (Quality Program Requirements). The goal of TI quality assurance activities were to provide the necessary direction and control of quality in operation and to provide an end product fit for use as intended.

Table A-1

Laboratory Tasks Inspected during 1976 Sampling Season

Inspection System	Task
Non-Systematic	Biological Characteristics a. Stomach Contents b. Aging
	Impingement a. Total Count/Identification b. Finclip/Mark Verification
MIL-STD 1235	Water Quality
100% Inspection	All Field-Coded Data
Zero Fraction Defective	Ichthyoplankton a. Total Count/Identification b. Sorting by Life Stage
	Fisheries Field-Lab a. Total Count/Identification b. Finclip/Mark Verification

Table A-2

Ichthyoplankton Surveys Conducted in Hudson River Estuary (RM 14-140 [KM 22-244]) during 1976

	Survey No.	Dates	River Miles (Kilometers)	Time*
Larval Atlantic Tomcod Survey	1	23-27 Feb	66-14 (105.6-22.4)	Day
	2	1-5 Mar	76-14 (121.6-22.4)	Day
	3	8-11 Mar	75-20 (120.0-32.0)	Day
	4	22-25 Mar	74-14 (118.4-22.4)	Day
	5	5-8 Apr	71-16 (113.6-25.6)	Day
Longitudinal Ichythyoplankton River Survey	6	19-21 Apr	130-14 (208.0-22.4)	Day
	7	26-29 Apr	140-14 (224.0-22.4)	Day
	8	3-5 May	130-14 (208.0-22.4)	Day
	9	10-13 May	128-15 (204.8-24.0)	Day
	10	17-19 May	131-15 (209.6-24.0)	Day
	11	24-26 May	130-14 (208.0-22.4)	Day
	12	1-4 Jun	130-16 (208.0-25.6)	Night
	13	7-11 Jun	130-15 (208.0-24.0)	Night
	14	14-17 Jun	130-15 (208.0-24.0)	Night
	15	21-24 Jun	130-16 (208.0-25.6)	Night
	16	28 Jun-1 Jul	126-14 (201.6-22.4)	Night
	17	6-9 Jul	126-14 (201.6-22.4)	Night
	18	12-15 Jul	136-15 (217.6-24.0)	Night
	19	26-29 Jul	129-15 (206.4-24.0)	Night
	20	10-13 Aug	126-14 (201.6-22.4)	Night
Fall Shoal Survey	21	16-20 Aug	75-14 (120.0-22.4)	Night
	22	30 Aug-3 Sep	74-15 (118.4-24.0)	Night
	23	13-16 Sep	76-15 (121.6-24.0)	Night
	24	27 Sep-1 Oct	61-16 (110.4-25.6)	Night
	25	11-14 Oct	76-15 (121.6-24.0)	Night
	26	25-28 Oct	74-14 (118.4-22.4)	Night
	27	8-12 Nov	76-14 (121.6-22.4)	Night
	28	21-24 Nov	74-15 (118.4-24.0)	Night
	29	6-8 Dec	76-14 (121.6-22.4)	Night

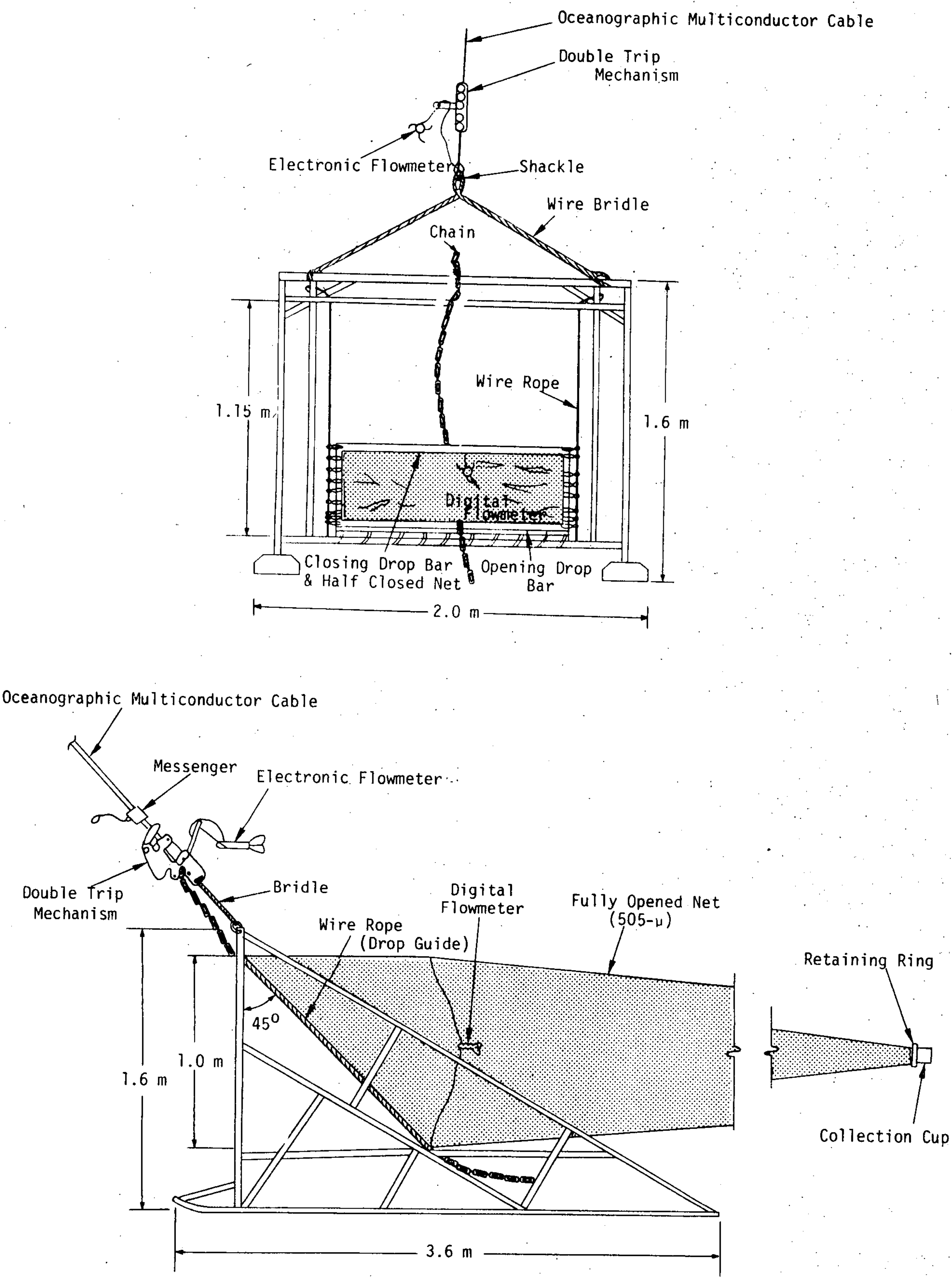


Figure A-1. Epibenthic Sled, Front View (top) and Side View (bottom)

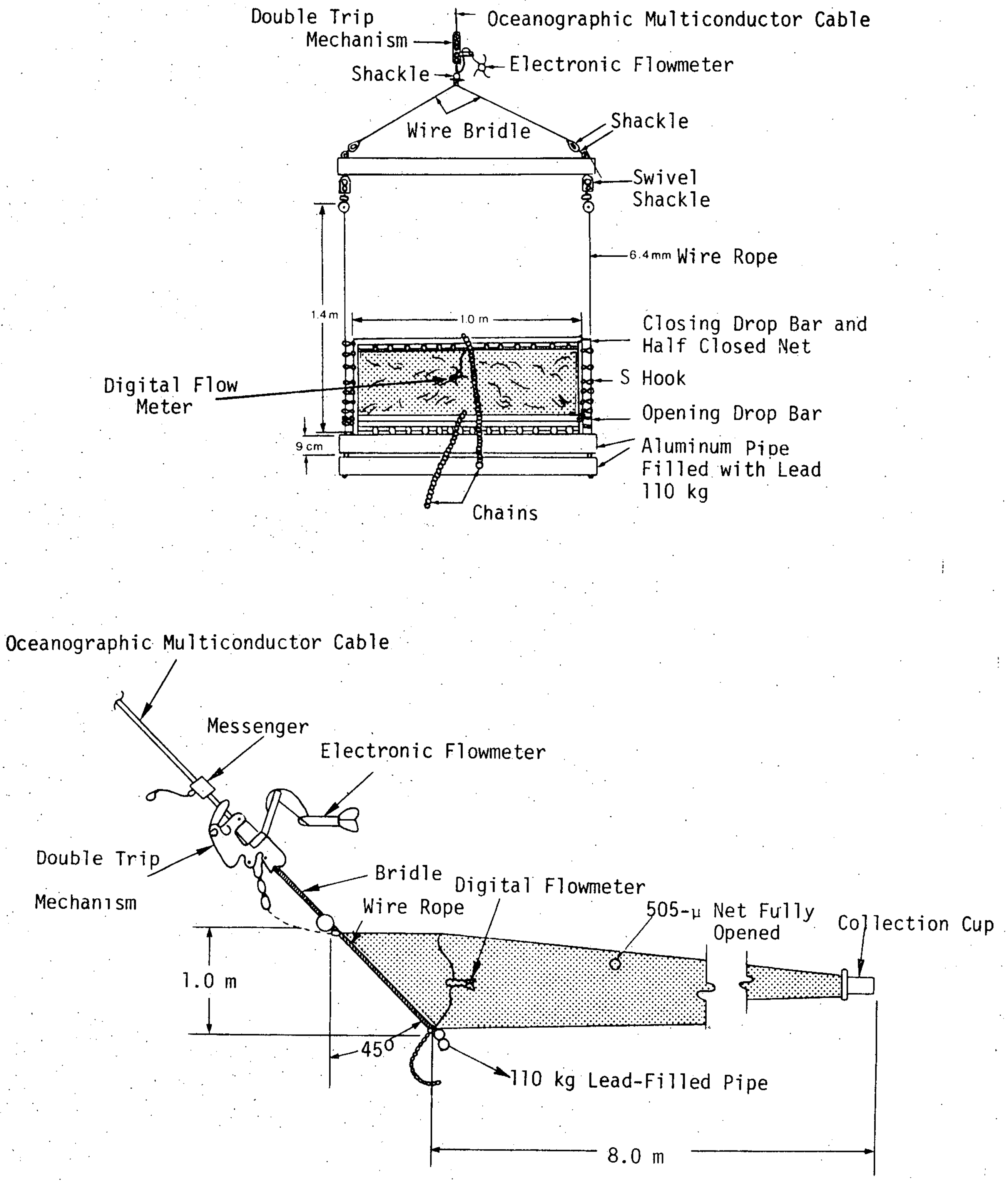


Figure A-2. Tucker Trawl, Front View (top) and Side View (bottom)

Table A-3

Details of Plankton Nets Used during Ichthyoplankton Surveys in the Hudson River Estuary during 1976

Size (micron)	Aperture	Weave	Material	Net Design	Open-Area Ratio*	Modification	Estimated Filtration Efficiency (%)
505	Square	Plain	Nytex	Truncated pyramid	8	None	95
3000	Hexagonal	Twist-locking braid	Knotless nylon	Truncated pyramid	5	Conical fyke cod-end extending 7 ft beyond net	95 to fyke; 100+ through fyke

*Ratio of area of filtering surface to area of mouth

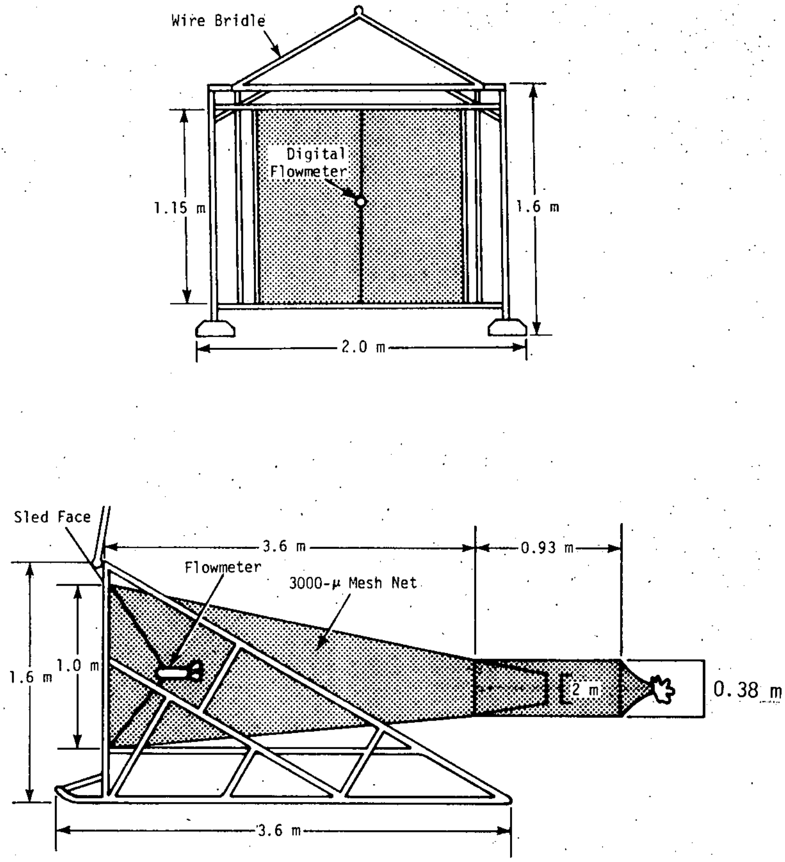


Figure A-3. Epibenthic Sled Used for 1976 Fall Shoal Survey, Front View (top) and Side View (bottom).

Table A-4

Description of Sampling Gear Used by Texas Instruments during 1976

Beach Seine	
Length	100 feet (30.5 m)
Wing	40.0 ft x 8.0 ft (12.2 m x 2.4 m) 0.375-in. (9.5-mm) mesh
Bunt	20.0 ft x 10.0 ft (6.1 m x 3.0 m) 0.25-in. (6.4-mm) mesh
Surface Trawl	
Total length	49.2 ft (15 m)
First section	6.9 ft (2.1 m), 1.7-in. (4.3-cm) mesh
Second section	10.8 ft (3.3 m), 1.4-in. (3.5-cm) mesh
Third section	9.8 ft (3.0 m), 1.2-in. (3.0-cm) mesh
Fourth section	12.1 ft (3.7 m), 1.0-in. (2.5-cm) mesh
Cod end	9.5 ft (2.9 m), 0.2-in. (4.0-mm) mesh
Head rope	17.4 ft (15.0 m)
Head rope float-size	4.7 in. x 5.5 in. (12.0 cm x 14.0 cm)
Number of floats	8
Spreader bar length	10.0 ft x 1.2 in. (3.28 in. x 33.0 mm)
Spreader bar float size	6.3 in. x 15.7 in. (16.0 cm x 40.0 cm)
Foot rope	17.4 ft (5.3 m)
Weights	38, 9-link tickler chains of 0.2-in. (0.6-cm) galvanized chain
Bottom Trawl	
Total length	44.3 ft (13.5 m)
First section	32.8 ft (10.0 m), 1.5-in. (3.8-cm) mesh
Cod end	11.5 ft (3.5 m), 1.3-in. (3.2-cm) mesh
Fine mesh liner	9.6-in. (1.6-cm) stretch
Cod end cover	21.8 ft (6.7 m), 0.5-in. (12.5-mm) mesh
Chafing cloth (interregional Bottom Trawl Survey only)	9.8 ft x 22.0 ft (3.0 m x 6.7 m)
Trawl doors	
Standard stations	1.25 ft x 2.5 ft (0.4 m x 0.8 m)
Interregional Bottom Trawl Survey	2.5 ft x 4.0 ft (0.8 m x 1.2 m)

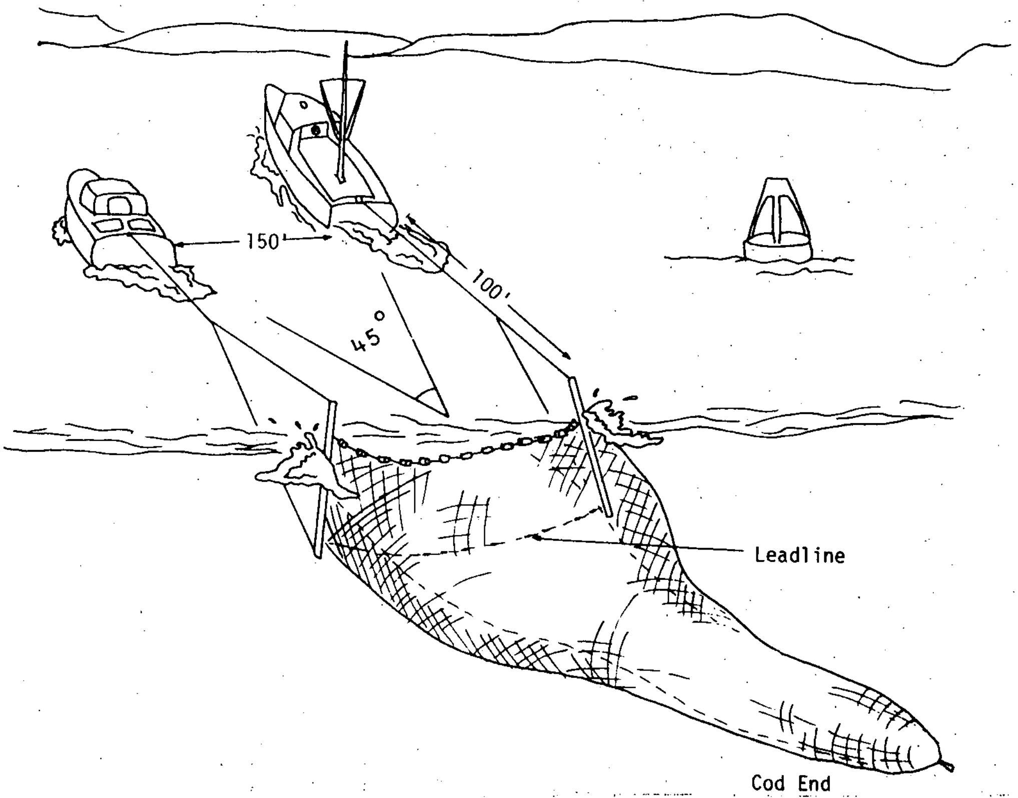


Figure A-4. Standard Station Surface Trawl

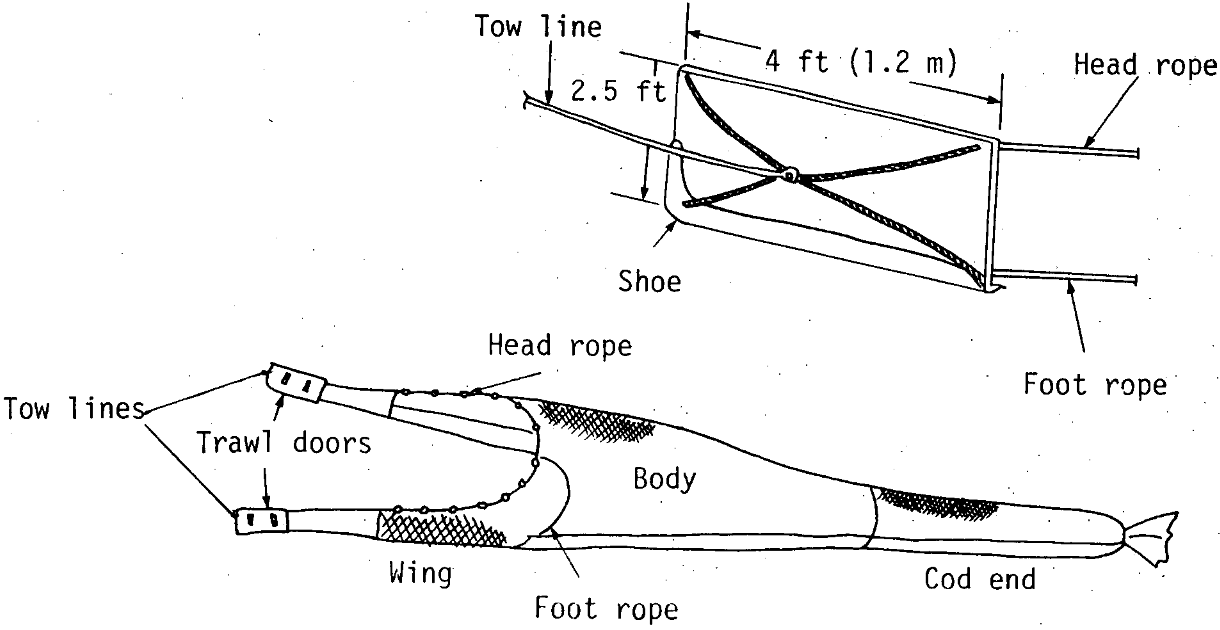


Figure A-5. Otter-Type Bottom Trawl and Trawl Door

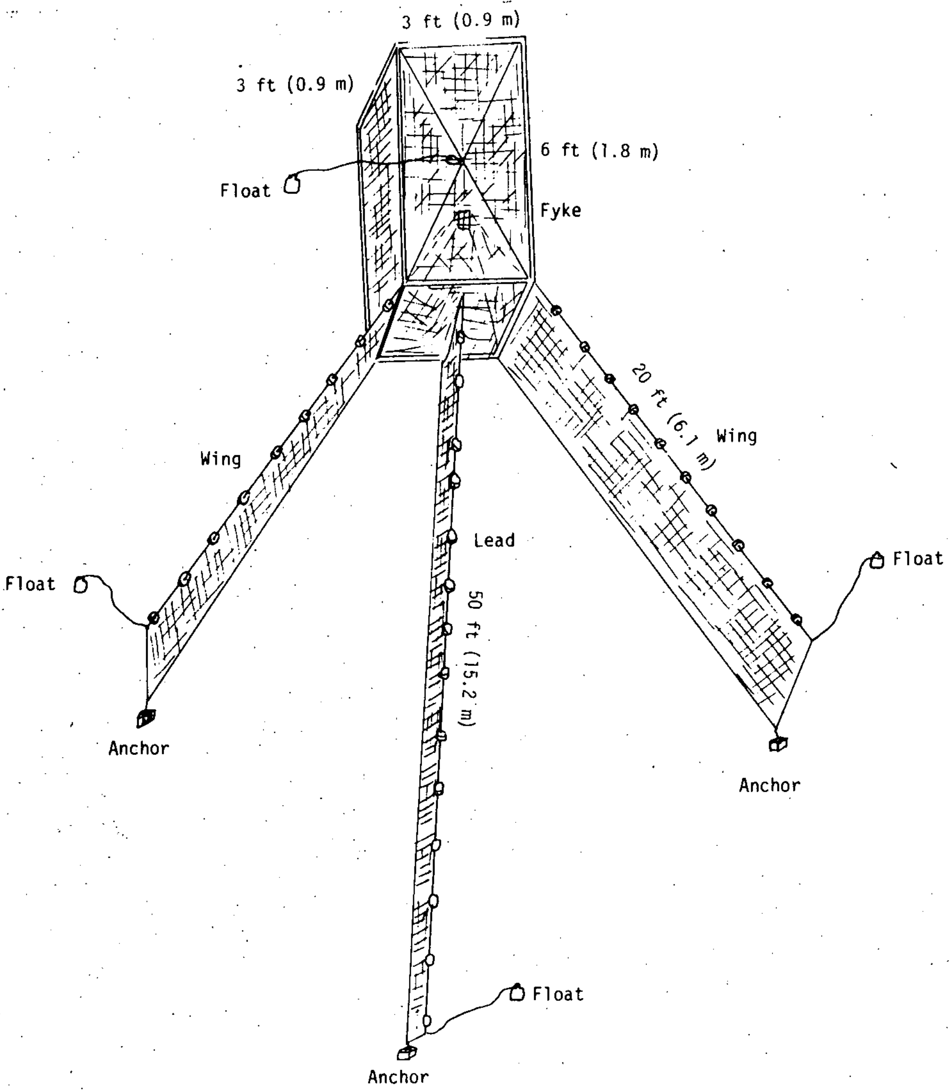


Figure A-6. Set Box Trap with Lead and Wings for Fisheries Mark-Recapture Program

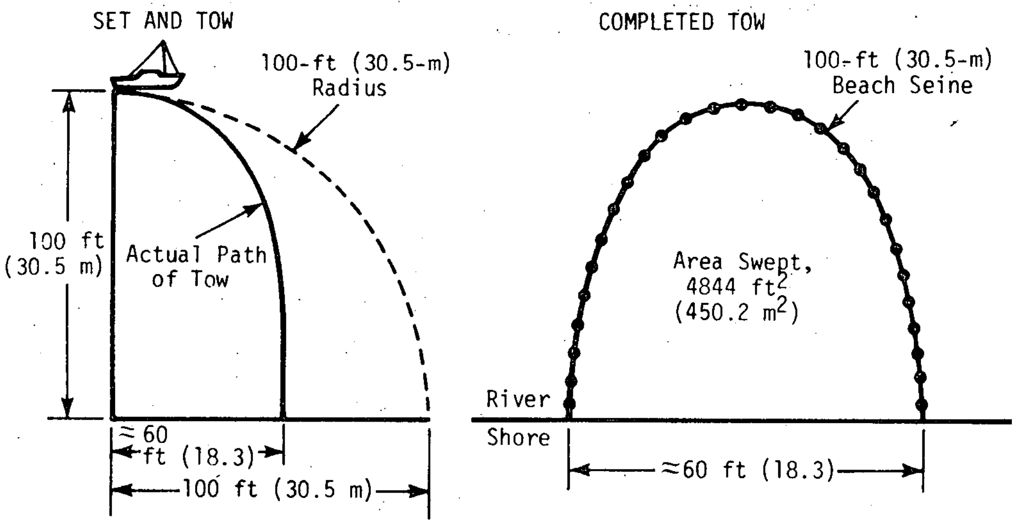
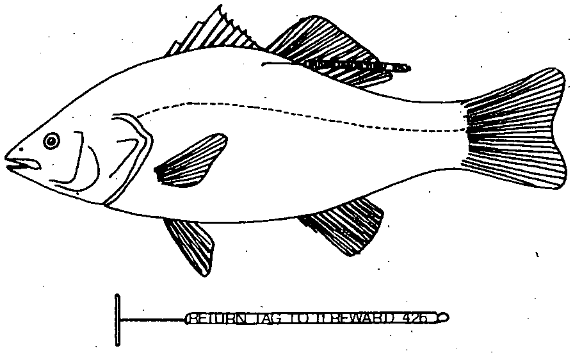
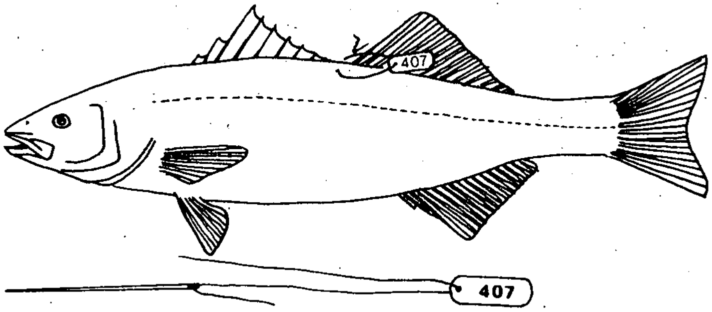


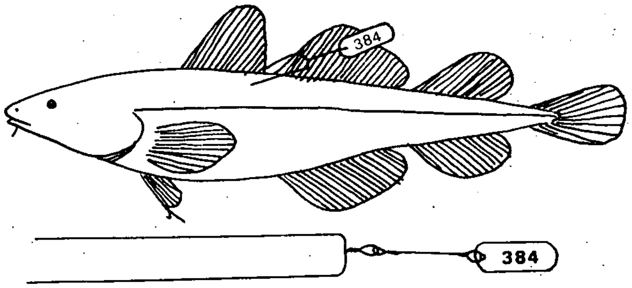
Figure A-7. Deployment of 100-Ft Beach Seine Used in 1975 Beach Seine Survey and Standard Station Program



Adult ($\geq$150 mm TL) White Perch With An Internal Anchor Tag; Also Used On Striped Bass $\geq$250 mm TL.



Juvenile Striped Bass (<250 mm TL) With Fingerling Tag; Also Used On Juvenile White Perch (<150 mm TL).



Adult Tomcod With Carlin Tag

Figure A-8. Tag Types, Area of Application and Categories of Fish Utilizing Tags

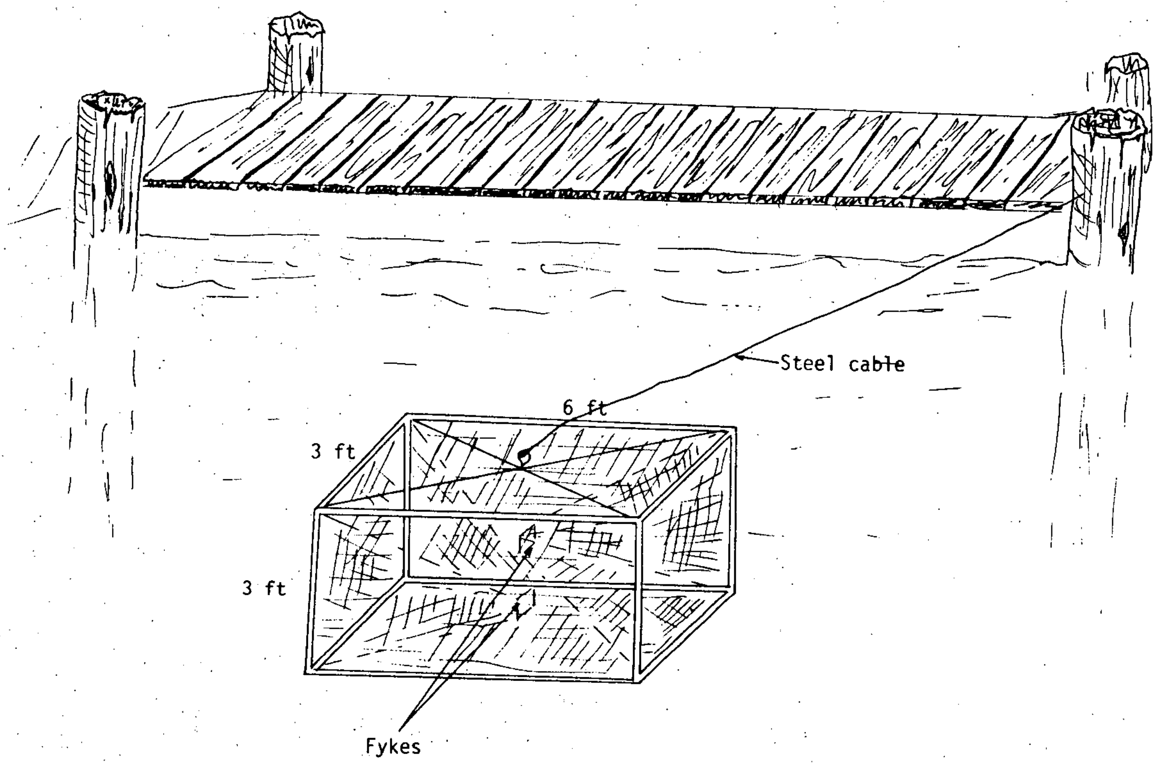


Figure A-9. Box Trap for Atlantic Tomcod Collection

Table A-5

Dimensions of Typical Gill Nets Used by TI and the Four TI Contracted Commercial Fishermen on the Hudson River during 1976

	Stretch Mesh (Inches)	Length (Feet)*	Gill Net Type	Depth (Feet)
TI Gill Nets	4	300	anchored multifilament	8
	4-1/2	300	anchored multifilament	8
	5	300	anchored multifilament	8
	6	300	anchored multifilament	8
	7	300	anchored multifilament	8
	4-1/2	300	anchored monofilament	8
	5	300	anchored monofilament	8
	6	300	anchored monofilament	8
	8	300	anchored multifilament	8
	5-1/2	300	drift multifilament	12
Commerical Fishermen				
Fisherman A	4-1/2	200	staked monofilament	15
Nyack-Tappan Zee Bridge Area (RM 27)	4-3/4	200	staked monofilament	15
	5-1/2	200	staked monofilament	15
	5-1/2	200	staked **multifilament**	15
	5-1/2	800	staked multifilament	15
	5-1/2	3000	staked multifilament	15
	5-1/2	2000	staked multifilament	15
	5-1/2	1600	staked multifilament	15
	5-1/2	1200	staked multifilament	15
	5-1/2	600	staked multifilament	15
	5-1/2	1400	staked multifilament	15
	5-1/2	2800	staked multifilament	15
	5-1/2	1000	staked multifilament	15
	5-1/2	400	staked multifilament	15
Fisherman B	4-5/8	600	staked multifilament	12
Haverstraw Bay (RM 38)	5-3/8	250	anchored multifilament	30
	5-1/2	300	anchored multifilament	30
	5-1/2	600	anchored multifilament	30
	5-1/2	150	anchored multifilament	30
	5-1/2	270	anchored monofilament	30
	6	75	anchored monofilament	30
	7	300	anchored multifilament	30
	8-1/2	90	anchored multifilament	30
	12	300	anchored multifilament	30
Fisherman C	6	300	staked multifilament	12
Garrison Area (RM 52)	6	600	staked multifilament	12
Fisherman D	5-1/2	900	drift multifilament	26
New Hamburg Area (RM 66)				

*Several individual nets were often strung together in a series.

Table A-6

Water Quality Parameters Taken/Biological Sample Depth*, Field or Laboratory Determination+ and Instrumentation Used to Determine Sample Values** during 1976

Task	Sample Depth	Water Quality Parameters Taken/Biological Sample				
		Water Temperature	pH	D.O.	Conductivity	Turbidity
Standard Station Surface and Bottom Trawl, and Long River Bottom Trawl	S,M,B	F(a)	F(a)	F(a)	F(a)	L(i)
Standard Station and Long River Beach Seine	S	F(b)	L(g)	F(b)	L(h)	L(i)
Mark/Recapture						
-Epibenthic Sled	B	F(f)	L(g)	--	L(h)	L(i)
-Bottom Trawl	S,M,B	F(a)	F(a)	F(a)	F(a)	L(i)
-Beach Seine, Box Trap, Gill Net, or other Gear Types	S	F(b)	L(g)	F(b)	L(h)	L(i)
Stock Assessment						
-Gill Net)	M	F(f)	L(g)	--	L(h)	L(i)
-Haul Seine)	S					
Ichthyoplankton/ Fall Shoals	SD/B	F(c)	F(d)	F(c)	F(e)	L(i)

*S = Surface
M = Middle
B = Bottom
SD = Sample Depth

+F = Field Determination
L = Laboratory Determination

**(a) Hydrolab Surveyor Model 6D In Situ Water Quality Analyzer. Reserve Equipment:
YSI Model 57 Dissolved Oxygen Meter
YSI Model 33 S-C-T Meter
(b) YSI Model 54 or 57 Dissolved Oxygen Meter
(c) Weston and Stack Model 330 or 300 Dissolved Oxygen Analyzer***
(d) Instrument Laboratories, Inc. IL 175 Porto-matic pH meter
(e) YSI Model 33 S-C-T Meter
(f) Mercury Thermometer
(g) Sargent-Welch Model PBL or LSX pH Meter
(h) YSI Model 31 Conductivity Bridge
(i) Hach Model 2100-A Laboratory Turbidimeter

*** (a mercury thermometer is used if a temperature response time problem is encountered with the instrument)

Table A-7

Monthly and Yearly Mean Values for Fresh Water Release (Fresh Water Release in CF/S) at Green Island, N.Y. (Hudson River Basin, U.S.G.S.) and Hudson River Water Temperature (Water Temp. °C) [Poughkeepsie Water Works], 1966-1976

	MONTHLY MEAN VALUES												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Mean Values
1966 Fresh Water Release	8130	11628	23090	15627	18406	8270	3674	4233	5630	5847	7042	9118	10055
Water Temp.	1.5	1.1	2.5	7.7	12.9	20.2	25.6	25.4	23.0	16.4	11.4	4.8	12.8
1967 Fresh Water Release	9616	7633	11364	30937	17061	6197	5075	5749	4934	6973	11742	16509	11149
Water Temp.	1.5	1.1	1.2	6.3	11.8	19.2	24.5	25.5	22.3	18.4	9.7	2.6	12.1
1968 Fresh Water Release	8867	9513	24862	18299	18487	15707	9795	4440	4463	5173	14400	15597	12467
Water Temp.	1.2	1.5	2.8	10.7	15.8	20.0	23.6	25.4	22.5	19.7	11.0	2.7	13.1
1969 Fresh Water Release	11683	12762	17466	40730	20913	9995	5430	6102	4133	4856	14271	11801	13307
Water Temp	1.1	1.6	2.0	8.0	14.8	21.0	24.1	24.8	23.1	17.8	9.6	2.8	12.6
1970 Fresh Water Release	8206	15336	15059	39347	14546	6387	5997	3923	6165	8186	9333	11386	11925
Water Temp.	1.0	1.1	2.0	7.1	15.4	21.0	23.5	26.0	22.9	18.0	11.3	3.5	12.8
1971 Fresh Water Release	9002	12111	20216	37273	35239	7334	6233	8929	9315	7811	7291	16998	14830
Water Temp.	0.7	0.8	1.9	6.8	11.7	20.0	24.7	25.0	22.4	17.8	11.8	3.5	12.3
1972 Fresh Water Release	13412	10928	26861	37963	40522	29630	18379	7616	6309	7291	26152	27010	21006
Water Temp.	1.0	0.6	1.7	6.0	12.9	19.3	22.4	24.3	22.9	16.2	7.2	1.6	11.4
1973 Fresh Water Release	26213	20464	29413	30957	27603	13053	10390	5591	4791	5650	8280	26419	17411
Water Temp.	0.8	0.6	3.6	8.6	13.9	20.1	23.7	24.8	23.7	18.0	10.5	4.0	12.8
1974 Fresh Water Release	22010	18639	20732	30167	22964	8791	11784	6359	10388	9049	17177	19381	16434
Water Temp.	0.9	0.8	3.3	7.8	14.4	19.0	22.9	24.4	21.1	13.9	8.5	1.8	11.6
1975 Fresh Water Release	19068	19371	23684	25583	19999	12973	7464	8966	17027	23400	22497	18784	18211
Water Temp.	1.3	1.2	3.6	6.9	14.6	21.2	24.9	25.0	20.8	14.6	10.4	3.4	12.4
1976 Fresh Water Release	14739	31255	31687	36757	31800	15223	15277	14631	9573	23235*	17930*	14078*	21349*
Water Temp.	0.6	1.2	3.7	8.6	13.2	19.6	24.5	23.3	21.7	13.8	5.5	1.3	11.4
Mean Fresh Water Release 1966-76	13722	15422	22221	31240	24322	12142	9045	6958	7521	9770	14192*	17007*	15297*
Mean Fresh Water Temp. 1966-76	1.1	1.1	2.6	7.7	13.8	20.1	24.0	24.9	22.4	16.8	9.7	2.9	12.3

*Provisional

APPENDIX B

Appendix B contains details, supportive data, and analyses related to the discussions of life histories and population dyanmics in Section IV.

Table B-1

Food Items of Striped Bass Collected[*] in Beach Seines from RM 39-46 (KM 62-74) during April-November 1974

Food Item[**]	No. Stomachs Containing Food Item	No.	Mean	S.E.	Mean Percent Frequency	S.E. for Percent Frequency
Bay anchovy	9	18	0.06	0.02	1.14	0.50
Banded killifish	6	14	0.04	0.02	1.14	0.52
Mummichog	2	4	0.01	0.01	0.63	0.45
Blueback herring	2	2	0.01	0.00	0.47	0.35
Striped bass	1	1	0.00[***]	0.00	0.32	0.32
Atlantic tomcod	18	29	0.09	0.02	4.70	1.16
Clupeid	11	20	0.06	0.02	3.17	0.96
Morone	1	2	0.01	0.01	0.32	0.32
Centrarchid	1	2	0.01	0.01	0.32	0.32
Fish remains	24	28	0.09	0.02	4.62	1.09
Chaoborus (L)	1	1	0.00	0.00	0.03	0.03
Chironomid (L)	58	196	0.62	0.20	4.16	0.74
Chironomid (P)	17	40	0.13	0.04	1.92	0.62
Odonata (J)	1	3	0.01	0.01	0.16	0.16
Coleoptera (J)	2	2	0.01	0.00	0.01	0.01
Trichoptera (J)	1	1	0.00	0.00	0.06	0.06
Homoptera	1	1	0.00	0.00	0.01	0.01
Corixidae	1	1	0.00	0.00	0.02	0.02
Insect remains	2	2	0.01	0.00	0.18	0.16
Diptera (L)	4	198	0.62	0.44	0.74	0.41
Diptera (P)	5	29	0.09	0.05	0.24	0.13
Crangon	11	24	0.08	0.03	1.61	0.62
Palaemonetes pugio	1	1	0.00	0.00	0.06	0.06
Rhithropanopeus	15	41	0.13	0.04	2.00	0.64
Decapoda	1	1	0.00	0.00	0.32	0.32
Gammarus	181	2168	6.84	0.72	41.12	2.42
Monoculodes	13	44	0.14	0.09	0.83	0.32
Corophium	42	121	0.38	0.11	4.59	0.96
Chirodotea	10	14	0.04	0.02	0.52	0.33
Cyathura	52	114	0.36	0.06	6.06	1.09
Cassidina	5	10	0.03	0.02	0.21	0.12
Lironeca ovalis[+]	1	1	0.00	0.00	0.32	0.32
Neomysis	8	143	0.45	0.31	1.48	0.60
Leptocheirus	29	181	0.57	0.25	3.71	0.90
Isopod	2	2	0.01	0.00	0.08	0.06
Harpacticoida	8	110	0.35	0.18	0.60	0.34
Cyclopoida	9	769	2.43	1.43	0.76	0.41
Calanoida	25	16190	51.07	36.94	6.56	1.32
Cladocera	2	1180	3.72	3.72	0.63	0.44
Nemertea	1	22	0.07	0.07	0.28	0.28
Oligochaeta	1	1	0.00	0.00	0.32	0.32
Polychaeta	23	229	0.72	0.35	3.46	0.87

---

[*] Total number of stomachs examined = 428; empty stomachs = 76; number of stomachs in which at least one countable food item was present = 317.

[**] Adult unless otherwise indicated.
(L) = Larvae
(P) = Pupae
(J) = Juvenile

[***] A mean and/or S.E. (standard error) of 0.00 indicates the value is <0.005.

Number of Occurrences of Uncountable Food Items.

Food Item	Number
Fish remains	5
Filamentous algae	9
Animal remains	63
Plant remains	13
Detritus	21

[+] *Livoneca ovalis* in previous TI reports.

Table B-2

Beach Seine Information from Ecological Survey Subsets of Historical Data Base Used to Assess Annual Fluctuation in Juvenile Striped Bass and White Perch Abundance, Hudson River 1965-1976

Study (Data Base Subset)	Year	Month Sampled	Length (ft)†	Mesh Size	Deployment Method	Sampling Station		Shore
						Identification Number	River Mile††	
New York University (NYU)	1965	Jun Jul Aug	50 (15.2)	0.38-in. stretch	Pulled parallel to shoreline from distance offshore where depth ≤4 ft (1.2 m)	IW3	27 (43)	West
						IIW1	41 (66)	West
						IIW2	45 (72)	West
						IIW2A	57 (91)	West
						IIIW2	68 (109)	West
						IVW1	87 (139)	West
						IVW2	96 (154)	West
						IVW3	101 (161)	West
						IVW4	105 (168)	West
	1966	Jun Jul Aug	50 (15.2)	0.38-in. stretch	Pulled parallel to shoreline from distance offshore where depth ≤4 ft (1.2 m)	IW3	27 (43)	West
						IIW1	41 (66)	West
						IIE1	41 (66)	East
						IIE3	44 (70)	East
						IIW2	45 (72)	West
						IIW2A	57 (91)	West
						IIIW2	68 (109)	West
						IVW1	87 (139)	West
						IVW2	96 (154)	West
						IVW3	101 (161)	West
						IVW4	105 (168)	West
	1967	Jun Jul Aug	50 (15.2)	0.38-in. stretch	Pulled parallel to shoreline from distance offshore where depth ≤4 ft (1.2 m)	IW3	27 (43)	West
						IIW1	41 (66)	West
						IIW2	45 (72)	West
						IIW2A	57 (91)	West
						IIIW2	68 (109)	West
						IVW1	87 (139)	West
						IVW2	96 (154)	West
						IVW3	101 (161)	West
						IVW4	105 (168)	West
	1968	Apr* May* Jun Jul Aug Sep* Oct* Dec*	50 (15.2)	0.38-in. stretch	Pulled parallel to shoreline from distance offshore where depth ≤4 ft (1.2 m)	IW3	27 (43)	West
						IIE1	41 (66)	East
						IIW1	41 (66)	West
						IIW2	45 (72)	West
						IIW2A	57 (91)	West
						IIIW2	68 (109)	West
						IVW1	87 (139)	West
						IVW2	96 (154)	West
						IVW3	101 (161)	West
						IVW4	105 (168)	West
	1969	Apr May Jun Jul Aug Sep Oct	50 (15.2)	0.38-in. stretch	Pulled parallel to shoreline from distance offshore where depth ≤ 4 ft (1.2 m)	IIE1	41 (66)	East
						IIW1	41 (66)	West
						IIW2A	57 (91)	West
						IVW1	87 (139)	West

*Only stations IIW1 and IIE1 sampled in these months
†Numbers in parentheses indicate meters
††Numbers in parentheses indicate kilometers

Table B-2 (Contd)

Study (Data Base Subset)	Year	Month Sampled	Length (ft)†	Mesh Size	Deployment Method	Sampling Station		Shore
						Identification Number	River Mile††	
Raytheon (RAY) Studies in Vicinity of Indian Point	1969	Jun	75 (22.9) until Sep 10, then 100 (30.5)	0.25-in. bar → 75 ft 0.38-in. bar (wings) 100 ft 0.25-in. bar (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	31	35 (56)	West
		Jul				32	35 (56)	East
		Aug				33	40 (64)	East
		Sep				34	42 (67)	East
		Oct				35	43 (69)	West
		Nov				36	44 (70)	East
		Dec				37	47 (75)	West
						38	40 (64)	West
						39	41 (66)	East
	1970	Apr	100 (30.5)	0.38-in. bar (wings) 0.25-in. bar (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	31	35 (56)	West
		May				32	35 (56)	East
		Jun				33	40 (64)	East
		Jul				34	42 (67)	East
		Aug				35	43 (69)	West
		Sep				36	44 (70)	East
		Oct				37	47 (75)	West
						38	40 (64)	West
						39	41 (66)	East
Texas Instruments (TI) Hudson River Ecological Study	1972	Apr	75 (22.9) at station 6, 7, 7A 100 (30.5) at station 8-12	0.5-in. stretch→75 ft 0.75-in. stretch (wings) 100 ft 0.5-in. stretch (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	6	35 (56)	East
		May				7	32 (51)	East
		Jun				7A	34 (54)	East
		Jul				8	43 (69)	East
		Aug				9	42 (67)	West
		Sep				10	42 (67)	East
		Oct				11	40 (64)	West
		Nov				12	40 (64)	East
		Dec						
Texas Instruments (TI)	1973	Apr	100 (30.5)	0.75-in. stretch (wings) 0.5-in. stretch (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	8	43 (69)	East
		May				9	42 (67)	West
		Jun				10	42 (67)	East
		Jul				11	40 (64)	West
		Aug				12	40 (64)	East
		Sep						
		Oct				Plus random-site beach seine survey	12-152 (19-243)	East and West
		Nov						
		Dec						
	1974	Apr	100 (30.5)	0.75-in. stretch (wings) 0.5-in. stretch (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	8	43 (69)	East
		May				9	42 (68)	West
		Jun				10	42 (68)	East
		Jul				11	40 (64)	West
		Aug				12	40 (64)	East
		Sep				20	40 (64)	East
		Oct				21	40 (64)	East
		Nov				Plus random-site beach seine survey	12-152 (19-243)	East and West
		Dec						
	1975	Apr	100 (30.5)	0.75-in. stretch (wings) 0.5-in. stretch (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	8	43 (69)	East
		May				9	42 (68)	West
		Jun				10	42 (68)	East
		Jul				11	40 (64)	West
		Aug				12	40 (64)	East
		Sep				20	40 (64)	East
		Oct				21	40 (64)	East
		Nov				Plus random-site beach seine survey	12-152 (19-243)	East and West
		Dec						
	1976	Apr	100 (30.5)	0.75-in. stretch (wings) 0.5-in. stretch (bag)	Set perpendicular to shoreline and then towed around in a semicircle to shore	8	43 (69)	East
		May				9	42 (68)	West
		Jun				10	42 (68)	East
		Jul				11	40 (64)	West
		Aug				12	40 (64)	East
		Sep				20	40 (64)	East
		Oct				21	40 (64)	East
		Nov						
		Dec				Plus random-site beach seine survey	12-152 19-243)	East and West

†Numbers in parentheses indicate meters
††Numbers in parentheses indicate kilometers

Table B-3

Adjustment of Juvenile Striped Bass Abundance Index

Beach seine sampling in 1969, 1970, and 1972 was concentrated in the Croton-Haverstraw and Indian Point regions. To make abundance indices from these years comparable to indices from the other years (1965-1968 and 1973-1976) when larger areas of the estuary were sampled, an adjustment factor was developed.

CPUA's from TI's standard station beach seine sites (8, 9, 10, and 11) from mid-July through August were calculated for 1973-1976 and the yearly ratios of the river-wide CPUA (abundance index) to the standard station CPUA were computed as follows:

Year	River-wide CPUA	Standard Station CPUA	RW/SS
1973	28.55	103.39	0.28
1974	9.51	23.93	0.40
1975	18.27	22.39	0.82
1976	11.28	30.13	0.37

A geometric mean of the four ratios was calculated as follows:

$$\sqrt[4]{(0.28)\ (0.40)\ (0.82)\ (0.37)} = 0.43$$

CPUA's from the same four beach seine sites (Raytheon's stations 34, 35, 36, 38 and TIs stations 8, 9, 10, 11) were calculated for the three years to be adjusted, 1969, 1970, and 1972. These standard station CPUA's multiplied by the adjustment factor (0.43) yielded the estimated river-wide abundance indices for the years 1969, 1970, and 1972 as follows:

Year	Standard Station CPUA	Estimated River-wide CPUA
1969	71.44 x 0.43 =	30.72
1970	37.01 x 0.43 =	15.91
1972	21.46 x 0.43 =	9.23

Table B-4

Friedman Analysis of the July-October Catch per Effort by Beach Seine of Juvenile Striped Bass

Time Period *	Year 1973	1974	1975	1976
1	4.4^{3}**	0.9^{1}	4.7^{4}	2.1^{2}
2	11.2^{4}	3.1^{1}	8.2^{3}	6.4^{2}
3	19.7^{4}	5.1^{1}	5.9^{3}	5.3^{2}
4	13.3^{4}	3.7^{1}	6.4^{3}	5.7^{2}
5	8.2^{3}	6.9^{2}	15.5^{4}	4.6^{1}
6	43.3^{4}	7.4^{2}	8.7^{3}	5.3^{1}
7	31.5^{4}	3.6^{1}	8.1^{3}	6.5^{2}
8	8.8^{4}	3.6^{2}	5.5^{3}	3.2^{1}
9	9.9^{4}	5.1^{3}	2.6^{1}	3.1^{2}
Sum of Ranks	34	14	27	15

*Dates used for July-October of each year are as follows:

1973	7/1-11/3
1974	6/30-11/2
1975	6/29-11/1
1976	6/27-10/30

**CPUE's were ranked across years

Table B-5

Distribution - Free Multiple Comparison Using Friedman Rank Sums of Juvenile Striped Bass C/f from July-October, 1973-1976

		1974	1976	1975	1973
Year	Rank	14	15	27	34
1974	14	—	1	13	20*
1976	15		—	12	19*
1975	27			—	7
1973	34				—

*r(0.01, 4, 9) = 17

Table B-6

Yearling and Older Striped Bass Caught in Beach Seines from Mid-July through August, Hudson River Estuary (RM 12-152, KM 19-243)

Date	No. Yearlings	No. Older
1974		
7/14 - 7/27	152	1
7/28 - 8/10	121	4
8/11 - 8/24	202	38
8/25 - 9/07	225	5
1975		
7/13 - 7/26	77	9
7/27 - 8/09	63	4
8/10 - 8/23	41	2
8/24 - 9/06	28	0
1976		
7/11 - 7/24	154	27
7/25 - 8/07	53	17
8/08 - 8/21	75	12
8/22 - 9/04	44	2
Totals	1235	121

$$\text{Percent Yearlings} = \frac{1235}{1356} \times 100 = 91\%$$

Table B-7

Recaptures* of Juvenile Striped Bass Marked September-December 1976 in the Hudson River Estuary

Sampling Period	Total Catch (C)	Recaptured Sep Releases (R_s)	R_s/C	Recaptured Oct Releases (R_o)	R_o/C	Recaptured Nov Releases (R_n)	R_n/C	Total Recaptures (R)	R/C
9/5-9/11	1478	4	0.0027					4	0.0027
9/12-9/18	1750	47	0.0268					47	0.0268
9/19-9/25	1487	94	0.0632					94	0.0632
9/26-10/2	2231	170	0.0762	1	0.0004			171	0.0766
10/3-10/9	1481	170	0.1148	38	0.0256			208	0.1404
10/10-10/16	1604	89	0.0555	35	0.0218			124	0.0773
10/17-10/23	1572	19	0.0121	19	0.0121			38	0.0242
10/24-10/30	826	5	0.0060	13	0.0157			18	0.0217
10/31-11/6	1300	12	0.0092	7	0.0054	2	0.0015	21	0.0162
11/7-11/13	833	3	0.0036	0		1	0.0012	4	0.0048
11/14-11/20	320	0		0		1	0.0031		0.0031
11/21-11/27	491	2	0.0041	0		0			0.0041
11/28-12/4	59								
12/5-12/11	90								
12/12-12/18	90								
12/19-12/25	257								
12/26-12/31	100								

*Data from Fish Collection in TI Field Sampling and Indian Point Impingement Collections Only

Table B-8

Release Data for Juvenile Striped Bass Marked in the Hudson River Estuary, September-November 1976

Release Month		Release Region						
		RM 12-23 (KM 19-37)	RM 24-38 (KM 38-61)	RM 39-46 (KM 62-74)	RM 47-76 (KM 75-122)	RM 77-152 (KM 123-243)	Total	Recapture Rate
Sep	Number marked	778.0	2206.0	1055.0	380.0	30.0	4449.0	
	Survival adjustment	0.95	0.95	0.95	0.95	0.95	0.95	
	Adjusted number marked	739.0	2096.0	1002.0	361.0	28.0	4226.0	
	Recaptured Sep-Dec	76.0	395.0	132.0	14.0	0.0	617.0	0.146
	Marked fish available on 1 Jan	663.0	1701.0	870.0	347.0	28.0	3609.0	
Oct	Number marked	581.0	1583.0	623.0	137.0	6.0	2930.0	
	Survival adjustment	0.77	0.77	0.77	0.77	0.77	0.77	
	Adjusted number marked	447.0	1219.0	480.0	105.0	5.0	2256.0	
	Recaptured Oct-Dec	15.0	89.0	10.0	1.0	0.0	115.0	0.051
	Marked fish available on 1 Jan	432.0	1130.0	470.0	104.0	5.0	2141.0	
Nov	Number marked	673.0	313.0	1133.0	5.0	0.0	2124.0	
	Survival adjustment	0.77	0.77	0.77	0.77	0.77	0.77	
	Adjusted Number marked	518.0	241.0	872.0	4.0	0.0	1635.0	
	Recaptured Nov-Dec	1.0	1.0	3.0	0.0	0.0	5.0	0.003
	Marked fish available on 1 Jan	517.0	240.0	869.0	4.0	0.0	1630.0	

Test results upon which survival adjustments are based are presented in Appendix Table B-41.

Table B-9

Estimated Combined Standing Crops (in Thousands) of Striped Bass Juveniles in the Hudson River Estuary (RM 12-152, KM 19-243) Determined from 20 June - 11 December 1976 Beach Seine, Epibenthic Sled, and Tucker Trawl Sampling. Standing crops are not adjusted for gear efficiency

6/20/76-6/26/76

Region (River Mile)		Shore Zone	Shoal (10 -20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	0*	0	0*	0	0
	SE	0	0	0	0	0
Tappan Zee (24-33)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
Croton-Haverstraw (34-38)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
Indian Point (39-46)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
West Point (47-55)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Cornwall (56-61)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
Poughkeepsie (62-76)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Hyde Park (77-85)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0*	0*	0	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	0	0	0	0	0
	SE	0	0	0	0	0

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

6/27/76-7/3/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	1	0	0*	0	1
	SE	1	0	0	0	1
Tappan Zee (24-33)	SC	178	0	0	0	178
	SE	166	0	0	0	166
Croton-Haverstraw (34-38)	SC	25	0	0	0	25
	SE	13	0	0	0	13
Indian Point (39-46)	SC	18	0	7	0	25
	SE	11	0	7	0	13
West Point (47-55)	SC	78	0***	0	0	78
	SE	43	0	0	0	43
Cornwall (56-61)	SC	29	0	0	0	29
	SE	27	0	0	0	27
Poughkeepsie (62-76)	SC	2	0***	0	0	2
	SE	2	0	0	0	2
Hyde Park (77-85)	SC	0	0***	0	0	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	23	0***	0	0	23
	SE	18	0	0	0	18
Saugerties (94-106)	SC	14	0***	0	0	14
	SE	14	0	0	0	14
Catskill (107-124)	SC	0	0***	0	0	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0***	0	0****	0
	SE	0	0	0	0	0
Stratum Total	SC	368	0	7	0	375
	SE	176	0	7	0	176

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

7/4/76-7/10/76

Region (River Mile)		Shore Zone	Shoal (10 -20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	1	0	0*	216	217
	SE	1	0	0	216	216
Tappan Zee (24-33)	SC	178	171	0	253	602
	SE	166	54	0	253	307
Croton-Haverstraw (34-38)	SC	25	105	21	0	151
	SE	13	50	21	0	56
Indian Point (39-46)	SC	18	8	67	0	93
	SE	11	8	51	0	53
West Point (47-55)	SC	78	0***	0	209	287
	SE	43	0	0	117	125
Cornwall (56-61)	SC	29	70	0	0	99
	SE	27	70	0	0	75
Poughkeepsie (62-76)	SC	2	0***	0	101	103
	SE	2	0	0	101	101
Hyde Park (77-85)	SC	0	0***	0	215	215
	SE	0	0	0	169	169
Kingston (86-93)	SC	23	5***	18	0	46
	SE	18	5	18	0	26
Saugerties (94-106)	SC	14	0***	0	0	14
	SE	14	0	0	0	14
Catskill (107-124)	SC	0	28***	45	0	73
	SE	0	28	45	0	53
Albany (125-152)	SC	0	0***	0	0****	0
	SE	0	0	0	0	0
Stratum Total	SC	368	387	151	994	1900
	SE	176	106	73	404	459

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

7/11/76-7/17/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	119	0	0*	0	119
	SE	31	0	0	0	31
Tappan Zee (24-33)	SC	492	437	84	0	1013
	SE	293	209	84	0	370
Croton-Haverstraw (34-38)	SC	867	125	0	0	992
	SE	594	97	0	0	602
Indian Point (39-46)	SC	77	87	466	0	630
	SE	24	87	393	0	403
West Point (47-55)	SC	46	4***	54	0	104
	SE	21	3	41	0	46
Cornwall (56-61)	SC	320	80	292	0	692
	SE	95	80	155	0	199
Poughkeepsie (62-76)	SC	37	0***	0	0	37
	SE	18	0	0	0	18
Hyde Park (77-85)	SC	17	0***	0	144	161
	SE	11	0	0	102	103
Kingston (86-93)	SC	166	12***	45	47	270
	SE	76	12	45	47	101
Saugerties (94-106)	SC	27	30***	85	0	142
	SE	14	21	59	0	64
Catskill (107-124)	SC	16	0***	0	0	16
	SE	9	0	0	0	9
Albany (125-152)	SC	0	0***	0	0****	0
	SE	0	0	0	0	0
Stratum Total	SC	2184	775	1026	191	4176
	SE	675	260	439	112	854

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

7/18/76-7/24/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	119	0**	0*	0**	119
	SE	31	0	0	0	31
Tappan Zee (24-33)	SC	492	951**	91**	0**	1534
	SE	293	361	75	0	471
Croton-Haverstraw (34-38)	SC	867	424**	286**	0**	1577
	SE	594	154	145	0	631
Indian Point (39-46)	SC	77	103**	272**	14**	466
	SE	24	98	232	14	253
West Point (47-55)	SC	46	2**	27**	0**	75
	SE	21	1	20	0	29
Cornwall (56-61)	SC	320	60**	146**	0**	526
	SE	95	55	77	0	134
Poughkeepsie (62-76)	SC	37	1**	14**	24**	76
	SE	18	1	14	24	33
Hyde Park (77-85)	SC	17	0**	0**	72**	89
	SE	11	0	0	51	52
Kingston (86-93)	SC	166	15**	56**	23**	260
	SE	76	15	56	23	98
Saugerties (94-106)	SC	27	27**	76**	0**	130
	SE	14	19	53	0	58
Catskill (107-124)	SC	16	0**	0**	0**	16
	SE	9	0	0	0	9
Albany (125-152)	SC	0	0**	0**	0**	0
	SE	0	0	0	0	0
Stratum Total	SC	2184	1583	968	133	4868
	SE	675	409	305	62	848

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

7/25/76-7/31/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	138	0	0*	0	138
	SE	29	0	0	0	29
Tappan Zee (24-33)	SC	417	1465	99	0	1981
	SE	159	514	67	0	542
Croton-Haverstraw (34-38)	SC	385	723	572	0	1680
	SE	131	212	291	0	383
Indian Point (39-46)	SC	130	120	78	29	357
	SE	32	110	71	29	138
West Point (47-55)	SC	41	0***	0	0	41
	SE	20	0	0	0	20
Cornwall (56-61)	SC	210	40	0	0	250
	SE	88	31	0	0	93
Poughkeepsie (62-76)	SC	15	2***	29	49	95
	SE	9	2	29	49	58
Hyde Park (77-85)	SC	14	0***	0	0	14
	SE	8	0	0	0	8
Kingston (86-93)	SC	32	18***	68	0	118
	SE	16	18	68	0	72
Saugerties (94-106)	SC	107	24***	68	0	199
	SE	57	17	47	0	76
Catskill (107-124)	SC	46	0***	0	0	46
	SE	24	0	0	0	24
Albany (125-152)	SC	4	0***	0	0****	4
	SE	2	0	0	0	2
Stratum Total	SC	1539	2392	914	78	4923
	SE	238	568	319	57	696

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

8/1/76-8/7/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	138	0**	0*	52**	190
	SE	29	0	0	52	60
Tappan Zee (24-33)	SC	417	993**	106**	0**	1516
	SE	159	340	90	0	386
Croton-Haverstraw (34-38)	SC	385	397**	296**	0**	1078
	SE	131	119	155	0	235
Indian Point (39-46)	SC	130	63**	62**	32**	287
	SE	32	58	46	32	87
West Point (47-55)	SC	41	0**	0**	20**	61
	SE	20	0	0	20	28
Cornwall (56-61)	SC	210	20**	0**	0**	230
	SE	88	15	0	0	89
Poughkeepsie (62-76)	SC	15	1**	14**	24**	54
	SE	9	1	14	24	29
Hyde Park (77-85)	SC	14	0**	0**	0**	14
	SE	8	0	0	0	8
Kingston (86-93)	SC	32	12**	45**	0**	89
	SE	16	12	45	0	49
Saugerties (94-106)	SC	107	12**	34**	0**	153
	SE	57	8	23	0	62
Catskill (107-124)	SC	46	0**	0**	0**	46
	SE	24	0	0	0	24
Albany (125-152)	SC	4	0**	0**	0**	4
	SE	2	0	0	0	2
Stratum Total	SC	1539	1498	557	128	3722
	SE	238	365	192	69	481

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

8/8/76-8/14/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	164	0	0*	105	269
	SE	44	0	0	105	114
Tappan Zee (24-33)	SC	1032	521	114	0	1667
	SE	328	166	114	0	385
Croton-Haverstraw (34-38)	SC	427	71	20	0	518
	SE	93	26	20	0	99
Indian Point (39-46)	SC	144	7	47	36	234
	SE	46	7	22	36	63
West Point (47-55)	SC	14	0***	0	40	54
	SE	5	0	0	40	40
Cornwall (56-61)	SC	122	0	0	0	122
	SE	39	0	0	0	39
Poughkeepsie (62-76)	SC	55	0***	0	0	55
	SE	30	0	0	0	30
Hyde Park (77-85)	SC	4	0***	0	0	4
	SE	2	0	0	0	2
Kingston (86-93)	SC	5	6***	23	0	34
	SE	5	6	23	0	24
Saugerties (94-106)	SC	150	0***	0	0	150
	SE	55	0	0	0	55
Catskill (107-124)	SC	96	0***	0	0	96
	SE	38	0	0	0	38
Albany (125-152)	SC	19	0***	0	0****	19
	SE	15	0	0	0	15
Stratum Total	SC	2232	605	204	181	3222
	SE	357	168	120	118	429

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

Table B-9 (Contd)

8/15/76-8/21/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	164	396	1175****	0*	1735
	SE	44	100	297	0	316
Tappan Zee (24-33)	SC	1032	4823	136	0*	5991
	SE	328	1143	78	0	1192
Croton-Haverstraw (34-38)	SC	427	373	159	0*	959
	SE	93	103	76	0	158
Indian Point (39-46)	SC	144	15	57	0*	216
	SE	46	6	57	0	73
West Point (47-55)	SC	14	0***	0	0*	14
	SE	5	0	0	0	5
Cornwall (56-61)	SC	122	5***	29	0*	156
	SE	39	3	18	0	43
Poughkeepsie (62-76)	SC	55	0***	0	0*	55
	SE	30	0	0	0	30
Hyde Park (77-85)	SC	4	0*	0*	0*	4
	SE	2	0	0	0	2
Kingston (86-93)	SC	5	0*	0*	0*	5
	SE	5	0	0	0	5
Saugerties (94-106)	SC	150	0*	0*	0*	150
	SE	55	0	0	0	55
Catskill (107-124)	SC	96	0*	0*	0*	96
	SE	38	0	0	0	38
Albany (125-152)	SC	19	0*	0*	0*	19
	SE	15	0	0	0	15
Stratum Total	SC	2232	5612	1556	0	9400
	SE	357	1152	322	0	1248

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in **bottom** ; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

8/22/76-8/28/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	174	309**	0*	917**	1400
	SE	36	118	0	351	372
Tappan Zee (24-33)	SC	817	3439**	219**	0*	4475
	SE	245	745	119	0	793
Croton-Haverstraw (34-38)	SC	456	586**	124**	0*	1166
	SE	277	255	73	0	384
Indian Point (39-46)	SC	57	27**	35**	0*	119
	SE	12	8	35	0	38
West Point (47-55)	SC	62	0**	5**	0*	67
	SE	24	0	5	0	25
Cornwall (56-61)	SC	65	2**	14**	0*	81
	SE	24	1	9	0	26
Poughkeepsie (62-76)	SC	21	0**	0**	0*	21
	SE	9	0	0	0	9
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	2	0	0	0	2
Kingston (86-93)	SC	31	0*	0*	0*	31
	SE	7	0	0	0	7
Saugerties (94-106)	SC	27	0*	0*	0*	27
	SE	14	0	0	0	14
Catskill (107-124)	SC	11	0*	0*	0*	11
	SE	6	0	0	0	6
Albany (125-152)	SC	4	0*	0*	0*	4
	SE	3	0	0	0	3
Stratum Total	SC	1728	4363	1314	0	7405
	SE	374	796	380	0	958

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom ; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

8/29/76-9/4/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	174	222	659****	0*	1055
	SE	36	137	406	0	430
Tappan Zee (24-33)	SC	817	2056	303	0*	3176
	SE	245	348	161	0	455
Croton-Haverstraw (34-38)	SC	456	799	89	0*	1344
	SE	277	407	70	0	497
Indian Point (39-46)	SC	57	39	13	0*	109
	SE	12	10	13	0	20
West Point (47-55)	SC	62	1***	10	0*	73
	SE	24	1	10	0	26
Cornwall (56-61)	SC	65	0***	0	0*	65
	SE	24	0	0	0	24
Poughkeepsie (62-76)	SC	21	0***	0	0*	21
	SE	9	0	0	0	9
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	2	0	0	0	2
Kingston (86-93)	SC	31	0*	0*	0*	31
	SE	7	0	0	0	7
Saugerties (94-106)	SC	27	0*	0*	0*	27
	SE	14	0	0	0	14
Catskill (107-124)	SC	11	0*	0*	0*	11
	SE	6	0	0	0	6
Albany (125-152)	SC	4	0*	0*	0*	4
	SE	3	0	0	0	3
Stratum Total	SC	1728	3117	1074	0	5919
	SE	374	553	443	0	801

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in **bottom**; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

9/5/76-9/11/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	201	120**	357**	0*	678
	SE	39	74	221	0	236
Tappan Zee (24-33)	SC	457	1262**	1084**	0*	2803
	SE	114	214	439	0	502
Croton-Haverstraw (34-38)	SC	479	459**	314**	0*	1252
	SE	141	217	144	0	296
Indian Point (39-46)	SC	79	24**	6**	0*	109
	SE	19	8	6	0	21
West Point (47-55)	SC	28	0**	5**	0*	33
	SE	7	0	5	0	9
Cornwall (56-61)	SC	67	0**	0**	0*	67
	SE	22	0	0	0	22
Poughkeepsie (62-76)	SC	9	0**	0**	0*	9
	SE	4	0	0	0	4
Hyde Park (77-85)	SC	4	0*	0*	0*	4
	SE	2	0	0	0	2
Kingston (86-93)	SC	12	0*	0*	0*	12
	SE	12	0	0	0	12
Saugerties (94-106)	SC	50	0*	0*	0*	50
	SE	33	0	0	0	33
Catskill (107-124)	SC	28	0*	0*	0*	28
	SE	14	0	0	0	14
Albany (125-152)	SC	18	0*	0*	0*	18
	SE	18	0	0	0	18
Stratum Total	SC	1432	1865	1766	0	5063
	SE	193	314	512	0	631

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom ; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

9/12/76-9/18/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	201	19	56****	0*	276
	SE	39	12	36	0	54
Tappan Zee (24-33)	SC	457	469	1865	0*	2791
	SE	114	81	717	0	731
Croton-Haverstraw (34-38)	SC	479	120	540	0*	1139
	SE	141	27	219	0	262
Indian Point (39-46)	SC	79	9	0	0*	88
	SE	19	7	0	0	20
West Point (47-55)	SC	28	0***	0	0*	28
	SE	7	0	0	0	7
Cornwall (56-61)	SC	67	0***	0	0*	67
	SE	22	0	0	0	22
Poughkeepsie (62-76)	SC	9	0***	0	0*	9
	SE	4	0	0	0	4
Hyde Park (77-85)	SC	4	0*	0*	0*	4
	SE	2	0	0	0	2
Kingston (86-93)	SC	12	0*	0*	0*	12
	SE	12	0	0	0	12
Saugerties (94-106)	SC	50	0*	0*	0*	50
	SE	33	0	0	0	33
Catskill (107-124)	SC	28	0*	0*	0*	28
	SE	14	0	0	0	14
Albany (125-152)	SC	18	0*	0*	0*	18
	SE	18	0	0	0	18
Stratum Total	SC	1432	617	2461	0	4510
	SE	193	87	751	0	780

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

9/19/76-9/25/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	257	210**	624**	0*	1091
	SE	64	86	255	0	277
Tappan Zee (24-33)	SC	731	638**	1101**	0*	2470
	SE	157	135	496	0	537
Croton-Haverstraw (34-38)	SC	732	100**	292**	0*	1124
	SE	204	29	125	0	241
Indian Point (39-46)	SC	66	13**	0**	0*	79
	SE	16	8	0	0	18
West Point (47-55)	SC	30	0**	0**	0*	30
	SE	7	0	0	0	7
Cornwall (56-61)	SC	29	0**	0**	0*	29
	SE	9	0	0	0	9
Poughkeepsie (62-76)	SC	9	1**	13**	0*	23
	SE	6	1	13	0	14
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	58	0*	0*	0*	58
	SE	35	0	0	0	35
Albany (125-152)	SC	11	0*	0*	0*	11
	SE	11	0	0	0	11
Stratum Total	SC	1923	962	2030	0	4915
	SE	269	163	572	0	653

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom ; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

9/26/76-10/2/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	257	402	1193****	0*	1852
	SE	64	160	475	0	505
Tappan Zee (24-33)	SC	731	808	338	0*	1877
	SE	157	189	275	0	369
Croton-Haverstraw (34-38)	SC	732	81	45	0*	858
	SE	204	31	31	0	209
Indian Point (39-46)	SC	66	17	0	0*	83
	SE	16	9	0	0	18
West Point (47-55)	SC	30	0***	0	0*	30
	SE	7	0	0	0	7
Cornwall (56-61)	SC	29	0***	0	0*	29
	SE	9	0	0	0	9
Poughkeepsie (62-76)	SC	9	2***	26	0*	37
	SE	6	2	26	0	27
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	58	0*	0*	0*	58
	SE	35	0	0	0	35
Albany (125-152)	SC	11	0*	0*	0*	11
	SE	11	0	0	0	11
Stratum Total	SC	1923	1310	1602	0	4835
	SE	269	250	550	0	661

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

10/3/76-10/9/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	123	239**	709**	0*	1071
	SE	26	96	286	0	303
Tappan Zee (24-33)	SC	378	995**	204**	0*	1577
	SE	132	308	150	0	367
Croton-Haverstraw (34-38)	SC	368	72**	26**	0*	466
	SE	103	25	19	0	108
Indian Point (39-46)	SC	44	10**	0**	0*	54
	SE	10	5	0	0	11
West Point (47-55)	SC	10	0**	0**	0*	10
	SE	3	0	0	0	3
Cornwall (56-61)	SC	29	0**	0**	0*	29
	SE	9	0	0	0	9
Poughkeepsie (62-76)	SC	8	1**	13**	0*	22
	SE	5	1	13	0	14
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	6	0*	0*	0*	6
	SE	6	0	0	0	6
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	12	0*	0*	0*	12
	SE	12	0	0	0	12
Albany (125-152)	SC	5	0*	0*	0*	5
	SE	5	0	0	0	5
Stratum Total	SC	983	1317	952	0	3252
	SE	171	324	324	0	489

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom ; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

10/10/76-10/16/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	123	76	225****	0*	424
	SE	26	33	98	0	107
Tappan Zee (24-33)	SC	378	1182	71	0*	1631
	SE	132	427	25	0	448
Croton-Haverstraw (34-38)	SC	368	64	8	0*	440
	SE	103	20	8	0	105
Indian Point (39-46)	SC	44	4	0	0*	48
	SE	10	2	0	0	10
West Point (47-55)	SC	10	0***	0	0*	10
	SE	3	0	0	0	3
Cornwall (56-61)	SC	29	0***	0	0*	29
	SE	9	0	0	0	9
Poughkeepsie (62-76)	SC	8	0***	0	0*	8
	SE	5	0	0	0	5
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	6	0*	0*	0*	6
	SE	6	0	0	0	6
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	12	0*	0*	0*	12
	SE	12	0	0	0	12
Albany (125-152)	SC	5	0*	0*	0*	5
	SE	5	0	0	0	5
Stratum Total	SC	983	1326	304	0	2613
	SE	171	429	101	0	473

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

10/17/76-10/23/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	262	67**	198**	0*	527
	SE	68	26	78	0	107
Tappan Zee (24-33)	SC	493	635**	35**	0*	1163
	SE	153	227	12	0	274
Croton-Haverstraw (34-38)	SC	220	34**	4**	0*	258
	SE	85	12	4	0	86
Indian Point (39-46)	SC	24	2**	6**	0*	32
	SE	7	1	6	0	9
West Point (47-55)	SC	7	0**	0**	0*	7
	SE	2	0	0	0	2
Cornwall (56-61)	SC	8	1**	10**	0*	19
	SE	5	1	10	0	11
Poughkeepsie (62-76)	SC	21	0**	0**	0*	21
	SE	13	0	0	0	13
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	1038	739	253	0	2030
	SE	188	229	80	0	307

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

10/24/76-10/30/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	262	58	172****	0*	492
	SE	68	20	59	0	92
Tappan Zee (24-33)	SC	493	88	0	0*	581
	SE	153	27	0	0	155
Croton-Haverstraw (34-38)	SC	220	5	0	0*	225
	SE	85	5	0	0	85
Indian Point (39-46)	SC	24	0	12	0*	36
	SE	7	0	12	0	14
West Point (47-55)	SC	7	0***	0	0*	7
	SE	2	0	0	0	2
Cornwall (56-61)	SC	8	3***	21	0*	32
	SE	5	3	21	0	22
Poughkeepsie (62-76)	SC	21	0***	0	0*	21
	SE	13	0	0	0	13
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	1038	154	205	0	1397
	SE	188	34	64	0	201

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

10/31/76-11/6/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	110	57**	170**	0*	337
	SE	29	23	68	0	77
Tappan Zee (24-33)	SC	106	70**	0**	0*	176
	SE	47	22	0	0	52
Croton-Haverstraw (34-38)	SC	80	16**	8**	0*	104
	SE	45	9	8	0	47
Indian Point (39-46)	SC	21	2**	6**	0*	29
	SE	9	2	6	0	11
West Point (47-55)	SC	0	0**	0**	0*	0
	SE	0	0	0	0	0
Cornwall (56-61)	SC	2	1**	10**	0*	13
	SE	2	1	10	0	10
Poughkeepsie (62-76)	SC	4	0**	0**	0*	4
	SE	4	0	0	0	4
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	323	146	194	0	663
	SE	72	33	69	0	105

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

11/7/76-11/13/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	110	57	169****	0*	336
	SE	29	26	77	0	86
Tappan Zee (24-33)	SC	106	52	0	0*	158
	SE	47	18	0	0	50
Croton-Haverstraw (34-38)	SC	80	28	16	0*	124
	SE	45	14	16	0	50
Indian Point (39-46)	SC	21	4	0	0*	25
	SE	9	4	0	0	10
West Point (47-55)	SC	0	0***	0	0*	0
	SE	0	0	0	0	0
Cornwall (56-61)	SC	2	0***	0	0*	2
	SE	2	0	0	0	2
Poughkeepsie (62-76)	SC	4	0***	0	0*	4
	SE	4	0	0	0	4
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	323	141	185	0	649
	SE	72	35	79	0	112

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

11/14/76-11/20/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	169	60**	178**	0*	407
	SE	42	22	66	0	81
Tappan Zee (24-33)	SC	49	37**	7**	0*	93
	SE	28	17	7	0	33
Croton-Haverstraw (34-38)	SC	5	14**	8**	0*	27
	SE	3	7	8	0	11
Indian Point (39-46)	SC	2	5**	0**	0*	7
	SE	2	5	0	0	5
West Point (47-55)	SC	0	0**	0**	0*	0
	SE	0	0	0	0	0
Cornwall (56-61)	SC	0	0**	0**	0*	0
	SE	0	0	0	0	0
Poughkeepsie (62-76)	SC	0	0**	0**	0*	0
	SE	0	0	0	0	0
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	225	116	193	0	534
	SE	51	29	67	0	89

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom ; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

11/21/76-11/27/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	169	63	187****	0*	419
	SE	42	19	56	0	73
Tappan Zee (24-33)	SC	49	23	15	0*	87
	SE	28	17	15	0	36
Croton-Haverstraw (34-38)	SC	5	0	0	0*	5
	SE	3	0	0	0	3
Indian Point (39-46)	SC	2	7	0	0*	9
	SE	2	7	0	0	7
West Point (47-55)	SC	0	0***	0	0*	0
	SE	0	0	0	0	0
Cornwall (56-61)	SC	0	0***	0	0*	0
	SE	0	0	0	0	0
Poughkeepsie (62-76)	SC	0	0***	0	0*	0
	SE	0	0	0	0	0
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	225	93	202	0	520
	SE	51	26	58	0	81

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

11/28/76-12/4/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	169	92**	273**	0*	534
	SE	42	26	77	0	91
Tappan Zee (24-33)	SC	0	17**	7**	0*	24
	SE	0	14	7	0	16
Croton-Haverstraw (34-38)	SC	16	0*	0*	0*	16
	SE	13	0	0	0	13
Indian Point (39-46)	SC	3	3**	0**	0*	6
	SE	3	3	0	0	4
West Point (47-55)	SC	1	0**	0**	0*	1
	SE	1	0	0	0	1
Cornwall (56-61)	SC	0	0**	0**	0*	0
	SE	0	0	0	0	0
Poughkeepsie (62-76)	SC	0	0**	0**	0*	0
	SE	0	0	0	0	0
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	189	112	280	0	581
	SE	44	30	77	0	94

