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**Fred Dacimo**
Vice President
License Renewal

January 4, 2008

Re: Indian Point Units 2 & 3
Docket Nos. 50-247 & 50-286

NL-08-006

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: **Reply to Request for Additional Information**
**Regarding Environmental Review for License Renewal Application**

Reference: NRC letter dated December 5, 2007; "Request for Additional Information Regarding Environmental Review for Indian Point Nuclear Generating Unit Nos. 2 and 3 License Renewal Application (TAC Nos. MD5411 and MD5412)"

Dear Sir or Madam:

Entergy Nuclear Operations, Inc is providing, in Attachment I, the additional information requested in the referenced letter pertaining to NRC review of the License Renewal Application for Indian Point 2 and Indian Point 3. The additional information provided in this transmittal addresses Environmental staff questions.

There are no new commitments identified in this submittal. If you have any questions or require additional information, please contact Mr. R. Walpole, Manager, Licensing at (914) 734-6710.

I declare under penalty of perjury that the foregoing is true and correct. Executed on 1-4-08.

Sincerely,

Patricia W. Conway for
Fred R. Dacimo per telecon
Vice President
License Renewal

A128
NRR

cc: next page

Attachment I – Reply to NRC Request For Additional Information Regarding License Renewal Application (Environmental)
Enclosure 1 – Striped Bass Winter Population Survey (marked recapture)
Enclosure 2 – Atlantic Tomcod Spawning Stock Survey (Table with mark and recapture data)

cc: w/Attachment & Enclosures

Mr. Bo M. Pham, NRC Environmental Project Manager

Ms. Jill Caverly, NRC Environmental Project Manager

Mr. John P. Boska, NRC NRR Senior Project Manager

Mr. Samuel J. Collins, Regional Administrator, NRC Region I

Mr. Sherwin E. Turk, NRC Office of General Counsel, Special Counsel

IPEC NRC Senior Resident Inspector Office

w/o Enclosures

Mr. Paul D. Tonko, President, NYSERDA

Mr. Paul Eddy, New York State Dept. of Public Service

ATTACHMENT I TO NL-08-006

**REPLY TO NRC REQUEST FOR ADDITIONAL INFORMATION**

**REGARDING**

**LICENSE RENEWAL APPLICATION**

**(Environmental)**

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 and 3
DOCKETS 50-247 and 50-286

# INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
# LICENSE RENEWAL APPLICATION (LRA)
# REQUESTS FOR ADDITIONAL INFORMATION (RAI)

The U.S. Nuclear Regulatory Commission (NRC or staff) has reviewed the Environmental information provided by the applicant in the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3) LRA. The staff has identified that additional information is needed to complete the review as addressed below.

**Environmental RAI 1**

Provide a copy of the final report, a preliminary version of which was briefly described in a presentation at the site audit that discusses the development of a conceptual groundwater flow model for the Indian Point Nuclear Generating Unit Nos. 2 and 3 including monitoring well locations, sampling data, and site geology. Further, discuss the pertinence of the report to license renewal, this information is necessary to complete the review of the environmental impacts of the proposed project for groundwater and surface water resources, insofar as it may affect license renewal.

**Response for RAI 1**

The final report discussing the development of a conceptual groundwater flow model for the Indian Point Nuclear Generating Unit Nos. 2 and 3 including monitoring well locations, sampling data, and site geology is in the process of being finalized and will be submitted to the NRC by January 31, 2008. Its pertinence to license renewal will be fully described in that submittal.

**Environmental RAI 2**

Provide the following information as it is necessary to complete the review of the environmental impacts for aquatic resources.

Provide a copy of Year Class Report Table E Series Density Data for Hudson River Long River Studies:

- Ichthyoplankton Survey (1974-2005 density data)
- Long River Fall Shoals (juvenile fish) Survey (1985-2005 density data) 1985-2005 employed the same gear
- Long River Beach Seine Survey (1974-2005 density data)
- Striped Bass Winter Population Survey (marked recapture)
- In-river mark recapture estimator (series of annual reports) table with mark and recapture data
- Atlantic Tomcod Spawning Stock Survey - table with mark and recapture data

Also, provide water quality data for each study and year for Icthyoplankton and Fall survey (March-October)

Provide the following data regarding impingement:

- Continuous sampling Unit 2 and 3 operation through 1980 (4-5 years)
  1981-1990: Stratified random program 110 samples per year
  Supplemental Ristroph studies 1 screen in 1985, special studies to 1990-99
- Impingement abundance to include Indian Point Monitoring Reports (1975-1990)

Provide the following data regarding entrainment:

- Abundance (# per unit volume 2 per week in April-October)
- Years of study 1981, 1983, 1985-87 (abundance)

Provide the following regarding data types:

- Abundance indices
- Weekly densities
- Weekly standing crops from the Barnthouse et al. report on Hudson River Fish Trends

Provide the Barnthouse et al compilation of fish trends in the Hudson River.

**Response for RAI 2**

The following items have previously been submitted to the NRC on December 20, 2007, letter number NL-07-156.

- Ichthyoplankton Survey (1974-2005 density data)
- Long River Fall Shoals (juvenile fish) Survey (1985-2005 density data)
  1985-2005 employed the same gear
- Long River Beach Seine Survey (1974-2005 density data)
- Continuous sampling Unit 2 and 3 operation through 1980 (4-5 years)
  1981-1990: Stratified random program 110 samples per year
  Supplemental Ristroph studies 1 screen in 1985, special studies to 1990-99
- Impingement abundance to include Indian Point Monitoring Reports (1975-1990)
- Abundance (# per unit volume 2 per week in April-October)
- Years of study 1981, 1983, 1985-87 (abundance)
- Abundance indices
- Weekly densities

Copies of the following reports and studies are attached:

- Striped Bass Winter Population Survey (marked recapture) (Enclosure 1)
- Atlantic Tomcod Spawning Stock Survey - table with mark and recapture data (Enclosure 2)

The following item is still being compiled and will be provided by January 11, 2008

- Water quality data for each study and year for Icthyoplankton and Fall survey (March-October)

The Barnhouse et al compilation of fish trends in the Hudson River is expected to be finalized by January 22, 2008 and will subsequently be provided to the NRC in a timely manner.

An additional report was listed in the RAI request [In-river mark recapture estimator (series of annual reports), table with mark and recapture data]. This request is redundant to the information being provided in Enclosures 1 and 2 of this letter.

**Environmental RAI 3**

During the environmental scoping process, the NRC staff received comments (ADAMS accession nos. ML071990093 and ML073100985) which indicate that the reactor vessel heads of both Indian Point Nuclear Generating Unit Nos. 2 and 3 may be replaced in anticipation of license renewal. Please discuss whether vessel head replacements are being planned at Indian Point and if so, the relation of these plans to license renewal; and please discuss the associated impacts of such refurbishment activities on each of the pertinent environmental issues listed under Table B-1 of Appendix B to Subpart A of Part 51 of Title 10 of the *Code of Federal Regulations.*

**Response for RAI 3**

As set forth in the IPEC license renewal application, based on the demonstrations provided in Appendix B of the application, the effects of aging associated with the reactor vessel, internals, and reactor coolant system will be managed such that there is reasonable assurance that the intended functions will be maintained consistent with the current licensing basis during the period of extended operation. *See* IPEC License Renewal Application, Section 3.1 (including associated tables). Therefore, no reactor vessel head replacements are required for purposes of aging management during the period of extended operation. Accordingly, no evaluation of the environmental impacts of reactor vessel head replacement as a refurbishment activity is required or presented in the Environmental Report. As stated in the Environmental Report:

> The evaluation of structures and components as required by 10 CFR 54.21 has been completed and is described in the body of the IP2 and IP3 License Renewal Application. This evaluation did not identify the need for refurbishment of structures or components for purposes of license renewal and there are no such refurbishment activities planned at this time. Although routine plant operational and maintenance activities will be performed during the license renewal period, these activities are not refurbishments as described in Sections 2.4 and 3.1 of the GEIS and will be managed in accordance with appropriate Entergy programs and procedures.

IPEC Environmental Report, Section 3.3 at 3-23 to 3-24.

The comments cited by the NRC staff appear to relate to an Entergy project to procure long lead items for replacement reactor vessel heads for the Indian Point Units. That activity consists of ordering long lead replacement head forgings and Inconel and stainless steel materials needed for fabrication of the reactor heads. An economic decision to financially invest in and continue with final fabrication of the replacement heads into a final product that can be installed on a reactor will be made based upon inspection activities in accordance with Inservice Inspection

and Water Chemistry Control Programs. Moreover, the decision to proceed with procurement of long lead items is strictly economic; *i.e.*, it is intended to reduce potential future costs if future inspections indicate the need for repairs. This pragmatic approach is analogous to the current practice of considering storage for long lead spare and replacement parts and equipment, such as those currently maintained in storage at the plant.

In other words, it reflects a prudent business decision to prepare for future contingencies. Thus, there is no planned "major refurbishment outage" activity as defined in the GEIS.

# ENCLOSURE 1 TO NL-08-006

Striped Bass Winter Population Survey (marked recapture)

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 and 3
DOCKETS 50-247 and 50-286

# HUDSON RIVER STRIPED BASS PROGRAM
# NOVEMBER 2000 – APRIL 2001

**DECEMBER 2006**

# Hudson River Striped Bass Program
# November 2000 – April 2001

*Program conducted under contract with*
**NEW YORK POWER AUTHORITY**
**123 Main Street**
**White Plains, New York 10601**

*Jointly financed by*
**Central Hudson Gas and Electric Corporation**
**Consolidated Edison Company of New York, Inc.**
**New York Power Authority**
**Niagara Mohawk Power Corporation**
**Mirant Corporation**

*Report prepared under contract with*
**ENTERGY NUCLEAR OPERATIONS, INC.**
**440 Hamilton Avenue**
**White Plains, New York 10601-5029**

*Prepared by*
**NORMANDEAU ASSOCIATES, INC.**
**25 Nashua Road**
**Bedford, NH 03110**

**R-17443.003**

**December 2006**

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- The Program Manager for Normandeau Associates was Dr. Mark T. Mattson.
- The Program Manager for the New York Power Authority was Dr. Dennis J. Dunning.

## EXECUTIVE SUMMARY

- The Hudson River utilities no longer operate a striped bass hatchery in Verplanck, New York.
- The estimated size of the 2000-2001 winter striped bass population ≥150 mm in upper New York Harbor and the Battery region was 388,000 fish with lower and upper 95% confidence limits of 293,000 and 570,000.
- Age 0+ striped bass accounted for 2% (5,700 fish) of the winter population, Age 1+ contributed 79% (306,000 fish), Age 2+ contributed 17% (66,000 fish), Age 3+ contributed 1% (5,000 fish), and Age >3+ contributed 1% (4,000 fish).
- During the 2000-2001 striped bass program, 14,287 fish ≥150mm were caught and 13,363 fish in good condition were tagged and released bringing the total number of striped bass tagged and released in these programs since 1984 to 256,171. An additional 513 fish with one or more gross external injuries were tagged and released in 2000-2001, bring the total number of these fish tagged and released to 4,690. Of the 185 fish that were recaptured, 155 were tagged and released in the present program, 21 were from 1999-2000, and 5 fish were from the 1998-1999, 2 were from 1997-1998, and 2 were from 1996-1997 program.
- Overall mean catch per unit of effort (CPUE) in the Battery region was 22.0 striped bass per ten-minute tow. Mean CPUE during mid-December through mid-March increased annually from 1985-1986 to a peak of 45.3 in the 1989-1990 program. Mean CPUE decreased following 1989-1990 to 14.3 in the 1995-1996 program, and increased again to 38.4 and 31.7 in 1998-1999 and 1999-2000, respectively. The mean CPUE during mid-December through mid-March was 26.1 in 2000-2001.
- Handling mortality was less than 1% and was comparable to previous programs even though smaller fish (between 150 and 200 mm) were tagged compared to programs prior to 1988-1989. No relationship between water temperature and handling mortality was observed.

# 1.0 INTRODUCTION

The Hudson River striped bass program began in 1984 as an evaluation of fishing gear and techniques that were most efficient and effective to catch and handle striped bass for the purpose of determining the proportion of stocked hatchery fish among the wild cohorts. The best locations, times, and fishing gear were evaluated in the 1984 through 1987-1988 programs to maximize total catch and catch per unit of effort of Age 1+ and Age 2+ striped bass. The Battery region of the Hudson River adjacent to Manhattan, and upper New York Harbor in the vicinity of Liberty Island provided the most consistent catches of Age 1+ and Age 2+ striped bass during the November through March period. The 9-m trawl was the most effective gear for capturing Age 1+ and Age 2+ striped bass, and has been the only gear used from 1988-1989 through the present program (Table 1-1). Concurrent with these gear evaluations, handling techniques were improved to increase the survival of striped bass that were caught, tagged, scanned for hatchery-administered magnetic tags, and released (Dunning et. al. 1987, 1989). As the Verplanck hatchery increased the annual production of fish, and more striped bass were recaptured with hatchery-administered tags, we also quantified magnetic tag detection efficiency (Mattson et al. 1989) and improved the internal anchor-external streamer tag design (Mattson et al. 1989; Waldman et al. 1990).

The Hudson River striped bass program from 1988-1989 to the present has become primarily a stock assessment program. Hatchery production and stocking of marked striped bass fingerlings ended in October 1995. The program has emphasized consistency of sampling gear and procedures, and the refinement of laboratory techniques for scale examination to accurately determine age (e.g. Humphreys et al. 1989). Mark-recapture estimates are calculated for the total population and for the Age 1+ and Age 2+ sub-populations of striped bass found in the combined Battery and upper New York Harbor regions during the winter. Program consistency is documented through the use of Standard Operating Procedures and a quality control/quality assurance system that has helped maintain and improve data quality (Geoghegan et al. 1989).

The April-June 1984 adult striped bass program (Normandeau 1985) demonstrated that it was effective to use a 12 m trawl and a Scottish seine to capture striped bass with an average mortality of less than 18% at water temperatures ranging from 8 to 16 °C. The 1984 program also demonstrated that striped bass ≥300 mm (total length) could be externally tagged and released without significantly increasing 24-hour mortality (Dunning et al. 1987). No hatchery-tagged striped bass were recaptured during the 1984 program, and population estimates were not calculated from the relatively small sample of 737 external-tagged fish that were released (Table 1-1).

The 1985-1986 Hudson River striped bass program (Normandeau 1986) was conducted primarily in the lower Hudson, Harlem, and East Rivers from November 1985 through May 1986. Sampling with trawls in the Battery and Upper Harbor regions of the Hudson River estuary between mid-December 1985 and mid-April 1986 produced higher catches of striped bass per tow than in the Harlem and East Rivers. When fished in the Battery region of the lower Hudson River in the same weeks, mean catch per unit of effort for a 12 m trawl was greater than for a 9 m trawl, but total catch and mean catch per day were similar for the two trawls because more tows could be taken with the 9 m trawl in a day. The 12 m trawl was more efficient for capturing striped bass from 251 to 450 mm (total length), while the 9 m trawl was more efficient for capturing striped bass <250 mm. The Scottish seine, fished in the Tappan Zee and Croton-Haverstraw regions during April and May 1986, was efficient for capturing striped bass >400 mm. Striped bass handling mortality was reduced from 17% in 1984 to

1% or less in programs from 1985-86 to present by using an in-water live car to hold the fish prior to tagging (Dunning et. al. 1989). No hatchery-tagged fish were recaptured during the 1985-86 program among the 20,820 striped bass examined for magnetic tags. The mid-winter population of striped bass ≥200 mm was estimated to be 540,000 fish in the Battery and Upper New York Harbor, and 239,000 of these fish were estimated to be Age 1+ (Table 1-1).

Data from the 1984 and 1985-1986 programs (Normandeau 1985, 1986) were used to recommend sampling options and determine the number of fish needed to calculate statistically reliable estimates of the proportion of hatchery-reared striped bass in the Hudson River striped bass population (MMES 1986; Heimbuch et al. 1990). Of the seven sampling options reviewed for the hatchery evaluation, three were recommended for further consideration: (1) sampling yearling striped bass in the mouth of the river in winter, (2) sampling Age 2+ (nonharvestable adult) striped bass in the mouth of the river in winter, and (3) sampling harvestable and nonharvestable adult striped bass down river of the spawning grounds in spring. These options were selected because the underlying statistical assumptions of the estimator could be satisfied and the required sampling effort was feasible.

The 1986-1987 Hudson River striped bass program was conducted in the Croton-Haverstraw, Tappan Zee, Battery, and Upper Harbor regions of the Hudson River. The Battery and Upper Harbor exhibited the highest catches per ten minute tow for both the 9 and 12 m trawls. Use of a cod end liner (2.5 cm stretch mesh) in the 9 m trawl did not affect the length-frequency or handling mortality of Age 1+ or older striped bass caught in the trawl. However, use of a cod end liner in the 12 m trawl significantly increased the catch of Age 1+ and older striped bass. Handling mortality was extremely low (< 1%) and was not related to gear type or the use of the cod end liners (Dunning et al. 1989). Stratified sampling to select scales for age analysis resulted in highly precise estimates of the proportion of Age 0+, 1+ and 2+ striped bass caught in this study (Normandeau 1987). Based on the estimated number of Age 1+ fish and the number of verified striped bass of hatchery origin that were recaptured in 1986-1987, the estimated hatchery proportion was 1.7%. The estimated over wintering population in the Battery and Upper Harbor was 394,000 striped bass ≥200 mm, and 108,000 of these fish were Age 1+ (Table 1-1).

The 1987-1988 Hudson River striped bass hatchery evaluation was conducted in the Upper Harbor and Battery regions of the Hudson River (Normandeau 1988). The Battery region received 98% of the fishing effort and exhibited a higher catch per ten minute tow for both the 9 m trawl and 12 m trawl with a cod end similar to the 9 m trawl. The catch was dominated by the strong 1987-year class of Age 0+ fish, which contributed more than one half of the catch. The 9 m trawl was more efficient than the 12 m trawl with a 9 m trawl cod end in capturing Age 0+ and Age 1+ striped bass. Handling mortality was extremely low (< 1%) and was not related to gear type or the use of the cod end liners (Dunning et al. 1989). Based on the estimated number of Age 1+ fish and the number of verified striped bass of hatchery origin that were recaptured in 1987-1988, the estimated hatchery proportion was 1.6%. The estimated over wintering population in the Battery and Upper Harbor was 295,000 striped bass ≥200 mm, and 181,000 of these fish were estimated to be Age 1+ (Table 1-1).

The striped bass catch in the Battery and Upper Harbor during the 1988-1989 program was dominated by a strong 1987 cohort of Age 1+ fish (70%), and the hatchery proportion for this cohort was estimated as 0.2% (Normandeau 1990). The minimum size of striped bass that were tagged was lowered from 200 mm to 150 mm during 1988-1989 to align the tagging effort with the expected size range of this large cohort of Age 1+ fish. Handling mortality remained low (<1%) even though smaller fish were tagged for the first time. The estimated over wintering population of striped bass in

the Battery and Upper Harbor was 1,190,000 fish ≥150 mm or 890,000 fish ≥200 mm, and an estimated 794,000 of the fish ≥200 mm were from the strong 1987 Age 1+ cohort (Table 1-1).

The striped bass catch in the Battery and Upper Harbor during the 1989-1990 program was dominated by a strong 1988 cohort of Age 1+ fish (65%), and the hatchery proportion for this cohort was estimated as 0.4% (Normandeau 1991). The estimated overwintering population of striped bass was 776,000 fish ≥150 mm or 528,000 fish ≥200 mm, and an estimated 397,000 of the fish ≥200mm were from the strong 1988 Age 1+ cohort (Table 1-1).

The striped bass population over-wintering in the Battery and Upper Harbor during 1990-1991 was estimated as 858,000 fish ≥150 mm or 786,000 fish ≥200 mm (Table 1-1). About 352,000 striped bass ≥200 mm were Age 1+ (Normandeau 1992). The 1989 cohort of Age 1+ hatchery fish was 0.2% of the Age 1+ catch.

The 1990 cohort of Age 1+ striped bass and the 1991 cohort of Age 0+ fish dominated the population statistics for fish caught in the Battery and Upper Harbor during the winter of 1991-1992 (Normandeau 1994). The estimated size of the mid-winter striped bass population was 1,163,000 fish ≥150 mm or 967,000 fish ≥200 mm (Table 1-1). Age 1+ striped bass represented 791,000 fish among the population ≥150 mm and 709,000 fish ≥200 mm. Age 2+ and Age 3+ hatchery striped bass were each about 0.3% of the respective cohort's catch. Age 0+ and Age 1+ hatchery striped bass were not tagged with CWTs and could not be differentiated from wild fish of the same cohorts.

The striped bass population found in the Battery and Upper Harbor during the winter of 1992-1993 was estimated as 920,000 fish ≥150 mm or 717,000 fish ≥200 mm (Table 1-1). About 475,000 striped bass ≥200 mm were Age 1+ during 1992-1993 (Table 1-1). The 1991 cohort of Age 1+ fish and the 1992 cohort of Age 0+ fish dominated the total catch, while Age 1+ and Age 2+ fish contributed most to the population estimate. Age 3+ hatchery fish from the 1989 cohort were 0.02% of the total catch of Age 3+ fish. Age 1+ and Age 2+ hatchery striped bass were not tagged with CWTs prior to tagging and could not be differentiated from wild fish of the same cohorts.

The 1993-1994 program experienced the 20$^{th}$ coldest winter on record for New York City and the coldest in the history of the striped bass program (Normandeau 1996). Bank-to-bank ice floes limited access to the Battery and Upper Harbor regions from 17 January through 21 February 1994, and influenced within- and among-program comparisons. The estimated size of the midwinter striped bass population ≥ 150 mm in Upper New York Harbor and the Battery regions during 1993-1994 was 443,000 fish, with lower and upper 95% confidence limits of 339,000 and 641,000 (Normandeau 1996). The 1992 cohort of Age 1+ striped bass and the 1991 cohort of Age 2+ fish dominated both the catch and midwinter population estimate, accounting for 57% (253,000) and 29% (129,000) of the population ≥ 150 mm, respectively. The estimated hatchery proportion of striped bass was 0.2% for Age 0+, 1.05% for Age 1+, and 0.05% for Age 4+ fish among the same age cohorts.

The striped bass population over wintering in the Battery and Upper Harbor regions during 1994-1995 was estimated as 350,000 fish ≥ 150 mm (LMS 1995). About 225,000 striped bass ≥ 150 mm were Age 1+. No Age 1+ (1993 cohort) hatchery fish were captured.

The 1995-1996 program estimated the midwinter striped bass population ≥ 150 mm in the Upper New York Harbor and the Battery regions to be approximately 949,000 fish, with lower and upper 95% confidence limits of 745,000 and 1,308,000 (LMS 1996). The 1994 (Age 1+) cohort dominated the catch of Hudson River striped bass and represented 77% of the population ≥ 150 mm. The total

population of Age 1+ and older striped bass ≥ 200 mm was estimated as 786,000 fish, the same as estimated during the 1990-1991 program, and the third highest calculated annually since 1985-1986. The estimated hatchery proportion of striped bass was < 0.1% for both Age 0+ and Age 1+ fish among the same cohorts.

The estimated size of the midwinter striped bass population ≥ 150 mm in Upper New York Harbor and the Battery regions during 1996-1997 was 768,000 fish, with lower and upper 95% confidence limits of 682,000 and 880,000 (LMS 1997). The 1995 cohort of Age 1+ striped bass and the 1994 cohort of Age 2+ fish dominated the catch, representing 61% (493,000) and 27% (219,000) of the population ≥ 150 mm, respectively. The estimated hatchery proportion of striped bass was < 0.1% for Age 1+ and for Age 2+ fish among the same age cohorts. Stocking of striped bass from the Verplanck hatchery ceased following 1995.

The 1997-1998 estimate of the mid-winter striped bass population ≥ 150 mm in the upper New York Harbor and Battery region was 453,000 with lower and upper 95% confidence limits of 382,000 and 555,000. The population estimate was predominantly Age 1+ and 2+ fish (90%) of 203,000 and 205,000 individuals, respectively.

The population estimate for the 1998-1999 program was 333,000 striped bass ≥ 150 mm in the Lower Hudson River and comprised of approximately 7,000 Age 0 +, 199,000 Age 1+, 92,000 Age 2+, 26,000 Age 3+ and 9,000 Age > 3+.

The estimated size of the 1999-2000 winter striped bass population ≥ 150 mm in the upper New York Harbor and Battery region was 1,377,000 with lower and upper 95% confidence limits of 1,180,000 and 1,653,000. Age 0 + accounted for 13% (174,000 fish), Age 1 + contributed 73% (1,012,000 fish), Age 2 + contributed 11% (147,000 fish), Age 3 + contributed 2% (30,000 fish), and Age > 3 + contributed 1% (14,000 fish). The estimated population of age 1+ and older striped bass ≥ 200 mm during the winter of 1999-2000 was the highest calculated annually since 1985-1986.

Objectives of the 2000-2001 Hudson River striped bass program were to:

1. Describe the catch characteristics of the 9-m trawl used to capture striped bass in the lower Hudson River during the winter,
2. Describe the length- and age-distribution of striped bass in the lower Hudson River during the winter,
3. Estimate the abundance of age 1+ and age 2+ striped bass in the lower Hudson River during the winter,
4. Compare the results of objectives 1 through 3 with those reported from previous years.

Operation of the striped bass hatchery at Verplanck, New York was discontinued following the 1995-1996 program, and the production and release of marked striped bass fingerlings ceased. The proportion of marked hatchery striped bass among the 1995 (Age 5+) and older cohorts was likely to be so small in the 2000-2001 program that we did not examine the striped bass catch for hatchery-administered magnetic coded wire tags.

Bottom water temperatures during the winter of 2000-2001 in the Battery region of the Hudson River deviated from the historical (1985-86 through 1999-2000) average during much of the season (Figure 1-1, Appendix Table B-1). Temperatures were colder than normal from the beginning of November through mid-January and the beginning of March through the remainder of the study.

# 2.0 METHODS

## 2.1 FIELD PROCEDURES

### 2.1.1 Field Sampling

A complete description of field and laboratory procedures is found in the 1999-2000 Hudson River Striped Bass and Atlantic Tomcod Programs Standard Operating Procedures (Normandeau 2000). These procedures have remained essentially unchanged since the start of the 1988-1989 program. The 2000-2001Hudson River Striped Bass Program consisted of sampling in the Battery and Upper Harbor regions of the lower Hudson River (Figure 2-1) with a 9 m trawl (Appendix Table A-1). Sampling locations were selected to maximize the catch per unit of effort of striped bass in the lower Hudson River, based on the results of previous programs (Normandeau 1986, 1987, 1988, 1990, 1991, 1992, 1994, 1996a, 1996b, 2000; LMS 1995, 1996, 1997). A 9-m trawl was used in the 2000-2001 program to catch striped bass because the results of the 1987-1988 program showed that the 9-m trawl was more efficient than other gear in catching striped bass of the target ages of Age 1+ and Age 2+ (Normandeau 1988). Striped bass captured in each trawl sample were enumerated and fish ≥150 mm were marked with internal anchor tags (Figure 2-2) and released.

For 24 weeks, from the week beginning Monday, 6 November 2000 through Friday, 20 April 2001, the 9-m trawl was deployed in the lower Hudson River. The 9-m trawl was fished in each of the 24 weeks in the Battery region and on selected days during 6 weeks in the Upper Harbor region (Appendix Table C-1). Tow duration was 10 minutes unless sampling difficulties such as bottom obstructions required shortening the tow. All striped bass captured by the trawl were handled in a manner that minimized stress before tagging. The cod end of the net was transferred while remaining in the water to the holding facility alongside the boat. Fish were then released from the cod end into the holding facility. Striped bass were then removed from the holding facility for processing using the following procedures:

1. fish were removed from the live car using a dip net,
2. all surfaces that came in contact with the live fish were wet,
3. striped bass were handled gently by the body and not handled by the eye sockets, gill arches, isthmus, or opercular flaps, and
4. struggling fish were quieted by covering the head and eyes with a wet hand, cloth or glove.

All striped bass were measured (mm total length) and visually examined for external tags and tag wounds. All striped bass ≥150 mm, in good condition, and not already tagged, were tagged with an internal anchor tag. Good condition was defined as:

1. no bleeding from gills or body wounds,
2. no significant loss of scales,
3. strong opercular movement, and
4. no obvious external abnormalities such as blindness, fin rot or skeletal abnormalities.

Starting during the 1991-1992 program, striped bass that were not in good condition were tagged, and we continued tagging these fish in the 2000-2001 program to determine if the presence of certain gross anatomical abnormalities (such as blindness or bacterial infection) affected their survival. The nature of the particular abnormality of each striped bass was recorded prior to release. In programs before 1991-1992, only striped bass in good condition were tagged.

The internal anchor tag was inserted by removing a scale midway between the vent and distal tip of the depressed pelvic fins, and five to six scale rows dorsolaterally from the ventral mid-line. This tag insertion site was selected to minimize the damage to internal organs during tag placement, based on gross anatomical examination of striped bass (Normandeau 1988). A horizontal incision about 5 mm long was made with a hooking movement of a curved scalpel blade. The incision was made through the musculature but not deep enough to damage the intestines. The anchor of the tag was inserted through the incision and set with a gentle pull on the streamer. Scalpel blades were changed frequently to avoid tearing of the tissue and all incisions were treated with a merbromin-based topical antiseptic.

Scale samples were taken from the left side from an area approximately 3-4 scale rows below the notch between the spinous and soft dorsal fins of all striped bass caught, except for fish less than 100 mm. Fish less than 100 mm were considered Age 0+. Scale samples from recaptured, tagged fish were taken on the right side of the fish to avoid regenerated scales from the release sample. Scale samples were taken from recaptured fish only if the tag number indicated the fish had been released in previous programs. Condition of the tag and tag insertion site of recaptured striped bass were also evaluated.

After processing, striped bass were released into a recovery pen (1 m wide x 2 m long x 1 m deep) deployed alongside the tagging vessel. The pen was enclosed with netting on four sides, open on the top and bottom, and provided a refuge where striped bass could recover from processing without being preyed on by gulls. Bird predation was estimated to remove about 2.4% of the tagged fish released during the 1990-91 program (Normandeau 1992), so we began using this recovery pen to reduce this predation. Any fish remaining in the recovery pen at the end of sample processing were considered dead. Fish were released at least 400 m from active fishing gear, but within 1.5 km (1 mile) of the capture location.

### 2.1.2 Water Quality Sampling

During each trawl sample, the direction of tow, time of tow, date, and sample number were recorded. A Yellow Springs Instruments (YSI) model 33 salinity-conductivity-temperature meter was used to measure surface (0.3 m) and bottom water temperature and conductivity at the end of each tow. All conductivity measurements were adjusted to 25 °C (specific conductance) for presentation in this report. Water quality data are summarized by region and week in Appendix Table B-1.

## 2.2 Laboratory Methods

### 2.2.1 Biocharacteristics and Food Habits

Striped bass that died during sampling procedures were placed on ice and transported to the laboratory at the end of each day for determination of biocharacteristics, including length, weight,

sex, and sexual condition (Appendix E). In addition, striped bass stomachs were analyzed for the presence of invertebrates, vertebrates, and Atlantic tomcod (Appendix E).

### 2.2.2 Age of Striped Bass Using Scales

Age was determined for a stratified random sample of striped bass using scales collected from the fish in the field. All striped bass less than 100 mm were considered Age 0+ and scale samples were not taken. The stratified random subsample was based on the expected number of Age 1+ striped bass in each 10 mm length group. Expected numbers of Age 1+ striped bass in each 10 mm length group were calculated from age at length data obtained during the current and 1999-2000 programs.

This program was conducted during the winter from one calendar year to the next. To eliminate confusion that may be caused by a fish becoming a year older on 1 January, the hatching date of striped bass was assumed to be 15 May. To note this, the convention of adding a "+" after the age of a fish was used. Therefore, a striped bass hatched 15 May 1998 and collected from November 1999 through April 2000 would be designated "Age 1+". This same fish, captured between November 2000 and April 2001, would be designated "Age 2+".

Striped bass scales were pressed on 0.050-inch thick, grade GC, acetate sheets with a Carver Press Model-C 12 ton hydraulic press equipped with a pressure gauge, electric hot plates, temperature controls and thermometers. Scale impressions were then examined with a microfiche reader at approximately 46x magnification and the location of each annulus was determined. Criteria used to determine the presence of annuli on striped bass scales were (1) changes in the relative spacing of circuli in the anterior field of the scale, (2) crossing of circuli across previously deposited circuli in the lateral field of the scale, and (3) variations in the thickness and shape of the circuli. Generally an annulus exhibited all three of the above characteristics. The distance from the scale focus to each annulus was measured along a line drawn through the focus and perpendicular to the anterior edge of each scale.

## 2.3 Analytical Methods

All field samples were assigned a Use Code (1, 2, or 5) that defined their use in analytical tasks (Appendix Table C-2). Use Code 1 samples were collections from which valid data were collected and no sampling problems were encountered. Use Code 2 samples were collections in which striped bass were captured, but sampling problems were encountered. Sampling problems were generally related to gear deployment, which would affect computation of catch per unit of effort, such as noticing a tear in the net after a tow, or stopping a tow before the required 10-minute duration. Use Code 1 and 2 samples were used for mark-recapture analysis. Use Code 2 samples were excluded from calculations involving catch per unit of effort and length-frequency distribution. Use Code 5 samples were Use Code 2 samples where no striped bass were caught. Use Code 5 samples were excluded from all analyses. Most data analyses were conducted using the Statistical Analysis System (SAS) software (SAS 1999).

No rounding of data was done prior to the final step in each analysis. This prevented introduction of rounding error in the final result, and may present the appearance in a table that a column of data does not sum exactly to the total shown in the last row.

### 2.3.1 Analysis of Catch Characteristics

Characteristics of the catch were compared among locations and sampling weeks by analysis of the catch per unit of effort, length-frequency, and handling mortality.

#### *2.3.1.1 Catch Per Unit Of Effort*

Catch Per Unit of Effort (CPUE) for the 9 m trawl was defined as catch per ten-minute tow (Use Code = 1). Mean CPUE was calculated as:

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{n} \left[ \frac{C_i}{E_i} x\, 10 \right] \qquad \text{Equation 1}$$

where,

$\overline{X}$ = The mean trawl catch per ten minute tow,

$C_i$ = total number of fish captured in trawl i,

$E_i$ = the tow duration of trawl i in minutes, and

n = the number of trawls.

#### *2.3.1.2 Length-Frequency*

Length-frequency histograms, with the number of fish on the ordinate and total length on the abscissa were constructed to describe the characteristics of the catch from the 9 m trawl (Use Code = 1 tows). Length-frequency distributions for striped bass caught by the 9 m trawl were characterized using moment statistics and frequency histograms. Moment statistics compare the observed length-frequency distributions with hypothetical, normal (bell-shaped) distributions.

#### *2.3.1.3 Handling Mortality*

Handling mortality was expressed as the proportion of dead striped bass in a "successful" trawl sample (Use Code = 1) by the following formula for each 1 °C temperature interval:

$$\text{Prop}D_x = D_x/T_x \qquad \text{Equation 2}$$

where,

Prop $D_x$ = the proportion of dead striped bass at bottom water temperature x,

$D_x$ = the number of dead striped bass at bottom water temperature x, and

$T_x$ = total number of striped bass captured at bottom water temperature x.

Comparisons of handling mortality among the 1985-1986 through 2000-2001 programs were also made using data subsetted to include the same sampling gear deployed during comparable water temperature ranges within the Battery region in each year. Differences in striped bass handling mortality among programs (1985-1986 through 2000-2001) were assessed by comparing the percentage of dead fish in the catch in one degree bottom water temperature increments.