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-9 (Contd)

12/5/76-12/11/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	169	121	359****	0*	649
	SE	42	33	98	0	112
Tappan Zee (24-33)	SC	0	12	0	0*	12
	SE	0	12	0	0	12
Croton-Haverstraw (34-38)	SC	16	0*	0*	0*	16
	SE	13	0	0	0	13
Indian Point (39-46)	SC	3	0	0	0*	3
	SE	3	0	0	0	3
West Point (47-55)	SC	1	0***	0	0*	1
	SE	1	0	0	0	1
Cornwall (56-61)	SC	0	0***	0	0*	0
	SE	0	0	0	0	0
Poughkeepsie (62-76)	SC	0	0***	0	0*	0
	SE	0	0	0	0	0
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	189	133	359	0	681
	SE	44	35	98	0	113

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

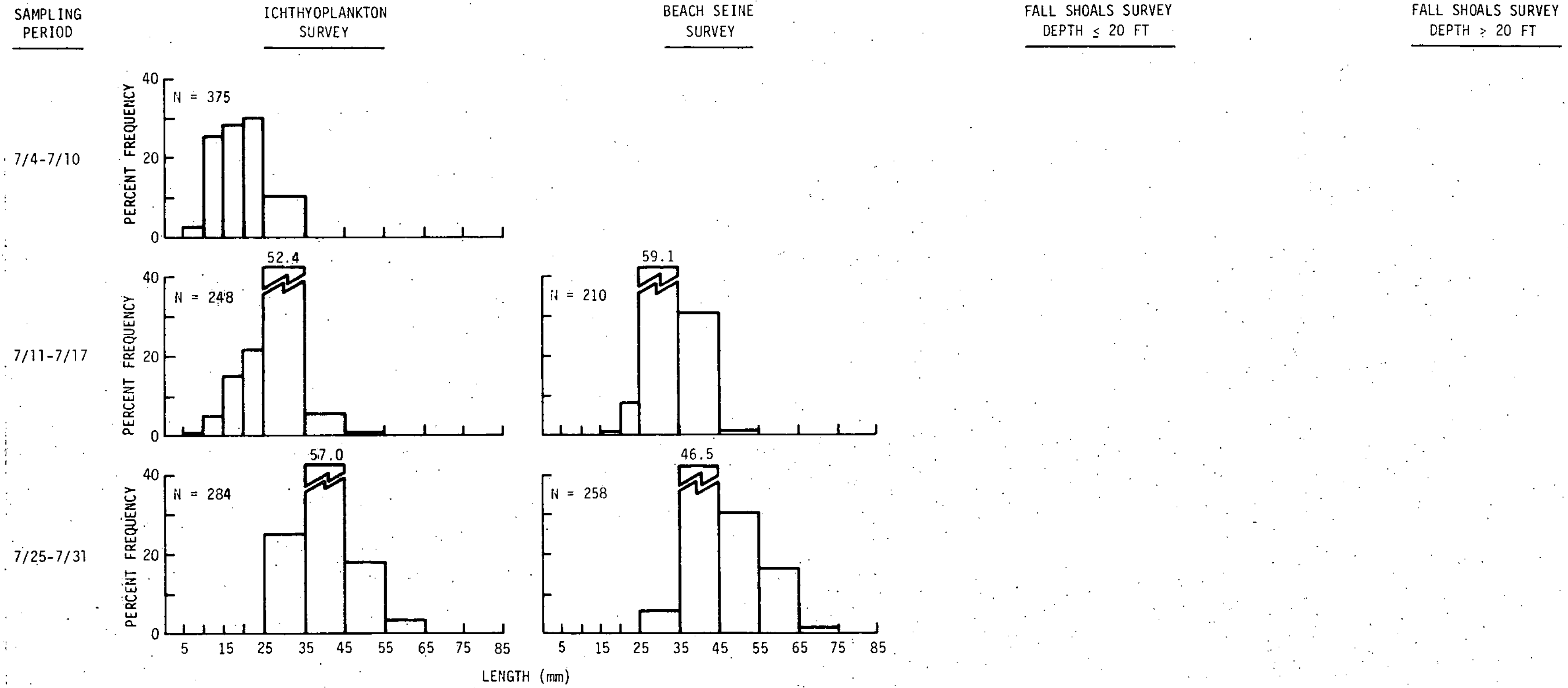


Figure B-1. Length Frequency of Juvenile Striped Bass from Ichthyoplankton, Beach Seine and Fall Shoals Surveys, Hudson River Estuary, July-December, 1976

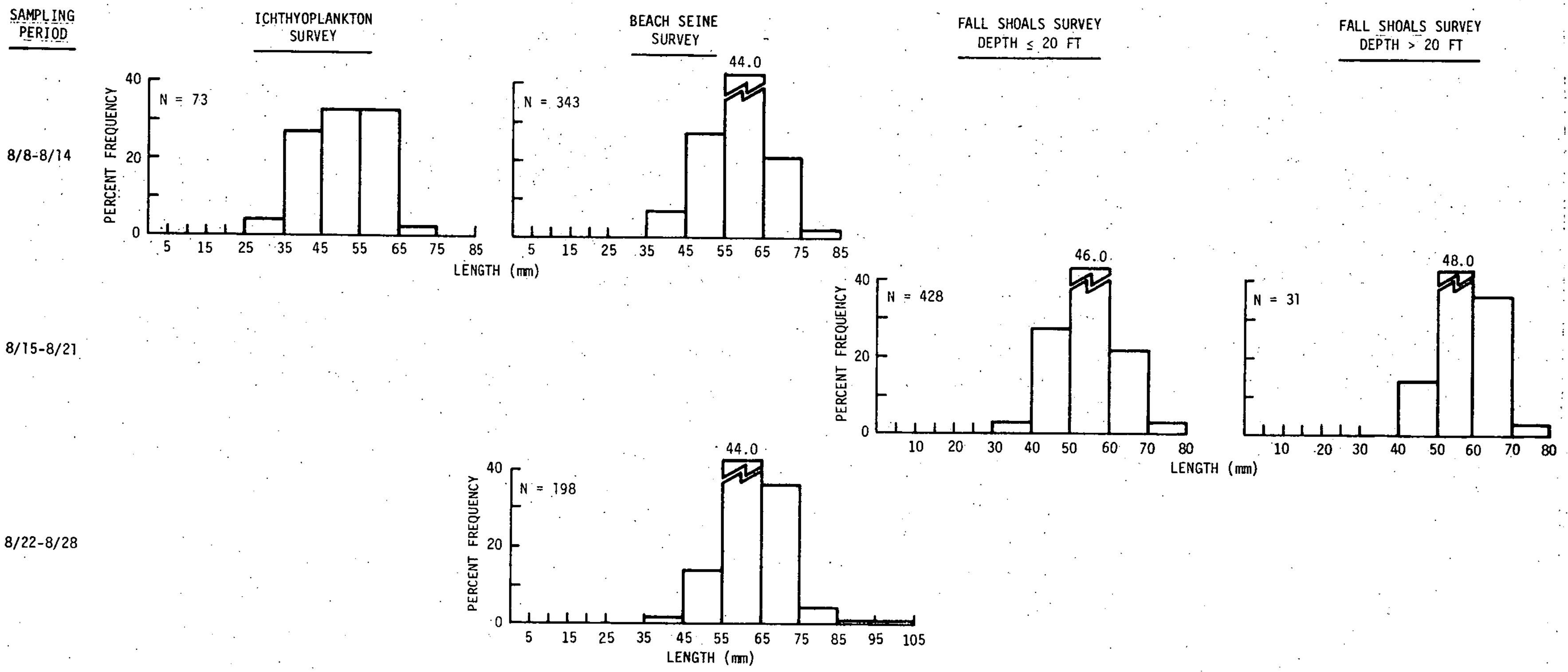


Figure B-1. (Contd)

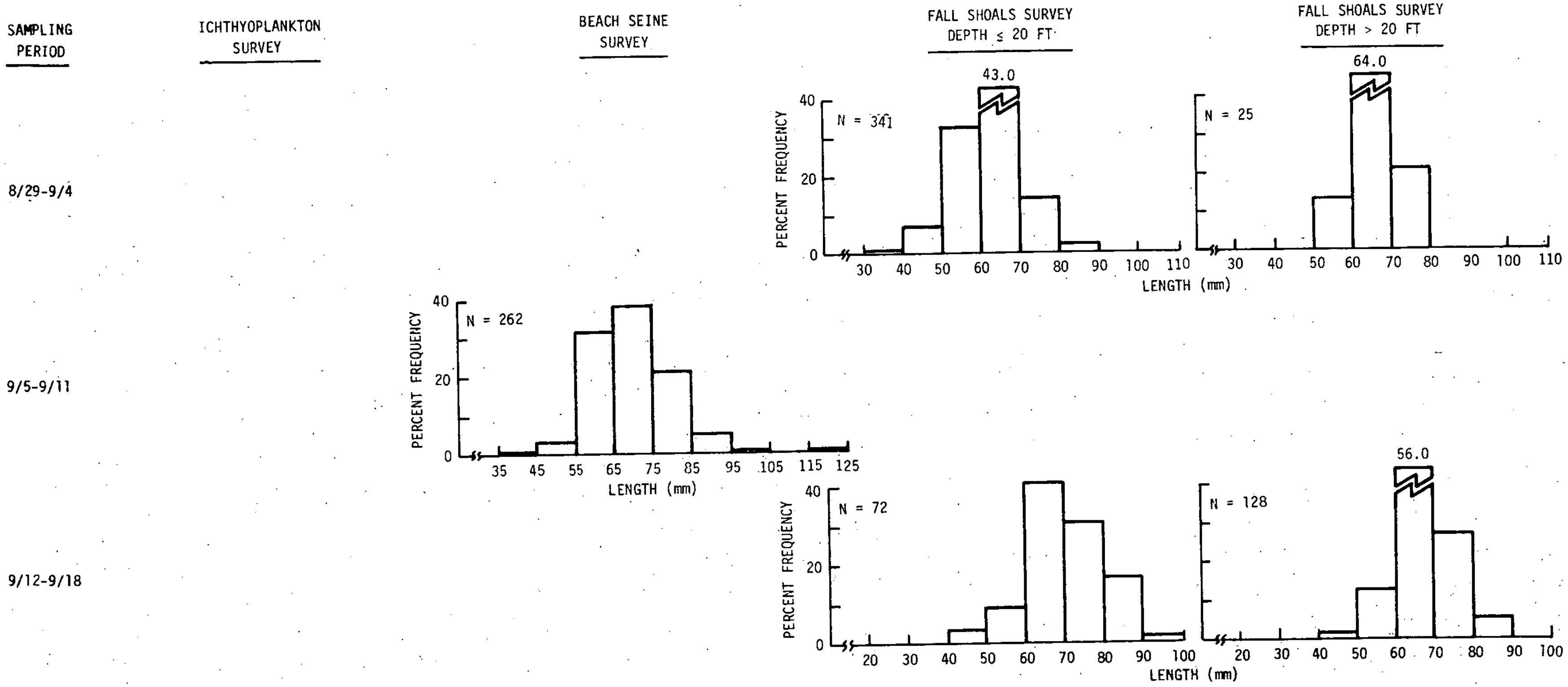


Figure B-1. (Contd)

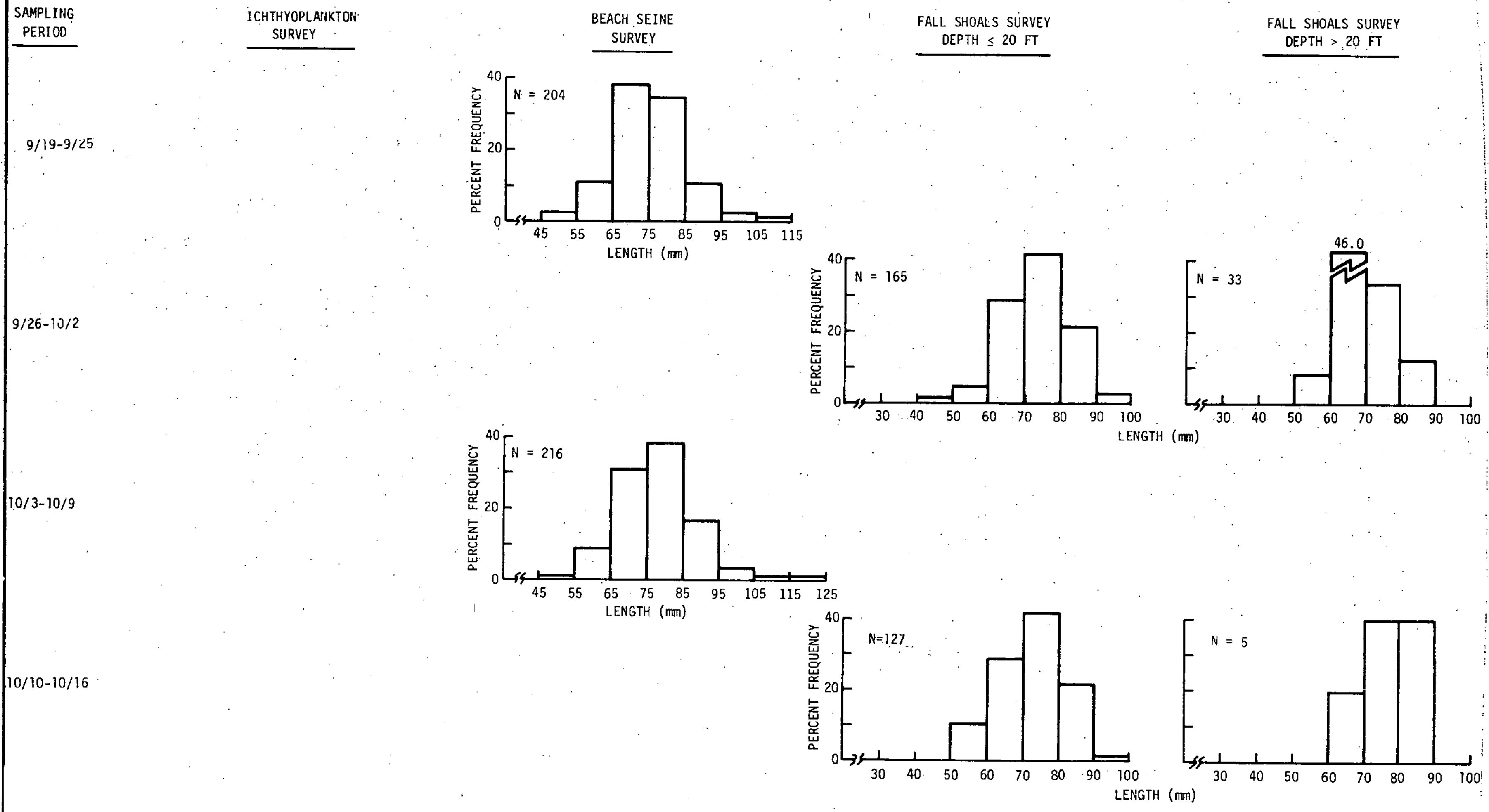


Figure B-1. (Contd)

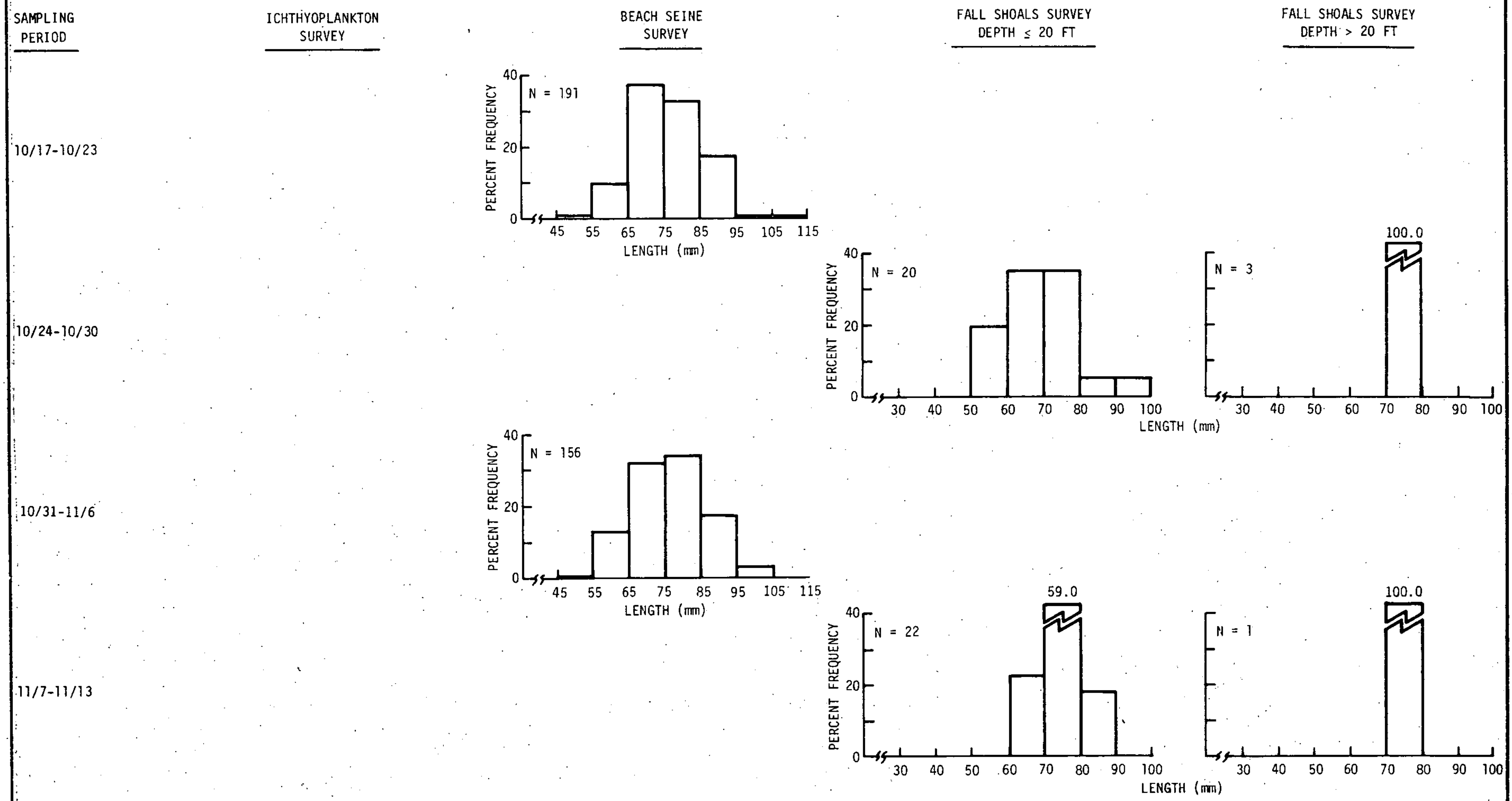


Figure B-1. (Contd)

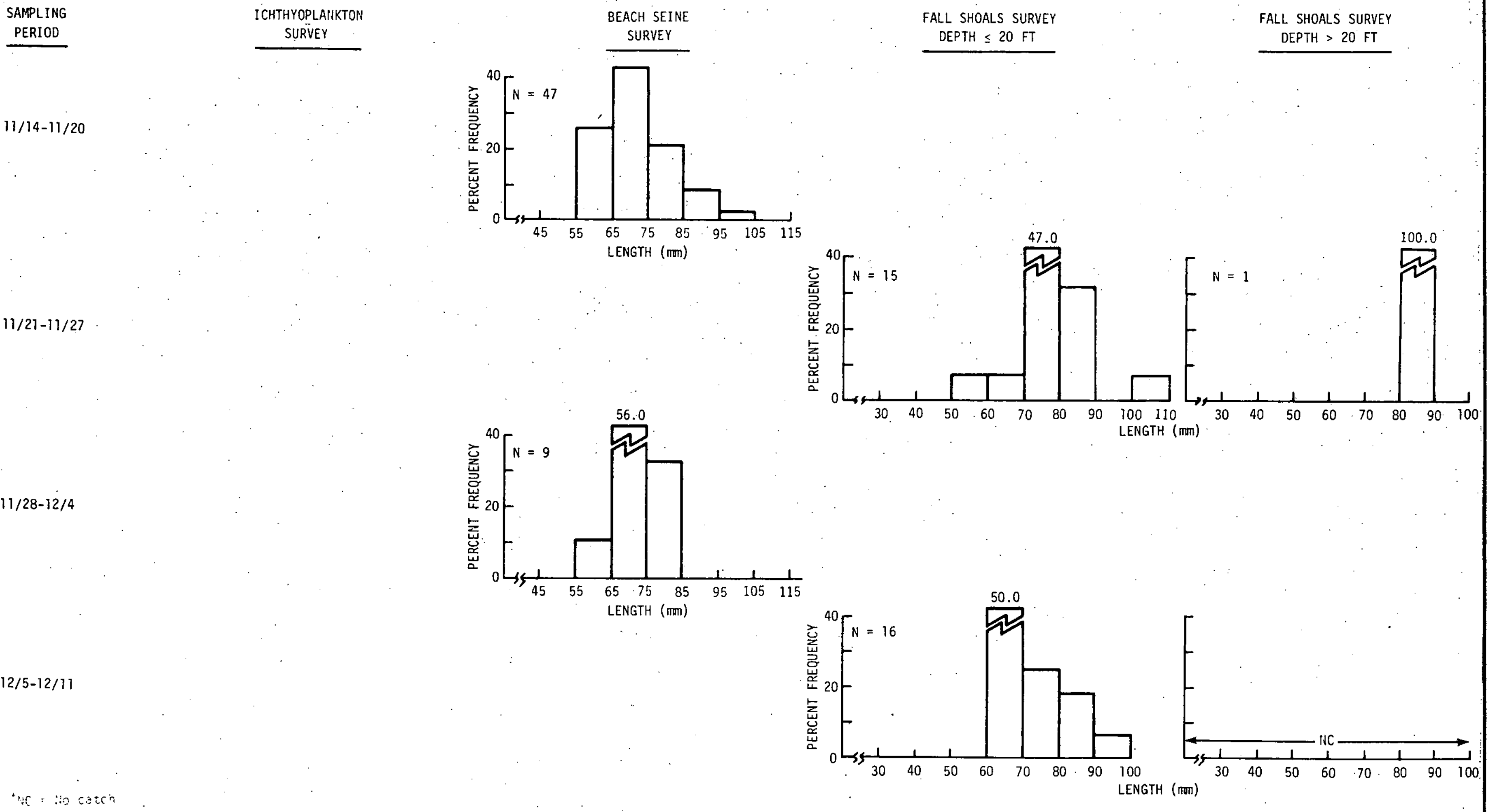


Figure B-1. (Contd)

Table B-10

Mean Percent Frequencies of Taxonomic Categories of Food Items Consumed by Striped Bass and White Perch Collected in Beach Seines, April-November, 1974

		Food Items (Taxonomic Categories)												
Month	Species	Order Diptera	Other Insecta	Suborder Decapoda	*Gammarus* sp.	*Corophium* sp.	Other Amphipoda	Suborder Isopoda	*Neomysis* sp.	Subclass Copepoda	Other Crustacea	Phylum Annelida	Class Osteichthyes	Fish Eggs
Apr	Striped Bass	8.59			46.58		0.03	4.07		29.62	11.11			
	White Perch	44.16			43.63		1.62	2.03		0.55	8.01			
May	Striped Bass				100.00									
	White Perch	26.87			21.40		10.90	0.52		24.86	0.30	12.32		2.79
Jun	Striped Bass	6.11			34.24		8.13	10.66	0.23	12.38	1.75	0.76	24.85	
	White Perch	28.71	<0.01		3.64		4.36	3.20	0.24	43.07	4.53	4.67	0.01	7.50
Jul	Striped Bass	12.9	1.89	3.33	24.33		2.64	28.29		5.14		14.82	6.67	
	White Perch	42.89	0.37		9.93	0.16	12.85	3.81	0.05	8.62	13.10	2.22	0.06	5.92
Aug	Striped Bass	9.03	0.53	7.28	31.71	21.01			4.82	0.15			25.46	
	White Perch	20.10	0.09	2.88	35.37	10.14	28.13	2.26		0.16		0.82		
Sep	Striped Bass	9.09	0.05	7.62	48.78	4.50	5.59	3.20	1.16	2.68		5.53	11.99	
	White Perch	15.88	0.54	6.99	30.95	4.07	16.28	4.91	0.61	17.91	1.34	0.78		
Oct	Striped Bass	5.55	0.73	2.73	52.11	4.27	6.39	5.88	0.13	2.61		2.11	17.48	
	White Perch	13.99	0.81	1.52	41.29	3.72	7.37	1.86	0.05	24.79	0.21	3.04	0.11	
Nov	Striped Bass	0.41		3.87	29.97	0.28	0.32	3.47	5.56	30.81		5.00	17.56	
	White Perch	0.13			9.18	4.44	0.10			86.14				

Table B-11

Mean Percent Frequencies of Taxonomic Categories of Food Items Consumed by White Perch and Striped Bass Collected in Beach Seines, April-November, 1974

Length: 76-150 mm; June

Taxonomic Category of Food Item	Mean Percent Frequency	
	White Perch (93)*	Striped Bass (51)*
Order Diptera	33.28	6.82
Gammarus	4.82	34.33
Other Amphipoda	2.17	9.09
Suborder Isopoda	2.00	11.92
Neomysis	0.33	0.26
Subclass Copepoda	41.45	11.90
Other Crustacea	3.86	1.96
Phylum Annelida	3.27	0.85
Class Osteichthyes	0.00	21.90
Phylum Mollusca	0.12	0.00
Fish eggs	8.72	0.00

Length: 76-150 mm; July

Taxonomic Category of Food Item	Mean Percent Frequency	
	White Perch (101)*	Striped Bass (21)*
Order Diptera	42.66	17.43
Other Insecta	0.07	2.70
Gammarus	10.52	34.76
Corophium	0.17	0.00
Other Amphipoda	13.46	2.98
Suborder Isopoda	4.02	27.65
Neomysis	0.05	0.00
Subclass Copepoda	7.45	7.35
Other Crustacea	13.88	0.00
Phylum Annelida	2.35	2.38
Class Osteichthyes	0.07	4.76
Fish eggs	5.30	0.00

Length: 76-150 mm; August

	White Perch (53)*	Striped Bass (30)*
Order Diptera	19.88	11.44
Other Insecta	0.09	0.67
Suborder Decapoda	2.99	9.22
Gammarus	36.60	39.06
Corophium	10.38	23.72
Other Amphipoda	27.27	0.00
Suborder Isopoda	1.98	0.00
Neomysis	0.00	6.11
Subclass Copepoda	0.12	0.19
Phylum Annelida	0.64	0.00
Class Osteichthyes	0.00	9.58
Phylum Mollusca	0.03	0.00

Length: 0-75 mm; September

	White Perch (33)*	Striped Bass (29)*
Order Diptera	16.43	7.22
Other Insecta	0.28	0.00
Suborder Decapoda	0.00	1.61
Gammarus	19.81	54.74
Corophium	0.38	6.35
Other Amphipoda	18.09	10.69
Suborder Isopoda	3.39	3.45
Neomysis	1.21	0.00
Subclass Copepoda	37.40	6.75
Other Crustacea	1.69	0.00
Phylum Annelida	1.25	8.62
Class Osteichthyes	0.00	0.57
Phylum Mollusca	0.07	0.00

Length: 76-150 mm; September

Taxonomic Category of Food Item	Mean Percent Frequency	
	White Perch (41)*	Striped Bass (38)*
Order Diptera	17.07	11.96
Other Insecta	0.81	0.10
Suborder Decapoda	12.89	12.89
Gammarus	40.38	47.33
Corophium	7.10	3.80
Other Amphipoda	12.18	2.57
Suborder Isopoda	3.31	0.73
Neomysis	0.20	0.00
Subclass Copepoda	4.41	0.00
Other Crustacea	1.22	0.00
Phylum Annelida	0.42	3.67
Class Osteichthyes	0.00	16.95

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*Number of stomachs in which at least one countable food item was present.

Table B-11 (Contd)

Length: 0-75 mm; October

Taxonomic Category of Food Item	Mean Percent Frequency White Perch (26)*	Striped Bass (26)*
Order Diptera	12.88	6.72
Other Insecta	0.41	0.00
Gammarus	36.59	56.47
Corophium	0.87	10.83
Other Amphipoda	4.81	11.69
Suborder Isopoda	0.98	5.08
Neomysis	0.09	0.38
Subclass Copepoda	34.04	3.81
Other Crustacea	0.44	0.00
Phylum Annelida	6.32	4.90
Class Osteichthyes	0.00	0.11
Phylum Mollusca	2.56	0.00

Length: 76-150 mm; October

Taxonomic Category of Food Item	Mean Percent Frequency White Perch (25)*	Striped Bass (37)*
Order Diptera	12.81	6.53
Other Insecta	0.00	1.49
Suborder Decapoda	3.28	5.54
Gammarus	45.93	63.70
Corophium	5.73	1.05
Other Amphipoda	10.89	4.73
Suborder Isopoda	2.96	5.65
Subclass Copepoda	18.16	2.61
Phylum Annelida	0.00	0.83
Class Osteichthyes	0.24	7.88

Length: 0-75 mm; April-November

	White Perch (108)*	Striped Bass (67)*
Order Diptera	14.70	5.76
Other Insecta	0.49	0.00
Suborder Decapoda	0.00	0.70
Gammarus	15.40	50.19
Corophium	0.70	6.95
Other Amphipoda	10.36	9.17
Suborder Isopoda	1.46	5.06
Neomysis	0.40	0.15
Subclass Copepoda	45.57	14.61
Other Crustacea	3.52	1.49
Phylum Annelida	5.02	5.63
Class Osteichthyes	0.00	0.29
Phylum Mollusca	0.64	0.00
Fish eggs	1.75	0.00

Length: 76-150 mm; April-November

	White Perch (342)*	Striped Bass (206)*
Order Diptera	30.70	8.94
Other Insecta	0.13	0.66
Suborder Decapoda	2.25	5.00
Gammarus	19.64	45.53
Corophium	2.93	4.39
Other Amphipoda	11.87	3.93
Suborder Isopoda	2.71	7.12
Neomysis	0.13	1.34
Subclass Copepoda	17.71	7.43
Other Crustacea	5.45	0.48
Phylum Annelida	2.16	2.06
Other	0.00	0.43
Class Osteichthyes	0.04	12.45
Phylum Mollusca	0.04	0.00
Fish eggs	4.23	0.00

Length: 151-200 mm; April-November

Taxonomic Category of Food Item	Mean Percent Frequency White Perch (37)*	Striped Bass (31)*
Order Diptera	28.32	0.67
Other Insecta	0.90	0.00
Suborder Decapoda	0.00	3.93
Gammarus	31.66	8.60
Corophium	1.64	2.80
Other Amphipoda	11.77	0.54
Suborder Isopoda	11.10	12.07
Neomysis	0.00	5.89
Subclass Copepoda	3.72	0.00
Phylum Annelida	8.20	12.72
Class Osteichthyes	0.02	52.78
Fish eggs	2.66	0.00

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*Number of stomachs in which at least one countable food item was present.

Table B-12

Weekly Mean Length Estimates for Juvenile Striped Bass Collected in Beach Seine Sampling during 1965-1976 (Excluding 1971) in Hudson River

Year	Week	Mean Total Length (mm)	Number Measured
1965	7/4-7/10	35.4	44
	7/18-7/24	47.5	9
	8/1-8/7	56.1	9
	8/15-8/21	71.1	9
1966	7/3-7/9	34.6	3
	7/10-7/16	30.0	28
	7/17-7/23	43.9	5
	7/24-7/30	53.9	88
	7/31-8/6	57.6	39
	8/7-8/13	65.1	51
	8/14-8/20	71.9	33
	8/21-8/27	69.9	60
1967	7/16-7/22	26.3	14
	7/23-7/29	43.2	25
	7/30-8/5	47.8	28
	8/6-8/12	51.1	14
	8/13-8/19	59.5	20
	8/20-8/26	73.9	15
1968	7/28-8/3	50.7	16
	8/4-8/10	55.5	13
	8/11-8/17	70.8	13
	8/18-8/24	57.4	2
1969	7/6-7/12	35.6	42
	7/13-7/19	50.5	75
	7/20-7/26	48.8	29
	7/27-8/2	50.4	280
	8/3-8/9	55.4	238
	8/10-8/16	58.0	108
	8/17-8/23	61.4	41
	8/24-8/30	63.6	22
1970	7/19-7/25	47.1	138
	7/26-8/1	46.4	484
	8/2-8/8	52.4	99
	8/9-8/15	55.0	207
	8/16-8/22	60.1	45
	8/23-8/29	60.5	208
	8/30-9/5	70.0	79

Table B-12 (Contd)

Year	Week	Mean Total Length (mm)	Number Measured
1972	7/9-7/15	34.3	26
	7/16-7/22	32.2	11
	7/23-7/29	50.8	188
	7/30-8/5	50.1	62
	8/6-8/12	63.8	13
	8/13-8/19	60.0	17
	8/20-8/26	61.5	180
	8/27-9/2	70.1	12
1973	7/1-7/14	29.4	176
	7/15-7/28	42.0	434
	7/29-8/11	60.1	1096
	8/12-8/25	63.9	973
1974	6/30-7/6	28.0	9
	7/7-7/13	33.0	80
	7/14-7/20	41.0	123
	7/21-7/27	45.0	325
	7/28-8/3	51.0	325
	8/4-8/10	57.0	367
	8/11-8/17	65.0	285
	8/18-8/24	68.0	270
	8/25-8/31	76.0	429
1975	6/29-7/5	32.0	292
	7/6-7/12	39.7	415
	7/13-7/19	47.1	568
	7/20-7/26	51.8	425
	7/27-8/2	59.5	463
	8/3-8/9	66.4	562
	8/10-8/16	68.8	455
	8/17-8/23	75.2	566
	8/24-8/30	77.1	591
1976	7/11-7/17	32.6	229
	7/25-7/31	46.6	279
	8/8-8/14	58.7	377
	8/22-8/28	62.9	224

Table B-13

Estimates Used to Analyze Factors Affecting Striped Bass Growth in the Hudson River Estuary, July and August 1965-1976 (Excluding 1971)

Year	Instantaneous Growth Rate	Juvenile Abundance Index	Mean Freshwater Flow (cfs)	Mean Water Temperature ($^{\circ}C$)
1965	0.0161	1.19	2997.3	24.05
1966	0.0179	8.20	3953.6	25.50
1967	0.0253	4.22	5412.1	24.99
1968	0.0093	1.31	7117.4	24.54
1969	0.0096	30.72	5766.0	24.46
1970	0.0085	15.91	4959.7	24.78
1972	0.0153	9.23	12997.6	23.35
1973	0.0192	28.55	7990.5	24.23
1974	0.0174	9.51	9071.6	23.66
1975	0.0153	18.27	8215.2	24.93
1976	0.0157	11.28	14953.9	23.86

Table B-14

Estimates Used to Analyze Factors Affecting Striped Bass Growth in the Hudson River Estuary, May-July 1965-1976 (Excluding 1971)

Year	Predicted Mean Length on 1 August (mm)	Mean Freshwater Flow (cfs)	Mean Water Temperature (^{o}C)
1965	53.4	4988.20	19.75
1966	51.5	10116.56	19.57
1967	41.8	9444.27	18.48
1968	52.6	14663.09	19.81
1969	51.0	12112.74	19.96
1970	49.6	8976.74	19.98
1972	47.0	29510.43	18.20
1973	48.5	17015.52	19.23
1974	49.1	14513.13	18.77
1975	56.2	13478.53	20.23
1976	45.6	20766.70	19.09

Table B-15

Simple Correlation Coefficients for Juvenile Striped Bass and Hudson River Environmental Variables, 1965-1976 (Excluding 1971)

Factor	Correlation Coefficients (r)
April freshwater flow	+0.552
Mean freshwater flow (Nov-Jun)	+0.535
Days to span, 16°-20°C	-0.083
Power plant water withdrawal	+0.284
Predator index	+0.038
Juvenile white perch abundance	+0.295

Table B-16

Abundance Indices* for Yearling and Older Striped Bass, Bluefish, and Both Predators Combined (Predator Index) during Mid-July and August, 1965-1976 (Excluding 1971) in the Hudson River Estuary

Year	Juvenile Bluefish	Yearling and Older Striped Bass	Combined Predator Index
1965	0.26	0.26	0.52
1966	0.00	0.03	0.03
1967	0.07	0.11	0.18
1968	0.15	0.03	0.18
1969	0.08	0.30	0.38
1970	0.77	1.10	1.87
1972	3.70	1.52	5.22
1973	1.28	0.68	1.96
1974	4.71	2.62	7.33
1975	2.97	0.62	3.59
1976	3.41	1.02	4.43

*Derived from river-wide beach seine catch-per-unit-area data.

Table B-17

Food Items of White Perch Collected* in Beach Seines from RM 39-46 (KM 62-74) during April-November, 1974

Food Item**	No. Stomachs Containing Food Item	No.	Mean	S.E.	Mean Percent Frequency	S.E. for Percent Frequency
American eel	1	1	0.00***	0.00	0.00	0.00
Fish remains	3	3	0.01	0.00	0.03	0.02
Fish (E)	22	1089	2.23	0.84	2.34	0.62
White perch (E)	1	100	0.20	0.20	0.12	0.12
Percidae (E)	1	150	0.31	0.31	0.20	0.20
Clupeidae (E)	9	213	0.44	0.20	0.90	0.37
Congeria	1	1	0.00	0.00	0.00	0.00
Gastropoda	5	11	0.02	0.01	0.17	0.14
Chaoborus (L)	2	3	0.01	0.00	0.02	0.01
Chironomid (L)	286	6615	13.56	1.90	22.22	1.43
Chironomid (P)	120	817	1.67	0.30	4.12	0.60
Odonata (J)	5	12	0.02	0.01	0.11	0.05
Thysanoptera	1	1	0.00	0.00	0.01	0.01
Lepidoptera (P)	1	1	0.00	0.00	0.07	0.07
Insect remains	3	3	0.01	0.00	0.08	0.07
Diptera (L)	4	122	0.25	0.19	0.44	0.27
Diptera (P)	3	3	0.01	0.00	0.12	0.09
Diptera	1	1	0.00	0.00	0.00	0.00
Crangon	2	3	0.01	0.00	0.06	0.06
Rhithropanopeus	17	50	0.10	0.03	1.46	0.48
Decapoda	2	2	0.00	0.00	0.05	0.04
Gammarus	231	3567	7.31	0.96	19.78	1.52
Monoculodes	60	243	0.50	0.12	2.09	0.44
Corophium	62	303	0.62	0.15	2.33	0.49
Chirodotea	7	16	0.03	0.01	0.05	0.02
Cyathura	90	241	0.49	0.08	3.01	0.53
Cassidina	1	1	0.00	0.00	0.00	0.00
Neomysis	10	15	0.03	0.01	0.18	0.10
Leptocheirus	154	1590	3.26	0.58	9.41	0.98
Amphipoda	1	1	0.00	0.00	0.01	0.01
Balanus	1	1	0.00	0.00	0.00	0.00
Harpacticoida	102	8136	16.67	4.89	6.10	0.84
Cyclopoida	45	2269	4.65	2.20	0.70	0.13
Calanoida	131	81954	167.94	27.21	15.99	1.50
Cladocera	63	3441	7.05	1.86	4.60	0.80
Oligochaeta	2	3	0.01	0.00	0.03	0.02
Polychaeta	44	425	0.87	0.24	3.16	0.60
Hirudina	1	3	0.01	0.01	0.06	0.06

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*Total number of stomachs examined = 603; empty stomachs = 91; number of stomachs in which at least one countable food item was present = 488.

**Adult unless otherwise indicated.

(E) = Eggs
(L) = Larvae
(P) = Pupae
(J) = Juvenile

Number of occurrences of uncountable food items:

Food Item	Number
Fish remains	0
Filamentous algae	62
Animal remains	119
Plat remains	62
Detritus	92

***A mean and/or S.E. (Standard Error) of 0.00 indicates the value is <0.005.

Table B-18

Summary of Results of Log$_{10}$ Fecundity Data Regressed on Log$_{10}$ Length, Log$_{10}$ Weight or Age of Hudson River White Perch Collected during May and June, 1975-1976

	Year	Month	α	β	R^2	N
Fecundity vs Length	1975	May	-3.3692	3.6830	0.5408	32
		Jun	2.8299	0.7985	0.0360	29
	1976	May	-3.8584	3.9104	0.6726	30
		Jun	0.1510	1.8742	0.0983	48
Common lines:	1975 vs 1976	May	-3.6238	3.8009	0.6079	62
Fecundity vs Weight	1975	May	2.6717	1.1377	0.6395	32
		Jun	4.0380	0.3042	0.0510	29
	1976	May	2.7480	1.1232	0.7598	30
		Jun	2.7370	0.8751	0.1913	48
Fecundity vs Age	1975	May	4.2988	0.1430	0.3475	31
		Jun	4.4465	0.0392	0.0564	29
	1976	May	4.1750	0.1808	0.5136	30
		Jun	3.8496	0.1196	0.1705	48

Table B-19

Friedman Analysis of the July-October Catch Unit Area by Beach Seine of Juvenile White Perch

	Year													
	1969		1970		1972		1973		1974		1975		1976	
Biweeks***														
1	3.8**	5*	2.1	3	0.0	1	5.7	7	1.2	2	4.8	6	2.3	4
2	9.6	3	35.1	7	0.3	1	24.0	6	2.3	2	13.3	4	19.2	5
3	31.8	6	10.3	3	0.4	1	14.1	5	4.7	2	13.2	4	32.2	7
4	28.2	7	4.8	1	9.2	2	23.6	4	10.4	3	27.0	6	24.0	5
5	35.0	5	39.2	6	7.2	1	21.0	3	11.1	2	52.3	7	25.7	4
6	39.3	4	53.0	7	21.0	2	51.9	6	9.0	1	51.7	5	24.7	3
7	28.7	6	19.8	4	14.1	3	66.0	7	4.1	1	10.3	2	23.9	5
8	36.5	6	71.6	7	9.8	4	17.6	5	5.8	1	6.4	2	8.3	3
9	44.4**	6	54.6	7	10.6	4	14.9	5	2.7	1	5.2	3	3.3	2
Sum of Ranks		48		45		19		48		15		39		38

*CPUA's were ranked across years

**Includes one week only

***Dates included in the July-October time period are as follows:

1969	7/6-10/25
1970	6/28-10/31
1972	7/2-11/4
1973	7/1-11/3
1974	6/30-11/2
1975	6/29-11/1
1976	6/27-10/30

Table B-20

Distribution - Free Multiple Comparison Using Friedman Rank Sums of Juvenile White Perch C/f from July-October, 1969-1976 (Excluding 1971)

Years		1974	1972	1976	1975	1970	1973	1969
	Ranks	15	19	38	39	45	48	48
1974	15	–	4	23	24	30*	33**	33**
1974	19		–	19	20	26*	29**	29**
1976	38			–	1	7	10	10
1975	39				–	6	9	9
1970	45					–	3	3
1973	48						–	0
1969	48							–

*r(0.05, 7, 9) = 27

**r(0.01, 7, 9) = 31

Table B-21

Release Data for Juvenile White Perch Marked in Hudson River Estuary, September-November 1976

Release Month		Release Region RM 12-23 (KM 19-37)	RM 24-38 (KM 38-61)	RM 39-46 (KM 62-74)	RM 47-76 (KM 75-122)	RM 77-152 (KM 123-243)	Total	Recapture Rate
Sep	Number marked	42	9873	3412	2161	471	15959	
	Survival adjustment	1.0	1.0	1.0	1.0	1.0	1.0	
	Adjusted no. marked	42	9873	3412	2161	471	15959	
	Recaptured Sep-Dec	2	646	305	35	3	991	0.0621
	Marked fish available on 1 Jan	40	9227	3107	2126	468	14968	
Oct	Number marked	40	3239	3065	537	214	7095	
	Survival adjustment	0.95	0.95	0.95	0.95	0.95	0.95	
	Adjusted no. marked	38	3077	2912	510	203	6740	
	Recaptured Oct-Dec	0	68	26	1	1	96	0.0142
	Marked fish available on 1 Jan	38	3009	2886	509	202	6644	
Nov	Number marked	59	316	1748	38	14	2175	
	Survival adjustment	0.95	0.95	0.95	0.95	0.95	0.95	
	Adjusted no. marked	56	300	1661	36	13	2066	
	Recaptured Nov-Dec	1	1	8	0	0	10	0.0048
	Marked fish available on 1 Jan	55	299	1653	36	13	2056	

Table B-22

Recaptures of Marked Juvenile White Perch in Hudson River Estuary, September 1976-June 1977*

	Field Collections			Impingement Collections			Combined		
Time Period	Total Catch (C)	Recaptures (R)	R/C	Catch (C)	Recaptures (R)	R/C	Catch (C)	Recaptures (R)	R/C
9/5-10/2	19959	611	0.03061	2663	5	0.00188	22622	616	0.02723
10/3-10/30	8936	425	0.04756	48985	10	0.00020	57921	435	0.00751
10/31-11/27	4929	22	0.00446	75160	2	0.00003	80089	24	0.00030
11/28-12/31	1423	2	0.00141	145190	11	0.00008	146613	13	0.00009
1/1-1/29	0	0	-	354015	59	0.00017	354015	59	0.00017
1/30-2/26	38	0	-	122284	7	0.00006	123677	7	0.00006
2/27-4/2	640	1	0.00156	84119	9	0.00011	84795	10	0.00012
4/3-4/30	1036	0	-	39767	1	0.00003	40803	1	0.00002
5/1-5/28	3821	4	0.00105	59573	7	0.00012	63394	11	0.00017
5/29-6/30	4739	6	0.00127	1355	0	-	6094	6	0.00098

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*Recaptures and catch for 1976 include only TI field sampling and Indian Point impingement collections. Data for 1977 also includes impingement collections from Bowline, Lovett, Roseton, and Danskammer power plants.

Table B-23

Estimated Combined Standing Crops (in Thousands) of White Perch Juveniles in the Hudson River Estuary (RM 12-152; KM 19-243) Determined from 20 June-11 December 1976 Beach Seine, Epibenthic Sled, and Tucker Trawl Sampling Standing crops are not adjusted for gear efficiency.

6/20/76-6/26/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	0*	0	0*	0	0
	SE	0	0	0	0	0
Tappan Zee (24-33)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
Croton-Haverstraw (34-38)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
Indian Point (39-46)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
West Point (47-55)	SC	0*	0*	10	0	10
	SE	0	0	10	0	10
Cornwall (56-61)	SC	0*	0	0	0	0
	SE	0	0	0	0	0
Poughkeepsie (62-76)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Hyde Park (77-85)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0*	0*	0	0	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0*	0*	0	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	0	0	10	0	10
	SE	0	0	10	0	10

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

6/27/76 - 7/3/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	0	0	0*****	0	0
	SE	0	0	0	0	0
Tappan Zee (24-33)	SC	14	0	0	0	14
	SE	8	0	0	0	8
Croton-Haverstraw (34-38)	SC	17	0	0	0	17
	SE	14	0	0	0	14
Indian Point (39-46)	SC	4	0	0	0	4
	SE	2	0	0	0	2
West Point (47-55)	SC	24	0***	0	0	24
	SE	13	0	0	0	13
Cornwall (56-61)	SC	35	0	0	0	35
	SE	27	0	0	0	27
Poughkeepsie (62-76)	SC	43	0***	0	0	43
	SE	35	0	0	0	35
Hyde Park (77-85)	SC	34	0***	0	0	34
	SE	29	0	0	0	29
Kingston (86-93)	SC	96	0***	0	0	96
	SE	96	0	0	0	96
Saugerties (94-106)	SC	11	0***	0	0	11
	SE	11	0	0	0	11
Catskill (107-124)	SC	4	0***	0	0	4
	SE	4	0	0	0	4
Albany (125-152)	SC	0	0***	0	0****	0
	SE	0	0	0	0	0
Stratum Total	SC	282	0	0	0	282
	SE	112	0	0	0	112

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

7/4/76 - 7/10/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	0	0	0*****	0	0
	SE	0	0	0	0	0
Tappan Zee (24-33)	SC	14	0	0	0	14
	SE	8	0	0	0	8
Croton-Haverstraw (34-38)	SC	17	0	0	0	17
	SE	14	0	0	0	14
Indian Point (39-46)	SC	4	0	0	0	4
	SE	2	0	0	0	2
West Point (47-55)	SC	24	0 ***	0	46	70
	SE	13	0	0	46	48
Cornwall (56-61)	SC	35	0	0	32	67
	SE	27	0	0	32	42
Poughkeepsie (62-76)	SC	43	2 ***	33	105	183
	SE	35	2	33	72	87
Hyde Park (77-85)	SC	34	0 ***	0	516	550
	SE	29	0	0	414	415
Kingston (86-93)	SC	96	9 ***	34	0	139
	SE	96	6	22	0	99
Saugerties (94-106)	SC	11	0 ***	0	0	11
	SE	11	0	0	0	11
Catskill (107-124)	SC	4	0 ***	0	0	4
	SE	4	0	0	0	4
Albany (125-152)	SC	0	0***	0	0 ****	0
	SE	0	0	0	0	0
Stratum Total	SC	282	11	67	699	1059
	SE	112	6	40	424	440

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

7/11/76 - 7/17/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	82	0	0*****	0	82
	SE	70	0	0	0	70
Tappan Zee (24-33)	SC	442	18	0	0	460
	SE	306	12	0	0	306
Croton-Haverstraw (34-38)	SC	89	0	42	44	175
	SE	34	0	42	44	70
Indian Point (39-46)	SC	109	0	6	0	115
	SE	50	0	6	0	50
West Point (47-55)	SC	116	1***	14	66	197
	SE	46	1	14	66	82
Cornwall (56-61)	SC	539	25	31	137	732
	SE	333	25	20	111	352
Poughkeepsie (62-76)	SC	315	24***	333	457	1129
	SE	102	21	298	457	555
Hyde Park (77-85)	SC	94	0***	0	3647	3741
	SE	29	0	0	1056	1056
Kingston (86-93)	SC	948	44***	169	185	1346
	SE	761	32	124	142	785
Saugerties (94-106)	SC	757	162***	455	0	1374
	SE	495	90	252	0	563
Catskill (107-124)	SC	52	23***	37	0	112
	SE	25	23	37	0	50
Albany (125-152)	SC	49	0***	0	0****	49
	SE	35	0	0	0	35
Stratum Total	SC	3592	297	1087	4536	9512
	SE	1026	104	414	1167	1611

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

7/18/76 - 7/24/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	82	18**	55**	0**	155
	SE	70	18	55	0	91
Tappan Zee (24-33)	SC	442	85**	0**	123**	650
	SE	306	38	0	123	332
Croton-Haverstraw (34-38)	SC	89	41**	69**	22**	221
	SE	34	19	49	22	66
Indian Point (39-46)	SC	109	72**	58**	46**	285
	SE	50	72	34	25	97
West Point (47-55)	SC	116	1**	19**	120**	256
	SE	46	1	15	75	89
Cornwall (56-61)	SC	539	12**	78**	96**	725
	SE	333	12	51	74	345
Poughkeepsie (62-76)	SC	315	27**	382**	352**	1076
	SE	102	22	316	298	447
Hyde Park (77-85)	SC	94	0**	0**	2126**	2220
	SE	29	0	0	640	641
Kingston (86-93)	SC	948	140**	539**	285**	1912
	SE	761	58	222	264	838
Saugerties (94-106)	SC	757	177**	497**	89**	1520
	SE	495	91	255	89	571
Catskill (107-124)	SC	52	25**	41**	27**	145
	SE	25	25	41	27	60
Albany (125-152)	SC	49	0**	0**	0**	49
	SE	35	0	0	0	35
Stratum Total	SC	3592	598	1738	3286	9214
	SE	1026	142	475	777	1379

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

7/25/76 - 7/31/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	85	37	110******	0	232
	SE	31	37	110	0	120
Tappan Zee (24-33)	SC	900	152	0	246	1298
	SE	289	64	0	246	385
Croton-Haverstraw (34-38)	SC	498	83	97	0	678
	SE	243	38	57	0	252
Indian Point (39-46)	SC	362	144	111	93	710
	SE	112	144	62	50	199
West Point (47-55)	SC	250	2***	25	175	452
	SE	80	1	16	84	117
Cornwall (56-61)	SC	363	0	125	56	544
	SE	201	0	83	37	221
Poughkeepsie (62-76)	SC	309	31***	431	248	1019
	SE	246	24	335	139	439
Hyde Park (77-85)	SC	205	0***	0	605	810
	SE	79	0	0	225	238
Kingston (86-93)	SC	543	237***	909	386	2075
	SE	350	84	321	386	618
Saugerties (94-106)	SC	1223	192***	540	178	2133
	SE	789	92	258	178	854
Catskill (107-124)	SC	321	28***	46	54	449
	SE	219	28	46	54	232
Albany (125-152)	SC	44	0***	0	0****	44
	SE	20	0	0	0	20
Stratum Total	SC	5103	906	2394	2041	10444
	SE	1031	211	557	570	1320

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

8/1/76 - 8/7/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	85	18**	55**	0**	158
	SE	31	18	55	0	66
Tappan Zee (24-33)	SC	900	180**	14**	123**	1217
	SE	289	75	14	123	323
Croton-Haverstraw (34-38)	SC	498	41**	89**	0**	628
	SE	243	19	47	0	248
Indian Point (39-46)	SC	362	75**	216**	104**	757
	SE	112	75	68	67	165
West Point (47-55)	SC	250	13**	167**	432**	862
	SE	80	9	122	153	212
Cornwall (56-61)	SC	363	0**	156**	28**	547
	SE	201	0	100	18	225
Poughkeepsie (62-76)	SC	309	50**	704**	836**	1899
	SE	246	32	454	636	820
Hyde Park (77-85)	SC	205	3**	61**	408**	667
	SE	79	1	14	197	213
Kingston (86-93)	SC	543	175*	670**	193**	1581
	SE	350	63	242	193	471
Saugerties (94-106)	SC	1223	100**	283**	89**	1695
	SE	789	50	142	89	808
Catskill (107-124)	SC	321	27**	44**	27**	419
	SE	219	27	44	27	227
Albany (125-152)	SC	44	0**	0**	0**	44
	SE	20	0	0	0	20
Stratum Total	SC	5103	682	2459	2240	10484
	SE	1031	142	567	730	1392

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

8/8/76 - 8/14/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	50	0	0*****	0	50
	SE	17	0	0	0	17
Tappan Zee (24-33)	SC	1059	208	29	0	1296
	SE	391	86	29	0	401
Croton-Haverstraw (34-38)	SC	620	0	82	0	702
	SE	276	0	38	0	279
Indian Point (39-46)	SC	286	7	321	116	730
	SE	95	7	75	85	148
West Point (47-55)	SC	120	24***	310	690	1144
	SE	57	17	228	222	324
Cornwall (56-61)	SC	343	0	187	0	530
	SE	152	0	117	0	192
Poughkeepsie (62-76)	SC	139	70***	978	1425	2612
	SE	99	41	574	1134	1276
Hyde Park (77-85)	SC	45	7***	122	211	385
	SE	29	2	29	169	174
Kingston (86-93)	SC	234	113***	432	0	779
	SE	117	43	164	0	206
Saugerties (94-106)	SC	2113	9***	26	0	2148
	SE	1286	9	26	0	1286
Catskill (107-124)	SC	483	26***	42	0	551
	SE	221	26	42	0	226
Albany (125-152)	SC	35	0***	0	0****	35
	SE	19	0	0	0	19
Stratum Total	SC	5527	464	2529	2442	10962
	SE	1411	110	658	1171	1951

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

8/15/76 - 8/21/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	50	74	220*****	0*	344
	SE	17	21	62	0	68
Tappan Zee (24-33)	SC	1059	1709	38	0*	2806
	SE	391	385	25	0	549
Croton-Haverstraw (34-38)	SC	620	397	355	0*	1372
	SE	276	79	208	0	355
Indian Point (39-46)	SC	286	88	10	0*	384
	SE	95	39	10	0	103
West Point (47-55)	SC	120	8***	100	0*	228
	SE	57	3	39	0	69
Cornwall (56-61)	SC	343	11***	65	0*	419
	SE	152	11	65	0	166
Poughkeepsie (62-76)	SC	139	7***	99	0*	245
	SE	99	3	44	0	108
Hyde Park (77-85)	SC	45	0*	0*	0*	45
	SE	29	0	0	0	29
Kingston (86-93)	SC	234	0*	0*	0*	234
	SE	117	0	0	0	117
Saugerties (94-106)	SC	2113	0*	0*	0*	2113
	SE	1286	0	0	0	1286
Catskill (107-124)	SC	483	0*	0*	0*	483
	SE	221	0	0	0	221
Albany (125-152)	SC	35	0*	0*	0*	35
	SE	19	0	0	0	19
Stratum Total	SC	5527	2294	887	0	8708
	SE	1411	396	236	0	1484

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

8/22/76 - 8/28/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	32	37**	110**	0*	179
	SE	19	10	31	0	38
Tappan Zee (24-33)	SC	1131	1183**	19	0*	2333
	SE	285	283	12	0	402
Croton-Haverstraw (34-38)	SC	1340	314**	191**	0*	1845
	SE	511	68	113	0	528
Indian Point (39-46)	SC	396	76**	10**	0*	482
	SE	100	30	10	0	105
West Point (47-55)	SC	193	10**	126**	0*	329
	SE	66	4	61	0	90
Cornwall (56-61)	SC	344	16**	94**	0*	454
	SE	151	11	65	0	165
Poughkeepsie (62-76)	SC	61	5**	73**	0*	139
	SE	23	2	36	0	43
Hyde Park (77-85)	SC	29	0*	0*	0*	29
	SE	25	0	0	0	25
Kingston (86-93)	SC	419	0*	0*	0*	419
	SE	327	0	0	0	327
Saugerties (94-106)	SC	199	0*	0*	0*	199
	SE	166	0	0	0	166
Catskill (107-124)	SC	231	0*	0*	0*	231
	SE	169	0	0	0	169
Albany (125-152)	SC	23	0*	0*	0*	23
	SE	15	0	0	0	15
Stratum Total	SC	4398	1641	623	0	6662
	SE	738	293	152	0	808

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

8/29/76 - 9/4/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	32	0	0*****	0*	32
	SE	19	0	0	0	19
Tappan Zee (24-33)	SC	1131	657	0	0*	1788
	SE	285	182	0	0	338
Croton-Haverstraw (34-38)	SC	1340	232	27	0*	1599
	SE	511	57	19	0	515
Indian Point (39-46)	SC	396	64	11	0*	471
	SE	100	22	11	0	103
West Point (47-55)	SC	193	12***	152	0*	357
	SE	66	6	83	0	106
Cornwall (56-61)	SC	344	21***	124	0*	489
	SE	151	11	66	0	165
Poughkeepsie (62-76)	SC	61	3***	48	0*	112
	SE	23	2	29	0	37
Hyde Park (77-85)	SC	29	0*	0*	0*	29
	SE	25	0	0	0	25
Kingston (86-93)	SC	419	0*	0*	0*	419
	SE	327	0	0	0	327
Saugerties (94-106)	SC	199	0*	0*	0*	199
	SE	166	0	0	0	166
Catskill (107-124)	SC	231	0*	0*	0*	231
	SE	169	0	0	0	169
Albany (125-152)	SC	23	0*	0*	0*	23
	SE	15	0	0	0	15
Stratum Total	SC	4398	989	362	0	5749
	SE	738	192	112	0	771

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

9/5/76 - 9/11/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	15	0**	0**	0*	15
	SE	5	0	0	0	5
Tappan Zee (24-33)	SC	1409	483**	0**	0*	1892
	SE	593	129	0	0	607
Croton-Haverstraw (34-38)	SC	802	178**	36**	0*	1016
	SE	288	42	27	0	292
Indian Point (39-46)	SC	417	35**	60**	0*	512
	SE	95	13	37	0	103
West Point (47-55)	SC	151	8**	109**	0*	268
	SE	58	4	63	0	86
Cornwall (56-61)	SC	159	77**	461**	0*	697
	SE	43	21	130	0	139
Poughkeepsie (62-76)	SC	155	11**	161**	0*	327
	SE	113	9	135	0	176
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	2	0	0	0	2
Kingston (86-93)	SC	170	0*	0*	0*	170
	SE	72	0	0	0	72
Saugerties (94-106)	SC	826	0*	0*	0*	826
	SE	663	0	0	0	663
Catskill (107-124)	SC	73	0*	0*	0*	73
	SE	34	0	0	0	34
Albany (125-152)	SC	164	0*	0*	0*	164
	SE	164	0	0	0	164
Stratum Total	SC	4344	792	827	0	5963
	SE	967	138	203	0	998

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

9/12/76 - 9/18/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	15	0	0*****	0*	15
	SE	5	0	0	0	5
Tappan Zee (24-33)	SC	1409	310	0	0*	1719
	SE	593	77	0	0	598
Croton-Haverstraw (34-38)	SC	802	124	46	0*	972
	SE	288	28	36	0	292
Indian Point (39-46)	SC	417	7	109	0*	533
	SE	95	5	63	0	114
West Point (47-55)	SC	151	5***	67	0*	223
	SE	58	3	43	0	72
Cornwall (56-61)	SC	159	133***	798	0*	1090
	SE	43	32	194	0	201
Poughkeepsie (62-76)	SC	155	20***	275	0*	450
	SE	113	17	241	0	267
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	2	0	0	0	2
Kingston (86-93)	SC	170	0*	0*	0*	170
	SE	72	0	0	0	72
Saugerties (94-106)	SC	826	0*	0*	0*	826
	SE	663	0	0	0	663
Catskill (107-124)	SC	73	0*	0*	0*	73
	SE	34	0	0	0	34
Albany (125-152)	SC	164	0*	0*	0*	164
	SE	164	0	0	0	164
Stratum Total	SC	4344	599	1295	0	6238
	SE	967	90	321	0	1023

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

9/19/76 - 9/25/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	7	3**	9*	0*	19
	SE	3	3	9	0	10
Tappan Zee (24-33)	SC	265	384**	0**	0*	649
	SE	90	105	0	0	138
Croton-Haverstraw (34-38)	SC	826	68**	26**	0*	920
	SE	262	17	21	0	263
Indian Point (39-46)	SC	332	13**	65**	0*	410
	SE	76	9	38	0	85
West Point (47-55)	SC	198	4**	62**	0*	264
	SE	60	2	36	0	70
Cornwall (56-61)	SC	155	74**	445**	0*	674
	SE	53	19	119	0	132
Poughkeepsie (62-76)	SC	4	14**	198**	0*	216
	SE	4	10	152	0	152
Hyde Park (77-85)	SC	20	0*	0*	0*	20
	SE	19	0	0	0	19
Kingston (86-93)	SC	96	0*	0*	0*	96
	SE	34	0	0	0	34
Saugerties (94-106)	SC	1556	0*	0*	0*	1556
	SE	1327	0	0	0	1327
Catskill (107-124)	SC	1540	0*	0*	0*	1540
	SE	987	0	0	0	987
Albany (125-152)	SC	3	0*	0*	0*	3
	SE	3	0	0	0	3
Stratum Total	SC	5002	560	805	0	6367
	SE	1681	109	201	0	1696

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

9/26/76 - 10/2/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	7	6	18*****	0*	31
	SE	3	6	18	0	19
Tappan Zee (24-33)	SC	265	459	0	0*	724
	SE	90	133	0	0	161
Croton-Haverstraw (34-38)	SC	826	13	6	0*	845
	SE	262	6	6	0	262
Indian Point (39-46)	SC	332	19	21	0*	372
	SE	76	14	13	0	78
West Point (47-55)	SC	198	4***	57	0*	259
	SE	60	2	30	0	67
Cornwall (56-61)	SC	155	15***	92	0*	262
	SE	53	7	44	0	69
Poughkeepsie (62-76)	SC	4	9***	121	0*	134
	SE	4	4	63	0	63
Hyde Park (77-85)	SC	20	0*	0*	0*	20
	SE	19	0	0	0	19
Kingston (86-93)	SC	96	0*	0*	0*	96
	SE	34	0	0	0	34
Saugerties (94-106)	SC	1556	0*	0*	0*	1556
	SE	1327	0	0	0	1327
Catskill (107-124)	SC	1540	0*	0*	0*	1540
	SE	987	0	0	0	987
Albany (125-152)	SC	3	0*	0*	0*	3
	SE	3	0	0	0	3
Stratum Total	SC	5002	525	315	0	5842
	SE	1681	134	86	0	1689

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

10/3/76 - 10/9/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	12	3**	9**	0*	24
	SE	4	3	9	0	10
Tappan Zee (24-33)	SC	154	318**	20**	0*	492
	SE	59	104	13	0	120
Croton-Haverstraw (34-38)	SC	192	53**	29**	0*	274
	SE	75	13	13	0	77
Indian Point (39-46)	SC	112	41**	76**	0*	229
	SE	33	19	42	0	57
West Point (47-55)	SC	59	2**	35**	0*	96
	SE	20	1	21	0	29
Cornwall (56-61)	SC	92	10**	64**	0*	166
	SE	40	5	33	0	52
Poughkeepsie (62-76)	SC	9	5**	77**	0*	91
	SE	4	3	48	0	48
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	3	0	0	0	3
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	163	0*	0*	0*	163
	SE	86	0	0	0	86
Catskill (107-124)	SC	981	0*	0*	0*	981
	SE	668	0	0	0	668
Albany (125-152)	SC	31	0*	0*	0*	31
	SE	27	0	0	0	27
Stratum Total	SC	1808	432	310	0	2550
	SE	683	107	78	0	696

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

10/10/76 - 10/16/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23	SC	12	0	0****	0*	12
	SE	4	0	0	0	4
Tappan Zee (24-33)	SC	154	178	40	0*	372
	SE	59	76	26	0	100
Croton-Haverstraw (34-38)	SC	192	94	52	0*	338
	SE	75	20	21	0	80
Indian Point (39-46)	SC	112	63	131	0*	306
	SE	33	25	72	0	83
West Point (47-55)	SC	59	1***	13	0*	73
	SE	20	1	13	0	24
Cornwall (56-61)	SC	92	6***	36	0*	134
	SE	40	4	22	0	46
Poughkeepsie (62-76)	SC	9	2***	34	0*	45
	SE	4	2	34	0	34
Hyde Park (77-85)	SC	3	0*	0*	0*	3
	SE	3	0	0	0	3
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	163	0*	0*	0*	163
	SE	86	0	0	0	86
Catskill (107-124)	SC	981	0*	0*	0*	981
	SE	668	0	0	0	668
Albany (125-152)	SC	31	0*	0*	0*	31
	SE	27	0	0	0	27
Stratum Total	SC	1808	344	306	0	2458
	SE	683	83	90	0	694

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

10/17/76 - 10/23/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	24	204**	606**	0*	834
	SE	11	64	190	0	201
Tappan Zee (24-33)	SC	199	372**	85**	0*	656
	SE	63	97	44	0	124
Croton-Haverstraw (34-38)	SC	142	160**	414**	0*	716
	SE	48	43	133	0	148
Indian Point (39-46)	SC	16	79**	182**	0*	277
	SE	5	26	105	0	108
West Point (47-55)	SC	25	4**	49**	0*	78
	SE	11	2	28	0	30
Cornwall (56-61)	SC	31	36**	219**	0*	286
	SE	13	16	95	0	97
Poughkeepsie (62-76)	SC	18	2**	32**	0*	52
	SE	18	2	32	0	37
Hyde Park (77-85)	SC	9	0*	0*	0*	9
	SE	1	0	0	0	1
Kingston (86-93)	SC	21	0*	0*	0*	21
	SE	3	0	0	0	3
Saugerties (94-106)	SC	65	0*	0*	0*	65
	SE	52	0	0	0	52
Catskill (107-124)	SC	146	0*	0*	0*	146
	SE	146	0	0	0	146
Albany (125-152)	SC	6	0*	0*	0*	6
	SE	6	0	0	0	6
Stratum Total	SC	702	857	1587	0	3146
	SE	176	128	279	0	354

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

10/24/76 - 10/30/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	24	409	1213*****	0*	1646
	SE	11	128	380	0	401
Tappan Zee (24-33)	SC	199	566	130	0*	895
	SE	63	118	62	0	147
Croton-Haverstraw (34-38)	SC	142	226	777	0*	1145
	SE	48	67	245	0	258
Indian Point (39-46)	SC	16	96	234	0*	346
	SE	5	28	138	0	141
West Point (47-55)	SC	25	7***	85	0*	117
	SE	11	3	44	0	45
Cornwall (56-61)	SC	31	67***	403	0*	501
	SE	13	28	169	0	172
Poughkeepsie (62-76)	SC	18	2***	31	0*	51
	SE	18	2	31	0	36
Hyde Park (77-85)	SC	9	0*	0*	0*	9
	SE	1	0	0	0	1
Kingston (86-93)	SC	21	0*	0*	0*	21
	SE	3	0	0	0	3
Saugerties (94-106)	SC	65	0*	0*	0*	65
	SE	52	0	0	0	52
Catskill (107-124)	SC	146	0*	0*	0*	146
	SE	146	0	0	0	146
Albany (125-152)	SC	6	0*	0*	0*	6
	SE	6	0	0	0	6
Stratum Total	SC	702	1373	2873	0	4948
	SE	176	322	509	0	571

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

10/31/76 - 11/6/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	14	354**	1051**	0*	1419
	SE	5	107	319	0	337
Tappan Zee (24-33)	SC	68	1464**	897**	0*	2429
	SE	36	227	187	0	296
Croton-Haverstraw (34-38)	SC	23	418**	794**	0*	1235
	SE	21	72	374	0	381
Indian Point (39-46)	SC	17	142**	151**	0*	310
	SE	10	30	81	0	87
West Point (47-55)	SC	6	5**	68**	0*	79
	SE	4	3	43	0	43
Cornwall (56-61)	SC	1	65**	393**	0*	459
	SE	1	30	179	0	181
Poughkeepsie (62-76)	SC	26	1**	15**	0*	42
	SE	26	1	15	0	30
Hyde Park (77-85)	SC	2	0*	0*	0*	2
	SE	2	0	0	0	2
Kingston (86-93)	SC	64	0*	0*	0*	64
	SE	64	0	0	0	64
Saugerties (94-106)	SC	33	0*	0*	0*	33
	SE	21	0	0	0	21
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	254	2449	3369	0	6072
	SE	84	265	563	0	628

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

11/7/76 - 11/13/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	14	300	890*****	0*	1204
	SE	5	87	258	0	272
Tappan Zee (24-33)	SC	68	2363	1664	0*	4095
	SE	36	336	313	0	461
Croton-Haverstraw (34-38)	SC	23	610	811	0*	1444
	SE	21	77	504	0	510
Indian Point (39-46)	SC	17	188	68	0*	273
	SE	10	33	25	0	43
West Point (47-55)	SC	6	4***	52	0*	62
	SE	4	3	43	0	43
Cornwall (56-61)	SC	1	64***	383	0*	448
	SE	1	32	190	0	193
Poughkeepsie (62-76)	SC	26	0***	0	0*	26
	SE	26	0	0	0	26
Hyde Park (77-85)	SC	2	0*	0*	0*	2
	SE	2	0	0	0	2
Kingston (86-93)	SC	64	0*	0*	0*	64
	SE	64	0	0	0	64
Saugerties (94-106)	SC	33	0*	0*	0*	33
	SE	21	0	0	0	21
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	254	3529	3868	0	7651
	SE	84	358	676	0	770

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

11/14/76 - 11/20/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	18	537**	1593**	0*	2148
	SE	6	129	382	0	403
Tappan Zee (24-33)	SC	15	1779**	879**	0*	2673
	SE	9	293	192	0	350
Croton-Haverstraw (34-38)	SC	6	691**	789**	0*	1486
	SE	4	141	413	0	436
Indian Point (39-46)	SC	2	218**	93**	0*	313
	SE	1	72	29	0	78
West Point (47-55)	SC	3	3**	37**	0*	43
	SE	2	2	28	0	28
Cornwall (56-61)	SC	0	51**	308**	0*	359
	SE	0	21	128	0	130
Poughkeepsie (62-76)	SC	9	2**	30**	0*	41
	SE	9	2	30	0	31
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	53	3281	3729	0	7063
	SE	15	358	610	0	707

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

11/21/76 - 11/27/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	18	774	2296*****	0*	3088
	SE	6	171	507	0	535
Tappan Zee (24-33)	SC	15	1195	95	0*	1305
	SE	9	251	71	0	261
Croton-Haverstraw (34-38)	SC	6	773	768	0*	1547
	SE	4	205	322	0	382
Indian Point (39-46)	SC	2	248	118	0*	368
	SE	1	112	34	0	117
West Point (47-55)	SC	3	2***	23	0*	28
	SE	2	1	14	0	14
Cornwall (56-61)	SC	0	39***	233	0*	272
	SE	0	11	66	0	67
Poughkeepsie (62-76)	SC	9	4***	60	0*	73
	SE	9	4	60	0	61
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	53	3035	3593	0	6681
	SE	15	383	612	0	722

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

11/28/76 - 12/4/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	18	399**	1183*	0*	1600
	SE	6	91	271	0	286
Tappan Zee (24-33)	SC	22	1048**	87**	0*	1157
	SE	22	278	75	0	289
Croton-Haverstraw (34-38)	SC	43	0*	0*	0*	43
	SE	38	0	0	0	38
Indian Point (39-46)	SC	1	662**	616**	0*	1279
	SE	1	505	371	0	627
West Point (47-55)	SC	3	2**	28**	0*	33
	SE	2	2	23	0	23
Cornwall (56-61)	SC	0	33**	199**	0*	232
	SE	0	13	81	0	82
Poughkeepsie (62-76)	SC	9	3**	46**	0*	58
	SE	9	3	46	0	47
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	96	2147	2159	0	4402
	SE	45	584	475	0	754

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-23 (Contd)

12/5/76 - 12/11/76

Region (River Mile)		Shore Zone	Shoal (10-20')	Bottom	Channel	Regional Totals
Yonkers (12-23)	SC	18	24	71*****	0*	113
	SE	6	12	36	0	38
Tappan Zee (24-33)	SC	22	901	80	0*	1003
	SE	22	306	80	0	317
Croton-Haverstraw (34-38)	SC	43	0*	0*	0*	43
	SE	38	0	0	0	38
Indian Point (39-46)	SC	1	1077	1115	0*	2193
	SE	1	899	708	0	1144
West Point (47-55)	SC	3	3***	33	0*	39
	SE	2	3	33	0	33
Cornwall (56-61)	SC	0	27***	165	0*	192
	SE	0	16	97	0	98
Poughkeepsie (62-76)	SC	9	2***	33	0*	44
	SE	9	2	33	0	34
Hyde Park (77-85)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Kingston (86-93)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Saugerties (94-106)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Catskill (107-124)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Albany (125-152)	SC	0	0*	0*	0*	0
	SE	0	0	0	0	0
Stratum Total	SC	96	2034	1497	0	3627
	SE	45	950	721	0	1193

*No samples collected.

**Standing crop interpolated from adjacent weeks.

***No samples collected in shoals; standing crop estimated by substituting bottom density for shoal density.

****No samples collected in channel; standing crop estimated by substituting bottom density for shoal density.

*****No samples collected in bottom; standing crop estimated by substituting shoal density for bottom density.

Table B-24

Weekly Mean Total Length Estimates for Juvenile White Perch Collected in Beach Seine Sampling during 1965-1976 (Excluding 1971) in Hudson River Estuary

Year	Week	Mean Length (mm)	Number Measured
1965	7/4-7/10	31.3	248
	7/18-7/24	43.4	164
	8/1-8/7	53.6	69
	8/15-8/21	60.0	55
1966	7/10-7/16	27.9	11
	7/24-7/30	31.3	158
	7/31-8/6	49.3	6
	8/7-8/13	44.8	55
	8/14-8/20	55.5	84
	8/21-8/27	50.1	128
1967	7/23-7/29	26.2	96
	7/30-8/5	32.1	153
	8/6-8/12	49.1	84
	8/13-8/19	39.5	168
	8/20-8/26	41.4	114
1968	6/30-7/6	25.0	2
	7/14-7/20	24.7	83
	7/21-7/27	41.1	11
	7/28-8/3	42.0	3
	8/4-8/10	36.1	173
	8/11-8/17	35.2	102
	8/18-8/24	54.1	11
1969	7/6-7/12	36.0	2
	7/27-8/2	51.2	28
	8/3-8/9	50.3	76
	8/10-8/16	54.5	86
	8/17-8/23	58.2	50
	8/24-8/30	62.2	51
1970	7/5-7-11	33.6	12
	7/12-7/18	37.1	254
	7/26-8/1	37.8	88
	8/2-8/8	45.3	36
	8/9-8/15	57.1	25
	8/16-8/22	57.3	19
	8/23-8/29	59.3	432

Table B-24 (Contd)

Year	Week	Mean Total Length (mm)	Number Measured
1972	7/23-7/29	33.2	8
	7/30-8/5	36.0	2
	8/13-8/19	34.1	25
	8/20-8/26	41.6	123
	8/27-9/2	36.3	26
1973	7/1-7/14	21.0	84
	7/15-7/28	31.0	355
	7/29-8/11	43.0	722
	8/12-8/25	53.0	885
1974	7/7-7/13	21.0	46
	7/14-7/20	28.0	90
	7/21-7/27	32.0	71
	7/28-8/3	37.0	97
	8/4-8/10	43.0	213
	8/11-8/17	47.0	242
	8/18-8/24	55.0	364
	8/25-8/31	60.0	287
1975	6/29-7/5	23.8	88
	7/6-7/12	30.1	187
	7/13-7/19	35.0	479
	7/20-7/26	40.0	273
	7/27-8/2	45.2	500
	8/3-8/9	51.7	404
	8/10-8/16	57.1	596
	8/17-8/23	59.8	548
	8/24-8/30	67.0	495
1976	7/11-7/17	24.6	286
	7/25-7/31	33.8	404
	8/8-8/14	44.0	466
	8/22-8/28	52.5	326

Table B-25

Estimates Used for Analysis of Factors Affecting White Perch Growth in the Hudson River Estuary During July and August 1965-1976 (Excluding 1971)

Year	Instantaneous Growth Rate	Juvenile Abundance Index	Mean Freshwater Flow (cfs)	Mean Water Temperature (^oC)
1965	0.0154	12.7	2997.3	24.50
1966	0.0164	18.6	3953.6	25.51
1967	0.0160	34.3	5412.1	24.99
1968	0.0133	11.9	7117.4	24.54
1969	0.0118	24.2	5766.0	24.46
1970	0.0129	22.2	4959.7	24.78
1972	0.0034	4.3	12997.6	23.35
1973	0.0222	20.1	7990.5	24.23
1974	0.0204	6.8	9071.6	23.66
1975	0.0177	26.0	8215.2	24.93
1976	0.0181	25.3	14953.9	23.86

Table B-26

Estimates of Mean Length on 1 August and the Mean Water Temperature and Mean Freshwater Flow during May-July 1965-1976 (Excluding 1971) Used for the Analysis of Factors Affecting Juvenile White Perch Growth in Hudson River Estuary

Year	Predicted Mean Length on 1 August (mm)	Mean Freshwater Flow (cfs)	Mean Water Temperature (°C)
1965	44.7	4988.20	19.75
1966	39.2	10116.56	19.57
1967	31.8	9444.27	18.48
1968	36.1	14663.09	19.81
1969	46.4	12112.74	19.96
1970	47.4	8976.74	19.98
1972	34.5	29510.43	18.20
1973	36.5	17015.52	19.23
1974	35.6	14513.13	18.77
1975	44.1	13478.53	20.23
1976	34.6	20766.70	19.09

Table B-27

Results of Ordinary Least Squares Regression Analyses of Six Selected Environmental Factors on Juvenile White Perch Abundance in the Hudson River Estuary, 1965-1976 (Excluding 1971)

Source	Degrees of Freedom	Sum of Square	Mean Square	F	R
Regression	4	436.94	109.24	1.73	0.536
Error	6	377.88	62.98		
Total	10	814.82			

Regressor	Modified t Statistic
Juvenile Striped Bass Abundance	0.88
May Freshwater Inflow	0.05
June Freshwater Inflow	-0.80
Degree Rise/Day 16°-20°C	-1.74

Prediction equation using standardized regressors:

$$Y = 32.82 + 0.24X_1 - 0.000033X_2 - 0.00065X_3 + 0.70X_4$$

Table B-28

Simple Correlation Coefficients for Juvenile White Perch Abundance and Hudson River Environmental Variables, 1965-1975 and 1965-1976 (Excluding 1971)

	1965-1975	1965-1976
Striped bass juvenile abundance*	+0.345	+0.295
Bluefish juvenile abundance*	-0.514	-0.394
May freshwater inflow**	-0.398	-0.281
June freshwater inflow**	-0.486	-0.439
July freshwater inflow**	-0.626	-0.444
Degree Rise/Day, 16°-20°C	+0.469	+0.491
Power plant water withdrawal***	-0.011	+0.135

*Based on beach seine catch per unit area for river-wide samples from mid-July through August.