### 2.3.2 Stratified Sampling for Age Determination and Mean Length at Age

#### *2.3.2.1 Estimated Number of Striped Bass in Each Age Category*

A stratified random sampling plan was used to determine the number of striped bass scale samples to be selected for age determination from the total scale samples collected during the 2000-2001 program. The stratified plan selected striped bass scale samples for age analysis in direct proportion to both the number of fish in each 10 mm length increment and the variance of the proportion of Age 1+ fish in each 10 mm length group. This Neyman allocation scheme is considered optimal with respect to its ability to maximize precision of the estimated proportion of Age 1+ fish, and is based on the following formula (Cochran 1977, Equation 5.60):

$$n_h = n(N_h\sqrt{p_h q_h}/\Sigma N_h\sqrt{p_h q_h}) \qquad \text{Equation 3}$$

where

$n_h$ = number of scale samples selected for age determination from length group h,

n = number of scale samples to be selected from the total fish caught (N),

$N_h$ = total number of fish caught in length group h,

$p_h$ = proportion of Age 1+ fish in length group h from the laboratory sample, and

$q_h$ = 1 - $p_h$

The stratified sampling plan was designed to select approximately 15% of the scale samples from fish caught for age analysis. Age and length-frequency data from 1999-2000 were applied to the first of three lots of 2000-2001 length-frequency data (6 November 2000 through 7 January 2001) to permit scale analysis to proceed during the study. Age and length-frequency data from analysis of the first lot of striped bass scales in 2000-2001 were then applied to the second lot of 2000-2001 scale samples (8 January through 22 February 2001), and the age and length frequency from the first two lots were combined and used to select scale samples from the third lot during 2000-2001 (23 February through 20 April 2001). In each lot scale samples from approximately 15% of the fish caught were randomly selected for age determination using the Neyman allocation formula. It should also be noted that the Neyman allocation for stratified random sampling was based on variance estimates derived from the proportion of Age 1+ fish and was, therefore, most precise for estimating the proportion and number of Age 1+ fish. However, age was determined for all fish examined in the laboratory so that the number and proportion could be determined for all age groups sampled.

The proportion and number of striped bass of a given age that were caught in the 2000-2001 program was estimated by stratified random sampling, as described in the preceding paragraph, using the following formula (Cochran 1977, Equation 5.5.2):

$$p_{sti} = \Sigma(N_h p_{hi}/N) \qquad \text{Equation 4}$$

where

$p_{sti}$ = the stratified mean proportion of Age i fish,

$p_{hi}$ = the proportion of Age i fish in length group h, and

$N_h$ and N are as defined in Equation 3.

The number of striped bass of Age i in the total catch ($A_i$) is:

$$A_i = N(p_{sti}) \qquad \text{Equation 5}$$

The sample variance for the stratified mean proportion of Age i fish in the total catch ($s^2 p_{sti}$) was calculated by the method of Cochran (1977, Equation 5.53):

$$s^2_{p_{sti}} = 1/N^2 \left[\sum [N_h^2 (N_h - n_h)/(N_h - 1)][(p_{hi} q_{hi})/(n_h - 1)]\right] \qquad \text{Equation 6}$$

where

N, $N_h$, $p_{hi}$, and $q_{hi}$ are as defined in Equation 3 for Age i fish.

Confidence intervals (CI) for the stratified mean proportion of Age i striped bass and for the total number of Age i fish were calculated based on Cochran (1977) Equations 5.14 and 5.15:

$$95\%\ \text{CI for}\ p_{sti} = p_{sti} \pm t\, s_{p_{sti}} \qquad \text{Equation 7}$$

$$95\%\ \text{CI for}\ A_i = N\, p_{sti} \pm t\, s_{p_{sti}} \qquad \text{Equation 8}$$

where $s_{p_{sti}} = \sqrt{s^2_{p_{sti}}}$

t = Student's two-tailed t statistic for $\alpha = 0.05$, based on the effective degrees of freedom (Cochran 1977, Equation 5.16), and

$p_{sti}$, $A_i$, N, $s^2_{p_{sti}}$ are as defined in Equations 4-7.

### *2.3.2.2 Stratified Mean Length in Each Age Category*

The mean length of striped bass of a given age that were caught in the 2000-2001 program was estimated based on the same stratified random sampling plan described above in Section 2.3.2.1, using the following formula (Cochran 1977, Equation 12.1):

$$\bar{y}_{sti} = \left[\sum_{h=1}^{L} n_{hi}\, \bar{y}_{hi}\right] / N_i \qquad \text{Equation 9}$$

where

$\bar{y}_{sti}$ = stratified mean length of striped bass of Age i among the total fish of Age i caught,

$\bar{y}_{hi}$ = mean length of Age i fish in length group h of the laboratory sample,

$n_{hi}$ = number of Age i fish caught in length group h,

$N_i$ = number of Age i fish caught in the program, and

L= number of length groups in which at least two Age i fish were measured. If only one Age i fish was present in a length group, its length was pooled with those of length group closest to the group containing the mean.

Variance estimates and confidence intervals for the stratified mean length of Age i fish were based on extrapolating mean length from the sample of striped bass for which age was determined ($n_{hi}$) to the entire population of striped bass in the Hudson River ($N_i$). However, extrapolating the variance of mean length to the entire river population is a two-phase sampling procedure in which the total catch is the primary sample and the aged fish are the secondary sample.

The two-phase variance of the stratified mean length of striped bass of a given age was estimated using the following formula (simplified from Cochran 1977, Equation 12.24 with the assumption that $N_i$ is large and substantially larger than $n_i$, therefore $N_i^{-1} \cong 0$ and $g'_i \cong 1$):

$$s^2_{\bar{y}_{sti}} = \sum_{h=1}^{L} \left[ W_{hi} \left( S^2_{hi} / n_i V_{hi} \right) \right] + \left( 1/n'_i \right) \sum_{h=1}^{L} w_{hi} \left( \bar{y}_{hi} - \bar{y}_{sti} \right)^2 \qquad \text{Equation 10}$$

where

$S^2_{\underline{y}_{sti}}$ = Two-phase variance of the stratified mean length of striped bass of Age i,

$w_{hi}$ = proportion of Age i fish in length group h, as estimated by the Bayes Theorum presented in Equation 11,

$S^2_{hi}$ = variance of the mean length of Age i fish in length group h of the laboratory sample,

$n'_I$ = total number of Age i fish in the laboratory sample,

$V_{hi}$ = proportion of Age i fish in length group h, and

$\underline{y}_{hi}$, $\underline{y}_{sti}$, and *L* are as defined in Equation 9.

The Neyman allocation for selecting scales to be aged (Section 2.3.2.1) requires the use of the Bayes Theorem as an indirect method of estimating $w_{hi}$ as follows:

$$w_{hi} = P(L_h | A_i) = [P(L_h)\, P(A | L_h)] / P(A_i) \qquad \text{Equation 11}$$

where

$w_{hi}$ is as defined in Equation 10,

$A_i$ = Age i striped bass,

$P(L_h)$ = proportion of the total catch of striped bass in length group h,

$P(A_i | L_h)$ = proportion of aged fish in length group h that are Age i, and

$P(A_i)$ = proportion of Age i fish in the total catch.

Confidence intervals for the stratified mean length of Age i fish were calculated using the following formula (Cochran 1977, Equation 5.14):

$$95\%\ \text{CI for } \underline{y}_{sti} = \underline{y}_{st} \pm t\, S_{\underline{y}_{sti}} \qquad \text{Equation 12}$$

where

$$S_{\bar{y}_{sti}} = \sqrt{S^2_{\bar{y}_{sti}}}$$

t = Student's t statistic for $\alpha = 0.05$ based on $n_i' - 1$ degrees of freedom (not the effective degrees of freedom), and

$\bar{y}_{sti}$ is as defined in Equation 9.

### 2.3.3 Recaptured Striped Bass

Three groups of recaptured, internal anchor-tagged striped bass were considered: (1) fish recaptured from our previous programs (cross-year recaptures), (2) fish caught, tagged, released and recaptured within the current (2000-2001) program (within-year recaptures), and (3) fish recaptured with external streamer tags from other tagging programs (other recaptures). All cross-year recaptures were examined to determine the condition of the tag legend and insertion site, recapture rate, mean length, and days at-large. We also determined the age and growth for cross-year recaptures by examining the scale samples taken at the time of release and time of recapture. Within-year recaptures consisted of two groups of striped bass: fish that were in good condition at the time they were tagged and released (REL_REC = 1), and fish that were tagged and released but exhibited one or more gross anatomical abnormalities (REL_REC = 6). Both groups of within-year recaptures were examined to determine the tag condition, recapture rate, mean length and days at-large. Within-year recaptures that were in good condition at the time of release (REL_REC = 1) were also used for a mark-recapture estimate of population size (Section 2.3.5). We obtained release and recapture information and observed the condition of the tag streamer and insertion site for other agency recaptures.

### 2.3.4 Population Movement

The two regions of the study area, Battery and Upper Harbor (Figure 2-1), were combined and treated as one region for analyses of population movement and abundance because they are contiguous. Movement within this combined lower Hudson River area was determined directly by plotting and by comparison of recapture rates and recapture proportions in each week:

$$\text{Recapture rate} = R_{ij}/M_{ij} \qquad \text{Equation 15}$$

where

$R_{ij}$ = number of tagged striped bass recaptured in time period (week) i in region j, and

$M_{ij}$ = number of tagged striped bass released during time period (week) i in region j.

$$\text{Recapture Proportion} = R_{ij}/C_{ij} \qquad \text{Equation 16}$$

where

$R_{ij}$ = number of tagged striped bass recaptured in time period (week) i in region j, and

$C_{ij}$ = number of striped bass caught and examined for tags in time period (week) i in region j.

### 2.3.5 Population Size

The Schumacher-Eschmeyer estimator was used to estimate striped bass population size because it is a multiple census population estimator which permits tagging and recapture efforts to occur concurrently. This estimator is a weighted linear regression of $R_i/C_i$ as a function of $M_i$ (where $M_i$ is the cumulative number marked prior to time 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 $\beta$ is the slope of the regression line and $e_i$ is a random error term with a mean of 0 (Seber 1982). When the squared residuals ($R_i/C_i - \beta M_i$) are weighted by the catch ($C_i$), then $N^{-1}$ equals the slope, $\beta$.

The Schumacher-Eschmeyer estimator (Ricker 1975) is

$$N = \Sigma(C_i M_i^2)/\Sigma(R_i M_i) \qquad \text{Equation 17}$$

where

$N$ = estimated population size,

$C_i$ = total catch during time interval i,

$M_i$ = total number of marked fish tagged and released in good condition and available for recapture at the midpoint of time interval i, and

$R_i$ = number of recaptured fish in $C_i$.

The variance of the reciprocal of the population size (1/N) is estimated by first calculating the mean of squared deviations from the regression as

$$S^2 = \frac{\sum\left(R_i^2 / C_i\right) - \left(\sum R_i M_i\right)^2 / \sum\left(C_i M_i\right)}{m-1}$$

Equation 18

where

$S^2$ = mean of squared deviations from the regression model described above,

$m$ = the number of data points in the regression, and $C_i$, $M_i$ and $R_i$ are as defined above in Equation 17.

The 95% confidence interval (CI) for the reciprocal of the population size (1/N) is computed as

$$CI = S^2/\Sigma C_i M_i^2 \times t_{m-1} \qquad \text{Equation 19}$$

where

$t_{m-1}$ = Student's t-statistic for m-1 degrees of freedom and $\alpha$=0.05.

Confidence limits for the population size N are obtained by first computing the 95% CI about 1/N and then inverting.

# 3.0 RESULTS AND DISCUSSION

## 3.1 CATCH CHARACTERISTICS OF THE 9 M TRAWL

### 3.1.1 Catch Per Unit Of Effort

A total of 826 valid, ten minute tows with no sampling problems (use code = 1) were taken with the 9-m trawl in the lower Hudson River between 6 November 2000 and 20 April 2001 with 800 in the Battery region, and 26 tows in the Upper Harbor region (Table 3-1, Appendix Table C-1). For all sampling weeks combined, the mean CPUE for striped bass in the Upper Harbor region (35.6 striped bass per 10-minute tow) was greater than the mean CPUE for the Battery region (22.0, Table 3-1), although sampling was only conducted in the Upper Harbor region during the first several weeks of the program (Appendix Table C-1). Past results indicate that striped bass are generally more abundant in the Upper Harbor region than in the Battery during November and early December and this trend was evident in 2000-2001 (Appendix Table C-1, Figure 3.1). The largest weekly mean CPUE in the Upper Harbor region (44.4 striped bass per 10-minute tow) was during the week of 27 November, highest CPUE in the Battery (43.7) was during the week of 4 December.

The greatest sampling effort during the 2000-2001 program was in the Battery region of the lower Hudson River (Appendix Table C-2) and the largest mean CPUE in the Battery was at river miles 5 and 8 (Appendix Table C-3). River mile 3 in the Battery actually had the highest CPUE, however there was only one tow conducted at this site (Appendix Table C-3). Historically, the Battery region has received the greatest sampling effort and data from this area were examined for annual comparisons of CPUE, after restricting the annual databases to a similar collection period (Table 3-2). The annual mean CPUE for the 9-m trawl in the Battery region increased from 8.1 (striped base per 10-minute tow) in the 1985-1986 program to a peak of 45.3 in 1989-1990. The increased catch during the 1988-89 and 1989-90 programs may be related to greater recruitment of the numerically dominant 1987 and 1988 year classes to the 9-m trawl (CES 1989, 1991). The decrease in CPUE observed after the 1989-90 program may be due to migration from the lower Hudson River of the older year classes from 1987 and 1988 cohorts and lower abundance of the 1989 through 1999 year classes. Sampling effort for part of the mid-winter period was low in 1993-1994 because extremely cold temperatures caused bank to bank ice floes in the Battery which restricted access to the river. Effort was also low in 1994-1995 and 1995-1996. During recent years, mean CPUE was lowest in the 1995-1996 program (14.3 striped bass per 10-minute tow) but has increased since then to 31.7 and 26.1 in 1999-2000 and 2000-2001 programs, respectively.

### 3.1.2 Length-Frequency Distributions

For the 2000-2001 program, overall mean length of striped bass caught by the 9-m trawl was larger in the Upper Harbor region (324 mm) than in the Battery (225 mm, Table 3-3). The range of striped bass lengths was considerably greater in the Battery than in the Upper Harbor region. Additional length-frequency information by size-class for the combined Battery and Upper Harbor regions is provided in Appendix Tables C-4 and C-5. The length-frequency distributions, compared to a bell-shaped normal distribution, for the two separate regions and regions combined were skewed to the right, i.e., more fish were smaller than the mean length and the kurtosis was leptokurtotic, i.e., more fish were found in length groups close to the mean length (Table 3-3). The length frequency

distribution was unimodal in both the Battery and Upper Harbor regions, with peaks in the 251-300 mm length group (Figure 3-2). The modes in the 251-300 mm length group in both sampling regions were Age 1+ fish from the 1999 year class. Based on the overall length frequency distributions from the 2000-2001 program, it was apparent that in the Battery region Age 0+ fish (<150 mm) and Age 1+ fish were common, but in the Upper Harbor region Age 1+ fish were dominant with few Age 0+ fish present. The unimodal length frequency distribution for the 2000-2001 program when both regions were combined differs from 1999-2000 when a bimodal distribution pattern was evident (Figure 3.3). A bimodal length distribution pattern was also evident during the winters of 1986-1987, 1987-1988, 1991-1992, 1993-1994, 1994-1995, 1997-1998, and 1998-1999 (Figure 3-3).

Weekly mean length of striped bass caught by the 9 m trawl in the Battery region during the 2000-2001 program was largest early in the program peaking during the week of December 25, declining to a low in January through mid March, and increasing during the remainder of the program (Appendix Table C-6). The cause for the change in weekly mean length was due to prevalent length groups collected weekly (Figure 3-4). The larger length groups were dominant during November and December, with smaller groups dominating January through mid March followed by an increase in the prevalence of larger length groups through April. This pattern of highest mean length occurring early in the program was similar to that observed in 1995-1996 and 1999-2000 when weekly mean lengths were highest during the beginning and end of the program. During the 1991-1992, 1992-1993, 1993-1994, 1997-1998, and 1998-1999 programs, weekly mean length was largest during the first nine or ten weeks. In the 1994-1995 and 1996-1997 programs the highest weekly mean lengths were observed near the end of the program.

### 3.1.3 Handling Mortality

Overall striped bass handling mortality in the 9 m trawl was 0.5% during 2000-2001 at bottom water temperatures from 2 to 13° C (Table 3-4). A total of 86 striped bass died out of 18,561 fish caught in Use Code = 1 tows that had river bottom water temperature data associated with each tow. The highest handling mortality of 0.9% was observed at bottom water temperatures of 6 and 7 °C, and the second highest handling mortality was at 10 °C (0.8%). The relatively consistent, low handling mortality indicated there was no relationship between handling mortality and water temperature for the 9 m trawl over bottom water temperatures of 2 to 13 °C experienced in this study. The 2000-2001 data were not examined for an interaction between water temperature, fish length and immediate handling mortality because this interaction was not significant in previous programs (Dunning et al. 1989).

For historical comparisons, striped bass handling mortality in the 2000-2001 program at water temperatures ranging from 4 to 12 °C was 0.6%, similar to the pooled mortality for the 1985-1986 through 1990-1991 programs, and generally less or comparable to the mortality observed in the 1991-92 through 1999-2000 programs (Table 3-5). The apparent increase in handling mortality observed following the 1990-1991 program was probably due to an underestimate of handling mortality during the 1985-1986 through 1990-1991 programs. During the 1985-1986 through 1990-1991 programs, bird predation on released striped bass was not considered to be a significant problem and little effort was made to quantify the bird predation rate. All striped bass that were not immediately identified as dead upon release were assumed to have survived. However, at the end of the 1990-1991 program it became apparent that bird predation on released striped bass was significant. Approximately 2.4% of the 2,969 tagged striped bass released between 12 March and 12 April 1991 were removed from the

water by gulls (Normandeau 1992). Therefore, handling mortality in the 1985-1986 through 1990-1991 programs may have been underestimated.

Field procedures were modified in 1991-1992 and these modifications continued through the 2000-2001 program to both quantify and minimize gull predation. After tagging, fish were released into a recovery pen that was deployed in the water alongside the boat. The pen was a 1 m x 2 m x 1 m deep enclosure with 0.9 cm mesh netting on four sides, open on the top and bottom, with the top of the frame suspended at the water surface. Striped bass released into the pen were provided a refuge alongside the boat where they could recover from handling stress without drifting away from the boat during recovery and possibly being preyed on by gulls. Fish in good condition typically escaped from the pen through the bottom. Stunned fish typically remained at the surface for several minutes until they recovered and escaped through the bottom of the pen. Any fish remaining in the recovery pen at the end of sample processing were considered dead and were removed and taken to the lab. A field technician also observed fish as they escaped from the recovery pen and recorded instances of gull predation. These procedures both minimized gull predation and accurately recorded handling mortality.

Quantitative comparison of the difference in handling mortality between the 1985-1986 through 1990-1991 programs and the 1991-1992 through 2000-2001 programs are probably not meaningful due to the change in field procedures. Striped bass handling mortality statistics from the recent programs are probably more accurate than previous programs because use of the observer and the recovery pen allowed more assessment of accurate bird predation data. Handling mortality during the 1991-1992 through 2000-2001 programs was probably lower than handling mortality recorded for previous programs because the recovery pen provided a refuge against gull predation.

Handling mortality in all programs conducted after the 1985-1986 program was approximately ten times less than that observed in the 1984 program (Normandeau 1992). The primary reason for the decrease in handling mortality observed after 1984 was the use of a submerged holding facility and the increased tagging efficiency of field crews (Dunning et al. 1989).

## 3.2 STRIPED BASS LENGTH AND AGE DISTRIBUTION

### 3.2.1 Length Distribution and Associated Statistics for Each Age Cohort

Age-length frequency histograms, presented by 10 mm length groups for Age 0+ through Age 3+ striped bass (Figure 3-5) demonstrate minimal overlap in size of Age 0+ and Age 1+ striped bass caught during the 2000-2001 program. Most of the fish in each length group <150 mm were Age 0+, while most of the fish in length groups between 150 and 300 mm were Age 1+. Age 1+ and Age 2+ striped bass overlapped in size primarily between 270 and 350 mm. Age 3+ striped bass overlapped with Age 2+ fish starting at about 360 mm. However, few fish Age 3+ or older were < 400 mm.

The 9 m trawl with 7.6 cm (stretch) mesh in the body and 3.8 cm (stretch) mesh in the cod end was the only gear that was consistently used among the 1986-1987 through 2000-2001 programs. Therefore, the striped bass catch by this gear was used for comparisons of mean length at age among programs. The 95% confidence intervals about the estimated mean length of each age cohort was used for the comparison of mean length at age. The 2000 cohort of Hudson River striped bass at Age 0+ was larger than only the 1987 and 1994 cohorts and not significantly different from the 1989, 1990, 1992, 1997 and 1998 cohorts at Age 0+ (Figure 3-6, Appendix Table C-7). The 2000 cohort

was smaller than the 1986, 1988, 1991, 1993, 1995, 1996 and 1999 cohorts at Age 0+. At Age 1+, the 1999 cohort was smaller than the 1986, 1993, 1995, 1996 and 1998 cohorts, equal in length to the 1990 and 1994 cohorts, and larger than the other seven year classes compared. At Age 2+, the 1998 cohort was larger than all previous year classes with the exception of the 1997 cohort. Among the Age 3+ striped bass, the 1997 cohort had a greater estimated mean length than the 1983, 1984, 1986, 1987, 1988, 1991, 1992, and 1993 cohorts. The 1997 cohort at Age 3+ observed in the 2000-2001 program did not differ in mean length from the 1985, 1989, 1990, 1994, 1995, or 1996 year classes at Age 3+.

### 3.2.2 Estimated Proportion and Number of Age 0+ Through Age 3+ Striped Bass

Stratified random sampling of about 23% of the scale samples resulted in extremely precise estimates of the proportion and number of Age 1+ striped bass in the 2000-2001 program (Table 3-6). For the allocation of 4,184 scale samples actually selected, the precision based on 95% confidence limits was 0.9% corresponding to an error term of 101 fish.

Relatively little gain in precision would be realized compared to the cost if age were determined for more than about 10% of the total sample (18,560 fish caught and measured in Use Code = 1 tows in 2000-2001). By determining the age from scale samples from as few as 500 fish, the total number of Age 1+ striped bass (11,498) out of the 18,560 fish caught and measured in use code = 1 samples during 2000-01could be estimated with 95% confidence limits of ± 317 fish (precision = 2.8%, Table 3-6). Using the stratified sampling plan, scales were selected for age analysis in direct proportion to both the number of Age 1+ fish in each 10 mm length group and the variance of the proportion of Age 1+ fish in each length group. However, the stratified design was also precise for estimating the proportion and number of Age 0+ through Age 2+ striped bass (Table 3-7), which collectively comprised 98% of the fish caught in this program. Only 200 of the 18,560 striped bass caught and measured in use code = 1 samples were estimated to be Age 3+, and 79 of the fish caught were older than Age 3+ in the 2000-01 program. The number of Age 0+ fish was estimated more precisely than would be expected based on Age 1+ fish because there was little overlap in size between these ages (Figure 3-5). The 1999 cohort of Age 1+ striped bass was approximately 62% of the total catch during 2000-2001. The number and proportion of Age 2+ striped bass (1998 cohort) were much less than these values for Age 1+ fish, but estimated with lower precision because the Age 2+ were more evenly distributed over a wide range of size groups (, and the sample size was smaller for these fish. The number of Age 3+ striped bass was estimated with relatively low precision because more than half of the catch of these fish were ≥ 400 mm and few scale samples were selected from this size group (Figure 3-5).

## 3.3 Characterization of Recaptured Striped Bass

During the 2000-2001 winter sampling program, 13,876 striped bass were tagged with an internal anchor-external streamer tag (internal anchor tag) inserted into the body cavity through the abdominal musculature. Of these tagged fish, 13,363 were released in good condition (Rel_Rec=1) and an additional 513 striped bass with external abnormalities were released (Rel_Rec=6). All striped bass were examined in the field for the presence of internal anchor tags or tag wounds at the insertion site. Internal anchor tag numbers for recaptured fish were recorded in the field and used to link recapture data with release data (Appendix Tables D-1 and D-2). We recaptured 159 of the 13,876 striped bass tagged in 2000-2001. Two of these fish were recaptured on more than one occasion resulting in 161

within year recapture events. Of the 161 recapture events, six were from the 513 Rel_Rec=6 striped bass tagged and 155 were from the 13,363 striped bass that were tagged and released in good condition (Rel_Rec=1). We also recaptured 30 striped bass with internal anchor tags implanted during previous programs, 12 fish were recaptured with suspected tag wounds, no fish were recaptured with illegible tag numbers, and eight fish were recaptured with tags from other tagging studies. These groups are described below in separate sections. A complete description of the number of fish caught, tagged with different types of internal anchor-external streamer tags since 1984, and the associated reward values printed on the external streamers is presented in Appendix Tables D-6 and D-7. Only internal anchor tags were used during the 2000-2001 program.

### 3.3.1 Striped Bass Internal Anchor-Tagged, Released, and Recaptured During the 2000-2001Winter Program

The majority (13,342 or 93%) of the taggable- size (≥150 mm) striped bass (14,287) were caught in the Battery region as were 150 or 97% of the 155 fish tagged, released in good condition and recaptured during this study (Table 3-8, Appendix Table D-1). This is not surprising since most (97%) of the trawl sampling effort was allocated to the Battery during 2000-2001 based on the high CPUE in this region during the previous programs (Normandeau 1986, 1987, 1988, 1990, 1992, 1994, 1996, 2000; LMS 1995, 1996, 1997). Recapture rates (R/M) and recapture proportions (R/C) can be used to examine the recapture of fish among different space or time frames. Recapture rates from the column totals compare the number of fish recaptured throughout the program (recaptured any time on or after the release date) to the number of fish released in a particular region or time period. Recapture rates from the row totals compare the number of fish recaptured in a region or time period to the number marked throughout the program. For example, in Table 3-8, the recapture rate for striped bass tagged, released and recaptured in the Battery (cell total) was 146/12,483 or 0.01170. The recapture rate for striped bass tagged and released in the Battery and recaptured throughout the study area (column total) was 150/12,483 or 0.01202. In contrast, recapture proportions (R/C) from column totals compare the number of fish released in a particular region to the number examined for tags throughout the program, while recapture proportions from the row totals compare both the number of fish recaptured in a particular region (regardless of origin) to the number of fish caught and examined for tags in that region. For example, in Table 3-8, the recapture proportion for striped bass tagged, released, and recaptured in the Battery among all fish examined for tags in the Battery (cell total) was 146/13,343 or 0.01094. It is generally most informative to examine recapture rates from the column totals and recapture proportions from the row totals since these statistics best describe specific movement among regions (or time periods).

Examination of monthly recapture rates (R/M) and recapture proportions (R/C) can provide insight into the movements of marked striped bass during the study period. Recapture rates that are stable with time (Schaefer 1951) and recapture proportions that increase with time suggest little movement of the marked population (Cormack 1968). Striped bass monthly recapture rates (R/M column totals; Table 3-9, Appendix Table D3) were generally stable for the November 2000 through mid-March 2001 period, with a fluctuation around a high in the first week of February 2001. Monthly recapture proportions (R/C row totals) steadily increased from January through early March 2001 followed by a decline through the rest of the sampling period. Both recapture rates (R/M) and recapture proportions (R/C) were lowest in April 2001. The pattern of reasonably stable monthly recapture rates and increasing recapture proportions during January 2001 through early March 2001 suggests that this was a period of little movement of the striped bass population in the lower Hudson River. The results

from linear regression analyses during this period showed that the slope over time (weeks) was not significant for recapture rates ($p=0.837$) but was significant ($p < 0.001$) for recapture proportion.

Striped bass tagged and released in the combined Battery and upper New York Harbor regions, and subsequently recaptured in those regions were at-large an average of 26 days and ranged in size between 151 mm and 512 mm (Table 3-10). Approximately 29% (45/155) of the striped bass were recaptured on the same day as they were tagged and released, and 71% (110/155) of the fish were recaptured within 30 days of release, suggesting most fish had remained in the contiguous region for approximately a month after they were tagged and released. Within two months (60 days), 85% (131/155) of the striped bass were recaptured, and the maximum days at-large was 136 days. Days at-large and recapture length data for the 2000-2001 program were similar to previous years (Normandeau 1987, 1988, 1990, 1991, 1992, 1994, 1996a, 1996b; 1999, 2000; LMS 1995, 1996, 1997).

### 3.3.2 Striped Bass Internal Anchor-Tagged and Released Prior to, and Recaptured During the 2000-2001 Winter Program

A total of 30 striped bass were recaptured during 2000-2001 with internal anchor tags identified from previous programs (Appendix Table D-2). Of these, 27 recaptured striped bass had the external portion of the tag (streamer) present, all tags numbers were completely legible, and none exhibited any abrasion on the external streamer (Table 3-11). An additional 12 striped bass were observed with suspected tag wounds but no tag streamer was present. Three of these fish with suspected tag wounds had Hallprint (MARK_CD = 98) anchors in the abdominal cavity containing the tag number indicating fishermen had cut off the external streamer. The remaining nine fish either had the tag and anchor removed by fishermen, had wounds unrelated to tagging, or had shed the tag. Upon autopsy, four of these nine striped bass had internal scars suggesting a tag anchor had been present, the other five fish had wounds judged to be unrelated to tagging. Tag numbers were defined as completely illegible if one or more digits of the 6-digit tag number could not be read in the field. Tag abrasion was first observed during 1986-1987, is time dependent, and the tagged fish must be at-large for at least six months for abrasion to affect the legibility of the legend on the external streamer (Mattson et al. 1990). In previous programs illegible tags were observed on 12-20% of the recaptured striped bass judged at-large at least one year, and 20-30% exhibited some degree of tag number abrasion (Normandeau 1987, 1988, and 1990). Changes in tag design since 1986-1987 have virtually eliminated tag abrasion, and no abraded tags were observed in the 2000-2001 program.

Prior to the 1986-1987 program, Floy internal anchor-external streamer tags were used: abrasion was observed in 28% of the recaptured fish at-large for at least six months (Mattson et al. 1990). During the 1986-1987 program, Floy internal anchor tags were first used with a clear, PVC tube over the external streamer to protect the legend from abrasion. Unfortunately, this tubing could not be sealed watertight and algal or bacterial growth proliferated between the clear tube and legend, making most of the external streamer legends unreadable. These tubing-type tags also had the number printed on the anchor, so the release information could be determined by sacrificing the fish and extracting the internal anchor.

Hallprint internal anchor tags were first used in 1987-1988. These tags have the legend sealed between layers of polyethylene on the external streamer, which is bonded to a monofilament core. The streamer was angled so that its distal end is posterior to the tag site. A similar but short length of streamer containing the tag number is used for the anchor (Figure 2-2). The external streamer on the

Hallprint tag has exhibited no abrasion or information loss due to abrasion. However, the streamer had an exposed section of monofilament core at the site of tag anchor insertion. A longitudinal scar at the tag wound site was observed frequently during early 1988-1989 from fish tagged and released during 1987-1988 with the exposed filament Hallprint tag (Normandeau 1990). Apparently, as continuous force was applied to the tag during swimming, the monofilament strand cut through the ventral body wall of the fish forming a longitudinal scar from the tag insertion site to the end of the abdominal cavity at the vent. When the tag reached the end of the abdominal cavity, it was displaced out of the fish and shed.

The Hallprint tag was modified in 1989 so that there was no exposed monofilament core. This modified extended-streamer Hallprint tag appears to have significantly reduced or eliminated the tag shedding problem. In 1988-1989, 13/26 fish recaptured with a wound at the insertion site exhibited a longitudinal scar and an additional 9/68 of the fish recaptured with a tag exhibited posterior displacement and a longitudinal scar. The 1988-1989 data suggested a long-term shedding rate for the original Hallprint tag with an exposed filament of 22/94 or 23%. Among the 9 fish with suspected tag wounds (and no anchor found) caught during the 2000-2001 program, 4 fish had a longitudinal scar suggesting they may have shed a tag and 5 fish had wounds that were judged to be not related to tagging. Changing to the Hallprint tag in 1987-1988 has virtually eliminated the problem of lost streamer information due to tag abrasion, and the change to the modified Hallprint tag with extended streamer in 1988-1989 has reduced tag loss due to shedding. Among the 30 striped bass recaptures from previous programs during 2000-2001 were 2 fish that had been tagged and released during 1996-1997, 2 fish that had been tagged and released during 1997-1998, 5 fish that had been tagged and released during 1998-1999, and 21 fish that had been tagged and released during 1999-2000 (Table 3-12, Appendix Table D-2). Three of the thirty cross-year recaptured striped bass in 2000-2001 were initially recaptured in programs prior to this year and these records are noted in Appendix Table D-2. Days at large and distance traveled calculations for these fish are determined from the last time they were handled (their initial recapture) rather than from the initial release date. All recaptured fish from the 1992-1993 through 2000-2001 programs were caught, tagged and released from the 9 m trawl, which was the only gear used. Recaptured fish were at-large between 223 and 1477 days, and ranged in length between 260 mm and 621 mm (Table 3-13).

Eight striped bass were recaptured in 2000-2001 with tags originating from other tagging programs (Table 3-14). Four fish were recaptured with U.S. Fish and Wildlife Service internal anchor tags and four fish were recaptured with Littoral Society spaghetti tags.

### 3.3.3 Condition of the Catch

Some of the striped bass caught in the 9 m trawl displayed one or more types of injury or abnormality, such as blindness, fin rot, fungal infection, skeletal deformity, or visible wounds. The incidence of such conditions among all fish that had not been previously caught (i.e., those without tags or tag wounds) was 3.4% (Table 3-15). About 76% (13,944 of 18,387) of all unmarked fish were subsequently tagged and released. Most of the fish not tagged were less than 150 mm and too small to tag, or were judged to be poor condition and not tagged. These groups of fish were either released without tags or were dead and taken to the laboratory for processing. The proportion of injured or anomalous striped bass among those tagged and released was 3.7% (521/13,944). The incidence of injuries or anomalies among recaptured fish (with tags or suspected tag wounds) was 11.5% (24 of 209). The most frequently observed conditions of unmarked striped bass were fin rot and stress from

the sampling gear. Of the unmarked fish, 0.2% displayed more than one type of injury or abnormality.

Each of the six general categories of poor condition were further classified (Table 3-16). Blindness in both eyes was nearly twice as frequent as blindness in one eye. Fin rot most commonly occurred on the caudal fin. Fungal infections, when present, were generally on both sides of the body. Skeletal anomalies included scoliosis (lateral spine curvature), head deformities (e.g., "pugnose"), or lordosis (dorso-ventral spine curvature) and damage from fishing hooks. Many of the visible wounds on the body were healed over. Other commonly noted wounds were damaged gills and missing or damaged fins. Infrequently observed conditions included hemorrhaged (bloodshot) eyes, bulging eyes ("pop-eye"), wounds to the eye, and tumors.

Fin rot and fungus accounted for a much larger proportion of the injuries/anomalies in recaptured striped bass (85%) than in unmarked fish (32%) (Table 3-16). Stress from the sampling gear among unmarked fish was 0.2% and not found among recaptured fish. Skeletal deformities among unmarked fish was 0.2% and not found among recaptured fish. The incidence of other types of conditions (blindness, wounds) was similar in recaptured fish to what was in unmarked fish or tagged fish.