**Mean daily freshwater inflow at Green Island Dam, Troy, New York, according to the United States Geological Survey records.

***Based on maximum daily water withdrawal with all units (Lovett, Bowline, Indian Point, Danskammer, and Roseton) operating at 100% capacity.

Table B-29

Correlation Matrix of Independent Variables Used in the Juvenile White Perch Latent Root Regression Analysis

	Striped Bass Juvenile Abundance	Bluefish Juvenile Abundance	May Freshwater Inflow (cfs)	June Freshwater Inflow (cfs)	July Freshwater Inflow (cfs)	Days to Span 16°-20°C	Power Plant Water Withdrawal ($m^3 \times 10^3$/day)
Striped Bass Juvenile Abundance	———						
Bluefish Juvenile Abundance	0.027	———					
May Freshwater Inflow	0.238	0.644	———				
June Freshwater Inflow	0.047	0.499	0.881	———			
July Freshwater Inflow	0.011	0.763	0.911	0.852	———		
Days to Span 16°-20°C	-0.083	0.148	-0.143	-0.056	0.078	———	
Power Plant Water Withdrawal	0.284	0.720	0.421	0.174	0.500	-0.199	———

Table B-30

Calculation of Average Monthly Ratios Used to Adjust 1972 and 1973 Juvenile Atlantic Tomcod Abundance Indices

Year	Month	Dates	Catch in Cod End	Catch in Cod-End Cover	Ratio*
1974	Jul	7/13-7/26	142	146	2.29
		7/27-8/9	191	285	
	Aug	8/10-8/23	198	115	2.25
		8/24-9/6	70	219	
	Sep	9/7-9/20	9	18	2.71
		9/21-10/4	8	11	
1975	Jul	7/13-7/26	116	1491	8.36
		7/27-8/9	133	341	
	Aug	8/10-8/23	448	1163	3.72
		8/24-9/6	173	527	
	Sep	9/7-9/20	100	267	1.84
		9/21-10/4	242	20	
1976	Jul	7/11-7/24	1480	34	1.04
		7/25-8/7	3409	163	
	Aug	8/8-8/21	4566	103	1.03
		8/22-9/4	2972	159	
	Sep	9/5-9/18	1670	76	1.05
		9/19-10/2	1096	59	

	1974	1975	1976	Average Ratio
Jul	2.29	8.36	1.04	3.90
Aug	2.25	3.72	1.03	2.33
Sep	2.71	1.84	1.05	1.87

$$\text{*Monthly Ratio} = \frac{\text{monthly catch in cod end + cod-end cover}}{\text{monthly catch in cod end}}$$

Table B-31

Friedman Analysis of Juvenile Atlantic Tomcod Catch per Unit Effort from July-September, Bottom Trawl Gear

Biweekly Interval*	1969		1970		1972†		1973†		1974		1975		1976	
1	146.3	7**	137.8	6	20.0	3	114.5	5	13.9	2	66.2	4	12.4	1
2	110.3	6	128.0	7	18.7	2	5.4	1	30.5	4	30.2	3	89.0	5
3	135.6	6	105.8	5	50.7	3	34.3	2	9.5	1	93.5	4	168.0	7
4	11.6	3	162.1	7	3.5	1	32.2	4	4.9	2	48.2	5	110.3	6
5	11.2	3	102.0	7	74.7	6	0.3	1.5	0.3	1.5	12.7	4	68.6	5
6	14.4	4	119.9	7	2.5	3	1.6	1	1.7	2	16.0	5	61.2	6
Sum of Ranks		29		39		18		14.5		12.5		25		30

*Dates included in the July-September time periods:

1969	7/6-9/27
1970	7/5-9/26
1972	7/9-9/30
1973	7/15-10/6
1974	7/13-10/4
1975	7/13-10/4
1976	7/11-10/2

**CPUE's were ranked across years

†CPUE's were adjusted for gear differences to be comparable with other years

Table B-32

Distribution — Free Multiple Comparison Using Friedman Rank Sums of Juvenile Atlantic Tomcod C/f from July-September 1969-1976 (Excluding 1971)

Years		1974	1973	1972	1975	1969	1976	1970
	Ranks	12.5	14.5	18	25	29	30	39
1974	12.5	—	2	5.5	12.5	16.5	17.5	26.5**
1973	14.5		—	3.5	10.5	14.5	15.5	24.5*
1972	18			—	7	11	12	21
1975	25				—	4	5	14
1969	29					—	1	10
1976	30						—	9
1970	39							—

*r (0.05, 7,6) = 22

**r (0.009, 7,6) = 25

Table B-33

Number of Marked Atlantic Tomcod Released in the Hudson River Estuary, November 1976-March 1977

	Region								
	RM 24-38 (KM 38-61)		RM 39-46 (KM 62-74)		RM 47-61 (KM 75-98)		RM 62-77 (KM 99-123)		
Release Period	Carlin Tag	Finclip	Carlin Tag	Finclip	Carlin Tag	Finclip	Carlin Tag	Finclip	Total
11/14-11/20	4				2				6
11/21-11/27	10				4				14
11/28-12/4	96				23				119
12/5-12/11	1023	171	1		932	326	240	246	2939
12/12-12/18	25		0		3782	4663	1367	2191	12028
12/19-12/25	0		26		1825	6284	1364	2516	12015
12/26-1/1	946	577	111		2807	1089	1402	391	7323
1/2-1/8	351	294	29		3368	5071	831	678	10622
1/9-1/15	194	245	28		550	5995	380	416	7808
1/16-1/22	30		53		584	2252	347	770	4036
1/23-1/29	48		29		435	263	264	61	1100
1/30-2/5	6		9		822	333	194	159	1523
2/6-2/12	3		18		202	191	66		480
2/13-2/19	1			1	85	111	26	2	226
2/20-2/26		13		3		53		20	89
2/27-3/5		3				19		3	25
3/6-3/12						6		5	11
3/13-3/19						7		7	14
Total	2737	1303	304	4	15421	26663	6481	7465	60378

Table B-34

Equations Used to Calculate Standard Error of Schaefer Estimate

Equation 1

$$\text{Standard error of } \hat{N} = \sqrt{\mathrm{Var}\ (\hat{N})}$$

Equation 2

$$\mathrm{Var}\ (\hat{N}) = \sum_i \sum_j \left[(C_j M_i)/(R_i R_j) - (M_i A_i/R_i^2) - (C_j B_j/R_j^2) \right]^2 \mathrm{Var}\ (R_{ij})$$

where

$$A_i = \sum_j R_{ij} C_j / R_j$$

$$B_j = \sum_i R_{ij} M_i / R_i$$

Equation 3

$$\mathrm{Var}\ (R_{ij}) = \left[R_{ij}^2\ (C_{\cdot} - R_j)\ (M_{\cdot} - R_i) \right] / \ (R_{ij} C_{\cdot} M_{\cdot} - R_i R_j)$$

where

$$C_{\cdot} = \sum_j C_j$$

$$M_{\cdot} = \sum_i M_i$$

Table B-35

Recapture Rates of Atlantic Tomcod Marked by Carlin Tags and Finclips above RM 46, 5 December 1976 to 15 January 1977

		Marking Region			
		RM 47-61 (KM 75-98)		RM 62-77 (KM 99-123)	
Release Period		Carlin Tag	Finclip	Carlin Tag	Finclip
12/ 5-12/18	M*	4714	4989	1607	2437
	R	137	75	21	31
	R/M	0.0291	0.0150	0.0131	0.0127
12/19- 1/ 1	M	4632	7373	2766	2907
	R	43	55	28	24
	R/M	0.0093	0.0075	0.0101	0.0083
1/ 2- 1/15	M	3918	11066	1211	1094
	R	25	70	6	6
	R/M	0.0064	0.0063	0.0050	0.0055

*M = number marked
R = number recaptured
R/M = recapture rate

Table B-36

Atlantic Tomcod Released in Region RM 47-77 (KM 75-123) and Recaptured in Regions RM 24-46 (KM 38-74) and RM 47-77 (KM 75-123), 5 December 1976 through 26 February 1977

		Recapture Period												
Release Period	RM	12/5-12/11	12/12-12/18	12/19-12/25	12/26-1/1	1/2-1/8	1/9-1/15	1/16-1/22	1/23-1/29	1/30-2/5	2/6-2/12	2/13-2/19	2/20-2/26	Total
12/5-12/18	24-46		3	7	5	2	2					3	1	23
	47-77	8	98	51	26	36	14	6	4					243
12/19-1/1	24-46			9	4	6	1	1					1	22
	47-77			22	22	39	21	15	6	2	1			128
1/2-1/15	24-46						2				2			4
	47-77					37	48	8	3	4	2		1	103
1/16-2/26	24-46								1				2	3
	47-77							9	8	18	7	1	1	44

Table B-37

Resident Fractions P_{ij}^{*} of Marked Atlantic Tomcod Remaining in Marking Region RM 47-77 (KM 75-123), 5 December 1976 through 26 February 1977

Recapture Period	Release Period			
	12/5-12/18	12/19-1/1	1/2-1/15	1/16-2/19
12/5-12/11	1.00			
12/12-12/18	0.97			
12/19-12/25	0.56	1.00		
12/26-1/1	0.35	0.83		
1/2-1/8	0.25	0.66	1.00	
1/9-1/15	0.10	0.35	0.64	
1/16-1/22	0.04	0.19	0.17	1.00
1/23-1/29	0.02	0.07	0.10	0.80
1/30-2/5		0.02	0.07	0.61
2/6-2/12		0.01	0.03	0.20
2/13-2/19			0.01	0.05
2/20-2/26			0.01	0.02

* $P_{ij} = \sum_{j=j}^{k} R_{ij} / \sum_{j=1}^{k} R_{ij}$

k = the number of recovery periods.

Table B-38

Date, Day Number and Standing Crop Estimates Used to Determine Mortality Rate for Atlantic Tomcod during 1976

Date	Day No.	Standing Crop Estimate
1/1	1	24,043,754,920*
5/3-5/5	124	168,236,000
5/10-5/13	131	4,285,000
5/17-5/19	138	22,516,000
5/24-5/26	145	21,547,000
6/1-6/4	153	11,208,000
6/7-6/11	160	22,324,000
6/14-6/17	166	16,835,000
6/21-6/24	174	65,551,000
6/28-7/1	180	52,424,000
7/6-7/9	189	34,243,000
7/12-7/15	195	3,263,000
7/26-7/29	208	7,172,000
8/10-8/13	223	11,723,000
12/31	365	14,284,104**

*Estimated number of eggs deposited during 1975-76 tomcod spawning season

**Estimated number of age I tomcod during 1976-77 tomcod spawning season

Table B-39

Juvenile Tomcod Abundance Index and Selected Environmental Variables Used for Correlation Analysis from the Hudson River Estuary 1969-1976 (Excluding 1971)

			Power Plant	Dec‡		Jan		Feb		Mar		Apr	
Year	Juvenile Tomcod Abundance Index *	Juvenile Bluefish Abundance Index**	Water Withdrawal∆ (m³x10³/day)	Temp (°C)†	Flow (cfs)‡	Temp (°C)	Flow (cfs)	Temp (°C)	Flow (cfs)	Temp (°C)	Flow (cfs)	Temp (°C)	Flow (cfs)
1977#				1.30	14078	0.60	7956	0.71	8032	2.64	43542	8.72	40563
1976	78.09	3.41	20616	3.42	18784	0.60	14739	1.19	31255	3.66	31687	8.64	36757
1975	44.64	2.97	15873	1.75	19381	1.34	19068	1.20	19371	3.55	23684	6.89	25583
1974	9.24	4.71	14113	4.05	26419	0.94	22010	0.80	18639	3.27	20733	7.80	30167
1973	30.95	1.28	12019	1.64	27010	0.80	26213	0.60	20464	3.59	29413	8.59	30957
1972	29.83	3.70	5183	3.53	16998	0.98	13412	0.63	10928	1.63	26861	5.96	37963
1970	125.40	0.77	5183	2.82	11801	1.00	8206	1.14	15336	1.98	15059	7.08	39347
1969	76.62	0.08	5183	2.68	15597	1.10	11683	1.59	12762	2.00	17466	7.98	40730

				May		Jun		Jul		Aug	
				Temp (°C)	Flow (cfs)	Temp (°C)	Flow (cfs)	Temp (°C)	Flow (cfs)	Temp (°C)	Flow (cfs)
1977#				14.38	16023	20.32	7325	24.37	5735	25.13	5439
1976	78.09	3.41	20616	13.15	31800	19.65	15223	24.47	15277	23.26	14631
1975	44.64	2.97	15873	14.55	19989	21.24	12973	24.89	7464	24.97	8966
1974	9.24	4.71	14113	14.42	22965	19.01	8791	22.89	11784	24.44	6359
1973	30.95	1.28	12019	13.86	27603	20.12	13053	23.71	10390	24.75	5591
1972	29.83	3.70	5183	12.87	40522	19.33	29630	22.39	18379	24.31	7616
1970	125.40	0.77	5183	15.37	14546	21.05	6387	23.51	5987	26.05	3923
1969	76.62	0.08	5183	14.78	20913	20.97	9995	24.12	5430	24.79	6102

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* Abundance index derived from bottom trawl catch-per-unit effort, July through September.

** Abundance index derived from beach seine catch-per-unit area, mid-July through August.

∆ Based on maximum daily water withdrawal with all units (Lovett, Bowline, Indian Point, Danskammer, and Roseton) operating at 100% capacity.

† Mean daily temperature for the month as recorded at Poughkeepsie Water Works, Poughkeepsie, New York.

‡ Mean daily freshwater inflow at Green Island Dam, Troy, New York, according to United States Gelogical Survey records

‡ December data from previous year.

\# Provisional data.

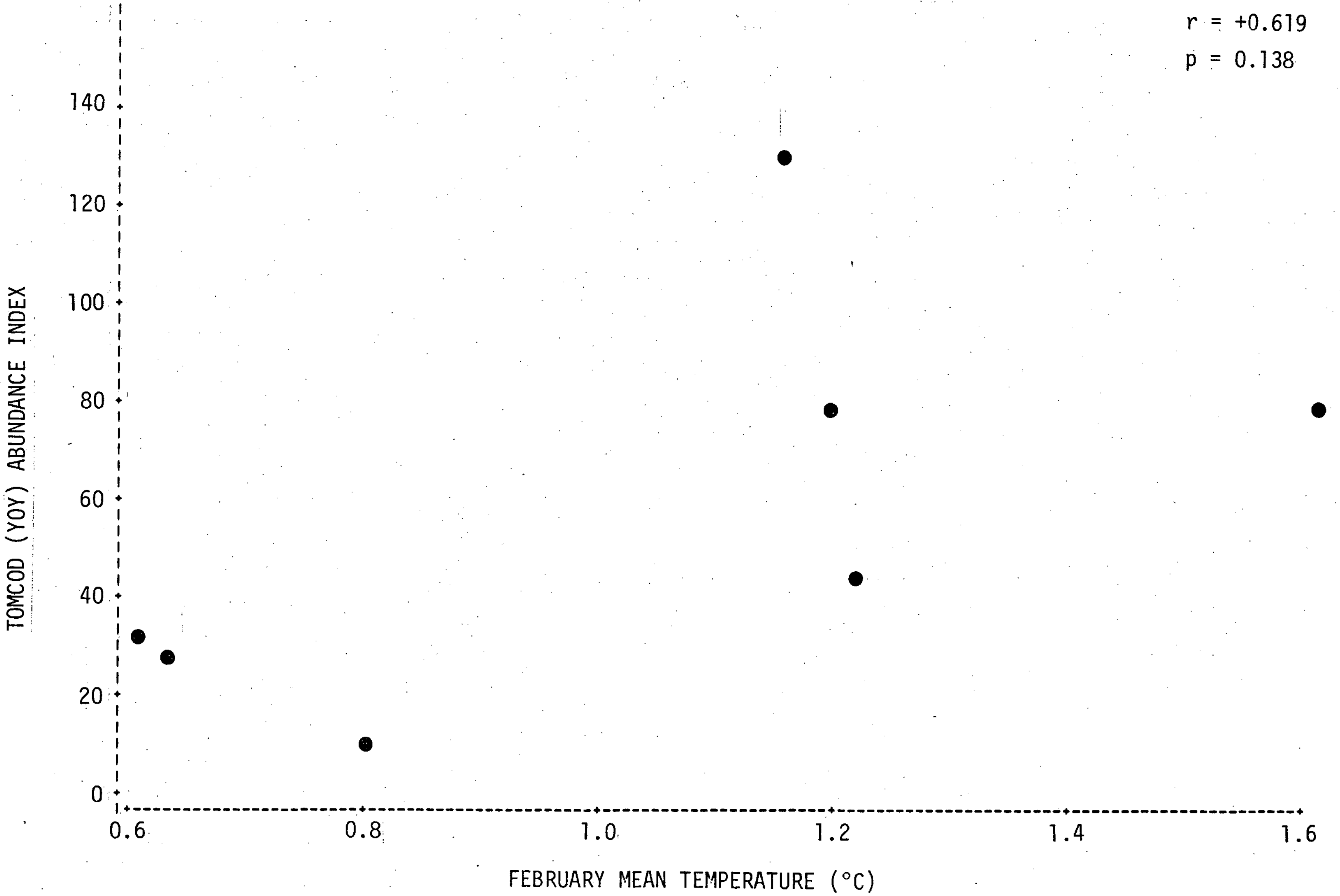

Figure B-2. Relationship Between Atlantic Tomcod Juvenile (YOY) Abundance and Mean Daily Water Temperature in February, Hudson River Estuary, 1969-1976 (Excluding 1971).

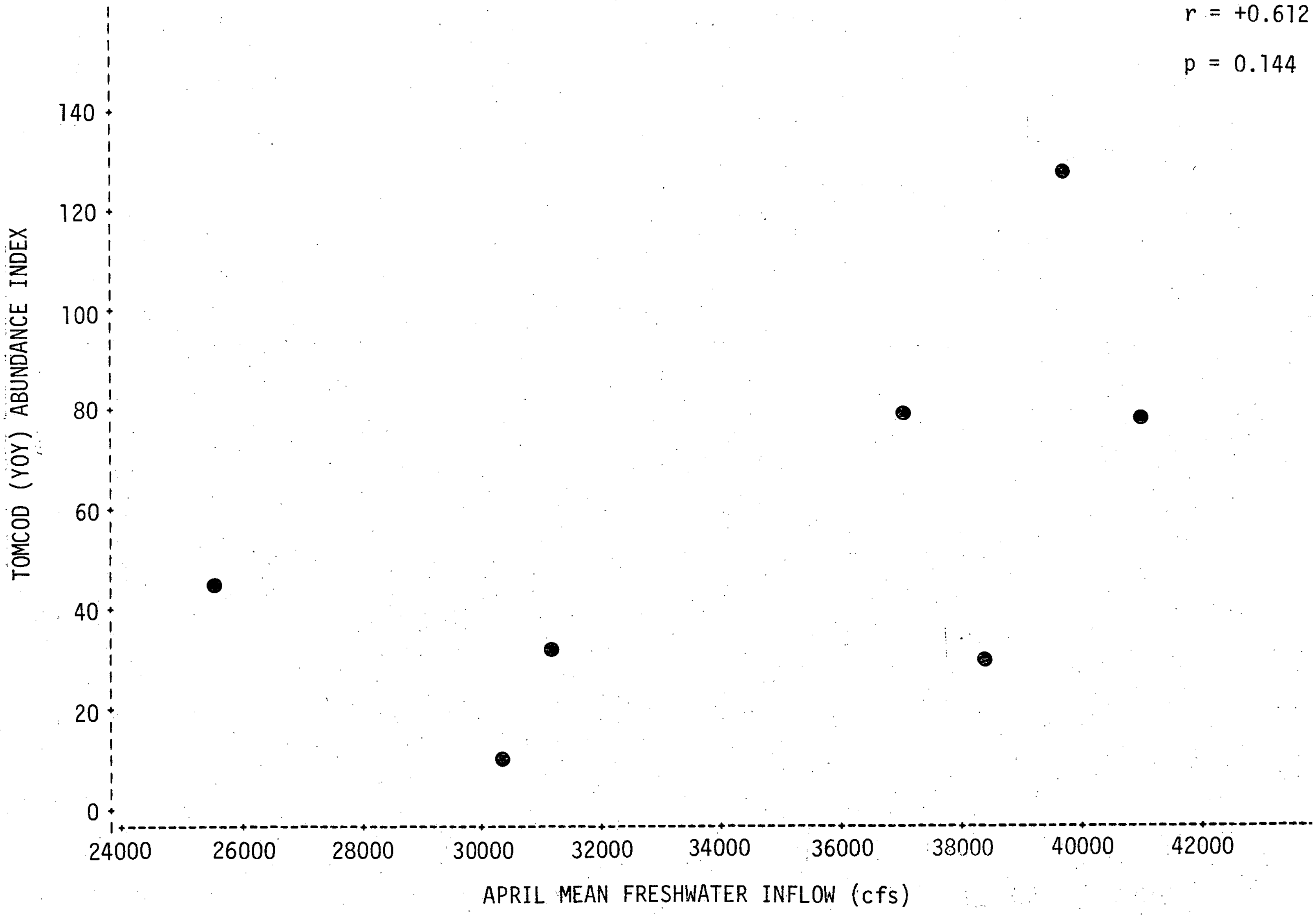

Figure B-3. Relationship Between Atlantic Tomcod Juvenile (YOY) Abundance and April Freshwater Flow, in Hudson River Estuary, 1969-1976 (Excluding 1971)

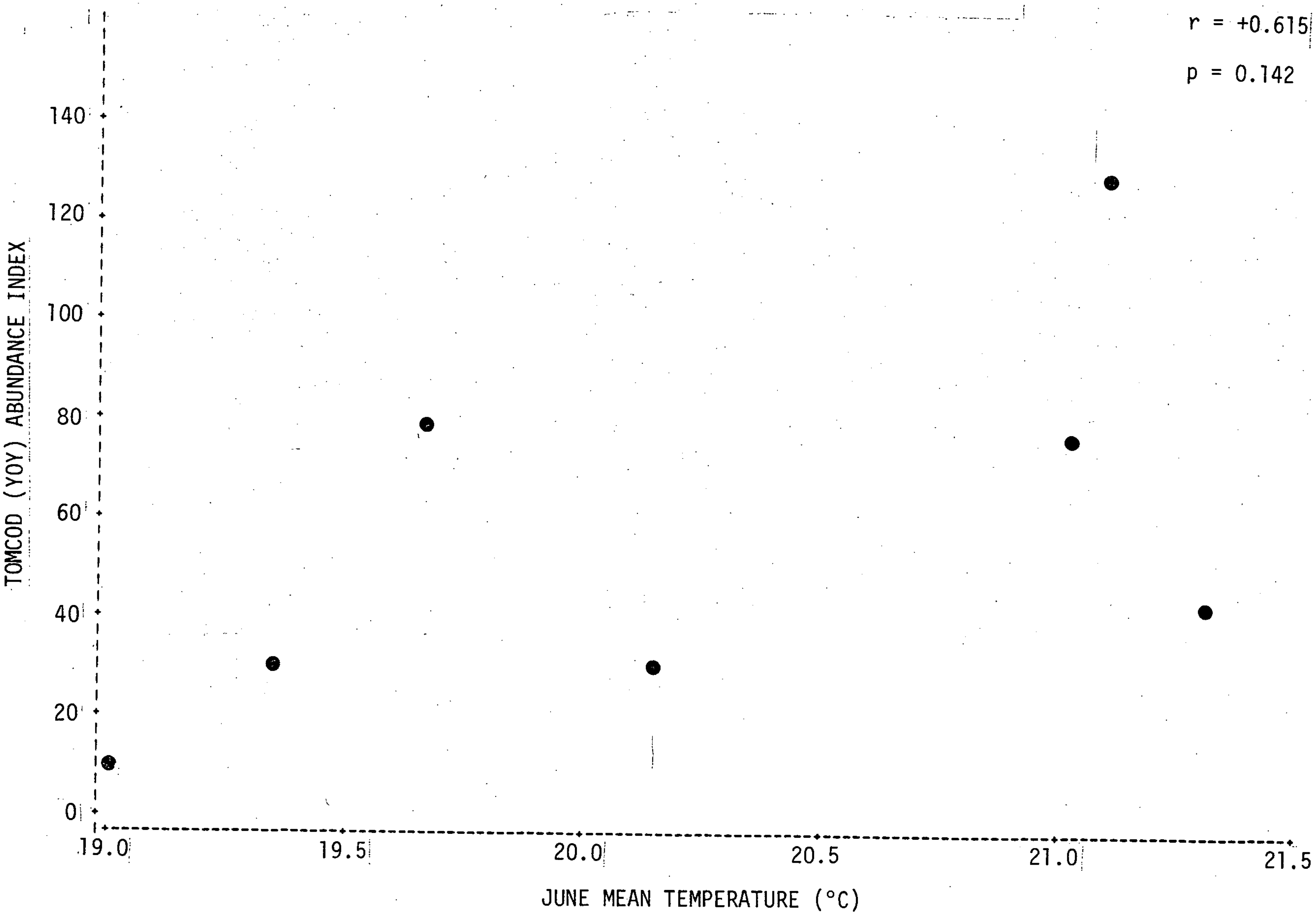

Figure B-4. Relationship Between Atlantic Tomcod Juvenile (YOY) Abundance and Mean Daily Water Temperatures in June, Hudson River Estuary, 1969-1976 (Excluding 1972).

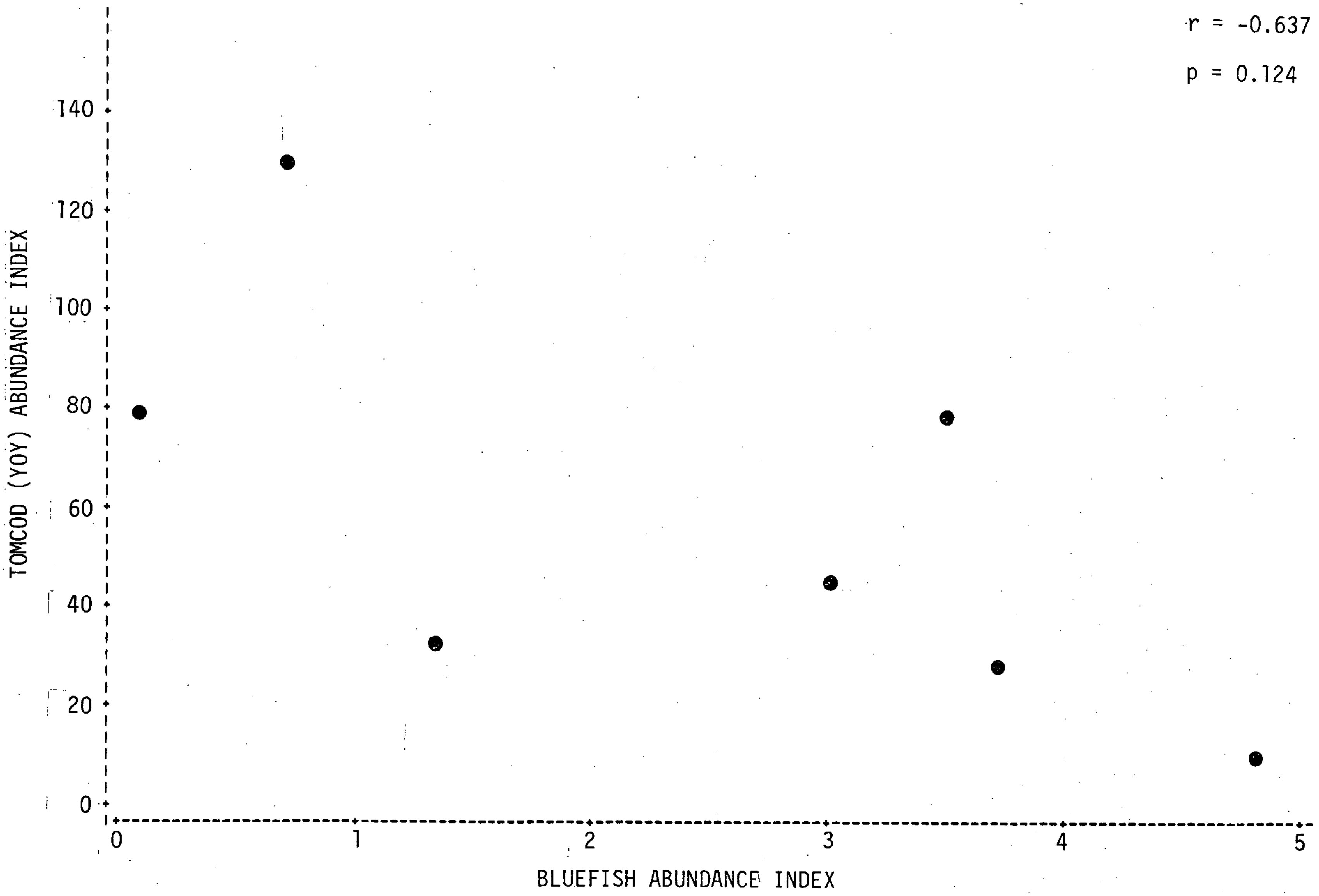

Figure B-5. Relationship Between Atlantic Tomcod Juvenile (YOY) Abundance and Juvenile (YOY) Bluefish Abundance, Hudson River Estuary, 1969-1976 (Excluding 1971)

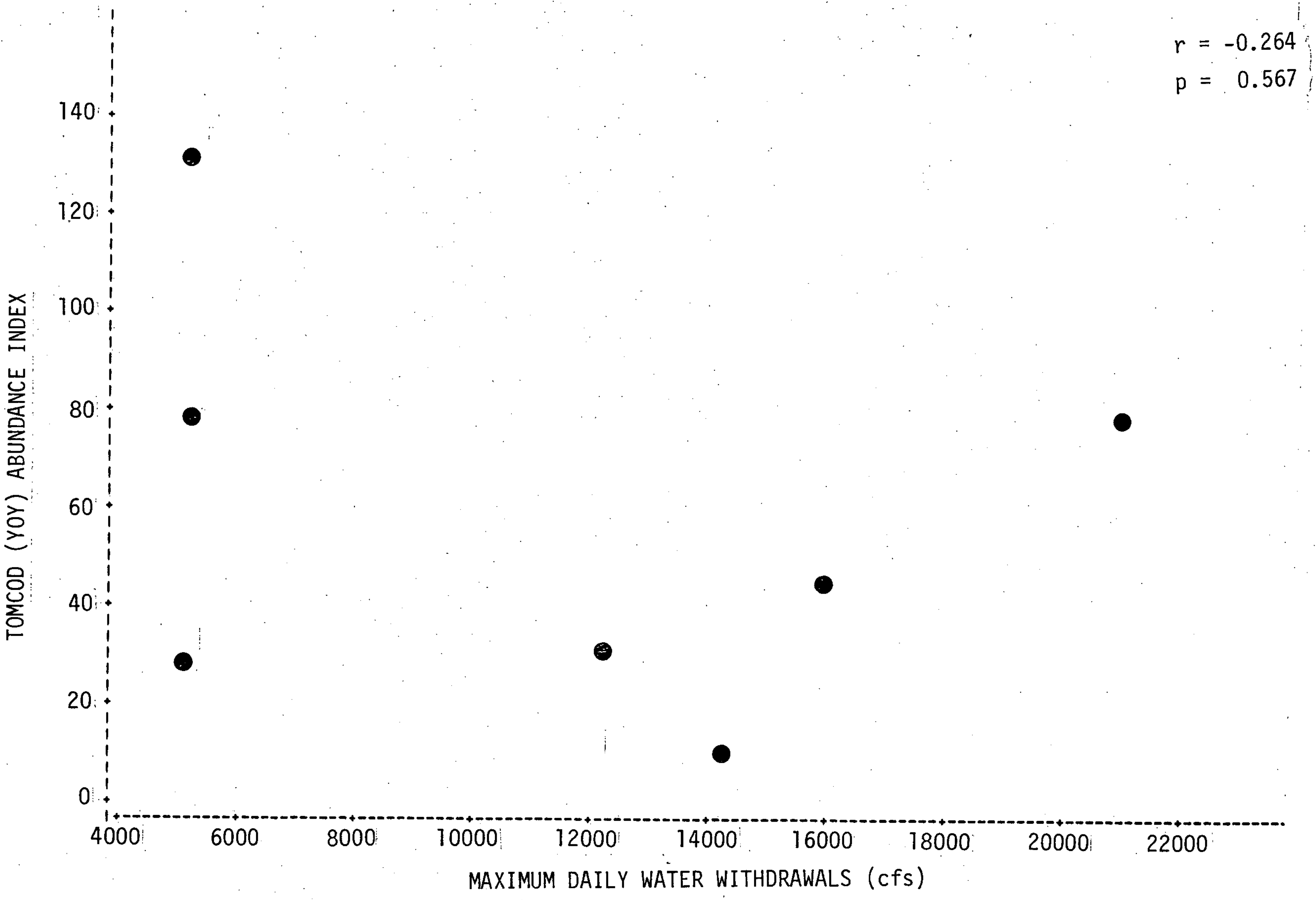

Figure B-6. Relationship Between Atlantic Tomcod Juvenile (YOY) Abundance and Maximum Daily Water Withdrawal for All Units (Lovett, Bowline, Indian Point, Danskammer, and Roseton) Operating at 100% Capacity, 1969-1976 (Excluding 1971)

Table B-40

Number of White Perch, by Age, Caught* in Bottom Trawls in Hudson River Estuary during October-December 1974-1976

	Year		
Age	1974	1975	1976
I	269	151	379
II	11	81	121
III	19	11	23
IV	6	11	15
V	1	4	3
VI		1	

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*Since not all white perch are subsampled for aging, monthly age date were weighted by the number caught in length groups 2 through 4 (see Section III-C-2 for additional information) to determine the total number caught by age.

Table B-41

Results of Marking Survival Tests used to Derive Marking Survival Adjustments for Fin-Clipped Fish

Start Date	Number at Start of Test	Number Surviving After 14 Days	Percent Survival
		Striped Bass	
9-15-76	20	19	95
10-9-74	20	15	75
10-9-74	20	16	80
10-9-74	20	13	65
10-10-74	50	47	81
Total	118	91	77
11	(see October)		
		White Perch	
9-21-76	21	21	100
10-22-75	19	18*	95
11	(see October)		

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*Mortality actually occurred after 14th day of the test.

APPENDIX C

Appendix C contains details and supportive data related to distribution, movements, and exposure (vulnerability) to power plants discussed in Section V.

Table C-1

Estimated Density (No./1000 m^3) of Striped Bass Eggs in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.0	9.296	8.700	0.105	0.0	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	0.0	0.0	0.0	3.605	4.833	0.105	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.0	10.138	91.924	126.469	3.104	1.895	2.617	1.073	0.0	0.0	0.0
5/13	SE	0.0	0.0	2.471	20.204	75.655	1.028	1.303	1.162	1.073	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.079	1.537	43.934	96.743	49.782	15.919	11.478	62.200	104.546	1.786	7.384	90.357
5/19	SE	0.079	0.571	12.828	24.020	19.648	7.170	5.539	18.697	30.723	0.459	3.583	38.346
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-1 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	0.423	0.406	1.841	57.024	24.300	2.032	2.148	1.752	3.785	0.0	35.425	9.811
5/26	SE	0.365	0.262	0.884	17.835	9.319	1.888	1.049	0.723	1.662	0.0	29.305	3.278
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	0.0	0.859	8.665	48.267	7.655	1.212	6.537	15.665	0.0	2.905	2.193
6/ 4	SE	0.0	0.0	0.304	2.265	16.659	4.800	0.685	4.518	4.025	0.0	2.905	1.099
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	0.0	0.181	3.537	36.668	62.647	7.874	1.041	3.234	10.010	26.896	0.0
6/11	SE	0.0	0.0	0.181	1.988	9.370	33.802	3.956	0.771	2.378	9.417	10.668	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	0.0	0.0	1.188	6.393	1.460	3.429	2.064	0.0	0.0	0.876	0.0
6/17	SE	0.0	0.0	0.0	0.649	2.206	0.713	2.994	1.300	0.0	0.0	0.876	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.0	0.0	0.423	1.736	0.085	0.0	0.0	0.0	0.0	0.0	0.0
6/24	SE	0.0	0.0	0.0	0.267	0.617	0.060	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

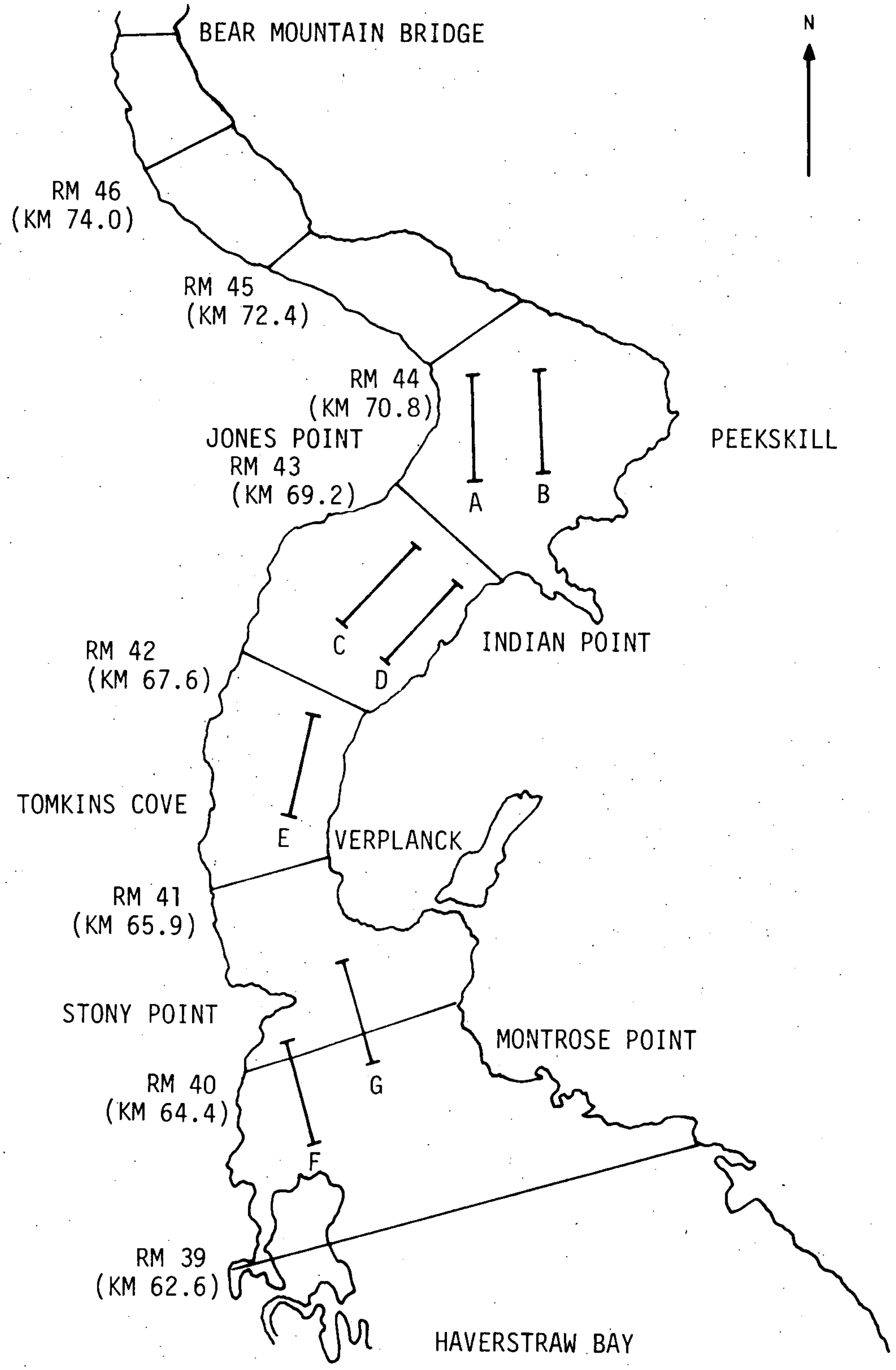

Figure C-1. New York University Indian Point Nearfield Study Sampling Sites during 1975.

Table C-2

Estimated Standing Crops (in Thousands) of Striped Bass Eggs in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	0	0	1936	1804	15	0	0	0	0	0	0	3756
5/ 5	SE	0	0	0	751	1002	15	0	0	0	0	0	0	1253
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	0	1497	19148	26230	434	565	433	152	0	0	0	48459
5/13	SE	0	0	365	4208	15691	144	389	192	152	0	0	0	16257
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	18	495	6489	20152	10325	2225	3423	10294	14793	315	1187	6424	76139
5/19	SE	18	184	1895	5003	4075	1002	1652	3094	4347	81	576	2726	9233
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-2 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	97	131	272	11878	5040	284	641	290	536	0	5693	698	25558
5/26	SE	84	84	131	3715	1933	264	313	120	235	0	4709	233	6328
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	0	127	1805	10010	1070	361	1082	2217	0	467	156	17295
6/ 4	SE	0	0	45	472	3455	671	204	748	570	0	467	78	3710
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	0	27	737	7605	8758	2348	172	458	1765	4322	0	26191
6/11	SE	0	0	27	414	1943	4725	1180	128	336	1660	1714	0	5788
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	0	0	247	1326	204	1022	342	0	0	141	0	3282
6/17	SE	0	0	0	135	458	100	893	215	0	0	141	0	1049
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	0	0	88	360	12	0	0	0	0	0	0	460
6/24	SE	0	0	0	56	128	8	0	0	0	0	0	0	140
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 1	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 9	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-3

Results of Analysis of Variance, Distribution of Striped Bass Eggs, Indian Point Study, 1976

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Prob F Exceeded	R-Square
Model	29	4.46034200	0.15380490	2.63	0.0400	0.863975
Error	12	0.70224010	0.05852001		0.24190909	
Corrected Total	41	5.16258210				
Diel	1	0.06580599		1.12	0.3098	
Site	6	1.55900001		4.44	0.0136	
Depth	2	0.80555450		6.88	0.0102	
Diel*Site	6	0.31189369		0.89	0.5326	
Diel*Depth	2	0.20566516		1.76	0.2141	
Site*Depth	12	1.51242266		2.15	0.0992	

Table C-4

Estimated Density (No./1000 m^3) of Striped Bass Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.0	0.0	0.0	0.423	0.0	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.299	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.185	2.981	1.640	0.635	1.475	1.779	0.142	0.0	0.0	0.0	0.0
5/13	SE	0.0	0.101	0.628	0.533	0.420	0.641	0.799	0.142	0.0	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	2.760	66.330	65.315	188.448	114.392	55.807	41.305	6.578	3.796	0.0	0.0	0.710
5/19	SE	0.884	14.657	18.760	33.816	26.499	8.121	16.090	1.838	1.827	0.0	0.0	0.710
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-4 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	2.533	25.958	24.391	18.090	6.722	2.035	0.555	0.0	0.0	0.0	0.0	0.0
5/26	SE	0.998	5.855	6.332	5.516	2.284	0.966	0.360	0.0	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	1.224	10.032	43.143	27.550	39.226	69.715	17.426	12.055	2.028	0.0	0.0
6/ 4	SE	0.0	0.552	3.308	4.429	4.889	7.702	15.796	4.581	3.698	1.182	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	6.219	18.764	70.973	82.152	80.920	118.909	51.363	14.300	35.824	2.767	0.0
6/11	SE	0.0	3.773	4.724	10.836	9.793	15.228	20.229	20.874	3.118	10.491	0.820	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	0.0	23.976	124.112	174.015	120.895	115.906	134.331	49.356	22.127	13.734	0.0
6/17	SE	0.0	0.0	13.688	15.330	30.101	43.437	27.856	39.190	14.436	3.778	8.965	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.529	0.590	16.717	53.642	1.210	0.0	0.0	0.0	0.0	0.0	0.0
6/24	SE	0.0	0.529	0.371	2.682	10.090	0.813	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.0	0.0	0.256	0.852	0.214	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	0.0	0.0	0.0	0.172	0.363	0.214	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.102	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-5

Estimated Standing Crops (in Thousands) of Striped Bass Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	0	0	0	0	59	0	0	0	0	0	0	59
5/ 5	SE	0	0	0	0	0	42	0	0	0	0	0	0	42
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	59	440	342	132	206	531	24	0	0	0	0	1733
5/13	SE	0	32	93	111	87	90	238	24	0	0	0	0	308
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	633	21345	9647	39254	23725	7802	12317	1089	537	0	0	51	116399
5/19	SE	203	4717	2771	7044	5496	1135	4798	304	258	0	0	51	11587
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-5 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	581	8353	3603	3768	1394	285	165	0	0	0	0	0	18150
5/26	SE	229	1884	935	1149	474	135	107	0	0	0	0	0	2460
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	394	1482	8987	5714	5484	20789	2884	1706	358	0	0	47796
6/ 4	SE	0	178	489	923	1014	1077	4710	758	523	208	0	0	5137
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	2001	2771	14784	17038	11313	35459	8501	2024	6316	445	0	100651
6/11	SE	0	1214	698	2257	2031	2129	6032	3455	441	1850	132	0	8226
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	0	3541	25853	36091	16901	34563	22232	6984	3901	2207	0	152272
6/17	SE	0	0	2022	3193	6243	6073	8307	6486	2043	666	1441	0	14418
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	170	87	3482	11125	169	0	0	0	0	0	0	15034
6/24	SE	0	170	55	559	2093	114	0	0	0	0	0	0	2176
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	0	0	53	177	30	0	0	0	0	0	0	260
7/ 1	SE	0	0	0	36	75	30	0	0	0	0	0	0	89
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 9	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	33	0	0	0	0	0	0	0	0	0	0	33
7/29	SE	0	33	0	0	0	0	0	0	0	0	0	0	33
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-6

Results of Analysis of Variance, Distribution of Striped Bass Yolk-Sac Larvae, Indian Point Study, 1976

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Prob. F Exceeded	R-Square
Model	161	4.81293837	0.02989403	1.96	0.0038	0.868229
Error	48	0.73046034	0.01521792			
Corrected Total	209	5.54339871				
Week	4	0.37422131		6.15	0.0004	
Diel	1	0.20662391		13.58	0.0006	
Site	6	0.22479896		2.46	0.0372	
Depth	2	0.78372882		25.75	0.0001	
Week*Diel	4	0.26197382		4.30	0.0047	
Week*Site	24	0.71799372		1.97	0.0231	
Week*Depth	8	0.15790082		1.30	0.2677	
Diel*Site	6	0.10896756		1.19	0.3259	
Diel*Depth	2	0.06290333		2.07	0.1377	
Site*Depth	12	0.32688314		1.79	0.0771	
Week*Diel*Site	24	0.48737040		1.33	0.1945	
Week*Diel*Depth	8	0.24960374		2.05	0.0600	
Week*Site*Depth	48	0.71334869		0.98	0.5326	
Diel*Site*Depth	12	0.13662015		0.75	0.6981	

Table C-7

Estimated Density (No./1000 m^3) of Striped Bass Post Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/19	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-7 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	0.0	0.145	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/26	SE	0.0	0.145	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	0.457	1.924	1.323	0.159	0.0	0.216	0.0	0.0	0.0	0.0	0.0
6/ 4	SE	0.0	0.457	1.121	0.414	0.111	0.0	0.216	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	9.204	8.769	5.936	9.086	6.084	49.879	6.052	0.612	0.0	0.0	0.0
6/11	SE	0.0	6.422	2.112	1.573	2.235	1.693	10.837	3.038	0.463	0.0	0.0	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	47.984	97.309	275.351	258.899	211.890	121.490	166.023	45.972	7.757	0.0	0.0
6/17	SE	0.0	14.830	16.543	31.643	43.244	52.638	34.581	79.458	14.622	4.186	0.0	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	1.626	19.413	303.242	319.544	191.083	83.833	34.952	12.409	18.877	1.195	0.787	0.0
6/24	SE	1.626	7.406	63.593	36.951	14.740	12.465	14.568	2.963	9.027	0.738	0.787	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.612	18.310	60.248	106.029	18.229	9.824	10.291	8.295	3.110	0.897	0.0	0.0
7/ 1	SE	0.612	14.360	11.230	19.869	2.682	3.253	3.818	3.030	1.351	0.897	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	3.423	7.398	11.332	3.601	6.343	1.733	1.437	2.405	2.112	0.263	0.0	0.0
7/ 9	SE	1.604	3.648	4.342	1.007	1.965	0.553	0.821	0.744	1.216	0.263	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	3.241	0.505	0.272	0.733	1.090	0.415	1.164	0.0	0.0	0.420	0.0
7/15	SE	0.0	0.900	0.297	0.202	0.455	0.592	0.415	0.879	0.0	0.0	0.420	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-8

Estimated Standing Crops (in Thousands) of Striped Bass Post Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
Date		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
2/23-2/27	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	6	10	14	18	26	16	3	0	0	0	0	0	93
3/1-3/5	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	6	10	14	18	26	16	10	0	0	0	0	0	100
3/8-3/11	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-3/25	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	6	11	13	18	26	16	10	0	0	0	0	0	100
4/5-4/8	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-4/21	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-4/29	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	16	34	27	24	16	20	24	14	11	11	8	3	208
5/3-5/5	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-5/13	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-5/19	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	18	33	26	27	17	21	24	16	9	13	7	4	215
5/24-5/26	SC	0	47	0	0	0	0	0	0	0	0	0	0	47
	SE	0	47	0	0	0	0	0	0	0	0	0	0	47
	Tows	15	31	27	26	17	21	24	16	11	11	8	4	211
6/1-6/4	SC	0	147	284	276	33	0	64	0	0	0	0	0	804
	SE	0	147	166	86	23	0	64	0	0	0	0	0	247
	Tows	4	10	27	51	39	32	16	10	10	6	5	3	213
6/7-6/11	SC	0	2962	1295	1237	1884	850	14874	1002	87	0	0	0	24191
	SE	0	2066	312	328	463	237	3231	503	66	0	0	0	3930
	Tows	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-6/17	SC	0	15441	14373	57356	53696	29622	36228	27477	6505	1368	0	0	242065
	SE	0	4772	2443	6591	8969	7359	10312	13150	2069	738	0	0	22156
	Tows	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-6/24	SC	373	6247	44789	66561	39631	11720	10423	2054	2671	211	126	0	184805
	SE	373	2383	9393	7697	3057	1743	4344	490	1277	130	126	0	13654
	Tows	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-7/1	SC	141	5892	8899	22086	3781	1373	3069	1373	440	158	0	0	47211
	SE	141	4621	1659	4139	556	455	1138	501	191	158	0	0	6586
	Tows	8	37	29	35	21	20	21	14	12	8	9	1	215
7/6-7/9	SC	786	2381	1674	750	1316	242	429	398	299	46	0	0	8320
	SE	368	1174	641	210	408	77	245	123	172	46	0	0	1499
	Tows	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-7/15	SC	0	1043	75	57	152	152	124	193	0	0	68	0	1863
	SE	0	290	44	42	94	83	124	146	0	0	68	0	380
	Tows	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-7/29	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-8/13	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-9

Results of Analysis of Variance, Distribution of Striped Bass Post Yolk-Sac Larvae, Indian Point Study, 1976

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Problem F Exceeded	R-Square
Model	101	8.67909898	0.08593167	1.33	0.2173	0.847977
Error	24	1.55596026	0.06483168			
Corrected Total	125	10.23505923				
Week	2	0.37167798		2.87	0.0765	
Diel	1	0.08706689		1.34	0.2579	
Site	6	0.75323971		1.94	0.1157	
Depth	2	2.02835542		15.64	0.0001	
Week*Diel	2	0.06813363		0.53	0.5979	
Week*Site	12	0.75283106		0.97	0.5034	
Week*Depth	4	0.21190071		0.82	0.5269	
Diel*Site	6	0.19252623		0.49	0.8057	
Diel*Depth	2	0.27907464		2.15	0.1381	
Site*Depth	12	1.01948921		1.31	0.2755	
Week*Diel*Site	12	0.83034974		1.07	0.4267	
Week*Diel*Depth	4	0.16242706		0.63	0.6483	
Week*Site*Depth	24	0.88736506		0.57	0.9119	
Diel*Site*Depth	12	1.03466163		1.33	0.2656	

Table C-10

Estimated Density (No./1000 m^3) of Striped Bass Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
Date		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-2/27	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	6	10	14	18	26	16	3	0	0	0	0	0
3/1-3/5	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	6	10	14	18	26	16	10	0	0	0	0	0
3/8-3/11	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	6	10	13	18	26	16	10	0	0	0	0	0
3/22-3/25	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	6	11	13	18	26	16	10	0	0	0	0	0
4/5-4/8	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	6	10	14	17	26	16	10	0	0	0	0	0
4/19-4/21	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	12	19	17	16	15	20	22	15	11	15	4	3
4/26-4/29	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	16	34	27	24	16	20	24	14	11	11	8	3
5/3-5/5	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	18	32	27	26	16	21	24	16	11	11	8	4
5/10-5/13	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	18	33	26	25	16	22	24	15	11	11	8	4
5/17-5/19	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	18	33	26	27	17	21	24	16	9	13	7	4
5/24-5/26	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	15	31	27	26	17	21	24	16	11	11	8	4
6/1-6/4	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	4	10	27	51	39	32	16	10	10	6	5	3
6/7-6/11	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	4	10	26	49	40	32	16	10	11	5	4	3
6/14-6/17	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	4	10	24	51	41	31	17	10	9	7	6	2
6/21-6/24	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	4	10	27	51	39	31	17	12	8	6	5	3
6/28-7/1	Den	0.0	0.0	0.0	0.032	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.032	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	8	37	29	35	21	20	21	14	12	8	9	1
7/6-7/9	Den	1.330	1.494	1.088	0.374	1.006	0.661	0.340	1.299	0.172	0.0	0.513	0.0
	SE	1.330	0.816	0.476	0.250	0.563	0.661	0.340	1.022	0.172	0.0	0.513	0.0
	Tows	8	37	30	34	20	21	21	13	13	8	8	2
7/12-7/15	Den	0.0	2.069	1.131	2.786	0.287	2.847	0.0	0.873	0.759	0.714	0.0	0.0
	SE	0.0	0.902	0.874	1.963	0.215	1.342	0.0	0.615	0.540	0.492	0.0	0.0
	Tows	8	37	29	34	21	21	21	12	14	8	8	2
7/26-7/29	Den	0.0	6.380	10.391	1.280	0.0	0.378	0.274	0.0	0.646	0.567	0.0	0.0
	SE	0.0	2.140	2.743	0.792	0.0	0.294	0.198	0.0	0.646	0.394	0.0	0.0
	Tows	7	37	29	34	21	21	21	14	12	8	8	2
8/10-8/13	Den	0.644	2.515	0.776	0.444	0.194	0.0	0.0	0.0	0.214	0.0	0.0	0.0
	SE	0.644	0.774	0.273	0.208	0.194	0.0	0.0	0.0	0.214	0.0	0.0	0.0
	Tows	8	37	29	34	20	21	21	13	13	8	8	2

Table C-11

Estimated Standing Crops (in Thousands) of Striped Bass Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213

Table C-11 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/17-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/19	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215
5/24-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/ 4	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	0	0	7	0	0	0	0	0	0	0	0	7
7/ 1	SE	0	0	0	7	0	0	0	0	0	0	0	0	7
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	305	481	161	78	209	92	101	215	24	0	82	0	1749
7/ 9	SE	305	262	70	52	117	92	101	169	24	0	82	0	488
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	666	167	580	59	398	0	144	107	126	0	0	2248
7/15	SE	0	290	129	409	45	188	0	102	76	87	0	0	574
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	2053	1535	267	0	53	82	0	91	100	0	0	4180
7/29	SE	0	689	405	165	0	41	59	0	91	69	0	0	827
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	148	809	115	93	40	0	0	0	30	0	0	0	1235
8/13	SE	148	249	40	43	40	0	0	0	30	0	0	0	300
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-12

Estimated Density (No./1000 m^3) of Striped Bass Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined by Fall Shoals Survey, 1976

		Region						
Date		YK	TZ	CH	IP	WP	CW	PK
8/16-8/20	Den	19.834	35.735	7.592	1.683	0.0	0.778	0.0
	SE	4.990	8.301	1.815	1.252	0.0	0.477	0.0
	Tows	7	26	36	19	5	5	5
8/30-9/3	Den	11.093	16.565	13.364	1.399	0.378	0.0	0.0
	SE	6.856	2.670	6.331	0.407	0.378	0.0	0.0
	Tows	7	26	35	20	5	5	5
9/13-9/16	Den	0.952	13.542	8.098	0.253	0.0	0.0	0.0
	SE	0.619	3.941	2.566	0.196	0.0	0.0	0.0
	Tows	7	26	37	18	5	5	5
9/27-10/1	Den	20.095	7.705	1.763	0.501	0.0	0.0	0.409
	SE	7.992	2.030	0.601	0.247	0.0	0.0	0.409
	Tows	7	26	36	19	5	5	5
10/11-10/14	Den	3.826	8.966	1.087	0.101	0.0	0.0	0.0
	SE	1.646	3.099	0.322	0.068	0.0	0.0	0.0
	Tows	7	26	36	19	5	5	5
10/25-10/28	Den	2.917	0.639	0.077	0.252	0.0	0.579	0.0
	SE	0.978	0.195	0.077	0.252	0.0	0.579	0.0
	Tows	8	43	24	13	5	5	5
11/8-11/12	Den	2.837	0.377	0.622	0.105	0.0	0.0	0.0
	SE	1.285	0.128	0.283	0.105	0.0	0.0	0.0
	Tows	6	43	24	13	6	4	5
11/21-11/24	Den	3.175	0.246	0.0	0.214	0.0	0.0	0.0
	SE	0.935	0.149	0.0	0.214	0.0	0.0	0.0
	Tows	8	42	24	13	5	5	5
12/6-12/8	Den	6.050	0.084	0.0	0.0	0.0	0.0	0.0
	SE	1.657	0.084	0.0	0.0	0.0	0.0	0.0
	Tows	8	29	0	6	5	5	5

Table C-13

Estimated Standing Crops (in Thousands) of Striped Bass Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region							
Date		YK	TZ	CH	IP	WP	CW	PK	Total
8/16-8/20	SC	530	6568	656	77	0	35	0	7866
	SE	133	1526	157	58	0	21	0	1541
	Tows	7	26	36	19	5	5	5	103
8/30-9/3	SC	296	3045	1155	64	11	0	0	4571
	SE	183	491	547	19	11	0	0	758
	Tows	7	26	35	20	5	5	5	103
9/13-9/16	SC	25	2489	700	12	0	0	0	3226
	SE	17	724	222	9	0	0	0	758
	Tows	7	26	37	18	5	5	5	103
9/27-10/1	SC	537	1416	152	23	0	0	28	2156
	SE	213	373	52	11	0	0	28	434
	Tows	7	26	36	19	5	5	5	103
10/11-10/14	SC	102	1648	94	5	0	0	0	1849
	SE	44	570	28	3	0	0	0	572
	Tows	7	26	36	19	5	5	5	103
10/25-10/28	SC	78	117	7	12	0	26	0	240
	SE	26	36	7	12	0	26	0	53
	Tows	8	43	24	13	5	5	5	103
11/8-11/12	SC	76	69	54	5	0	0	0	204
	SE	34	24	24	5	0	0	0	49
	Tows	8	43	24	13	6	4	5	103
11/21-11/24	SC	85	45	0	10	0	0	0	140
	SE	25	27	0	10	0	0	0	38
	Tows	8	42	24	13	5	5	5	102
12/6-12/8	SC	162	15	0	0	0	0	0	177
	SE	44	15	0	0	0	0	0	47
	Tows	8	29	0	6	5	5	5	58

Table C-14

Estimated Standing Crops of Striped Bass Juveniles in 12 Geographic Regions of Hudson River Estuary (RM 12-152; KM 19-243) Determined from 100-Ft (30.5-m) Beach Seine during Daytime, 1976

		Region												
Dates		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
6/27- 7/10	SC	342	83299	11525	8601	36419	13610	788	0	10761	6583	0	0	171928
	SE	342	77483	6097	4839	19830	12383	788	0	8148	6583	0	0	81983
	Tows	22	24	28	30	22	18	9	5	4	8	11	19	200
7/11- 7/24	SC	55889	230207	405928	36072	21639	149648	17148	7794	77480	12540	7568	0	1021911
	SE	12329	134891	275082	10370	9470	40066	7979	5196	34436	6312	4191	0	311695
	Tows	19	15	21	35	19	20	12	7	2	7	13	20	190
7/25- 8/ 7	SC	64485	195106	180053	60964	19240	98366	7096	6407	15066	50159	21315	2038	720293
	SE	10672	70428	56691	12570	8936	39638	4097	3753	7351	26103	10954	1113	104806
	Tows	16	17	23	39	20	17	10	6	4	7	12	20	191
8/ 8- 8/21	SC	76640	483052	200070	67504	6658	57015	25544	1653	2152	70222	44973	9058	1044540
	SE	18245	140846	34475	19893	2079	16914	13961	762	2152	24153	16937	6771	152188
	Tows	17	19	25	40	19	17	10	6	4	8	14	18	197
8/22- 9/ 4	SC	81513	382193	213336	26909	29242	30622	10052	1447	14348	12540	4919	1853	808974
	SE	13159	103745	127555	4498	10634	10690	3950	745	2870	6312	2569	1354	165912
	Tows	17	17	15	50	21	16	12	6	3	7	12	22	198
9/ 5- 9/18	SC	94139	213814	224903	36862	13068	31469	4257	1653	5739	23407	13117	8492	670111
	SE	13671	45563	59180	7444	2777	9257	1738	1094	5739	15483	6559	8492	79410
	Tows	28	17	18	51	24	22	5	3	3	3	6	8	188
9/19-10/ 2	SC	120498	342103	342613	30885	13837	13519	4257	0	0	0	27054	4941	899705
	SE	25783	58456	84814	6380	2484	3809	2838	0	0	0	16181	4941	107847
	Tows	31	17	27	37	24	26	5	3	2	5	8	11	196
10/ 3-10/16	SC	57559	176960	172103	20479	4912	13694	3548	0	2870	0	5622	2470	460216
	SE	9616	57398	42801	3562	1324	3968	2424	0	2870	0	5622	2470	72807
	Tows	28	19	25	45	22	21	6	2	3	4	7	11	193
10/17-10/30	SC	122851	230673	102928	11203	3094	3705	9934	1240	0	0	0	0	485627
	SE	27489	65524	37796	2912	1056	2076	6186	0	0	0	0	0	80807
	Tows	16	26	29	51	23	23	5	1	2	4	7	11	198
10/31-11/13	SC	51691	49566	37234	9616	0	1121	1774	0	0	0	0	0	151002
	SE	11823	21053	20887	4219	0	1121	1774	0	0	0	0	0	32272
	Tows	22	33	26	46	16	19	4	2	3	4	5	10	190
11/14-11/27	SC	79328	22718	2241	1128	0	0	0	0	0	0	0	0	105415
	SE	16833	12945	1550	790	0	0	0	0	0	0	0	0	21306
	Tows	45	22	24	49	18	14	4	3	3	4	8	11	205
11/28-12/11	SC	0	0	7683	1626	310	0	0	0	0	0	0	0	9620
	SE	0	0	5932	1626	310	0	0	0	0	0	0	0	6159
	Tows	0	5	14	17	17	14	0	0	0	0	3	3	73

Table C-15

Estimated Density (No./1000 m^3) of Striped Bass Yearlings in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region						
Date		YK	TZ	GH	IP	WP	CW	PK
8/16-8/20	Den	1.182	0.529	0.118	0.105	0.0	0.0	0.0
	SE	0.786	0.256	0.082	0.071	0.0	0.0	0.0
	Tows	7	26	36	19	5	5	5
8/30-9/3	Den	0.0	0.0	0.293	0.157	0.0	0.431	0.0
	SE	0.0	0.0	0.120	0.113	0.0	0.431	0.0
	Tows	7	26	35	20	5	5	5
9/13-9/16	Den	0.0	0.186	0.126	0.283	0.0	0.0	0.530
	SE	0.0	0.128	0.088	0.283	0.0	0.0	0.530
	Tows	7	26	37	18	5	5	5
9/27-10/1	Den	0.0	0.073	0.0	0.140	0.0	0.0	0.0
	SE	0.0	0.073	0.0	0.101	0.0	0.0	0.0
	Tows	7	26	36	19	5	5	5
10/11-10/14	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	7	26	36	19	5	5	5
10/25-10/28	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	8	43	24	13	5	5	5
11/8-11/12	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	8	43	24	13	6	4	5
11/21-11/24	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	8	42	24	13	5	5	5
12/6-12/8	Den	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	8	29	0	6	5	5	5

Table C-16

Estimated Standing Crops (in Thousands) of Striped Bass Yearlings in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region							
Date		YK	TZ	CH	IP	WP	CW	PK	Total
8/16-8/20	SC	32	97	10	5	0	0	0	144
	SE	21	47	7	3	0	0	0	52
	Tows	7	26	36	19	5	5	5	103
8/30-9/3	SC	0	0	25	7	0	19	0	52
	SE	0	0	10	5	0	19	0	23
	Tows	7	26	35	20	5	5	5	103
9/13-9/16	SC	0	34	11	13	0	0	37	95
	SE	0	24	8	13	0	0	37	46
	Tows	7	26	37	18	5	5	5	103
9/27-10/1	SC	0	13	0	6	0	0	0	20
	SE	0	13	0	5	0	0	0	14
	Tows	7	26	36	19	5	5	5	103
10/11-10/14	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	7	26	36	19	5	5	5	103
10/25-10/28	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	43	24	13	5	5	5	103
11/8-11/12	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	43	24	13	6	4	5	103
11/21-11/24	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	42	24	13	5	5	5	102
12/6-12/8	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	29	0	6	5	5	5	58

Table C-17

Estimated Standing Crops of Striped Bass Yearlings in 12 Geographical Regions of Hudson River Estuary (RM 12-152; KM 19-243) Based on 100-Ft (30.5-m) Beach Seine During Daytime, 1977

Date		Region												
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
4/ 3-4/16	SC	14255	15145	0	0	0	0	0	0	0	0	0	0	29400
	SE	3957	7003	0	0	0	0	0	0	0	0	0	0	8043
	Tows	28	30	27	35	24	20	6	3	3	5	7	11	199
4/17-4/30	SC	30662	25390	1454	0	0	0	0	0	0	0	0	0	57506
	SE	6388	7719	1454	0	0	0	0	0	0	0	0	0	10124
	Tows	28	34	37	27	20	22	5	2	2	4	5	4	190
5/ 1-5/14	SC	23311	25488	0	0	0	0	0	0	0	0	0	0	48799
	SE	6754	8552	0	0	0	0	0	0	0	0	0	0	10897
	Tows	21	41	35	49	15	12	2	3	1	4	7	9	199
5/15-5/28	SC	6455	40193	27706	4156	0	0	0	0	0	0	0	0	78510
	SE	3574	10491	15722	2102	0	0	0	0	0	0	0	0	19350
	Tows	21	26	33	51	21	29	3	3	2	5	8	12	214
5/29-6/11	SC	837	10905	23530	1988	405	0	3548	0	0	4389	2811	21739	70150
	SE	574	4751	11481	829	405	0	3548	0	0	4389	2811	14773	20336
	Tows	18	25	24	51	13	24	4	2	2	4	7	10	184
6/12-6/25	SC	991	10326	10756	1940	110	380	2365	0	0	13167	0	8656	48682
	SE	419	5928	7329	823	110	380	2365	0	0	13167	0	6151	17512
	Tows	38	22	15	57	24	28	3	3	3	4	7	11	215
6/26-7/ 9	SC	0	0	8964	1280	0	1775	0	0	0	0	0	0	12019
	SE	0	0	6890	652	0	1775	0	0	0	0	0	0	7145
	Tows	16	11	12	36	18	12	0	0	0	0	0	0	105

Table C-18

Mean Length (mm) and Length Frequency of Striped Bass Post Yolk-Sac Larvae and Juveniles from Hudson River Estuary (RM 14-140; KM 22-224) Ichthyoplankton Survey, 1976

				Number of Striped Bass/Length Interval (mm)											
Date	Stratum	Mean Length	Standard Error	<5	5-9.9	10-14.9	15-19.9	20-24.9	25-34.9	35-44.9	45-54.9	55-64.9	65-74.9	>75	Number Measured per Stratum
5/24-5/26	Shoals	NC													NC
	Bottom	6.9	0.0	0	1	0	0	0	0	0	0	0	0	0	1
	Channel	NC													NC
6/07-6/01	Shoals	6.8	0.439	0	5	0	0	0	0	0	0	0	0	0	5
	Bottom	5.5	0.289	3	5	0	0	0	0	0	0	0	0	0	8
	Channel	7.0	0.143	0	28	0	0	0	0	0	0	0	0	0	28
6/07/6/11	Shoals	6.2	0.090	0	31	0	0	0	0	0	0	0	0	0	31
	Bottom	6.2	0.044	1	127	0	0	0	0	0	0	0	0	0	128
	Channel	6.2	0.024	0	408	1	0	0	0	0	0	0	0	0	409
6/14-6/17	Shoals	6.5	0.021	0	408	0	0	0	0	0	0	0	0	0	408
	Bottom	6.2	0.014	2	977	0	0	0	0	0	0	0	0	0	979
	Channel	6.3	0.008	2	2462	0	0	0	0	0	0	0	0	0	2464
6/21-6/24	Shoals	7.2	0.056	0	364	3	0	0	0	0	0	0	0	0	367
	Bottom	7.1	0.039	0	907	21	0	0	0	0	0	0	0	0	928
	Channel	6.7	0.022	3	2333	40	0	0	0	0	0	0	0	0	2376
6/28-7/01	Shoals	10.1	0.121	0	244	201	16	0	0	0	0	0	0	0	441
	Bottom	9.7	0.098	0	333	198	18	1	0	0	0	0	0	0	550
	Channel	9.8	0.108	0	272	203	15	0	0	0	0	0	0	0	490
7/06-7/09	Shoals	18.3	0.350	0	9	61	52	63	27	0	0	0	0	0	212
	Bottom	18.7	0.530	0	0	18	20	24	7	0	0	0	0	0	69
	Channel	18.9	0.498	0	2	18	33	32	9	0	0	0	0	0	94
7/12-7/15	Shoals	24.1	0.502	0	1	9	34	29	73	5	1	0	0	0	152
	Bottom	27.8	0.579	0	0	2	3	18	54	5	0	0	0	0	82
	Channel	22.2	0.865	0	0	0	3	8	3	0	0	0	0	0	14
7/26-7/29	Shoals	39.4	0.416	0	0	0	0	0	55	137	36	4	0	0	232
	Bottom	40.3	1.034	0	0	0	0	0	11	25	13	1	0	0	50
	Channel	54.0	4.000	0	0	0	0	0	0	0	1	1	0	0	2
8/10-8/13	Shoals	48.1	1.097	0	0	0	0	0	3	19	20	14	2	0	58
	Bottom	53.8	1.904	0	0	0	0	0	0	1	3	8	0	0	12
	Channel	57.7	2.892	0	0	0	0	0	0	0	1	2	0	0	3

NC = No catch

Table C-19

Mean Length (mm) of Striped Bass Post Yolk-Sac Larvae and Juveniles by Strata In 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

			REGION											
DATE	STRATUM		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24- 5/26	SHOALS	MEAN LENGTH	NC*	NC	NC	NC		NC						
		S.E.												
		N MEASURED												
	BOTTOM	MEAN LENGTH		6.9	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
		S.E.		0.0										
		N MEASURED		1										
	CHANNEL	MEAN LENGTH	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	
		S.E.												
		N MEASURED												
6/01- 6/04	SHOALS	MEAN LENGTH	NC	NC	6.5	8.0		NC						
		S.E.			0.41	0.0								
		N MEASURED			4	1								
	BOTTOM	MEAN LENGTH		NC	6.2	5.4	NC	NC	NC	NC	NC	NC	NC	NC
		S.E.			0.0	0.31								
		N MEASURED			1	7								
	CHANNEL	MEAN LENGTH	NC	7.8	7.4	6.6	6.8	NC	7.1	NC	NC	NC	NC	
		S.E.		0.0	0.22	0.19	0.20		0.0					
		N MEASURED		1	10	14	2		1					

*NC=No catch

Table C-19 (Contd)

		REGION											
DATE	STRATUM	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
6/07- 6/11	SHOALS MEAN LENGTH	NC	6.2	6.3	6.8		5.9						
	S.E.		0.11	0.09	0.69		0.12						
	N MEASURED		7	13	3		8						
	BOTTOM MEAN LENGTH		NC	6.6	6.5	6.3	6.1	6.1	5.6	6.3	NC	NC	NC
	S.E.			0.13	0.30	0.06	0.07	0.08	0.0	0.0			
	N MEASURED			3	10	28	45	40	1	1			
	CHANNEL MEAN LENGTH	NC	6.0	6.4	6.3	6.2	6.0	6.2	6.1	6.0	NC	NC	
	S.E.		0.09	0.09	0.05	0.05	0.11	0.03	0.19	0.0			
	N MEASURED		18	72	70	79	12	148	9	1			
6/14- 6/17	SHOALS MEAN LENGTH	NC	6.8	6.4	6.4		6.3						
	S.E.		0.05	0.05	0.03		0.03						
	N MEASURED		64	73	138		133						
	BOTTOM MEAN LENGTH		6.7	6.3	6.3	6.3	6.2	6.1	6.0	5.9	5.7	NC	NC
	S.E.		0.08	0.08	0.02	0.03	0.02	0.06	0.07	0.07	0.12		
	N MEASURED		20	24	219	193	357	67	54	40	5		
	CHANNEL MEAN LENGTH	NC	6.8	6.5	6.3	6.3	6.2	6.1	6.0	5.9	5.9	NC	
	S.E.		0.09	0.02	0.01	0.01	0.04	0.04	0.06	0.07	0.14		
	N MEASURED		27	341	817	774	155	185	96	61	8		

Table C-19 (Contd)

DATE	STRATUM		REGION											
			YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
6/21- 6/24	SHOALS	MEAN LENGTH	NC	7.7	7.0	6.5		7.8						
		S.E.		0.15	0.08	0.07		0.10						
		N MEASURED		33	100	100		134						
	BOTTOM	MEAN LENGTH		9.0	7.9	6.6	6.3	7.4	8.3	9.1	9.6	7.1	5.2	NC
		S.E.		0.0	0.11	0.06	0.05	0.05	0.20	0.33	0.56	1.17	0.0	
		N MEASURED		1	100	231	182	345	34	25	6	3	1	
	CHANNEL	MEAN LENGTH	8.7	7.0	7.0	6.4	6.6	7.2	9.3	8.9	8.2	NC	NC	
		S.E.	0.0	0.15	0.05	0.02	0.03	0.10	0.15	0.33	0.28			
		N MEASURED	1	19	454	899	755	129	81	17	21			
6/28- 7/01	SHOALS	MEAN LENGTH	NC	9.2	10.6	8.9		10.6						
		S.E.		0.35	0.16	0.16		0.54						
		N MEASURED		39	287	101		14						
	BOTTOM	MEAN LENGTH		8.9	9.5	8.8	9.7	11.4	13.4	14.8	15.8	15.4	NC	NC
		S.E.		0.28	0.17	0.09	0.27	0.25	0.30	0.47	1.48	0.96		
		N MEASURED		21	96	284	50	47	31	13	5	3		
	CHANNEL	MEAN LENGTH	9.0	8.9	8.9	8.8	10.8	10.2	13.0	14.1	13.1	NC	NC	
		S.E.	0.0	0.36	0.25	0.11	0.22	0.53	0.25	0.35	0.89			
		N MEASURED	1	18	52	254	87	14	39	19	6			

Table C-19 (Contd)

DATE	STRATUM		REGION											
			YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
7/06- 7/09	SHOALS	MEAN LENGTH	NC	17.0	18.6	20.3		21.7						
		S.E.		0.61	0.48	0.92		0.64						
		N MEASURED		89	88	18		17						
	BOTTOM	MEAN LENGTH		13.2	15.5	19.6	16.7	18.9	20.1	17.2	22.4	20.3	26.0	NC
		S.E.		0.80	1.79	0.90	0.67	0.71	0.66	2.32	0.95	0.0	0.0	
		N MEASURED		5	6	30	3	10	6	4	3	1	1	
	CHANNEL	MEAN LENGTH	19.4	15.5	16.5	14.8	19.7	19.3	21.0	21.7	21.4	NC	NC	
		S.E.	1.60	3.51	1.54	0.93	0.69	0.0	1.95	1.25	1.62			
		N MEASURED	7	5	11	12	36	1	6	11	5			
7/12- 7/15	SHOALS	MEAN LENGTH	NC	21.9	28.0	28.0		27.6						
		S.E.		0.56	1.14	0.98		1.48						
		N MEASURED		98	25	13		19						
	BOTTOM	MEAN LENGTH		21.3	13.6	30.1	25.9	27.4	21.0	NC	28.3	28.7	23.2	NC
		S.E.		2.74	0.0	0.73	2.15	0.85	0.74		1.60	2.33	0.0	
		N MEASURED		5	1	37	5	25	3		2	3	1	
	CHANNEL	MEAN LENGTH	NC	20.4	NC	NC	20.3	20.0	NC	22.9	29.0	NC	NC	
		S.E.		0.0			0.75	0.0		1.16	0.0			
		N MEASURED		1			4	1		7	1			

Table C-19 (Contd)

DATE	STRATUM		REGION											
			YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
7/26- 7/29	SHOALS	MEAN LENGTH	NC	38.2	41.4	37.7		36.0						
		S.E.		0.58	0.64	1.48		1.47						
		N MEASURED		120	91	15		6						
	BOTTOM	MEAN LENGTH		37.2	39.2	40.6	NC	NC	41.0	NC	44.3	49.2	NC	NC
		S.E.		7.92	1.21	1.55			0.0		3.18	7.55		
		N MEASURED		3	30	10			1		3	3		
	CHANNEL	MEAN LENGTH	NC	NC	NC	50.0	NC	NC	58.0	NC	NC	NC	NC	
		S.E.				0.0			0.0					
		N MEASURED				1			1					
8/10- 8/13	SHOALS	MEAN LENGTH	NC	48.6	45.7	52.0		NC						
		S.E.		1.19	3.05	0.0								
		N MEASURED		47	10	1								
	BOTTOM	MEAN LENGTH		48.4	56.0	55.8	NC	NC	NC	NC	61.0	NC	NC	NC
		S.E.		4.09	0.0	1.63					0.0			
		N MEASURED		4	1	6					1			
	CHANNEL	MEAN LENGTH	58.0	NC	NC	62.5	52.5	NC	NC	NC	NC	NC	NC	
		S.E.	0.0			0.0	0.0							
		N MEASURED	1			1	1							

Table C-20

Release and Recapture Data for Tagged Striped Bass Recaptured July 1976-July 1977

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
July 1976	5-17128	5/27/75	Manhasset Bay	216	15	7/ 3/76	Manhasset Bay		403	14	98-Sports Fisherman
September	**5-37409	9/ 7/76	39 East	185	5	9/13/76	39 East	183	6	0	5-Box Trap
	5-37411	9/ 7/76	39 East	187	5	9/13/76	39 East	183	6	0	5-Box Trap
	**5-37412	9/ 7/76	39 East	174	5	9/13/76	39 East	170	6	0	5-Box Trap
	**5-37413	9/ 7/76	39 East	176	5	9/13/76	39 East	172	6	0	5-Box Trap
	**5-37414	9/ 7/76	39 East	169	5	9/13/76	39 East	168	6	0	5-Box Trap
	**5-37415	9/ 7/76	39 East	178	5	9/13/76	39 East	175	6	0	5-Box Trap
	**5-37416	9/ 7/76	39 East	150	5	9/13/76	39 East	145	6	0	5-Box Trap
	**5-37424	9/ 7/76	39 East	161	5	9/13/76	39 East	162	6	0	5-Box Trap
	**5-37430	9/ 7/76	39 East	179	5	9/13/76	39 East	176	6	0	5-Box Trap
	**5-37432	9/ 7/76	39 East	151	5	9/13/76	39 East	152	6	0	5-Box Trap
	**5-37433	9/ 7/76	39 East	162	5	9/13/76	39 East	160	6	0	5-Box Trap
	**9-79107	9/ 7/76	60 East	335	5	9/13/76	60 East	327	6	0	5-Box Trap
	5-34701	9/ 7/76	60 East	215	5	9/16/76	60 East	215	9	0	5-Box Trap
	5-37404	9/ 7/76	60 East	190	5	9/16/76	60 East	182	9	0	5-Box Trap
	5-37405	9/ 7/76	60 East	185	5	9/16/76	60 East	175	9	0	5-Box Trap
	5-37408	9/ 7/76	34 East	154	5	9/16/76	34 East	151	9	0	5-Box Trap
	**5-37409	9/ 7/76	39 East	185	5	9/16/76	39 East	185	9	0	5-Box Trap
	**5-37412	9/ 7/76	39 East	174	5	9/16/76	39 East	170	9	0	5-Box Trap
	**5-37413	9/ 7/76	39 East	176	5	9/16/76	39 East	176	9	0	5-Box Trap
	**5-37414	9/ 7/76	39 East	169	5	9/16/76	39 East	168	9	0	5-Box Trap
	**5-37415	9/ 7/76	39 East	178	5	9/16/76	39 East	180	9	0	5-Box Trap
	**5-37416	9/ 7/76	39 East	150	5	9/16/76	39 East	148	9	0	5-Box Trap
	**5-37424	9/ 7/76	39 East	161	5	9/16/76	39 East	162	9	0	5-Box Trap
	**5-37430	9/ 7/76	39 East	179	5	9/16/76	39 East	175	9	0	5-Box Trap
	**5-37432	9/ 7/76	39 East	151	5	9/16/76	39 East	149	9	0	5-Box Trap
	**5-37433	9/ 7/76	39 East	162	5	9/16/76	39 East	159	9	0	5-Box Trap
	5-37611	9/13/76	39 East	149	5	9/16/76	39 East	142	3	0	5-Box Trap
	5-37628	9/13/76	39 East	173	5	9/16/76	39 East	165	3	0	5-Box Trap
	**5-37666	9/13/76	39 East	154	5	9/16/76	39 East	152	3	0	5-Box Trap
	9-79104	9/ 7/76	60 East	278	5	9/16/76	60 East	271	9	0	5-Box Trap
	**9-79109	9/ 7/76	39 East	275	5	9/16/76	39 East	267	9	0	5-Box Trap
	**5-37412	9/ 7/76	39 East	174	5	9/20/76	39 East	170	13	0	5-Box Trap
	**5-37414	9/ 7/76	39 East	169	5	9/20/76	39 East	166	13	0	5-Box Trap
	**5-37415	9/ 7/76	39 East	178	5	9/20/76	39 East	177	13	0	5-Box Trap
	**5-37424	9/ 7/76	39 East	161	5	9/20/76	39 East	160	13	0	5-Box Trap
	**5-37430	9/ 7/76	39 East	179	5	9/20/76	39 East	175	13	0	5-Box Trap
	**5-37432	9/ 7/76	39 East	151	5	9/20/76	39 East	152	13	0	5-Box Trap
	**5-37433	9/ 7/76	39 East	162	5	9/20/76	39 East	161	13	0	5-Box Trap
	**5-37666	9/13/76	39 East	154	5	9/20/76	39 East	154	7	0	5-Box Trap
	5-38629	9/14/76	38 West	140	14	9/20/76	39 West	140	6	-1	14-200' Beach Seine
	5-37693	9/13/76	60 East	192	5	9/20/76	60 East		7	0	5-Box Trap
	5-37748	9/16/76	39 East	145	5	9/20/76	39 East	141	4	0	5-Box Trap
	**5-37336	9/10/76	40 East	170	12	9/23/76	40 East	166	13	0	14-200' Beach Seine
	**5-37415	9/ 7/76	39 East	178	5	9/23/76	39 East	179	16	0	5-Box Trap
	**5-37430	9/ 7/76	39 East	179	5	9/23/76	39 East	176	16	0	5-Box Trap
	**5-37432	9/ 7/76	39 East	151	5	9/23/76	39 East	149	16	0	5-Box Trap
	**5-37666	9/13/76	39 East	154	5	9/23/76	39 East	152	10	0	5-Box Trap
	5-37844	9/16/76	15 East	133	12	9/23/76	15 East	135	7	0	12-100' Beach Seine
	**5-39422	9/20/76	39 East	165	5	9/23/76	39 East	165	3	0	5-Box Trap

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-20 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel GR	Date	RM/Site	Total Length (mm)	Days at Large	Distance[*] (mi)	Recovery Gear
	**5-37415	9/ 7/76	39 East	178	5	9/27/76	39 East	179	20	0	5-Box Trap
	**5-37432	9/ 7/76	39 East	151	5	9/27/76	39 East	148	20	0	5-Box Trap
	**5-37433	9/ 7/76	39 East	162	5	9/27/76	39 East	160	20	0	5-Box Trap
	**5-37666	9/13/76	39 East	154	5	9/27/76	39 East	153	14	0	5-Box Trap
	**5-39378	9/20/76	60 East	218	5	9/27/76	60 East	220	7	0	5-Box Trap
	**5-39422	9/20/76	39 East	165	5	9/27/76	39 East	164	7	0	5-Box Trap
	9-79101	9/ 7/76	60 East	308	5	9/27/76	60 East		20	0	5-Box Trap
	9-79113	9/13/76	60 East	303	5	9/27/76	60 East	278	14	0	5-Box Trap
	9-79116	9/20/76	60 East	346	5	9/27/76	60 East	342	7	0	5-Box Trap
	5-40067	9/21/76	59 East	153	12	9/28/76	59 East	154	7	0	12-100' Beach Seine
	5-35876	9/23/76	35 East	151	14	9/29/76	35 East	149	6	0	53-100' Beach Seine
October	5-37812	9/15/76	20 East	141	12	10/ 0/76	20 East		15	0	98-Sports Fisherman
	**5-37415	9/ 7/76	39 East	178	5	10/ 4/76	39 East	183	27	0	5-Box Trap
	**5-37666	9/13/76	39 East	154	5	10/ 4/76	39 East	153	21	0	5-Box Trap
	5-40520	9/23/76	60 East	196	5	10/ 4/76	60 East	190	11	0	5-Box Trap
	5-40523	9/23/76	60 East	199	5	10/ 4/76	60 East	194	11	0	5-Box Trap
	5-40527	9/23/76	60 East	170	5	10/ 4/76	60 East	163	11	0	5-Box Trap
	5-40528	9/23/76	60 East	168	5	10/ 4/76	60 East	163	11	0	5-Box Trap
	5-40529	9/23/76	60 East	168	5	10/ 4/76	60 East	166	11	0	5-Box Trap
	**5-37430	9/ 7/76	39 East	179	5	10/ 7/76	39 East	179	30	0	5-Box Trap
	**5-37433	9/ 7/76	39 East	162	5	10/ 7/76	39 East	167	30	0	5-Box Trap
	**5-39378	9/20/76	60 East	218	5	10/ 7/76	60 East	225	17	0	5-Box Trap
	5-39380	9/20/76	60 East	167	5	10/ 7/76	60 East	153	17	0	5-Box Trap
	5-40515	9/23/76	60 East	195	5	10/ 7/76	60 East	189	14	0	5-Box Trap
	5-40535	9/27/76	39 East	145	5	10/ 7/76	39 East	187	10	0	5-Box Trap
	**9-79109	9/ 7/76	39 East	275	5	10/ 7/76	39 East	268	30	0	5-Box Trap
	9-79115	9/13/76	60 East	273	5	10/ 7/76	60 East	251	24	0	5-Box Trap
	5-40519	9/23/76	60 East	185	5	10/11/76	60 East	182	18	0	5-Box Trap
	5-40573	9/27/76	60 East	210	5	10/11/76	60 East		14	0	5-Box Trap
	5-46395	10/ 8/76	40 West	132	14	10/12/76	40 West	131	4	0	14-200' Beach Seine
	**5-37415	9/ 7/76	39 East	178	5	10/14/76	39 East	186	37	0	5-Box Trap
	**5-37433	9/ 7/76	39 East	162	5	10/14/76	39 East	163	37	0	5-Box Trap
	5-39382	9/20/76	60 East	169	5	10/14/76	60 East		24	0	5-Box Trap
	5-40522	9/23/76	60 East	194	5	10/14/76	60 East	193	21	0	5-Box Trap
	5-40536	9/27/76	39 East	153	5	10/14/76	39 East	153	17	0	5-Box Trap
	**5-37336	9/10/76	40 East	170	12	10/21/76	40 East	177	41	0	14-200' Beach Seine
	5-27794	11/ 6/75	42 East	172	14	10/25/76	42 East	194	354	0	14-200' Beach Seine
	5-43530	10/19/76	34 East	147	14	10/25/76	34 East	148	6	0	14-200' Beach Seine
	5-46643	10/18/76	40 West	148	5	10/25/76	40 West	148	7	0	5-Box Trap
November	5-38335	9/13/76	40 West	172	14	11/ 2/76	40 West	183	50	0	14-200' Beach Seine
	5-39265	9/16/76	33 East	175	14	11/ 4/76	33 East	194	49	0	14-200' Beach Seine
	5-44465	11/ 2/76	42 East	181	14	11/16/76	9 West		14	33	98-Sports Fisherman
	5-43784	10/12/76	35 East	150	53	11/17/76	13 West	154	36	22	12-100' Beach Seine
1977 January	5-30414	4/30/76	40 West	234	14	1/21/77	Raritan River		265	40	98-Sports Fisherman
February	5-40117	9/24/76	57 West	175	12	2/23/77	3 West		151	54	98-Sports Fisherman
March	5-44240	10/25/76	42 East	213	14	3/12/77	3 West		137	39	98-Sports Fisherman
June	5-37400	9/ 7/76	60 East	176	5	6/ 8/77	38 East	190	273	22	5-Box Trap
	5-46939	11/ 9/76	42 East	169	14	6/18/77	75		220	-33	98-Sports Fisherman
	5-30625	6/15/76	33 East	238	14	6/18/77	Upper N.Y. Bay		365		98-Sports Fisherman
	5-30077	10/22/75	33 East	202	14	6/26/77	5 East		612	28	98-Sports Fisherman
July	5-40585	9/27/76	60 East	218	5	7/ 1/77	152 West		276	-92	98-Sports Fisherman
	5-39381	9/20/76	60 East	217	5	7/27/77	60 East	233	309	0	5-Box Trap
	5-46932	11/9/76	42 East	218	14	7/27/77	65 West	218	259	-23	96-Danskammer

[*] Minus sign indicates movement north of release site; no sign indicates southward movement.