## 3.4 STRIPED BASS POPULATION SIZE

An important objective of the 2000-2001 program was to estimate the size of the striped bass population that overwintered in the Battery and Upper Harbor regions of the Hudson River. The Schumacher-Eschmeyer regression technique was selected because it is a multiple census estimator which permits tagging and recapture efforts to occur concurrently. This estimator was used during the 1985-1986 through 2000-2001 programs to estimate the size of the mid-winter striped bass population in the Upper Harbor and Battery regions of the lower Hudson River (Normandeau 1986, 1987, 1988, 1990, 1991, 1992, 1994, 1996, 1999, 2000; LMS 1995, 1996, 1997).

Eight assumptions must be satisfied to estimate the winter striped bass population size in the lower Hudson River estuary using the Schumacher-Eschmeyer method or related methods (Cormack 1968; Ricker 1975; Seber 1982; MMES 1986):

1. mortality is not different for tagged and untagged bass,
2. tagging does not affect bass catchability,
3. tagged bass do not lose their marks,
4. all tags are recognized and reported,
5. natural marking does not occur or is recognizable,
6. immigration, emigration, and recruitment are negligible in the study area i.e., the population is closed,
7. tagged bass are randomly distributed among untagged fish or the distribution of recapture fishing effort is proportional to the abundance of fish in various river regions, and
8. marked fish have the same probability of being caught as unmarked fish.

With regard to Assumption 1, Dunning et al. (1987) observed no difference in mortality between tagged and untagged striped bass retained (1) in the Hudson River for 24 hours and (2) in holding pools for up to 180 days. However, during the 1990-1991 program, predation by birds (gulls) was observed to remove about 2.4% of the tagged fish as they were released from the tagging vessel (Normandeau 1992). Most of the bird predation was observed to occur as the released fish drifted away from the tagging vessel before sounding. In the 1991-1992 through present programs, all striped bass were released into a recovery pen that was suspended in the water alongside the tagging vessel. The pen provided cover until the fish sounded, and virtually eliminated bird predation. Therefore, the number of tagged striped bass at-large was not adjusted for mortality during the 2000-2001 program.

Differential catchability of tagged and untagged striped bass during the winter (Assumption 2) was probably not significant. With respect to trawling as recapture gear, tagged fish would not be differentially caught due to the presence of tags. This assumption is more a problem with gill nets or other recapture methods which rely on entanglement to catch fish.

With regard to Assumption 3, field crews were specifically instructed to examine fish for tag wounds (Normandeau 1998) which would provide evidence of tag loss. QA/QC procedures (Normandeau 1998) and audits provide documentation that incorrect identification or non-reporting of tags by field crews did not occur. Dunning et al. (1987) found 97.7% of tagged fish held for 180 days in pools retained their tags. Based on a 2.3% loss rate (Dunning et al. 1987) and the recapture of 155 fish out of 13,363 tagged fish, approximately 4 fish would be expected to have lost tags in the 2000-2001 program. However, the tag loss rate from Dunning et al. (1987) was based on Floy style tags which may exhibit a higher shedding rate than the Hallprint tags now used. Throughout the 2000-2001 program, 14,287 striped bass were examined for tags and tag wounds, and 12 fish were observed with suspected tag wounds. Three of these fish had anchors present without streamers indicating the streamer was cut and removed by fishermen. It was judged that of the remaining nine fish, five exhibited a longitudinal scar, suggesting the scar originated from shed Hallprint tags and the remaining four fish with scars were not attributed to tagging. Therefore, loss of internal anchor tags for fish tagged and released during 2000-2001 was considered to be near zero. This assumption provides a conservative estimate of abundance. If tag loss did occur and we adjusted for it, abundance estimates would be higher.

The recognition and reporting of tags, Assumption 4, was addressed by field and laboratory standard operating procedures and QA/QC procedures reviewed by the NYSDEC (Normandeau 1993, Geoghegan et al. 1990). Since this program provided both marking and recapture efforts, non-reporting of tags did not occur. Assumption 5 was satisfied because marking techniques which could be imitated by natural conditions (e.g., fin-clips) were not used in this study. Furthermore, tags from other programs (e.g., New York University or Littoral Society) were observed by field crews and easily distinguished from the internal anchor tags used in this study.

Immigration and emigration (Assumption 6) were apparently negligible during most of the study period (November 2000 through April 2001) as indicted by recapture rates, recapture proportions, and previous studies of the movement of striped bass in the lower Hudson River (Appendix Table D-3, Normandeau 1986, 1987, 1988, 1990, 1991, 1992, 1994, 1996; LMS 1995, 1996, 1997). A linear regression of weekly recapture proportions (R/C) on cumulative number of marked fish (Figure 3-7) was significant and positive and exhibited the largest coefficient of determination ($r^2$) for the weeks 1 January 2001 through the week of 5 March 2001 (Appendix Tables D-4 and D-5). In addition, the

results from linear regression analyses during this period showed that the slope over time (weeks) was not significant for recapture rates (R/M, p= 0.837) but was significant for recapture proportion (R/C, p= < 0.001). In previous programs, a late November through mid-March period of about 15-17 weeks was found to be representative for the population estimator (Normandeau 1994). However, the plot of recapture proportions against cumulative number of marked fish exhibited relatively high variability in November through December 2000 (Figure 3-7). In recent years (1996-1997, 1997-1998, 1998-1999), the January through March period has been used because of high variability in November and December (LMS 1997; Normandeau 1999). In the 1999-2000 program all weeks were included in the Schumacher-Eschmeyer population estimator. The significant linear regression (Appendix Table D-5), which formed the basis for the Schumacher-Eschmeyer closed population estimator, supported the assumption of random mixing of tagged and untagged striped bass during the 2000-2001 program (Assumption 7). Further-more, step-wise polynomial regressions did not significantly improve goodness of fit, which indicated a linear model was appropriate for the selected period.

With regard to Assumption 8, marked fish in the winter striped bass population of the Battery and Upper Harbor regions do not appear to be differentially exposed to recapture. This assumption is generally applied to fish populations where one or more age groups of tagged fish may migrate out of the study area while other age groups remain in the area. The winter population in the Battery and Upper Harbor regions was composed primarily of immature fish (Section 3.2; Appendix E) of similar size and age composition which probably are equally exposed to the trawl recapture effort.

The assumptions of a closed population, mark-recapture, population estimator appeared to be satisfied for the weeks of 1 January 2000 through the week of 5 March 2001 in this study. The Schumacher-Eschmeyer population estimate of the mid-winter striped bass population in Upper New York Harbor and the Battery during 2000-2001 was 388,000 fish ≥ 150 mm, with upper and lower 95% confidence limits (based on the t-distribution) ranging from 293,000 to 570,000 fish. The age composition of the winter population was approximated using the population estimate and the data from Section and the estimated population of Age 1+ and older striped bass during 2000-2001 was 381,000 fish (Table 3-17).

For comparison with previous programs, the total population of Age 1+ and older striped bass ≥200 mm was estimated as 319,000 fish by adjusting the estimate derived for the entire population of fish ≥150 mm, based on the proportion of Age 1+ fish between 150 and 200 mm (Table 3-18). This estimate was the third lowest calculated annually since 1985-86 (Table 3-19). The 1999 cohort of Age 1+ fish was the primary contributor to this estimate of Hudson River striped bass in the winter population during 2000-2001.

The Schumacher-Eschmeyer population estimate presented in this report section provides an index of absolute abundance of Age 1+ and Age 2+ striped bass over-wintering in Upper New York Harbor and the Battery region of the Hudson River. It is a "closed" population estimate (Cormack 1968), meaning that this estimator relies on satisfying Assumption #6 that immigration, emigration, and recruitment are negligible in this study area during the evaluation period. Recruitment is negligible during the study period because striped bass spawn in May in the Hudson River and because the program tags and recaptures fish older than Age 0+. Recapture rates and recapture proportions are systematically examined each year to select a mid-winter period when these rates demonstrate that immigration into, and emigration out of the contiguous Upper New York Harbor and Battery regions are negligible, thus satisfying Assumption #6. Therefore, the Schumacher-Eschmeyer estimate

presented in this report section provides an absolute estimate of the abundance of striped bass found in the two regions sampled. However, it is possible that the entire population of Age 1+ and Age 2+ Hudson River striped bass may not be found exclusively within Upper New York Harbor and the Battery region in all winters. Evidence from the earlier programs (1985-1986, and 1986-1987) suggests that in some years a portion of the striped bass population may over-winter either in the Hudson River just north of the Battery region (i.e. in the Yonkers or Tappan Zee regions), or in the Harlem River and East Rivers (Normandeau 1986, 1987). In years when the entire Hudson River population of Age 1+ and Age 2+ striped bass is not found over-wintering in the study area, the Schumacher-Eschmeyer estimate presented in this report becomes an index of abundance, but may underestimate the total population size. Age 1+ and Age 2+ population estimates calculated by one or more of the "open" population estimators that do not require Assumption #6 (i.e. Jolly-Seber estimator, MMES 1986, Seber 1982), based on the striped bass tagged in this program as the release sample and angler tag returns as the recapture sample (Waldman et al. 1990), may provide a more robust estimate of absolute population abundance.

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# FIGURES

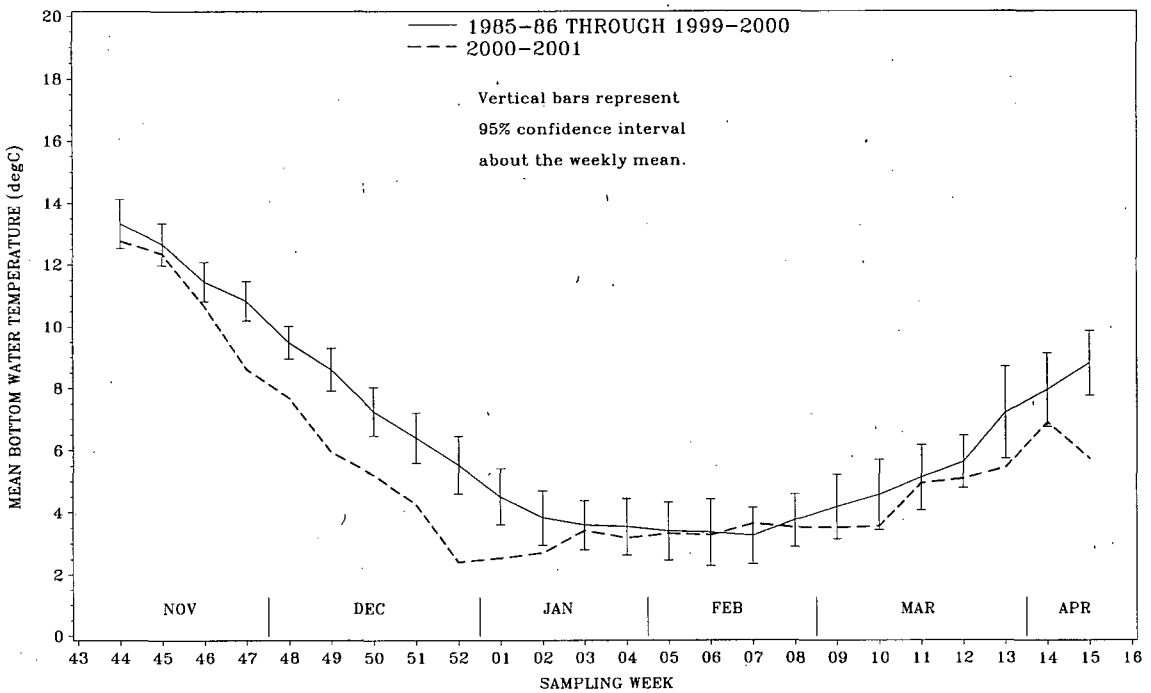



Figure 1-1. Weekly mean bottom temperature in the Battery region of the Hudson River during 2000-2001 compared to the weekly mean and 95% confidence intervals for the 1985-1986 through 1999-2000 Hudson River Striped Bass Programs.

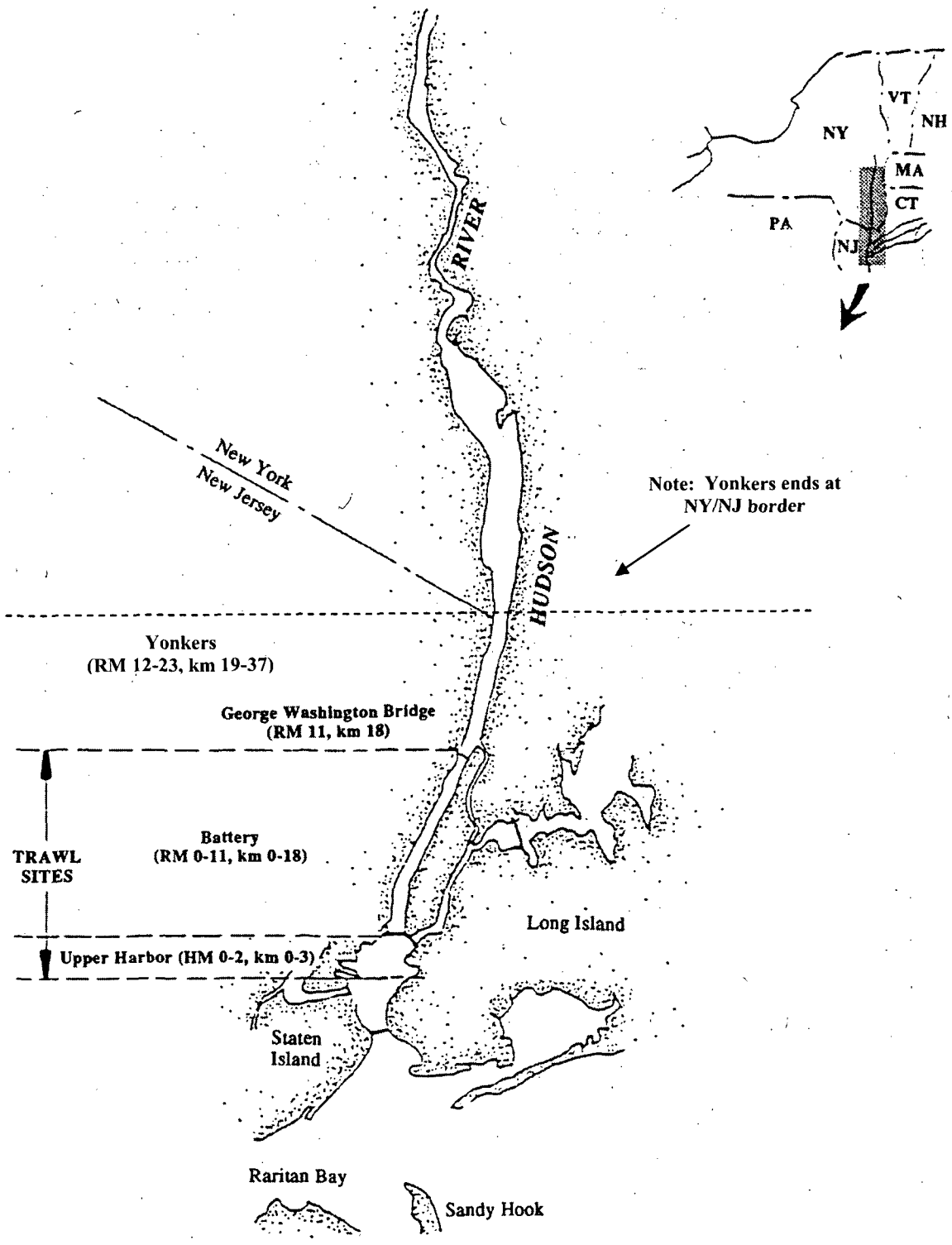
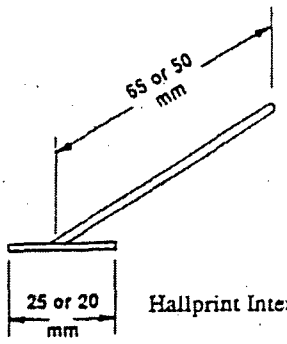
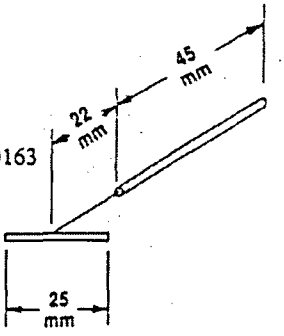


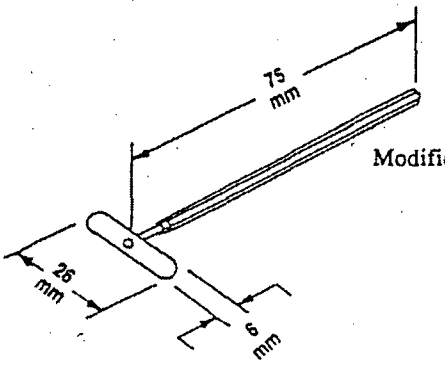

Figure 2-1. Sampling regions in the lower Hudson River and New York Harbor during the winter 2000-2001 Hudson River Striped Bass Program.