[**] Multiple recaptures.

EXPLANATORY NOTES FOR TABLE C-21 AND C-46

To compensate for fish marked with the wrong clip-type, it was necessary to make an adjustment in the number of finclip recaptures used in the analysis of interregional movement of juvenile striped bass and white perch. The release of striped bass and white perch finclipped for a particular region but inadvertently released in another region presented a problem in determining whether the recaptured fish had migrated to the region after being correctly finclipped and released elsewhere, or whether it was a fish that had been incorrectly finclipped and remained where released. To adjust for fish incorrectly finclipped and released in the incorrect region, the percentage of the recaptured fish that were correctly finclipped and released was applied to the number of fish incorrectly finclipped and released in the same region to determine an approximate number (percentage) that would have been recaptured (assuming that all finclips released in that region had the same probability of recapture). This approximate number was then subtracted from the total number of recaptures of the correctly marked fish in the region and the remainder was the number of fish that migrated into the region.

Example

Released in Region 2 were 1256 white perch with the Region 3 clip-type and 114 white perch with Region 3 clip-types were recaptured in Region 2 (3412 were correctly released in Region 3). Released in Region 2 were 8617 correctly finclipped white perch and 642 were recaptured there.

642/8617 = 0.0745,	7.45% = percentage of correct region 2 fin-clips recaptured in region 2.
0.0745 x 1256 = 93.5,	94 of the incorrect fin-clips that would be expected to be recaptured.
114 - 94 = 20,	the number of white perch which moved into Region 2 from Region 3.

Table C-21

Fall 1976 Striped Bass Fin-Clip Releases and Recaptures with Adjusted Number of Recaptures Used in Analysis of Movement

		Releases						Recaptures					
Month	Clip-Code	RM 12-23	RM 24-38	RM 39-46	RM 47-76	RM 77-152	Total	RM 12-23	RM 24-38	RM 39-46	RM 47-76	RM 77-153	Total
September	65	778					778	76					76
	68		2206				2206	1	393	1			395
	73		219	836			1055		23,0*	109			132,109*
	67				380		380		1	4	9		14
	66					30	30						0
	Total	778	2425	836	380	30	4449	77	417,394*	114	9	0	617,594*
October	75	581					581	14	1				15
	13		1583				1583		89				89
	60		3	620			623		2	8			10
	71				137		137		1				1
	70					6	6						0
	Total	581	1586	620	137	6	2930	14	93	8	0	0	115
November	64	673					673		1				1
	61		313				313			1			1
	12		52	1081			1133			3			3
	63				5		5						0
	62					0	0			1			1
	Total	673	365	1081	5	0	2124	0	1	5	0	0	6
	Grand Total	2032	4376	2537	522	36	9503	91	511,488*	127	9	0	738,715*

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*Adjusted number — see explanatory notes on page C-33.

Table C-22

Physiochemical Factors at Time of Peak Abundance of Each Life Stage of Striped Bass from 1974-1976

Date	Life Stage*	River Mile	Values	Temperature (C°)	Conductivity ($mS/cm \times 10^{-3}$)	Dissolved Oxygen (mg/ℓ)	pH	Turbidity** (FTU)	Mean Freshwater Flow (ft^3/sec)
1974									
May 15-18	Eggs	39-55	Mean	15.4	159	8.9	7.2	7	35,225
			Min	14.9	140	6.2	7.0	3	30,400
			Max	16.2	178	10.2	7.0	18	42,900
May 28- Jun 14	YSL	62-76	Mean	19.2	151	6.7	7.1	10	9,680
			Min	17.2	136	1.5	6.8	2	6,280
			Max	21.3	176	10.0	7.0	36	13,700
Jun 17-23	PYSL	39-55	Mean	21.6	1,340	7.4	7.2	9	9,608
			Min	19.2	192	6.0	6.1	5	7,320
			Max	23.5	4,630	8.6	8.0	28	12,300
Aug 11- Nov 30	Juveniles	24-46	Mean	18.3	4,413	8.2	7.6	12	11,010
			Min	4.4	160	1.6	6.3	2	3,800
			Max	31.7	16,100	13.0	9.0	120	39,500
1975									
May 19-23	Eggs	39-55	Mean	17.9	139	8.9	7.4	13	14,320
			Min	15.0	114	7.4	6.8	7	12,800
			Max	19.7	164	10.8	8.0	42	15,700
May 26- Jun 6	YSL	39-55	Mean	19.5	213	9.0	7.3	7	10,939
			Min	17.0	70	7.6	6.4	1	8,420
			Max	22.0	2,400	11.2	8.0	27	16,300
Jun 2-14	PYSL	39-55	Mean	20.4	831	8.2	7.2	9	15,428
			Min	19.0	70	6.0	6.4	1	9,370
			Max	24.0	5,515	10.4	8.0	59	24,000
Jul 27- Oct 18	Juveniles	24-38	Mean	22.2	3,967	7.9	7.5	5	13,426
			Min	15.2	206	2.5	6.5	1	4,500
			Max	30.1	17,800	14.0	9.0	33	59,100
1976									
May 10-19	Eggs	39-55	Mean	14.4	154	9.6	7.5	16	26,540
			Min	13.0	85	9.0	6.9	4	19,700
			Max	16.0	277	10.8	8.0	31	38,400
May 17-19 (1st peak)	YSL	39-55 62-76	Mean	14.5	144	9.7	7.5	14	28,967
			Min	14.0	85	9.2	7.0	4	23,600
			Max	16.0	161	10.8	8.0	31	38,400
Jun 7-17 (2nd peak)	YSL	39-55 62-76	Mean	18.5	154	8.8	7.3	15	14,582
			Min	16.0	144	7.6	6.5	2	10,100
			Max	22.0	227	11.2	8.0	65	20,700
Jun 14-24	PYSL	39-46	Mean	20.6	204	8.8	7.2	9	14,845
			Min	18.6	142	7.5	6.4	3	10,100
			Max	24.0	2,650	10.1	8.0	22	18,800
Jul 11- Oct 30	Juveniles	24-38	Mean	21.1	4,605	8.2	7.5	11	15,362
			Min	7.8	125	2.5	6.4	2	6,320
			Max	28.1	21,500	14.0	9.0	62	60,600

*YSL - Yolk sac larvae
PYSL - Post yolk sac larvae

**Maximum turbidity figure rounded to whole number.

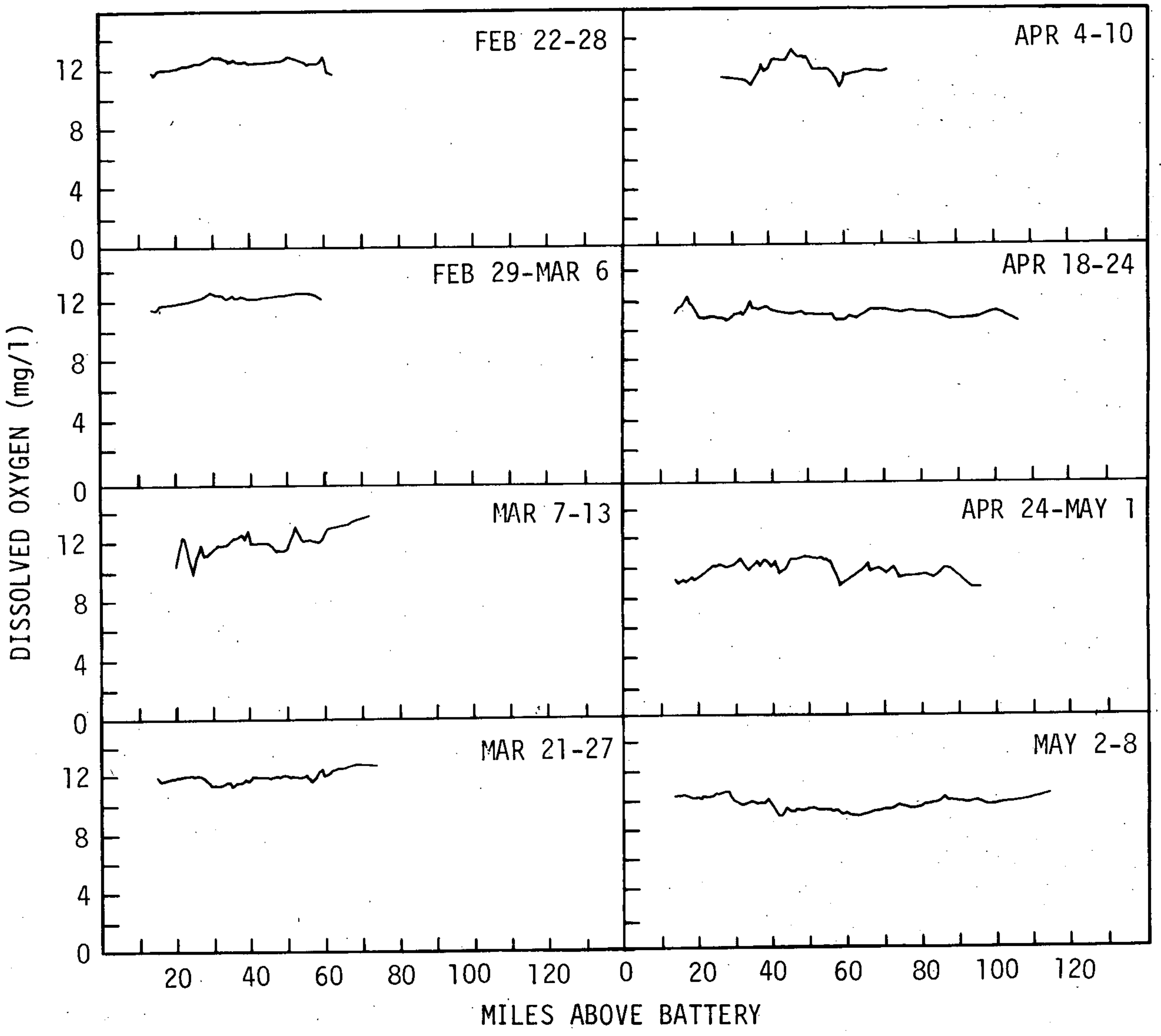


Figure C-2. Weekly Distribution of Dissolved Oxygen Concentration by River Mile, Hudson River Estuary, as Determined from Measurements during 1976 Ichthyoplankton Surveys

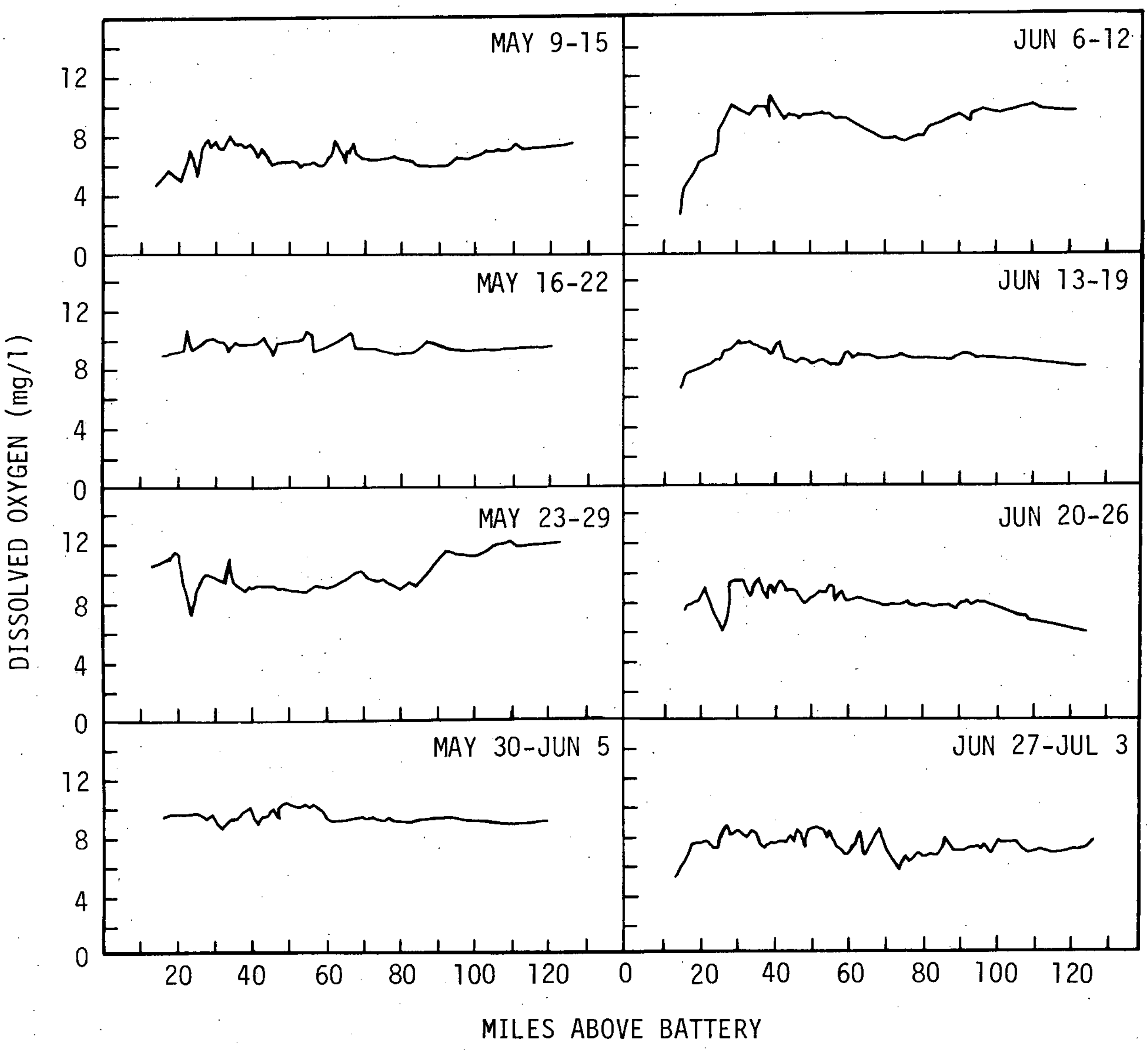


Figure C-2 (Contd)

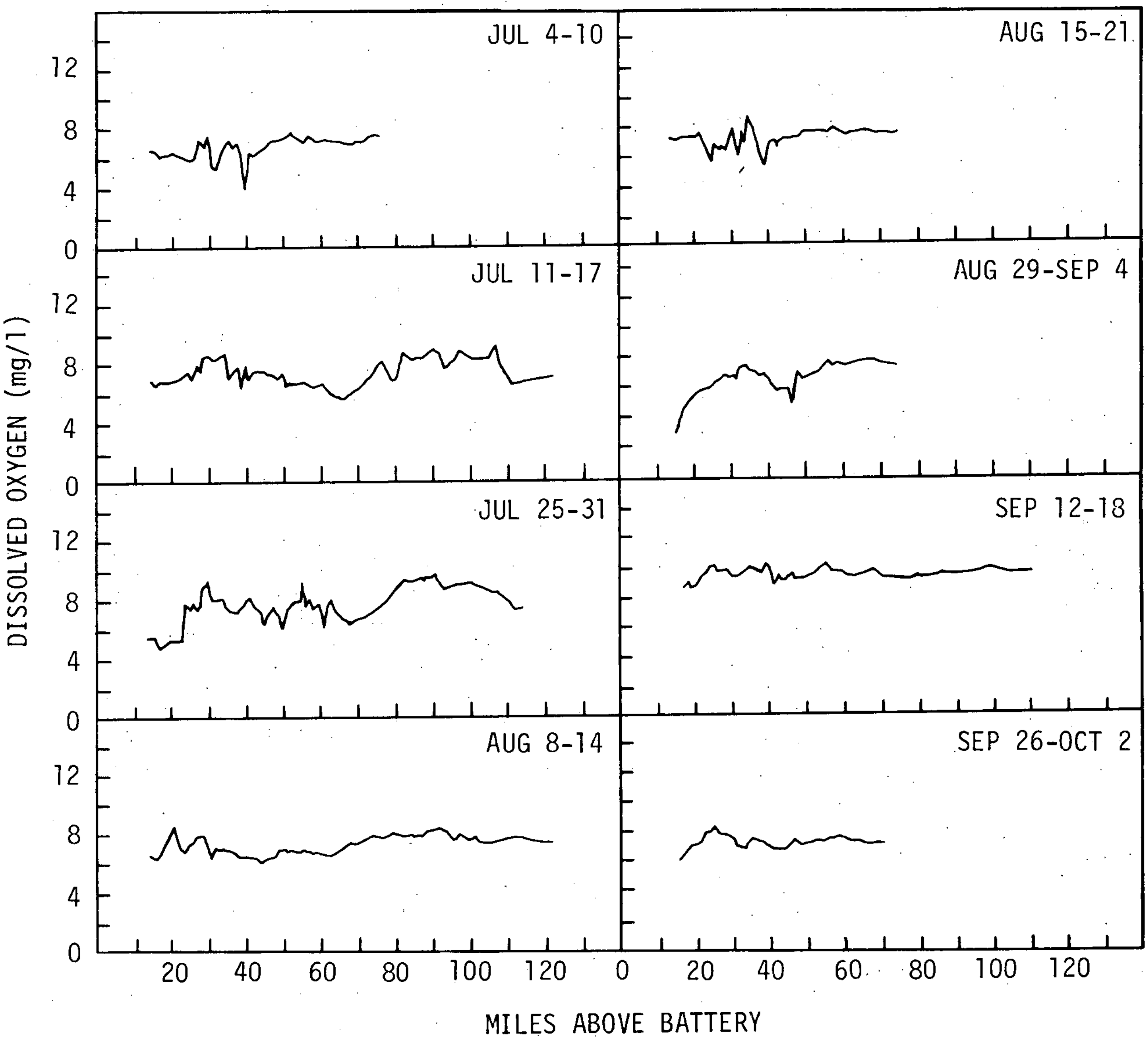


Figure C-2 (Contd)

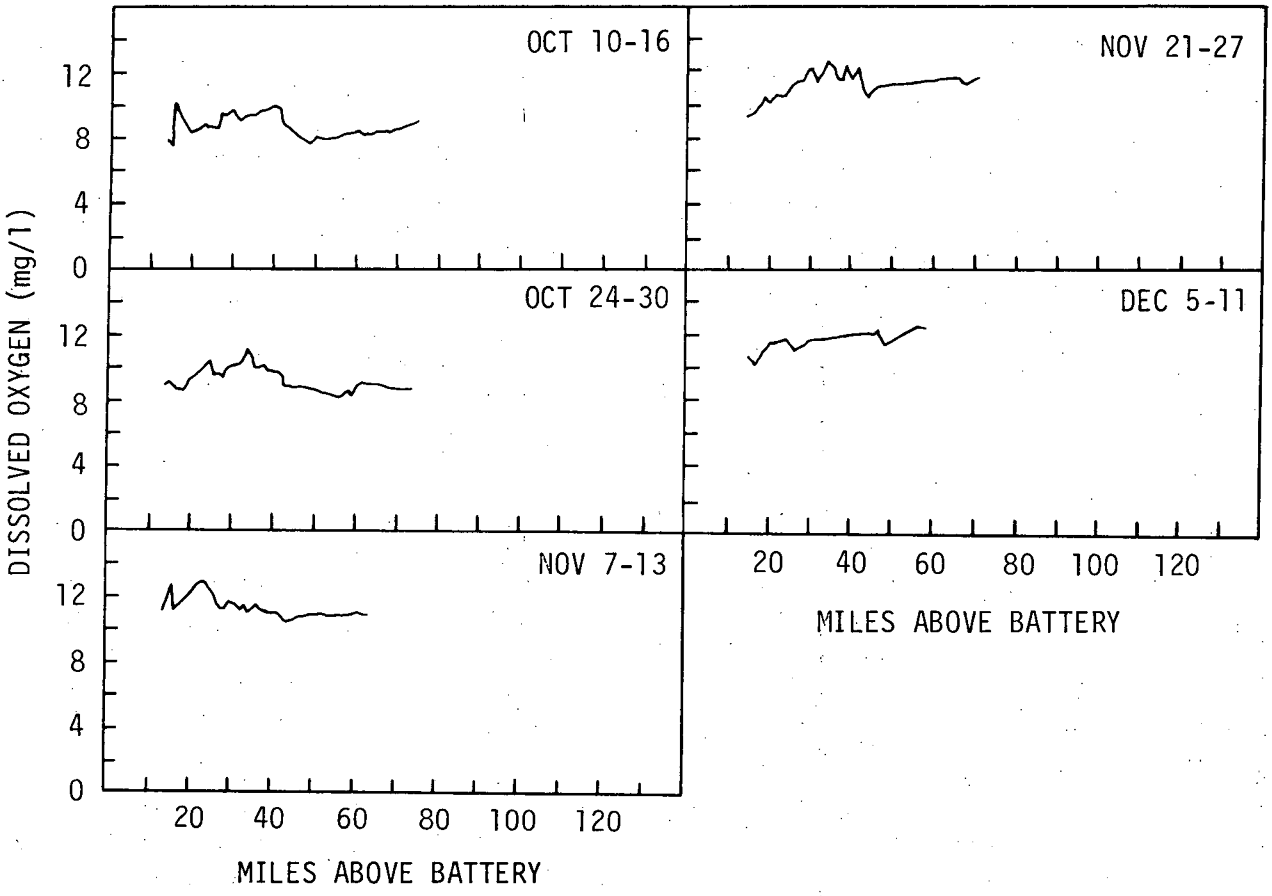


Figure C-2 (Contd)

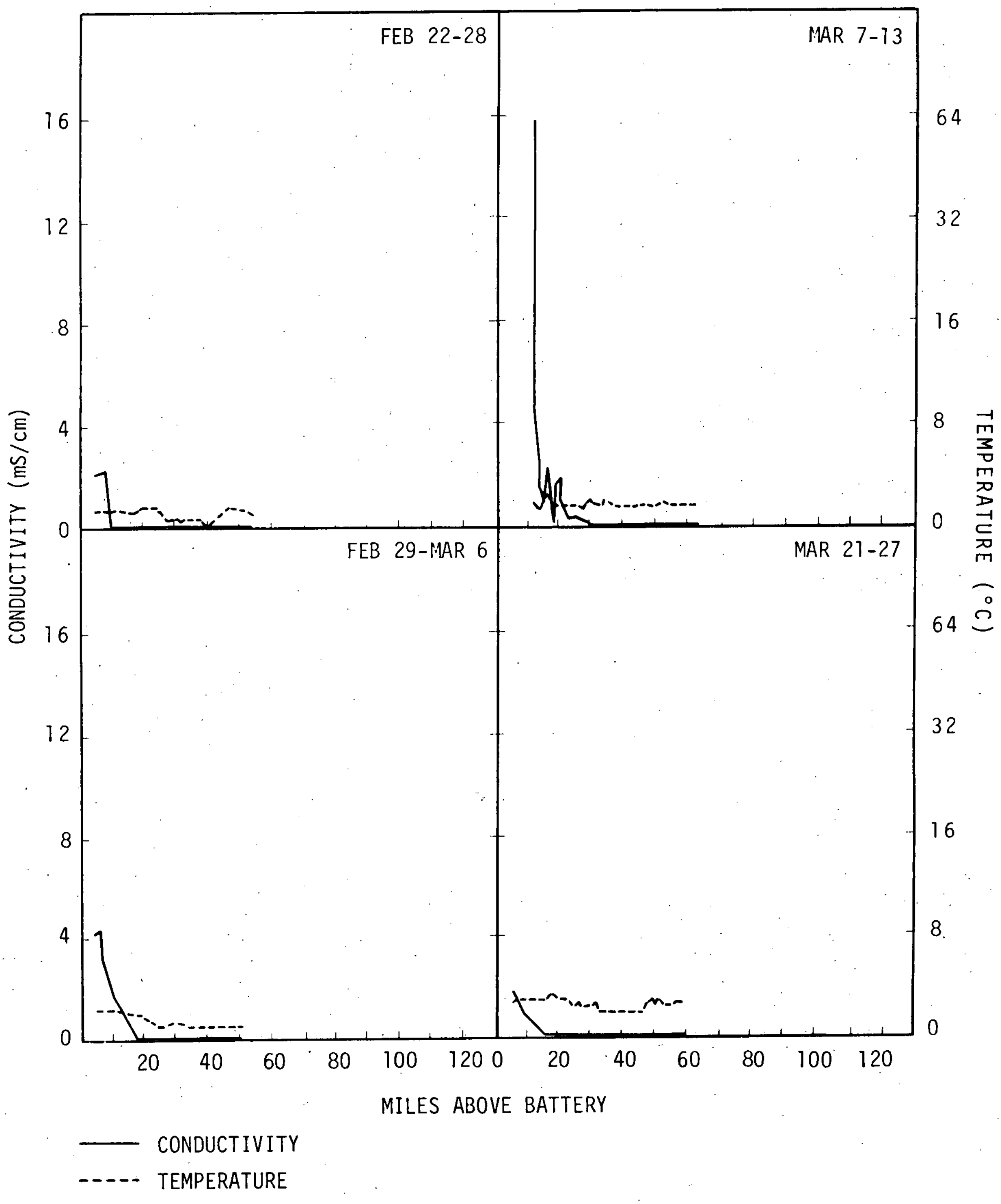


Figure C-3. Distribution of Mean Temperature and Conductivity by River Mile, Hudson River Estuary, as Determined from Measurements during 1976 Ichthyoplankton and Fall Shoals Surveys

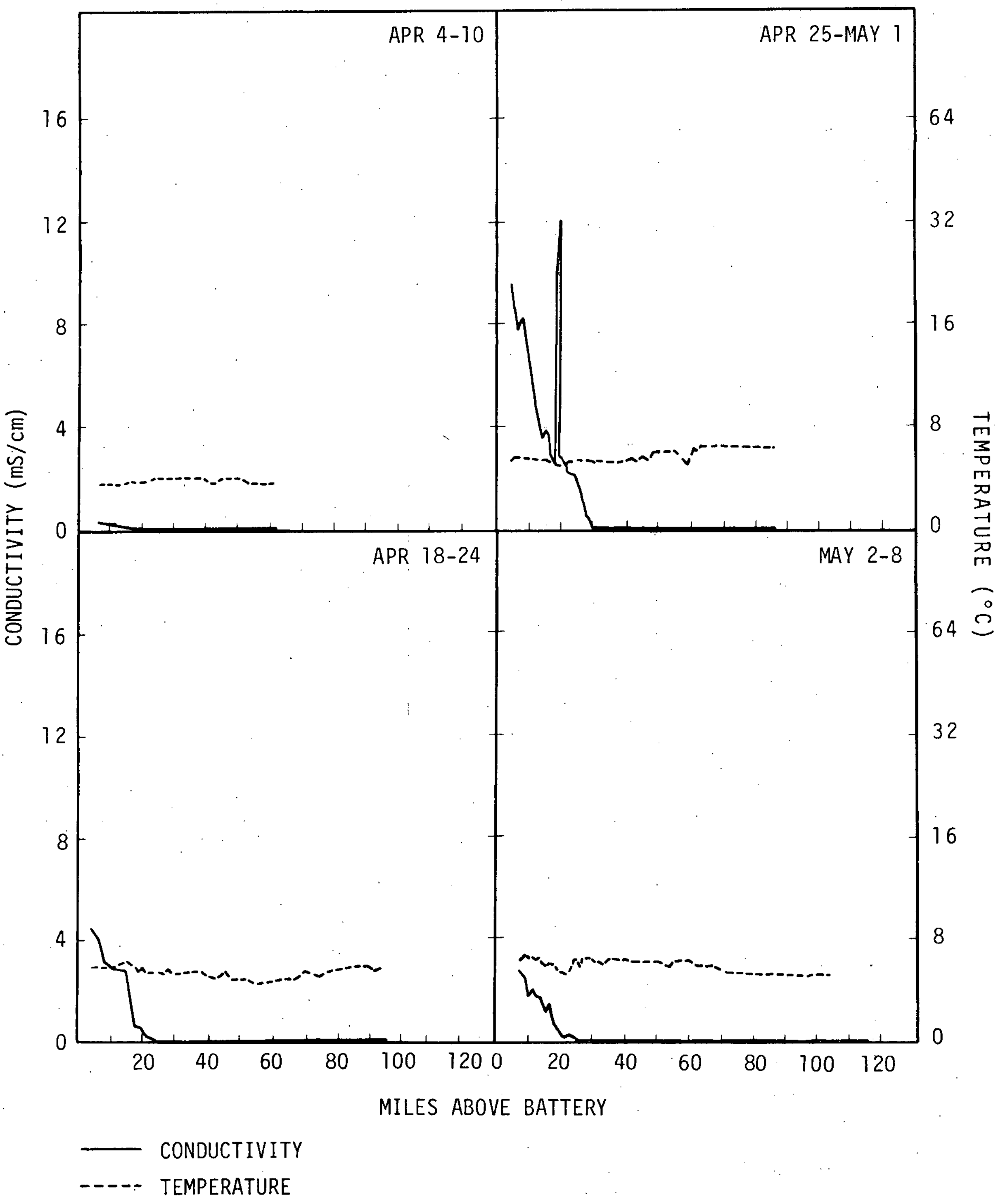


Figure C-3 (Contd)

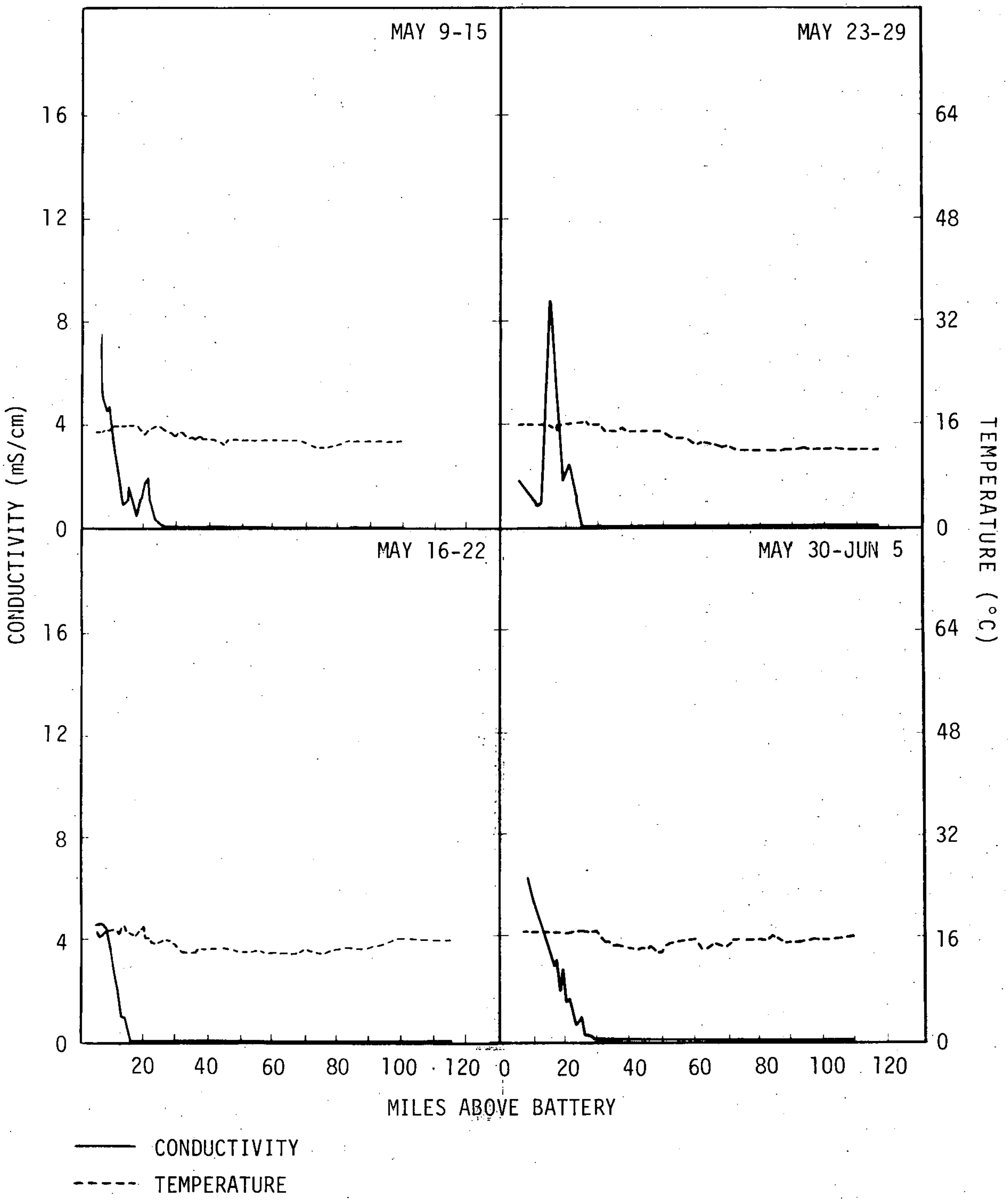


Figure C-3 (Contd)

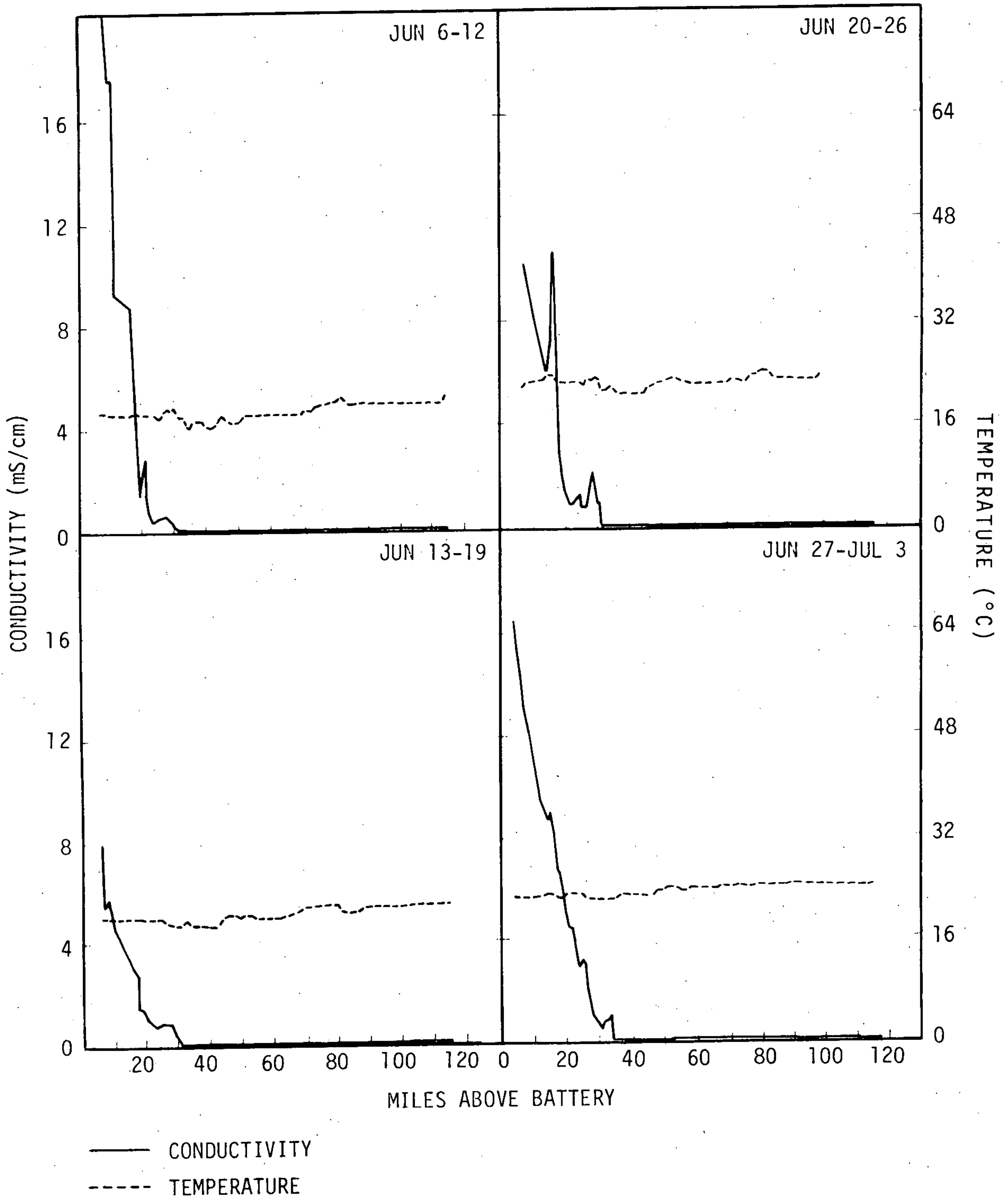


Figure C-3 (Contd)

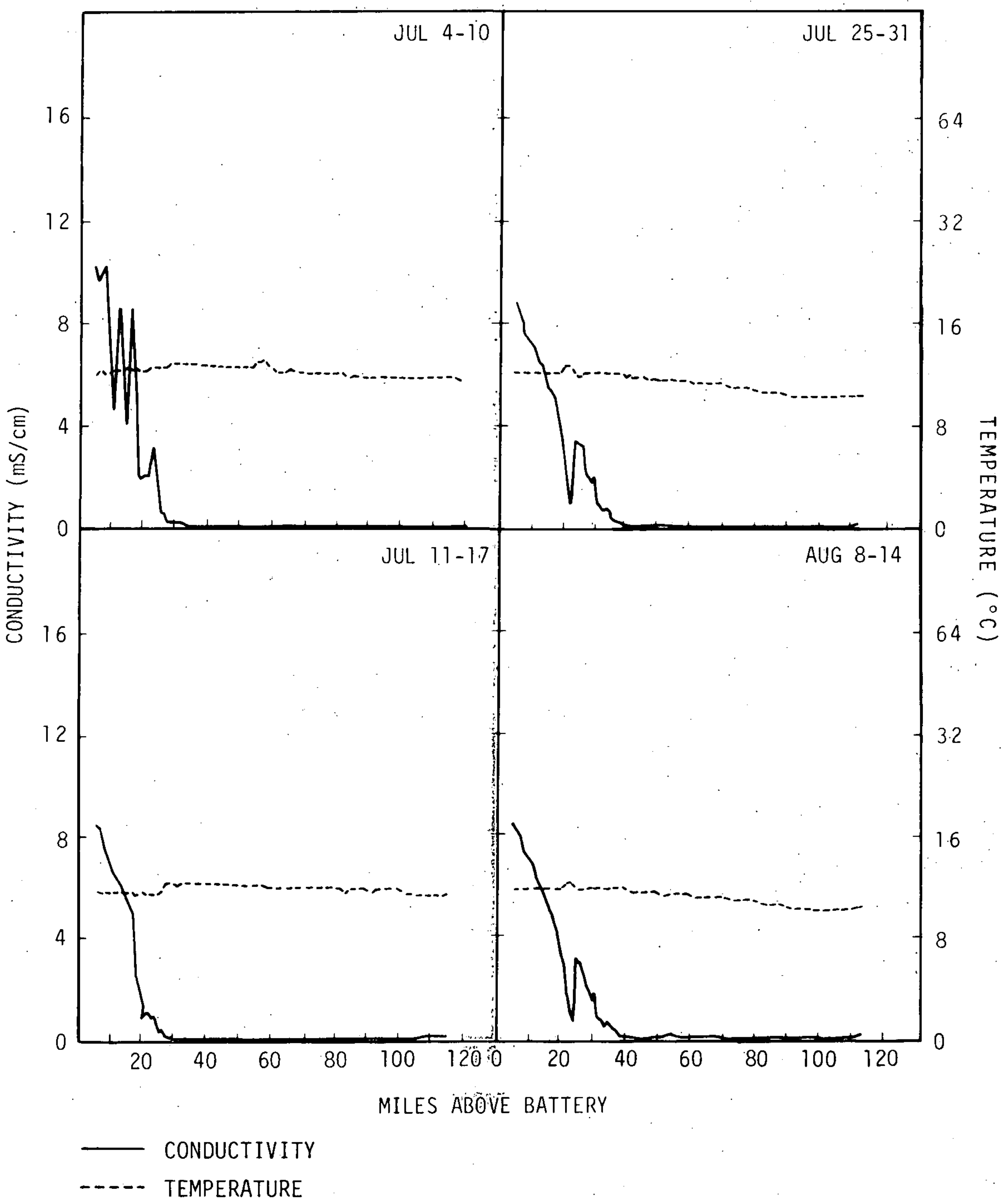


Figure C-3 (Contd)

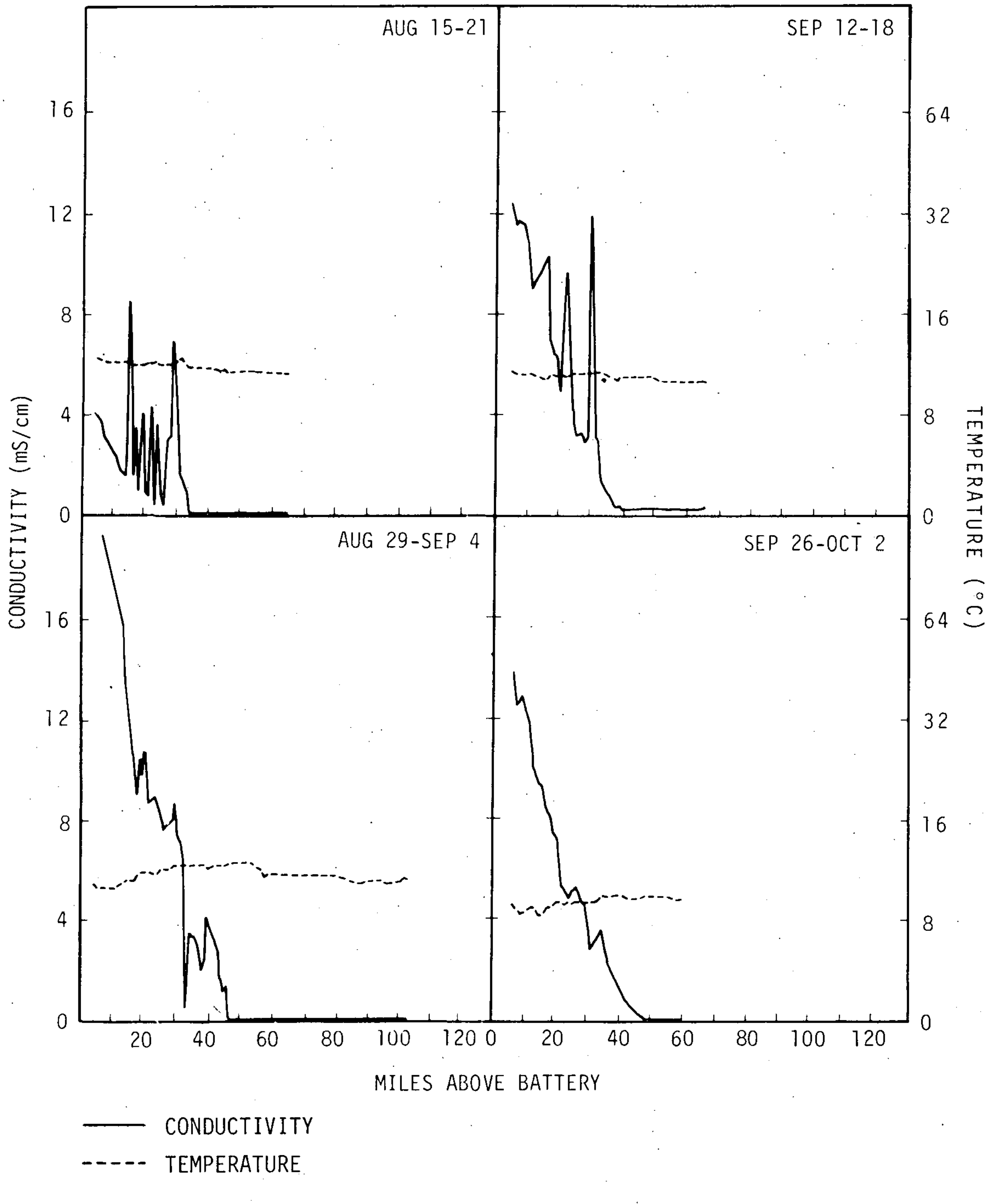


Figure C-3 (Contd)

Table C-23

Adult Striped Bass Tagged and Released in Hudson River in 1976† (Sorted by Days at Large)

Releases					Recovery							
Date	RM (KM)	Site	Rel Gr.	Total Length (mm)	Date	RM (KM)	Site	Total Length (mm)	Days at Large	Distance*** in Miles (km)	Sex‡	Recovery Gear
5/4/76	33 (53)	East	55	485	5/4/76	33 (53)	East	488	**	0	0	55-GN
4/20/76	34 (54)	East	20	472	4/00/76	32 (51)	East	0	**	2 (3)	0	98-SF
4/20/76	35 (56)	East	57	515	4/00/76	35 (56)	East	0	**	0	0	98-SF
5/17/76	36 (58)	West	14	449	8/4/76	**		0	79	**	0	93-CF
4/27/76	27 (43)	West	93	555	4/00/76	26 (42)	West	0	**	1 (2)	0	98-SF
4/12/76	27 (43)	West	93	542	4/00/76	26 (42)	West	0	12	1 (2)	0	93-CF
4/15/76	35 (56)	East	25	587	4/00/76	26 (42)	West	0	15	9 (14)	0	93-CF
5/4/76	33 (53)	East	55	488	5/00/76	Upper NY Bay		0	**	35 (56)	0	98-SF
*4/7/76	33 (53)	East	55	453	4/7/76	33 (53)	East	453	0	0	0	55-GN
4/13/76	34 (54)	East	20	488	4/13/76	34 (54)	East	485	0	0	M	20-GN
4/14/76	33 (53)	East	38	400	4/14/76	33 (53)	East	401	0	0	0	38-GN
4/21/76	33 (53)	East	38	423	4/21/76	33 (53)	East	422	0	0	F	38-GN
4/21/76	33 (53)	East	38	406	4/21/76	33 (53)	East	407	0	0	F	38-GN
4/21/76	35 (56)	East	20	524	4/21/76	35 (56)	East	522	0	0	F	20-GN
4/21/76	35 (56)	East	20	488	4/21/76	35 (56)	East	490	0	0	M	20-GN
4/21/76	35 (56)	East	20	492	4/21/76	35 (56)	East	495	0	0	F	20-GN
4/22/76	33 (53)	East	38	438	4/22/76	35 (56)	East	438	0	-2 (-3)	F	94-OF
4/22/76	33 (53)	East	38	421	4/22/76	33 (53)	East	420	0	0	F	38-GN
4/29/76	44 (70)	West	25	587	4/29/76	44 (70)	West	596	0	0	0	25-GN
5/4/76	40 (64)	West	38	371	5/4/76	40 (64)	West	373	0	0	0	38-GN
5/5/76	35 (56)	East	38	405	5/5/76	35 (56)	East	405	0	0	0	38-GN
5/5/76	35 (56)	East	38	416	5/5/76	35 (56)	East	408	0	0	0	38-GN
5/5/76	33 (53)	East	55	412	5/5/76	33 (53)	East	412	0	0	0	55-GN
5/6/76	44 (70)	West	25	732	5/6/76	44 (70)	West	728	0	0	F	25-GN
5/7/76	35 (56)	East	20	489	5/7/76	35 (56)	East	484	0	0	0	20-GN
5/13/76	33 (53)	East	54	770	5/13/76	33 (53)	East	764	0	0	F	54-GN
5/13/76	33 (53)	East	55	485	5/13/76	33 (53)	East	486	0	0	F	55-GN
5/13/76	33 (53)	East	55	704	5/13/76	33 (53)	East	715	0	0	0	54-GN
5/25/76	44 (70)	West	56	654	5/25/76	44 (70)	West	643	0	0	M	56-GN
5/26/76	33 (53)	East	25	595	5/26/76	33 (53)	East	597	0	0	F	25-GN
5/27/76	33 (53)	East	25	873	5/27/76	33 (53)	East	860	0	0	0	25-GN
5/27/76	35 (56)	East	54	634	5/27/76	35 (56)	East	611	0	0	F	54-GN
5/27/76	35 (56)	East	54	603	5/27/76	35 (56)	East	597	0	0	0	54-GN
3/23/76	33 (53)	East	55	497	3/24/76	33 (53)	East	497	1	0	M	55-GN
3/23/76	33 (53)	East	55	459	3/24/76	33 (53)	East	458	1	0	0	20-GN
3/23/76	33 (53)	East	55	498	3/24/76	33 (53)	East	498	1	0	0	55-GN
3/23/76	33 (53)	East	55	470	3/24/76	33 (53)	East	470	1	0	0	55-GN
3/23/76	33 (53)	East	20	504	3/24/76	33 (53)	East	510	1	0	0	20-GN
3/23/76	33 (53)	East	20	484	3/24/76	33 (53)	East	0	1	0	0	20-GN
3/23/76	33 (53)	East	20	471	3/24/76	33 (53)	East	479	1	0	0	20-GN
3/23/76	33 (53)	East	55	465	3/24/76	33 (53)	East	460	1	0	0	55-GN
3/23/76	33 (53)	East	55	477	3/24/76	33 (53)	East	477	1	0	0	55-GN
3/23/76	33 (53)	East	55	460	3/24/76	33 (53)	East	457	1	0	0	55-GN
3/23/76	33 (53)	East	55	471	3/24/76	33 (53)	East	466	1	0	0	55-GN
3/23/76	33 (53)	East	55	520	3/24/76	33 (53)	East	520	1	0	M	20-GN
3/23/76	33 (53)	East	55	472	3/24/76	33 (53)	East	465	1	0	F	55-GN
3/23/76	33 (53)	East	55	482	3/24/76	33 (53)	East	482	1	0	0	55-GN
3/24/76	33 (53)	East	20	458	3/25/76	33 (53)	East	454	1	0	M	20-GN
3/24/76	33 (53)	East	20	0	3/25/76	33 (53)	East	485	1	0	M	20-GN
3/24/76	26 (42)	West	38	423	3/25/76	26 (42)	West	412	1	0	0	38-GN
3/24/76	26 (42)	West	38	379	3/25/76	26 (42)	West	378	1	0	0	38-GN
3/24/76	33 (53)	East	55	477	3/25/76	33 (53)	East	482	1	0	0	55-GN
3/24/76	33 (53)	East	55	573	3/25/76	33 (53)	East	571	1	0	0	20-GN
3/24/76	33 (53)	East	55	491	3/25/76	33 (53)	East	492	1	0	0	55-GN
3/24/76	33 (53)	East	55	525	3/25/76	33 (53)	East	524	1	0	0	55-GN
3/24/76	33 (53)	East	55	521	3/25/76	33 (53)	East	524	1	0	M	55-GN
3/24/76	33 (53)	East	55	494	3/25/76	33 (53)	East	492	1	0	F	55-GN
3/24/76	33 (53)	East	55	480	3/25/76	33 (53)	East	483	1	0	0	20-GN
3/25/76	33 (53)	East	20	490	3/26/76	33 (53)	East	490	1	0	0	20-GN
3/25/76	33 (53)	East	55	506	3/26/76	33 (53)	East	503	1	0	0	55-GN
3/25/76	33 (53)	East	55	484	3/26/76	33 (53)	East	479	1	0	0	55-GN
3/25/76	33 (53)	East	55	490	3/26/76	33 (53)	East	491	1	0	0	55-GN
3/25/76	33 (53)	East	55	464	3/26/76	33 (53)	East	466	1	0	0	55-GN
3/25/76	33 (53)	East	55	501	3/26/76	33 (53)	East	493	1	0	0	55-GN
3/25/76	33 (53)	East	55	464	3/26/76	33 (53)	East	461	1	0	0	55-GN
3/25/76	33 (53)	East	55	449	3/26/76	33 (53)	East	450	1	0	0	55-GN
3/25/76	33 (53)	East	55	500	3/26/76	33 (53)	East	497	1	0	M	55-GN
3/25/76	33 (53)	East	55	445	3/26/76	33 (53)	East	449	1	0	F	55-GN
3/25/76	33 (53)	East	55	492	3/26/76	33 (53)	East	490	1	0	F	55-GN
3/25/76	33 (53)	East	55	524	3/26/76	33 (53)	East	542	1	0	F	55-GN
3/25/76	34 (54)	East	20	471	3/26/76	34 (54)	East	477	1	0	F	20-GN
3/25/76	37 (59)	East	39	468	3/26/76	37 (59)	East	468	1	0	M	39-GN
3/30/76	34 (54)	East	20	489	3/31/76	34 (54)	East	486	1	0	F	20-GN
3/31/76	36 (58)	Cntr	25	623	4/1/76	35 (56)	East	626	1	1 (2)	0	25-GN
4/5/76	35 (56)	East	39	469	4/6/76	35 (56)	East	468	1	0	M	39-GN

*Multiple recapture.

**Unknown.

***Minus sign indicates movement north of release site; no sign indicates southward movement.

†Previous years' tagged Striped Bass included when recaptured in 1976.

‡Sex code of 0 equals sex unknown.

GN - Gill Net
HS - Haul Seine
CF - Commercial Fisher
OF - Other Firms
SF - Sports Fisherman

Table C-23 (Contd)

Releases					Recovery							
Date	RM (KM)	Site	Rel Gr.	Total Length (mm)	Date	RM (KM)	Site	Total Length (mm)	Days at Large	Distance*** in Miles (km)	Sex†	Recovery Gear
04/06/76	33 (53)	East	55	458	04/07/76	33 (53)	East	460	1	0	0	55-GN
04/06/76	33 (53)	East	55	508	04/07/76	33 (53)	East	509	1	0	M	55-GN
04/06/76	33 (53)	East	55	440	04/07/76	33 (53)	East	445	1	0	0	55-GN
04/06/76	33 (53)	East	55	452	04/07/76	33 (53)	East	453	1	0	0	55-GN
04/06/76	33 (53)	East	55	472	04/07/76	33 (53)	East	472	1	0	F	55-GN
04/06/76	33 (53)	East	55	471	04/07/76	33 (53	East	469	1	0	F	55-GN
04/06/76	26 (42)	Cntr	39	455	04/07/76	26 (42)	Cntr	457	1	0	M	39-GN
04/06/76	27 (42)	Cntr	38	437	04/07/76	26 (42)	Cntr	436	1	0	0	39-GN
04/06/76	27 (43)	West	38	447	04/07/76	27 (43)	West	447	1	0	0	38-GN
04/06/76	33 (53)	East	55	502	04/07/76	33 (53)	East	503	1	0	0	55-GN
04/06/76	34 (54)	East	20	508	04/07/76	34 (54)	East	508	1	0	F	20-GN
04/06/76	34 (54)	East	20	503	04/07/76	34 (54)	East	505	1	0	0	20-GN
04/06/76	35 (56)	East	39	599	04/07/76	35 (56)	East	603	1	0	F	39-GN
04/06/76	35 (56)	East	39	456	04/07/76	35 (56)	East	458	1	0	M	39-GN
04/06/76	35 (56)	East	39	472	04/07/76	35 (56)	East	473	1	0	0	39-GN
04/07/76	33 (53)	East	55	476	04/08/76	33 (53)	East	477	1	0	M	55-GN
04/07/76	33 (53)	East	55	501	04/08/76	33 (53)	East	503	1	0	0	55-GN
04/07/76	34 (54)	East	25	590	04/08/76	34 (54)	East	598	1	0	0	25-GN
04/07/76	35 (56)	East	39	457	04/08/76	35 (56)	East	464	1	0	0	39-GN
04/07/76	35 (56)	East	39	487	04/08/76	35 (56)	East	487	1	0	M	39-GN
04/07/76	35 (56)	East	39	456	04/08/76	35 (56)	East	460	1	0	M	39-GN
04/07/76	35 (56)	East	39	473	04/08/76	35 (56)	East	478	1	0	0	39-GN
04/07/76	35 (56)	East	39	508	04/08/76	35 (56)	East	507	1	0	M	39-GN
04/07/76	35 (56)	East	39	471	04/08/76	35 (56)	East	474	1	0	0	39-GN
04/07/76	35 (56)	East	39	462	04/08/76	35 (56)	East	467	1	0	M	39-GN
04/07/76	35 (56)	East	39	441	04/08/76	35 (56)	East	442	1	0	M	39-GN
04/07/76	38 (61)	East	93	438	04/08/76	38 (61)	East	440	1	0	M	93-CF
04/07/76	33 (53)	East	55	463	04/08/76	33 (53)	East	469	1	0	0	55-GN
04/07/76	35 (56)	East	38	589	04/08/76	27 (43)	West	583	1	8 (13)	F	93-CF
04/07/76	35 (56)	East	38	433	04/08/76	36 (58)	East	435	1	-1 (-2)	0	38-GN
04/07/76	35 (56)	East	38	430	04/08/76	36 (58)	East	431	1	-1 (-2)	0	38-GN
04/07/76	35 (56)	East	38	433	04/08/76	36 (58)	East	437	1	-1 (-2)	M	38-GN
*04/08/76	33 (53)	East	55	503	04/09/76	33 (53)	East	503	1	0	F	55-GN
04/08/76	36 (58)	East	38	462	04/09/76	36 (58)	East	455	1	0	M	38-GN
04/08/76	33 (53)	East	55	523	04/09/76	33 (53)	East	519	1	0	F	55-GN
04/08/76	33 (53)	East	55	463	04/09/76	33 (53)	East	**	1	0	0	55-GN
04/13/76	33 (53)	East	38	426	04/14/75	33 (53)	East	427	1	0	0	38-GN
04/13/76	33 (53)	East	38	419	04/14/76	33 (53)	East	420	1	0	0	38-GN
04/13/76	42 (67)	West	38	418	04/14/76	42 (67)	West	421	1	0	0	38-GN
04/14/76	34 (54)	East	39	477	04/15/76	34 (54)	East	477	1	0	F	39-GN
04/19/76	34 (54)	East	20	479	04/20/76	34 (54)	East	490	1	0	0	20-GN
04/19/76	34 (54)	East	20	489	04/20/76	34 (54)	East	493	1	0	M	20-GN
04/19/76	34 (54)	East	38	432	04/20/76	34 (54)	East	427	1	0	F	38-GN
04/19/76	34 (54)	East	38	441	04/20/76	34 (54)	East	441	1	0	0	38-GN
04/19/76	34 (54)	East	38	420	04/20/76	34 (54)	East	418	1	0	0	38-GN
04/19/76	34 (54)	East	38	448	04/20/76	34 (54)	East	444	1	0	M	38-GN
04/20/76	33 (53)	East	38	415	04/21/76	33 (53)	East	416	1	0	F	38-GN
04/20/76	34 (54)	East	20	510	04/21/76	34 (54)	East	507	1	0	M	20-GN
04/20/76	34 (54)	East	38	427	04/21/76	34 (54)	East	427	1	0	M	38-GN
04/20/76	34 (54)	East	20	482	04/21/76	34 (54)	East	486	1	0	0	20-GN
04/20/76	35 (56)	East	57	650	04/21/76	35 (56)	East	647	1	0	F	57-GN
04/21/76	35 (56)	East	57	619	04/22/76	35 (56)	East	627	1	0	0	57-GN
04/21/76	35 (56)	East	20	591	04/22/76	35 (56)	East	601	1	0	0	20-GN
04/21/76	33 (53)	East	38	394	04/22/76	33 (53)	East	394	1	0	F	38-GN
*04/21/76	33 (53)	East	38	443	04/22/76	33 (53)	East	447	1	0	0	38-GN
04/21/76	33 (53)	East	38	409	04/22/76	33 (53)	East	**	1	0	0	38-GN
04/21/76	34 (54)	East	38	399	04/22/76	33 (53)	East	408	1	1 (-2)	0	38-GN
*04/22/76	33 (53)	East	38	447	04/23/76	33 (53)	East	443	1	0	F	39-GN
04/22/76	33 (53)	East	25	620	04/23/76	33 (53)	East	613	1	0	F	25-GN
04/22/76	34 (54)	East	38	435	04/23/76	34 (54)	East	443	1	0	F	38-GN
04/27/76	44 (70)	West	25	604	04/28/76	44 (70)	West	604	1	0	0	25-GN
04/27/76	33 (53)	East	20	490	04/28/76	33 (53)	East	490	1	0	F	20-GN
04/27/76	33 (53)	East	20	508	04/28/76	33 (53)	East	505	1	0	F	20-GN
04/27/76	33 (53)	East	20	456	04/28/76	33 (53)	East	456	1	0	M	20-GN
05/03/76	35 (56)	East	38	440	05/04/76	35 (56)	East	443	1	0	0	38-GN
05/03/76	42 (67)	East	39	454	05/04/76	42 (67)	East	452	1	0	M	39-GN
05/04/76	52 (83)	East	93	603	05/05/76	52 (83)	East	602	1	0	M	93-CF
05/04/76	52 (83)	East	93	585	05/05/76	52 (83)	East	589	1	0	M	93-CF
*05/04/76	35 (56)	East	38	405	05/05/76	35 (56)	East	405	1	0	0	38-GN
*05/04/76	40 (64)	West	38	373	05/05/76	40 (64)	West	370	1	0	M	38-GN
05/04/76	33 (53)	East	55	494	05/05/76	33 (53)	East	494	1	0	0	55-GN
*05/05/76	35 (56)	East	38	408	05/06/76	35 (56)	East	415	1	0	F	38-GN
05/06/76	34 (54)	East	25	616	05/07/76	34 (54)	East	617	1	0	M	25-GN
05/10/76	58 (93)	East	28	794	05/11/76	58 (93)	East	792	1	0	M	28-GN
05/12/76	35 (56)	East	20	390	05/13/76	35 (56)	East	395	1	0	F	20-GN
*05/12/76	33 (53)	East	54	704	05/13/76	33 (53)	East	704	1	0	0	55-GN
05/12/76	33 (53)	East	55	612	05/13/76	33 (53)	East	615	1	0	F	55-GN
05/13/76	33 (53)	East	54	680	05/14/76	33 (53)	East	679	1	0	0	54-GN
05/27/76	35 (56)	East	61	424	05/28/76	35 (56)	East	420	1	0	0	94-OF

*Multiple recapture.

**Unknown.

***Minus sign indicates movement north of release site; no sign indicates southward movement.

†Sex code of 0 equals sex unknown.

GN - Gill Net
HS - Haul Seine
CF - Commercial Fisher
OF - Other Firms
SF - Sports Fisherman

Table C-23 (Contd)

Releases					Recovery							
Date	RM (KM)	Site	Rel. Gr.	Total Length (mm)	Date	RM (KM)	Site	Total Length (mm)	Days at Large	Distance*** in Miles (km)	Sex†	Recovery Gear
06/08/76	44 (70)	West	25	679	06/09/76	44 (70)	West	685	1	0	0	25-GN
06/10/76	44 (70)	West	54	822	06/11/76	44 (70)	West	830	1	0	F	54-GN
03/16/76	33 (53)	East	39	428	03/18/76	34 (54)	East	435	2	-1 (-2)	0	39-GN
03/23/76	33 (53)	East	55	446	03/25/76	33 (53)	East	447	2	0	M	55-GN
04/06/76	34 (54)	East	20	500	04/08/76	34 (54)	East	502	2	0	M	20-GN
04/07/76	33 (53)	East	55	480	04/09/76	33 (53)	East	479	2	0	M	55-GN
*04/07/76	33 (53)	East	54	673	04/09/76	33 (53)	East	674	2	0	M	54-GN
04/07/76	35 (56)	East	38	416	04/09/76	36 (58)	East	419	2	-1 (-2)	F	38-GN
04/14/76	33 (53)	East	38	437	04/16/76	27 (43)	West	435	2	.6 (10)	F	93-CF
04/19/76	36 (58)	East	25	832	04/21/76	36 (58)	East	843	2	0	0	25-GN
04/19/76	34 (54)	East	38	386	04/21/76	34 (54)	East	383	2	0	M	38-GN
04/20/76	35 (56)	East	57	581	04/22/76	12 (19)		0	2	23 (37)	0	93-CF
04/23/76	35 (56)	East	20	586	04/26/76	12 (19)		0	3	23 (37)	0	93-CF
04/19/76	35 (56)	East	57	598	04/23/76	12 (19)		0	4	23 (37)	0	93-CF
05/06/76	40 (64)	West	38	435	05/10/76	40 (64)	West	440	4	0	0	94-OF
05/13/76	35 (56)	East	61	960	05/17/76	39 (62)	East	960	4	-4 (-6)	0	61-900' HS
04/22/76	33 (53)	East	38	495	04/28/76	35 (56)	Cntr	0	6	-2 (-3)	0	93-CF
05/07/76	40 (64)	West	38	650	05/13/76	35 (56)	East	657	6	5 (8)	0	61-900' HS
10/08/76	34 (54)	East	14	559	10/15/76	14 (22)	East	0	7	20 (32)	0	98-SF
*03/30/76	36 (58)	East	25	677	04/07/76	33 (53)	East	673	8	3 (5)	0	54-GN
04/19/76	34 (54)	East	38	444	04/27/76	32 (51)	East	0	8	2 (3)	0	98-SF
*04/29/76	44 (70)	West	25	595	05/09/76	34 (54)	East	0	10	10 (16)	0	98-SF
04/13/76	33 (53)	East	38	424	04/24/76	Gov's. Island, NY		0	11	35 (56)	0	98-SF
04/15/76	34 (54)	East	39	531	04/26/76	66 (106)	Cntr	526	11	-32 (-51)	M	93-CF
05/27/76	35 (56)	East	54	840	06/07/76	W.Bank LtHse NY		0	11	47 (75)	0	98-SF
05/28/76	40 (64)	West	25	584	06/08/76	27 (43)	West	572	11	13 (21)	F	93-CF
04/15/76	38 (61)	East	93	525	04/27/76	41 (66)	West	0	12	-3 (-5)	0	93-CF
06/09/76	35 (56)	East	25	982	06/22/76	Moriches Is Fire Is NY		0	13	117 (187)	0	98-SF
04/09/76	33 (53)	East	55	472	04/23/76	12 (19)		0	14	21 (34)	0	93-CF
04/14/76	35 (56)	East	25	796	04/28/76	34 (54)	East	0	14	1 (2)	0	98-SF
04/07/76	35 (56)	East	39	632	04/22/76	12 (19)		0	15	23 (37)	0	93-CF
04/12/76	27 (43)	West	93	520	04/27/76	12 (19)		0	15	15 (24)	0	93-CF
04/30/76	34 (54)	East	61	485	05/17/76	36 (58)	West	476	17	-2 (-3)	0	14-200' HS
06/04/76	52 (83)	East	93	942	06/24/76	Atlantic Bch NY		0	20	78 (125)	0	98-SF
04/07/76	34 (54)	East	20	785	04/30/76	LI Sound No.Port NY		0	23	73 (117)	0	98-SF
04/07/76	33 (53)	East	55	448	05/01/76	Rockaway NY		0	24	48 (77)	0	98-SF
09/23/76	60 (96)	East	05	257	10/18/76	East River NY		0	25	40 (64)	0	98-SF
03/24/76	33 (53)	East	55	481	04/19/76	Jersey City NJ		0	26	33 (53)	0	98-SF
03/31/76	36 (58)	Cntr	25	611	04/26/76	12 (19)		0	26	24 (38)	0	93-CF
04/27/76	59 (94)	Cntr	20	530	05/25/76	Brd Ch Jamaica Bay,NY		0	28	81 (130)	0	98-SF
04/06/76	33 (53)	East	55	509	05/05/76	34 (54)	East	0	29	-1 (-2)	0	61-900' HS
04/14/76	35 (56)	East	25	606	05/13/76	33 (53)	East	610	29	2 (3)	M	61-900' HS
04/09/76	26 (42)	Cntr	39	455	05/09/76	E. River Astoria NY		0	30	28 (45)	0	98-SF
05/24/76	44 (70)	West	56	546	06/23/76	Verrazano Br NY		0	30	52 (83)	0	98-SF
03/23/76	33 (53)	East	20	522	04/23/76	34 (54)	East	0	31	-1 (-2)	0	98-SF
04/07/76	33 (53)	East	55	465	05/10/76	33 (53)	East	464	33	0	F	55-GN
04/19/76	34 (54)	East	38	452	05/22/76	Jamestown RI		0	33	159 (254)	0	98-SF
03/30/76	34 (54)	East	20	534	05/03/76	40 (64)	East	0	34	-6 (-10)	0	98-SF
03/25/76	27 (43)	Cntr	39	438	05/00/76	Robbins Rf U Bay NY		0	36-67‡	30 (48)	0	98-SF
05/27/76	46 (74)	West	28	871	07/02/76	Rockaway NY		0	36	61 (98)	0	98-SF
*04/20/76	35 (56)	East	57	631	05/27/76	33 (53)	East	642	37	2 (3)	0	38-GN
05/27/76	39 (62)	East	61	383	07/04/76	39 (62)	East	0	38	0	0	98-SF
06/10/76	52 (83)	East	93	957	07/18/76	Chatham Mass		0	38	283 (453)	0	98-SF
03/26/76	37 (59)	East	39	488	05/04/76	72 (115)	West	0	39	-35 (-56)	0	93-CF
05/17/76	40 (64)	East	14	560	06/26/76	Whitestone NY		0	40	52 (83)	0	98-SF
04/07/76	35 (56)	East	39	448	05/20/76	Amagansett NY		0	43	147 (235)	0	98-SF
04/07/76	35 (56)	East	39	550	05/21/76	Orient NY		0	44	134 (214)	0	93-CF
04/13/76	33 (53)	East	38	459	05/27/76	Huntington NY		0	44	66 (106)	0	98-SF
05/17/76	36 (58)	West	14	945	07/02/76	Coney Is Brooklyn NY		0	46	46 (74)	0	98-SF
04/19/76	34 (54)	East	38	488	06/05/76	Lower NY Bay NJ		0	47	47 (75)	0	98-SF
04/06/76	33 (53)	East	55	501	05/25/76	Jamaica Bay		0	49	52 (83)	0	98-SF
04/20/76	35 (56)	East	57	672	06/08/76	Sandy Hook NJ		0	49	66 (106)	0	98-SF
05/05/76	34 (54)	East	61	491	06/24/76	Verrazano Br.NY		0	50	42 (67)	0	98-SF
04/08/76	27 (43)	West	38	412	05/29/76	Ram Is Norwalk CT		0	51	44 (70)	0	98-SF
03/26/76	26 (42)	West	38	424	05/18/76	112 (179)	West	0	53	-86 (-138)	0	98-SF
03/24/76	34 (54)	East	20	540	05/17/76	91 (146)	West	0	54	-57 (-91)	0	98-SF
05/27/76	33 (53)	East	38	644	07/20/76	Hampton Bays NY		0	54	130 (208)	0	98-SF
*05/27/76	33 (53)	East	38	642	07/21/76	Hoffman Is NY		0	55	45 (72)	0	98-SF
04/19/76	34 (54)	East	38	438	06/15/76	Huntington NY		0	57	72 (115)	0	98-SF
03/24/76	27 (43)	West	20	522	05/22/76	Manhasset Bay NY		0	59	48 (77)	0	98-SF
04/08/76	36 (58)	East	38	415	06/09/76	Jamaica Bay NY		0	62	58 (93)	0	98-SF
05/11/76	27 (43)	West	93	439	07/12/76	Verrazano Br NY		0	62	35 (56)	0	98-SF
05/12/76	27 (43)	West	93	590	07/13/76	Breezy Pt NY		0	62	42 (67)	0	98-SF
04/02/76	26 (42)	West	39	465	06/04/76	Mouth of Ct.River Ct		0	63	126 (202)	0	98-SF
05/20/76	39 (62)	East	14	642	07/22/76	Hoffman Is NY		0	63	45 (72)	0	98-SF
03/23/76	33 (53)	East	20	524	05/28/76	Motts Pt NY		0	66	59 (94)	0	98-SF
03/26/76	37 (59)	East	39	525	06/00/76	Raritan Bay NJ		0	66-96‡	52 (83)	0	98-SF
03/24/76	26 (42)	West	38	386	06/01/76	Cos Cob Ct		0	69	61 (98)	0	98-SF

*Multiple recapture.

**Unknown. le recapture.

***Minus sign indicates movement north of release site; no sign indicates southward movement.

†Sex code of 0 equals sex unknown.

‡No recapture date available; range of days at large within noted month of recapture.

GN - Gill Net
HS - Haul Seine
CF - Commercial Fisher
OF - Other Firms
SF - Sports Fisherman

Table C-23 (Contd)

Releases					Recovery							
Date	RM (KM)	Site	Rel Gr.	Total Length (mm)	Date	RM (KM)	Site	Total Length (mm)	Days at Large	Distance*** in Miles (km)	Sex†	Recovery Gear
04/22/76	34 (54)	East	38	415	07/02/76	64 (102)	East	0	71	-30 (-48)	0	98-SF
03/30/76	33 (53)	East	20	467	06/10/76	Pelham Bay		0	72	52 (83)	0	98-SF
05/27/76	33 (53)	East	38	468	08/07/76	Plum Bch Bklyn NY		0	72	40 (64)	0	98-SF
04/13/76	33 (53)	East	38	404	06/27/76	55 (88)	West	0	75	-22 (-35)	0	98-SF
04/15/76	33 (53)	East	38	473	07/00/76	Verrazano Br NY		0	76-107‡	42 (67)	0	98-SF
04/06/76	35 (56)	East	39	502	06/23/76	Shinnecock Bay NY		0	78	135 (216)	0	98-SF
04/07/76	35 (56)	East	38	410	06/25/76	Mamaroneck NY		0	79	58 (93)	0	98-SF
06/23/76	27 (43)	West	93	531	09/10/76	Montauk Pt NY		0	79	161 (258)	0	98-SF
04/20/76	34 (54)	East	20	415	07/10/76	Stockport Creek		0	81	-86 (-138)	0	98-SF
05/12/76	35 (56)	East	20	781	08/01/76	Montauk Pt NY		0	81	169 (270)	0	98-SF
04/08/76	35 (58)	East	38	432	06/30/76	Hart Is NY		0	83	57 (91)	0	98-SF
03/23/76	33 (53)	East	55	463	06/16/76	Sea Bright NJ		0	85	58 (93)	0	98-SF
04/06/76	35 (56)	East	39	473	07/00/76	Verrazano Br NY		0	85-116‡	42 (67)	0	98-SF
04/22/76	35 (56)	East	57	640	07/18/76	Jamaica Bay		0	87	57 (91)	0	98-SF
03/23/76	33 (53)	East	20	566	06/19/76	Mamaroneck NY		0	88	56 (90)	0	98-SF
03/24/76	37 (59)	East	39	465	06/20/76	Democrat Pt NY		0	88	86 (138)	0	98-SF
03/26/76	27 (43)	West	20	479	06/22/76	Verrazano Br NY		0	88	35 (56)	0	98-SF
04/21/76	34 (54)	East	38	381	07/19/76	Stamford Ct		0	89	70 (112)	0	98-SF
05/05/76	34 (54)	East	61	399	08/05/76	Jamaica Bay NY		0	92	58 (93)	0	98-SF
04/02/76	26 (42)	West	25	665	07/04/76	Short Bch NY		0	93	62 (99)	0	98-SF
04/06/76	33 (53)	East	55	519	07/08/76	Greenwich Ct		0	93	64 (102)	0	98-SF
03/23/76	33 (53)	East	55	519	06/26/76	Whitestone NY		0	95	52 (83)	0	98-SF
04/19/76	34 (54)	East	20	692	07/23/76	Montauk Pt NY		0	95	168 (269)	0	98-SF
04/19/76	34 (54)	East	38	387	07/23/76	Brooklyn NY		0	95	42 (67)	0	98-SF
04/09/76	33 (53)	East	55	481	07/14/76	91 (146)	West	0	96	58 (93)	0	98-SF
05/27/76	44 (70)	West	56	557	08/31/76	Jamaica Bay NY		0	96	72 (115)	0	98-SF
04/07/76	35 (56)	East	38	395	07/13/76	69 (110)	East	0	97	-34 (-54)	0	94-OF
03/30/76	27 (43)	West	38	424	07/07/76	Rockaway Inlet		0	99	42 (67)	0	98-SF
04/08/76	38 (60)	East	93	699	07/18/76	Sands Pt NY		0	101	59 (94)	0	98-SF
03/26/76	37 (59)	East	39	472	07/07/76	Verrazano Br NY		0	103	45 (72)	0	98-SF
04/09/76	26 (42)	West	20	460	07/22/76	Lordship Ct		0	104	83 (133)	0	98-SF
03/23/76	33 (53)	East	20	526	07/07/76	East Hampton NY		0	106	146 (234)	0	98-SF
03/24/76	37 (59)	East	39	457	07/08/76	Moriches NY		0	106	119 (190)	0	98-SF
04/02/76	26 (42)	West	25	588	07/17/76	Belmar NJ		0	106	65 (104)	0	98-SF
03/16/76	33 (53)	East	38	446	07/03/76	Greenwich Ct		0	109	64 (102)	0	98-SF
03/30/76	36 (58)	East	25	559	07/19/76	Rockaway NY		0	111	51 (82)	0	98-SF
04/09/76	33 (53)	East	55	508	07/30/76	Jamaica NY		0	112	36 (58)	0	98-SF
04/09/76	33 (53)	East	55	494	07/31/76	New Rochelle NY		0	113	53 (85)	0	98-SF
04/08/76	36 (58)	East	38	650	07/31/76	Ambrose Channel NY		0	114	66 (106)	0	98-SF
04/19/76	34 (54)	East	38	387	08/17/76	151 (242)	West	0	120	-117 (-187)	0	98-SF
03/24/76	26 (42)	West	38	413	07/24/76	Rye Beach NY		0	122	55 (88)	0	98-SF
04/22/76	33 (53)	East	38	390	08/22/76	Bayonne NJ		0	122	36 (58)	0	98-SF
03/23/76	33 (53)	East	55	536	07/25/76	Greenwich Ct		0	124	65 (104)	0	98-SF
05/27/76	39 (62)	East	61	400	10/04/76	Verrazano Br NY		0	130	47 (75)	0	98-SF
03/23/76	33 (53)	East	55	450	08/05/76	Brooklyn NY		0	135	48 (77)	0	98-SF
03/16/76	33 (53)	East	38	440	07/31/76	Cape Cod Ma		0	137	286 (458)	0	98-SF
04/06/76	33 (53)	East	55	464	08/21/76	Zachs Bay, NY		0	137	73 (117)	0	98-SF
04/13/76	33 (53)	East	38	400	08/30/76	New Rochelle, NY		0	139	55 (88)	0	98-SF
03/25/76	35 (56)	East	25	630	08/12/76	City Is, LI Sound		0	140	55 (88)	0	98-SF
04/13/76	33 (53)	East	38	441	09/05/76	152 (243)	West	0	145	-119 (-190)	0	98-SF
04/30/76	34 (54)	East	61	409	09/23/76	Rockaway Pt. NY		0	146	48 (77)	0	98-SF
04/14/76	33 (53)	East	38	394	09/10/76	S. Oyster Bay, NY		0	149	73 (117)	0	98-SF
04/07/76	35 (56)	East	39	485	09/04/76	Verrazano Br. NY		0	150	43 (69)	0	98-SF
04/08/76	33 (53)	East	55	474	09/06/76	Coney Is.Norton's Pt		0	151	42 (67)	0	98-SF
05/13/76	35 (56)	East	61	729	10/11/76	Cuttyhunk Is. RI		0	151	209 (334)	0	98-SF
04/07/76	35 (56)	East	38	463	09/10/76	Stamford Ct,LI Snd		0	156	70 (112)	0	98-SF
03/23/76	33 (53)	East	20	506	09/01/76	Verrazano Br. NY		0	162	41 (66)	0	98-SF
04/26/76	27 (43)	West	93	570	10/13/76	Jamaica Bay NY		0	170	49 (78)	0	98-SF
04/26/76	27 (43)	West	93	586	10/17/76	Plum Gut Orient Pt NY		0	174	130 (208)	0	98-SF
03/26/76	26 (42)	East	38	375	09/17/76	Greenwich Ct		0	175	58 (93)	0	98-SF
04/14/76	33 (53)	East	38	425	10/07/76	Milford Ct		0	176	96 (154)	0	98-SF
03/31/76	33 (53)	East	20	563	09/24/76	Jamaica Bay NY		0	177	55 (88)	0	98-SF
04/09/76	33 (53)	East	55	528	10/10/76	Hoffman Is.Lwr NY Bay		0	184	40 (64)	0	98-SF
04/07/76	27 (43)	West	12	641	10/16/76	28 (45)	West	0	192	-1 (-2)	0	98-SF
03/25/76	34 (54)	East	20	497	10/04/76	Sloop Chan.E.Bay NY		0	193	73 (117)	0	98-SF
04/09/76	33 (53)	East	55	487	10/19/76	Rockaway NY		0	193	49 (78)	0	98-SF
09/18/75	35 (56)	East	12	676	03/31/76	36 (58)	Center	678	195	-1 (-2)	0	25-GN
03/16/76	33 (53)	East	38	418	10/03/76	Narragansett RI		0	201	184 (294)	0	98-SF
04/15/76	34 (54)	East	20	479	11/02/76	Lower NY Bay NY		0	201	42 (67)	0	98-SF
03/24/76	33 (53)	East	55	500	10/12/76	Jamaica Bay NY		0	202	49 (78)	0	98-SF
04/20/76	35 (56)	East	57	596	11/17/76	Sea Isle NJ		0	211	169 (270)	0	93-CF
03/16/76	30 (48)	East	39	493	10/16/76	Peacock Pt. NY		0	214	70 (112)	0	98-SF
03/30/76	34 (54)	East	20	497	11/07/76	Breezy Pt. NY		0	222	53 (85)	0	98-SF
03/16/76	33 (53)	East	38	426	11/24/76	S.Bch. Staten Is.NY		0	253	42 (67)	0	98-SF
06/19/75	Jamaica Bay NY		15	244	04/21/76	33 (53)	East	338	307	52 (83)	0	61-900' HS
04/16/75	35 (56)	East	25	583	04/00/76	26 (42)	West	0	350-380 ‡	9 (14)	0	93-CF
09/19/75	34 (54)	East	12	392	09/12/76	Verrazano Br. NY		0	359	42 (67)	0	98-SF
04/10/75	34 (54)	East	25	532	04/21/76	36 (58)	East	592	377	-2 (-3)	0	25-GN
11/11/74	41 (66)	East	0	264	05/21/76	38 (61)	East	0	557	3 (5)	0	98-SF
04/29/75	38 (61)	West	25	663	07/13/76	Breezy Pt. NY		0	440	53 (85)	0	98-SF

*Multiple recapture.

**Unknown.

***Minus sign indicates movement north of release site; no sign indicates southward movement.

†Sex code of 0 equals sex unknown.

‡No specific recapture date available; range of days at large within noted month of recapture.

‡Release from survival pens.

GN - Gill Net
HS - Haul Seine
CF - Commercial Fisher
OF - Other Firms
SF - Sports Fisherman

Table C-24

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Striped Bass Eggs above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Egg Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
5/10-5/13	Above	34994.5	72.2	24902.4	51.4	21990.9	45.4	773.1	1.6	735.8	1.5
	Within	13464.5	27.8	23257.1	47.9	25869.3	53.4	593.8	1.2	558.7	1.1
	Below	0.0	0.0	299.4	0.6	598.8	1.2	47092.0	97.2	47164.5	97.3
5/17-5/19	Above	56543.0	74.3	47839.9	62.8	46693.9	61.3	34152.8	44.8	33927.0	44.5
	Within	19232.5	25.2	26489.3	34.8	26337.5	34.6	3395.6	4.4	3249.9	4.3
	Below	364.5	0.5	1810.8	2.4	3108.6	4.1	38591.5	50.7	38963.1	51.2
5/24-5/26	Above	17636.2	69.0	12622.6	49.4	12063.1	47.2	7430.4	29.1	7388.1	28.9
	Within	7735.0	30.3	12655.0	49.5	13160.1	51.5	569.5	2.2	564.4	2.2
	Below	188.7	0.7	282.4	1.1	336.8	1.3	17560.0	68.7	17607.4	68.9
6/1-6/4	Above	16039.9	92.7	14251.9	82.4	13140.8	75.9	4042.2	23.4	4018.4	23.2
	Within	1255.1	7.2	3017.7	17.4	4103.4	23.7	775.8	4.5	620.9	3.6
	Below	0.0	0.0	25.4	0.1	50.8	0.3	12477.0	72.1	12655.7	73.2
6/7-6/11	Above	25704.4	98.1	24583.8	93.9	23739.7	90.6	7498.9	28.6	7343.9	28.0
	Within	487.6	1.9	1602.7	6.1	2441.5	9.3	5945.1	22.7	4637.5	17.7
	Below	0.0	0.0	5.4	0.0	10.8	0.0	12748.0	48.7	14210.6	54.2
Totals	Above	150918.0	78.0	124201.0	64.0	117629.0	60.0	53897.0	28.0	53413.0	28.0
	Within	42176.0	22.0	67022.0	35.0	71912.0	37.0	11281.0	6.0	9632.0	5.0
	Below	554.0	<1.0	2422.0	1.0	4107.0	2.0	128469.0	66.0	130602.0	67.0

Table C-25

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Striped Bass Yolk-Sac Larvae above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Yolk-Sac Larva Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
5/17-5/19	Above	60241.2	51.7	42887.5	36.8	40254.0	34.6	5778.6	4.9	4965.6	4.3
	Within	40584.2	34.9	49605.1	42.6	50309.1	43.2	12116.4	10.4	11626.4	9.9
	Below	15574.5	13.4	23907.4	20.5	25836.8	22.2	98505.0	84.6	99807.9	85.7
5/24-5/26	Above	3257.0	17.9	1689.3	9.3	1534.5	8.4	54.9	0.3	44.0	0.2
	Within	8463.9	46.6	6805.1	37.5	6239.3	34.4	252.5	1.4	215.8	1.2
	Below	6428.1	35.4	9654.6	53.2	10375.2	57.2	17841.5	98.3	17889.1	98.6
6/1-6/4	Above	40305.1	84.3	36300.7	75.9	35666.5	74.6	11870.7	24.8	10498.7	21.9
	Within	7217.1	15.1	10806.8	22.6	11144.7	23.3	16608.3	34.7	17064.5	35.7
	Below	275.8	0.6	690.4	1.4	986.8	2.1	19319.0	40.4	20234.8	42.3
6/7-6/11	Above	86640.0	86.1	79204.8	78.7	77313.6	76.8	29093.8	28.9	26753.5	26.6
	Within	12611.3	12.5	18892.0	18.8	20229.0	20.1	29307.6	29.1	29758.7	29.6
	Below	1400.7	1.4	2555.2	2.5	3109.4	3.1	42250.5	41.9	44139.8	43.8
6/14-6/17	Above	132573.9	87.1	118872.9	78.1	114866.8	75.4	46833.5	30.7	44552.3	29.2
	Within	19699.1	12.9	32691.9	21.5	35989.8	23.6	31504.0	20.7	30962.7	20.3
	Below	0.0	0.0	708.2	0.5	1416.4	0.9	73935.5	48.5	76757.9	50.4
Totals	Above	323017.0	74.0	278956.0	64.0	269637.0	62.0	93633.0	22.0	86815.0	20.0
	Within	88575.0	20.0	118801.0	27.0	123915.0	28.0	89789.0	21.0	89629.0	21.0
	Below	23680.0	5.0	37516.0	9.0	41724.0	10.0	251853.0	58.0	258830.0	59.0

Table C-26

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Striped Bass Post Yolk-Sac Larvae above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Post Yolk-Sac Larva Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
6/14-6/17	Above	176404.5	72.9	148935.7	61.5	142975.5	59.1	47413.9	19.6	45022.9	18.6
	Within	54852.8	22.7	74814.6	30.9	77900.3	32.2	38975.1	16.1	36419.2	15.0
	Below	10808.7	4.5	18315.6	7.6	21190.2	8.7	155677.0	64.3	160623.9	66.3
6/21-6/24	Above	91796.4	49.7	62436.9	33.8	58037.0	31.4	8532.8	4.6	7844.9	4.2
	Within	88263.7	47.8	106791.2	57.8	102232.5	55.3	12812.1	6.9	11542.8	6.2
	Below	4745.9	2.6	15577.8	8.4	24535.6	13.3	163461.0	88.4	165418.2	89.5
6/28-7/1	Above	18476.2	39.1	9774.3	20.7	9354.6	19.8	2992.9	6.3	2790.4	5.9
	Within	24470.3	51.8	29624.9	62.7	28264.8	59.9	2733.5	5.8	2706.8	5.7
	Below	4265.4	9.0	7812.8	16.5	9592.6	20.3	41485.5	87.8	41714.8	88.3
Totals	Above	286677.0	60.0	221147.0	47.0	210369.0	44.0	58940.0	12.0	55658.0	12.0
	Within	167587.0	35.0	211231.0	45.0	208398.0	44.0	54521.0	12.0	50669.0	11.0
	Below	19820.0	4.0	41707.0	9.0	55319.0	12.0	360624.0	76.0	367757.0	78.0

Table C-27

Estimated Standing Crops and Percent Standing Crops of Striped Bass Juveniles above, within, and below 5 Power-Plant Regions Determined from 100-Ft (30.5-m) Beach Seine during Periods of Juvenile Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
6/27-7/10	Above	71385	41.5	64117	37.3	60075	34.9	17604	10.2	17552	10.2
	Within	41891	24.4	21864	12.7	23602	13.7	7331	4.3	5110	3.0
	Below	58652	34.1	85947	50.0	88252	51.3	146993	85.5	149266	86.8
7/11-7/24	Above	307342	30.1	291413	28.5	289011	28.3	111089	10.9	109957	10.8
	Within	497536	48.7	363217	35.5	284434	27.8	86262	8.4	62402	6.1
	Below	217034	21.2	367282	35.9	448468	43.9	824561	80.7	849553	83.1
7/25-8/7	Above	242546	33.7	217548	30.2	215412	29.9	97344	13.5	96876	13.4
	Within	276689	38.4	207144	28.8	173268	24.1	53916	7.5	37957	5.3
	Below	201060	27.9	295602	41.0	331613	46.0	569034	79.0	585461	81.3
8/8-8/21	Above	242588	23.2	216535	20.7	215795	20.7	136562	13.1	134376	12.9
	Within	287176	37.1	228300	21.9	189025	18.1	45546	4.4	37710	3.6
	Below	414777	39.7	599707	57.4	639721	61.2	862434	82.6	871955	83.5
8/22-9/4	Above	115112	14.2	101775	12.6	98529	12.2	38451	4.8	37787	4.7
	Within	344813	42.6	200825	24.8	161404	20.0	22016	2.7	17586	2.2
	Below	349049	43.1	506374	62.6	549042	67.9	748508	92.5	753621	93.2
9/5-9/18	Above	115025	17.2	99751	14.9	98300	14.7	53823	8.0	53542	8.0
	Within	311277	46.5	217588	32.5	174220	26.0	18575	2.8	13600	2.0
	Below	243810	36.4	352773	52.6	397591	59.3	597713	89.2	602969	90.0
9/19-10/2	Above	75188	8.4	62070	6.9	60534	6.7	33409	3.7	33128	3.7
	Within	464547	51.6	306511	34.1	239525	26.6	9600	1.1	7623	0.8
	Below	359971	40.0	531124	59.0	599647	66.6	856697	95.2	858954	95.5
10/3-10/16	Above	40794	8.9	32569	7.1	32023	7.0	12140	2.6	11906	2.6
	Within	237991	51.7	158708	34.5	124832	27.1	9214	2.0	7161	1.6
	Below	181432	39.4	268940	58.4	303361	65.9	438862	95.4	441149	95.9
10/17-10/30	Above	22172	4.6	17628	3.6	17284	3.6	4545	0.9	3889	0.8
	Within	179133	36.9	93890	19.3	73648	15.2	8479	1.7	8516	1.8
	Below	284323	58.5	374111	77.0	394696	81.3	472604	97.3	478223	97.4
10/31-11/13	Above	6500	4.3	2894	1.9	2894	1.9	588	0.4	471	0.3
	Within	58115	38.5	39404	26.1	31957	21.2	1744	1.2	1674	1.1
	Below	86388	57.2	108705	72.0	116151	76.9	148670	98.5	148857	98.6
11/14-11/27	Above	422	0.4	0	0.0	0	0.0	0	0.0	0	0.0
	Within	9762	9.3	2922	2.8	2474	2.3	0	0.0	0	0.0
	Below	95231	90.3	102495	97.2	102943	97.7	105417	100.0	105417	100.0
11/28-12/11	Above	920	9.6	275	2.9	241	2.5	0	0.0	0	0.0
	Within	8700	90.4	7808	81.2	6306	65.6	0	0.0	0	0.0
	Below	0	0.0	1537	16.0	3073	31.9	9621	100.0	9621	100.0

Table C-28

Estimated Standing Crops and Percent Standing Crops of Striped Bass Yearlings above, within, and below 5 Power-Plant Regions Determined from 100-Ft (30.5-m) Beach Seine during Periods of Yearling Abundance, 1977

DATE	AREA	BOWLINE		LOVETT		INDIAN POINT		ROSETON		DANSKAMMER	
		S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
4/ 3- 4/16	ABOVE	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	WITHIN	4544.	15.5	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	BELOW	24858.	84.5	29401.	100.0	29401.	100.0	29401.	100.0	29401.	100.0
4/17- 4/30	ABOVE	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	WITHIN	9071.	15.8	1163.	2.0	872.	1.5	0.	0.0	0.	0.0
	BELOW	48437.	84.2	56345.	98.0	56635.	98.5	57508.	100.0	57508.	100.0
5/ 1- 5/14	ABOVE	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	WITHIN	7647.	15.7	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	BELOW	41153.	84.3	48800.	100.0	48800.	100.0	48800.	100.0	48800.	100.0
5/15- 5/28	ABOVE	1557.	2.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	WITHIN	42362.	54.0	26322.	33.5	20780.	26.5	0.	0.0	0.	0.0
	BELOW	34591.	44.1	52191.	66.5	57732.	73.5	78512.	100.0	78512.	100.0
5/29- 6/11	ABOVE	33636.	47.9	32845.	46.8	32800.	46.8	30117.	42.9	29883.	42.6
	WITHIN	28044.	40.0	20857.	29.7	16196.	23.1	2367.	3.4	2601.	3.7
	BELOW	8471.	12.1	16448.	23.4	21154.	30.2	37667.	53.7	37667.	53.7
6/12- 6/25	ABOVE	25394.	52.2	24654.	50.6	24642.	50.6	22597.	46.4	22441.	46.1
	WITHIN	15068.	31.0	10558.	21.7	8419.	17.3	1768.	3.6	1861.	3.8
	BELOW	8220.	16.9	13470.	27.7	15621.	32.1	24317.	49.9	24330.	50.1
6/26- 7/ 9	ABOVE	2255.	18.8	1775.	14.8	1775.	14.8	0.	0.0	0.	0.0
	WITHIN	9764.	81.2	8452.	70.3	6659.	55.4	888.	7.4	591.	4.9
	BELOW	0.	0.0	1793.	14.9	3586.	29.8	11132.	92.6	11429.	95.1

Table C-29

Estimated Density (No./1000 m^3) of White Perch Eggs in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.049	0.104	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.049	0.061	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.129	0.0	0.0	0.094	0.307	2.825	0.0	1.124	159.848	1.690	25.555
4/29	SE	0.0	0.129	0.0	0.0	0.094	0.215	1.384	0.0	0.797	81.823	1.210	23.940
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.053	50.430	0.696	0.712	1.105	114.184	213.704	8.121	6.617	147.673	5.288
5/ 5	SE	0.0	0.053	48.313	0.474	0.307	0.583	70.948	75.000	3.215	6.016	42.893	4.252
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.373	25.957	1.354	7.719	0.664	68.541	25.098	99.802	111.533	277.083	142.122
5/13	SE	0.0	0.220	19.050	0.697	4.680	0.279	38.020	20.569	45.649	64.968	108.351	39.835
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4

Table C-29 (Contd)

DATE		Region											
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/17-	DEN	0.0	12.229	18.762	5.068	19.948	0.665	8.493	80.807	344.785	789.953	1343.215	69.617
5/19	SE	0.0	5.768	14.983	2.694	6.620	0.311	5.393	29.456	139.637	733.149	492.715	40.574
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4
5/24-	DEN	0.0	4.512	182.985	1.647	2.668	97.215	62.644	3.257	32.233	86.236	3.098	10.079
5/26	SE	0.0	3.148	94.315	0.680	2.278	63.050	58.352	1.539	18.605	70.880	3.098	2.430
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	93.153	6.858	14.199	53.577	36.122	70.188	33.495	35.707	67.614	806.295	280.165
6/ 4	SE	0.0	38.082	3.246	5.966	41.676	31.874	61.374	28.675	16.362	47.636	626.982	146.890
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	33.573	20.706	5.179	35.036	21.260	26.167	16.141	189.809	1582.277	208.197	12.325
6/11	SE	0.0	23.164	15.891	1.644	10.229	8.662	19.792	7.591	76.394	1555.036	109.118	6.582
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	18.939	0.784	3.269	12.498	80.943	94.512	25.315	4.029	21.565	25.222	13.013
6/17	SE	0.0	5.253	0.501	2.688	3.564	65.595	72.574	22.047	3.735	21.202	12.524	13.013
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	1.503	10.886	4.323	6.360	0.452	17.667	2.835	3.009	11.939	1.507	2.014
6/24	SE	0.0	1.503	10.886	2.572	2.387	0.300	9.815	2.074	3.009	10.642	1.507	1.009
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	1.239	4.011	0.485	0.0	0.0	0.0	0.0	0.0	0.0	0.321	0.0
7/ 1	SE	0.0	0.673	2.712	0.260	0.0	0.0	0.0	0.0	0.0	0.0	0.321	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	2.761	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	0.0	2.661	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.003
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.003
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-30

Estimated Standing Crops (in Thousands) of White Perch Eggs in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	10	15	0	0	0	0	0	0	25
4/21	SE	0	0	0	0	10	9	0	0	0	0	0	0	13
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	41	0	0	20	43	842	0	159	28181	272	1817	31375
4/29	SE	0	41	0	0	20	30	413	0	113	14425	194	1702	14533
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	17	7448	145	148	155	34050	35368	1149	1167	23731	376	103753
5/ 5	SE	0	17	7136	99	64	82	21157	12413	455	1061	6893	302	26487
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	120	3834	282	1601	93	20439	4154	14122	19663	44527	10105	118939
5/13	SE	0	71	2814	145	971	39	11337	3404	6459	11454	17412	2832	25162
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	0	3935	2771	1056	4137	93	2533	13374	48787	139269	215855	4950	436759
5/19	SE	0	1856	2213	561	1373	43	1608	4875	19759	129254	79179	2885	153009
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-30 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	0	1452	27027	343	553	13591	18680	539	4561	15203	498	717	83164
5/26	SE	0	1013	13930	142	473	8814	17400	255	2633	12496	498	173	27189
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	29977	1013	2958	11112	5050	20930	5543	5053	11920	129572	19920	243047
6/ 4	SE	0	12255	479	1243	8644	4456	18302	4746	2315	8398	100756	10444	104598
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	10804	3058	1079	7266	2972	7803	2671	26858	278956	33457	876	375801
6/11	SE	0	7454	2347	342	2122	1211	5902	1256	10810	274153	17535	468	275114
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	6095	116	681	2592	11316	28184	4190	570	3802	4053	925	62523
6/17	SE	0	1691	74	560	739	9170	21642	3649	529	3738	2013	925	24262
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	484	1608	901	1319	63	5268	469	426	2105	242	143	13028
6/24	SE	0	484	1608	536	495	42	2927	343	426	1876	242	72	3975
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	399	592	101	0	0	0	0	0	0	52	0	1144
7/ 1	SE	0	217	401	54	0	0	0	0	0	0	52	0	461
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	0	888	0	0	0	0	0	0	0	0	0	0	888
7/ 9	SE	0	856	0	0	0	0	0	0	0	0	0	0	856
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	0	0	0	0	0	0	0	0	0	0	142	142
7/15	SE	0	0	0	0	0	0	0	0	0	0	0	142	142
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-31

Estimated Density (No./1000 m^3) of White Perch Yolk-Sac Larvae in 12 Geographical Regions of the Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.061	0.0	0.986	0.724	0.794	0.139	1.765	17.010	7.849	10.112	0.0
4/29	SE	0.0	0.061	0.0	0.563	0.571	0.355	0.139	0.884	3.453	3.431	4.317	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.494	0.111	0.468	2.884	21.329	33.595	25.717	24.206	18.944	1.850	5.362	6.956
5/ 5	SE	0.334	0.077	0.237	0.813	7.014	7.997	5.818	7.669	5.492	0.888	1.955	2.760
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.724	39.724	87.521	24.001	29.680	108.391	35.144	29.846	42.056	48.247	17.884	7.762
5/13	SE	0.461	8.028	35.976	3.991	4.702	16.670	9.840	6.165	6.186	12.316	4.087	2.639
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.260	96.180	56.933	31.582	89.162	234.919	185.913	351.142	188.022	108.875	175.733	112.051
5/19	SE	0.126	12.359	14.495	5.308	23.121	20.004	23.490	59.424	29.543	19.512	36.092	55.865
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-31 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	3.851	26.880	88.889	86.022	118.673	44.683	15.708	5.795	16.585	9.744	14.616	5.976
5/26	SE	1.357	4.924	27.229	20.023	20.671	14.849	3.709	1.158	2.182	1.853	1.749	1.790
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	4.960	9.790	3.468	2.418	4.417	7.239	18.862	29.935	61.934	135.948	181.898
6/ 4	SE	0.0	1.820	2.080	0.630	0.540	1.064	1.747	7.221	7.421	25.275	44.429	28.267
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	7.653	16.888	2.360	3.778	9.360	8.687	8.823	45.503	116.139	324.314	365.737
6/11	SE	0.0	3.185	5.685	0.361	0.628	2.483	2.500	3.106	10.602	74.371	34.468	67.391
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.199	25.503	9.323	5.757	6.338	24.425	30.525	87.721	250.848	139.265	273.379	96.199
6/17	SE	0.199	7.186	1.540	0.874	0.986	6.820	4.241	31.126	73.750	24.942	45.946	52.516
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.0	2.059	2.119	4.195	1.335	0.0	0.737	7.343	20.262	10.873	132.783
6/24	SE	0.0	0.0	0.847	0.439	0.864	0.397	0.0	0.461	2.567	8.252	5.206	40.720
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.400	1.346	0.544	0.0	0.0	0.0	0.0	0.295	0.0	1.123	0.0
7/ 1	SE	0.0	0.400	0.629	0.233	0.0	0.0	0.0	0.0	0.295	0.0	0.559	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.059	0.033	0.0	0.0	0.0	0.0	0.0	0.0	0.324	2.971
7/ 9	SE	0.0	0.0	0.059	0.033	0.0	0.0	0.0	0.0	0.0	0.0	0.324	2.971
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-32

Estimated Standing Crops (in Thousands) of White Perch Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	20	0	205	150	111	41	292	2407	1384	1625	0	6235
4/29	SE	0	20	0	117	118	50	41	146	489	605	694	0	1068
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	113	36	69	601	4424	4697	7669	4006	2681	326	862	495	25977
5/ 5	SE	77	25	35	169	1455	1118	1735	1269	777	156	314	196	2965
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	166	12783	12927	4999	6156	15153	10480	4939	5951	8506	2874	552	85486
5/13	SE	106	2584	5314	831	975	2330	2934	1020	875	2171	657	188	7589
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	60	30951	8409	6579	18492	32842	55439	58114	26605	19195	28240	7967	292892
5/19	SE	29	3977	2141	1106	4795	2797	7005	9835	4180	3440	5800	3972	16642
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-32 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	884	8650	13129	17919	24613	6247	4684	959	2347	1718	2349	425	83922
5/26	SE	311	1585	4022	4171	4287	2076	1106	192	309	327	281	127	7773
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	1596	1446	722	502	617	2159	3122	4236	10919	21847	12933	60098
6/ 4	SE	0	586	307	131	112	149	521	1195	1050	4456	7140	2010	8841
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	2463	2494	492	784	1309	2590	1460	6439	20475	52117	26004	116627
6/11	SE	0	1025	840	75	130	347	745	514	1500	13112	5539	4792	15183
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	46	8207	1377	1199	1315	3415	9103	14518	35495	24553	43932	6840	149997
6/17	SE	46	2312	228	182	205	953	1265	5151	10436	4397	7383	3734	15206
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	0	304	441	870	187	0	122	1039	3572	1747	9441	17723
6/24	SE	0	0	125	92	179	56	0	76	363	1455	837	2895	3376
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	129	199	113	0	0	0	0	42	0	181	0	663
7/ 1	SE	0	129	93	48	0	0	0	0	42	0	90	0	193
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	0	0	9	7	0	0	0	0	0	0	52	211	279
7/ 9	SE	0	0	9	7	0	0	0	0	0	0	52	211	218
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	[illegible]	2	214

Table C-33

Results of Analysis of Variance, Distribution of White Perch Yolk-Sac Larvae, Indian Point Study, 1976

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Prob F Exceeded	R-Square
Model	29	0.15015640	0.00517781	2.50	0.0481	0.857908
Error	12	0.02486985	0.00207249			
Corrected Total	41	0.17502626				
Diel	1	0.00051231		0.25	0.6280	
Site	6	0.04774082		3.84	0.0226	
Depth	2	0.01700628		4.10	0.0439	
Diel*Site	6	0.04948387		3.98	0.0200	
Diel*Depth	2	0.00679472		1.64	0.2347	
Site*Depth	12	0.02861840		1.15	0.4059	

Table C-34

Estimated Density (No./1000 m^3) of White Perch Post Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.094	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.094	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.099	0.0	0.047	0.705	2.290	0.0	0.188	0.515	0.0	2.971
5/ 5	SE	0.0	0.0	0.099	0.0	0.047	0.467	1.354	0.0	0.188	0.515	0.0	2.971
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	2.249	22.754	16.435	8.633	5.957	2.570	2.120	2.988	2.904	0.890	0.0
5/13	SE	0.0	1.241	3.192	3.701	3.064	1.693	0.622	0.947	1.208	1.345	0.671	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	5.394	91.084	21.089	48.786	51.074	70.084	29.423	21.499	5.571	0.200	0.0	0.0
5/19	SE	2.902	23.516	4.353	6.887	8.850	5.611	6.593	8.542	4.336	0.200	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-34 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	12.771	112.244	249.099	175.942	106.692	18.277	1.923	0.558	0.549	0.0	0.0	0.0
5/26	SE	2.409	20.439	46.649	27.565	26.671	6.055	0.722	0.558	0.317	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	12.221	42.382	44.216	26.140	15.020	7.416	4.318	0.769	0.730	0.741	0.0
6/ 4	SE	0.0	3.643	6.124	4.250	5.308	4.068	1.808	2.402	0.476	0.730	0.741	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	3.242	9.706	25.649	13.910	18.936	87.295	710.511	1033.964	537.345	270.328	17.978
6/11	SE	0.0	1.557	1.905	3.649	1.641	1.971	17.650	281.088	147.355	182.826	102.543	7.272
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	61.199	49.892	43.811	54.127	133.651	488.795	2611.504	2556.617	2037.912	2007.694	291.023
6/17	SE	0.0	19.620	8.174	4.856	6.098	30.284	81.808	752.539	324.646	600.832	246.465	262.941
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	21.845	141.302	163.498	315.027	904.570	1783.199	1914.541	3924.877	1319.382	1051.477	294.710
6/24	SE	0.0	5.962	28.249	15.488	46.028	184.848	318.166	355.767	479.150	198.528	83.632	103.351
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	31.230	124.440	602.535	562.260	531.877	234.157	744.457	490.884	296.743	95.376	6.557
7/ 1	SE	0.0	19.975	25.269	74.648	107.409	83.969	42.851	106.473	61.308	125.711	43.646	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	1.424	18.982	81.216	47.423	108.937	95.890	84.423	314.884	378.538	52.966	8.350	1.485
7/ 9	SE	0.875	5.504	11.528	7.522	17.247	22.630	30.220	82.309	103.409	38.790	7.707	1.485
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.841	13.794	15.602	5.002	25.654	23.909	73.378	651.836	238.991	44.477	6.844	0.0
7/15	SE	0.712	3.618	3.224	1.038	6.710	8.881	26.393	122.830	129.077	23.108	2.246	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.673	0.048	0.0	0.182	1.161	5.904	2.817	9.753	6.000	1.377	1.073	0.0
7/29	SE	0.673	0.048	0.0	0.149	0.475	2.376	1.017	3.201	2.544	1.034	0.811	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.067	0.0	0.0	0.202	0.288	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.067	0.0	0.0	0.202	0.211	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-35

Estimated Standing Crops (in Thousands) of White Perch Post Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	0	0	0	0	13	0	0	0	0	0	0	13
4/29	SE	0	0	0	0	0	13	0	0	0	0	0	0	13
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	0	15	0	10	99	683	0	27	91	0	211	1134
5/ 5	SE	0	0	15	0	10	65	404	0	27	91	0	211	470
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	724	3361	3423	1790	833	766	351	423	512	143	0	12326
5/13	SE	0	399	471	771	635	237	185	157	171	237	108	0	1262
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	1238	29311	3115	10162	10593	9798	8774	3558	788	35	0	0	77372
5/19	SE	666	7568	643	1435	1836	784	1966	1414	614	35	0	0	8391
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

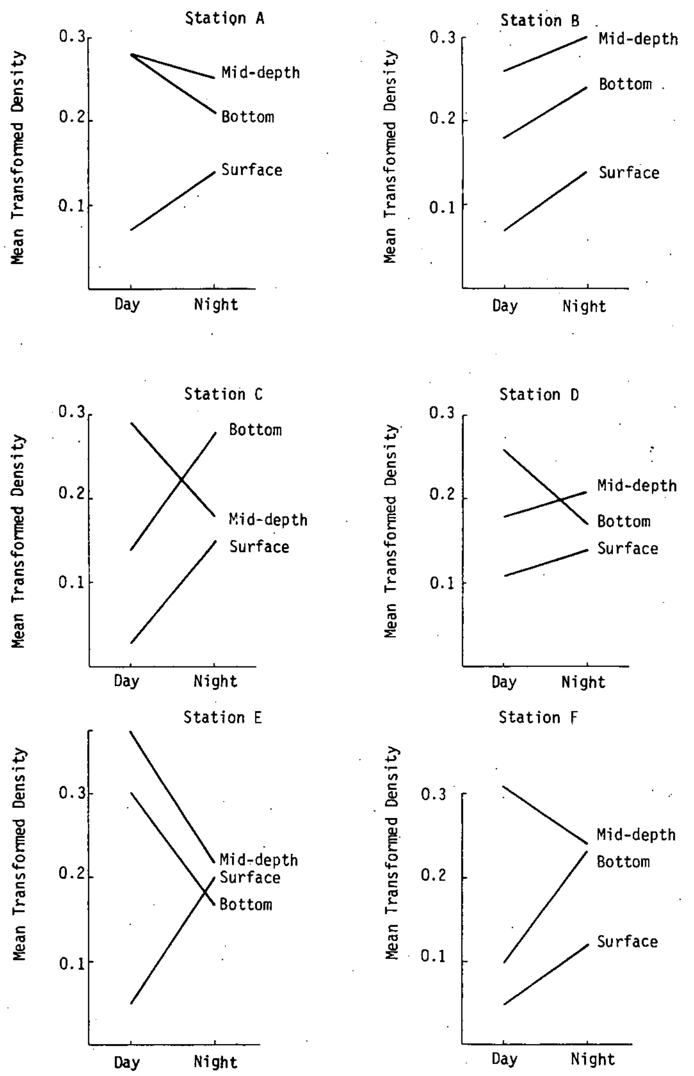
Table C-35 (Contd)

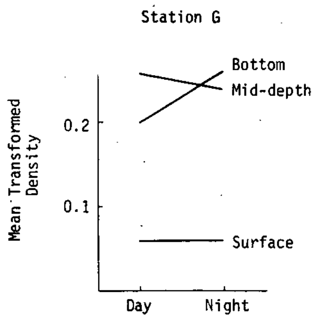
DATE		Region												
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	2931	36120	36792	36649	22128	2555	573	92	78	0	0	0	137918
5/26	SE	553	6577	6890	5742	5532	846	215	92	45	0	0	0	12465
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	3933	6260	9210	5422	2100	2212	715	109	129	119	0	30207
6/ 4	SE	0	1172	904	885	1101	569	539	398	67	129	119	0	2235
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	1043	1434	5343	2885	2647	26031	117590	146306	94734	43442	1278	442733
6/11	SE	0	501	281	760	340	276	5263	46520	20851	32232	16479	517	62757
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	19694	7369	9126	11226	18684	145759	432204	361761	359284	322637	20692	1708436
6/17	SE	0	6314	1207	1012	1265	4234	24395	124545	45937	105927	39607	18695	177250
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	7030	20870	34057	65337	126459	531750	316857	555370	232607	168972	20954	2080263
6/24	SE	0	1919	4172	3226	9546	25842	94877	58879	67800	35001	13440	7348	138980
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	10050	18380	125508	116613	74356	69826	123208	69460	52316	15327	466	675509
7/ 1	SE	0	6428	3732	15549	22277	11739	12778	17621	8675	22163	7014	0	44950
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	327	6108	11996	9878	22594	13405	25175	52113	53563	9338	1342	106	205945
7/ 9	SE	201	1771	1703	1567	3577	3164	9012	13622	14632	6839	1238	106	23675
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	193	4439	2304	1042	5321	3343	21881	107879	33817	7841	1100	0	189160
7/15	SE	163	1164	476	216	1392	1242	7870	20328	18264	4074	361	0	28821
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	155	16	0	38	241	825	840	1614	849	243	172	0	4992
7/29	SE	155	16	0	31	99	332	303	530	360	182	130	0	835
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	10	0	0	28	86	0	0	0	0	0	-124
8/13	SE	0	0	10	0	0	28	63	0	0	0	0	0	70
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

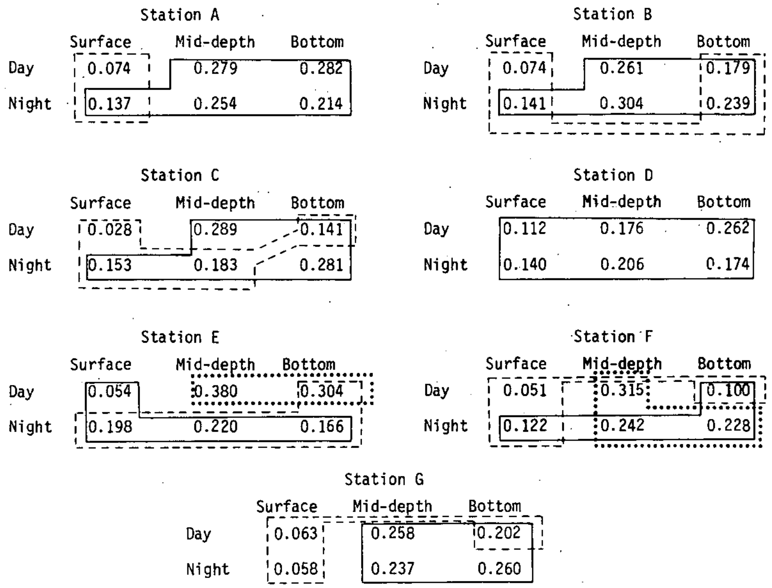
Table C-36

Results of Analysis of Variance, Distribution of White Perch Post Yolk-Sac Larvae, Indian Point Study, 1976

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Prob. F Exceeded	R-Square
Model	221	9.16553120	0.04147299	2.96	0.0001	0.900803
Error	72	1.00931853	0.01401831			
Corrected Total	293	10.17484973				
Week	6	2.61460090		31.09	0.0001	
Diel	1	0.01263219		0.90	0.3457	
Site	6	0.07585931		0.90	0.4985	
Depth	2	1.30139619		46.42	0.0001	
Week*Diel	6	0.75140623		8.93	0.0001	
Week*Site	36	0.62524985		1.24	0.2180	
Week*Depth	12	0.75795369		4.51	0.0001	
Diel*Site	6	0.10011578		1.19	0.3213	
Diel*Depth	2	0.16134821		5.75	0.0048	
Site*Depth	12	0.14089411		0.84	0.6120	
Week*Diel*Site	36	0.74581020		1.48	0.0801	
Week*Diel*Depth	12	0.46961045		2.79	0.0035	
Week*Site*Depth	72	1.08438260		1.07	0.3808	
Diel*Site*Depth	12	0.32427150		1.93	0.0448	







Station A

	Surface	Mid-depth	Bottom
Day	0.074	0.279	0.282
Night	0.137	0.254	0.214

Station B

	Surface	Mid-depth	Bottom
Day	0.074	0.261	0.179
Night	0.141	0.304	0.239

Station C

	Surface	Mid-depth	Bottom
Day	0.028	0.289	0.141
Night	0.153	0.183	0.281

Station D

	Surface	Mid-depth	Bottom
Day	0.112	0.176	0.262
Night	0.140	0.206	0.174

Station E

	Surface	Mid-depth	Bottom
Day	0.054	0.380	0.304
Night	0.198	0.220	0.166

Station F

	Surface	Mid-depth	Bottom
Day	0.051	0.315	0.100
Night	0.122	0.242	0.228

Station G

	Surface	Mid-depth	Bottom
Day	0.063	0.258	0.202
Night	0.058	0.237	0.260

*No significant difference ($p > 0.05$) exists between any two members of a grouping; values are mean transformed ($\sqrt{X}$) densities, Indian Point Study, 1976

Figure C-4. Day/Night Depth Distribution of White Perch Post Yolk-Sac Larvae at 7 Stations in the Indian Point Area and Results of Newman-Keuls Test on Day/Night x Depth x Station Interaction

Table C-37

Estimated Density (No./1000 m^3) of White Perch Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/19	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-37 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/26	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/ 4	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/17	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.0	0.0	0.0	0.054	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/24	SE	0.0	0.0	0.0	0.0	0.054	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.0	0.0	0.220	0.227	0.474	3.121	0.322	0.0	0.0	0.0
7/ 9	SE	0.0	0.0	0.0	0.0	0.220	0.227	0.269	2.502	0.208	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.074	0.582	0.030	0.393	1.440	2.756	22.041	2.919	3.809	0.420	0.0
7/15	SE	0.0	0.051	0.412	0.030	0.326	0.841	1.884	6.382	1.547	2.105	0.420	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.215	1.393	1.403	1.902	0.975	1.293	2.414	3.657	11.383	5.524	0.851	0.0
7/29	SE	0.215	0.809	0.518	0.996	0.413	0.653	1.316	1.358	4.097	2.385	0.615	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.953	0.557	2.143	4.972	1.336	8.371	2.066	4.114	0.218	0.469	0.0
8/13	SE	0.0	0.369	0.254	0.547	1.616	0.837	4.348	1.038	1.560	0.218	0.469	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-38

Estimated Standing Crops (in Thousands) of White Perch Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/19	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-38 (Contd)

DATE	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
	Region												
5/24- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/ 4 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21- SC	0	0	0	0	11	0	0	0	0	0	0	0	11
6/24 SE	0	0	0	0	11	0	0	0	0	0	0	0	11
TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 1 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6- SC	0	0	0	0	46	32	141	517	46	0	0	0	781
7/ 9 SE	0	0	0	0	46	32	80	414	29	0	0	0	426
TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12- SC	0	24	86	6	81	201	822	3648	413	672	68	0	6021
7/15 SE	0	17	61	6	68	118	562	1056	219	371	68	0	1282
TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26- SC	49	448	207	396	202	181	720	605	1611	974	137	0	5531
7/29 SE	49	260	77	207	86	91	392	225	580	421	99	0	928
TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10- SC	0	307	82	446	1031	187	2496	342	582	38	75	0	5587
8/13 SE	0	119	38	114	335	117	1297	172	221	38	75	0	1386
TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-39

Estimated Density (No./1000 m^3) of White Perch Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

Date		Region						
		YK	TZ	CH	IP	WP	CW	PK
8/16- 8/20	Den	3.701	12.609	10.230	2.748	3.867	1.761	1.571
	SE	1.051	2.799	2.697	1.153	1.520	1.761	0.692
	Tows	7	26	36	19	5	5	5
8/30- 9/3	Den	0.0	4.765	3.896	2.103	5.845	3.371	0.754
	SE	0.0	1.318	0.911	0.668	3.189	1.785	0.462
	Tows	7	26	35	20	5	5	5
9/13- 9/16	Den	0.0	2.246	2.443	2.581	2.583	21.706	4.356
	SE	0.0	0.560	0.598	1.387	1.647	5.279	3.819
	Tows	7	26	37	18	5	5	5
9/27-10/ 1	Den	0.308	3.332	0.266	0.993	2.201	2.516	1.912
	SE	0.308	0.967	0.117	0.501	1.142	1.208	0.997
	Tows	7	26	36	19	5	5	5
10/11-10/14	Den	0.0	1.508	2.054	4.665	0.498	0.979	0.533
	SE	0.0	0.566	0.397	1.718	0.498	0.600	0.533
	Tows	7	26	36	19	5	5	5
10/25-10/28	Den	20.456	4.814	12.480	7.856	3.254	10.963	0.493
	SE	6.379	0.917	3.021	3.117	1.689	4.609	0.493
	Tows	8	43	24	13	5	5	5
11/8-11/12	Den	14.989	26.191	18.790	6.919	2.019	10.413	0.0
	SE	4.332	2.971	5.949	1.104	1.667	5.155	0.0
	Tows	8	43	24	13	6	4	5
11/21-11/24	Den	38.716	9.186	20.807	9.708	0.878	6.347	0.954
	SE	8.566	1.860	4.887	3.307	0.538	1.801	0.954
	Tows	8	42	24	13	5	5	5
12/ 6-12/ 8	Den	1.214	6.968	0.0	55.291	1.258	4.490	0.530
	SE	0.593	2.260	0.0	30.156	1.258	2.641	0.530
	Tows	8	29	0	6	5	5	5

Table C-40

Estimated Standing Crops (in Thousands) of White Perch Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

Date		Region							Total
		YK	TZ	CH	IP	WP	CW	PK	
8/16-8/20	SC	99	2318	884	126	111	79	109	3725
	SE	28	514	233	53	43	79	48	577
	Tows	7	26	36	19	5	5	5	103
8/30-9/ 3	SC	0	876	337	97	167	151	52	1680
	SE	0	242	79	31	91	80	32	286
	Tows	7	26	35	20	5	5	5	103
9/13-9/16	SC	0	413	211	119	74	975	301	2092
	SE	0	103	52	64	47	237	264	382
	Tows	7	26	37	18	5	5	5	103
9/27-10/1	SC	8	612	23	46	63	113	132	997
	SE	8	178	10	23	33	54	69	203
	Tows	7	26	36	19	5	5	5	103
10/11-10/14	SC	0	277	177	215	14	44	37	764
	SE	0	104	34	79	14	27	37	143
	Tows	7	26	36	19	5	5	5	103
10/25-10/28	SC	546	885	1078	361	93	492	34	3490
	SE	170	169	261	143	48	207	34	439
	Tows	8	43	24	13	5	5	5	103
11/ 8-11/12	SC	400	4814	1623	318	58	468	0	7681
	SE	116	546	514	51	48	231	0	796
	Tows	8	43	24	13	6	4	5	103
11/21-11/24	SC	1034	1688	1798	447	25	285	66	5342
	SE	229	342	422	152	15	81	66	618
	Tows	8	42	24	13	5	5	5	102
12/ 6-12/ 8	SC	32	1281	0	2543	36	202	37	4131
	SE	16	415	0	1387	36	119	37	1454
	Tows	8	29	0	6	5	5	5	58

Table C-41

Estimated Standing Crops of White Perch Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 12-152; KM 19-243) Based on 100-Ft (30.5-m) Beach Seine during Daytime, 1976

		Region												
Date		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
6/27- 7/10	SC	0	5679	6723	1536	9584	14201	17345	13888	38740	4389	1789	0	113874
	SE	0	3133	5807	776	5078	11027	13948	11760	38740	4389	1789	0	45251
	Tows	22	24	28	30	22	18	9	5	4	8	11	19	200
7/11- 7/24	SC	33295	178713	35855	43971	47024	217815	127129	38086	383095	305968	21189	19701	1451840
	SE	28333	122276	12767	19264	17576	132458	37449	10416	305615	197167	9828	13921	410145
	Tows	19	15	21	35	19	20	12	7	2	7	13	20	190
7/25- 8/ 7	SC	34361	363484	201099	146267	101205	146609	124882	82873	219527	494063	129531	17663	2061561
	SE	11887	105913	94854	40828	29299	79551	98859	30214	139281	314193	87640	7578	407125
	Tows	16	17	23	39	20	17	10	6	4	7	12	20	191
8/ 8- 8/21	SC	20378	428051	250625	115425	48550	138464	56055	18187	94698	853639	195350	14341	2233753
	SE	6287	147589	106932	35059	22359	58801	39428	11547	45824	510557	85651	7568	557039
	Tows	17	19	25	40	19	17	10	6	4	8	14	18	197
8/22- 9/ 4	SC	12847	457028	541408	160166	77812	139130	24834	11780	169308	80254	93459	9264	1777286
	SE	7689	96420	193823	34141	24575	58383	8799	10093	131158	66779	67818	6022	280318
	Tows	17	17	15	50	21	16	12	6	3	7	12	22	198
9/ 5- 9/18	SC	5917	569281	324187	168590	60837	64391	62441	1240	68871	333556	29513	66235	1755085
	SE	2063	228348	108144	30794	21906	15054	45178	716	27674	266436	13199	66235	379281
	Tows	28	17	18	51	24	22	5	3	3	3	6	8	188
9/19-10/2	SC	2672	106907	333649	134248	80165	62678	1419	8267	38740	628489	622239	1235	2020707
	SE	1332	33275	95741	24633	21853	19855	1419	7655	12913	534145	393070	1235	672159
	Tows	31	17	27	37	24	26	5	3	2	5	8	11	196
10/3-10/16	SC	4841	62175	77446	45054	23960	37025	3548	1240	0	65833	396322	12352	729796
	SE	1607	22574	28767	11956	7446	15498	1587	1240	0	33902	266631	11061	272297
	Tows	28	19	25	45	22	21	6	2	3	4	7	11	193
10/17-10/30	SC	9885	80386	57491	6324	10198	12503	7096	3720	8609	26333	59027	2470	284043
	SE	4166	23004	17842	1702	4103	4859	7096	0	0	20895	59027	2470	69896
	Tows	16	26	29	51	23	23	5	1	2	4	7	11	198
10/31-11/13	SC	5477	27537	9308	7012	2306	561	10643	620	25827	13167	0	0	102457
	SE	1931	13973	8297	4012	1500	561	10643	620	25827	8404	0	0	33731
	Tows	22	33	26	46	16	19	4	2	3	4	5	10	190
11/14-11/27	SC	7364	6196	2241	940	1318	0	3548	0	0	0	0	0	21606
	SE	2423	3403	1550	484	648	0	3548	0	0	0	0	0	5753
	Tows	45	22	24	49	18	14	4	3	3	4	8	11	205
11/28-12/11	SC	0	9087	17287	542	1085	0	0	0	0	0	0	0	28002
	SE	0	9087	15339	542	680	0	0	0	0	0	0	0	17850
	Tows	0	5	14	17	17	14	0	0	0	0	3	3	73

Table C-42

Catch per Unit Effort of White Perch Juveniles in Hudson River Estuary by Bottom Trawl, 1976

		Number Caught			Σ/tows x 1.54
Date	Tows	Small Bottom Trawl	Cod End Cover	Total Number Caught (Σ)	Catch per Unit Effort
7/11-7/24	30	15	432	447	22.95
7/25-8/7	32	24	148	172	8.28
8/8-8/21	32	199	157	356	17.13
8/22-9/4	32	41	30	71	3.42
9/5-9/18	32	70	11	81	3.90
9/9 - 10/2	32	6	5	11	0.53
10/3-10/16	32	5	5	10	0.48
10/17-10/30	32	13	4	17	0.82
11/1-11/13	32	63	11	74	3.56
11/14-11/27	32	191	27	218	10.49
11/20-12/11	32	170	111	281	13.52

Table C-43

Estimated Density (NO./1000 m^3) of White Perch Yearlings in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region						
DATE		YK	TZ	CH	IP	WP	CW	PK
8/16- 8/20	DEN	0.385	13.653	12.852	1.425	0.782	0.373	1.838
	SE	0.385	2.488	4.532	0.512	0.782	0.373	0.810
	TOWS	7	26	36	19	5	5	5
8/30- 9/ 3	DEN	0.0	9.632	3.755	0.299	2.241	9.806	2.867
	SE	0.0	2.114	0.820	0.178	0.972	5.217	2.008
	TOWS	7	26	35	20	5	5	5
9/13- 9/16	DEN	0.0	6.441	0.806	1.353	1.158	23.363	0.530
	SE	0.0	1.205	0.303	0.659	0.489	14.019	0.530
	TOWS	7	26	37	18	5	5	5
9/27- 10/ 1	DEN	0.602	1.147	0.154	0.427	1.891	2.559	0.409
	SE	0.389	0.333	0.154	0.256	1.097	1.724	0.409
	TOWS	7	26	36	19	5	5	5
10/11- 10/14	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	26	36	19	5	5	5
10/25- 10/28	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	43	24	13	5	5	5
11/ 8- 11/12	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	43	24	13	6	4	5
11/21- 11/24	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	42	24	13	5	5	5
12/ 6- 12/ 8	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	29	0	6	5	5	5

Table C-44

Estimated Standing Crops (in Thousands) of White Perch Yearlings in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region							
Date		YK	TZ	CH	IP	WP	CW	PK	Total
8/16-8/20	SC	10	2509	1110	66	22	17	127	3862
	SE	10	457	392	24	22	17	56	606
	Tows	7	26	36	19	5	5	5	103
8/30-9/ 3	SC	0	1770	324	14	64	440	198	2811
	SE	0	388	71	8	28	234	139	481
	Tows	7	26	35	20	5	5	5	103
9/13-9/16	SC	0	1184	70	62	33	1049	37	2434
	SE	0	221	26	30	14	629	37	670
	Tows	7	26	37	18	5	5	5	103
9/27-10/ 1	SC	16	211	13	20	54	115	28	457
	SE	10	61	13	12	31	77	28	109
	Tows	7	26	36	19	5	5	5	103
10/11-10/14	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	7	26	36	19	5	5	5	103
10/25-10/28	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	43	24	13	5	5	5	103
11/ 8-11/12	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	43	24	13	6	4	5	103
11/21-11/24	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	42	24	13	5	5	5	102
12/6-12/8	SC	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0
	Tows	8	29	0	6	5	5	5	58

Table C-45

Estimated Standing Crops of White Perch Yearlings in 12 Geographical Regions of Hudson River Estuary (RM 12-152; KM 19-243) Based on 100-Ft (30.5-m) Beach Seine during Daytime, 1977

DATE		REGION												
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
4/ 3- 4/16														
	SC	6186	3029	0	263	0	0	0	0	0	0	0	0	9479
	SE	4535	2105	0	263	0	0	0	0	0	0	0	0	5006
	TOWS	28	30	27	35	24	20	6	3	3	5	7	11	199
4/17- 4/30														
	SC	1345	20045	0	0	0	0	0	0	4304	0	0	0	25694
	SE	677	9817	0	0	0	0	0	0	4304	0	0	0	10741
	TOWS	28	34	37	27	20	22	5	2	2	4	5	4	190
5/ 1- 5/14														
	SC	6455	17731	3842	1693	2284	0	7096	0	0	0	11243	0	50343
	SE	2161	7589	2500	1161	1309	0	7096	0	0	0	8432	0	13893
	TOWS	21	41	35	49	15	12	2	3	1	4	7	9	199
5/15- 5/28														
	SC	4662	155529	17113	4879	6401	8447	0	1240	43044	0	2459	0	243775
	SE	3007	41196	7922	2149	2403	5966	0	1240	43044	0	2459	0	60624
	TOWS	21	26	33	51	21	29	3	3	2	5	8	12	214
5/29- 6/11														
	SC	1674	276248	364150	45897	4055	20415	51443	0	0	100944	22486	124997	1012309
	SE	1300	104268	155980	24501	1596	11250	37588	0	0	100944	14515	84432	234253
	TOWS	18	25	24	51	13	24	4	2	2	4	7	10	184
6/12- 6/25														
	SC	198	382072	313730	36054	11421	16357	0	2893	8609	118500	137729	44465	1072027
	SE	198	96992	148538	15146	4816	9240	0	1802	8609	69625	121819	31842	229320
	TOWS	38	22	15	57	24	28	3	3	3	4	7	11	215
6/26- 7/ 9														
	SC	0	190003	622977	32510	1318	14201	0	0	0	0	0	0	861010
	SE	0	79602	362295	7311	776	5614	0	0	0	0	0	0	371052
	TOWS	16	11	12	36	18	12	0	0	0	0	0	0	105

Table C-46

White Perch Finclip Releases and Recaptures with Adjusted Number of Recaptures Used in Analysis of Movement, Fall 1976

		Releases						Recaptures					
Clip-Code		RM 12-23	24-38	39-46	47-76	77-152	Total	RM 12-23	24-38	39-46	47-76	77-152	Total
	65	42					42	2					2
	68		8617				8617		642	4			646
September	73		1256	3412			4668		114,*20	191			305,*211
	67				2161		2161			3	32		35
	66					471	471		1	1		1	3
Total		42	9873	3412	2161	471	15959	2	757,*663	199	32	1	991,*897
	75	40					40						
	13		3239				3239		68				68
October	60			3065			3065		1	25			26
	71				537		537			1			1
	70					214	214			1			1
Total		40	3239	3065	537	214	7095	0	69	27	0	0	96
	64	59					59			1			1
	61		269				269		1				1
November	12		47	1748			1795		2	6			8
	63				38		38						0
	62					14	14						0
Total		59	316	1748	38	14	2175	0	3	7	0	0	10
Grand Total		141	13428	8225	2736	699	25229	2	829,*735	233	32	1	1097,*1003

*Adjusted number – See explanatory notes on page C-33.

Table C-47

Physiochemical Factors at Time of Each Life Stage of White Perch from 1974-1976

Date	Life Stage*	River Mile	Values	Temperature (C°)	Conductivity (mS/cm x 10^{-3})	Dissolved Oxygen (mg/ℓ)	pH	Turbidity (FTU)	Mean Freshwater Flow (ft^3/sec)
1974									
May 30-June 14	Eggs	34-38	Mean	18.5	358	8.6	7.1	10.7	9,196
		125-140	Min	15.2	160	5.1	6.6	4.5	6,280
			Max	22.4	4,711	10.3	8.0	29.0	13,000
May 21-24	YSL	24-38	Mean	16.6	348	9.1	7.2	11.4	18,775
		77-106	Min	15.9	132	6.8	6.5	4.9	17,200
			Max	17.9	4,255	12.0	8.0	42.0	20,500
Jun 10-23	PYSL	39-93	Mean	21.1	446	7.9	7.4	9.6	8,313
			Min	19.2	125	6.0	6.1	1.9	6,280
			Max	23.5	4,630	10.1	8.0	32.0	12,300
Nov 3-16 (1st peak)	Juveniles	24-33	Mean	13.3	7,782	8.9	7.6	12.5	13,982
			Min	11.1	1,700	6.7	6.3	3.0	6,140
			Max	15.0	16,100	10.1	8.0	39.0	25,300
Jul 29-Sep 7 (2nd peak)	Juveniles	94-124	Mean	23.7	317	9.0	8.0	7.4	7,440
			Min	17.5	200	4.6	6.9	1.9	3,800
			Max	26.0	970	12.5	9.0	49.0	20,800
1975									
May 26-29	Eggs	24-33	Mean	20.5	447	9.1	7.2	8.6	9,735
		62-76	Min	18.5	127	7.0	6.9	1.4	8,420
		94-124	Max	22.0	6,774	11.0	8.0	33.0	10,500
May 19-29	YSL	24-33	Mean	19.6	287	9.2	7.4	8.2	12,449
		62-85	Min	15.5	119	7.0	6.9	1.4	8,420
		94-124	Max	22.0	6,774	11.0	8.0	33.0	15,700
May 26-Jun 6	PYSL	34-38	Mean	20.5	422	8.6	7.4	5.6	10,939
		47-61	Min	18.0	116	6.2	6.8	1.1	8,420
		77-93	Max	22.5	7,897	10.4	8.0	31.0	16,300
Aug 10-Oct 4	Juveniles	24-38	Mean	22.4	4,304	7.8	7.5	4.8	13,847
		107-124	Min	16.9	169	2.5	6.6	1.0	4,500
			Max	28.9	17,800	13.8	9.0	33.0	59,100
1976									
May 17-Jun 11	Eggs	94-124	Mean	16.2	151	10.0	7.4	10.9	28,038
			Min	12.0	134	8.9	7.1	2.5	9,400
			Max	21.0	218	12.3	8.0	25.0	72,000
May 17-Jun 17	YSL	62-124	Mean	16.8	153	9.4	7.4	12.0	25,403
			Min	12.0	132	7.7	7.0	2.2	9,400
			Max	22.0	218	12.3	8.0	32.0	72,000
Jun 14-24	PYSL	62-124	Mean	22.4	180	8.1	7.6	7.9	14,845
			Min	19.5	146	5.9	7.4	2.2	10,100
			Max	24.5	210	9.2	8.0	18.0	18,800
Jul 11-Oct 16	Juveniles	24-38	Mean	22.0	3,259	8.5	7.5	9.1	13,811
		86-124	Min	13.8	125	2.5	6.5	1.2	6,320
			Max	28.1	21,500	14.0	9.0	35.0	60,600

*YSL – Yolk-sac larvae
PYSL – Post yolk-sac larvae

Table C-48

Estimated Standing Crops of White Perch Adults in 12 Geographical Regions of Hudson River Estuary (RM 12-152; KM 19-243) Based on 100-Ft (30.5-m) Beach Seine during Daytime, 1976

Date		Region												
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
3/21-4/3	SC	1255	20653	15366	9216	0	1937	0	0	0	0	0	0	48426
	SE	846	12798	11525	5321	0	1937	0	0	0	0	0	0	18149
	Tows	12	11	7	3	5	11	0	0	0	0	0	0	49
4/4-4/17	SC	1159	37534	67228	307	1198	4660	57778	0	17218	0	4372	0	191453
	SE	520	11301	45939	307	642	4005	31597	0	8609	0	2892	0	57756
	Tows	39	23	34	30	22	16	7	3	2	4	9	10	199
4/18-5/1	SC	8126	45436	41871	88632	3163	37612	62086	413	8609	8778	55092	0	359316
	SE	2499	13898	34022	85014	2119	13902	22747	413	0	8778	55092	0	111408
	Tows	38	19	26	34	25	32	8	3	1	4	5	9	204
5/2-5/15	SC	3274	67245	134456	13363	4073	73769	193354	140120	766191	491556	24594	0	1911992
	SE	1237	25852	103452	5865	981	14715	61407	0	0	289534	14281	0	315323
	Tows	23	25	16	40	33	27	4	1	1	4	8	7	189
5/16-5/29	SC	1953	29533	48802	8092	7452	148327	234153	120900	977109	1310814	203314	191723	3282170
	SE	762	14091	15125	3253	1813	39909	227058	69835	641362	778295	117798	80074	1046826
	Tows	27	20	27	41	29	27	2	4	2	3	6	9	187
5/30-6/12	SC	2929	156500	132387	15263	17395	67102	0	79360	482098	223833	26234	58229	1261328
	SE	1079	38564	62452	4109	5235	16776	0	0	241049	72870	17352	37586	266163
	Tows	18	18	26	32	35	30	0	1	2	4	6	7	179
6/13-6/26	SC	18485	276744	209751	62095	19022	66812	468307	0	8609	337067	212496	23777	1703160
	SE	11198	69783	71571	18681	6036	17842	99338	0	0	168698	141801	6157	253235
	Tows	22	22	40	42	23	22	2	1	1	5	5	8	193
6/27-7/10	SC	10612	530081	192079	31947	6110	37871	71744	5704	62414	267722	139518	99387	1455198
	SE	5577	159486	65734	10463	2250	16680	34243	1864	23934	68697	114280	35676	225791
	Tows	22	24	28	30	22	18	9	5	4	8	11	19	200
7/11-7/24	SC	11495	533110	295802	50817	1110	43137	44939	6200	43044	165524	96864	26494	1318534
	SE	4005	91245	124412	22820	507	11782	17078	3788	43044	49928	28044	10171	173267
	Tows	19	15	21	35	19	20	12	7	2	7	13	20	190
7/25-8/7	SC	21652	906038	233836	70416	1977	32580	10643	5167	15066	57683	19676	8152	1382879
	SE	7464	354616	76180	24400	973	7502	5209	1336	6457	20883	8390	3740	364493
	Tows	16	17	23	39	20	17	10	6	4	7	12	20	191
8/8-8/21	SC	3987	423268	69917	16588	5826	36966	4967	1860	32283	100944	89945	218141	1004633
	SE	1723	146140	15985	4030	2617	12493	3672	947	32283	31255	24812	176843	236045
	Tows	17	19	25	40	19	17	10	8	4	8	14	18	197
8/22-9/4	SC	11518	887330	211543	30411	3138	23965	7096	5167	45914	77746	54108	10499	1368429
	SE	3381	353666	65705	8840	1582	9551	4097	4441	25506	51091	25873	6804	385508
	Tows	17	17	15	50	21	16	12	6	3	7	12	22	198
9/5-9/18	SC	64552	801804	947164	35417	4283	6778	17029	1240	31566	140444	45910	8492	2104673
	SE	28869	269194	598773	10667	1902	2673	7305	716	31566	82964	21949	8492	663055
	Tows	28	17	18	51	24	22	5	3	3	3	6	8	188
9/19-10/2	SC	41057	411593	581645	52803	3075	12290	9934	0	12913	49156	167242	3705	1345497
	SE	9429	211807	193335	26448	1072	3219	8275	0	12913	20322	78350	2649	299724
	Tows	31	17	27	37	24	26	5	3	2	5	8	11	196
10/3-10/16	SC	12642	193699	53782	23960	1797	13187	1183	2480	0	13167	30919	2470	349285
	SE	3124	74912	20243	8389	723	10598	1183	2480	0	13167	17628	1657	81808
	Tows	28	19	25	45	22	21	6	2	3	4	7	11	193
10/17-10/30	SC	14121	193975	54709	4337	1260	3705	4257	0	4304	35111	39851	3705	358836
	SE	4757	128500	15591	1776	660	1965	4257	0	4304	14334	36178	3705	136463
	Tows	16	26	29	51	23	23	5	1	2	4	7	11	198
10/31-11/13	SC	685	13768	3103	200	2306	0	1774	0	0	17556	0	0	39392
	SE	472	9582	1718	200	1798	0	1774	0	0	17556	0	0	20239
	Tows	22	33	26	46	16	19	4	2	3	4	5	10	190
11/14-11/27	SC	669	14457	2241	188	1171	0	0	0	8609	0	0	0	27335
	SE	323	12465	1550	188	910	0	0	0	8609	0	0	0	15260
	Tows	45	22	24	49	18	14	4	3	3	4	8	11	205
11/28-12/11	SC	0	9087	1921	542	155	0	0	0	0	0	0	0	11705
	SE	0	9087	1921	542	155	0	0	0	0	0	0	0	9305
	Tows	0	5	14	17	17	14	0	0	0	0	3	3	73

Table C-49

Release and Recapture Data for Tagged White Perch Recaptured July 1976-December 1976