Hallprint Internal Anchor-External Streamer Tag (1988-present)
(with covered filament)
65 mm x 25 mm tags for fish ≥ 300mmTL
50 mm x 20 mm tags for fish 150-299mmTL
MARK_CD = 98 YELLOW EXTERNAL STREAMER
LINE 1: REWARD $10-$1000 No ######
LINE 2: MAIL TO HRF BOX 1731 G.C.S. NY NY 10163
ANCHOR: YELLOW No ######

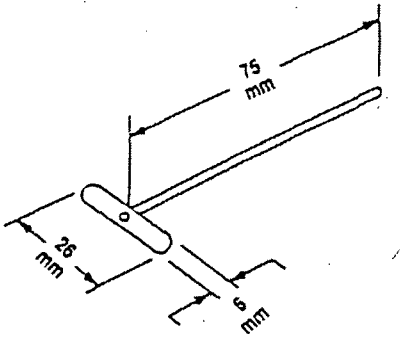
Hallprint Internal Anchor-External Streamer Tag (1987-1988)
(with exposed filament)
MARK_CD = 98 YELLOW EXTERNAL STREAMER
LINE 1: REWARD $10-$1000 No ######
LINE 2: MAIL TO HRF BOX 1731 G.C.S. NY NY 10163
ANCHOR: YELLOW No ######

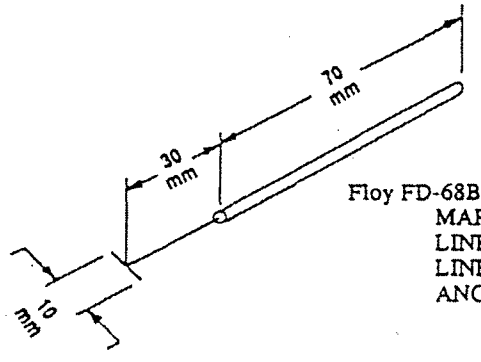



Modified Floy Internal Anchor-External Streamer Tag (1987)
(with clear vinyl tubing over external streamer)
MARK_CD = 97 PINK EXTERNAL STREAMER
LINE 1: REWARD $10-$1000 #####
LINE 2: MAIL TO HRF BOX 1731 GCS NY NY 10163
ANCHOR: (BLUE 26 mm x 6 mm for fish ≥300 mmTL,
RED 20 mm x 5 mm for fish 200-299 mmTL)
same legend as lines 1 and 2 of the external streamer

Floy Internal Anchor-External Streamer Tag (1984-1987)
MARK_CD = 96 YELLOW EXTERNAL STREAMER
LINE 1: REWARD $10-$1000 #####
LINE 2: MAIL TO HRF BOX 1731 GCS NY NY 10163
ANCHOR: (BLUE 26 mm x 6 mm for fish ≥300 mmTL,
RED 20 mm x 5 mm for fish 200-299 mmTL)
no legend




Floy FD-68B Anchor Tag (1984)
MARK_CD = 82 YELLOW EXTERNAL STREAMER
LINE 1: REWARD $10-$1000 A#####
LINE 2: RET TO HRF BOX 1731 GRAND CENTRAL STN NY 10163
ANCHOR: monofilament, no legend

Figure 2-2. Tags used to mark striped bass during the 1984-present Hudson River Striped Bass Programs.

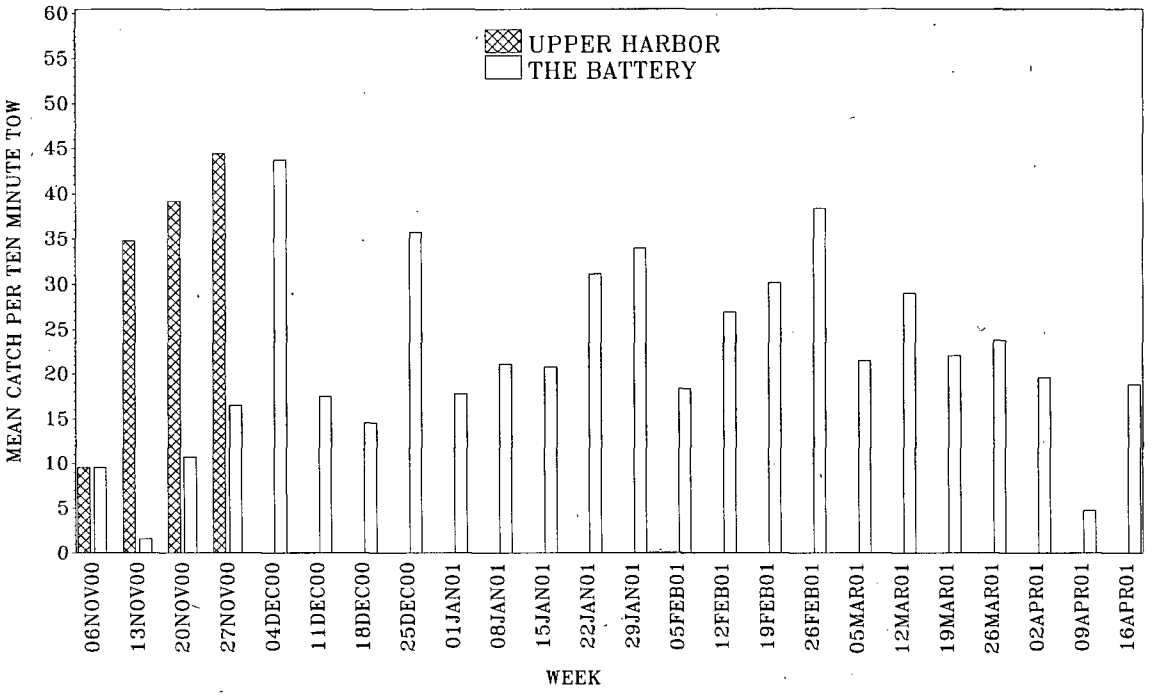



Figure 3-1. Weekly mean catch per ten minute tow (use code 1 tows only) by a 9m trawl in the Battery and Upper Harbor regions of the Hudson River, 6 November 2000 through 20 April 2001.

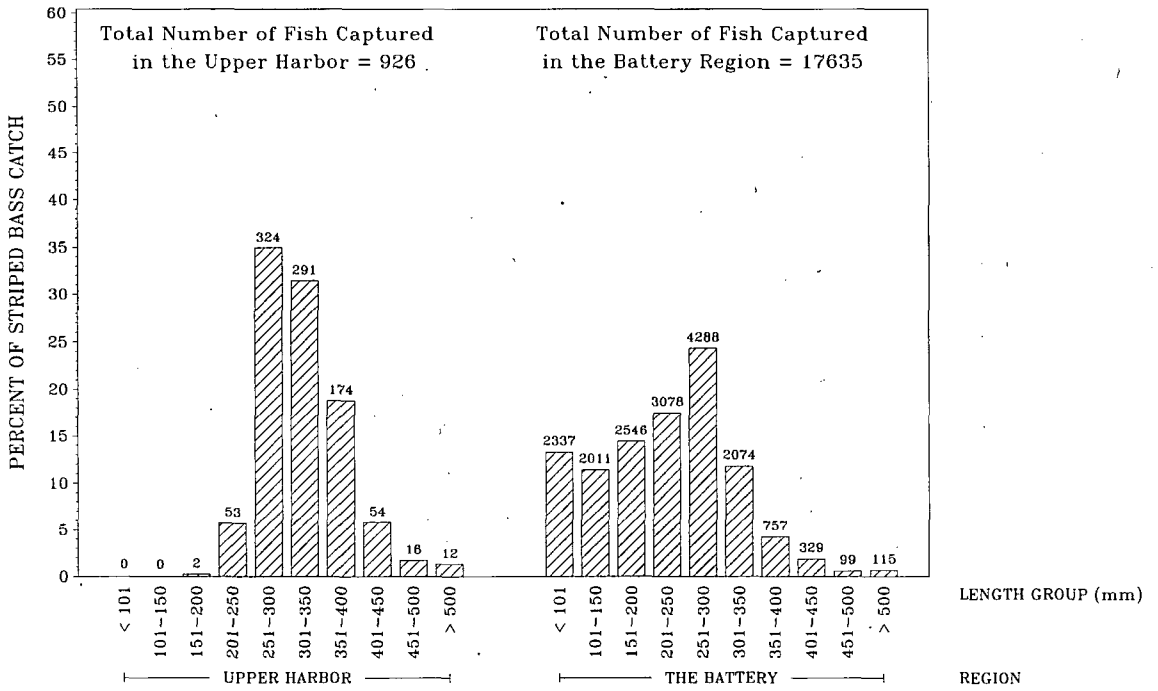



Figure 3-2. Length-frequency distribution for striped bass captured by a 9m trawl in the Battery and Upper Harbor regions of the Hudson River, 6 November 2000 through 20 April 2001.

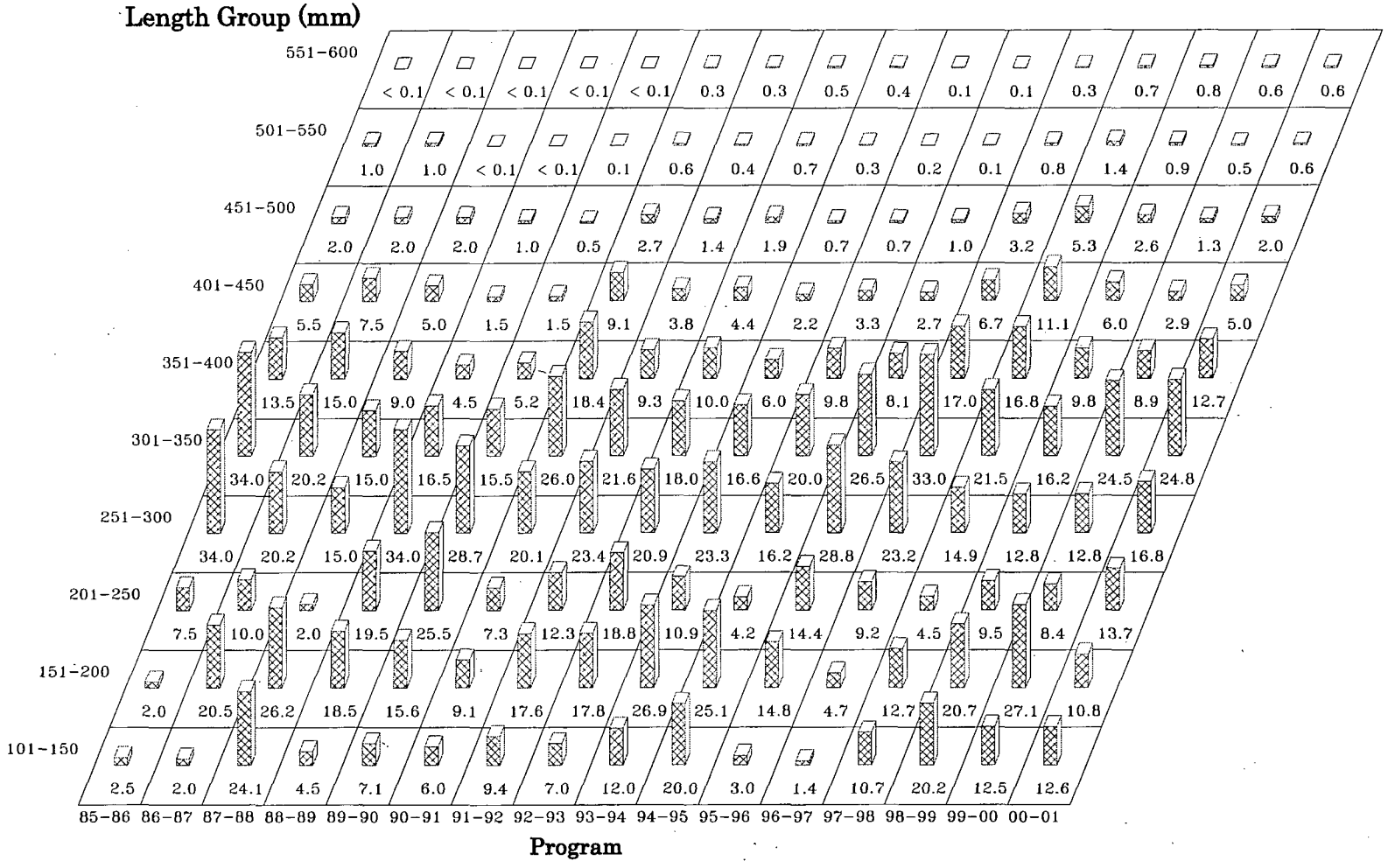



Figure 3-3. Standardized length-frequency of striped bass captured by a 9m trawl in the Battery and Upper Harbor regions of the Hudson River, 1985-1986 through 2000-2001.

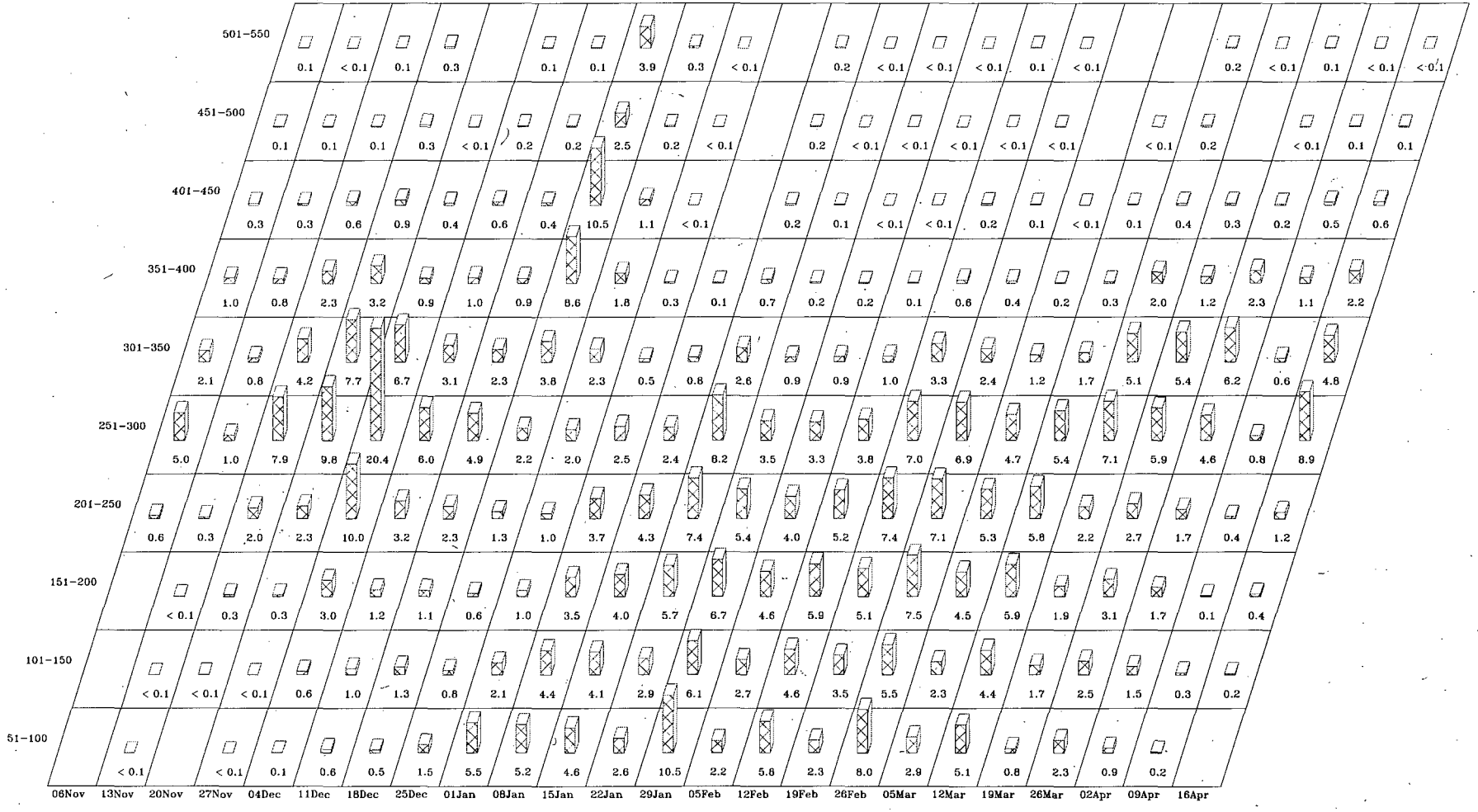



Figure 3-4. Weekly length-frequency distributions for striped bass caught per ten minute tow in a 9m trawl in the Battery and Upper Harbor regions of the Hudson River, 6 November 2000 through 20 April 2001.

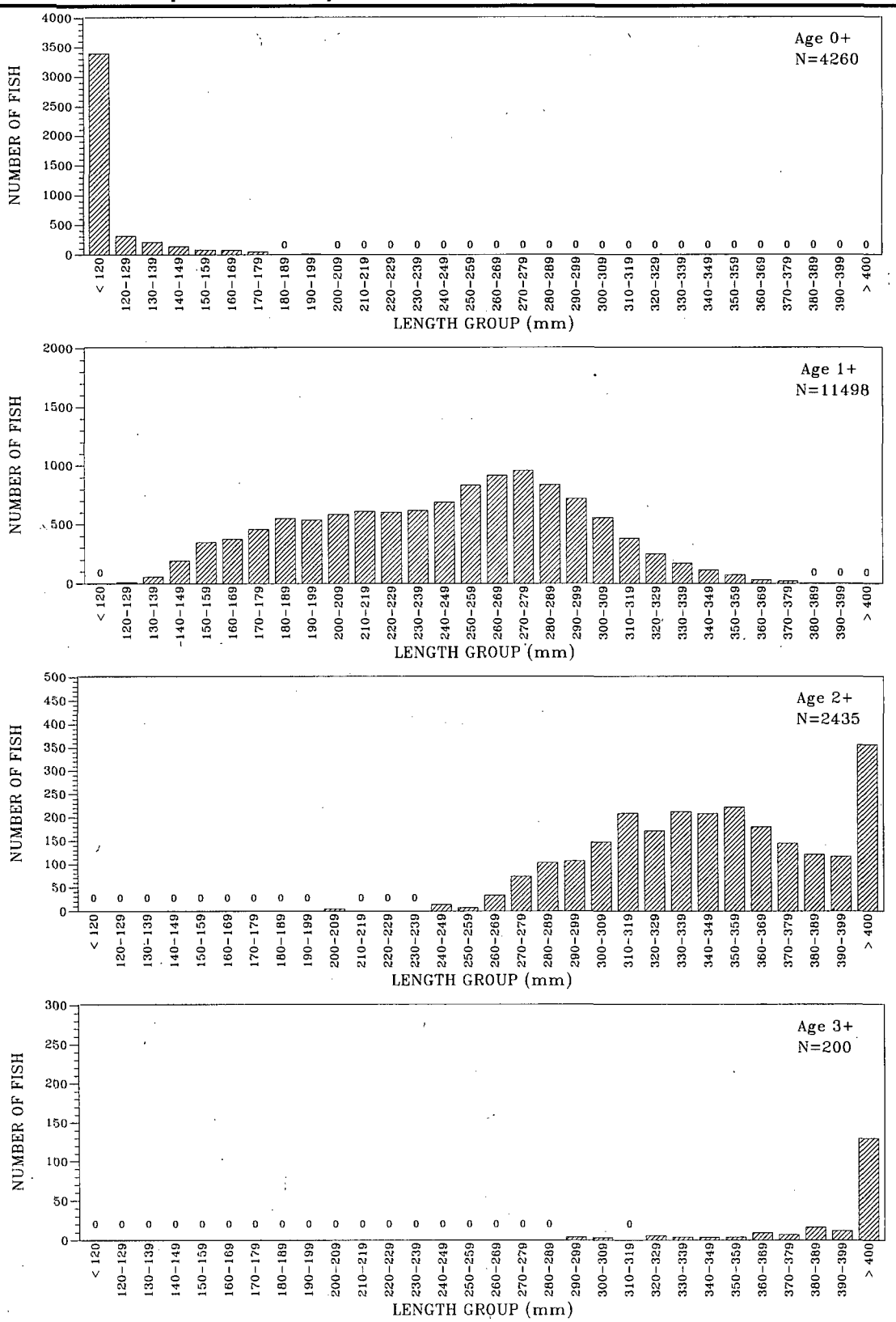



Figure 3-5. Length-frequency distributions for Age 0+, 1+, 2+ and 3+ striped bass captured by a 9m trawl in the Hudson River, 6 November 2000 through 20 April 2001. (Note the Vertical scales differ among the graphs).