	Releases					Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance * (mi)	Recovery Gear
July	5-33555	6/10/76	42 East	140	14	7/ 0/76	28 East		20	14	98-Sports Fisherman
	5-28522	10/ 7/75	34 East	145	12	7/ 1/76	34 East	141	268	0	12-100' Beach Seine
	9-49624	10/22/75	22 Cntr	157	64	7/ 1/76	44 West	154	253	-22	25-Gill Net
	9-59157	4/28/76	34 East	192	12	7/ 1/76	34 East	188	64	0	12-100' Beach Seine
	9-60124	5/21/76	34 East	179	12	7/ 1/76	34 East	173	41	0	12-100' Beach Seine
	9-60486	5/ 6/76	34 East	200	12	7/ 1/76	34 East	192	56	0	12-100' Beach Seine
	9-60662	6/14/76	34 East	178	12	7/ 1/76	34 East	160	17	0	12-100' Beach Seine
	9-62869	6/14/76	34 East	184	12	7/ 1/76	34 East	165	17	0	12-100' Beach Seine
	9-60718	5/19/76	105 West	162	12	7/ 3/76	105 West		45	0	98-Sports Fisherman
	9-60761	5/20/76	92 West	187	12	7/ 4/76	40 West		45	52	98-Sports Fisherman
	9-56190	4/21/76	26 West	189	12	7/ 6/76	26 West	183	76	0	12-100' Beach Seine
	5-30021	10/20/75	38 East	130	14	7/ 7/76	38 East	133	261	0	14-200' Beach Seine
	9-42652	11/ 5/75	27 West	189	12	7/ 8/76	27 West	181	246	0	12-100' Beach Seine
	9-44867	10/29/76	34 East	163	14	7/ 8/76	33 East	159	253	1	14-200' Beach Seine
	9-64768	6/ 3/76	81 West	189	14	7/ 8/76	42 East	183	35	39	99-Indian Point
	**9-42653	11/ 5/75	27 West	199	12	7/ 9/76	27 West		247	0	12-100' Beach Seine
	9-62335	5/29/76	82 West	156	14	7/ 9/76	57 West	149	41	25	12-100' Beach Seine
	9-64537	6/ 8/76	61 West	157	12	7/ 9/76	44 West		31	17	98-Sports Fisherman
	5-32748	5/27/76	80 West	137	14	7/10/76	82 West		44	-2	98-Sports Fisherman
	5-31025	5/26/76	40 East	134	12	7/11/76	40 East		46	0	98-Sports Fisherman
	9-33464	5/20/75	40 West	185	5	7/11/76	57 West		418	40	98-Sports Fisherman
	9-59815	5/13/76	59 East	156	12		(Moodna				
	9-62949	5/29/76	84 West	163	14		Creek)				
	5-28158	10/ 1/75	39 East	125	14	7/11/76	27 East		59	32	98-Sports Fisherman
	9-56165	4/21/76	34 East	192	12	7/11/76	37 West		43	47	98-Sports Fisherman
	9-60122	5/21/76	34 East	206	12	7/12/76	39 East	127	285	0	12-100' Beach Seine
	5-26420	10/24/75	33 East	147	14	7/12/76	34 East	180	82	0	12-100' Beach Seine
	9-40398	9/ 9/75	36 East	175	12	7/12/76	34 East	201	52	0	12-100' Beach Seine
	9-48198	10/ 8/75	39 East	204	14	7/14/76	36 East	143	264	-3	14-200' Beach Seine
	9-48521	10/17/75	36 East	178	12	7/14/76	36 East	170	309	0	14-200' Beach Seine
	9-52522	11/18/75	36 East	166	14	7/14/76	39 East		280	0	98-Sports Fisherman
	9-58225	5/ 5/76	96 West	165	12	7/14/76	36 East	176	271	0	14-200' Beach Seine
	9-65281	6/17/76	36 East	161	14	7/14/76	36 East	164	239	0	14-200' Beach Seine
	9-59410	5/27/76	59 East	214	12	7/14/76	25 West		70	71	98-Sports Fisherman
	5-31476	6/14/76	36 East	138	12	7/14/76	36 East	156	27	0	14-200' Beach Seine
	9-52123	11/ 6/75	36 East	176	14	7/15/76	59 East	210	49	0	12-100' Beach Seine
	9-66743	6/15/76	40 East	183	5	7/16/76	36 East	140	32	0	14-200' Beach Seine
	9-57863	5/ 7/76	71 West	154	12	7/16/76	36 East	175	253	0	14-200' Beach Seine
	9-62913	5/29/76	84 West	160	14	7/16/76	42 East	178	31	-2	99-Indian Point
	9-50349	11/11/75	33 East	176	14	7/18/76	43 East		72	28	98-Sports Fisherman
	9-66760	6/15/76	57 West	192	5	7/19/76	39 West	155	51	45	1-Bottom Trawl
	5-26501	9/ 6/75	38 West	140	12	7/20/76	27 East		252	6	98-Sports Fisherman
	5-33328	6/ 7/76	58 East	141	5	7/20/76	57 West	185	35	0	5-Box Trap
	9-48549	10/ 9/75	84 West	204	12	7/21/76	38 West	150	319	0	12-100' Beach Seine
	9-60605	6/17/76	28 East	166	12	7/21/76	37 West	132	44	21	90-L.M.S.
	5-03068	10/29/74	57 West	106	12	7/21/76	37 West	196	286	47	97-Bowline
	5-28838	10/13/75	57 West	120	12	7/21/76	28 East	165	34	0	12-100' Beach Seine
	9-42869	10/ 2/75	16 West	206	12	7/23/76	57 West	136	633	0	14-200' Beach Seine
	5-26878	11/ 7/75	34 East	140	14	7/23/76	57 West	125	284	0	14-200' Beach Seine
	9-63721	5/29/76	83 West	161	12	7/23/76	15 East		295	1	98-Sports Fisherman
	5-29420	11/12/75	39 East	128	12	7/25/76	33 East		261	1	98-Sports Fisherman
	9-44849	10/29/75	36 East	152	14	7/25/76	67 East		57		98-Sports Fisherman
	9-48181	10/ 8/75	39 East	155	14	7/26/76	39 East	130	257	0	12-100' Beach Seine
	9-63243	6/ 7/76	60 East	180	12	7/26/76	36 East	155	271	0	14-200' Beach Seine
	9-64529	6/ 8/76	60 East	157	12	7/26/76	39 East	143	292	0	12-100' Beach Seine
	5-30070	10/21/75	37 West	115	14	7/27/76	60 East	176	50	0	5-Box Trap
	9-59168	4/30/76	60 East	166	12	7/27/76	60 East	152	49	0	5-Box Trap
	5-30650	11/21/75	36 West	148	14	7/28/76	37 West	131	281	0	90-L.M.S.
	9-48498	9/22/75	36 West	168	14	7/29/76	60 East	161	90	0	5-Box Trap
	9-50021	10/20/75	39 East	178	14	7/30/76	36 West	151	252	0	14-200' Beach Seine
	9-54576	12/ 2/75	30 West	162	64	7/30/76	36 West	158	312	0	14-200' Beach Seine
	9-55414	12/ 4/75	30 West	184	64	7/30/76	18 East		284	21	98-Sports Fisherman
	9-60553	4/30/76	36 West	193	14	7/30/76	42 East		241	-12	99-Indian Point
	9-64613	6/ 3/76	76 West	180	14	7/30/76	42 East		239	-12	99-Indian Point
						7/30/76	36 West	189	91	0	14-200' Beach Seine
August	9-63205	5/29/76	87 West	187	14	7/30/76	42 East		57	34	99-Indian Point
	5-28062	9/25/75	43 East	136	14						
	5-28065	9/25/75	43 East	128	14	8/ 1/76	42 East	181	64	45	99-Indian Point
	9-64426	6/16/76	27 West	191	12	8/ 2/76	43 East	149	312	0	12-100' Beach Seine
	5-28560	9/25/75	77 East	121	12	8/ 2/76	43 East	144	312	0	12-100' Beach Seine
	9-64449	6/16/76	34 East	150	12	8/ 2/76	42 East		47	-15	99-Indian Point
	9-61650	5/27/76	80 West	156	14	8/ 4/76	76 East		314	1	94-Other
	9-62948	5/29/76	84 West	157	14	8/ 4/76	34 East	141	49	0	14-200' Beach Seine
	**9-48514	10/23/75	34 East	177	53	8/ 5/76	42 East		70	38	99-Indian Point
	9-52600	11/18/75	33 East	161	14	8/ 5/76	42 East		68	42	99-Indian Point
	9-56570	5/20/76	49 West	153	12	8/ 6/76	34 East	172	288	0	14-200' Beach Seine
	5-34337	6/18/76	34 East	135	14	8/ 6/76	34 East	160	262	-1	14-200' Beach Seine
	9-30292	4/22/75	40 East	155	5	8/ 6/76	42 East	151	78	7	99-Indian Point
	5-29288	10/17/75	40 West	149	14	8/ 7/76	33 East		50	1	98-Sports Fisherman
						8/ 7/76	East- chester Bay		473		98-Sports Fisherman
						8/ 9/76	40 West	149	297	0	12-100- Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	5-29968	6/ 7/76	36 East	144	14	8/ 9/76	39 West	146	63	-3	12-100' Beach Seine
	5-25032	9/ 3/75	33 East	149	14	8/10/76	37 West	148	342	-4	97-Bowline
	9-59843	5/20/76	92 West	164	12	8/10/76	36 West		82	56	98-Sports Fisherman
	9-62918	5/29/76	84 West	167	14	8/11/76	60 East	165	74	24	5-Box Trap
	9-56497	4/ 6/76	38 East	166	5	8/14/76	34 East		130	4	98-Sports Fisherman
	9-64969	6/10/76	86 West	164	14	8/14/76	26 West		65	60	98-Sports Fisherman
	5-28875	10/29/75	34 East	142	14	8/16/76	34 East	141	292	0	14-200' Beach Seine
	9-56158	4/21/76	34 East	229	12	8/16/76	34 East	223	117	0	14-200' Beach Seine
	9-65502	6/15/76	33 East	175	5	8/17/76	33 East	166	63	0	11-Box Trap
	9-48533	10/14/75	60 East	159	12	8/18/76	60 East	161	309	0	5-Box Trap
	9-61864	5/26/76	84 West	160	14	8/21/76	32 East		87	52	98-Sports Fisherman
	5-27114	10/ 2/75	39 East	138	14	8/24/76	39 East	138	327	0	14-200' Beach Seine
	9-43803	9/25/75	34 East	176	64	8/24/76	48 East	176	334	-14	4-Bottom Trawl
	9-64038	6/ 9/76	80 West	151	14	8/24/76	48 East	152	76	32	4-Bottom Trawl
	5-29645	11/10/75	40 West	147	12	8/25/76	40 West	152	289	0	12-100' Beach Seine
	9-61815	5/26/76	84 West	174	14	8/29/76	84 West		95	0	98-Sports Fisherman
	9-48147	10/ 7/75	29 West	181	12	8/30/76	29 West	180	328	0	12-100' Beach Seine
September	5-35351	9/ 1/76	40 East	106	14	9/ 1/76	41 West	109	0	-1	95-Lovett
	9-51884	11/ 6/75	34 East	168	64	9/ 1/76	42 East	150	300	-8	99-Indian Point
	9-55265	12/ 3/75	29 West	175	64	9/ 1/76	42 East		273	-13	99-Indian Point
	9-55922	12/ 4/75	30 West	193	64	9/ 1/76	37 West	184	272	-7	90-L.M.S.
	5-30874	5/10/76	38 East	145	12	9/ 2/76	38 East	146	115	0	14-200' Beach Seine
	5-34809	8/31/76	39 East	125	14	9/ 2/76	39 East	116	2	0	14-200' Beach Seine
	5-34860	8/31/76	39 East	117	14	9/ 2/76	39 East	114	2	0	14-200' Beach Seine
	5-35922	9/ 1/76	38 West	136	14	9/ 2/76	38 West	136	1	0	12-100' Beach Seine
	5-35944	9/ 1/76	38 West	112	14	9/ 2/76	38 West	111	1	0	12-100' Beach Seine
	9-41957	10/16/75	38 West	163	14	9/ 2/76	38 West	165	322	0	12-100' Beach Seine
	9-56444	5/ 6/76	39 East	167	12	9/ 2/76	39 East	163	119	0	14-200' Beach Seine
	5-34836	8/31/76	39 East	127	14	9/ 3/76	39 East	125	3	0	12-100' Beach Seine
	5-35972	9/ 1/76	38 West	124	14	9/ 3/76	38 West	119	2	0	14-200' Beach Seine
	9-61632	5/27/76	80 West	151	14	9/ 3/76	42 East	148	99	38	99-Indian Point
	5-34817	8/31/76	39 East	101	14	9/ 6/76	42 East		6	-3	99-Indian Point
	*5-26879	11/ 7/75	34 East	135	14	9/ 7/76	34 East	138	305	0	14-200' Beach Seine
	5-36648	9/ 2/76	37 West	103	14	9/ 7/76	42 East		5	-5	99-Indian Point
	9-44543	11/ 7/75	34 East	162	14	9/ 7/76	34 East	160	305	0	14-200' Beach Seine
	9-49186	10/ 8/75	33 Cntr	164	64	9/ 7/76	42 East	165	335	-9	99-Indian Point
	**9-66812	9/ 2/76	60 East	162	5	9/ 7/76	60 East	162	5	0	5-Box Trap
	5-28194	10/ 7/75	110 East	137	12	9/ 8/76	42 East	136	337	68	99-Indian Point
	5-36664	9/ 2/76	37 West	121	14	9/ 8/76	42 East		6	-5	99-Indian Point
	9-63855	9/ 3/76	39 East	179	14	9/ 9/76	39 East	174	6	0	53-500' Beach Seine
	9-58194	4/ 7/76	35 East	150	12	9/10/76	30 West	145	156	5	64-Epibenthic Sled
	9-59160	4/29/76	43 East	203	12	9/10/76	43 East	218	134	0	12-100' Beach Seine
	9-59299	5/ 7/76	71 West	155	12	9/11/76	46 West		127	25	98-Sports Fisherman
	9-63663	6/ 9/76	26 West	230	12	9/11/76	42 East	224	94	-16	99-Indian Point
	9-44836	10/29/75	34 East	156	14	9/12/76	34 East		319	0	98-Sports Fisherman
	9-64791	6/ 3/76	81 West	169	14	9/12/76	32 East		101	49	98-Sports Fisherman
	9-65033	9/ 2/76	27 West	165	12	9/12/76	26 West		10	1	98-Sports Fisherman
	**5-30479	4/19/76	33 East	137	5	9/13/76	34 East	135	147	-1	14-200' Beach Seine
	5-36346	9/ 3/76	43 East	121	12	9/13/76	43 East	110	10	0	12-100' Beach Seine
	5-37203	9/ 7/76	38 West	114	12	9/13/76	38 West	111	6	0	12-100' Beach Seine
	5-38182	9/ 9/76	33 East	107	53	9/13/76	34 East	109	4	-1	14-200' Beach Seine
	9-66592	8/31/76	39 East	156	14	9/13/76	39 East	154	13	0	5-Box Trap
	**9-66812	9/ 2/76	60 East	162	5	9/13/76	60 East	163	11	0	5-Box Trap
	5-36735	9/ 2/76	39 East	121	14	9/14/76	39 East	119	12	0	14-200' Beach Seine
	5-38124	9/ 9/76	39 East	142	53	9/14/76	39 East	140	5	0	14-200' Beach Seine
	9-44443	10/22/75	27 West	185	12	9/14/76	27 West	187	328	0	12-100' Beach Seine
	**9-48514	10/23/75	34 East	177	53	9/14/76	33 East	176	327	1	14-200' Beach Seine
	9-65028	9/ 2/76	27 West	185	12	9/14/76	27 West	181	12	0	12-100' Beach Seine
	9-53173	11/13/75	37 Cntr	190	64	9/15/76	39 East		307	-2	98-Sports Fisherman
	9-56516	4/21/76	38 East	151	5	9/15/76	39 East	149	147	-1	14-200' Beach Seine
	9-59082	6/ 4/76	51 East	175	12	9/15/76	43 East		103	8	98-Sports Fisherman
	9-59121	4-20/76	14 West	175	12	9/15/76	15 East	175	148	-1	12-100' Beach Seine
	9-64456	6/17/76	43 East	177	12	9/15/76	34 East	173	90	9	14-200' Beach Seine
	9-66634	9/ 1/76	40 West	156	12	9/15/76	40 West	153	14	0	14-200' Beach Seine
	9-67105	9/ 7/76	40 West	166	12	9/15/76	40 West	160	8	0	14-200' Beach Seine
	5-29039	11/12/75	35 West	127	12	9/16/76	35 West	137	309	0	14-200' Beach Seine
	5-35187	9/13/76	40 East	115	14	9/16/76	40 East	112	3	0	14-200' Beach Seine
	5-36201	8/31/76	23 East	105	12	9/16/76	23 East	104	16	0	12-100' Beach Seine
	5-37214	9/ 7/76	35 West	147	12	9/16/76	35 West	142	9	0	14-200' Beach Seine
	5-37969	9/13/76	43 East	143	12	9/16/76	43 East	138	3	0	12-100' Beach Seine
	5-38208	9/13/76	36 West	125	14	9/16/76	35 West	118	3	1	14-200' Beach Seine
	**5-38352	9/13/76	40 West	120	14	9/16/76	40 West	117	3	0	12-100' Beach Seine
	**5-38352	9/13/76	40 West	120	14	9/16/76	40 West	117	3	0	12-100' Beach Seine
	5-39602	9/15/76	35 East	108	14	9/16/76	34 East	115	1	1	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance * (mi)	Recovery Gear
	5-39620	9/15/76	35 East	123	14	9/16/76	34 East	121	1	1	14-200' Beach Seine
	5-39633	9/15/76	35 East	112	14	9/16/76	34 East	110	1	1	14-200' Beach Seine
	**9-42653	11/ 5/75	27 West	199	12	9/16/76	27 West	196	316	0	12-100' Beach Seine
	9-50670	11/11/75	34 East	173	14	9/16/76	34 East	168	310	0	12-100' Beach Seine
	9-50857	11/ 6/75	34 East	181	14	9/16/76	34 East	173	315	0	12-100' Beach Seine
	9-52168	11/ 6/75	34 East	194	14	9/16/76	34 East	187	315	0	12-100' Beach Seine
	9-58193	4/ 7/76	35 East	196	12	9/16/76	34 East		162	1	98-Sports Fisherman
	9-59708	8/31/76	19 East	180	12	9/16/76	19 East	179	16	0	12-100' Beach Seine
	**9-59797	9/ 9/76	33 East	176	53	9/16/76	33 East	176	7	0	14-200' Beach Seine
	**9-62870	6/14/76	34 East	162	12	9/16/76	34 East	160	94	0	12-100' Beach Seine
	9-63809	9/ 2/76	39 East	172	14	9/16/76	39 East	174	14	0	14-200' Beach Seine
	9-66645	9/ 2/76	34 East	180	12	9/16/76	34 East	177	14	0	12-100' Beach Seine
	9-67172	9/13/76	34 West	195	12	9/16/76	34 East	195	3	0	14-200' Beach Seine
	9-67979	9/10/76	34 East	155	12	9/16/76	34 East	153	6	0	14-200' Beach Seine
	9-68410	9/10/76	34 East	190	12	9/16/76	34 East	185	6	0	12-100' Beach Seine
	5-37441	9/10/76	36 West	119	53	9/17/76	36 West	107	7	0	53-500' Beach Seine
	5-37490	9/10/76	36 West	111	53	9/17/76	36 West	100	7	0	53-500' Beach Seine
	5-37492	9/10/76	36 West	118	53	9/17/76	36 West	115	7	0	53-500' Beach Seine
	5-37499	9/10/76	36 West	148	53	9/17/76	36 West	145	7	0	53-500' Beach Seine
	5-37524	9/10/76	36 West	145	53	9/17/76	36 West	130	7	0	53-500' Beach Seine
	5-37526	9/10/76	36 West	130	53	9/17/76	36 West	125	7	0	53-500' Beach Seine
	**5-37527	9/10/76	36 West	114	53	9/17/76	36 West	111	7	0	53-500' Beach Seine
	5-37537	9/10/76	36 West	130	53	9/17/76	36 West	126	7	0	53-500' Beach Seine
	**5-37539	9/10/76	36 West	117	53	9/17/76	36 West	112	7	0	53-500' Beach Seine
	5-37590	9/10/76	36 West	112	53	9/17/76	36 West	112	7	0	53-500' Beach Seine
	5-38203	9/13/76	36 West	125	14	9/17/76	36 West	115	4	0	53-500' Beach Seine
	5-38204	9/13/76	36 West	102	14	9/17/76	36 West		4	0	53-500' Beach Seine
	**9-42248	10/ 7/75	33 East	168	14	9/17/76	32 East	165	346	1	53-500' Beach Seine
	9-42566	10/ 7/75	33 East	174	14	9/17/76	32 East	169	346	1	53-500' Beach Seine
	**9-68003	9/14/76	39 East	152	12	9/17/76	39 East	146	3	0	12-100' Beach Seine
	5-35375	9/ 2/76	38 East	149	14	9/19/76	35 East		17	3	98-Sports Fisherman
	**5-26879	11/ 7/75	34 East	135	14	9/20/76	34 East	140	318	0	14-200' Beach Seine
	5-31908	5/29/76	82 West	148	14	9/20/76	48 East	145	114	34	1-Bottom Trawl
	5-34442	9/ 2/76	26 East	121	12	9/20/76	26 East	122	18	0	12-100' Beach Seine
	5-35118	9/ 7/76	34 East	135	14	9/20/76	34 East	133	13	0	14-200' Beach Seine
	5-35125	9/ 7/76	34 East	122	14	9/20/76	34 East	115	13	0	14-200' Beach Seine
	5-35134	9/ 7/76	34 East	120	14	9/20/76	34 East	117	13	0	14-200' Beach Seine
	5-35141	9/ 7/76	34 East	128	14	9/20/76	34 East	121	13	0	14-200' Beach Seine
	5-35161	9/ 7/76	34 East	128	14	9/20/76	34 East	127	13	0	14-200' Beach Seine
	5-35595	9/14/75	26 West	128	12	9/20/76	26 West	124	6	0	12-100' Beach Seine
	5-38092	9/13/76	36 East	112	14	9/20/76	36 East	109	7	0	12-100' Beach Seine
	5-38096	9/13/76	36 East	116	14	9/20/76	36 East	116	7	0	12-100' Beach Seine
	5-39012	9/15/76	37 West	106	14	9/20/76	40 East		5	-3	12-100' Beach Seine
	5-39552	9/15/76	35 East	123	14	9/20/76	34 East	120	5	1	14-200' Beach Seine
	5-39612	9/15/76	35 East	122	14	9/20/76	34 East	119	5	1	14-200' Beach Seine
	5-39621	9/15/76	35 East	108	14	9/20/76	42 East		5	-7	99-Indian Point
	5-39629	9/15/76	35 East	115	14	9/20/76	34 East	114	5	1	14-200' Beach Seine
	5-39631	9/15/76	35 East	115	14	9/20/76	34 East	112	5	1	14-200' Beach Seine
	5-39638	9/15/76	35 East	113	14	9/20/76	34 East	110	5	1	14-200' Beach Seine
	5-39647	9/15/76	35 East	123	14	9/20/76	34 East	119	5	1	14-200' Beach Seine
	5-39665	9/15/76	35 East	118	14	9/20/76	34 East	118	5	1	14-200' Beach Seine
	5-39672	9/15/76	35 East	116	14	9/20/76	34 East	114	5	1	14-200' Beach Seine
	**5-39680	9/15/76	35 East	113	14	9/20/76	34 East	112	5	1	14-200' Beach Seine
	5-39688	9/15/76	35 East	116	14	9/20/76	34 East	114	5	1	14-200' Beach Seine
	9-56184	4/21/76	28 East	150	12	9/20/76	27 East	153	152	1	89-N.Y.S.D.E.C.
	9-66215	9/15/76	35 East	161	14	9/20/76	34 East	160	5	1	14-200' Beach Seine
	9-66224	9/15/76	35 East	200	14	9/20/76	34 East	200	5	1	14-200' Beach Seine
	9-66232	9/15/76	35 East	172	14	9/20/76	34 East	172	5	1	14-200' Beach Seine
	9-66239	9/15/76	35 East	168	14	9/20/76	34 East	165	5	1	14-200' Beach Seine
	9-66879	9/ 7/76	34 East	155	14	9/20/76	34 East	154	13	0	14-200' Beach Seine
	5-38133	9/ 9/76	33 East	117	53	9/21/76	34 East	119	12	-1	14-200' Beach Seine
	5-38722	9/20/76	36 East	106	12	9/21/76	36 East	106	1	0	12-100' Beach Seine
	9-48519	10/23/75	34 East	153	53	9/21/76	34 East	156	334	0	14-200' Beach Seine
	9-59321	9/14/76	39 East	155	14	9/21/76	38 East		7	1	12-100' Beach Seine
	9-66199	9/16/76	35 West	154	14	9/21/76	35 West	149	5	0	12-100' Beach Seine
	9-67739	9/16/76	33 East	175	14	9/21/76	34 East	169	5	-1	14-200' Beach Seine
	9-67957	9/10/76	34 East	192	12	9/21/76	34 East	191	11	0	14-200' Beach Seine
	9-67983	9/10/76	34 East	183	12	9/21/76	34 East	176	11	0	14-200' Beach Seine
	9-68089	9/10/76	34 East	184	12	9/21/76	34 East	177	11	0	14-200' Beach Seine
	5-25945	9/16/75	36 West	148	53	9/22/76	36 West	152	372	0	14-200' Beach Seine
	5-31229	5/ 6/76	34 East	144	12	9/22/76	34 East	143	139	0	14-200' Beach Seine
	5-37169	9/21/76	35 West	107	12	9/22/76	36 West	117	1	-1	14-200' Beach Seine
	5-37457	9/10/76	36 West	112	53	9/22/76	36 West	109	12	0	14-200' Beach Seine
	**5-37539	9/10/76	36 West	117	53	9/22/76	36 West	112	12	0	14-200' Beach Seine
	5-39183	9/15/76	34 East	129	14	9/22/76	34 East	127	7	0	14-200' Beach Seine
	5-39216	9/16/76	35 West	105	14	9/22/76	35 West	106	6	0	12-100' Beach Seine
	5-39223	9/16/76	35 West	103	14	9/22/76	36 West	101	6	-1	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

	Releases					Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	5-39759	9/16/76	34 East	129	14	9/22/76	34 East	123	6	0	14-200' Beach Seine
	**9-60685	6/15/76	34 East	169	12	9/22/76	34 East	164	99	0	14-200' Beach Seine
	**9-62870	6/14/76	34 East	162	12	9/22/76	34 East	162	100	0	14-200' Beach Seine
	9-65449	9/13/76	36 West	175	14	9/22/76	36 West	174	9	0	14-200' Beach Seine
	**9-66177	9/15/76	34 East	162	14	9/22/76	34 East	153	7	0	14-200' Beach Seine
	9-68530	9/15/76	22 East	157	12	9/22/76	22	153	7	0	89-N.Y.S.D. E.C.
	9-68547	9/15/76	22 East	160	12	9/22/76	22	153	7	0	89-N.Y.S.D. E.C.
	9-68566	9/15/76	22 East	183	12	9/22/76	22	177	7	0	89-N.Y.S.D. E.C.
	9-68567	9/15/76	23 East	151	12	9/22/76	22	144	7	0	89-N.Y.S.D. E.C.
	9-68590	9/15/76	22 East	181	12	9/22/76	22	175	7	0	89-N.Y.S.D. E.C.
	9-68595	9/15/76	22 East	170	12	9/22/76	22	165	7	0	89-N.Y.S.D. E.C.
	5-31554	5/11/76	40 East	135	14	9/23/76	40 East	143	135	0	14-200' Beach Seine
	5-39828	9/16/76	40 East	112	14	9/23/76	40 East	110	7	0	14-200' Beach Seine
	5-39849	9/16/76	40 West	118	14	9/23/76	40 West	112	7	0	14-200' Beach Seine
	9-65079	9/ 7/76	60 East	170	5	9/23/76	60 East	165	16	0	5-Box Trap
	**9-65080	9/ 7/76	60 East	203	5	9/23/76	60 East	202	16	0	5-Box Trap
	**9-67614	9/13/76	39 East	175	5	9/23/76	39 East	172	10	0	5-Box Trap
	9-68220	9/15/76	15 East	170	12	9/23/76	15 East	169	8	0	12-100' Beach Seine
	5-34465	9/ 2/76	26 West	106	12	9/24/76	27	101	22	-1	89-N.Y.S.D. E.C.
	5-38007	9/ 9/76	33 East	123	53	9/24/76	34 East	123	15	-1	53-500' Beach Seine
	5-38019	9/ 9/76	33 East	124	53	9/24/76	34 East	125	15	-1	53-500' Beach Seine
	5-38031	9/ 9/76	33 East	122	53	9/24/76	34 East	123	15	-1	53-500' Beach Seine
	5-38129	9/ 9/76	33 East	126	53	9/24/76	34 East	124	15	-1	53-500' Beach Seine
	5-38134	9/ 9/76	33 East	107	53	9/24/76	34 East	109	15	-1	53-500' Beach Seine
	5-38177	9/ 9/76	33 East	119	53	9/24/76	34 East	121	15	-1	53-500' Beach Seine
	**5-39272	9/16/76	33 East	124	14	9/24/76	34 East	124	8	-1	53-500' Beach Seine
	5-39310	9/17/76	32 East	128	53	9/24/76	33 East	119	7	-1	53-500' Beach Seine
	9-42200	10/ 3/75	33 East	189	14	9/24/76	33 East	185	357	0	53-500' Beach Seine
	9-42237	10/ 7/75	33 East	161	14	9/24/76	33 East	158	353	0	53-500' Beach Seine
	**9-42248	10/ 7/75	33 East	168	14	9/24/76	33 East		353	0	53-500' Beach Seine
	9-42361	10/ 3/75	33 East	166	14	9/24/76	33 East	168	357	0	53-500' Beach Seine
	**9-48582	10/27/75	34 East	171	14	9/24/76	34 East	167	333	0	53-500' Beach Seine
	9-58145	4/13/76	57 West	179	12	9/24/76	90 West		164	-33	98-Sports Fisherman
	5-30290	10/23/75	38 West	130	14	9/27/76	38 West	139	340	0	14-200' Beach Seine
	5-31226	5/ 6/77	34 East	136	12	9/27/76	34 East	139	144	0	14-200' Beach Seine
	5-31350	5/14/76	69 East	127	14	9/27/75	40 West	128	136	29	14-200' Beach Seine
	5-34668	9/ 1/76	40 West	110	12	9/27/76	40 West	110	26	0	14-200' Beach Seine
	5-34938	6/14/76	40 West	128	14	9/27/76	40 West	129	105	0	5-Box Trap
	5-35303	9/ 1/76	40 East	121	14	9/27/76	40 East	121	26	0	14-200' Beach Seine
	** 5-36332	9/ 3/76	43 East	118	12	9/27/76	43 East	116	24	0	12-100' Beach Seine
	5-36335	9/ 3/76	43 East	127	12	9/27/76	43 East	121	24	0	12-100' Beach Seine
	5-38785	9/20/76	34 East	125	12	9/27/76	34 East	123	7	0	14-200' Beach Seine
	5-39940	9/21/76	34 East	124	14	9/27/76	34 East	121	6	0	14-200' Beach Seine
	5-39955	9/21/76	34 East	129	14	9/27/76	34 East	128	6	0	14-200' Beach Seine
	5-40112	9/22/76	38 West	120	12	9/27/76	38 West	118	5	0	14-200' Beach Seine
	5-40447	9/24/76	34 East	122	53	9/27/76	34 East	123	3	0	14-200' Beach Seine
	5-40459	9/24/76	34 East	133	53	9/27/76	34 East	132	3	0	14-200' Beach Seine
	5-41042	9/22/76	34 East	112	14	9/27/76	34 East	110	5	0	14-200' Beach Seine
	5-41372	9/21/76	40 East	110	14	9/27/76	40 East	109	6	0	14-200' Beach Seine
	9-55741	12/ 4/75	30 Cntr	173	64	9/27/76	42 East	166	298	-12	99-Indian Point
	**9-59797	9/ 9/76	33 East	176	53	9/27/76	34 East	176	18	-1	14-200' Beach Seine
	9-60493	5/ 6/76	34 East	157	12	9/27/76	34 East	154	144	0	14-200' Beach Seine
	**9-63891	9/16/76	34 East	169	12	9/27/76	34 East	165	11	0	14-200' Beach Seine
	**9-65080	9/ 7/76	60 East	203	5	9/27/76	60 East	199	20	0	5-Box Trap
	9-66149	9/15/76	34 East	186	14	9/27/76	34 East	176	12	0	14-200' Beach Seine
	9-66153	9/15/76	34 East	158	14	9/27/76	34 East	153	12	0	14-200' Beach Seine
	9-66559	9/ 2/76	38 East	161	14	9/27/76	38 East	159	25	0	12-100' Beach Seine
	9-66564	9/ 2/76	38 East	155	14	9/27/76	38 East	154	25	0	12-100' Beach Seine
	**9-67614	9/13/76	39 East	175	5	9/27/76	39 East	173	14	0	5-Box Trap
	9-69814	9/13/76	43 East	173	12	9/27/76	43 East	166	14	0	12-100' Beach Seine
	9-70494	9/21/76	34 East	168	14	9/27/76	34 East	171	6	0	14-200' Beach Seine
	9-73821	9/22/76	34 East	165	14	9/27/76	34 East	161	5	0	14-200' Beach Seine
	5-31419	6/ 9/76	53 West	131	12	9/28/76	53 West	130	111	0	12-100' Beach Seine
	5-34641	9/ 1/76	43 East	111	12	9/28/76	43 East	114	27	0	14-200' Beach Seine
	5-35117	9/ 7/76	34 East	121	14	9/28/76	34 East	122	21	0	14-200' Beach Seine
	5-35121	9/ 7/76	34 East	137	14	9/28/76	34 East	136	21	0	14-200' Beach Seine
	5-35136	9/ 7/76	34 East	136	14	9/28/76	34 East	134	21	0	14-200' Beach Seine
	5-35139	9/ 7/76	34 East	114	14	9/28/76	34 East	116	21	0	14-200' Beach Seine
	5-35152	9/ 7/76	34 East	132	14	9/28/76	34 East	126	21	0	14-200' Beach Seine
	5-35165	9/ 7/76	34 East	138	14	9/28/76	34 East	136	21	0	14-200' Beach Seine
	5-35170	9/ 7/76	34 East	123	14	9/28/76	34 East		21	0	14-200' Beach Seine
	5-36276	9/ 3/76	39 East	117	12	9/28/76	39 East	115	25	0	14-200' Beach Seine
	5-39903	9/20/76	34 East	148	14	9/28/76	34 East	145	8	0	14-200' Beach Seine
	5-39911	9/20/76	34 East	141	14	9/28/76	34 East	136	8	0	14-200' Beach Seine
	5-39913	9/20/76	34 East	129	14	9/28/76	34 East	127	8	0	14-200' Beach Seine
	5-39919	9/20/76	34 East	121	14	9/28/76	34 East	121	8	0	14-200' Beach Seine
	5-39936	9/20/76	34 East	126	14	9/28/76	34 East		8	0	14-200' Beach Seine
	5-39939	9/20/76	34 East	137	14	9/28/76	34 East		8	0	14-200' Beach Seine
	5-41327	9/21/76	24 West	131	14	9/28/76	23 West		7	1	14-200' Beach Seine
	9-44576	11/ 7/75	34 East	174	14	9/28/76	34 East	173	326	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	9-48146	10/ 7/75	29 West	165	12	9/28/76	29 West	162	357	0	14-200' Beach Seine
	9-63842	9/ 2/76	39 East	182	14	9/28/76	39 East	178	26	0	14-200' Beach Seine
	9-65040	9/ 2/76	29 West	195	12	9/28/76	29 West	195	26	0	14-200' Beach Seine
	9-65043	9/ 2/76	29 West	170	12	9/28/76	29 West	167	26	0	14-200' Beach Seine
	9-65050	9/ 2/76	29 West	178	12	9/28/76	29 West	175	26	0	14-200' Beach Seine
	9-65654	9/16/76	27 West	174	12	9/28/76	27 West		12	0	14-200' Beach Seine
	9-66605	9/ 1/76	43 East	158	12	9/28/76	43 East	155	27	0	14-200' Beach Seine
	9-66898	9/ 7/76	34 East	170	14	9/28/76	34 East	167	21	0	14-200' Beach Seine
	9-67493	9/23/76	12 West	159	12	9/28/76	12 West	155	5	0	12-100' Beach Seine
	**9-67614	9/13/76	39 East	175	5	9/28/76	39 East	175	15	0	14-200' Beach Seine
	9-67923	9/ 9/76	16 West	210	12	9/28/76	16 West	210	19	0	12-100' Beach Seine
	9-68599	9/15/76	22 East	200	12	9/28/76	22 East	195	13	0	14-200' Beach Seine
	9-70467	9/20/76	34 East	187	14	9/28/76	34 East		8	0	14-200' Beach Seine
	5-28368	10/14/75	34 East	135	14	9/29/76	35 East	141	351	-1	53-500' Beach Seine
	5-34454	9/ 2/76	26 West	119	12	9/29/76	26 West	120	27	0	12-100' Beach Seine
	5-34666	9/ 1/76	40 West	129	12	9/29/76	40 West	132	28	0	14-200' Beach Seine
	5-35824	9/23/76	36 West	112	14	9/29/76	36 West	103	6	0	14-200' Beach Seine
	**5-36332	9/ 3/76	43 East	118	12	9/29/76	43 East	115	26	0	12-100' Beach Seine
	5-36950	9/ 9/76	21 East	144	12	9/29/76	21 East	150	20	0	12-100' Beach Seine
	5-37329	9/10/76	39 East	141	12	9/29/76	39 East	143	19	0	12-100' Beach Seine
	5-37330	9/10/76	39 East	108	12	9/29/76	39 East	108	19	0	14-200' Beach Seine
	5-39866	9/20/76	34 East	121	14	9/29/76	35 East	118	9	-1	53-500' Beach Seine
	5-40216	9/27/76	40 West	142	14	9/29/76	40 West	144	2	0	14-200' Beach Seine
	5-40269	9/27/76	40 West	140	14	9/29/76	40 West	143	2	0	14-200' Beach Seine
	5-40688	9/28/76	29 West	128	14	9/29/76	29 West	129	1	0	53-500' Beach Seine
	5-40740	9/22/76	36 West	118	14	9/29/76	37 West	117	7	-1	90-L.M.S.
	5-42217	9/29/76	39 East	139	12	9/29/76	39 East	145	0	0	14-200' Beach Seine
	9-65014	9/ 2/76	26 West	171	12	9/29/76	19 East	193	27	7	12-100' Beach Seine
	9-65115	6/14/76	37 West	175	14	9/29/76	36 West	167	107	1	14-200' Beach Seine
	9-67107	9/ 7/76	40 West	164	12	9/29/76	40 West	160	22	0	14-200' Beach Seine
	9-67610	9/13/76	39 East	154	5	9/29/76	39 East	155	16	0	14-200' Beach Seine
	**9-68024	9/14/76	39 East	166	12	9/29/76	39 East	169	15	0	14-200' Beach Seine
	9-68554	9/15/76	15 West	194	12	9/29/76	12 West	194	14	3	12-100' Beach Seine
	9-71786	9/28/76	29 West	175	14	9/29/76	29 West	175	1	0	53-500' Beach Seine
	5-29349	11/18/75	38 West	128	14	9/30/76	38 West	134	317	0	14-200' Beach Seine
	5-36597	9/13/76	38 West	101	12	9/30/76	38 West	104	17	0	14-200' Beach Seine
	5-37068	9/21/76	38 East	104	12	9/30/76	38 East	101	9	0	14-200' Beach Seine
	5-37202	9/ 7/76	38 West	128	12	9/30/76	38 West	127	23	0	14-200' Beach Seine
	5-37489	9/10/76	36 West	125	53	9/30/76	38 West	130	20	-2	14-200' Beach Seine
	5-37529	9/10/76	36 West	111	53	9/30/76	35 West	112	20	1	53-500' Beach Seine
	**5-37539	9/10/76	36 West	117	53	9/30/76	35 West	113	20	1	53-500' Beach Seine
	5-38097	9/13/76	36 East	134	14	9/30/76	35 East	127	17	1	14-200' Beach Seine
	5-40134	9/27/76	36 East	118	12	9/30/76	35 East	115	3	1	14-200' Beach Seine
	5-40176	9/27/76	34 East	142	12	9/30/76	34 East	137	3	0	14-200' Beach Seine
	5-40704	9/22/76	36 West	115	14	9/30/76	35 West	112	8	1	53-500' Beach Seine
	5-41410	9/22/76	36 West	104	14	9/30/76	35 West	103	8	1	53-500' Beach Seine
	5-41414	9/22/76	36 West	115	14	9/30/76	35 West	118	8	1	53-500' Beach Seine
	5-41473	9/22/76	36 West	113	14	9/30/76	35 West	110	8	1	53-500' Beach Seine
	5-41499	9/22/76	36 West	118	14	9/30/76	35 West	115	8	1	53-500' Beach Seine
	5-42593	9/29/76	35 East	140	53	9/30/76	35 East	145	1	0	14-200' Beach Seine
October	**5-34462	9/ 2/76	26 West	118	12	10/ 1/76	26 West	120	29	0	12-100' Beach Seine
	5-34781	6/10/76	43 East	125	12	10/ 1/76	43 East	130	113	0	12-100' Beach Seine
	**5-37044	9/21/76	27 West	147	12	10/ 1/76	27 West	147	10	0	12-100' Beach Seine
	5-37181	9/16/76	26 East	112	12	10/ 1/76	26 East	109	15	0	12-100' Beach Seine
	5-37188	9/16/76	26 East	125	12	10/ 1/76	26 East	122	15	0	12-100' Beach Seine
	5-37875	9/17/76	39 West	131	12	10/ 1/76	39 West	130	14	0	12-100' Beach Seine
	9-67143	9/13/76	26 West	181	12	10/ 1/76	27 West	184	18	-1	12-100' Beach Seine
	9-68292	9/ 7/76	27 West	169	12	10/ 1/76	27 West	172	24	0	12-100' Beach Seine
	9-70538	9/22/76	27 West	190	12	10/ 1/76	27 West	188	9	0	12-100' Beach Seine
	9-70541	9/22/76	27 West	176	12	10/ 1/76	27 West	177	9	0	12-100' Beach Seine
	9-73163	10/ 1/76	38 West	170	12	10/ 2/76	40 West		1	-2	98-Sports Fisherman
	5-39987	9/21/76	34 East	130	14	10/ 3/76	42 East	132	12	-8	99-Indian Point
	5-28326	10/14/75	33 East	143	14	10/ 4/76	38 West		356	-5	98-Sports Fisherman
	5-39085	9/15/76	34 East	124	14	10/ 4/76	34 East	118	19	0	14-200' Beach Seine
	5-40055	9/20/76	26 West	137	12	10/ 4/76	42 East		14	-16	99-Indian Point
	5-41067	9/27/76	34 East	133	14	10/ 4/76	34 East	132	7	0	14-200' Beach Seine
	5-41351	9/21/76	26 West	111	14	10/ 4/76	22	108	13	4	89-N.Y.S.D. E.C.
	9-61682	5/29/76	82 West	160	14	10/ 4/76	42 East	161	128	40	99-Indian Point
	9-62850	6/ 7/76	34 East	203	12	10/ 4/76	34 East	194	119	0	14-200' Beach Seine
	9-64419	6/16/76	34 East	175	12	10/ 4/76	34 East	169	110	0	14-200' Beach Seine
	9-66103	9/15/76	34 East	182	14	10/ 4/76	34 East	180	19	0	14-200' Beach Seine
	**9-67614	9/13/76	39 East	175	5	10/ 4/76	39 East	173	21	0	5-Box Trap
	**9-68202	9/15/76	22 East	170	12	10/ 4/76	22	165	19	0	89-N.Y.S.D. E.C.
	9-68531	9/15/76	22 East	170	12	10/ 4/76	22	166	19	0	89-N.Y.S.D. E.C.
	9-68570	9/15/76	23 East	175	12	10/ 4/76	22	168	19	0	89-N.Y.S.D. E.C.
	9-68591	9/15/76	22 East	183	12	10/ 4/76	22	178	19	0	89-N.Y.S.D. E.C.
	9-69789	9/29/76	34 East	170	12	10/ 4/76	34 East	168	5	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates outward movement.

**Multiple recaptures.

Table C-49 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
	9-70051	9/22/76	34 East	190	14	10/ 4/76	34 East	188	12	0	14-200' Beach Seine
	9-70596	9/20/76	26 West	161	12	10/ 4/76	42 East		14	-16	99-Indian Point
	9-71383	9/22/76	34 East	184	14	10/ 4/76	34 East	181	12	0	14-200' Beach Seine
	9-72304	9/27/76	34 East	169	14	10/ 4/76	34 East	165	7	0	14-200' Beach Seine
	9-72313	9/27/76	34 East	174	14	10/ 4/76	41 Cntr	169	7	-7	4-Bottom Trawl
	9-72331	9/27/76	34 East	160	14	10/ 4/76	34 East	154	7	0	14-200' Beach Seine
	9-72953	9/23/76	34 East	156	14	10/ 4/76	34 East	152	11	0	14-200' Beach Seine
	5-34212	6/14/76	52 East	139	12	10/ 5/76	35 East	139	113	17	53-500' Beach Seine
	5-38073	9/ 9/76	33 East	123	53	10/ 5/76	34 East		26	-1	53-500' Beach Seine
	5-38180	9/ 9/76	33 East	120	53	10/ 5/76	34 East	117	26	-1	53-500' Beach Seine
	5-38197	9/ 9/76	33 East	117	53	10/ 5/76	34 East	119	26	-1	53-500' Beach Seine
	**5-39272	9/16/76	33 East	124	14	10/ 5/76	34 East	123	19	-1	53-500' Beach Seine
	5-40415	9/24/76	35 East	130	53	10/ 5/76	35 East		11	0	53-500' Beach Seine
	5-40492	9/27/76	34 East	122	14	10/ 5/76	34 East	122	8	0	53-500' Beach Seine
	5-42320	9/29/76	34 East	120	12	10/ 5/76	35 East	118	6	-1	53-500' Beach Seine
	5-42755	9/28/76	43 East	117	14	10/ 5/76	42 East		7	1	99-Indian Point
	9-52139	11/ 6/75	34 East	188	14	10/ 5/76	34 East	184	334	0	14-200' Beach Seine
	9-65602	9/21/76	38 East	188	12	10/ 5/76	38 East	180	14	0	12-100' Beach Seine
	9-66667	9/ 2/76	34 East	194	12	10/ 5/76	34 East	191	.33	0	14-200' Beach Seine
	9-67471	9/21/76	34 East	155	12	10/ 5/76	34 East	154	14	0	14-200' Beach Seine
	9-67939	9/10/76	34 East	197	12	10/ 5/76	34 East	193	25	0	14-200' Beach Seine
	9-67984	9/10/76	34 East	172	12	10/ 5/76	34 East	168	25	0	14-200' Beach Seine
	9-67998	9/10/76	34 East	161	12	10/ 5/76	34 East	157	25	0	14-200' Beach Seine
	9-72887	9/27/76	34 East	183	14	10/ 5/76	34 East	183	8	0	53-500' Beach Seine
	9-72934	9/23/76	34 East	186	14	10/ 5/76	34 East	179	12	0	14-200' Beach Seine
	9-72947	9/23/76	34 East	151	14	10/ 5/76	34 East	147	12	0	14-200' Beach Seine
	9-75054	10/ 5/76	34 East	171	14	10/ 5/76	34 East	172	0	0	64-Epibenthic Sled
	5-31406	6/ 8/76	39 East	130	12	10/ 6/76	39 East	137	120	0	14-200' Beach Seine
	5-34835	8/31/76	39 East	105	14	10/ 6/76	39 East	102	36	0	14-200' Beach Seine
	5-34850	8/31/76	39 East	112	14	10/ 6/76	39 East	107	36	0	14-200' Beach Seine
	5-35386	9/ 2/76	39 East	108	14	10/ 6/76	39 East	103	34	0	14-200' Beach Seine
	5-36600	9/ 2/76	39 East	110	14	10/ 6/76	39 East	108	34	0	14-200' Beach Seine
	5-36603	9/ 2/76	39 East	121	14	10/ 6/76	39 East	120	34	0	14-200' Beach Seine
	5-37058	9/21/76	36 East	136	12	10/ 6/76	36 East	136	15	0	14-200' Beach Seine
	5-38673	9/14/76	39 East	129	14	10/ 6/76	38 East	128	22	1	12-100' Beach Seine
	5-40657	9/28/76	29 West	123	14	10/ 6/76	22	119	8	7	89-N.Y.S.D. E.C.
	5-41182	9/27/76	39 East	107	14	10/ 6/76	39 East	104	9	0	14-200' Beach Seine
	5-41730	9/28/76	39 East	114	14	10/ 6/76	39 East	114	8	0	14-200' Beach Seine
	5-41741	9/28/76	39 East	136	14	10/ 6/76	39 East	131	8	0	14-200' Beach Seine
	5-42715	9/28/75	39 East	115	14	10/ 6/76	39 East	108	8	0	14-200' Beach Seine
	5-42903	9/27/76	38 West	107	14	10/ 6/76	42 East		9	-4	99-Indian Point
	5-43287	10/ 5/76	35 East	124	53	10/ 6/76	34 East	123	1	1	14-200' Beach Seine
	9-44311	11/ 6/75	51 East	200	14	10/ 6/76	42 East	198	335	9	99-Indian Point
	9-61254	5/24/76	83 West	161	12	10/ 6/76	42 East	160	135	41	99-Indian Point
	9-65328	9/21/76	23 East	190	14	10/ 6/76	22	189	15	1	89-N.Y.S.D. E.C.
	9-65329	9/21/76	23 East	164	14	10/ 6/76	22	165	15	1	89-N.Y.S.D. E.C.
	9-65610	9/23/76	22 East	170	12	10/ 6/76	22 East	171	13	0	14-200' Beach Seine
	9-66359	9/23/76	35 East	165	14	10/ 6/76	34 East	160	13	1	14-200' Beach Seine
	**5-30479	4/19/76	33 East	137	5	10/ 7/76	34 East	137	171	-1	14-200' Beach Seine
	5-36452	9/30/76	35 West	118	53	10/ 7/76	36 West		7	-1	53-500' Beach Seine
	5-36469	9/30/76	35 West	101	53	10/ 7/76	36 West		7	-1	53-500' Beach Seine
	5-37167	9/21/76	35 West	109	12	10/ 7/76	36 West		16	-1	53-500' Beach Seine
	5-37501	9/10/76	36 West	114	53	10/ 7/76	36 West		27	0	53-500' Beach Seine
	**5-37527	9/10/76	36 West	114	53	10/ 7/76	36 West	113	27	0	53-500' Beach Seine
	5-37580	9/10/76	36 West	104	53	10/ 7/76	36 West	106	27	0	53-500' Beach Seine
	5-38090	9/13/76	36 East	116	14	10/ 7/76	36 East	115	24	0	14-200' Beach Seine
	5-39275	9/16/76	33 East	126	14	10/ 7/76	34 East	123	21	-1	14-200' Beach Seine
	5-39622	9/15/76	35 East	115	14	10/ 7/76	34 East	110	22	1	14-200' Beach Seine
	5-39661	9/15/76	35 East	120	14	10/ 7/76	34 East	113	22	1	14-200' Beach Seine
	**5-39680	9/15/76	35 East	113	14	10/ 7/76	34 East	110	22	1	14-200' Beach Seine
	5-39855	9/20/76	34 East	121	14	10/ 7/76	34 East	118	17	0	14-200' Beach Seine
	5-39869	9/20/76	34 East	120	14	10/ 7/76	34 East	115	17	0	14-200' Beach Seine
	5-40095	9/22/76	35 West	139	12	10/ 7/76	36 West	135	15	-1	53-500' Beach Seine
	5-40484	9/27/76	34 East	144	14	10/ 7/76	34 East	141	10	0	53-500' Beach Seine
	5-41412	9/22/76	36 West	125	14	10/ 7/76	36 West		15	0	53-500' Beach Seine
	5-41435	9/22/76	36 West	124	14	10/ 7/76	36 West	122	15	0	53-500' Beach Seine
	5-43329	10/ 4/76	36 East	126	14	10/ 7/76	36 East	120	3	0	14-200' Beach Seine
	5-44032	9/30/76	35 West	139	53	10/ 7/76	36 West	120	7	-1	53-500' Beach Seine
	5-44087	9/30/76	35 West	125	53	10/ 7/76	36 West		7	-1	53-500' Beach Seine
	5-44093	9/30/76	35 West	116	53	10/ 7/76	36 West		7	-1	53-500' Beach Seine
	5-44319	10/ 5/76	35 East	114	53	10/ 7/76	35 East	103	2	0	89-N.Y.S.D. E.C.
	5-44336	10/ 5/76	35 East	134	53	10/ 7/76	34 East	133	2	1	14-200' Beach Seine
	5-44340	10/ 5/76	35 East	116	53	10/ 7/76	34 East	112	2	1	14-200' Beach Seine
	5-45155	10/ 5/76	35 East	107	53	10/ 7/76	35 East	110	2	0	89-N.Y.S.D. E.C.
	5-45246	10/ 5/76	35 East	109	53	10/ 7/76	34 East	108	2	1	14-200' Beach Seine
	5-45261	10/ 5/76	35 East	118	53	10/ 7/76	34 East	116	2	1	14-200' Beach Seine
	5-45419	10/ 6/76	34 East	103	14	10/ 7/76	34 East	103	1	0	14-200' Beach Seine
	5-45429	10/ 6/76	34 East	125	14	10/ 7/76	34 East	124	1	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

	Releases					Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi) *	Recovery Gear
	5-45448	10/ 6/76	34 East	107	14	10/ 7/76	34 East	108	1	0	14-200' Beach Seine
	9-41884	10/24/77	34 East	179	14	10/ 7/76	34 East	175	349	0	14-200' Beach Seine
	9-59639	6/ 9/76	33 East	183	14	10/ 7/76	34 East	177	120	-1	14-200' Beach Seine
	9-59660	6/ 8/76	58 West	158	14	10/ 7/76	34 East	148	121	24	14-200' Beach Seine
	9-59766	9/ 9/76	33 East	184	53	10/ 7/76	34 East	181	28	-1	14-200' Beach Seine
	**9-65080	9/ 7/76	60 East	203	5	10/ 7/76	60 East	193	30	0	5-Box Trap
	9-67749	9/16/76	33 East	180	14	10/ 7/76	34 East	183	21	-1	14-200' Beach Seine
	9-68335	10/ 5/76	35 East	173	53	10/ 7/76	34 East	171	2	1	14-200' Beach Seine
	9-70268	9/16/76	34 East	151	14	10/ 7/76	34 East	144	21	0	14-200' Beach Seine
	9-71630	9/23/76	60 East	156	5	10/ 7/76	60 East	160	14	0	5-Box Trap
	9-72899	9/27/76	34 East	178	14	10/ 7/76	34 East	170	10	0	14-200' Beach Seine
	9-75007	10/ 5/76	34 East	175	14	10/ 7/76	34 East	172	2	0	14-200' Beach Seine
	5-27097	10/14/75	40 West	125	14	10/ 8/76	40 West	133	360	0	14-200' Beach Seine
	5-35182	9/13/76	40 East	119	14	10/ 8/76	40 East	109	25	0	14-200' Beach Seine
	5-37723	9/15/76	40 West	140	14	10/ 8/76	40 West	136	23	0	14-200' Beach Seine
	5-39705	9/15/76	40 West	143	14	10/ 8/76	40 West	141	23	0	14-200' Beach Seine
	5-39810	9/16/76	40 East	105	14	10/ 8/76	40 East	102	22	0	14-200' Beach Seine
	**5-41363	9/21/76	40 East	105	14	10/ 8/76	40 East	104	17	0	14-200' Beach Seine
	5-42709	9/28/76	39 East	118	14	10/ 8/76	39 East	117	10	0	12-100' Beach Seine
	9-44808	10/21/75	40 West	155	5	10/ 8/76	40 West	151	353	0	14-200' Beach Seine
	9-66262	9/15/76	40 West	187	14	10/ 8/76	40 West	178	23	0	14-200' Beach Seine
	9-66300	9/16/76	34 East	185	14	10/ 8/76	34 East	179	22	0	14-200' Beach Seine
	9-69605	10/ 4/76	34 East	158	14	10/ 8/76	34 East	155	4	0	14-200' Beach Seine
	9-70123	9/21/76	34 East	191	14	10/ 8/76	34 East	186	17	0	14-200' Beach Seine
	9-70221	9/16/76	34 East	200	14	10/ 8/76	34 East	198	22	0	14-200' Beach Seine
	9-70297	9/16/76	34 East	180	14	10/ 8/76	34 East	177	22	0	14-200' Beach Seine
	9-70437	9/16/76	34 East	182	14	10/ 8/76	34 East	184	22	0	14-200' Beach Seine
	5-39451	9/17/76	32 East	125	53	10/ 9/76	42 East		22	-10	99-Indian Point
	5-42232	9/29/76	39 East	115	12	10/10/76	42 East		11	-3	99-Indian Point
	5-37171	9/21/76	35 West	135	12	10/11/76	35 West	134	20	0	12-100' Beach Seine
	5-37217	9/ 7/76	35 West	121	12	10/11/76	35 West	119	34	0	12-100' Beach Seine
	5-37596	9/10/76	36 West	104	53	10/11/76	36 West	103	31	0	14-200' Beach Seine
	5-39184	9/15/76	34 East	137	14	10/11/76	34 East	135	26	0	14-200' Beach Seine
	5-41043	9/22/76	34 East	145	14	10/11/76	34 East	143	19	0	14-200' Beach Seine
	5-41479	9/22/76	36 West	101	14	10/11/76	36 West	99	19	0	14-200' Beach Seine
	**9-66177	9/15/76	34 East	162	14	10/11/76	34 East		26	0	14-200' Beach Seine
	9-69697	9/13/76	39 West	171	12	10/11/76	39 West	163	28	0	14-200' Beach Seine
	9-69866	9/22/76	34 East	187	14	10/11/76	34 East	185	19	0	14-200' Beach Seine
	9-69876	9/27/76	34 East	203	14	10/11/76	34 East	201	14	0	14-200' Beach Seine
	9-69895	9/27/76	34 East	172	14	10/11/76	34 East	167	14	0	14-200' Beach Seine
	9-70850	10/ 1/76	39 West	151	12	10/11/76	39 West	153	10	0	14-200' Beach Seine
	9-70880	10/ 4/76	36 East	162	14	10/11/76	34 East	162	7	2	14-200' Beach Seine
	5-34855	8/31/76	39 East	120	14	10/12/76	39 East	118	42	0	14-200' Beach Seine
	5-39822	9/16/76	40 East	120	14	10/12/76	40 East	120	26	0	14-200' Beach Seine
	5-39824	9/16/76	40 East	119	14	10/12/76	40 East	116	26	0	14-200' Beach Seine
	5-40403	9/24/76	35 East	112	53	10/12/76	35 East	112	18	0	53-500' Beach Seine
	**5-40970	9/24/76	40 East	110	14	10/12/76	40 East	108	19	0	14-200' Beach Seine
	5-41536	9/27/76	39 East	119	12	10/12/76	39 East	121	15	0	14-200' Beach Seine
	5-42584	9/29/76	35 East	126	53	10/12/76	35 East		13	0	53-500' Beach Seine
	5-42714	9/28/76	39 East	134	14	10/12/76	39 East	130	14	0	14-200' Beach Seine
	5-42745	9/28/76	39 East	116	14	10/12/76	39 East	111	14	0	14-200' Beach Seine
	5-42939	9/27/76	40 East	148	14	10/12/76	40 East	145	15	0	14-200' Beach Seine
	5-46352	10/ 8/76	40 East	135	14	10/12/76	40 East	134	4	0	14-200' Beach Seine
	9-63843	9/ 2/76	39 East	175	14	10/12/76	39 East	174	40	0	14-200' Beach Seine
	9-66256	9/15/76	40 West	184	14	10/12/76	40 West	180	27	0	14-200' Beach Seine
	9-66260	9/15/76	40 West	162	14	10/12/76	40 West	157	27	0	14-200' Beach Seine
	9-67716	9/16/76	33 East	197	14	10/12/76	34 East	192	26	-1	53-500' Beach Seine
	9-67717	9/16/76	33 East	173	14	10/12/76	34 East	171	26	-1	53-500' Beach Seine
	9-69003	10/ 4/76	34 East	159	64	10/12/76	41 Cntr	156	8	-7	1-Bottom Trawl
	9-70497	9/21/76	34 East	195	14	10/12/76	34 East	195	21	0	53-500' Beach Seine
	**9-70660	9/24/76	34 East	176	53	10/12/76	34 East	172	18	0	53-500' Beach Seine
	9-70681	9/24/76	34 East	164	53	10/12/76	34 East	161	18	0	53-500' Beach Seine
	9-71085	10/ 5/76	34 East	175	53	10/12/76	34 East	174	7	0	53-500' Beach Seine
	9-72475	10/ 6/76	16 West	194	14	10/12/76	15 West	197	6	1	12-100' Beach Seine
	**9-72895	9/27/76	34 East	160	14	10/12/76	34 East	155	15	0	53-500' Beach Seine
	5-38527	9/14/76	34 East	120	53	10/13/76	35 East	113	29	-1	14-200' Beach Seine
	5-39851	9/20/76	34 East	120	14	10/13/76	35 East	120	23	-1	14-200' Beach Seine
	5-40158	9/27/76	35 East	127	12	10/13/76	35 East	132	16	0	14-200' Beach Seine
	5-46000	10/ 7/76	36 West	119	53	10/13/76	36 West	121	6	0	14-200' Beach Seine
	**9-42248	10/ 7/75	33 East	168	14	10/13/76	33 East	157	372	0	14-200' Beach Seine
	9-58514	4/20/76	34 East	211	14	10/13/76	34 East	208	176	0	14-200' Beach Seine
	9-62824	6/14/76	36 East	184	12	10/13/76	37 West	155	121	-1	90-L.M.S.
	9-63853	9/ 2/76	39 East	152	14	10/13/76	39 East	150	41	0	14-200' Beach Seine
	9-64423	6/16/76	34 East	169	12	10/13/76	0 West		119	34	98-Sports Fisherman
	9-68408	9/10/76	34 East	191	12	10/13/76	35 East	191	33	-1	14-200' Beach Seine
	9-69828	9/27/76	34 East	175	14	10/13/76	34 East	179	16	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	9-71307	9/22/76	34 East	189	14	10/13/76	34 East	190	21	0	14-200' Beach Seine
	9-71350	9/22/76	34 East	183	14	10/13/76	34 East	179	21	0	14-200' Beach Seine
	9-72400	9/27/76	34 East	170	14	10/13/76	34 East	173	16	0	14-200' Beach Seine
	9-72810	9/24/76	33 East	173	53	10/13/76	33 East	180	19	0	14-200' Beach Seine
	9-73828	9/22/76	34 East	173	14	10/13/76	34 East	169	21	0	14-200' Beach Seine
	9-75112	10/ 5/76	34 East	180	14	10/13/76	34 East	165	8	0	14-200' Beach Seine
	5-34482	9/ 2/76	26 West	111	12	10/14/76	26 West	116	42	0	12-100' Beach Seine
	5-37961	9/13/76	43 East	124	12	10/14/76	42 East		31	1	99-Indian Point
	5-39018	9/15/76	37 West	111	14	10/14/76	37 West		29	0	14-200' Beach Seine
	5-40948	9/23/76	40 West	101	14	10/14/76	40 West	101	21	0	14-200' Beach Seine
	5-41912	10/11/76	58 West	115	12	10/14/76	42 East		3	16	99-Indian Point
	5-45305	10/ 6/76	39 East	121	14	10/14/76	42 East	123	8	-3	99-Indian Point
	9-44557	11/ 7/75	34 East	172	14	10/14/76	42 East		342	-8	99-Indian Point
	**9-67614	9/13/76	39 East	175	5	10/14/76	39 East	172	31	0	5-Box Trap
	**9-68003	9/14/76	39 East	152	12	10/14/76	39 East		30	0	14-200' Beach Seine
	**9-68024	9/14/76	39 East	166	12	10/14/76	39 East	165	30	0	14-200' Beach Seine
	9-72767	10/ 6/76	38 East	157	12	10/14/76	38 East	156	8	0	14-200' Beach Seine
	9-73476	10/ 5/76	38 East	191	12	10/14/76	38 East	188	9	0	14-200' Beach Seine
	5-29689	10/29/75	40 East	139	14	10/15/76	40 East	149	352	0	12-100' Beach Seine
	5-30057	10/22/75	33 East	143	14	10/15/76	33 East	147	359	0	53-500' Beach Seine
	5-38905	9/13/76	33 East	119	14	10/15/76	33 East	120	32	0	53-500' Beach Seine
	5-39367	9/17/76	32 East	112	53	10/15/76	33 East	110	28	-1	53-500' Beach Seine
	5-39473	9/17/76	32 East	113	53	10/15/76	33 East	115	28	-1	53-500' Beach Seine
	5-42436	9/29/76	35 East	126	53	10/15/76	35 East	127	16	0	53-500' Beach Seine
	5-42482	9/29/76	35 East	125	53	10/15/76	35 East	126	16	0	53-500' Beach Seine
	5-42489	9/29/76	35 East	143	53	10/15/76	35 East	144	16	0	53-500' Beach Seine
	9-44169	10/22/75	33 East	159	14	10/15/76	33 East	162	359	0	53-500' Beach Seine
	9-66310	9/23/76	35 East	180	14	10/15/76	35 East	186	22	0	53-500' Beach Seine
	9-67564	9/24/76	35 East	208	53	10/15/76	35 East	207	21	0	53-500' Beach Seine
	9-67568	9/24/76	35 East	182	53	10/15/76	35 East	180	21	0	53-500' Beach Seine
	9-67584	9/24/76	35 East	186	53	10/15/76	35 East	186	21	0	53-500' Beach Seine
	9-72815	9/24/76	33 East	172	53	10/15/76	33 East	162	21	0	53-500' Beach Seine
	9-72823	9/24/76	33 East	157	53	10/15/76	33 East	159	21	0	53-500' Beach Seine
	9-73703	9/24/76	33 East	158	53	10/15/76	33 East	160	21	0	53-500' Beach Seine
	5-45957	10/14/76	43 East	109	12	10/17/76	42 East		3	1	99-Indian Point
	5-29372	11/19/75	34 East	125	14	10/18/76	35 East	137	334	-1	12-100' Beach Seine
	5-34480	9/ 2/76	26 West	111	12	10/18/76	26 West	111	46	0	12-100' Beach Seine
	**5-37044	9/21/76	27 West	147	12	10/18/76	27 West	147	27	0	12-100' Beach Seine
	5-37418	9/ 7/76	39 East	120	5	10/18/76	39 East	119	41	0	5-Box Trap
	5-39407	9/20/76	40 West	108	5	10/18/76	40 West	108	28	0	5-Box Trap
	5-40082	9/22/76	26 East	116	12	10/18/76	26 East	117	26	0	12-100' Beach Seine
	5-40084	9/22/76	27 West	148	12	10/18/76	27 West	147	26	0	12-100' Beach Seine
	5-41350	9/21/76	26 West	122	14	10/18/76	26 West	119	27	0	12-100' Beach Seine
	5-41966	10/12/76	26 West	113	12	10/18/76	22 East		6	4	98-Sports Fisherman
	5-43349	10/ 4/76	36 East	128	14	10/18/76	37 East	128	14	-1	14-200' Beach Seine
	5-43376	10/ 4/76	36 East	134	14	10/18/76	37 East	133	14	-1	14-200' Beach Seine
	5-43381	10/ 4/76	36 East	128	14	10/18/76	37 East	123	14	-1	14-200' Beach Seine
	9-42632	10/14/75	27 West	168	12	10/18/76	27 West	167	370	0	12-100' Beach Seine
	9-59932	9/14/76	27 West	199	12	10/18/76	27 West		34	0	12-100' Beach Seine
	**9-68202	9/15/76	22 East	170	12	10/18/76	22 East		33	0	98-Sports Fisherman
	9-70879	10/ 4/76	36 East	197	14	10/18/76	37 East	197	14	-1	14-200' Beach Seine
	**9-70881	10/ 4/76	36 East	189	14	10/18/76	37 East	188	14	-1	14-200' Beach Seine
	9-70892	10/ 4/76	36 East	171	14	10/18/76	37 East	167	14	-1	14-200' Beach Seine
	**9-70895	10/ 4/76	36 East	196	14	10/18/76	37 East	193	14	-1	14-200' Beach Seine
	9-70899	10/ 4/76	36 East	171	14	10/18/76	37 East	167	14	-1	14-200' Beach Seine
	9-71003	10/ 4/76	36 East	162	14	10/18/76	37 East	158	14	-1	14-200' Beach Seine
	**9-71005	10/ 4/76	36 East	178	14	10/18/76	37 East	174	14	-1	14-200' Beach Seine
	**9-71005	10/ 4/76	36 East	178	14	10/18/76	37 East	175	14	-1	14-200' Beach Seine
	9-71008	10/ 4/76	36 East	157	14	10/18/76	37 East	158	14	-1	14-200' Beach Seine
	9-71011	10/ 4/76	36 East	161	14	10/18/76	37 East	157	14	-1	14-200' Beach Seine
	9-71023	10/ 4/76	36 East	174	14	10/18/76	37 East	167	14	-1	14-200' Beach Seine
	9-71029	10/ 4/76	36 East	166	14	10/18/76	37 East	164	14	-1	14-200' Beach Seine
	9-73455	10/ 5/76	32 East	178	12	10/18/76	32 East	174	13	0	12-100' Beach Seine
	5-38147	9/ 9/76	33 East	136	53	10/19/76	34 East	134	40	-1	14-200' Beach Seine
	5-39959	9/21/76	34 East	149	14	10/19/76	34 East	148	28	0	14-200' Beach Seine
	5-40231	9/27/76	40 West	147	14	10/19/76	38 West	146	22	2	12-100' Beach Seine
	5-40435	9/24/76	34 East	130	53	10/19/76	34 East	130	25	0	14-200' Beach Seine
	5-40463	9/24/76	34 East	139	53	10/19/76	34 East	138	25	0	14-200' Beach Seine
	5-40937	9/22/76	34 East	148	14	10/19/76	40 East	139	27	-6	14-200' Beach Seine
	**5-40970	9/23/76	40 East	110	14	10/19/76	40 East	110	26	0	14-200' Beach Seine
	**9-48519	10/23/75	34 East	153	53	10/19/76	34 East	152	362	0	14-200' Beach Seine
	**9-48582	10/27/75	34 East	171	14	10/19/76	34 East		358	0	14-200' Beach Seine
	9-49883	11/ 4/75	31 West	152	64	10/19/76	34 East	175	350	-3	14-200' Beach Seine
	9-50432	11/18/75	33 East	173	14	10/19/76	34 East	170	336	-1	14-200' Beach Seine
	9-52136	11/ 6/75	34 East	150	14	10/19/76	34 East	146	348	0	14-200' Beach Seine
	9-59638	6/ 9/76	33 East	186	14	10/19/76	34 East	180	132	-1	14-200' Beach Seine
	9-67429	9/29/76	34 East	165	12	10/19/76	34 East		20	0	14-200' Beach Seine
	9-67968	9/10/76	34 East	195	12	10/19/76	34 East	193	39	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

	Releases					Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
	9-67971	9/10/76	34 East	157	12	10/19/76	34 East	153	39	0	14-200' Beach Seine
	9-67992	9/10/76	34 East	180	12	10/19/76	34 East	178	39	0	14-200' Beach Seine
	9-67999	9/10/76	34 East	173	12	10/19/76	34 East		39	0	14-200' Beach Seine
	9-68080	9/10/76	34 East	182	12	10/19/76	34 East	173	39	0	14-200' Beach Seine
	9-68401	9/10/76	34 East	180	12	10/19/76	34 East	170	39	0	14-200' Beach Seine
	9-70498	9/21/76	34 East	174	14	10/19/76	34 East	175	28	0	14-200' Beach Seine
	9-70659	9/24/76	34 East	170	53	10/19/76	34 East	168	25	0	14-200' Beach Seine
	9-71075	10/ 5/76	34 East	173	53	10/19/76	34 East		14	0	14-200' Beach Seine
	5-35804	9/14/76	26 West	114	12	10/20/76	26 West	114	36	0	12-100' Beach Seine
	5-38680	9/14/76	39 East	114	14	10/20/76	39 East	109	36	0	14-200' Beach Seine
	5-39513	9/14/76	39 East	112	14	10/20/76	39 East	108	36	0	14-200' Beach Seine
	5-41187	9/27/76	39 East	115	14	10/20/76	39 East	116	23	0	14-200' Beach Seine
	**9-63891	9/16/76	34 East	169	12	10/20/76	34 East	165	34	0	12-100' Beach Seine
	9-70668	9/27/76	39 East	169	14	10/20/76	39 East	167	23	0	14-200' Beach Seine
	5-41153	9/23/76	40 East	115	14	10/21/76	40 East	113	28	0	14-200' Beach Seine
	5-41366	9/21/76	40 East	114	14	10/21/76	40 East	111	30	0	14-200' Beach Seine
	5-44528	10/13/76	40 East	130	12	10/21/76	40 East	122	8	0	14-200' Beach Seine
	5-46116	10/ 7/76	36 West	105	53	10/21/76	42 East	106	14	-6	99-Indian Point
	9-74757	10/ 4/76	34 East	182	14	10/21/76	42 East		17	-8	99-Indian Point
	5-37871	9/17/76	39 West	103	12	10/22/76	39 West.	101	35	0	12-100' Beach Seine
	9-72568	9/28/76	14 West	186	12	10/22/76	15 West	187	24	-1	12-100' Beach Seine
	9-70326	9/16/76	34 East	177	14	10/24/76	42 East	170	38	-8	99-Indian Point
	5-38006	9/ 9/76	33 East	127	53	10/25/76	34 East	127	46	-1	14-200' Beach Seine
	5-38067	9/ 9/76	33 East	120	53	10/25/76	34 East	109	46	-1	14-200' Beach Seine
	5-39729	9/15/76	40 West	126	14	10/25/76	40 West	118	40	0	14-200' Beach Seine
	5-39941	9/21/76	34 East	126	14	10/25/76	34 East	120	34	0	14-200' Beach Seine
	**5-41363	9/21/76	40 East	105	14	10/25/76	40 East	103	34	0	14-200' Beach Seine
	5-43308	10/ 4/76	36 East	133	14	10/25/76	37 East	127	21	-1	14-200' Beach Seine
	9-66268	9/15/76	40 West	155	14	10/25/76	40 West	150	40	0	14-200' Beach Seine
	9-67745	9/16/76	33 East	209	14	10/25/76	34 East	203	39	-1	14-200' Beach Seine
	9-69858	9/22/76	34 East	168	14	10/25/76	34 East	167	33	0	12-100' Beach Seine
	**9-70881	10/ 4/76	36 East	189	14	10/25/76	37 East	190	21	-1	14-200' Beach Seine
	**9-70895	10/ 4/76	36 East	196	14	10/25/76	37 East	189	21	-1	14-200' Beach Seine
	9-70897	10/ 4/76	36 East	153	14	10/25/76	37 East		21	-1	14-200' Beach Seine
	9-71032	10/ 4/76	36 East	197	14	10/25/76	37 East	198	21	-1	14-200' Beach Seine
	9-71033	10/ 4/76	36 East	181	14	10/25/76	37 East	179	21	-1	14-200' Beach Seine
	9-71057	10/ 5/76	34 East	180	53	10/25/76	34 East	177	20	0	14-200' Beach Seine
	9-71426	10/ 8/76	40 West	150	14	10/25/76	40 West	192	17	0	14-200' Beach Seine
	9-73737	10/12/76	34 East	183	53	10/25/76	34 East	182	13	0	14-200' Beach Seine
	9-73746	10/12/76	34 East	184	53	10/25/76	34 East	183	13	0	14-200' Beach Seine
	9-74002	10/18/76	37 East	178	14	10/25/76	37 East	181	7	0	14-200' Beach Seine
	9-74439	10/18/76	37 East	161	14	10/25/76	37 East	161	7	0	14-200' Beach Seine
	9-58500	6/11/76	39 East	154	14	10/26/76	37 West	153	137	2	97-Bowline
	5-40049	9/21/76	59 East	137	12	10/27/76	37 West	138	36	22	90-L.M.S.
	9-65265	6/17/76	36 East	169	14	10/27/76	37 West		132	-1	97-Bowline
	5-36615	9/ 2/76	39 East	124	14	10/28/76	39 East	123	56	0	14-200' Beach Seine
	5-40113	9/22/76	38 West	109	12	10/28/76	38 West	108	36	0	14-200' Beach Seine
	9-66169	9/15/76	34 East	203	14	10/28/76	34 East	194	43	0	12-100' Beach Seine
	5-28615	10/27/75	34 East	123	14	10/29/76	34 East	130	368	0	14-200' Beach Seine
	**9-62870	6/14/76	34 East	162	12	10/29/76	34 East	159	137	0	12-100' Beach Seine
	**9-63891	9/16/76	34 East	169	12	10/29/76	34 East	163	43	0	12-100' Beach Seine
	9-70490	9/21/76	34 East	165	14	10/29/76	34 East	164	38	0	14-200' Beach Seine
	9-70499	9/21/76	34 East	180	14	10/29/76	34 East	181	38	0	14-200' Beach Seine
	9-71056	10/ 5/76	34 East	161	53	10/29/76	34 East	159	24	0	14-200' Beach Seine
	9-71077	10/ 5/76	34 East	192	53	10/29/76	34 East	190	24	0	14-200' Beach Seine
	9-72892	9/27/76	34 East	152	14	10/29/76	34 East	151	32	0	14-200' Beach Seine
	9-72895	9/27/76	34 East	160	14	10/29/76	34 East	155	32	0	14-200' Beach Seine
	9-73454	10/ 5/76	32 East	168	12	10/29/76	34 East	172	24	-2	14-200' Beach Seine
	9-73741	10/12/76	34 East	173	53	10/29/76	34 East	171	17	0	14-200' Beach Seine
	9-75711	10/ 7/76	34 East	186	53	10/29/76	34 East	185	22	0	14-200' Beach Seine
November	5-32346	5/26/76	27 West	123	12	11/ 1/76	27 West	136	159	0	12-100' Beach Seine
	**5-34462	9/ 2/76	26 West	118	12	11/ 1/76	26 West	119	60	0	12-100' Beach Seine
	5-40111	9/22/76	38 West	113	12	11/ 1/76	38 West	108	40	0	14-200' Beach Seine
	5-40949	9/23/76	40 West	125	14	11/ 2/76	40 West	125	40	0	14-200' Beach Seine
	9-67712	9/16/76	33 East	191	14	11/ 2/76	34 East	189	47	-1	14-200' Beach Seine
	**9-70660	9/24/76	34 East	176	53	11/ 2/76	34 East	173	39	0	14-200' Beach Seine
	**9-84106	10/25/76	34 East	194	14	11/ 2/76	34 East	196	8	0	14-200' Beach Seine
	9-84116	10/25/76	34 East	190	14	11/ 2/76	34 East	188	8	0	14-200' Beach Seine
	9-84129	10/25/76	34 East	170	14	11/ 2/76	34 East	171	8	0	14-200' Beach Seine
	5-45221	10/25/76	35 East	127	53	11/ 3/76	30 West	124	29	5	64-Epibenthic Sled
	**9-60685	6/15/76	34 East	169	12	11/ 3/76	34 East	165	141	0	14-200' Beach Seine
	9-69831	9/27/76	34 East	175	14	11/ 3/76	34 East	176	37	0	14-200' Beach Seine
	9-72320	9/27/76	34 East	181	14	11/ 3/76	34 East	183	37	0	14-200' Beach Seine
	5-28890	10/29/75	34 East	118	14	11/ 4/76	42 East	124	372	-8	99-Indian Point
	5-30341	11/ 5/75	34 East	122	14	11/ 4/76	34 East	136	365	0	14-200' Beach Seine
	5-39800	9/16/76	34 East	140	14	11/ 4/76	34 East	136	49	0	14-200' Beach Seine
	5-39801	9/16/76	34 East	128	14	11/ 4/76	34 East	123	49	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-49 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	9-41889	10/24/75	34 East	188	14	11/ 4/76	34 East	182	377	0	14-200' Beach Seine
	9-66298	9/16/76	34 East	162	14	11/ 4/76	34 East	158	49	0	14-200' Beach Seine
	9-70352	9/16/76	34 East	168	14	11/ 4/76	34 East	167	49	0	14-200' Beach Seine
	9-70519	9/27/76	34 East	170	12	11/ 4/76	34 East	167	38	0	14-200' Beach Seine
	**9-72895	9/27/76	34 East	160	14	11/ 4/76	34 East	157	38	0	14-200' Beach Seine
	9-73155	10/ 1/76	32 West	181	12	11/ 4/76	32 West		34	0	98-Sports Fisherman
	9-76659	10/29/76	34 East	174	14	11/ 4/76	33 East	172	6	1	14-200' Beach Seine
	**9-84106	10/25/76	34 East	194	14	11/ 4/76	34 East	200	10	0	14-200' Beach Seine
	9-84109	10/25/76	34 East	185	14	11/ 4/76	34 East	183	10	0	14-200' Beach Seine
	9-61845	5/26/76	84 West	155	14	11/ 9/76	42 East	154	167	42	99-Indian Point
	5-47686	11/10/76	40 West	125	14	11/12/76	42 East	123	2	-2	99-Indian Point
	9-15402	4/10/74	42 East	158	5	11/16/76	66 West	167	951	-24	96-Danskammer
	9-44017	9/29/75	34 East	181	53	11/17/76	East River	168	415		94-other
	9-67951	9/10/76	38 East	163	12	11/17/76	38 East	162	68	0	12-100' Beach Seine
	9-65603	9/21/76	38 East	191	12	11/19/76	38 East	185	59	0	14-200' Beach Seine
	9-76898	10/14/76	38 East	173	14	11/19/76	38 East	165	36	0	14-200' Beach Seine
	9-73575	10/22/76	39 West	219	12	11/23/76	37 West	218	32	2	97-Bowline
	9-72772	10/ 6/76	38 East	170	12	11/24/76	37 West	171	49	1	97-Bowline
	9-73279	9/28/76	27 West	174	14	11/25/76	37 West	171	58	-10	97-Bowline
	9-52138	11/ 6/75	34 East	178	14	11/27/76	37 West	176	387	-3	97-Bowline
	9-75239	10/ 5/76	34 East	156	14	11/27/76	37 West	158	53	-3	97-Bowline
	5-45274	10/ 5/76	35 East	120	53	11/28/76	37 West	123	54	-2	97-Bowline
	9-59748	9/ 9/76	39 East	174	53	11/28/76	42 East	178	80	-3	99-Indian Point
	9-72466	10/ 4/76	60 East	192	5	11/28/76	East River		55		98-Sports Fisherman
	5-40361	10/ 8/76	39 East	133	12	11/29/76	37 West	129	52	2	97-Bowline
	5-42209	9/29/76	39 East	113	12	11/29/76	37 West		61	2	97-Bowline
December	5-33446	5/28/76	57 West	119	14	12/ 6/76	37 West	124	192	20	97-Bowline
	5-34784	6/11/76	29 West	137	12	12/ 7/76	22 West	145	179	7	1-Bottom Trawl
	5-39284	9/16/76	39 East	109	14	12/ 7/76	42 East	108	82	-3	99-Indian Point
	5-45245	10/ 5/76	35 East	110	53	12/ 7/76	42 East	110	63	-7	99-Indian Point
	9-85104	11/30/76	31 West	198	64	12/ 7/76	22 West	203	7	9	1-Bottom Trawl
	9-71781	9/28/76	29 West	172	14	12/ 8/76	41 West	172	71	-12	95-Lovett
	5-31632	5/25/76	58 East	146	14	12/ 9/76	37 West	147	198	21	97-Bowline
	9-70522	9/27/76	34 East	175	12	12/ 9/76	37 West	170	73	-3	97-Bowline
	9-38269	6/ 5/75	57 West	156	12	12/10/76	42 East	159	554	15	99-Indian Point
	5-32453	5/19/76	110 East	144	12	12/16/76	66 West	142	211	44	96-Danskammer
	5-44333	10/ 5/76	35 East	130	53	12/18/76	37 West	125	74	-2	97-Bowline
	5-43428	10/14/76	38 West	115	14	12/20/76	42 East	112	67	-4	99-Indian Point
	5-46192	10/ 7/76	36 East	117	14	12/21/76	42 East	162	75	-6	99-Indian Point
	5-46712	10/25/76	40 West	135	14	12/21/76	37 West	132	57	3	97-Bowline
	9-73112	10/ 1/76	27 West	172	12	12/21/76	37 West	163	81	-10	97-Bowline
	9-72997	9/23/76	34 East	196	14	12/22/76	37 West	195	90	-3	97-Bowline
	5-44376	10/ 5/76	35 East	115	53	12/23/76	42 East	114	79	-7	99-Indian Point
	5-31614	5/25/76	57 East	128	14	12/25/76	42 East	135	214	15	99-Indian Point
	9-40180	9/ 8/75	39 East	184	12	12/25/76	42 East	180	474	-3	99-Indian Point
	9-71488	10/11/76	34 East	183	14	12/25/76	42 East		75	-8	99-Indian Point
	9-72985	9/23/76	34 East	156	14	12/26/76	42 East	155	94	-8	99-Indian Point
	9-74800	10/ 4/76	34 East	176	14	12/26/76	42 East	183	83	-8	99-Indian point
	9-67793	9/20/76	39 East	182	5	12/29/76	42 East	180	100	-3	99-Indian Point
	5-37910	9/ 9/76	99 East	101	12	12/31/76	42 East	101	113	57	99-Indian Point
	9-65434	9/13/76	36 West	161	14	12/31/76	42 East	157	109	-6	99-Indian Point
	9-74978	10/ 8/76	34 East	188	14	12/31/76	42 East	182	84	-8	99-Indian Point

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-50

Release and Recapture Data for Tagged White Perch Recaptured January - June 1977

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
January	5-46746	10/28/76	38 West	113	14	1/ 0/77	42 East	111	63	-4	99-Indian Point
	9-60846	5/28/76	57 West	157	14	1/ 0/77	42 East	155	216	15	99-Indian Point
	9-63868	9/16/76	34 East	189	12	1/ 0/77	42 East	182	105	-8	99-Indian Point
	9-67538	9/24/76	35 East	209	53	1/ 0/77	42 East	202	97	-7	99-Indian Point
	5-43791	10/12/76	34 East	128	53	1/ 1/77	42 East	130	80	-8	99-Indian Point
	9-68899	10/21/76	34 East	156	64	1/ 1/77	42 East	154	71	-8	99-Indian Point
	9-75496	10/18/76	27 West	168	12	1/ 1/77	42 East	162	74	-15	99-Indian Point
	9-53508	11/20/75	28 West	156	64	1/ 3/77	42 East	155	409	-14	99-Indian Point
	9-68034	9/20/76	34 East	154	12	1/ 3/77	42 East	151	104	-8	99-Indian Point
	9-75371	10/ 5/76	34 East	184	14	1/ 3/77	42 East	184	89	-8	99-Indian Point
	9-84110	10/25/76	34 East	175	14	1/ 3/77	42 East	171	69	-8	99-Indian Point
	9-68978	9/ 9/76	32 West	162	64	1/ 4/77	42 East	160	116	-10	99-Indian Point
	9-70710	9/21/76	118 West	157	12	1/ 4/77	42 East	155	104	76	99-Indian Point
	9-70750	9/28/76	39 East	176	14	1/ 4/77	42 East	173	97	-3	99-Indian Point
	9-75192	10/ 5/76	34 East	174	14	1/ 4/77	42 East	168	90	-8	99-Indian Point
	9-76674	11/ 2/76	34 East	152	14	1/ 4/77	42 East	151	62	-8	99-Indian Point
	9-83817	10/15/76	33 East	176	53	1/ 4/77	42 East	174	80	-9	99-Indian Point
	5-42818	10/13/76	35 East	116	14	1/ 5/77	41 West	113	83	-6	95-Lovett
	9-76700	11/ 2/76	34 East	187	14	1/ 5/77	37 West	186	63	-3	94-Other
	5-41542	9/27/76	39 East	110	12	1/ 6/77	42 East	103	100	-3	99-Indian Point
	5-45250	10/ 5/76	35 East	112	53	1/ 6/77	42 East	114	92	-7	99-Indian Point
	5-46344	10/ 8/76	40 East	140	14	1/ 6/77	42 East	138	89	-2	99-Indian Point
	9-50901	11/ 5/75	33 East	171	14	1/ 6/77	42 East	168	427	-9	99-Indian Point
	9-73273	9/28/76	27 West	180	14	1/ 6/77	42 East	179	99	-15	99-Indian Point
	9-74378	11/29/76	30 West	216	64	1/ 6/77	42 East	213	37	-12	99-Indian Point
	9-75227	10/ 5/76	34 East	181	14	1/ 6/77	42 East	182	92	-8	99-Indian Point
	5-37654	9/13/76	39 East	126	5	1/ 7/77	42 East		115	-3	99-Indian Point
	9-44985	11/ 3/75	38 West	158	12	1/ 7/77	42 East	158	430	-4	99-Indian Point
	9-62719	5/28/76	57 West	158	14	1/ 7/77	42 East	154	223	15	99-Indian Point
	9-67712	9/16/76	33 East	191	14	1/ 7/77	42 East	191	112	-9	99-Indian Point
	9-74458	10/19/76	40 East	157	14	1/ 7/77	42 East	150	79	-2	99-Indian Point
	9-85016	11/29/76	30 West	171	64	1/ 7/77	42 East	165	38	-12	99-Indian Point
	9-42669	11/11/75	15 West	174	12	1/ 8/77	42 East	175	423	-27	99-Indian Point
	9-52578	11/18/75	33 East	175	14	1/ 8/77	42 East	176	416	-9	99-Indian Point
	9-59274	5/14/76	58 East	155	14	1/ 8/77	42 East	153	238	16	99-Indian Point
	9-62198	5/26/76	58 West	166	12	1/ 8/77	42 East	163	226	16	99-Indian Point
	9-66856	9/13/76	34 East	192	14	1/ 8/77	42 East	191	116	-8	99-Indian Point
	9-56128	4/22/76	59 East	158	12	1/ 9/77	42 East	155	261	17	99-Indian Point
	9-57882	5/ 5/76	40 West	172	12	1/ 9/77	42 East	167	248	-2	99-Indian Point
	5-29327	11/19/75	34 East	140	14	1/10/77	42 East	141	417	-8	99-Indian Point
	5-39700	9/15/76	35 East	125	14	1/10/77	42 East	121	116	-7	99-Indian Point
	5-43657	10/18/76	40 East	122	14	1/10/77	42 East	124	83	-2	99-Indian Point
	5-44822	10/ 6/76	39 East	122	14	1/10/77	42 East	121	95	-3	99-Indian Point
	5-45921	10/11/76	39 West	123	12	1/10/77	37 West		90	2	97-Bowline
	9-72412	9/29/76	39 East	153	12	1/10/77	42 East	154	102	-3	99-Indian Point
	9-72650	9/29/76	34 East	191	12	1/10/77	42 East	184	102	-8	99-Indian Point
	9-74077	10/18/76	37 East	175	14	1/10/77	42 East	176	83	-5	99-Indian Point
	9-62083	5/27/76	74 West	150	27	1/11/77	42 East	151	228	32	99-Indian Point
	9-62927	5/29/76	84 West	172	14	1/11/77	42 East	170	226	42	99-Indian Point
	9-71710	9/28/76	29 West	153	14	1/11/77	42 East	150	104	-13	99-Indian Point
	9-83840	10/15/76	33 East	170	53	1/11/77	42 East	170	87	-9	99-Indian Point
	9-56228	4/ 8/76	69 East	167	12	1/12/77	42 East	165	278	27	99-Indian Point
	9-73591	10/29/76	38 East	196	14	1/12/77	37 West	187	74	1	94-Other
	9-74025	10/18/76	37 East	195	14	1/12/77	42 East	198	85	-5	99-Indian Point
	5-32721	5/27/76	74 West	140	27	1/13/77	42 East	137	230	32	99-Indian Point
	9-48539	10/14/75	61 East	181	12	1/13/77	42 East	177	456	19	99-Indian Point
	9-56114	4/14/76	30 West	158	12	1/13/77	37 West	159	273	-7	94-Other
	9-62091	5/27/76	74 West	171	27	1/13/77	42 East	168	230	32	99-Indian Point
	9-62454	5/29/76	78 East	166	12	1/13/77	42 East	162	228	36	99-Indian Point
	9-63207	5/29/76	87 West	151	14	1/13/77	42 East	151	228	45	99-Indian Point
	9-72777	9/27/76	40 East	154	14	1/13/77	42 East	151	107	-2	99-Indian Point
	5-30595	5/17/76	34 East	138	12	1/14/77	42 East	138	241	-8	99-Indian Point
	5-38981	9/14/76	34 East	119	53	1/14/77	42 East	119	121	-8	99-Indian Point
	9-42550	10/ 7/75	33 East	190	14	1/14/77	42 East	189	464	-9	99-Indian Point
	9-44761	11/12/75	36 East	164	12	1/14/77	42 East	161	428	-6	99-Indian Point
	9-50198	10/28/75	57 West	172	12	1/14/77	42 East	155	443	15	99-Indian Point
	9-57617	5/24/76	36 East	168	5	1/14/77	42 East	155	234	-6	99-Indian Point
	9-65239	6/17/76	36 East	160	14	1/14/77	42 East	157	210	-6	99-Indian Point
	9-74110	10/19/76	34 East	152	14	1/14/77	42 East	150	86	-8	99-Indian Point
	9-76809	10/12/76	40 West	191	14	1/14/77	37 West	188	93	3	94-Other
	9-76843	10/11/76	34 East	178	14	1/14/77	42 East	177	94	-8	99-Indian Point
	9-85342	12/ 1/76	30 West	155	64	1/14/77	37 West	150	43	-7	94-Other
	5-37980	9/ 9/76	99 East	106	12	1/15/77	42 East	108	127	57	99-Indian Point
	5-38622	9/14/76	36 West	115	14	1/15/77	42 East	116	122	-6	99-Indian Point
	5-40378	10/12/76	52 East	139	12	1/15/77	42 East	129	94	10	99-Indian Point
	5-44786	10/ 6/76	39 East	124	14	1/15/77	42 East	126	100	-3	99-Indian Point
	9-65413	9/13/76	36 West	163	14	1/15/77	42 East	157	123	-6	99-Indian Point
	9-69578	10/ 7/76	29 West	155	64	1/15/77	42 East	154	99	-13	99-Indian Point

*Minus sign indicates movement north of release site; no sign indicates southward movement.