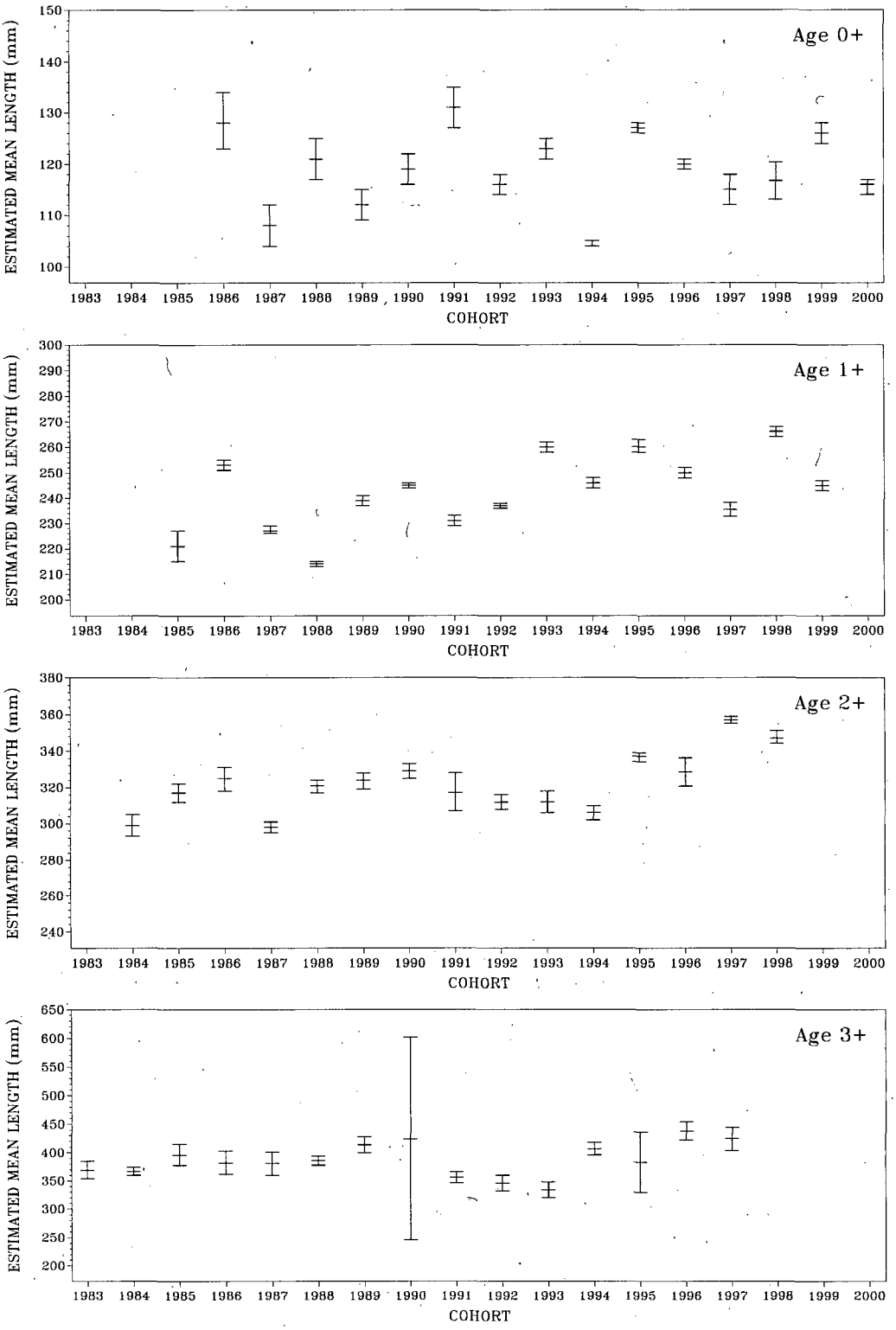



Figure 3-6. Mean length at age (and 95% confidence interval) for Age 0+ through Age 3+ wild striped bass of the 1983 through 2000 cohorts caught in a 9m trawl in the Hudson River. (Note the vertical scales differ among the graphs).

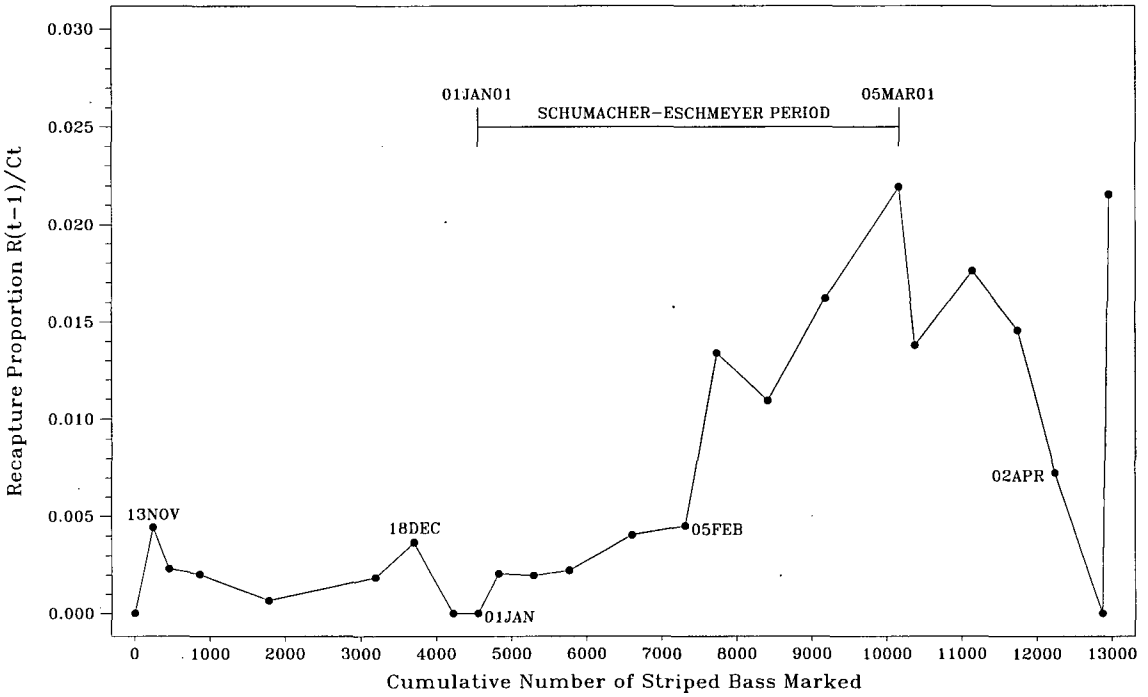



Figure 3-7. Striped bass recapture proportion ($R_{(t-1)}$/ $C_t$) versus cumulative number of striped bass tagged in the combined Upper Harbor and Battery regions of the Hudson River, 6 November 2000 through 20 April 2001.

# TABLES

**Table 1-1. Comparison of Sampling Designs and Selected Results of the 1984 through 1999-2000 Hudson River Striped Bass Programs.**

| Program | Gear | Dates | Sampling Regions | Catch Statistics | | | | | | | Population Estimates | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | N-Tows | CPUE | N-Total | N-Tagged | N-Recaptured | N-Hatchery | Handling Mortality (%) | Total (≥ 200 mm) | Age 1+ | Hatchery Proportion Age 1+ (%) |
| 1984 | 12 m trawl | 9Apr-7Jun | TZ,CH,IP, WP,CW,PK | 200 | 2.8 | | 345 | | 0 | 18 | – | – | |
| | Scottish seine | 9Apr-7Jun | TZ,CH,CW | 139 | 2.2 | | 392 | | 0 | 16 | – | – | |
| | Total | | | 339 | 2.6 | 1,620 | 737 | 0 | 0 | 17 | – | – | 0 |
| 1985-1986 | 9m trawl | 11Nov-18May | BT | 900 | 8.2 | | 6,366 | | 0 | 1 | | | |
| | 12 m trawl | 11Nov-18May | BT,HR,ER,LH | 346 | 20.7 | | 7,265 | | 0 | 2 | | | |
| | Scottish seine | 31Mar-18May | TZ,CH | 226 | 19.4 | | 4,856 | | 0 | 1 | | | |
| | Total | | | 1,472 | 12.9 | 20,820 | 18,487 | 171 | 0 | 1 | 540,000 | 239,000 | 0 |
| 1986-1987 | 9m trawl | 21Dec-9May | BT | 845 | 9.8 | | 5,349 | | 74 | 1 | | | |
| | 12m trawl | 21Dec-9May | BT | 219 | 24.1 | | 4,039 | | 20 | 1 | | | |
| | Total | | BT | 1,064 | 12.7 | 14,136 | 9,388 | 261 | 94 | 1 | 394,000 | 108,000 | 1.7 |
| 198719-88 | 9m trawl | 9Nov-22Apr9 | BT | 896 | 20.0 | 18,075 | 7,582 | | 176 | <1 | | | |
| | 12m trawl | Nov22Apr | BT | 296 | 33.9 | 10,117 | 4,854 | | 62 | <1 | | | |
| | Total | | BT | 1,192 | 23.5 | 28,192 | 12,436 | 465 | 238 | <1 | 295,000 | 181,000 | 1.6 |
| 1988-1989 | 9m trawl | 31Oct-15Apr | BT | 1,151 | 28.5 | 32,975 | 24,393 | 453 | 213 | <1 | 890,000 | 794,000 | 0.2 |
| 1989-1990 | 9m trawl | 31Oct-15Apr | BT | 891 | 37.3 | 33,386 | 24,362 | 655 | 141 | <1 | 528,000 | 397,000 | 0.4 |
| 1990-1991 | 9m trawl | 12Nov-20Apr | BT | 971 | 29.7 | 29,346 | 22,406 | 865 | 52 | <1 | 786,000 | 352,000 | 0.2 |
| 1991-1992 | 9m trawl | 4Nov-7May | BT | 1,169 | 29.3 | 34,202 | 23,514 | 631 | 17 | <1 | 967,000 | 709,000 | [a] |
| 1992-1993 | 9m trawl | 2Nov-16Apr | BT | 818 | 34.0 | 27,778 | 20,847 | 345 | 190 | 1.6 | 717,000 | 475,000 | [a] |
| 1993-1994 | 9m trawl | 1Nov-20Apr | BT | 794 | 36.2 | 28,739 | 17,500 | 333 | 134 | 1.6 | 379,000 | 217,000 | 0.01 |
| 1994-1995 | 9m trawl | 2Nov-14Apr | BT | 819 | 15.4 | 12,635 | 6,837 | 75 | 54 | <1 | 325,000 | 225,000 | 1.0 |
| 1995-1996 | 9m trawl | 6Nov-15Apr | BT | 806 | 16.9 | 13,643 | 10,889 | 111 | 9 | 1.5 | 786,000 | 621,000 | 0.08 |
| 1996-1997 | 9m trawl | 4Nov-13Apr | BT | 954 | 15.1 | 14,377 | 12,794 | 125 | 2 | 1.2 | 694,000 | 425,000 | 0.0001 |
| 1997-1998 | 9m trawl | 2Nov-16Apr | BT | 1,004 | 20.1 | 20,222 | 14,428 | 193 | 0 | 0.6 | 427,000 | 184,000 | [a] |
| 1998-1999 | 9m trawl | 2Nov-16Apr | BT | 941 | 20.9 | 19,715 | 11,203 | 187 | 0 | 0.5 | 280,000 | 153,000 | [a] |
| 1999-2000 | 9-m trawl | 1 Nov-14 Apr | BT, YK | 781 | 27.3 | 21,338 | 12,587 | 80 | 0 | 0.3 | 1,180,000 | 986,000 | [a] |

SAMPLING REGIONS: BT = Battery and Upper New York Harbor, Hudson River Miles 0-11 (km 0-18) and Upper New York Harbor. YK = Yonkers, Hudson River Miles 12-23 (km 19-37), TZ = Tappan Zee, Hudson River Miles 24-33 (km 38-53). CH = Croton-Haverstraw, Hudson River Miles 34-38 (km 54-61). IP = Indian Point, Hudson River Miles 39-46 (km 62-74). CW = Cornwall, Hudson River Miles 56-61 (km 90-98). PK = Poughkeepsie, Hudson river miles 62-76 (km 99-122). HR = Harlem River. ER = East River. LH = Lower New York Harbor.

[a] Hatchery striped bass were not tagged before release in 1990 or 1991, and the hatchery operation was discontinued following the 1995-96 program. Therefore an Age 1+ hatchery proportion was not computed.

**Table 3-1. Mean Catch of Striped Bass per Ten Minute Tow by a 9 m Trawl in the Hudson River, 6 November 2000 through 20 April 2001.**

| Region | Number of Tows[1] | Number of Fish Caught | Mean Catch per Ten Minute Tow | Standard Error |
|---|---|---|---|---|
| Battery | 800 | 17,635 | 22.0 | 0.8 |
| Upper Harbor | 26 | 926 | 35.6 | 7.0 |

[1]Use Code = 1 tows only.

**Table 3-2. Mean Catch of Striped Bass per Ten Minute Tow by a 9 m Trawl in the Battery Region of the Hudson River During Common Time Periods in the Winters of 1985-1986 through 2000-2001.**

| Year | Period | Tows | Mean CPUE | 95% CI |
|---|---|---|---|---|
| 1985-1986 | 23 Dec 85 - 21 Mar 86 | 638 | 8.1 | ± 1.0 |
| 1986-1987 | 21 Dec 86 - 21 Mar 87 | 385 | 12.2 | ± 1.2 |
| 1987-1988 | 20 Dec 87 - 19 Mar 88 | 437 | 28.5 | ± 2.5 |
| 1988-1989 | 19 Dec 88 - 18 Mar 89 | 527 | 38.9 | ± 3.3 |
| 1989-1990 | 18 Dec 89 - 16 Mar 90 | 458 | 45.3 | ± 4.3 |
| 1990-1991 | 17 Dec 90 - 15 Mar 91 | 477 | 40.7 | ± 3.5 |
| 1991-1992 | 23 Dec 91 - 21 Mar 92 | 578 | 35.5 | ± 2.2 |
| 1992-1993 | 21 Dec 92 - 20 Mar 93 | 397 | 32.7 | ± 2.9 |
| 1993-1994 | 20 Dec 93 - 20 Mar 94 | 341 | 33.7 | ± 5.2 |
| 1994-1995 | 19 Dec 94 - 19 Mar 95 | 291 | 21.9 | ± 2.2 |
| 1995-1996 | 18 Dec 95 - 17 Mar 96 | 299 | 14.3 | ± 2.0 |
| 1996-1997 | 16 Dec 96 - 16 Mar 97 | 476 | 19.6 | ± 1.8 |
| 1997-1998 | 22 Dec 97 - 22 Mar 98 | 487 | 23.5 | ± 1.9 |
| 1998-1999 | 21 Dec 98 - 21 Mar 99 | 384 | 38.4 | ± 3.1 |
| 1999-2000 | 20 Dec 99 - 19 Mar 00 | 402 | 31.7 | ± 3.5 |
| 2000-2001 | 18 Dec 00 – 18 Mar 01 | 453 | 26.1 | ± 4.6 |

**Table 3-3. Descriptive Statistics for the Length-Frequency Distribution of Striped Bass Captured by a 9 m Trawl in the Upper Harbor And Battery Regions of the Hudson River, 6 November 2000 through 20 April 2001.**

| Region | N | Mean TL (mm) | Range | S.D. | Skewness (95% C.I.) | Kurtosis (95% C.I.) | Description |
|---|---|---|---|---|---|---|---|
| Upper Harbor | 926 | 324 | 191-651 | 63 | 1.77 ± 0.16 | 6.79 ± 0.32 | Right skewness leptokurtoic |
| Battery | 17,634[a] | 225 | 54-824 | 95 | 0.41 ± 0.04 | 0.83 ± 0.07 | Right skewness leptokurtoic |
| Combined | 18,560 | 230 | 54-824 | 96 | 0.37 ± 0.04 | 0.77 ± 0.07 | Right skewness leptokurtoic |

N = Number caught
TL = Total length
S.D. = Standard Deviation
95% C.I. = 95% confidence interval

Right skewness = Significant positive skewness indicating more striped bass were smaller than the mean length than would be expected from a normal distribution.

Leptokurtosis = Significant positive kurtosis indicating that more striped bass were close to the mean length than would be expected from a normal distribution.

[a] No length recorded for one fish collected in the Battery Region for use code =1.