Table C-50 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
	5-37100	9/13/76	42 West	112	12	1/16/77	42 East	114	124	0	99-Indian Point
	5-37578	9/10/76	36 West	104	53	1/16/77	42 East	109	127	-6	99-Indian Point
	5-39252	9/16/76	35 West	116	14	1/16/77	42 East	116	121	-7	99-Indian Point
	5-42400	9/29/76	35 East	110	53	1/16/77	42 East	110	108	-7	99-Indian Point
	5-43507	10/19/76	40 East	105	14	1/16/77	42 East	105	88	-2	99-Indian Point
	9-63197	9/16/76	57 West	175	5	1/16/77	42 East	175	121	15	99-Indian Point
	9-63818	9/ 2/76	37 West	152	14	1/16/77	42 East	152	135	-5	99-Indian Point
	9-65309	9/20/76	57 West	176	5	1/16/77	42 East	200	117	15	99-Indian Point
	5-44381	10/ 5/76	35 East	127	53	1/17/77	42 East	124	103	-7	99-Indian Point
	9-53952	11/20/75	28 West	194	64	1/17/77	42 East	193	423	-14	99-Indian Point
	5-31663	5/13/76	69 East	147	14	1/18/77	42 East	150	249	27	99-Indian Point
	9-60870	5/25/76	59 East	163	14	1/18/77	42 East	162	237	17	99-Indian Point
	9-66666	9/ 2/76	34 East	176	12	1/18/77	42 East	170	137	-8	99-Indian Point
	9-75554	10/ 5/76	35 East	155	53	1/18/77	42 East	158	104	-7	99-Indian Point
	9-76958	10/19/76	34 East	191	14	1/18/77	42 East	186	90	-8	99-Indian Point
	5-38130	9/ 9/76	33 East	104	53	1/19/77	42 East	104	131	-9	99-Indian Point
	9-62472	5/29/76	81 East	155	12	1/19/77	42 East	150	234	39	99-Indian Point
	9-67203	11/12/76	34 East	187	14	1/19/77	37 West	188	67	-3	97-Bowline
	5-39757	9/16/76	34 East	112	14	1/20/77	42 East	110	125	-8	99-Indian Point
	9-66869	9/21/76	41 East	176	0	1/20/77	42 East	168	120	-1	99-Indian Point
	9-72499	10/ 8/76	34 East	185	14	1/20/77	42 East	184	103	-8	99-Indian Point
	9-76670	10/29/76	34 East	184	14	1/20/77	42 East	178	82	-8	99-Indian Point
	5-42850	10/13/76	35 East	117	14	1/21/77	42 East	112	99	-7	99-Indian Point
	5-47703	11/ 1/76	30 West	102	12	1/21/77	42 East	101	80	-12	99-Indian Point
	9-40178	9/ 8/75	39 East	154	12	1/21/77	42 East	152	500	-3	99-Indian Point
	9-63980	6/ 2/76	54 East	169	14	1/21/77	42 East	164	232	12	99-Indian Point
	9-66827	9/ 7/76	34 East	175	14	1/21/77	42 East	172	135	-8	99-Indian Point
	9-67204	11/12/76	34 East	193	14	1/21/77	42 East	190	69	-8	99-Indian Point
	9-72932	9/23/76	34 East	182	14	1/21/77	42 East	177	119	-8	99-Indian Point
	5-38093	9/13/76	36 West	112	14	1/22/77	42 East	106	130	-6	99-Indian Point
	9-42255	10/ 9/75	40 East	182	5	1/22/77	42 East	177	470	-2	99-Indian Point
	9-61895	5/26/76	86 West	182	14	1/22/77	42 East	180	240	44	99-Indian Point
	9-69694	9/14/76	48 East	165	12	1/22/77	42 East	155	129	6	99-Indian Point
	9-73596	10/29/76	34 East	186	14	1/22/77	42 East	185	84	-8	99-Indian Point
	5-44199	10/14/76	43 East	122	14	1/23/77	42 East	118	100	1	99-Indian Point
	9-68251	9/10/76	43 East	178	12	1/23/77	42 East	179	134	1	99-Indian Point
	9-84607	11/15/76	39 East	177	64	1/23/77	42 East	173	68	-3	99-Indian Point
	5-36481	10/ 1/76	26 East	118	12	1/24/77	42 East	121	114	-16	99-Indian Point
	5-39425	9/17/76	32 East	113	53	1/24/77	42 East	111	128	-10	99-Indian Point
	5-44724	10/ 6/76	39 East	127	14	1/24/77	42 East	114	109	-3	99-Indian Point
	9-40290	11/ 5/75	34 East	173	14	1/24/77	42 East	167	445	-8	99-Indian Point
	9-52864	12/18/75	35 Cntr	180	64	1/24/77	42 East	174	402	-7	99-Indian Point
	9-62462	5/29/76	78 East	152	12	1/24/77	42 East	151	239	36	99-Indian Point
	9-65195	6/14/76	34 East	166	14	1/24/77	42 East	157	223	-8	99-Indian Point
	9-67103	9/ 7/76	43 East	154	12	1/24/77	42 East	150	138	1	99-Indian Point
	9-72011	9/27/76	34 East	209	12	1/24/77	42 East	205	118	-8	99-Indian Point
	5-30227	10/22/75	34 East	137	14	1/25/77	42 East	139	460	-8	99-Indian Point
	5-37065	9/21/76	38 East	115	12	1/25/77	42 East	113	125	-4	99-Indian Point
	5-37329	9/10/76	39 East	141	12	1/25/77	42 East	143	136	-3	99-Indian Point
	5-41727	9/28/76	39 East	103	14	1/25/77	42 East	103	118	-3	99-Indian Point
	5-42413	9/29/76	35 East	121	53	1/25/77	42 East	120	117	-7	99-Indian Point
	5-43349	10/ 4/76	36 East	128	14	1/25/77	42 East	131	112	-6	99-Indian Point
	5-45504	10/15/76	34 East	122	12	1/25/77	42 East	122	101	-8	99-Indian Point
	5-46159	10/ 7/76	36 East	117	14	1/25/77	42 East	116	109	-6	99-Indian Point
	9-16708	4/30/74	57 West	150	12	1/25/77	42 East	153	1001	-15	99-Indian Point
	9-48482	10/14/75	33 East	150	14	1/25/77	42 East	145	468	-9	99-Indian Point
	9-59428	9/ 8/76	41 East	180	0	1/25/77	42 East	175	138	-1	99-Indian Point
	9-60533	9/22/76	26 East	183	12	1/25/77	42 East	158	124	-16	99-Indian Point
	9-62846	6/ 7/76	34 East	170	12	1/25/77	42 East	167	231	-8	99-Indian Point
	9-70506	9/27/76	34 East	173	12	1/25/77	42 East	179	119	-8	99-Indian Point
	9-71469	10/11/76	34 East	156	14	1/25/77	42 East	153	105	-8	99-Indian Point
	9-72005	9/27/76	35 East	167	12	1/25/77	42 East	169	119	-7	99-Indian Point
	9-76889	10/14/76	38 East	159	14	1/25/77	42 East	162	102	-4	99-Indian Point
	9-53237	11/13/75	37 Cntr	162	64	1/26/77	41 West	161	439	-4	95-Lovett
	9-60882	5/28/76	57 West	167	14	1/26/77	37 West	164	242	20	97-Bowline
	9-84325	11/16/76	34 East	165	64	1/26/77	42 East	165	70	-8	99-Indian Point
	5-41313	9/21/76	24 West	131	14	1/27/77	42 East	128	127	-18	99-Indian Point
	5-44325	10/ 5/76	35 East	120	53	1/27/77	42 East	121	113	-7	99-Indian Point
	9-44444	10/23/75	35 East	190	53	1/27/77	42 East	192	461	-7	99-Indian Point
	9-46316	10/30/75	53 East	159	14	1/27/77	42 East	158	454	11	99-Indian Point
	9-58990	4/21/76	41 West	170	5	1/28/77	42 East	172	281	-1	99-Indian Point
	9-68760	9/10/76	29 West	174	64	1/28/77	42 East	180	139	-13	99-Indian Point
	9-72558	9/28/76	15 West	172	12	1/28/77	42 East	180	121	-27	99-Indian Point
	9-54662	12/ 2/75	30 Cntr	167	64	1/29/77	37 West	166	423	-7	97-Bowline
	5-29353	11/20/75	39 East	122	14	1/31/77	37 West	125	437	2	97-Bowline
	5-43162	11/22/76	52 East	122	12	1/31/77	42 East	123	69	10	99-Indian Point

*Minus sign indicates movement north of release site; no sign indicates southward movement.

Table C-50 (Contd)

			Releases				Recovery				
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
February	5-38023	9/ 9/76	33 East	107	53	2/ 2/77	42 East	108	145	-9	99-Indian Point
	5-41743	9/28/76	39 East	112	14	2/ 7/77	42 East		131	-3	99-Indian Point
	5-44154	10/ 5/76	29 West	119	12	2/ 7/77	37 West		124	-8	97-Bowline
	5-37252	9/ 7/76	26 West	118	12	2/ 8/77	42 East	113	153	-16	99-Indian Point
	9-61629	5/27/76	80 West	158	14	2/ 8/77	42 East	152	256	38	99-Indian Point
	5-26861	11/ 7/75	34 East	129	14	2/ 9/77	37 West	135	459	-3	97-Bowline
	9-41897	10/30/75	36 East	154	14	2/ 9/77	37 West	156	467	-1	97-Bowline
	9-36783	6/ 5/75	57 West	175	5	2/12/77	37 West	183	617	20	97-Bowline
	9-53888	11/20/75	28 West	178	64	2/16/77	41 West	175	453	-13	95-Lovett
	5-43456	10/14/76	43 East	122	14	2/19/77	37 West		127	6	97-Bowline
	9-71018	10/ 4/76	36 East	154	14	2/20/77	42 East		138	-6	99-Indian Point
	5-44149	10/ 5/76	29 West	121	12	2/21/77	42 East	118	138	-13	99-Indian Point
	9-46296	10/14/75	39 East	153	14	2/21/77	42 East	151	495	-3	99-Indian Point
	9-74026	10/18/76	37 East	235	14	2/21/77	37 West	226	125	0	97-Bowline
	5-40980	9/23/76	42 East	114	14	2/22/77	42 East	114	151	0	99-Indian Point
	5-43398	10/ 4/76	36 East	108	14	2/22/77	42 East	113	140	-6	99-Indian Point
	5-45019	10/ 5/76	35 East	109	53	2/22/77	42 East	109	139	-7	99-Indian Point
	5-38534	9/14/76	34 East	111	53	2/23/77	42 East	111	161	-8	99-Indian Point
	5-39886	9/20/76	39 West	109	14	2/23/77	42 East	113	155	-3	99-Indian Point
	5-40085	9/22/76	27 West	104	12	2/23/77	42 East	104	153	-15	99-Indian Point
	5-45163	10/ 5/76	35 East	112	53	2/23/77	42 East	122	140	-7	99-Indain Point
	5-45266	10/ 5/76	35 East	124	53	2/23/77	41 West		140	-6	95-Lovett
	9-65011	9/ 2/76	26 West	185	12	2/23/77	42 East	184	173	-16	99-Indian Point
	9-66565	9/ 2/76	38 East	162	14	2/23/77	42 East	162	173	-4	99-Indian Point
	9-67176	9/13/76	29 West	189	12	2/23/77	41 West	185	162	-12	95-Lovett
	9-70681	9/24/76	34 East	164	53	2/23/77	42 East	162	151	-8	99-Indian Point
	9-75710	10/ 7/76	34 East	202	53	2/23/77	37 West	202	138	-3	97-Bowline
	5-41766	9/27/76	54 East	108	12	2/24/77	42 East	103	149	12	99-Indian Point
	5-41856	11/ 3/76	40 East	113	14	2/24/77	42 East	113	112	-2	99-Indian Point
	5-44083	9/30/76	35 West	102	53	2/24/77	42 East	106	146	-7	99-Indian Point
	5-44588	10/18/76	26 East	127	12	2/24/77	42 East	126	128	-16	99-Indian Point
	5-45877	11/10/76	40 West	130	14	2/24/77	42 East	123	105	-2	99-Indian Point
	5-45922	10/11/76	39 West	113	12	2/24/77	42 East	113	135	-3	99-Indian Point
	9-63327	5/29/76	83 West	177	14	2/24/77	42 East	178	270	41	99-Indian Point
	9-72713	10/28/76	48 West	156	12	2/24/77	42 East	151	118	6	99-Indian Point
	5-41488	9/22/76	36 West	120	14	2/25/77	42 East	122	155	-6	99-Indian Point
	5-45078	10/ 5/76	35 East	121	53	2/25/77	42 East	123	142	-7	99-Indian Point
	5-47377	10/15/76	35 East	119	53	2/25/77	42 East	122	132	-7	99-Indian Point
	9-73524	10/ 8/76	34 East	181	14	2/25/77	42 East	175	139	-8	99-Indian Point
	5-39407	9/20/76	40 West	108	5	2/26/77	42 East	105	158	-2	99-Indian Point
	9-75502	10/ 5/76	35 East	188	53	2/26/77	42 East	183	143	-7	99-Indian Point
	9-60164	5/11/76	49 West	220	12	2/28/77	37 West	217	292	12	97-Bowline
March	5-40194	9/28/76	51 East	117	12	3/ 1/77	42 East	113	153	9	99-Indian Point
	5-45045	10/ 5/76	35 East	120	53	3/ 4/77	42 East	123	149	-7	99-Indian Point
	9-46399	10/15/75	36 West	169	14	3/ 4/77	42 East	173	505	-6	99-Indian Point
	5-39248	9/16/76	35 West	114	14	3/11/77	42 East	117	175	-7	99-Indian Point
	5-40283	9/29/76	40 East	105	12	3/16/77	41 West		167	-1	95-Lovett
	5-25533	9/ 4/75	34 East	134	12	3/28/77	35 East		570	-1	88-88
	9-66366	9/24/76	35 East	214	53	3/29/77	35 East	216	185	0	61-900' Haul Seine
	**9-83855	10/15/76	35 East	197	53	3/29/77	35 East	197	164	0	61-900' Haul Seine
April	9-62959	5/29/76	84 West	158	14	4/10/77	42 East	154	315	42	99-Indian Point
	9-58242	4/23/76	39 East	186	5	4/12/77	14 West	185	353	25	12-100'Beach Seine
	9-59754	9/ 9/76	33 East	193	53	4/12/77	33 East		214	0	98-Sports Fisherman
	9-66809	9/ 2/76	60 East	152	5	4/12/77	42 East	147	221	18	99-Indian Point
	9-72177	11/ 2/76	30 West	172	64	4/14/77	31 West		162	-1	98-Sports Fisherman
	5-41815	11/ 2/76	40 West	128	14	4/16/77	37 Cntr		164	3	98-Sports Fisherman
	9-71248	9/23/76	38 East	181	64	4/16/77	37 Cntr		204	1	98-Sports Fisherman
	9-71715	9/28/76	29 West	191	14	4/16/77	37 Cntr		199	-8	98-Sports Fisherman
	9-75705	10/ 7/76	36 West	150	53	4/16/77	37 Cntr		190	-1	98-Sports Fisherman
	9-85097	11/30/76	30 West	187	64	4/16/77	37 Cntr		136	-7	98-Sports Fisherman
	9-68536	9/15/76	22 East	183	12	4/17/77	18 East		213	4	98-Sports Fisherman
	9-72449	10/ 4/76	38 East	178	5	4/17/77	26 West		194	12	93-Commercial Fisherman
	9-76201	11/17/76	32 East	198	12	4/19/77	32 East	197	152	0	12-100' Beach Seine
	9-68319	10/ 5/76	35 East	160	53	4/20/77	35 East		196	0	87-E.A.I.
	9-68377	10/ 5/76	35 East	170	53	4/20/77	35 East		196	0	87-E.A.I.
	9-75535	10/ 5/76	35 East	157	53	4/20/77	35 East	155	196	0	61-900' Haul Seine
	9-75570	10/ 5/76	35 East	175	53	4/20/77	35 East		196	0	87-E.A.I.
	5-36652	9/ 2/76	37 West	141	14	4/21/77	14 West	140	230	23	14-200' Beach Seine
	**5-38881	9/21/76	41 East	135	0	4/21/77	32 East	129	211	9	38-300' Gill Net
	**5-38881	9/21/76	41 East	135	0	4/21/77	32 East	131	211	9	38-300' Gill Net
	9-85830	4/12/77	14 West	185	12	4/21/77	14 West	184	9	0	14-200' Beach Seine
	9-86972	4/20/77	15 West	220	12	4/21/77	16 West	219	1	-1	14-200' Beach Seine
	5-40626	9/28/76	29 West	121	14	4/22/77	29 West	120	205	0	12-100' Beach Seine
	9-69883	9/27/76	34 East	180	14	4/22/77	34 East	180	206	0	12-100' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.
**Multiple recaptures.

Table C-50 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
	9-71311	9/22/76	34 East	179	14	4/22/77	34 East	176	211	0	12-100' Beach Seine
	9-75514	10/ 5/76	35 East	153	53	4/22/77	35 East		198	0	87-E.A.I.
	**9-83855	10/15/76	35 East	197	53	4/22/77	35 East		188	0	87-E.A.I.
	**9-86916	4/18/77	34 East	174	12	4/22/77	34 East	174	4	0	12-100' Beach Seine
	9-86924	4/18/77	34 East	167	12	4/22/77	34 East	165	4	0	12-100' Beach Seine
	**9-67553	9/24/76	35 East	204	53	4/25/77	35 East		212	0	87-E.A.I.
	9-67714	9/16/76	33 East	180	14	4/25/77	34 East	180	220	-1	14-200' Beach Seine
	9-84113	10/25/76	34 East	180	14	4/25/77	34 East	185	181	0	14-200' Beach Seine
	5-42773	9/29/76	23 East	134	12	4/27/77	24 East	139	209	-1	14-200' Beach Seine
	9-86902	4/18/77	27 West	161	12	4/27/77	27 West	160	9	0	14-200' Beach Seine
	9-85790	4/ 5/77	15 West	195	12	4/28/77	10 West		23	5	98-Sports Fisherman
	9-85858	4/ 7/77	26 West	175	12	4/28/77	14 West	188	21	12	12-100' Beach Seine
	9-86666	4/21/77	14 West	179	14	4/28/77	14 West	178	7	0	12-100' Beach Seine
	9-86914	4/18/77	34 East	173	12	4/28/77	34 East	169	10	0	12-100' Beach Seine
	9-87322	4/21/77	16 West	210	14	4/28/77	16 West	209	7	0	12-100' Beach Seine
	5-37918	9/ 9/76	99 East	149	12	4/29/77	99 East		231	0	98-Sports Fisherman
	9-86742	4/19/77	16 West	175	12	4/29/77	26 West	185	10	-10	12-100' Beach Seine
May	9-84839	11/ 4/76	30 West	155	64	5/ 0/77	39		176	-9	93-Commercial Fisherman
	9-86660	4/21/77	14 West	217	14	5/ 1/77	14 West		10	0	98-Sports Fisherman
	5-49949	4/27/77	94 West	104	12	5/ 3/77	42 East	109	6	52	99-Indian Point
	5-30658	4/22/76	69 East	142	12	5/ 4/77	42 East	139	376	27	99-Indian Point
	9-86680	4/21/77	14 West	185	14	5/ 4/77	66 West	182	13	-52	96-Danskammer
	5-27762	10/27/75	53 West	122	12	5/ 5/77	49 West	132	555	4	12-100' Beach Seine
	5-31404	6/ 8/76	42 West	137	12	5/ 5/77	42 East	140	330	0	99-Indian Point
	9-70672	9/27/76	39 East	165	14	5/ 5/77	39 East	167	219	0	87-E.A.I.
	9-70678	9/24/76	34 East	178	53	5/ 5/77	39 East	165	222	-5	87-E.A.I.
	5-49589	4/27/77	96 West	115	12	5/ 6/77	42 East	120	9	54	99-Indian Point
	5-37090	9/22/76	47 West	122	12	5/ 8/77	42 East	121	227	5	99-Indian Point
	9-86456	4/15/77	33 East	165	5	5/ 8/77	17 East		23	16	98-Sports Fisherman
	5-35129	9/ 7/76	34 East	130	14	5/ 9/77	33 East	129	243	1	14-200' Beach Seine
	**9-86916	4/18/77	34 East	174	12	5/ 9/77	34 East	170	21	0	14-200' Beach Seine
	9-86920	4/18/77	34 East	183	12	5/ 9/77	34 East	182	21	0	14-200' Beach Seine
	9-86922	4/18/77	34 East	162	12	5/ 9/77	34 East	159	21	0	14-200' Beach Seine
	9-87021	4/22/77	34 East	197	12	5/ 9/77	34 East	196	17	0	14-200' Beach Seine
	5-49967	4/28/77	78 West	149	12	5/10/77	66 West	147	12	12	96-Danskammer
	9-71377	9/22/76	34 East	192	14	5/10/77	34 East	185	229	0	14-200' Beach Seine
	9-86311	4/20/77	28 East	163	12	5/10/77	29 East		20	-1	98-Sports Fisherman
	9-86392	4/28/77	18 East	171	12	5/10/77	18 East	171	12	0	12-100' Beach Seine
	9-87045	4/22/77	34 East	172	12	5/10/77	34 East	170	18	0	14-200' Beach Seine
	9-87054	4/22/77	34 East	177	12	5/10/77	34 East	175	18	0	14-200' Beach Seine
	5-41954	10/11/76	58 West	119	12	5/11/77	58 West	117	211	0	12-100' Beach Seine
	9-58801	4/26/76	38 West	167	5	5/11/77	39 East	164	379	-1	5-Box Trap
	9-86875	5/ 5/77	39 East	164	5	5/11/77	39 East	164	6	0	5-Box Trap
	5-38787	9/20/76	34 East	117	12	5/12/77	34 East	119	233	0	14-200' Beach Seine
	9-71327	9/22/76	34 East	185	14	5/12/77	34 East	184	231	0	14-200' Beach Seine
	9-74584	10/22/76	12 West	203	12	5/15/77	12 West		204	0	98-Sports Fisherman
	9-88007	5/ 5/77	27 West	163	12	5/15/77	27 West		10	0	98-Sports Fisherman
	5-37665	9/13/76	39 East	147	5	5/17/77	38 East	149	245	1	5-Box Trap
	**5-40490	9/27/76	34 East	128	14	5/17/77	34 East	126	231	0	14-200' Beach Seine
	9-70741	9/23/76	76 East	157	12	5/18/77	37 Cntr		236	39	98-Sports Fisherman
	9-85853	4/ 5/77	36 West	185	14	5/18/77	37 Cntr		43	-1	98-Sports Fisherman
	9-74544	11/ 3/76	40 East	170	14	5/21/77	99 West		198	-59	98-Sports Fisherman
	9-85720	4/ 4/77	15 West	184	12	5/21/77	57 West		47	-42	98-Sports Fisherman
	5-39940	9/21/76	34 East	118	14	5/23/77	34 East	119	243	0	12-100' Beach Seine
	**5-40490	9/27/76	34 East	128	14	5/23/77	34 East	124	237	0	12-100' Beach Seine
	9-65842	6/ 9/76	76 West	150	14	5/23/77	57 West	151	347	19	12-100' Beach Seine
	5-40425	9/24/76	34 East	123	53	5/24/77	34 East	120	241	0	14-200' Beach Seine
	9-88899	6/ 6/77	58 East	170	12	5/24/77	34 East	170	13	24	5-Box Trap
	5-26435	11/ 3/75	36 West	122	12	5/25/77	36 West	132	568	0	14-200' Beach Seine
	5-35551	9/14/76	36 West	110	12	5/25/77	36 West	115	252	0	14-200' Beach Seine
	**5-44071	9/30/76	35 West	119	53	5/25/77	36 West	119	236	-1	14-200' Beach Seine
	5-50045	5/17/77	35 West	130	14	5/25/77	35 West	129	8	0	14-200' Beach Seine
	5-49299	5/18/77	60 West	134	12	5/26/77	42 East	127	8	18	99-Indian Point
	9-73799	10/13/76	36 West	172	14	5/26/77	37 West	174	224	-1	97-Bowline
	9-87698	4/28/77	78 West	172	12	5/26/77	78 West	169	28	0	12-100' Beach Seine
	9-72083	9/27/76	34 East	170	12	5/28/77	33 East		242	1	98-Sports Fisherman
	9-85883	4/14/77	34 East	227	14	5/28/77	12 West		44	22	98-Sports Fisherman
	5-49172	5/11/77	87 West	130	12	5/29/77	42 East	123	18	45	99-Indian Point
	5-30007	10/20/75	39 East	137	14	5/31/77	42 East	140	588	-3	99-Indian Point
	5-48919	5/ 2/77	13 West	116	12	5/31/77	42 East	121	29	-29	99-Indian Point
	5-50249	5/12/77	34 East	128	14	5/31/77	34 East	122	19	0	5-Box Trap
	5-50955	5/24/77	34 East	110	5	5/31/77	42 East	103	7	-8	99-Indian Point
	5-51019	5/24/77	34 East	115	14	5/31/77	42 East	110	7	-8	99-Indian Point
	5-51050	5/25/77	36 East	122	14	5/31/77	42 East	120	6	-6	99-Indian Point
	9-65622	9/23/76	15 East	179	12	5/31/77	66 West	174	249	-51	96-Danskammer
	9-69071	10/ 6/76	28 West	180	64	5/31/77	42 East	181	236	-14	99-Indian Point

*Minus sign indicates movement north of release site; no sign indicates southward movement.
**Multiple recaptures.

Table C-50 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
June	5-49201	5/25/77	58 West	128	12	6/ 1/77	41 West		7	17	95-Lovett
	5-50590	5/25/77	34 East	123	12	6/ 1/77	41 West		7	-7	95-Lovett
	5-51511	5/26/77	34 East	109	14	6/ 1/77	42 East		6	-8	99-Indian Point
	9-86516	4/18/77	39 East	186	5	6/ 1/77	40 West		44	-1	94-Other
	9-88853	5/25/77	36 West	166	14	6/ 1/77	42 East		7	-6	99-Indian Point
	5-34439	9/ 2/76	32 East	118	12	6/ 2/77	32 East	120	272	0	12-100' Beach Seine
	5-39800	9/16/76	34 East	140	14	6/ 2/77	34 East	137	258	0	14-200' Beach Seine
	5-41877	11/ 4/76	34 East	118	14	6/ 2/77	34 East	121	209	0	14-200' Beach Seine
	5-49252	4/22/77	29 West	127	12	6/ 2/77	29 West	130	41	0	12-100' Beach Seine
	5-50235	5/11/77	39 East	125	5	6/ 2/77	42 East		22	-3	99-Indian Point
	5-51494	5/25/77	34 East	132	14	6/ 2/77	42 East		8	-8	99-Indian Point
	5-51510	5/26/77	34 East	125	14	6/ 2/77	42 East		7	-8	99-Indian Point
	9-70402	9/16/76	34 East	184	14	6/ 2/77	34 East	176	258	0	14-200' Beach Seine
	9-70753	9/28/76	39 East	189	14	6/ 2/77	42 East	188	246	-3	99-Indian Point
	9-72067	9/27/76	34 East	185	12	6/ 2/77	34 East	184	247	0	14-200' Beach Seine
	9-76208	11/23/76	39 East	176	12	6/ 2/77	39 East	179	190	0	5-Box Trap
	9-86485	4/20/77	26 West	205	12	6/ 2/77	30 West	197	43	-4	12-100' Beach Seine
	5-50793	5/26/77	80 West	149	12	6/ 3/77	42 East	138	8	38	99-Indian Point
	9-61966	5/24/76	74 West	161	12	6/ 3/77	42 East	163	374	32	99-Indian Point
	9-75458	10/18/76	27 West	171	12	6/ 4/77	42 East	170	228	-15	99-Indian Point
	5-51147	5/26/77	78 West	133	12	6/ 5/77	42 East		10	36	99-Indian Point
	5-33404	5/25/76	57 West	136	14	6/ 6/77	57 West	138	376	0	12-100' Beach Seine
	5-43862	9/30/76	57 West	108	14	6/ 6/77	57 West	111	248	0	12-100' Beach Seine
	5-50956	5/24/77	34 East	126	5	6/ 6/77	34 East	104	13	0	5-Box Trap
	9-64518	6/ 8/76	58 West	162	12	6/ 6/77	37 West	162	362	21	97-Bowline
	9-72578	10/ 5/76	34 East	170	14	6/ 6/77	37 West	170	243	-3	97-Bowline
	9-77302	10/21/76	39 West	185	64	6/ 6/77	48 East	181	227	-9	12-100' Beach Seine
	9-87751	5/10/77	34 East	161	14	6/ 6/77	34 East	160	27	0	5-Box Trap
	9-87761	5/10/77	34 East	184	14	6/ 6/77	42 East		27	-8	99-Indian Point
	9-87848	5/12/77	34 East	169	14	6/ 6/77	34 East	166	25	0	5-Box Trap
	9-70742	9/23/76	76 East	155	12	6/ 7/77	77 East	155	256	-1	14-200' Beach Seine
	9-86928	4/19/77	39 East	169	12	6/ 7/77	39 East	163	49	0	12-100' Beach Seine
	5-47104	10/20/76	40 East	113	14	6/ 8/77	40 East	113	230	0	14-200' Beach Seine
	5-50085	5/19/77	36 West	125	14	6/ 8/77	42 East		20	-6	99-Indian Point
	5-50095	5/20/77	38 East	116	5	6/ 8/77	38 East	104	19	0	5-Box Trap
	5-50246	5/11/77	39 East	149	5	6/ 8/77	38 East	143	28	1	5-Box Trap
	5-50282	6/ 1/77	51 East	147	12	6/ 8/77	51 East	145	7	0	12-100' Beach Seine
	**9-63839	9/ 2/76	39 East	184	14	6/ 8/77	38 East	182	278	1	5-Box Trap
	9-73300	9/28/76	27 West	180	14	6/ 8/77	42 East	175	252	-15	99-Indian Point
	5-51459	5/25/77	34 East	134	14	6/10/77	42 East		16	-8	99-Indian Point
	5-52430	5/31/77	38 East	120	5	6/10/77	39 East	121	10	-1	5-Box Trap
	5-52527	6/ 2/77	39 East	125	5	6/10/77	39 East	124	8	0	5-Box Trap
	5-52944	6/ 9/77	40 West	118	14	6/10/77	42 East	119	1	-2	99-Indian Point
	9-83662	11/19/76	39 East	170	14	6/10/77	96 West		202	-57	98-Sports Fisherman
	9-85759	5/10/77	121 Cntr	189	12	6/10/77	42 East		31	79	99-Indian Point
	9-87825	5/11/77	39 East	157	5	6/10/77	39 East	155	30	0	5-Box Trap
	9-92523	6/ 6/77	34 East	153	5	6/10/77	42 East	152	4	-8	99-Indian Point
	5-52260	6/ 3/77	37 East	136	12	6/11/77	42 East		8	-5	99-Indian Point
	5-50373	5/26/77	30 West	121	12	6/12/77	42 East		17	-12	99-Indian Point
	5-52258	6/ 3/77	37 East	123	12	6/12/77	42 East		9	-5	99-Indian Point
	5-52903	6/ 9/77	40 West	116	14	6/12/77	42 East		3	-2	99-Indian Point
	9-87376	5/19/77	41 East	179	12	6/12/77	43 East		24	-2	98-Sports Fisherman
	9-88984	6/ 8/77	38 East	164	5	6/12/77	42 East		4	-4	99-Indian Point
	5-34602	8/31/76	53 West	115	12	6/13/77	53 West	121	285	0	12-100' Beach Seine
	5-50078	5/19/77	36 East	127	14	6/13/77	37 East	129	25	-1	12-100' Beach Seine
	9-93297	6/ 8/77	77 West	152	14	6/13/77	42 East		5	35	99-Indian Point
	5-40150	9/27/76	35 East	110	12	6/14/77	35 East	118	259	0	14-200' Beach Seine
	**5-40452	9/24/76	34 East	147	53	6/14/77	34 East	149	262	0	14-200' Beach Seine
	5-45254	10/ 5/76	35 East	129	53	6/14/77	35 East	129	251	0	12-100' Beach Seine
	5-49752	5/27/77	35 East	123	5	6/14/77	36 East	119	18	-1	14-200' Beach Seine
	5-51965	6/13/77	34 East	145	5	6/14/77	32 East		1	2	88-88
	9-70301	9/16/76	34 East	169	14	6/14/77	34 East	165	270	0	12-100' Beach Seine
	9-70440	9/16/76	34 East	171	14	6/14/77	34 East	171	270	0	12-100' Beach Seine
	9-70455	9/20/76	34 East	167	14	6/14/77	35 East	164	266	-1	14-200' Beach Seine
	9-92759	6/10/77	39 East	162	5	6/14/77	39 West	160	4	0	1-Bottom Trawl
	9-93288	6/ 8/77	77 West	177	14	6/14/77	42 East	175	6	35	99-Indian Point
	**5-39272	9/16/76	33 East	124	14	6/15/77	34 East	132	271	-1	14-200' Beach Seine
	9-71802	9/29/76	29 West	178	53	6/15/77	29 West	178	258	0	14-200' Beach Seine
	9-76662	10/29/76	34 East	193	14	6/15/77	34 East	190	228	0	14-200' Beach Seine
	5-34232	6/16/76	34 East	142	12	6/16/77	34 East	147	364	0	5-Box Trap
	5-49663	4/27/77	27 West	131	14	6/16/77	27 West	129	50	0	14-200' Beach Seine
	5-50005	5/16/77	36 East	142	14	6/16/77	36 East	139	31	0	14-200' Beach Seine
	5-51703	6/13/77	27 West	142	12	6/16/77	27 West	140	3	0	14-200' Beach Seine
	5-52415	5/31/77	34 East	136	5	6/16/77	34 East	129	16	0	5-Box Trap
	**9-87472	4/27/77	27 West	180	14	6/16/77	27 West	180	50	0	14-200' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-50 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
	**9-87472	4/27/77	27 West	180	14	6/16/77	27 West	175	50	0	14-200' Beach Seine
	**9-87492	4/27/77	27 West	160	14	6/16/77	27 West	164	50	0	14-200' Beach Seine
	**9-87497	4/27/77	27 West	175	14	6/16/77	27 West	174	50	0	14-200' Beach Seine
	9-88926	6/ 7/77	27 West	202	12	6/16/77	27 West	200	9	0	14-200' Beach Seine
	**9-88928	6/ 7/77	27 West	165	12	6/16/77	27 West	163	9	0	14-200' Beach Seine
	9-89034	5/31/77	34 East	174	5	6/16/77	42 East	170	16	-8	99-Indian Point
	9-92625	6/ 9/77	76 East	156	12	6/16/77	46	151	7	30	65-1 M Tucker Trawl
	**5-40452	9/24/76	34 East	147	53	6/17/77	34 East	150	265	0	14-200' Beach Seine
	5-50910	5/20/77	34 East	138	12	6/17/77	34 East	144	28	0	14-200' Beach Seine
	5-51668	6/ 8/77	34 East	114	5	6/17/77	42 East		9	-8	99-Indian Point
	5-51994	6/14/77	34 East	125	14	6/17/77	34 East	120	3	0	14-200' Beach Seine
	5-53897	6/ 9/77	69 West	108	12	6/17/77	42 East		8	27	99-Indian Point
	9-88149	6/ 3/77	43 East	181	12	6/17/77	43 East	177	14	0	14-200' Beach Seine
	5-51933	6/ 8/77	38 East	148	5	6/18/77	42 East		10	-4	99-Indian Point
	9-88990	6/ 8/77	38 East	157	5	6/18/77	42 East		10	-4	99-Indian Point
	5-52940	6/ 9/77	40 West	137	14	6/19/77	42 East		10	-2	99-Indian Point
	5-37960	9/13/76	43 East	147	12	6/20/77	43 East	146	279	0	12-100' Beach Seine
	5-53877	6/ 9/77	69 West	112	12	6/20/77	42 East		11	27	99-Indian Point
	9-67481	9/27/76	43 East	178	12	6/20/77	43 East	175	265	0	12-100' Beach Seine
	9-71061	10/ 5/76	34 East	156	53	6/20/77	34 East	162	257	0	14-200' Beach Seine
	**9-72502	9/27/76	43 East	161	12	6/20/77	43 East	162	265	0	12-100' Beach Seine
	9-83660	11/ 4/76	34 East	171	14	6/20/77	34 East	168	227	0	14-200' Beach Seine
	9-86098	5/25/77	34 East	152	12	6/20/77	34 East	146	26	0	12-100' Beach Seine
	9-87829	5/11/77	39 East	171	5	6/20/77	39 East	165	40	0	5-Box Trap
	5-35565	9/14/76	29 West	120	12	6/21/77	29 West	134	279	0	12-100' Beach Seine
	5-36711	9/ 2/76	39 East	148	14	6/21/77	57 West	146	291	-18	12-100' Beach Seine
	**5-39272	9/16/76	33 East	124	14	6/21/77	34 East	131	277	-1	14-200' Beach Seine
	5-40445	9/24/76	34 East	130	53	6/21/77	34 East	140	269	0	14-200' Beach Seine
	5-40447	9/24/76	34 East	122	53	6/21/77	34 East	131	269	0	14-200' Beach Seine
	5-40481	9/27/76	34 East	131	14	6/21/77	34 East	136	266	0	14-200' Beach Seine
	5-40487	9/27/76	34 East	130	14	6/21/77	34 East	130	266	0	14-200' Beach Seine
	5-49617	4/19/77	33 East	122	14	6/21/77	34 East	125	63	-1	14-200' Beach Seine
	5-50926	5/23/77	34 East	121	12	6/21/77	34 East	121	29	0	12-100' Beach Seine
	5-52046	6/15/77	34 East	137	14	6/21/77	34 East	139	6	0	14-200' Beach Seine
	5-52056	6/15/77	34 East	136	14	6/21/77	34 East	134	6	0	14-200' Beach Seine
	5-52061	6/15/77	34 East	141	14	6/21/77	34 East	136	6	0	14-200' Beach Seine
	5-52065	6/15/77	34 East	137	14	6/21/77	34 East	133	6	0	14-200' Beach Seine
	5-52066	6/15/77	34 East	124	14	6/21/77	34 East	120	6	0	14-200' Beach Seine
	5-52080	6/15/77	34 East	130	14	6/21/77	34 East	130	6	0	14-200' Beach Seine
	5-52091	6/16/77	34 East	132	14	6/21/77	34 East	129	5	0	14-200' Beach Seine
	9-76643	10/29/76	34 East	159	14	6/21/77	34 East	162	234	0	14-200' Beach Seine
	9-76665	10/29/76	34 East	163	14	6/21/77	34 East	161	234	0	14-200' Beach Seine
	9-76671	10/29/76	34 East	160	14	6/21/77	34 East	157	234	0	14-200' Beach Seine
	9-86219	6/16/77	34 East	187	5	6/21/77	42 East	183	5	-8	99-Indian Point
	9-87274	4/21/77	15 West	189	14	6/21/77	57 West	182	61	-42	12-100' Beach Seine
	9-94026	6/15/77	34 East	172	14	6/21/77	34 East	166	6	0	14-200' Beach Seine
	9-94030	6/15/77	34 East	171	14	6/21/77	34 East	169	6	0	14-200' Beach Seine
	5-29645	11/10/75	40 West	147	12	6/22/77	40 West	155	589	0	14-200' Beach Seine
	5-34484	9/ 2/76	26 West	123	12	6/22/77	26 West	137	292	0	14-200' Beach Seine
	5-36048	9/ 9/76	99 East	123	12	6/22/77	99 East	123	285	0	12-100' Beach Seine
	5-37920	9/ 9/76	99 East	114	12	6/22/77	99 East	119	285	0	12-100' Beach Seine
	5-37971	9/13/76	43 East	141	12	6/22/77	43 East	143	281	0	12-100' Beach Seine
	**5-44071	9/30/76	35 West	119	53	6/22/77	36 West	120	264	-1	14-200' Beach Seine
	5-45801	10/25/76	36 West	117	12	6/22/77	36 West	119	239	0	14-200' Beach Seine
	5-45962	10/15/76	43 East	138	12	6/22/77	43 East	137	249	0	12-100' Beach Seine
	5-47506	10/19/76	35 West	112	12	6/22/77	35 West	117	245	0	14-200' Beach Seine
	5-47702	11/ 1/76	35 West	118	12	6/22/77	35 West	123	232	0	14-200' Beach Seine
	5-49664	4/27/77	27 West	120	14	6/22/77	27 West	129	56	0	14-200' Beach Seine
	5-49670	4/27/77	27 West	149	14	6/22/77	27 West	149	56	0	14-200' Beach Seine
	5-49756	6/14/77	38 West	133	14	6/22/77	36 West	132	8	2	14-200' Beach Seine
	5-50315	6/14/77	34 East	119	12	6/22/77	42 East		8	-8	99-Indian Point
	5-50391	6/14/77	36 West	130	12	6/22/77	36 West	132	8	0	14-200' Beach Seine
	5-51785	6/16/77	27 West	129	14	6/22/77	26 West	125	6	1	14-200' Beach Seine
	5-51791	6/16/77	27 West	123	14	6/22/77	27 West	118	6	0	14-200' Beach Seine
	5-51792	6/16/77	27 West	118	14	6/22/77	27 West	114	6	0	14-200' Beach Seine
	5-51793	6/16/77	27 West	132	14	6/22/77	27 West	128	6	0	14-200' Beach Seine
	5-51876	6/16/77	27 West	140	14	6/22/77	27 West	133	6	0	14-200' Beach Seine
	5-51887	6/16/77	27 West	140	14	6/22/77	27 West	131	6	0	14-200' Beach Seine
	5-51888	6/16/77	27 West	132	14	6/22/77	27 West	131	6	0	14-200' Beach Seine
	5-51894	6/16/77	27 West	132	14	6/22/77	27 West	125	6	0	14-200' Beach Seine
	5-52153	6/20/77	38 East	127	5	6/22/77	42 East		2	-4	99-Indian Point
	5-52462	6/ 1/77	40 West	104	14	6/22/77	40 West	105	21	0	14-200' Beach Seine
	5-53089	6/ 7/77	77 East	145	14	6/22/77	42 East		15	35	99-Indian Point
	**9-72502	9/27/76	43 East	161	12	6/22/77	43 East	159	267	0	12-100' Beach Seine
	9-72517	9/28/76	16 West	190	12	6/22/77	16 West	190	266	0	12-100' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.
**Multiple recaptures.

†Upper New York Bay

Table C-50 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance (mi)*	Recovery Gear
	9-86042	6/13/77	43 East	177	12	6/22/77	43 East	180	9	0	12-100' Beach Seine
	9-87368	6/14/77	38 West	157	14	6/22/77	36 West	157	8	2	14-200' Beach Seine
	9-87448	6/16/77	27 West	160	14	6/22/77	27 West	161	6	0	14-200' Beach Seine
	9-87450	6/16/77	27 West	170	14	6/22/77	27 West	172	6	0	14-200' Beach Seine
	9-87487	4/27/77	26 West	194	14	6/22/77	27 West	195	56	-1	14-200' Beach Seine
	**9-87492	4/27/77	27 West	160	14	6/22/77	27 West	168	56	0	14-200' Beach Seine
	**9-87497	4/27/77	27 West	175	14	6/22/77	27 West	174	56	0	14-200' Beach Seine
	9-88003	5/ 5/77	27 West	167	12	6/22/77	27 West	168	48	0	14-200' Beach Seine
	9-88510	6/16/77	27 West	204	14	6/22/77	27 West	204	6	0	14-200' Beach Seine
	9-88513	6/16/77	27 West	159	14	6/22/77	27 West	162	6	0	14-200' Beach Seine
	**9-88928	6/ 7/77	27 West	165	12	6/22/77	27 West	167	15	0	14-200' Beach Seine
	**5-38743	9/14/76	39 East	149	12	6/23/77	39 East	136	281	0	12-100' Beach Seine
	5-40758	9/22/76	39 East	120	14	6/23/77	38 East	122	273	1	5-Box Trap
	5-46002	10/ 7/76	36 West	120	53	6/23/77	36 West	132	258	0	14-200' Beach Seine
	5-49270	4/29/77	29 West	125	12	6/23/77	29 West	125	55	0	14-200' Beach Seine
	5-49276	4/49/77	29 West	115	12	6/23/77	29 West	120	55	0	14-200' Beach Seine
	5-49395	6/16/77	39 East	119	5	6/23/77	39 East	115	7	0	5-Box Trap
	5-50245	5/11/77	39 East	146	5	6/23/77	39 East	149	43	0	5-Box Trap
	5-51263	5/11/77	39 East	145	12	6/23/77	38 East	141	43	1	5-Box Trap
	5-51781	6/15/77	29 West	126	14	6/23/77	29 West	123	8	0	14-200' Beach Seine
	5-51783	6/15/77	29 West	114	14	6/23/77	29 West	110	8	0	14-200' Beach Seine
	5-52427	5/31/77	38 East	115	5	6/23/77	38 East	115	23	0	5-Box Trap
	**9-67553	9/24/76	35 East	204	53	6/23/77	42 East	204	271	-7	99-Indian Point
	9-68306	10/ 5/76	35 East	186	53	6/23/77	35 East	175	260	0	14-200' Beach Seine
	9-75577	10/ 5/76	35 East	178	53	6/23/77	35 East	177	260	0	14-200' Beach Seine
	9-87808	5/11/77	38 East	159	5	6/23/77	38 East	156	43	0	5-Box Trap
	9-88078	5/17/77	38 East	157	5	6/23/77	38 East	152	37	0	5-Box Trap
	5-42921	9/27/76	40 East	144	14	6/24/77	40 East	150	269	0	14-200' Beach Seine
	5-49072	4/20/77	26 West	111	12	6/24/77	43 East	114	65	-17	14-200' Beach Seine
	9-85981	6/20/77	43 East	164	12	6/24/77	43 East	167	4	0	14-200' Beach Seine
	9-85990	6/20/77	43 East	162	12	6/24/77	43 East	159	4	0	14-200' Beach Seine
	9-85995	6/20/77	43 East	155	12	6/24/77	43 East	156	4	0	14-200' Beach Seine
	9-88529	6/16/77	36 West	184	14	6/24/77	42 East	177	8	-6	99-Indian Point
	9-89027	5/31/77	34 East	233	5	6/24/77	33 East		24	1	98-Sports Fisherman
	9-89094	6/ 1/77	40 West	181	14	6/24/77	40 West	183	23	0	14-200' Beach Seine
	9-92356	6/ 6/77	34 East	180	5	6/24/77	42 East	175	18	-8	99-Indian Point
	9-92522	6/ 6/77	34 East	192	5	6/24/77	42 East	188	18	-8	99-Indian Point
	9-94053	6/17/77	40 West	171	14	6/24/77	40 West	167	7	0	14-200' Beach Seine
	5-54557	6/23/77	39 East	140	5	6/25/77	42 East	135	2	-3	99-Indian Point
	9-93961	6/13/77	34 East	176	5	6/25/77	42 East		12	-8	99-Indian Point
	5-50196	6/23/77	51 East	118	12	6/26/77	42 East	117	3	9	99-Indian Point
	5-54299	6/22/77	40 West	117	14	6/26/77	37 West		4	3	97-Bowline
	5-54608	6/21/77	57 West	124	12	6/26/77	42 East	120	5	15	99-Indian Point
	9-88258	6/16/77	34 East	184	5	6/26/77	42 East		10	-8	99-Indian Point
	**5-38743	9/14/76	39 East	149	12	6/27/77	39 East	136	285	0	12-100' Beach Seine
	5-50206	5/10/77	34 East	118	14	6/27/77	34 East	127	48	0	5-Box Trap
	5-54413	6/24/77	40 East	115	14	6/27/77	42 East		3	-2	99-Indian Point
	5-55565	6/22/77	27 West	117	14	6/27/77	42 East	119	5	-15	99-Indian Point
	9-87889	5/20/77	38 East	160	5	6/27/77	38 East	157	38	0	5-Box Trap
	5-35142	9/ 7/76	34 East	128	14	6/28/77	34 East	135	293	0	14-200' Beach Seine
	5-35176	9/ 7/76	34 East	130	14	6/28/77	34 East	133	293	0	5-Box Trap
	5-37710	9/15/77	40 West	108	14	6/28/77	39 East	118	285	1	12-100' Beach Seine
	5-41872	11/ 4/76	34 East	128	14	6/28/77	34 East	131	235	0	14-200' Beach Seine
	5-41883	11/ 4/76	34 East	128	14	6/28/77	34 East	134	235	0	14-200' Beach Seine
	5-51294	6/20/77	43 East	109	12	6/28/77	43 East	106	8	0	12-100' Beach Seine
	5-51865	6/20/77	32 West	130	14	6/28/77	42 East		8	-10	99-Indian Point
	5-54261	6/21/77	34 East	120	14	6/28/77	42 East		7	-8	99-Indian Point
	5-55431	6/24/77	40 West	128	14	6/28/77	39 East	124	4	1	12-100' Beach Seine
	9-61157	5/19/76	58 East	157	5	6/28/77	42 East	164	404	16	99-Indian Point
	9-70467	9/20/76	34 East	187	14	6/28/77	34 East	182	280	0	14-200' Beach Seine
	9-86488	4/21/77	16 West	202	12	6/28/77	42 East	205	68	-26	99-Indian Point
	9-87440	6/15/77	29 West	177	14	6/28/77	29 West	176	13	0	12-100' Beach Seine
	9-92289	6/20/77	27 West	171	12	6/28/77	26 West	171	8	1	12-100' Beach Seine
	9-93996	6/15/77	34 East	165	14	6/28/77	34 East	164	13	0	5-Box Trap
	9-94168	6/23/77	39 East	169	5	6/28/77	38 East	166	5	1	14-200' Beach Seine
	5-51779	6/15/77	29 West	123	14	6/29/77	29 West	124	14	0	14-200' Beach Seine
	5-55847	6/24/77	34 East	137	5	6/29/77	42 East		5	-8	99-Indian Point
	**9-63839	9/ 2/76	39 East	184	14	6/29/77	42 East	180	299	-3	99-Indian Point
	9-87429	6/15/77	30 West	170	14	6/29/77	66 West	167	14	-36	96-Danskammer
	9-87743	5/ 5/77	39 East	166	5	6/29/77	42 East	165	55	-3	99-Indian Point
	5-49350	6/16/77	34 East	147	5	6/30/77	42 East		14	-8	99-Indian Point
	5-51916	6/ 8/77	38 East	124	5	6/30/77	42 East		22	-4	99-Indian Point
	5-54874	6/27/77	38 East	134	5	6/30/77	42 East		3	-4	99-Indian Point
	9-87772	5/10/77	34 East	160	14	6/30/77	34 East	155	51	0	5-Box Trap
	9-87846	5/12/77	34 East	159	14	6/30/77	34 East	156	49	0	5-Box Trap
	9-92785	6/14/77	39 East	158	12	6/30/77	39 East	159	16	0	12-100' Beach Seine

*Minus sign indicates movement north of release site; no sign indicates southward movement.
**Multiple recaptures.

Table C-51

Estimated Standing Crops (in Thousands) and Percent Standing Crops of White Perch Eggs above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Egg Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
5/3-5/5	Above	96198.4	92.7	96127.6	92.6	96111.1	92.6	73129.6	70.5	70882.3	68.3
	Within	7543.7	7.3	6119.8	5.9	4646.6	4.5	22788.8	21.9	25010.3	24.1
	Below	11.9	0.0	1506.6	1.4	2996.2	2.9	7835.5	7.5	7861.4	7.6
5/10-5/13	Above	114809.7	96.5	114526.3	96.3	114348.6	96.1	99377.2	83.5	98028.2	82.4
	Within	4046.2	3.4	3526.9	2.9	2937.8	2.5	13679.3	11.5	15012.7	12.6
	Below	84.0	0.0	886.8	0.7	1653.6	1.4	5883.5	4.9	5899.0	4.9
5/17-5/19	Above	429394.0	98.3	428538.8	98.1	428079.6	98.0	423078.5	96.9	422911.3	96.8
	Within	4611.5	1.0	3732.0	0.8	3637.0	0.8	1736.0	0.4	1887.6	0.4
	Below	2754.5	0.6	4489.2	1.0	5043.4	1.1	11945.5	2.7	11961.0	2.7
5/24-5/26	Above	54470.6	65.5	54280.6	65.3	54219.2	65.2	27738.4	33.3	26505.6	31.9
	Within	27676.9	33.3	22025.9	26.5	16681.9	20.0	19255.1	23.1	18218.2	21.9
	Below	1016.4	1.2	6857.4	8.2	12262.8	14.7	36170.5	43.5	38440.2	46.2
6/1-6/4	Above	210209.2	86.5	207866.6	85.5	206633.1	85.0	178977.7	73.6	177596.3	73.1
	Within	11854.8	4.9	5001.8	2.0	6032.7	2.5	16485.3	6.8	17023.3	7.0
	Below	20983.9	8.6	30179.6	12.4	30382.2	12.5	47585.0	19.6	48428.3	19.9
6/7-6/11	Above	361263.6	96.1	360052.5	95.8	359245.9	95.6	345416.4	91.9	344901.4	91.8
	Within	6973.6	1.8	4331.9	1.1	4526.8	1.2	6690.6	1.8	6709.3	1.8
	Below	7562.8	2.0	11415.6	3.0	12027.2	3.2	23693.0	6.3	24189.3	6.4
Total	Above	1266346.0	93.0	1261394.0	93.0	1258638.0	92.0	1147718.0	84.0	1140825.1	84.0
	Within	62708.0	5.0	44738.0	3.0	38464.0	3.0	80635.0	6.0	83861.0	6.0
	Below	32414.0	2.0	55336.0	4.0	64365.0	5.0	133115.0	10.0	136778.0	10.0

Table C-52

Estimated Standing Crops (in Thousands) and Percent Standing Crops of White Perch Yolk-Sac Larvae above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Yolk-Sac Larva Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
5/10-5/13	Above	56485.6	66.1	53927.7	63.1	53244.4	62.3	26311.8	30.8	25620.2	29.9
	Within	19886.3	23.3	16023.9	18.7	14121.8	16.5	14566.7	17.0	12727.8	14.9
	Below	9114.1	10.7	15534.4	18.2	18119.8	21.2	44607.5	52.2	47138.0	55.1
5/17-5/19	Above	249361.1	85.1	244841.4	83.6	242788.8	82.9	158582.2	54.1	154923.2	52.9
	Within	21806.2	9.4	15358.8	5.2	15729.6	5.4	53398.8	18.2	51573.2	17.6
	Below	21725.7	7.4	32692.8	11.2	34374.6	11.7	80912.0	27.6	86396.6	29.5
5/24-5/26	Above	50061.6	59.6	40609.9	48.4	37877.9	45.1	9357.8	11.1	9048.6	10.8
	Within	26922.1	32.1	31154.2	37.1	31260.5	37.2	6247.7	7.4	5513.6	6.6
	Below	6939.0	8.3	12159.8	14.5	14785.6	17.6	68318.5	81.4	69361.7	82.6
6/1-6/4	Above	56605.7	94.2	56279.3	93.6	56223.5	93.5	53775.9	89.5	53633.4	89.2
	Within	2376.0	3.9	1934.5	3.2	1700.0	2.8	1748.5	2.9	1788.0	2.9
	Below	1117.2	1.8	1885.0	3.1	2174.4	3.6	4574.5	7.6	4677.5	7.7
6/7-6/11	Above	111362.5	95.5	111090.9	95.2	111003.9	95.2	107357.5	92.0	107186.5	91.9
	Within	3540.4	3.0	2574.2	2.2	2162.4	1.8	2382.0	2.0	2334.4	2.0
	Below	1724.1	1.5	2961.8	2.5	3460.6	2.9	6887.5	5.9	7106.1	6.1
6/14-6/17	Above	139620.6	92.1	139025.0	92.7	138879.1	92.6	128369.3	85.6	127768.5	85.2
	Within	4588.5	3.0	2446.6	1.6	2317.1	1.5	7779.2	5.2	7809.7	5.2
	Below	5790.9	3.9	8528.4	5.7	8803.8	5.9	13851.5	9.2	14421.8	9.6
Totals	Above	663499.0	84.0	645774.0	82.0	640018.0	81.0	483755.0	61.0	478181.0	61.0
	Within	79119.0	10.0	69493.0	9.0	67292.0	9.0	86124.0	11.0	81747.0	10.0
	Below	46410.0	6.0	73762.0	9.0	81720.0	10.0	219154.0	28.0	229103.0	29.0

Table C-53

Estimated Standing Crops (in Thousands) and Percent Standing Crops of White Perch Post Yolk-Sac Larvae above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Post Yolk-Sac Larva Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
6/7-6/11	Above	436916.6	98.7	434592.8	98.2	434272.5	98.1	412018.3	93.1	410300.3	92.7
	Within	5086.3	1.1	6810.4	1.5	6843.8	1.5	18686.2	4.2	19962.2	4.5
	Below	730.1	0.2	1329.8	0.3	1616.6	0.4	12028.5	2.7	12470.5	2.8
6/14-6/17	Above	1675669.2	98.1	1671001.0	97.8	1669754.8	97.7	1545115.7	90.4	1535495.6	89.9
	Within	18980.9	1.1	16267.3	0.9	16039.6	0.9	106563.2	6.2	113063.1	6.6
	Below	13785.8	0.8	21167.8	1.2	22641.6	1.3	56757.0	3.3	59877.2	3.5
6/21-6/24	Above	2031077.4	97.6	2011053.6	96.7	2003801.2	96.3	1471832.7	70.7	1436737.2	69.1
	Within	44264.6	2.1	58005.4	2.8	61083.8	2.9	417906.7	20.1	431883.6	20.8
	Below	4921.0	0.2	11204.0	0.5	15378.0	0.7	190523.5	9.1	211642.1	10.2
6/28-7/1	Above	568637.5	84.2	508627.9	75.3	495683.9	73.4	284029.0	42.0	279420.5	41.4
	Within	99837.5	14.8	153156.0	22.7	162424.1	24.0	83751.9	12.4	75943.0	11.2
	Below	7035.0	1.0	13726.0	2.0	17402.0	2.6	307729.0	45.5	320146.4	47.4
7/6-7/9	Above	181340.2	88.0	175128.1	85.0	172620.1	83.8	124845.3	60.6	123183.9	59.8
	Within	20002.1	9.7	21982.7	10.7	22091.5	10.7	23494.2	11.4	22917.1	11.1
	Below	4602.6	2.2	8834.2	4.2	11233.4	5.4	57605.5	27.9	59844.1	29.0
	Above	4893641.0	96.0	4800405.0	94.0	4776133.0	93.0	3837841.0	75.0	3785140.0	74.0
Totals	Within	188172.0	4.0	256221.0	5.0	268482.8	5.0	650402.0	13.0	663768.0	13.0
	Below	31074.0	1.0	56262.0	1.0	68272.0	1.0	624645.0	12.0	663980.0	13.0

Table C-54

Estimated Standing Crops and Percent Standing Crops of White Perch Juveniles above, within, and below 5 Power-Plant Regions Determined from 100-Ft (30.5-m) Beach Seine during Periods of Juvenile Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
6/27-7/10	Above	100511	88.3	98871	86.8	97807	85.9	64579	56.7	63434	55.7
	Within	9388	8.2	7979	7.0	7698	6.8	18670	16.4	17443	15.3
	Below	3976	3.5	7025	6.2	8369	7.3	30625	26.9	32997	29.0
7/11-7/24	Above	1176492	81.0	1154783	79.5	1149564	79.2	810368	55.8	801978	55.2
	Within	116952	8.1	77876	5.4	75924	5.2	193703	13.3	165718	11.4
	Below	158395	10.9	219180	15.1	226352	15.6	447769	30.8	484144	33.3
7/25-8/7	Above	1371198	66.5	1305114	63.3	1293880	62.8	985236	47.8	976994	47.4
	Within	401562	19.5	318361	15.4	289395	14.0	156601	7.8	140360	6.8
	Below	288800	14.0	438066	21.2	478286	23.2	919724	44.8	944207	45.8
8/8-8/21	Above	1462563	65.5	1413889	63.3	1408500	63.1	1194874	53.5	1191174	53.3
	Within	451181	20.2	321315	14.4	276579	12.4	106621	4.8	87197	3.9
	Below	320014	14.3	498555	22.3	548680	24.6	932263	41.7	955387	42.8
8/22-9/4	Above	665898	37.5	597198	33.6	588561	33.1	372328	20.9	370689	20.9
	Within	778621	43.8	601930	33.9	502286	28.3	86130	4.8	64534	3.6
	Below	332767	18.7	578158	32.5	686439	38.6	1318827	74.2	1342062	75.5
9/5-9/18	Above	750300	42.8	680325	38.8	673572	38.4	520202	29.6	516081	29.4
	Within	600341	34.2	434694	24.8	376609	21.5	73844	4.2	67212	3.8
	Below	404414	23.0	640036	36.5	704874	40.2	1161008	66.2	1171761	66.8
9/19-10/2	Above	1493572	73.9	1434330	71.0	1425432	70.5	1299438	64.3	1299344	64.3
	Within	449627	22.3	410066	20.3	352235	17.4	32286	1.6	21912	1.1
	Below	77508	3.8	176310	8.7	243040	12.0	688983	34.1	699450	34.6
10/3-10/16	Above	557173	76.3	537618	73.7	534959	73.3	476925	65.4	476691	65.3
	Within	124258	17.0	109671	15.0	96841	13.3	20880	2.9	14930	2.0
	Below	48365	6.6	82507	11.3	97996	13.4	231991	31.8	238175	32.6
10/17-10/30	Above	132327	46.6	128823	45.4	127691	45.0	102519	36.1	102051	35.9
	Within	85561	30.1	53450	18.8	43084	15.2	10985	3.9	9365	3.3
	Below	66156	22.3	101770	35.8	113268	39.9	170539	60.0	172627	60.8
10/31-11/13	Above	55751	54.4	52866	51.6	52610	51.3	43155	42.1	42452	41.4
	Within	21953	21.4	14716	14.4	13110	12.8	7380	7.2	7989	7.8
	Below	24754	24.2	34877	34.0	36738	35.9	51923	50.7	52017	50.8
11/14/11/27	Above	5217	24.1	4718	21.8	4571	21.2	1179	5.5	945	4.4
	Within	4688	21.7	2880	13.3	2578	11.9	2367	11.0	2601	12.0
	Below	11702	54.2	14009	64.8	14457	66.9	18061	83.6	18061	83.6
11/28-12/11	Above	1288	4.6	964	3.4	843	3.0	0	0.0	0	0.0
	Within	20353	72.7	14493	51.8	11156	39.8	0	0.0	0	0.0
	Below	6361	22.7	12545	44.8	16003	57.1	28004	100.0	28004	100.0

Table C-55

Estimated Standing Crops and Percent Standing Crops of White Perch Yearlings above, within, and below 5 Power-Plant Regions Determined from 100-Ft (30.5-m) Beach Seine during Periods of Yearlings Abundance, 1977

DATE	AREA	BOWLINE		LOVETT		INDIAN POINT		ROSETON		DANSKAMMER	
		S.C.	%	S.C.	%	S.C.	%	S.C.	%	S.C.	%
4/ 3- 4/16	ABOVE	98.	1.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	WITHIN	1074.	11.3	264.	2.8	264.	2.8	0.	0.0	0.	0.0
	BELOW	8307.	87.6	9216.	97.2	9216.	97.2	9480.	100.0	9480.	100.0
4/17- 4/30	ABOVE	4304.	16.8	4304.	16.8	4304.	16.8	4304.	16.8	4304.	16.8
	WITHIN	6014.	23.4	0.	0.0	0.	0.0	0.	0.0	0.	0.0
	BELOW	15377.	59.8	21391.	83.2	21391.	83.2	21391.	83.2	21391.	83.2
5/ 1- 5/14	ABOVE	21256.	42.2	20368.	40.5	20114.	40.0	13604.	27.0	13135.	26.1
	WITHIN	10220.	20.3	5020.	10.0	4506.	8.9	4733.	9.4	5201.	10.3
	BELOW	18868.	37.5	24956.	49.6	25724.	51.1	32007.	63.6	32007.	63.6
5/15- 5/28	ABOVE	63420.	26.0	60880.	25.0	60169.	24.7	46741.	19.2	46741.	19.2
	WITHIN	66821.	27.4	19280.	7.9	16568.	6.8	4224.	1.7	2813.	1.2
	BELOW	113533.	46.6	163615.	67.1	167038.	68.5	192810.	79.1	194221.	79.7
5/29- 6/11	ABOVE	341550.	33.7	323889.	32.0	323439.	32.0	265556.	26.2	262161.	25.9
	WITHIN	475711.	47.0	337668.	33.4	265288.	26.2	44520.	4.4	44506.	4.4
	BELOW	195048.	19.3	350753.	34.6	423583.	41.8	702234.	69.4	705643.	69.7
6/12- 6/25	ABOVE	353492.	33.0	338704.	31.6	337437.	31.5	312193.	29.1	312193.	29.1
	WITHIN	450886.	42.1	288306.	26.9	226828.	21.2	8179.	0.8	5447.	0.5
	BELOW	267649.	25.0	445017.	41.5	507763.	47.4	751655.	70.1	754387.	70.4
6/26- 7/ 9	ABOVE	27710.	3.2	15372.	1.8	15226.	1.8	0.	0.0	0.	0.0
	WITHIN	700298.	81.3	531039.	61.7	406590.	47.2	7101.	0.8	4729.	0.5
	BELOW	133002.	15.4	314599.	36.5	439195.	51.0	853912.	99.2	856283.	99.5

Table C-56

Estimated Density (No./1000 m^3) of Atlantic Tomcod Eggs in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.237	0.542	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.136	0.280	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.048	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.033	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/19	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-56 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/26	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/ 4	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/17	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/24	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-57

Estimated Standing Crops (in Thousands) of Atlantic Tomcod Eggs in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

	Region												
DATE	YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23- SC	0	0	0	0	49	76	0	0	0	0	0	0	125
2/27 SE	0	0	0	0	28	39	0	0	0	0	0	0	48
TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/11 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22- SC	0	0	0	0	10	0	0	0	0	0	0	0	10
3/25 SE	0	0	0	0	7	0	0	0	0	0	0	0	7
TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/29 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/ 5 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/13 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17- SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/19 SE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-57 (Contd)

DATE		Region												
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24- 5/26	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1- 6/ 4	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7- 6/11	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14- 6/17	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21- 6/24	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28- 7/ 1	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6- 7/ 9	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12- 7/15	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26- 7/29	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10- 8/13	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-58

Estimated Density (No./1000 m^3) of Atlantic Tomcod Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

DATE		Region											
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	101.587	77.268	65.117	77.855	51.203	9.940	3.395	0.0	0.0	0.0	0.0	0.0
2/27	SE	12.678	9.425	10.187	13.413	8.803	2.142	2.680	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	12.831	76.693	107.167	123.544	126.041	83.118	61.017	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	3.603	21.006	22.919	13.692	8.474	25.534	7.148	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	113.328	349.242	619.456	308.072	190.707	99.774	34.024	0.0	0.0	0.0	0.0	0.0
3/11	SE	36.732	164.572	184.532	46.328	32.022	20.372	10.815	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	157.638	199.729	151.266	120.345	21.104	8.678	4.391	0.0	0.0	0.0	0.0	0.0
3/25	SE	14.367	32.122	20.508	6.665	4.122	2.255	1.394	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.096	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.096	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/19	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-58 (Contd)

DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
		Region											
5/24-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/26	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/ 4	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/11	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/17	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/24	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-59

Estimated Standing Crops (in Thousands) of Atlantic Tomcod Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	23314	24865	9618	16217	10620	1390	1012	0	0	0	0	0	87035
2/27	SE	2910	3033	1505	2794	1826	299	799	0	0	0	0	0	5639
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	2945	24680	15829	25734	26141	11620	18195	0	0	0	0	0	125144
3/ 5	SE	827	6760	3385	2852	1757	3570	2131	0	0	0	0	0	9292
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	26009	112386	91494	64171	39553	13948	10146	0	0	0	0	0	357707
3/11	SE	8430	52959	27255	9650	6641	2848	3225	0	0	0	0	0	61436
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	36178	64273	22342	25068	4377	1213	1309	0	0	0	0	0	154760
3/25	SE	3297	10337	3029	1388	855	315	416	0	0	0	0	0	11394
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	22	0	0	0	0	0	0	0	0	0	0	0	22
4/ 8	SE	22	0	0	0	0	0	0	0	0	0	0	0	22
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/21	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/19	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-59 (Contd)

DATE		Region YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/ 4	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 1	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 9	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-60

Estimated Density (No./1000 m^3) of Atlantic Tomcod Post Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.933	1.360	0.0	0.536	0.830	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.612	0.688	0.0	0.316	0.370	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.451	54.943	67.230	3.532	0.021	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.096	31.927	65.891	3.370	0.021	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	231.240	36.393	2.941	0.487	0.877	0.050	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	20.366	13.693	1.504	0.241	0.559	0.050	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.096	0.293	0.0	0.0	0.0	0.042	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.096	0.293	0.0	0.0	0.0	0.042	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	4.057	218.211	54.835	4.604	0.421	0.082	0.0	0.0	0.0	0.0	0.0	0.0
4/21	SE	2.435	90.555	21.797	2.195	0.421	0.082	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.130	168.064	208.840	98.794	0.056	0.635	0.070	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.130	97.287	69.553	70.863	0.056	0.353	0.070	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	3.881	119.272	0.837	0.439	1.823	0.0	0.371	0.0	0.398	0.0	0.0	0.0
5/ 5	SE	2.106	98.611	0.558	0.241	0.939	0.0	0.158	0.0	0.244	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	0.341	1.447	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/13	SE	0.341	0.812	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	0.0	1.905	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/19	SE	0.0	1.312	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-60 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	0.0	0.159	0.0	0.065	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/26	SE	0.0	0.159	0.0	0.065	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	0.0	0.0	0.0	0.032	0.0	0.103	0.0	0.0	0.0	0.0	0.0	0.0
6/ 4	SE	0.0	0.0	0.0	0.032	0.0	0.103	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	0.0	8.559	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/11	SE	0.0	8.559	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/17	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/24	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/29	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-61

Estimated Standing Crops (in Thousands) of Atlantic Tomcod Post Yolk-Sac Larvae in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	300	201	0	111	116	0	0	0	0	0	0	728
2/27	SE	0	197	102	0	65	52	0	0	0	0	0	0	237
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	103	17681	9930	736	4	0	0	0	0	0	0	0	28454
3/11	SE	22	10274	9732	702	4	0	0	0	0	0	0	0	14169
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	53070	11711	434	101	182	7	0	0	0	0	0	0	65505
3/25	SE	4674	4406	222	50	116	7	0	0	0	0	0	0	6429
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	22	94	0	0	0	6	0	0	0	0	0	0	122
4/ 8	SE	22	94	0	0	0	6	0	0	0	0	0	0	97
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	931	70220	8099	959	87	11	0	0	0	0	0	0	80308
4/21	SE	559	29141	3219	457	87	11	0	0	0	0	0	0	29327
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	30	54083	30846	20579	12	89	21	0	0	0	0	0	105658
4/29	SE	30	31307	10273	14761	12	49	21	0	0	0	0	0	36105
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	891	38382	124	92	378	0	111	0	56	0	0	0	40033
5/ 5	SE	483	31733	82	50	195	0	47	0	34	0	0	0	31737
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	78	466	0	0	0	0	0	0	0	0	0	0	544
5/13	SE	78	261	0	0	0	0	0	0	0	0	0	0	273
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	0	613	0	0	0	0	0	0	0	0	0	0	613
5/19	SE	0	422	0	0	0	0	0	0	0	0	0	0	422
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-61 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	0	51	0	13	0	0	0	0	0	0	0	0	65
5/26	SE	0	51	0	13	0	0	0	0	0	0	0	0	53
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	0	0	0	7	0	14	0	0	0	0	0	0	21
6/ 4	SE	0	0	0	7	0	14	0	0	0	0	0	0	16
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	0	2754	0	0	0	0	0	0	0	0	0	0	2754
6/11	SE	0	2754	0	0	0	0	0	0	0	0	0	0	2754
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 1	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/ 9	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
7/29	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-62

Estimated Density (No./1000 m^3) of Atlantic Tomcod Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
2/23-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0
3/ 1-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/ 5	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0
3/ 8-	DEN	0.0	0.0	20.979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/11	SE	0.0	0.0	20.979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0
3/22-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/25	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0
4/ 5-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/ 8	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0
4/19-	DEN	0.0	0.0	0.0	0.0	0.0	0.0	0.081	0.0	0.0	0.0	0.0	0.0
4/21	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.081	0.0	0.0	0.0	0.0	0.0
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3
4/26-	DEN	0.0	45.768	57.879	3.718	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/29	SE	0.0	26.476	18.890	2.905	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3
5/ 3-	DEN	6.257	384.266	11.875	3.245	2.037	0.634	0.566	0.0	0.0	0.0	0.0	0.0
5/ 5	SE	4.810	336.391	6.014	1.992	0.938	0.350	0.409	0.0	0.0	0.0	0.0	0.0
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4
5/10-	DEN	1.473	9.666	0.0	0.489	0.0	0.273	0.0	0.0	1.073	0.0	0.0	0.0
5/13	SE	1.184	7.635	0.0	0.297	0.0	0.196	0.0	0.0	1.073	0.0	0.0	0.0
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4
5/17-	DEN	9.526	49.829	1.403	5.508	0.350	6.540	1.638	1.520	3.980	0.214	0.0	0.0
5/19	SE	6.694	24.778	0.984	3.349	0.259	6.540	1.028	0.954	3.469	0.214	0.0	0.0
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4

Table C-62 (Contd)

		Region											
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL
5/24-	DEN	0.0	61.813	0.0	5.940	0.294	1.389	0.173	0.282	0.0	0.0	0.0	0.0
5/26	SE	0.0	58.953	0.0	2.735	0.235	0.855	0.173	0.173	0.0	0.0	0.0	0.0
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4
6/ 1-	DEN	13.062	10.106	4.225	5.412	11.984	3.193	0.463	0.490	0.245	0.0	0.0	0.0
6/ 4	SE	10.329	4.471	2.495	1.792	4.417	1.202	0.463	0.300	0.245	0.0	0.0	0.0
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3
6/ 7-	DEN	35.246	22.917	16.253	3.434	0.381	1.633	1.861	0.446	0.383	0.0	0.0	0.0
6/11	SE	24.742	21.172	12.357	0.812	0.168	0.392	0.856	0.295	0.383	0.0	0.0	0.0
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3
6/14-	DEN	2.174	29.747	27.969	3.736	3.340	4.976	1.348	0.168	0.253	0.0	0.0	0.0
6/17	SE	1.767	7.930	21.530	0.984	1.076	1.394	0.847	0.168	0.253	0.0	0.0	0.0
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2
6/21-	DEN	1.613	188.582	17.942	8.424	0.062	0.093	0.144	0.129	0.0	0.0	0.0	0.0
6/24	SE	1.613	95.504	7.290	3.059	0.062	0.064	0.144	0.129	0.0	0.0	0.0	0.0
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3
6/28-	DEN	172.015	21.957	15.991	9.323	2.986	6.850	0.0	0.0	0.0	0.0	0.0	0.0
7/ 1	SE	92.862	5.729	13.317	2.503	0.568	2.956	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1
7/ 6-	DEN	35.218	72.056	11.796	4.901	0.787	0.329	0.0	0.0	0.0	0.0	0.0	0.0
7/ 9	SE	21.802	14.820	2.554	2.127	0.416	0.329	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2
7/12-	DEN	0.692	7.762	0.696	1.112	0.757	0.821	0.0	0.0	0.0	0.0	0.0	0.0
7/15	SE	0.523	1.649	0.535	0.343	0.340	0.340	0.0	0.0	0.0	0.0	0.0	0.0
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2
7/26-	DEN	1.653	9.319	10.397	4.711	3.484	3.733	0.108	0.0	0.0	0.0	0.0	0.0
7/29	SE	1.653	4.724	6.138	2.311	1.984	1.644	0.108	0.0	0.0	0.0	0.0	0.0
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2
8/10-	DEN	2.386	8.732	3.042	19.198	16.610	1.734	0.640	0.0	0.0	0.223	0.0	0.0
8/13	SE	1.318	4.470	1.267	3.531	9.544	0.651	0.258	0.0	0.0	0.223	0.0	0.0
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2

Table C-63

Estimated Standing Crops (in Thousands) of Atlantic Tomcod Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 14-140; KM 22-224) Determined from Ichthyoplankton Survey, 1976

DATE		Region												
		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
2/23-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
2/27	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	3	0	0	0	0	0	93
3/ 1-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/ 5	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	18	26	16	10	0	0	0	0	0	100
3/ 8-	SC	0	0	3099	0	0	0	0	0	0	0	0	0	3099
3/11	SE	0	0	3099	0	0	0	0	0	0	0	0	0	3099
	TOWS	6	10	13	18	26	16	10	0	0	0	0	0	99
3/22-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
3/25	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	11	13	18	26	16	10	0	0	0	0	0	100
4/ 5-	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
4/ 8	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOWS	6	10	14	17	26	16	10	0	0	0	0	0	99
4/19-	SC	0	0	0	0	0	0	24	0	0	0	0	0	24
4/21	SE	0	0	0	0	0	0	24	0	0	0	0	0	24
	TOWS	12	19	17	16	15	20	22	15	11	15	4	3	169
4/26-	SC	0	14728	8549	774	0	0	0	0	0	0	0	0	24051
4/29	SE	0	8520	2790	605	0	0	0	0	0	0	0	0	8986
	TOWS	16	34	27	24	16	20	24	14	11	11	8	3	208
5/ 3-	SC	1436	123657	1754	676	422	89	169	0	0	0	0	0	128203
5/ 5	SE	1104	108251	888	415	195	49	122	0	0	0	0	0	108261
	TOWS	18	32	27	26	16	21	24	16	11	11	8	4	214
5/10-	SC	338	3111	0	102	0	38	0	0	152	0	0	0	3741
5/13	SE	272	2457	0	62	0	27	0	0	152	0	0	0	2477
	TOWS	18	33	26	25	16	22	24	15	11	11	8	4	213
5/17-	SC	2186	16035	207	1147	73	914	489	252	563	38	0	0	21903
5/19	SE	1536	7974	145	698	54	914	307	158	491	38	0	0	8225
	TOWS	18	33	26	27	17	21	24	16	9	13	7	4	215

Table C-63 (Contd)

		Region												
DATE		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	TOTL
5/24-	SC	0	19892	0	1237	61	194	52	47	0	0	0	0	21482
5/26	SE	0	18971	0	570	49	120	52	29	0	0	0	0	18980
	TOWS	15	31	27	26	17	21	24	16	11	11	8	4	211
6/ 1-	SC	2998	3252	624	1127	2486	446	138	81	35	0	0	0	11187
6/ 4	SE	2371	1439	369	373	916	168	138	50	35	0	0	0	2976
	TOWS	4	10	27	51	39	32	16	10	10	6	5	3	213
6/ 7-	SC	8089	7375	2401	715	79	228	555	74	54	0	0	0	19570
6/11	SE	5678	6813	1825	169	35	55	255	49	54	0	0	0	9061
	TOWS	4	10	26	49	40	32	16	10	11	5	4	3	210
6/14-	SC	499	9573	4131	778	693	696	402	28	36	0	0	0	16835
6/17	SE	405	2552	3180	205	223	195	253	28	36	0	0	0	4121
	TOWS	4	10	24	51	41	31	17	10	9	7	6	2	212
6/21-	SC	370	60686	2650	1755	13	13	43	21	0	0	0	0	65551
6/24	SE	370	30733	1077	637	13	9	43	21	0	0	0	0	30761
	TOWS	4	10	27	51	39	31	17	12	8	6	5	3	213
6/28-	SC	39477	7066	2362	1942	619	958	0	0	0	0	0	0	52424
7/ 1	SE	21312	1844	1967	521	118	413	0	0	0	0	0	0	21492
	TOWS	8	37	29	35	21	20	21	14	12	8	9	1	215
7/ 6-	SC	8083	23188	1742	1021	163	46	0	0	0	0	0	0	34243
7/ 9	SE	5004	4769	377	443	86	46	0	0	0	0	0	0	6937
	TOWS	8	37	30	34	20	21	21	13	13	8	8	2	215
7/12-	SC	159	2498	103	232	157	115	0	0	0	0	0	0	3263
7/15	SE	120	531	79	71	71	48	0	0	0	0	0	0	561
	TOWS	8	37	29	34	21	21	21	12	14	8	8	2	215
7/26-	SC	379	2999	1536	981	723	522	32	0	0	0	0	0	7172
7/29	SE	379	1520	907	481	411	230	32	0	0	0	0	0	1932
	TOWS	7	37	29	34	21	21	21	14	12	8	8	2	214
8/10-	SC	548	2810	449	3999	3445	242	191	0	0	39	0	0	11723
8/13	SE	303	1438	187	736	1979	91	77	0	0	39	0	0	2583
	TOWS	8	37	29	34	20	21	21	13	13	8	8	2	214

Table C-64

Estimated Density (No./1000 m^3) of Atlantic Tomcod Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region						
DATE		YK	TZ	CH	IP	WP	CW	PK
8/16-	DEN	101.832	58.724	46.895	27.791	4.201	1.652	0.0
8/20	SE	35.277	9.792	18.582	10.237	2.321	0.812	0.0
	TOWS	7	26	36	19	5	5	5
8/30-	DEN	35.435	11.082	4.566	17.541	53.314	21.185	3.083
9/ 3	SE	10.350	4.200	1.445	2.830	28.196	9.193	1.138
	TOWS	7	26	35	20	5	5	5
9/13-	DEN	21.469	14.691	5.132	19.883	37.854	33.540	11.615
9/16	SE	4.877	3.121	1.524	2.765	17.346	16.481	3.529
	TOWS	7	26	37	18	5	5	5
9/27-	DEN	25.507	3.148	2.276	8.700	8.726	10.235	0.824
10/ 1	SE	5.237	1.301	0.812	2.741	6.395	5.479	0.504
	TOWS	7	26	36	19	5	5	5
10/11-	DEN	6.087	11.159	0.872	1.061	0.387	0.470	0.0
10/14	SE	3.551	4.736	0.229	0.344	0.387	0.470	0.0
	TOWS	7	26	36	19	5	5	5
10/25-	DEN	5.687	4.108	1.039	4.287	8.727	11.547	1.434
10/28	SE	2.340	0.726	0.471	2.592	2.420	2.979	0.946
	TOWS	8	43	24	13	5	5	5
11/ 8-	DEN	3.460	9.507	4.975	0.510	2.157	2.313	0.503
11/12	SE	2.426	1.579	1.769	0.300	2.157	1.624	0.503
	TOWS	8	43	24	13	6	4	5
11/21-	DEN	9.543	16.439	2.892	0.214	0.0	2.929	0.0
11/24	SE	5.294	3.441	0.760	0.214	0.0	1.840	0.0
	TOWS	8	42	24	13	5	5	5
12/ 6-	DEN	11.238	17.775	0.0	7.338	1.518	2.073	2.136
12/ 8	SE	3.427	2.704	0.0	2.347	0.621	0.931	1.562
	TOWS	8	29	0	6	5	5	5

Table C-65

Estimated Standing Crops (in Thousands) of Atlantic Tomcod Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

		Region							
DATE		YK	TZ	CH	IP	WP	CW	PK	TOTL
8/16-	SC	2719	10793	4052	1278	120	74	0	19037
8/20	SE	942	1800	1605	471	66	36	0	2633
	TOWS	7	26	36	19	5	5	5	103
8/30-	SC	946	2037	403	807	1525	951	213	6882
9/ 3	SE	276	772	125	130	806	413	79	1238
	TOWS	7	26	35	20	5	5	5	103
9/13-	SC	573	2700	443	915	1083	1506	804	8024
9/16	SE	130	574	132	127	496	740	244	1110
	TOWS	7	26	37	18	5	5	5	103
9/27-	SC	681	579	197	400	250	460	57	2623
10/ 1	SE	140	239	70	126	183	246	35	439
	TOWS	7	26	36	19	5	5	5	103
10/11-	SC	163	2051	75	49	11	21	0	2370
10/14	SE	95	870	20	16	11	21	0	876
	TOWS	7	26	36	19	5	5	5	103
10/25-	SC	152	755	90	197	250	518	99	2061
10/28	SE	62	133	41	119	69	134	65	254
	TOWS	8	43	24	13	5	5	5	103
11/ 8-	SC	92	1747	430	23	62	104	35	2493
11/12	SE	65	290	153	14	62	73	35	350
	TOWS	8	43	24	13	6	4	5	103
11/21-	SC	255	3021	250	10	0	132	0	3668
11/24	SE	141	632	66	10	0	83	0	657
	TOWS	8	42	24	13	5	5	5	102
12/ 6-	SC	300	3267	0	338	43	93	148	4189
12/ 8	SE	91	497	0	108	18	42	108	530
	TOWS	8	29	0	6	5	5	5	58

Table C-66

Estimated Density (No./1000 m^3) of Atlantic Tomcod Juveniles in 7 Geographical Regions of Hudson River Estuary (RM 14-76; KM 22-122) Determined from Fall Shoals Survey, 1976

			Region						
DATE	STRATA		YK	TZ	CH	IP	WP	CW	PK
8/16- 8/20	SHOALS(< 20 FT.)	DEN	101.83	11.07	0.09	0.54	0.0	0.0	0.0
		SE	35.28	7.22	0.09	0.39	0.0	0.0	0.0
		TOW	7	19	27	13	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	152.10	124.52	38.07	4.20	1.65	0.0
		SE	0.0	25.29	49.40	14.10	2.32	0.81	0.0
		TOW	0	7	9	6	5	5	5
8/30- 9/ 3	SHOALS(< 20 FT.)	DEN	35.44	1.04	1.69	18.22	0.0	0.0	0.0
		SE	10.35	0.39	0.97	6.13	0.0	0.0	0.0
		TOW	7	19	26	14	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	30.76	9.60	17.28	53.31	21.19	3.08
		SE	0.0	12.41	3.49	3.14	28.20	9.19	1.14
		TOW	0	7	9	6	5	5	5
9/13- 9/16	SHOALS(< 20 FT.)	DEN	21.47	0.0	0.0	0.24	0.0	0.0	0.0
		SE	4.88	0.0	0.0	0.24	0.0	0.0	0.0
		TOW	7	19	28	12	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	43.48	13.64	27.29	37.85	33.54	11.61
		SE	0.0	9.24	4.05	3.81	17.35	16.48	3.53
		TOW	0	7	9	6	5	5	5
9/27-10/ 1	SHOALS(< 20 FT.)	DEN	25.51	1.91	0.45	3.34	0.0	0.0	0.0
		SE	5.24	1.02	0.19	1.92	0.0	0.0	0.0
		TOW	7	19	27	13	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	5.57	5.30	10.72	8.73	10.24	0.82
		SE	0.0	3.30	2.13	3.70	6.40	5.48	0.50
		TOW	0	7	9	6	5	5	5
10/11-10/14	SHOALS(< 20 FT.)	DEN	6.09	5.17	0.60	0.67	0.0	0.0	0.0
		SE	3.55	1.33	0.24	0.50	0.0	0.0	0.0
		TOW	7	19	27	12	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	22.91	1.32	1.21	0.39	0.47	0.0
		SE	0.0	13.77	0.46	0.44	0.39	0.47	0.0
		TOW	0	7	9	7	5	5	5

Table C-66 (Contd)

			Region						
DATE	STRATA		YK	TZ	CH	IP	WP	CW	PK
10/25-10/28	SHOALS(< 20 FT.)	DEN	5.69	4.33	1.13	0.71	0.0	0.0	0.0
		SE	2.34	0.74	0.68	0.46	0.0	0.0	0.0
		TOW	8	32	19	7	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	3.66	0.89	5.64	8.73	11.55	1.43
		SE	0.0	1.58	0.55	3.56	2.42	2.98	0.95
		TOW	0	11	5	6	5	5	5
11/ 8-11/12	SHOALS(< 20 FT.)	DEN	3.46	7.96	2.41	1.05	0.0	0.0	0.0
		SE	2.43	1.44	0.80	0.73	0.0	0.0	0.0
		TOW	8	32	19	7	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	12.55	9.23	0.31	2.16	2.31	0.50
		SE	0.0	3.73	4.51	0.31	2.16	1.62	0.50
		TOW	0	11	5	6	6	4	5
11/21-11/24	SHOALS(< 20 FT.)	DEN	9.54	17.20	2.42	0.78	0.0	0.0	0.0
		SE	5.29	4.00	1.12	0.78	0.0	0.0	0.0
		TOW	8	31	19	7	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	14.95	3.68	0.0	0.0	2.93	0.0
		SE	0.0	6.51	0.80	0.0	0.0	1.84	0.0
		TOW	0	11	5	6	5	5	5
12/ 6-12/ 8	SHOALS(< 20 FT.)	DEN	11.24	11.60	0.0	9.57	0.0	0.0	0.0
		SE	3.43	2.52	0.0	1.53	0.0	0.0	0.0
		TOW	8	23	0	2	0	0	0
	BOTTOM(> 20 FT.)	DEN	0.0	29.88	0.0	6.50	1.52	2.07	2.14
		SE	0.0	6.30	0.0	3.18	0.62	0.93	1.56
		TOW	0	6	0	4	5	5	5

Table C-67

Catch Per Unit Effort of Atlantic Tomcod Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 12-152; KM 19-243) Based on 100-Ft (30.5-m) Beach Seine during Daytime, 1976

		Region												
Date		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
3/7-3/20	CPUE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	0	0	0	0	0	0	0	0	0	0	0	0	0
3/21-4/3	CPUE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	12	11	7	3	5	11	0	0	0	0	0	0	49
4/4-4/17	CPUE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	39	23	34	30	22	16	7	3	2	4	9	10	199
4/18-5/1	CPUE	0.13	0.21	0.12	0.59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.16
	SE	0.07	0.12	0.06	0.22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04
	Tows	38	19	26	34	25	32	8	3	1	4	5	9	204
	$\bar{X}$ length	33.00	28.50	25.00	28.70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.00
5/2-5/15	CPUE	2.43	3.96	0.25	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.86
	SE	1.84	1.44	0.25	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.31
	Tows	23	25	16	40	33	27	4	1	1	4	8	7	189
	$\bar{X}$ length	26.00	36.17	0.0	37.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.95
5/16-5/29	CPUE	8.48	1.60	0.41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.38
	SE	2.79	0.65	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.43
	Tows	27	20	27	41	29	27	2	4	2	3	6	9	197
	$\bar{X}$ length	49.45	46.94	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.56
5/30-6/12	CPUE	24.28	6.89	0.31	0.19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.21
	SE	7.89	3.28	0.12	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00
	Tows	18	18	26	32	35	30	0	1	2	4	6	7	179
	$\bar{X}$ length	65.43	55.00	64.67	60.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.02
6/13-6/26	CPUE	11.36	1.77	0.02	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.51
	SE	3.17	1.02	0.02	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.45
	Tows	22	22	40	42	23	22	2	1	1	5	5	8	193
	$\bar{X}$ length	75.40	70.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.17
6/27-7/10	CPUE	5.73	0.29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.66
	SE	5.02	0.22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.56
	Tows	22	24	28	30	22	18	9	5	4	8	11	19	200
	$\bar{X}$ length	75.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.83
7/11-7/24	CPUE	1.63	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.24
	SE	0.56	0.58	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.08
	Tows	19	15	21	35	19	20	12	7	2	7	13	20	190
	$\bar{X}$ length	81.74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.74
7/25-8/7	CPUE	2.19	1.29	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.31
	SE	0.81	0.58	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.10
	Tows	16	17	23	39	20	17	10	6	4	7	12	20	191
	$\bar{X}$ length	88.35	73.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.13
8/8-8/21	CPUE	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
	SE	0.0	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
	Tows	17	19	25	40	19	17	10	6	4	8	14	18	197
8/22-9/4	CPUE	0.06	0.53	0.13	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07
	SE	0.06	0.21	0.09	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02
	Tows	17	17	15	50	21	16	12	6	3	7	12	22	198
	$\bar{X}$ length	0.0	87.25	86.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.00
9/5-9/18	CPUE	0.04	0.41	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05
	SE	0.04	0.35	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03
	Tows	28	17	18	51	24	22	5	3	3	3	6	8	188
	$\bar{X}$ length	0.0	93.83	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	93.83
9/19-10/2	CPUE	0.10	0.24	1.59	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.26
	SE	0.05	0.14	1.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.16
	Tows	31	17	27	37	24	26	5	3	2	5	8	11	196
	$\bar{X}$ length	124.00	95.00	100.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	101.67
10/3-10/16	CPUE	0.07	0.21	1.28	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.23
	SE	0.05	0.12	1.24	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.16
	Tows	28	19	25	45	22	21	6	2	3	4	7	11	198
	$\bar{X}$ length	111.50	0.0	98.55	105.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.08
10/17-10/30	CPUE	0.38	0.54	0.31	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.17
	SE	0.13	0.27	0.17	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05
	Tows	16	26	29	51	23	23	5	1	2	4	7	11	198
	$\bar{X}$ length	119.50	121.75	120.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	120.86
10/31-11/13	CPUE	0.23	0.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.05
	SE	0.11	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02
	Tows	22	33	26	46	16	19	4	2	3	4	5	10	190
	$\bar{X}$ length	113.50	119.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.67
11/14-11/27	CPUE	0.53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.12
	SE	0.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04
	Tows	45	22	24	49	18	14	4	3	3	4	8	11	205
11/28-12/11	CPUE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tows	0	5	14	17	17	14	0	0	0	0	3	3	73

Table C-68

Estimated Standing Crops of Atlantic Tomcod Juveniles in 12 Geographical Regions of Hudson River Estuary (RM 12-152; KM 19-243) Based on 100-Ft (30.5-m) Beach Seine during Daytime, 1976

		Region												
Date		YK	TZ	CH	IP	WP	CW	PK	HP	KG	SG	CS	AL	Total
3/ 7-3/20	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	0	0	0	0	0	0	0	0	0	0	0	0	0
3/21-4/ 3	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	12	11	7	3	5	11	0	0	0	0	0	0	49
4/ 4-4/17	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	39	23	34	30	22	16	7	3	2	4	9	10	199
4/18-5/ 1	SC	991	9565	3103	5421	0	0	0	0	0	0	0	0	19080
	SE	506	5580	1718	2063	0	0	0	0	0	0	0	0	6213
	Tows	38	19	26	34	25	32	8	3	1	4	5	9	204
5/ 2-5/15	SC	18337	179925	6723	691	0	0	0	0	0	0	0	0	205675
	SE	13867	65553	6723	389	0	0	0	0	0	0	0	0	67342
	Tows	23	25	16	40	33	27	4	1	1	4	8	7	189
5/16-5/29	SC	63875	72697	10956	0	0	0	0	0	0	0	0	0	147527
	SE	20985	29556	4816	0	0	0	0	0	0	0	0	0	36567
	Tows	27	20	27	41	29	27	2	4	2	3	6	9	197
5/30-6/12	SC	182839	313000	8274	1728	0	0	0	0	0	0	0	0	505841
	SE	59431	149248	3258	965	0	0	0	0	0	0	0	0	160681
	Tows	18	18	26	32	35	30	0	1	2	4	6	7	179
6/13-6/26	SC	85581	80545	672	219	0	0	0	0	0	0	0	0	167017
	SE	23890	46209	672	219	0	0	0	0	0	0	0	0	52024
	Tows	22	22	40	42	23	22	2	1	1	5	5	8	193
6/27-7/10	SC	43133	13252	0	0	0	0	0	0	0	0	0	0	56385
	SE	37812	10041	0	0	0	0	0	0	0	0	0	0	39123
	Tows	22	24	28	30	22	18	9	5	4	8	11	19	200
7/11-7/24	SC	12288	45436	0	0	0	0	0	0	0	0	0	0	57723
	SE	4201	26232	0	0	0	0	0	0	0	0	0	0	26566
	Tows	19	15	21	35	19	20	12	7	2	7	13	20	190
7/25-8/ 7	SC	16474	58799	2338	0	0	0	0	0	0	0	0	0	77612
	SE	6080	26357	1615	0	0	0	0	0	0	0	0	0	27097
	Tows	16	17	23	39	20	17	10	6	4	7	12	20	191
8/ 8-8/21	SC	0	0	2151	0	0	0	0	0	0	0	0	0	2151
	SE	0	0	1489	0	0	0	0	0	0	0	0	0	1489
	Tows	17	19	25	40	19	17	10	6	4	8	14	18	197
8/22-9/ 4	SC	443	24054	3585	184	0	0	0	0	0	0	0	0	28267
	SE	443	9636	2443	184	0	0	0	0	0	0	0	0	9953
	Tows	17	17	15	50	21	16	12	6	3	7	12	22	198
9/ 5-9/18	SC	269	18709	2988	0	0	0	0	0	0	0	0	0	21966
	SE	269	16092	2050	0	0	0	0	0	0	0	0	0	16224
	Tows	28	17	18	51	24	22	5	3	3	3	6	8	188
9/19-10/ 2	SC	729	10691	42827	0	0	0	0	0	0	0	0	0	54246
	SE	407	6196	30793	0	0	0	0	0	0	0	0	0	31413
	Tows	31	17	27	37	24	26	5	3	2	5	8	11	196
10/3-10/16	SC	538	9565	34421	1434	0	0	0	0	0	0	0	0	45957
	SE	373	5580	33317	1054	0	0	0	0	0	0	0	0	33800
	Tows	28	19	25	45	22	21	6	2	3	4	7	11	193
10/17-10/30	SC	2824	24465	8346	903	0	0	0	0	0	0	0	0	36538
	SE	941	12147	4643	903	0	0	0	0	0	0	0	0	13070
	Tows	16	26	29	51	23	23	5	1	2	4	7	11	198
10/31-11/13	SC	1712	6884	0	0	0	0	0	0	0	0	0	0	8596
	SE	848	3493	0	0	0	0	0	0	0	0	0	0	3595
	Tows	22	33	26	46	16	19	4	2	3	4	5	10	190
11/14-11/27	SC	4017	0	0	0	0	0	0	0	0	0	0	0	4017
	SE	1163	0	0	0	0	0	0	0	0	0	0	0	1163
	Tows	45	22	24	49	18	14	4	3	3	4	8	11	205
11/28-12/11	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	0	5	14	17	17	14	0	0	0	0	3	3	73
12/12-12/25	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	0	0	0	0	0	0	0	0	0	0	0	0	0
12/26-12/31	SC	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tows	0	0	0	0	0	0	0	0	0	0	0	0	0

Table C- 69

Catch Per Unit Effort of Atlantic Tomcod Juveniles in Hudson River Estuary Determined by Bottom Trawl, 1974 (NS = no sample)

Sampling Period	Region YK	TZ	CH	IP	WP	CW
3/23 - 4/5	NS*	0.0	0.0	0.0	NS	NS
4/6 - 4/19	0.0	0.0	0.0	0.0	0.0	0.0
4/20 - 5/3	NS	NS	NS	0.0	0.0	0.0
5/4 - 5/17	NS	793.10	2.04	1.53	NS	NS
6/1 - 6/14	0.61	5.74	1.02	0 0	4.59	2.91
6/15 - 6/28	9.18	35.95	59.16	52.63	3.82	1.84
6/29 - 7/12	0.0	0.0	0.0	0.0	0.0	0.38
7/13 - 7/26	0.0	0.38	0.0	26.65	19.63	0.0
7/27 - 8/9	1.53	0.0	0.0	73.22	41.92	0.0
8/10 - 8/23	NS	0.0	0.0	18.97	72.29	0.0
8/24 - 9/6	0.0	0.0	0.0	9.56	121.89	0.0
9/7 - 9/20	0.0	0.0	0.0	1.53	7.65	0.0
9/21 - 10/4	NS	NS	0.0	3.24	0.0	NS
10/5 - 10/18	0.0	0.0	0.0	2.30	1.53	0.0
10/19 - 11/1	NS	NS	3.06	4.40	2.30	5.81
11/2 - 11/15	0.19	5.00	1.02	9.56	3.06	1.91
11/16 - 11/29	NS	5.40	30.98	17.60	NS	NS
11/30 - 12/13	NS	1.53	1.53	3.67	8.42	0.51

Table C- 70

Catch Per Unit Effort of Atlantic Tomcod Juveniles in Hudson River Estuary Determined by Bottom Trawl, 1975

Sampling Period	Region TZ	CH	IP	WP	CW
4/6 - 4/19	0.0	0.0	2.86	0.0	0.0
4/20 - 5/3	0.92	NS	0.0	0.0	0.0
5/4 - 5/17	12.56	0.0	319.69	0.0	0.0
5/18 - 5/31	47.88	6.92	14.87	52.31	0.0
6/1 - 6/14	0.19	0.0	184.27	7.08	0.0
6/15 - 6/28	121.10	23.08	60.38	11.38	6.92
7/13 - 7/12	46.59	1.54	139.62	300.00	22.15
7/27 - 8/9	14.29	1.03	60.15	6.67	0.0
8/10 - 8/23	16.48	1.03	186.92	90.15	6.54
8/24 - 9/6	0.0	0.0	89.08	43.46	1.54
9/7 - 9/20	0.51	0.51	25.81	80.77	0.38
9/21 - 10.4	0.58	0.0	32.82	20.31	0.0
10/5 - 10/18	1.15	0.51	14.15	2.69	0.0
10/19 - 11/1	2.12	0.0	2.62	1.85	0.0
11/2 - 11/15	0.51	0.0	0.42	3.08	1.15
11/16 - 11/29	0.58	0.0	0.31	0.31	0.0
11/30 - 12/13	0.58	0.0	0.84	0.0	0.0
12/14 - 12/27	0.0	0.0	7.86	1.54	1.23

Table C-71

Release and Recapture Data for Tagged Atlantic Tomcod Recaptured January 1977 to June 1977

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
January	6-27230	12/21/76	56 West	126	36	1/ 2/77	42 East		11	14	99-Indian Point
	6-20870	12/ 8/76	51 West	202	36	1/ 3/77	51 West	202	25	0	36-Box Trap
	6-21466	12/16/76	51 East	234	36	1/ 3/77	51 East	234	17	0	36-Box Trap
	**6-21598	12/15/76	76 East	138	36	1/ 3/77	67 East	135	18	9	36-Box Trap
	6-21955	12/16/76	51 West	177	36	1/ 3/77	50 West		17	1	98-Sports Fisherman
	6-22497	12/13/76	51 East	223	36	1/ 3/77	51 East	222	20	0	36-Box Trap
	6-22980	12/16/76	51 East	210	36	1/ 3/77	51 West	208	17	0	36-Box Trap
	6-23165	12/13/76	51 West	216	36	1/ 3/77	51 East	215	20	0	36-Box Trap
	6-23239	12/13/76	51 West	168	36	1/ 3/77	51 East	166	20	0	36-Box Trap
	6-24074	12/17/76	51 West	158	36	1/ 3/77	51 East	158	16	0	36-Box Trap
	6-24612	12/17/76	51 West	196	36	1/ 3/77	51 East	196	16	0	36-Box Trap
	6-26668	12/16/76	51 West	135	36	1/ 3/77	51 West	139	17	0	36-Box Trap
	6-27053	12/21/76	56 West	253	36	1/ 3/77	51 East	252	12	5	36-Box Trap
	6-28024	12/30/76	67 East	159	36	1/ 3/77	67 East	158	3	0	36-Box Trap
	6-28498	12/20/76	52 West	115	36	1/ 3/77	42 East	111	13	10	99-Indian Point
	6-28589	12/27/76	67 East	166	36	1/ 3/77	67 East	163	6	0	36-Box Trap
	6-29512	12/21/76	51 West	161	36	1/ 3/77	51 East	160	12	0	36-Box Trap
	6-29684	12/21/76	67 East	145	36	1/ 3/77	76 East	144	12	-9	36-Box Trap
	6-29936	12/20/76	76 East	215	36	1/ 3/77	67 East	214	13	9	36-Box Trap
	6-34666	12/30/76	51 East	163	36	1/ 3/77	51 East	160	3	0	36-Box Trap
	6-35814	12/28/76	56 West	162	36	1/ 3/77	51 West	164	5	5	36-Box Trap
	6-19685	12/10/76	51 East	205	36	1/ 4/77	51 East	208	24	0	36-Box Trap
	6-22947	12/16/76	51 East	216	36	1/ 4/77	51 West	215	18	0	36-Box Trap
	6-25366	12/15/76	71 West	119	36	1/ 4/77	66 West	116	19	5	96-Danskammer
	6-26867	12/15/76	51 East	226	36	1/ 4/77	52 West	232	19	-1	36-Box Trap
	6-28221	12/22/76	67 East	155	36	1/ 4/77	66 West	151	12	1	96-Danskammer
	6-28569	12/27/76	67 East	147	36	1/ 4/77	65 West	143	7	2	91-Roseton
	6-29517	12/21/76	51 West	136	36	1/ 4/77	51 East	137	13	0	36-Box Trap
	6-30698	12/21/76	51 East	187	36	1/ 4/77	51 East	189	13	0	36-Box Trap
	6-32701	1/ 3/77	51 West	247	36	1/ 4/77	51 West	244	1	0	36-Box Trap
	6-35490	1/ 3/77	51 East	150	36	1/ 4/77	51 East	150	1	0	36-Box Trap
	6-35574	1/ 3/77	51 East	134	36	1/ 4/77	51 East	132	1	0	36-Box Trap
	6-35629	1/ 3/77	51 East	149	36	1/ 4/77	51 East	149	1	0	36-Box Trap
	6-35640	1/ 3/77	51 East	137	36	1/ 4/77	51 East	139	1	0	36-Box Trap
	6-38219	12/30/76	51 West	134	36	1/ 4/77	52 West	132	4	-1	36-Box Trap
	6-38909	1/ 3/77	51 West	150	36	1/ 4/77	51 West	149	1	0	36-Box Trap
	6-39992	1/ 3/77	51 East	170	36	1/ 4/77	51 East	171	1	0	36 Box Trap
	6-10116	12/23/75	51 East	188	36	1/ 5/77	66 West	254	378	-15	96-Danskammer
	6-19571	12/10/76	51 East	154	36	1/ 5/77	51 East	151	25	0	36-Box Trap
	6-26926	12/20/76	71 West	127	36	1/ 5/77	66 West	127	15	5	96-Danskammer
	6-33868	1/ 3/77	76 East	168	36	1/ 5/77	76 East	165	2	0	36-Box Trap
	6-35522	1/ 3/77	51 East	162	36	1/ 5/77	51 East	162	2	0	36-Box Trap
	6-35608	1/ 3/77	51 East	151	36	1/ 5/77	51 West	150	2	0	36-Box Trap
	6-39288	1/ 4/77	51 East	152	36	1/ 5/77	51 East	149	1	0	36-Box Trap
	6-40315	1/ 4/77	76 East	232	36	1/ 5/77	76 East	232	1	0	36-Box Trap
	6-19312	11/24/76	27 East	142	36	1/ 6/77	36 East	146	42	-9	36-Box Trap
	6-23230	12/13/76	51 West	154	36	1/ 6/77	51 East	154	23	0	36-Box Trap
	6-23607	12/29/76	60 East	168	36	1/ 6/77	51 East	166	7	9	36-Box Trap
	6-31006	12/17/76	51 East	253	36	1/ 6/77	52 West	253	19	-1	36-Box Trap
	6-32157	12/30/76	36 East	160	36	1/ 6/77	36 East	158	6	0	36-Box Trap
	6-32381	1/ 3/77	51 West	180	36	1/ 6/77	51 East	179	3	0	36-Box Trap
	6-35643	1/ 3/77	51 East	114	36	1/ 6/77	51 East	116	3	0	36-Box Trap
	6-37384	12/29/76	51 East	226	36	1/ 6/77	51 East	224	7	0	36-Box Trap
	6-39375	1/ 4/77	51 East	167	36	1/ 6/77	51 East	166	2	0	36-Box Trap
	6-21822	12/16/76	51 West	126	36	1/ 7/77	51 East	126	21	0	36-Box Trap
	6-22176	12/ 9/76	71 West	150	36	1/ 7/77	51 East	146	28	20	36-Box Trap
	6-23219	12/13/76	51 West	136	36	1/ 7/77	51 East	135	24	0	36-Box Trap
	6-23416	12/14/76	51 East	176	36	1/ 7/77	51 East	175	23	0	36-Box Trap
	6-23952	12/16/76	51 East	125	36	1/ 7/77	51 East	126	21	0	36-Box Trap
	6-25736	12/20/76	76 East	139	36	1/ 7/77	51 East	140	17	25	36-Box Trap
	6-28331	12/20/76	51 West	148	36	1/ 7/77	51 West	148	17	0	36-Box Trap
	6-37071	12/29/76	51 East	139	36	1/ 7/77	42 East	134	8	9	99-Indian Point
	6-37426	12/29/76	51 East	157	36	1/ 7/77	51 East	155	8	0	36-Box Trap
	6-39177	1/ 4/77	51 East	142	36	1/ 7/77	51 East	143	3	0	36-Box Trap
	**6-39441	1/ 4/77	51 East	203	36	1/ 7/77	51 East	201	3	0	36-Box Trap
	6-29150	12/27/76	36 East	152	36	1/10/77	36 East	151	13	0	36-Box Trap
	6-30572	12/30/76	36 East	145	36	1/10/77	36 East	139	10	0	36-Box Trap
	6-38734	12/30/76	36 East	176	36	1/10/77	36 East	175	10	0	36-Box Trap
	**6-39441	1/ 4/77	51 East	203	36	1/10/77	51 East	200	6	0	36-Box Trap
	6-39938	1/ 3/77	51 East	283	36	1/10/77	36 East	286	7	15	36-Box Trap
	6-23010	12/13/76	51 West	148	36	1/11/77	51 West	149	28	0	36-Box Trap
	6-24779	12/17/76	67 East	179	36	1/11/77	65 West	175	24	2	96-Danskammer
	6-28270	12/22/76	67 East	158	36	1/11/77	66 West	155	19	1	96-Danskammer
	6-28552	12/27/76	67 East	150	36	1/11/77	66 West	148	14	1	96-Danskammer
	6-28692	12/22/76	67 East	148	36	1/11/77	66 West	143	19	1	96-Danskammer

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*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-71 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	6-30346	12/27/76	71 West	116	36	1/11/77	65 West	113	14	6	91-Roseton
	6-30365	12/27/76	71 West	142	36	1/11/77	65 West	141	14	6	96-Danskammer
	6-30481	12/27/76	71 West	148	36	1/11/77	65 West	147	14	6	96-Danskammer
	6-31089	12/17/76	51 East	137	36	1/11/77	51 West	137	24	0	36-Box Trap
	6-32833	1/ 3/77	51 East	153	36	1/11/77	51 East	150	8	0	36-Box Trap
	6-39789	1/ 4/77	51 East	145	36	1/11/77	51 East	143	7	0	36-Box Trap
	6-24031	12/17/76	51 West	177	36	1/12/77	65 West	170	25	-14	91-Roseton
	6-29132	12/27/76	36 East	232	36	1/12/77	51 East	230	15	-15	36-Box Trap
	6-30967	12/21/77	51 East	148	36	1/12/77	51 East	149	21	0	36-Box Trap
	6-35552	1/ 3/77	51 East	255	36	1/12/77	51 East	250	9	0	36-Box Trap
	6-35828	12/28/76	56 West	147	36	1/12/77	51 West	146	14	5	36-Box Trap
	6-37076	12/29/76	51 East	133	36	1/12/77	51 East	135	13	0	36-Box Trap
	6-39970	1/ 3/77	51 East	135	36	1/13/77	37 West	132	10	14	94-Other
	6-40625	1/11/77	67 East	154	36	1/13/77	71 West	155	2	-4	36-Box Trap
	6-25500	12/16/76	51 East	122	36	1/14/77	42 East	116	28	9	99-Indian Point
	6-37173	12/29/76	51 East	141	36	1/14/77	51 East	140	15	0	36-Box Trap
	6-19125	12/ 2/76	52 West	151	36	1/15/77	37 West	207	43	15	94-Other
	6-24157	12/16/76	56 West	150	36	1/15/77	37 West	147	29	19	94-Other
	6-35974	12/28/76	56 West	125	36	1/15/77	42 East	122	17	14	99-Indian Point
	6-26005	12/16/76	52 West	158	36	1/17/77	51 East	156	31	1	36-Box Trap
	6-36153	1/ 7/77	51 West	162	36	1/17/77	51 West	158	10	0	36-Box Trap
	**6-43927	1/13/77	36 East	161	36	1/17/77	36 East	130	4	0	36-Box Trap
	**6-43927	1/13/77	36 East	161	36	1/17/77	36 East	159	4	0	36-Box Trap
	6-33988	1/ 3/77	76 East	146	36	1/18/77	65 West	140	15	11	91-Roseton
	6-39860	1/17/77	51 West	149	36	1/18/77	51 West	149	1	0	36-Box Trap
	6-27840	12/27/76	71 West	141	36	1/19/77	65 West	137	22	6	91-Roseton
	6-29205	12/27/76	67 East	155	36	1/19/77	65 West	149	22	2	91-Roseton
	6-31504	12/20/76	51 East	161	36	1/19/77	52 West	164	29	-1	36-Box Trap
	6-37216	12/29/76	51 East	145	36	1/19/77	51 East	146	20	0	36-Box Trap
	6-28908	12/20/76	52 West	161	36	1/20/77	51 East	160	30	1	36-Box Trap
	6-30595	12/30/76	36 East	141	36	1/20/77	51 East	140	20	-15	36-Box Trap
	**6-38153	12/30/76	51 West	146	36	1/20/77	51 East	143	20	0	36-Box Trap
	6-38530	1/ 4/77	51 East	148	36	1/20/77	51 East	146	16	0	36-Box Trap
	6-41527	1/ 4/77	51 West	231	36	1/20/77	51 East	228	16	0	36-Box Trap
	**6-38153	12/30/76	51 West	146	36	1/21/77	51 East	144	21	0	36-Box Trap
	6-38339	12/30/76	51 West	166	36	1/21/77	51 East	165	21	0	36-Box Trap
	6-20401	12/ 8/76	36 East	148	36	1/22/77	37 West	149	44	-1	97-Bowline
	6-30587	12/30/76	36 East	142	36	1/22/77	37 West	142	22	-1	97-Bowline
	6-21769	12/ 9/76	51 East	201	36	1/24/77	51 East	192	45	0	36-Box Trap
	6-36259	1/ 4/77	36 East	160	36	1/24/77	36 East	148	20	0	36-Box Trap
	6-23542	12/29/76	71 West	143	36	1/25/77	65 West	139	26	6	91-Roseton
	6-24300	12/16/76	56 West	216	36	1/25/77	65 West	209	39	-9	91-Roseton
	6-28050	12/30/76	67 East	137	36	1/25/77	66 West	134	25	1	96-Danskammer
	6-34425	12/30/76	67 East	157	36	1/25/77	66 West	153	25	1	96-Danskammer
	6-36708	12/29/76	51 West	210	36	1/25/77	65 West	205	26	-14	91-Roseton
	6-38389	12/30/76	51 East	173	36	1/25/77	66 West	175	25	-15	94-Other
	6-40066	1/ 4/77	67 East	193	36	1/25/77	66 West	192	21	1	94-Other
	6-41942	1/24/77	76 East	118	36	1/25/77	76 East	119	1	0	36-Box Trap
	6-41946	1/24/77	76 East	165	36	1/25/77	76 East	163	1	0	36-Box Trap
	6-41948	1/24/77	76 East	158	36	1/25/77	76 East	159	1	0	36-Box Trap
	6-33752	1/25/77	71 West	128	36	1/26/77	72 West	125	1	-1	36-Box Trap
	6-32297	12/30/76	36 East	121	36	1/27/77	27 East	121	27	9	36-Box Trap
	6-36572	12/29/76	51 West	150	36	1/27/77	51 East	146	28	0	36-Box Trap
	6-37709	1/26/77	51 East	141	36	1/27/77	51 East	139	1	0	36-Box Trap
	6-37726	1/26/77	51 East	135	36	1/31/77	51 East	133	5	0	36-Box Trap
	6-40944	1/20/77	60 East	151	36	1/31/77	51 East	149	11	9	36-Box Trap
February	6-25866	12/20/76	76 East	159	36	2/ 1/77	66 West	153	42	10	96-Danskammer
	6-33798	1/28/77	76 East	137	36	2/ 1/77	71 West	138	4	5	36-Box Trap
	6-40865	1/31/77	51 East	126	36	2/ 1/77	51 East	122	1	0	36-Box Trap
	6-41913	1/21/77	52 West	157	36	2/ 1/77	51 East	157	11	1	36-Box Trap
	6-33307	2/ 1/77	51 East	142	36	2/ 2/77	51 East	140	1	0	36-Box Trap
	6-33707	1/ 5/77	51 West	173	36	2/ 2/77	51 East	143	28	0	36-Box Trap
	6-42972	2/ 2/77	51 East	137	36	2/ 3/77	51 East	137	1	0	36-Box Trap
	6-41146	1/19/77	71 West	159	36	2/ 7/77	51 East	157	19	20	36-Box Trap
	6-42375	1/13/77	76 East	154	36	2/ 8/77	66 West	149	26	10	96-Danskammer
	6-28770	12/21/76	67 East	244	36	2/ 9/77	65 West	230	49	2	91-Roseton
	6-33598	2/ 1/77	51 East	141	36	2/ 9/77	51 East	140	8	0	36-Box Trap
	6-38583	1/ 4/77	51 East	147	36	2/ 9/77	37 West	144	36	14	97-Bowline
	6-42839	2/ 7/77	51 East	160	36	2/ 9/77	51 East	158	2	0	36-Box Trap
	6-42877	2/ 8/77	71 West	133	36	2/10/77	71 West	132	2	0	36-Box Trap
	6-42884	2/ 8/77	71 West	147	36	2/10/77	65 West	146	2	6	91-Roseton
	6-36325	12/30/76	43 East	120	36	2/12/77	37 West	119	43	6	97-Bowline
	6-24278	12/16/76	56 West	146	36	2/14/77	37 West	142	59	19	97-Bowline
	6-26690	12/16/76	51 West	177	36	2/14/77	37 West	178	59	14	97-Bowline
	6-33767	1/25/77	76 East	165	36	2/15/77	66 West	166	21	10	96-Danskammer
	6-18023	1/26/76	51 East	164	36	2/16/77	51 East		386	0	88-88
	6-21898	12/16/76	51 West	137	36	2/16/77	37 West	133	61	14	97-Bowline

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*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-71 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel Gr	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	6-06859	12/17/75	51 East	163	36	2/21/77	42 East		431	9	99-Indian Point
	6-36411	1/20/77	71 West	117	36	2/22/77	42 East	115	33	29	99-Indian Point
	6-42038	1/ 5/77	67 East	195	36	2/22/77	66 West	190	48	1	96-Danskammer
	6-35819	12/28/76	56 West	121	36	2/23/77	42 East		56	14	99-Indian Point
	6-43047	2/ 9/77	51 East	133	36	2/23/77	42 East	133	14	9	99-Indian Point
March	6-29040	12/28/77	67 East	283	36	3/ 1/77	66 West	270	62	1	94-Other
	6-33751	1/25/77	71 West	221	36	3/ 2/77	42 East	213	36	29	99-Indian Point
	6-36042	12/28/76	56 West	268	36	3/ 3/77	17 East		64	39	98-Sports Fisherman
	6-17685	1/28/76	51 East	150	36	3/ 6/77	3 West		402	48	98-Sports Fisherman
	6-27987	12/27/76	71 West	240	36	3/11/77	3 West		73	68	98-Sports Fisherman
	6-42660	1/11/77	51 East	177	36	3/12/77	19 East		60	32	98-Sports Fisherman
	6-43400	2/ 2/77	51 East	114	36	3/12/77	37 West	113	38	14	97-Bowline
	6-43998	2/ 9/77	41 East	125	0	3/16/77	37 West	123	35	4	97-Bowline
	6-29171	12/27/76	36 East	182	36	3/19/77	37 West	176	81	-1	97-Bowline
	6-34291	12/28/76	51 East	134	36	3/19/77	37 West	133	80	14	97-Bowline
	6-33919	1/ 3/77	76 East	208	36	3/20/77	19 East		76	57	98-Sports Fisherman
	6-27086	12/21/76	56 West	270	36	3/29/77	East River		97	56	98-Sports Fisherman
	6-31387	12/17/76	51 East	245	36	3/29/77	East River		101	51	98-Sports Fisherman
	6-35239	1/ 3/77	51 East	226	36	3/30/77	13 West		86	38	98-Sports Fisherman
	6-36575	12/29/76	51 West	187	36	3/30/77	East River		90	51	98-Sports Fisherman
April	6-30855	12/21/76	51 East	261	36	4/ 4/77	11 East		103	40	98-Sports Fisherman
	6-33451	1/24/77	52 West	240	36	4/ 7/77	East River		73		98-Sports Fisherman
	6-38080	12/30/76	51 West	190	36	4/ 9/77	Kill Van Kull,N.J.		99	51	98-Sports Fisherman
	6-27811	12/27/76	71 West	262	36	4/14/77	13 West		107	58	98-Sports Fisherman
	6-29420	12/21/76	76 East	139	36	4/14/77	31 West		113	45	98-Sports Fisherman
	6-32525	1/ 7/77	51 East	136	36	4/17/77	26 West		100	25	93-Commercial Fisherman
	6-38376	12/30/76	51 East	145	36	4/17/77	East River		107		98-Sports Fisherman
	6-43751	1/14/77	52 West	137	36	4/17/77	26 West		93	26	93-Commercial Fisherman
	6-33339	2/ 1/77	71 West	132	36	4/19/77	27 West		77	44	93-Commercial Fisherman
	6-36445	1/20/77	52 West	142	36	4/19/77	27 West		89	25	93-Commercial Fisherman
	6-41679	1/31/77	67 East	157	36	4/19/77	27 West		78	40	93-Commercial Fisherman
	6-32325	1/ 3/77	51 West	185	36	4/21/77	Upper NY Bay		108		98-Sports Fisherman
	6-37429	12/29/76	51 East	122	36	4/24/77	27 West		115	24	93-Commercial Fisherman
	6-25788	12/20/76	76 East	153	36	4/27/77	3 West		127	73	98-Sports Fisherman
	6-39804	1/17/77	71 West	153	36	4/29/77	10 West		101	61	98-Sports Fisherman
	6-34259	12/28/76	51 East	184	36	4/30/77	East River		122		98-Sports Fisherman
May	6-40479	1/ 4/77	60 East	164	36	5/ 7/77	Gravesend Bay		123		98-Sports Fisherman
	6-24208	12/16/76	56 West	200	36	5/14/77	27 West		148	29	98-Sports Fisherman
	6-32649	1/ 6/77	76 East	189	36	5/18/77	Upper NY Bay		132		98-Sports Fisherman
	6-42619	1/10/77	51 East	196	36	5/30/77	13 East		140	38	98-Sports Fisherman
June	6-41450	1/ 4/77	51 West	134	36	6/ 7/77	38 Cntr		154	13	93-Commercial Fisherman
	6-42056	1/ 5/77	67 East	149	36	6/ 9/77	27 West	150	155	40	54-300' Gill Net
	6-33162	2/14/77	51 East	109	36	6/11/77	42 East	135	117	9	99-Indian Point
	6-35392	1/ 3/77	51 East	241	36	6/11/77	1 West		159	50	98-Sports Fisherman

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*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-72

Release and Recapture Data for Tagged Atlantic Tomcod Recaptured August to December, 1976

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel GR	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
August	6-11179	12/23/75	51 East	164	36	8/ 8/76	42 East		229	9	99-Indian Point
November	6-19303	11/18/76	36 East	168	36	11/29/76	36 East	169	11	0	36-Box Trap
December	6-19328	11/29/76	36 East	217	36	12/ 1/76	36 East	220	2	0	36-Box Trap
	6-19343	12/ 1/76	34 East	170	36	12/ 2/76	34 East	171	1	0	36-Box Trap
	6-19382	12/ 1/76	34 East	181	36	12/ 2/76	34 East	168	1	0	36-Box Trap
	6-19107	12/ 2/76	34 East	167	36	12/ 7/76	34 East	164	5	0	36-Box Trap
	6-19971	12/ 7/76	34 East	148	36	12/ 9/76	34 East	147	2	0	36-Box Trap
	6-20009	12/ 7/76	34 East	137	36	12/ 9/76	36 East	137	2	-2	36-Box Trap
	6-20265	12/ 8/76	34 East	135	36	12/ 9/76	34 East	133	1	0	36-Box Trap
	**6-20836	12/ 8/76	51 West	272	36	12/ 9/76	51 East	265	1	0	36-Box Trap
	6-22195	12/ 9/76	71 West	159	36	12/ 9/76	66 West	154	0	5	6-Box Trap
	**6-20836	12/ 8/76	51 West	272	36	12/10/76	51 East	270	2	0	36-Box Trap
	6-21636	12/ 9/76	51 East	159	36	12/10/76	51 East	159	1	0	36-Box Trap
	6-21738	12/ 9/76	51 East	260	36	12/10/76	51 East	259	1	0	36-Box Trap
	6-21741	12/ 9/76	51 East	175	36	12/10/76	51 East	174	1	0	36-Box Trap
	6-21748	12/ 9/76	51 East	238	36	12/10/76	51 East	238	1	0	36-Box Trap
	**6-21769	12/ 9/76	51 East	201	36	12/10/76	51 East	203	1	0	36-Box Trap
	6-22164	12/ 9/76	71 West	159	36	12/11/76	66 West	155	2	5	94-Other
	6-19510	12/10/76	51 East	237	36	12/13/76	51 East	233	3	0	36-Box Trap
	6-19680	12/10/76	51 East	235	36	12/13/76	51 East	235	3	0	36-Box Trap
	6-20857	12/ 8/76	51 West	146	36	12/13/76	51 East	148	5	0	36-Box Trap
	6-21297	12/10/76	51 East	220	36	12/13/76	51 East	220	3	0	36-Box Trap
	6-21625	12/ 9/76	51 East	160	36	12/13/76	51 East	158	4	0	36-Box Trap
	6-21704	12/ 9/76	51 East	182	36	12/13/76	51 East	184	4	0	36-Box Trap
	6-21727	12/ 9/76	51 East	218	36	12/13/76	51 East	220	4	0	36-Box Trap
	6-21787	12/ 9/76	51 East	140	36	12/13/76	51 East	142	4	0	36-Box Trap
	**6-22248	12/10/76	51 East	189	36	12/13/76	51 East	191	3	0	36-Box Trap
	6-22253	12/10/76	51 East	155	36	12/13/76	51 East	156	3	0	36-Box Trap
	6-19150	12/ 6/76	52 West	138	36	12/14/76	51 East	135	8	1	36-Box Trap
	6-19609	12/ 7/76	51 East	171	36	12/14/76	51 East	170	7	0	36-Box Trap
	6-19690	12/10/76	51 East	182	36	12/14/76	51 East	183	4	0	36-Box Trap
	6-19828	12/ 7/76	34 East	167	36	12/14/76	51 East	165	7	-17	36-Box Trap
	6-20565	12/ 9/76	34 East	158	36	12/14/76	51 East	155	7	-17	36-Box Trap
	6-22199	12/ 9/76	71 West	154	36	12/14/76	66 West	149	5	5	96-Danskammer
	6-22501	12/10/76	51 East	159	36	12/14/76	51 East	158	4	0	36-Box Trap
	6-22539	12/10/76	51 East	180	36	12/14/76	51 East	181	4	0	36-Box Trap
	6-23225	12/13/76	51 West	180	36	12/14/76	51 West	174	1	0	36-Box Trap
	6-23261	12/13/76	51 West	131	36	12/14/76	51 West	128	1	0	36-Box Trap
	6-19025	12/13/76	51 West	181	36	12/15/76	51 East	175	2	0	36-Box Trap
	6-19413	12/14/76	52 West	214	36	12/15/76	51 East	210	1	1	36-Box Trap
	6-19597	12/10/76	51 East	174	36	12/15/76	51 East	172	5	0	36-Box Trap
	6-20715	12/ 9/76	56 West	158	36	12/15/76	51 East	157	6	5	36-Box Trap
	6-22450	12/13/76	51 East	219	36	12/15/76	51 East	215	2	0	36-Box Trap
	6-22451	12/13/76	51 East	161	36	12/15/76	51 East	158	2	0	36-Box Trap
	6-22680	12/14/76	51 East	160	36	12/15/76	51 East	161	1	0	36-Box Trap
	6-23061	12/13/76	51 West	204	36	12/15/76	51 East	199	2	0	36-Box Trap
	6-23426	12/14/76	51 East	159	36	12/15/76	51 East	156	1	0	36-Box Trap
	6-23462	12/14/76	51 East	259	36	12/15/76	51 East	245	1	0	36-Box Trap
	6-19147	12/ 6/76	52 West	207	36	12/16/76	51 East	208	10	1	36-Box Trap
	6-19474	12/14/76	52 West	200	36	12/16/76	51 West	200	2	1	36-Box Trap
	6-19825	12/ 7/76	34 East	228	36	12/16/76	51 West	229	9	-17	36-Box Trap
	6-20373	12/ 8/76	36 East	153	36	12/16/76	56 West	155	8	-20	36-Box Trap
	6-20386	12/ 8/76	36 East	139	36	12/16/76	51 East	141	8	-15	36-Box Trap
	6-21033	12/15/76	76 East	241	36	12/16/76	76 East	233	1	0	36-Box Trap
	6-21604	12/ 9/76	51 East	215	36	12/16/76	51 West	216	7	0	36-Box Trap
	6-21734	12/ 9/76	51 East	202	36	12/16/76	51 West	203	7	0	36-Box Trap
	6-22042	12/16/76	51 West	155	36	12/16/76	51 East	205	0	0	36-Box Trap
	6-22132	12/ 9/76	71 West	138	36	12/16/76	52 West	138	7	19	36-Box Trap
	6-22528	12/10/76	51 East	174	36	12/16/76	51 West	171	6	0	36-Box Trap
	6-22537	12/10/76	51 East	227	36	12/16/76	51 East	230	6	0	36-Box Trap
	6-22696	12/14/76	51 East	148	36	12/16/76	51 East	149	2	0	36-Box Trap
	6-23354	12/14/76	51 East	140	36	12/16/76	51 East	141	2	0	36-Box Trap
	6-23897	12/15/76	76 East	207	36	12/16/76	76 East	200	1	0	36-Box Trap
	6-26537	12/15/76	51 East	230	36	12/16/76	51 East	228	1	0	36-Box Trap
	6-19404	12/14/76	52 West	238	36	12/17/76	56 West	233	3	-4	36-Box Trap
	6-21025	12/15/76	76 East	143	36	12/17/76	76 East	145	2	0	36-Box Trap
	6-21551	12/15/76	76 East	196	36	12/17/76	76 East	194	2	0	36-Box Trap
	6-21793	12/ 9/76	51 East	228	36	12/17/76	51 West	228	8	0	36-Box Trap
	6-22131	12/ 9/76	71 West	160	36	12/17/76	67 East	156	8	4	36-Box Trap
	6-22279	12/10/76	51 East	154	36	12/17/76	51 East	153	7	0	36-Box Trap
	6-22962	12/16/76	51 East	243	36	12/17/76	51 East	246	1	0	36-Box Trap
	6-23275	12/13/76	51 West	164	36	12/17/76	67 East	158	4	-16	36-Box Trap
	6-23358	12/14/76	51 East	145	36	12/17/76	51 East	148	3	0	36-Box Trap
	6-23844	12/15/76	76 East	150	36	12/17/76	76 East	148	2	0	36-Box Trap
	6-23992	12/16/76	51 East	240	36	12/17/76	51 East	241	1	0	36-Box Trap
	6-24172	12/16/76	56 West	260	36	12/17/76	56 West	245	1	0	36-Box Trap
	6-24231	12/16/76	56 West	195	36	12/17/76	56 West	184	1	0	36-Box Trap
	6-24282	12/16/76	56 West	119	36	12/17/76	56 West	206	1	0	36-Box Trap
	6-24318	12/16/76	56 West	122	36	12/17/76	56 West	214	1	0	36-Box Trap
	6-24328	12/16/76	56 West	200	36	12/17/76	56 West	185	1	0	36-Box Trap

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-72 (Contd)

		Releases				Recovery					
Recovery Period	Tag No.	Date	RM/Site	Total Length (mm)	Rel GR	Date	RM/Site	Total Length (mm)	Days at Large	Distance* (mi)	Recovery Gear
	6-24374	12/16/76	56 West	142	36	12/17/76	56 West	141	1	0	36-Box Trap
	6-25365	12/15/76	71 West	212	36	12/17/76	67 East	212	2	4	36-Box Trap
	6-25927	12/16/76	51 West	132	36	12/17/76	51 West	135	1	0	36-Box Trap
	6-25982	12/16/76	51 West	161	36	12/17/76	51 West	163	1	0	36-Box Trap
	6-26386	12/16/76	51 East	142	36	12/17/76	51 East	144	1	0	36-Box Trap
	6-26420	12/16/76	51 East	207	36	12/17/76	51 East	210	1	0	36-Box Trap
	6-26574	12/15/76	51 East	146	36	12/17/76	51 West	150	2	0	36-Box Trap
	6-26880	12/15/76	51 East	174	36	12/17/76	51 East	172	2	0	36-Box Trap
	6-26888	12/15/76	51 East	170	36	12/17/76	51 West	172	2	0	36-Box Trap
	6-23203	12/13/76	51 West	137	36	12/18/76	37 West	139	5	14	97-Bowline
	6-24427	12/17/76	51 West	122	36	12/18/76	42 East	117	1	9	99-Indian Point
	6-24425	12/17/76	51 West	134	36	12/19/76	42 East	128	2	9	99-Indian Point
	6-19086	12/14/76	52 West	148	36	12/20/76	51 East	147	6	1	36-Box Trap
	6-19425	12/14/76	52 West	242	36	12/20/76	51 West	240	6	1	36-Box Trap
	6-20547	12/ 9/76	34 East	142	36	12/20/76	36 East	142	11	-2	36-Box Trap
	6-21310	12/13/76	71 West	148	36	12/20/76	76 East	147	7	-5	36-Box Trap
	6-21736	12/ 9/76	51 East	182	36	12/20/76	51 East	180	11	0	36-Box Trap
	**6-21769	12/ 9/76	51 East	201	36	12/20/76	51 East	200	11	0	36-Box Trap
	6-21842	12/16/76	51 West	289	36	12/20/76	51 West	284	4	0	36-Box Trap
	6-22324	12/13/76	51 East	232	36	12/20/76	52 West	232	7	-1	36-Box Trap
	6-23041	12/13/76	51 West	161	36	12/20/76	51 East	162	7	0	36-Box Trap
	6-23294	12/13/76	51 West	134	36	12/20/76	51 East	134	7	0	36-Box Trap
	6-23428	12/14/76	51 East	171	36	12/20/76	51 East	172	6	0	36-Box Trap
	6-24020	12/17/76	51 West	231	36	12/20/76	51 East	225	3	0	36-Box Trap
	6-24118	12/16/76	56 West	131	36	12/20/76	52 West	129	4	4	36-Box Trap
	6-24207	12/16/76	56 West	221	36	12/20/76	51 East	218	4	5	36-Box Trap
	6-24564	12/17/76	51 West	161	36	12/20/76	51 East	160	3	0	36-Box Trap
	6-25580	12/16/76	51 East	131	36	12/20/76	51 East	128	4	0	36-Box Trap
	6-25936	12/16/76	51 West	147	36	12/20/76	51 East	145	4	0	36-Box Trap
	6-26814	12/15/76	51 East	152	36	12/20/76	51 West	154	5	0	36-Box Trap
	6-31057	12/17/76	51 East	153	36	12/20/76	51 East	151	3	0	36-Box Trap
	6-31297	12/17/76	51 East	148	36	12/20/76	51 West	153	3	0	36-Box Trap
	6-19265	12/14/76	52 West	144	36	12/21/76	51 East	142	7	1	36-Box Trap
	6-19267	12/14/76	52 West	156	36	12/21/76	51 East	155	7	1	36-Box Trap
	6-19514	12/10/76	51 East	205	36	12/21/76	56 West	206	11	-5	36-Box Trap
	6-20029	12/ 7/76	34 East	168	36	12/21/76	56 West	169	14	-22	36-Box Trap
	6-20712	12/ 9/76	56 West	150	36	12/21/76	51 East	151	12	5	36-Box Trap
	6-21619	12/ 9/76	51 East	238	36	12/21/76	56 West	236	12	-5	36-Box Trap
	6-22033	12/16/76	51 West	130	36	12/21/76	51 East	129	5	0	36-Box Trap
	**6-22248	12/10/76	51 East	189	36	12/21/76	51 East	190	11	0	36-Box Trap
	**6-22248	12/10/76	51 East	189	36	12/21/76	51 East	189	11	0	36-Box Trap
	6-22870	12/15/76	76 East	160	36	12/21/76	76 East	159	6	0	36-Box Trap
	6-25725	12/20/76	76 East	146	36	12/21/76	76 East	177	1	0	36-Box Trap
	6-26764	12/16/76	51 West	142	36	12/21/76	51 East	143	5	0	36-Box Trap
	6-30012	12/20/76	51 East	205	36	12/21/76	51 East	206	1	0	36-Box Trap
	6-31446	12/20/76	71 West	121	36	12/21/76	66 West	118	1	5	96-Danskammer
	6-31719	12/20/76	51 East	227	36	12/21/76	51 East	230	1	0	36-Box Trap
	6-31757	12/20/76	51 East	209	36	12/21/76	51 East	207	1	0	36-Box Trap
	6-21154	12/ 9/76	34 East	124	36	12/22/76	66 West	153	13	-32	96-Danskammer
	6-22849	12/15/76	76 East	205	36	12/22/76	71 West	206	7	5	36-Box Trap
	6-24830	12/17/76	67 East	158	36	12/22/76	66 West	157	5	1	96-Danskammer
	6-26928	12/20/76	71 West	137	36	12/22/76	66 West	136	2	5	96-Danskammer
	6-27189	12/21/76	56 West	131	36	12/22/76	41 West	131	1	15	95-Lovett
	6-28734	12/21/76	67 East	215	36	12/22/76	67 East	215	1	0	36-Box Trap
	6-21077	12/15/76	76 East	133	36	12/23/76	42 East	134	8	34	99-Indian Point
	6-29540	12/21/76	51 West	140	36	12/24/76	42 East	141	3	9	99-Indian Point
	6-20606	12/ 9/76	71 West	148	36	12/26/76	42 East	144	17	29	99-Indian Point
	6-21221	12/ 9/76	36 East	144	36	12/28/76	51 East	141	19	-15	36-Box Trap
	6-22028	12/16/76	51 West	213	36	12/28/76	51 East	213	12	0	36-Box Trap
	6-23013	12/13/76	51 West	105	36	12/28/76	56 West	163	15	-5	36-Box Trap
	6-24255	12/16/76	56 West	133	36	12/28/76	66 West	132	12	-10	96-Danskammer
	6-24337	12/16/76	56 West	154	36	12/28/76	56 West	152	12	0	36-Box Trap
	6-28784	12/21/76	67 East	124	36	12/28/76	66 West	125	7	1	96-Danskammer
	6-19234	12/ 6/76	52 West	150	36	12/29/76	51 East	147	23	1	36-Box Trap
	6-19860	12/ 7/76	34 East	141	36	12/29/76	51 East	141	22	-17	36-Box Trap
	6-23421	12/14/76	51 East	175	36	12/29/76	51 East	177	15	0	36-Box Trap
	6-26636	12/16/76	51 West	143	36	12/29/76	51 East	144	13	0	36-Box Trap
	6-27106	12/21/76	56 West	252	36	12/29/76	51 East	251	8	5	36-Box Trap
	6-28275	12/22/76	67 East	130	36	12/29/76	51 East	128	7	16	36-Box Trap
	6-34105	12/28/76	51 East	147	36	12/29/76	51 East	151	1	0	36-Box Trap
	6-35119	12/28/76	51 East	129	36	12/29/76	51 East	130	1	0	36-Box Trap
	6-37039	12/29/76	51 East	136	36	12/29/76	51 East	135	0	0	36-Box Trap
	6-37323	12/29/76	51 East	137	36	12/29/76	51 East	138	0	0	36-Box Trap
	6-20449	12/ 9/76	34 East	127	36	12/30/76	36 East	127	21	-2	36-Box Trap
	6-20883	12/ 8/76	51 West	240	36	12/30/76	51 East	231	22	0	36-Box Trap
	6-21760	12/ 9/76	51 East	243	36	12/30/76	51 East	241	21	0	36-Box Trap
	6-22541	12/10/76	51 East	159	36	12/30/76	51 East	155	20	0	36-Box Trap
	6-23220	12/13/76	51 West	123	36	12/30/76	42 East	127	17	9	99-Indian Point
	6-23351	12/14/76	51 East	131	36	12/30/76	42 East	130	16	9	99-Indian Point
	6-23808	12/15/76	76 East	156	36	12/30/76	66 West	154	15	10	96-Danskammer
	6-27774	12/27/76	36 East	151	36	12/30/76	36 East	153	3	0	36-Box Trap
	6-29877	12/21/76	67 East	175	36	12/30/76	51 East	175	9	16	36-Box Trap
	6-30123	12/20/76	51 West	159	36	12/30/76	51 East	157	10	0	36-Box Trap
	6-31016	12/17/76	51 East	198	36	12/30/76	51 East	196	13	0	36-Box Trap
	6-36581	12/29/76	51 West	170	36	12/30/76	51 West	169	1	0	36-Box Trap
	6-37249	12/29/76	51 East	122	36	12/30/76	51 East	142	1	0	36-Box Trap
	6-37305	12/29/76	51 East	128	36	12/30/76	51 East	128	1	0	36-Box Trap

*Minus sign indicates movement north of release site; no sign indicates southward movement.

**Multiple recaptures.

Table C-73

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Atlantic Tomcod Eggs above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Egg Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	S. C.	%	S. C.	%	S. C.	%	S. C.	%	S. C.	%
2/23 - 2/27	Above	125.0	100.0	119.6	95.6	114.1	91.3	0.0	0.0	0.0	0.0
	Within	0.0	0.0	5.4	4.3	10.9	8.7	38.0	30.4	25.3	20.2
	Below	0.0	0.0	0.0	0.0	0.0	0.0	87.0	69.6	99.7	79.7
3/22 - 3/25	Above	10.0	100.0	8.89	88.9	7.78	77.8	0.0	0.0	0.0	0.0
	Within	0.0	0.0	2.0	11.1	2.22	22.2	0.0	0.0	0.0	0.0
	Below	0.0	0.0	0.0	0.0	0.0	0.0	10.0	100.0	10.0	100.0
Totals	Above	135.0	100.0	129.0	96.0	122.0	90.0	0.0	0.0	0.0	0.0
	Within	0.0	0.0	6.0	4.0	13.0	10.0	38.0	28.0	25.0	19.0
	Below	0.0	0.0	0.0	0.0	0.0	0.0	97.0	72.0	110.0	91.0

Table C-74

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Atlantic Tomcod Yolk-Sac Larvae above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Yolk-Sac Larva Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%
2/23 - 3/27	Above	19,103.4	21.9	11,843.2	13.6	10,664.4	12.2	336.9	0.4	270.2	0.4
	Within	27,213.1	31.3	25,090.2	28.8	24,345.4	27.9	1,370.0	1.6	1,204.7	1.4
	Below	40,719.5	46.8	50,102.6	57.6	52,026.2	59.8	85,329.0	9.8	85,561.1	98.3
3/1 - 3/5	Above	65,606.2	52.4	53,054.3	42.4	50,152.7	40.1	6,058.9	4.8	4,858.1	3.9
	Within	39,316.7	31.4	41,298.8	33.0	41,034.7	32.8	17,946.1	14.3	17,206.4	13.7
	Below	20,221.0	16.1	30,790.8	24.6	33,956.6	27.1	101,139.0	80.8	103,079.5	82.4
3/8 - 3/11	Above	87,711.1	24.5	59,256.6	16.6	54,866.2	15.3	3,378.6	0.9	2,708.9	0.7
	Within	165,316.7	46.2	141,756.6	39.6	127,848.2	35.7	13,741.4	3.8	12,081.7	3.4
	Below	104,679.2	29.3	156,693.8	43.8	174,992.6	48.9	340,587.0	95.2	342,916.3	95.9
3/22 - 3/25	Above	16,299.5	10.5	6,413.1	4.1	5,927.3	3.8	435.9	0.3	349.5	0.2
	Within	57,291.4	37.0	43,427.4	28.1	39,444.9	25.5	1,479.6	0.9	1,363.4	0.9
	Below	81,169.1	52.4	104,919.4	67.8	109,387.8	70.7	152,844.5	98.8	153,047.1	98.9
Totals	Above	188,720.0	26.0	130,567.0	18.0	121,610.0	17.0	10,211.0	1.0	8,187.0	1.0
	Within	289,138.0	40.0	251,573.0	35.0	232,673.0	32.0	34,537.0	5.0	31,855.0	4.0
	Below	246,789.0	34.0	342,506.0	47.0	370,364.0	51.0	679,900.0	94.0	684,604.0	95.0

Table C-75

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Atlantic Tomcod Post Yolk-Sac Larvae above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey during Periods of Post Yolk-Sac Larva Abundance, 1976

		Bowline		Lovett		Indian Point		Roseton		Danskammer	
Date	Area	Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%
3/22 - 3/25	Above	226.9	0.3	168.8	0.2	148.6	0.2	0.0	0.0	0.0	0.0
	Within	4,010.4	6.1	468.4	0.7	401.8	0.6	3.5	0.0	2.3	0.0
	Below	61,267.7	93.5	64,867.8	99.0	64,954.6	99.1	65,501.5	99.9	65,502.7	99.9
4/5 - 4/8	Above	6.0	4.9	6.0	4.9	6.0	4.9	0.0	0.0	0.0	0.0
	Within	28.2	23.1	0.0	0.0	0.0	0.0	3.0	2.4	1.9	1.6
	Below	87.8	71.9	116.0	95.1	116.0	95.1	119.0	97.5	120.0	98.4
4/19 - 4/21	Above	457.6	0.6	90.0	0.1	78.7	0.1	0.0	0.0	0.0	0.0
	Within	29,764.4	37.1	7,447.8	9.3	5,837.7	7.3	5.5	0.0	3.7	0.0
	Below	50,085.0	62.4	72,770.8	90.6	74,390.6	92.6	80,301.5	99.9	80,303.3	99.9
4/26 - 4/29	Above	7,839.1	7.4	120.7	0.1	119.3	0.1	6.9	0.0	5.6	0.0
	Within	59,932.8	56.7	45,257.1	42.8	39,089.3	36.9	58.5	0.0	45.0	0.0
	Below	37,888.1	35.8	60,282.2	57.0	66,451.4	62.9	105,594.5	99.9	105,609.4	99.9
5/3 - 5/5	Above	579.5	1.4	503.0	1.2	461.1	1.1	92.9	0.2	85.6	0.2
	Within	11,696.1	29.2	233.1	0.6	250.3	0.6	74.0	0.2	81.4	0.2
	Below	27,758.4	69.3	39,297.8	98.1	39,322.6	98.2	39,867.0	99.6	39,867.0	99.6
5/10 - 5/13	Above	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Within	139.8	25.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Below	404.2	74.3	544.0	100.0	544.0	100.0	544.0	100.0	544.0	100.0
5/17 - 5/19	Above	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Within	183.9	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Below	429.1	70.0	613.0	100.0	613.0	100.0	613.0	100.0	613.0	100.0
Totals	Above	9,110.0	3.0	887.0	<1.0	813.0	<1.0	100.0	<1.0	92.0	<1.0
	Within	105,755.0	36.0	53,406.0	18.0	45,580.0	16.0	146.0	<1.0	134.0	<1.0
	Below	177,920.0	61.0	238,375.6	81.0	246,393.0	84.0	292,542.0	99.0	292,560.0	99.0

Table C-76

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Atlantic Tomcod Juveniles above, within, and below 5 Power-Plant Regions Determined from Ichthyoplankton Survey, 1976

Date	Area	Bowline		Lovett		Indian Point		Roseton		Danskammer	
		Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%
4/26 - 4/29	Above	290.0	1.2	0	0.0	0	0.0	0	0.0	0	0.0
	Within	13,451.0	55.9	7,613.0	31.7	5,903.0	25.0	0	0.0	0	0.0
	Below	10,310.0	42.9	16,437.0	68.3	18,147.0	75.0	24,051.0	100.0	24,051.0	100.0
5/3 - 5/5	Above	934.0	0.7	633.0	0.5	586.0	0.5	56.0	0.0	45.0	0.0
	Within	39,274.0	30.6	2,126.0	1.7	1,822.0	1.4	157.0	0.1	154.0	0.1
	Below	87,996.0	68.6	125,443.0	97.8	125,795.0	98.1	127,990.0	99.8	128,004.0	99.8
5/10 - 5/13	Above	229.0	6.1	190.0	5.1	190.0	5.1	152.0	4.1	152.0	4.1
	Within	997.0	26.7	102.0	2.7	102.0	2.7	19.0	0.5	13.0	0.3
	Below	2,516.0	67.2	3,449.0	92.2	3,449.0	92.2	3,570.0	95.4	3,576.0	95.6
5/17 - 5/19	Above	2,759.0	12.6	2,321.0	10.6	2,313.0	10.6	1,016.0	4.6	984.0	4.5
	Within	5,734.0	26.2	1,321.0	6.0	1,287.0	5.9	783.0	3.6	663.0	3.0
	Below	13,411.0	61.2	18,262.0	83.4	18,304.0	83.6	20,105.0	91.8	20,258.0	92.5
5/24 - 5/26	Above	818.0	3.8	347.0	1.6	340.0	1.6	64.0	0.3	61.0	0.3
	Within	6,741.0	31.4	1,244.0	5.8	1,251.0	5.8	132.0	0.6	103.0	0.5
	Below	13,924.0	64.8	19,892.0	92.6	19,892.0	92.6	21,287.0	99.1	21,319.0	99.2
6/1 - 6/4	Above	3,609.0	32.3	2,910.0	26.0	2,634.0	23.5	162.0	1.4	153.0	1.4
	Within	2,304.0	20.6	1,902.0	17.0	2,053.0	18.4	315.0	2.8	250.0	2.2
	Below	5,274.0	47.1	6,375.0	57.0	6,500.0	58.1	10,710.0	95.7	10,784.0	96.4
6/7 - 6/11	Above	1,258.0	6.4	981.0	5.0	972.0	5.0	313.0	1.6	276.0	1.4
	Within	5,060.0	25.9	2,645.0	13.5	2,173.0	11.1	484.0	2.5	483.0	2.5
	Below	13,252.0	67.7	15,944.0	81.5	16,424.0	83.9	18,773.0	95.9	18,811.0	96.1
6/14 - 6/17	Above	2,147.0	12.8	1,778.0	10.6	1,701.0	10.1	198.0	1.2	171.0	1.0
	Within	7,489.0	44.5	4,160.0	24.7	3,410.0	20.3	616.0	3.7	526.0	3.1
	Below	7,200.0	42.8	10,898.0	64.7	11,724.0	69.6	16,022.0	95.2	16,138.0	95.9
6/21 - 6/24	Above	748.0	1.1	89.0	0.1	87.0	0.1	35.0	0.1	32.0	0.0
	Within	21,953.0	33.5	3,876.0	5.9	3,348.0	5.1	35.0	0.1	36.0	0.1
	Below	42,850.0	65.4	61,586.0	94.0	62,116.0	94.8	65,480.0	99.9	65,481.0	99.9
6/28 - 7/1	Above	2,305.0	4.4	1,508.0	2.9	1,440.0	2.7	0	0.0	0	0.0
	Within	5,696.0	10.9	3,900.0	7.4	3,497.0	6.7	479.0	1.0	319.0	0.6
	Below	44,423.0	84.7	47,015.0	89.7	47,488.0	90.6	51,945.0	99.1	52,105.0	99.4
7/6 - 7/9	Above	592.0	1.7	191.0	0.6	173.0	0.5	0	0.0	0	0.0
	Within	9,337.0	17.3	2,433.0	7.1	2,102.0	6.1	23.0	0.1	15.0	0.0
	Below	24,315.0	71.0	31,619.0	92.3	31,968.0	93.4	34,220.0	99.9	34,228.0	100.0

Table C-77

Estimated Standing Crops (in Thousands) and Percent Standing Crops of Atlantic Tomcod Juveniles above, within, and below 5 Power-Plant Regions Determined from Fall Shoals Survey, 1976

Date	Area	Bowline		Lovett		Indian Point		Roseton		Danskammer	
		Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%	Standing Crop	%
8/16 - 8/20	Above	674.0	3.5	181.0	1.0	168.0	0.9	1.0	0.0	1.0	0.0
	Within	8089.0	42.5	4534.0	23.8	3737.0	19.6	38.0	0.2	25.0	0.1
	Below	10275.0	54.0	14323.0	75.2	15134.0	79.5	19000.0	99.8	19013.0	99.9
8/30 - 9/3	Above	2992.0	43.5	2521.0	36.6	2351.0	34.2	72.0	1.0	57.0	0.8
	Within	1519.0	22.1	1299.0	18.9	1388.0	20.2	618.0	9.0	474.0	6.9
	Below	2372.0	34.5	3064.0	44.5	3145.0	45.7	6194.0	90.0	6353.0	92.3
9/13 - 9/16	Above	3736.0	46.6	3273.0	40.8	3152.0	39.3	268.0	3.3	215.0	2.7
	Within	1826.0	22.7	1390.0	17.3	1421.0	17.7	1290.0	16.1	1091.0	13.6
	Below	2464.0	30.7	3363.0	41.9	3451.0	43.0	6468.0	80.6	6719.0	83.7
9/27 - 10/1	Above	917.0	34.9	739.0	28.2	711.0	27.1	19.0	0.7	16.0	0.6
	Within	621.0	23.7	586.0	22.3	574.0	21.9	268.0	10.2	195.0	7.4
	Below	1087.0	41.4	1299.0	49.5	1339.0	51.0	2336.0	89.1	2413.0	92.0
10/11 - 10/14	Above	51.0	2.1	31.0	1.3	30.0	1.3	0.0	0.0	0.0	0.0
	Within	722.0	30.4	111.0	4.7	97.0	4.1	11.0	0.4	8.0	0.3
	Below	1599.0	67.4	2229.0	94.0	2244.0	94.7	2360.0	99.6	2363.0	99.7
10/25 - 10/28	Above	942.0	45.7	840.0	40.7	812.0	39.4	34.0	1.6	27.0	1.3
	Within	440.0	21.3	297.0	14.4	307.0	14.9	326.0	15.8	246.0	11.9
	Below	681.0	33.0	925.0	44.9	943.0	45.7	1703.0	82.6	1790.0	86.8
11/8 - 11/12	Above	210.0	8.4	194.0	7.8	187.0	7.5	12.0	0.5	10.0	0.4
	Within	969.0	38.9	375.0	15.0	296.0	11.8	76.0	3.0	61.0	2.4
	Below	1316.0	52.8	1926.0	77.2	2012.0	80.7	2407.0	96.5	2425.0	97.2
11/21 - 11/24	Above	136.0	3.7	132.0	3.6	132.0	3.6	0.0	0.0	0.0	0.0
	Within	1163.0	31.7	210.0	5.7	160.0	4.4	66.0	1.8	44.0	1.2
	Below	2370.0	64.6	3327.0	90.7	3377.0	92.1	3602.0	98.2	3624.0	98.8
12/6 - 12/8	Above	411.0	9.8	280.0	6.7	275.0	6.6	50.0	1.2	40.0	0.9
	Within	1192.0	28.4	343.0	8.2	348.0	8.3	146.0	3.5	140.0	3.3
	Below	2587.0	61.8	3568.0	85.2	3568.0	85.2	3995.0	95.4	4011.0	95.7

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