**Table 3-4. Handling Mortality for Striped Bass (Percentage of Dead Striped Bass in a Temperature Increment) Captured by a 9 m Trawl in Relation to Hudson River Bottom Water Temperature, 6 November 2000 through 20 April 2001.**

| Bottom Water Temperature (°C) | % Of Catch Dead[1] | Number Dead[1] | Total Catch[1] |
|---|---|---|---|
| 2 | 0.0 | 0 | 505 |
| 3 | 0.2 | 6 | 4,101 |
| 4 | 0.5 | 32 | 6,358 |
| 5 | 0.6 | 11 | 1,900 |
| 6 | 0.9 | 18 | 1,934 |
| 7 | 0.9 | 6 | 703 |
| 8 | 0.7 | 9 | 1,274 |
| 9 | 0.1 | 1 | 874 |
| 10 | 0.8 | 1 | 125 |
| 11 | 0.3 | 1 | 303 |
| 12 | 0.0 | 0 | 166 |
| 13 | 0.3 | 1 | 318 |
| 2–13 | 0.5 | 86 | 18,561 |

[1]Mortality and catch data for striped bass caught in use code = 1 tows for which river bottom water temperature was available.

**Table 3-5. Handling Mortality for Striped Bass (Percentage of Dead Striped Bass at a Temperature Increment) Captured by a 9 m trawl Among Common Bottom Water Temperature Increments during the 1985-1986 through the 2000-2001 Hudson River Striped Bass Programs.**

| Program | Statistic | Bottom Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 4-12°C |
| **1985-1986 through 1990-1991** | | | | | | | | | | | |
| | **% Dead** | 0.3 | 0.3 | 0.2 | 0.4 | 0.2 | 0.5 | 0.2 | 0.3 | 0.3 | 0.3 |
| | **n/N** | 51/16,155 | 58/21,071 | 43/18,783 | 43/11,785 | 20/8,731 | 29/5,709 | 8/4,843 | 11/3,185 | 6/1,995 | 269/92,257 |
| **1991-1992** | | | | | | | | | | | |
| | **% Dead** | 0.5 | 0.2 | 1.5 | 1.0 | 1.4 | 0.9 | 1.1 | 0.6 | 0.5 | 0.8 |
| | **n/N** | 45/9,685 | 13/5,419 | 98/6,438 | 26/2,728 | 29/2,135 | 10/1,133 | 21/1,897 | 5/879 | 1/187 | 248/30,501 |
| **1992-1993** | | | | | | | | | | | |
| | **% Dead** | 3.5 | 2.2 | 1.8 | 1.2 | 2.2 | 0.2 | 0.7 | 0.5 | 0.2 | 1.7 |
| | **n/N** | 107/3,090 | 86/3,858 | 44/2,380 | 16/1,347 | 17/756 | 3/1,361 | 6/806 | 17/3,406 | 1/434 | 297/17,438 |
| **1993-1994** | | | | | | | | | | | |
| | **% Dead** | 3.3 | 1.2 | 2.0 | 1.4 | 2.1 | 0.5 | 0.0 | 0.3 | 0.5 | 1.9 |
| | **n/N** | 156/4,713 | 53/4,438 | 65/3,206 | 36/2,564 | 29/1,354 | 1/196 | 0/91 | 4/1,424 | 2/243 | 346/18,409 |
| **1994-1995** | | | | | | | | | | | |
| | **% Dead** | 0.3 | 0.6 | 0.4 | 0.3 | 0.6 | 0.2 | 0.4 | 0.0 | 0.0 | 0.4 |
| | **n/N** | 6/1,759 | 15/2,692 | 8/1,987 | 4/1,585 | 2/326 | 1/640 | 3/836 | 0/295 | 0/69 | 39/10,186 |
| **1995-1996** | | | | | | | | | | | |
| | **% Dead** | 0.7 | 1.2 | 1.5 | 1.7 | 0.2 | 0.9 | 0.2 | 1.0 | 1.1 | 1.0 |
| | **n/N** | 3/448 | 8/664 | 18/1,180 | 34/1,989 | 4/1,935 | 17/1,790 | 1/578 | 16/1,617 | 5/447 | 106/10,648 |
| **1996-1997** | | | | | | | | | | | |
| | **% Dead** | 2.0 | 1.0 | 0.9 | 1.6 | 2.3 | 0.0 | 0.0 | 0.5 | 0.9 | 1.2 |
| | **n/N** | 60/3,030 | 34/3,500 | 32/3,571 | 18/1,110 | 11/471 | 0/489 | 0/180 | 1/212 | 1/110 | 157/12,674 |
| **1997-1998** | | | | | | | | | | | |
| | **% Dead** | 0.0 | 0.6 | 0.9 | 0.6 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.6 |
| | **n/N** | 0/260 | 35/5,913 | 43/5,043 | 9/1,464 | 0/521 | 0/486 | 0/465 | 1/425 | 0/24 | 88/14,601 |
| **1998-1999** | | | | | | | | | | | |
| | **% Dead** | 0.6 | 0.4 | 0.0 | 0.0 | 1.9 | 0.1 | 0.5 | 1.2 | 0.0 | 0.5 |
| | **n/N** | 55/9,493 | 16/2,436 | 0/135 | 0/483 | 4/213 | 1/852 | 1/194 | 1/85 | 0/11 | 78/15,702 |

(continued)

**Table 3-5. (Continued)**

| Program | Statistic | Bottom Water Temperature (°C) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 4-12°C |
| **1999-2000** | | | | | | | | | | | |
| | **% Dead** | 0.3 | 0.5 | 0.7 | 0.3 | 0.1 | 0 | 0.1 | 0 | 0 | 0.4 |
| | **n/N** | 8/2,396 | 14/2,401 | 12/1,758 | 21/2,967 | 2/2,353 | 0/525 | 1/1,582 | 0/997 | 0/248 | 58/15,727 |
| **2000-2001** | | | | | | | | | | | |
| | **% Dead** | 0.5 | 0.6 | 0.9 | 0.9 | 0.7 | 0.1 | 0.8 | 0.3 | 0 | 0.6 |
| | **n/N** | 32/6,358 | 11/1,900 | 18/1,934 | 6/703 | 9/1,274 | 1/874 | 1/125 | 1/303 | 0/166 | 79/13,637 |

n = Number of dead striped bass collected at a temperature (Use Code = 1 samples only).
N = Total number of striped bass caught at a temperature (Use Code = 1 samples only).

**Table 3-6. Relationship between the Number of Scale Samples Selected for Age Determination by Neyman Sample Allocation and Precision of the Stratified Estimate of Proportion and Total Number of Age 1+ Striped Bass Captured by a 9 m Trawl in the Hudson River, 6 November 2000 through 20 April 2001.**

| | Estimated Number Of Age 1+ Fish Caught | | | | |
|---|---|---|---|---|---|
| Sample size | Proportion Age 1+ | Stratified Total[b] | Lower 95% C.I | Upper 95% C.I | Precision (%)[a] |
| 500 | 0.620 | 11,498 | 11,181 | 11,815 | 2.8 |
| 1,000 | 0.620 | 11,498 | 11,283 | 11,713 | 1.9 |
| 2,000 | 0.620 | 11,498 | 11,355 | 11,641 | 1.2 |
| 3,000 | 0.620 | 11,498 | 11,389 | 11,607 | 0.9 |
| 4,000 | 0.620 | 11,498 | 11,410 | 11,586 | 0.8 |
| 4,184[c] | 0.620 | 11,498 | 11,397 | 11,599 | 0.9 |
| 5,000 | 0.620 | 11,498 | 11,426 | 11,570 | 0.5 |

[a]Precision = 95% confidence interval (CI) half width/stratified total x 100.

[b]Based on 18,560 striped bass caught and measured in use code = 1 samples from the Battery and Upper Harbor.

[c]Results for sample size =4,184 are based on actual allocations from use code = 1 samples which deviate slightly from the Neyman sample allocations because some scale samples consisted of regenerated scales and could not be used for age determination.

**Table 3-7. Estimated Proportion and Number of Age 0+ through Age 3+ Striped Bass Captured by a 9 m Trawl in the Hudson River, 6 November 2000 through 20 April 2001.**

| | | | Estimated Number of Fish Caught | | | |
|---|---|---|---|---|---|---|
| Age | Year Class | Proportion | Stratified Total[a] | Lower 95% CI | Upper 95% CI | Precision (%) |
| 0+ | 2000 | 0.230 | 4,260 | 4,214 | 4,307 | 1.1 |
| 1+ | 1999 | 0.620 | 11,498 | 11,397 | 11,599 | 0.9 |
| 2+ | 1998 | 0.131 | 2,437 | 2,332 | 2,541 | 4.3 |
| 3+ | 1997 | 0.011 | 200 | 155 | 245 | 22.5 |

[a]Based on a laboratory sample of scales from 4,184 striped bass selected by stratified random sampling from 18,560 fish caught and measured in use code = 1 samples from the Battery and Upper Harbor regions.

**Table 3-8. Recapture of Tagged Striped Bass Cross-Classified by Release and Recapture Region in the Hudson River, 6 November 2000 through 20 April 2001.**

| Recapture Region | Number Examined for Marks (C) | Statistic | Number of Recaptures By Release Region | | |
|---|---|---|---|---|---|
| | | | Upper Harbor M= 880 | Battery M= 12,483 | Total M=13,363 |
| Upper Harbor | 944 | R | 2 | 4 | 6 |
| | | R/M | 0.00227 | 0.00032 | 0.00045 |
| | | R/C | 0.00212 | 0.00424 | 0.00636 |
| Battery | 13,343 | R | 3 | 146 | 149 |
| | | R/M | 0.00341 | 0.01170 | 0.01115 |
| | | R/C | 0.00022 | 0.01094 | 0.01117 |
| Total | 14,287 | R | 5 | 150 | 155 |
| | | R/M | 0.00568 | 0.01202 | 0.01160 |
| | | R/C | 0.00035 | 0.01050 | 0.01085 |

Recaptures include only fish released during the current sampling season.

LEGEND:
R = number of striped bass recaptured
M = number of striped bass ≥150 mm marked and released
C = number of striped bass ≥150 mm caught and examined for tags
R/M = recapture rate
R/C = recapture proportion

**Table 3-9. Recapture of Tagged Striped Bass Cross-Classified by Release and Recapture Month for Fish Released and Recaptured by Trawls in the Combined Upper Harbor and Battery Regions of the Hudson River from 6 November 2000 through 20 April 2001.**

| Recapture Month | Number Examined for Marks | Statistic | Number of Recaptures by Release Month | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Nov | Dec | Jan | Feb | Mar | Apr | Total |
| | | | M=1617 | M=2932 | M=2455 | M=2665 | M=2573 | M=1121 | M=13363 |
| Nov | C = 1709 | R | 7 | | | | | | 7 |
| | | R/M | 0.00433 | | | | | | 0.00052 |
| | | R/C | 0.00410 | | | | | | 0.00410 |
| Dec | C = 3110 | R | 6 | 21 | | | | | 27 |
| | | R/M | 0.00371 | 0.00716 | | | | | 0.00202 |
| | | R/C | 0.00351 | 0.00675 | | | | | 0.00868 |
| Jan | C = 2578 | R | 0 | 3 | 11 | | | | 14 |
| | | R/M | 0.00000 | 0.00102 | 0.00448 | | | | 0.00105 |
| | | R/C | 0.00000 | 0.00096 | 0.00427 | | | | 0.00543 |
| Feb | C = 2873 | R | 2 | 6 | 11 | 22 | | | 41 |
| | | R/M | 0.00124 | 0.00205 | 0.00448 | 0.00826 | | | 0.00307 |
| | | R/C | 0.00117 | 0.00193 | 0.00427 | 0.00766 | | | 0.01427 |
| Mar | C = 2772 | R | 3 | 5 | 9 | 18 | 14 | | 49 |
| | | R/M | 0.00186 | 0.00171 | 0.00367 | 0.00675 | 0.00544 | | 0.00367 |
| | | R/C | 0.00176 | 0.00161 | 0.00349 | 0.00627 | 0.00505 | | 0.01768 |
| Apr | C = 1245 | R | 0 | 4 | 2 | 2 | 7 | 2 | 17 |
| | | R/M | 0.00000 | 0.00136 | 0.00081 | 0.00075 | 0.00272 | 0.00178 | 0.00127 |
| | | R/C | 0.00000 | 0.00129 | 0.00078 | 0.00070 | 0.00253 | 0.00161 | 0.01365 |
| Total | C = 14287 | R | 18 | 39 | 33 | 42 | 21 | 2 | 155 |
| | | R/M | 0.01113 | 0.01330 | 0.01344 | 0.01576 | 0.00816 | 0.00178 | 0.01160 |
| | | R/C | 0.00126 | 0.00273 | 0.00231 | 0.00294 | 0.00147 | 0.00014 | 0.01085 |

Recaptures include only fish released during the current sampling season.

LEGEND:
R = number of striped bass recaptured
M = number of striped bass ≥150 mm marked and released
C = number of striped bass ≥150 mm caught and examined for tags
R/M = recapture rate
R/C = recapture proportion

**Table 3-10. Recapture Statistics for Striped Bass Tagged, Released and Recaptured in the Hudson River by a 9 m Trawl, 6 November 2000 through 20 April 2001.**

| | | |
|---|---|---|
| Number Tagged (≥150 mm) | M | 13,363 |
| Number Examined for Tags (≥ 150 mm) | C | 14,287 |
| Number Recaptured | R | 155 |
| Size Range of Recaptured Fish (mm) | Min | 151 |
| | Max | 512 |
| | Mean | 248 |
| | S.D. | 61 |
| Days At-Large | Min | 0 |
| | Max | 136 |
| | Mean | 26 |
| | S.D. | 33 |
| Frequency Of Days At-Large | 0 Days | 45 |
| | 1- 5 Days | 12 |
| | 6- 10 Days | 14 |
| | 11- 20 Days | 21 |
| | 21- 30 Days | 18 |
| | 31- 40 Days | 9 |
| | 41- 50 Days | 9 |
| | 51- 60 Days | 3 |
| | 61- 70 Days | 4 |
| | 71- 80 Days | 5 |
| | 81- 90 Days | 5 |
| | 91-100 Days | 2 |
| | 101-110 Days | 1 |
| | 111-120 Days | 3 |
| | 121-130 Days | 1 |
| | 131-140 Days | 3 |
| | 141-150 Days | 0 |

**Table 3-11. Incidence of Tag Number Abrasion and Condition of the Tag Insertion Site for Hudson River Striped Bass that were at Large at Least One Year Prior to their Recapture during the 1988-1989 through 2000-2001 Programs.**

| Description | Condition of Tag Insertion | Number of Fish Recaptured during Program* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1988-1989 | 1989-1990 | 1990-1991 | 1991-1992 | 1992-1993 | 1993-1994 | 1994-95** | 1995-96** | 1996-97** | 1997-1998 | 1998-1999 | 1999-2000 | 2000-2001 |
| Tag number completely legible | Healed | 34 | 63 | 206 | 102 | 118 | 116 | 27 | 4 | 37 | 67 | 54 | 30 | 22 |
| | Infected | 13 | 6 | 22 | 15 | 14 | 14 | 2 | 1 | 0 | 5 | 5 | 1 | 2 |
| | | 47 | 69 | 228 | 117 | 132 | 130 | 29 | 5 | 37 | 72 | 59 | 31 | 24 |
| | (Anchor Protruding) | (5) | (0) | (6) | (1) | (0) | (14) | (0) | (0) | (0) | (0) | (0) | (1) | 3 |
| Tag number partly or completely missing and not legible | Healed | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Infected | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (Anchor Protruding) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| Suspected tag wound, tag and anchor missing | Healed | 4 | 6 | 69 | 43 | 57 | 28 | 0 | 0 | 0 | 22 | 25 | 8 | 4 |
| | Infected | 0 | 0 | 3 | 4 | 7 | 3 | 0 | 0 | 0 | 3 | 1 | 3 | 0 |
| | | 4 | 6 | 72 | 47 | 64 | 31 | 0 | 0 | 0 | 25 | 26 | 11 | 4 |
| Suspected tag wound, anchor present | Healed | 2 | 0 | 9 | 10 | 12 | 18 | 0 | 0 | 0 | 7 | 12 | 4 | 2 |
| | Infected | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | | 2 | 0 | 9 | 10 | 15 | 18 | 0 | 0 | 0 | 8 | 13 | 5 | 3 |

*Striped bass that were tagged and released prior to the program which could be cross-classified by degree of tag number abrasion and condition of the tag insertion site.

**Data from LMS (1997).

**Table 3-12. Recapture Statistics for Striped Bass Tagged and Released in Years Prior to, and Recaptured in the Hudson River, 6 November 2000 through 20 April 2001.**

| Release Year | Release Gear | Number Released (M) | Number Recaptured (R) | Recapture Rate (R/M) | Length of Recaptured Fish (mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Max | Mean | S.D. |
| 1999-2000 | 9 m trawl | 12,587 | 21 | 0.00167 | 260 | 435 | 336 | 9 |
| 1998-1999 | 9 m trawl | 11,203 | 5 | 0.00045 | 315 | 452 | 368 | 24 |
| 1997-1998 | 9 m trawl | 14,428 | 2 | 0.00014 | 530 | 64 | 576 | 46 |
| 1996-1997 | 9 m trawl | 12,794 | 2 | 0.00016 | 335 | 550 | 443 | 108 |

**Table 3-13. Recapture Statistics for Striped Bass Tagged and Released Prior to November 2000, and Recaptured in the Hudson River by a 9 m Trawl, 6 November 2000 through 20 April 2001.**

| | | |
|---|---|---|
| Total Number Tagged[a] | M | 221,057 |
| Number Age 2+ or Older[b] Examined for Tags | C | 2,802 |
| Number Recaptured | R | 30 |
| Recapture Rate | R/M | 0.00014 |
| Recapture Proportion | R/C | 0.01071 |
| Length of Recaptured Fish (mm) | Min | 260 |
| | Max | 621 |
| | Mean | 364 |
| | S.D. | 81 |
| Days At-Large | Min | 223 |
| | Max | 1477 |
| | Mean | 552 |
| | S.D. | 350 |
| Frequency of Days At Large | 201-250 Days | 3 |
| | 251-300 Days | 1 |
| | 301-350 Days | 5 |
| | 351-400 Days | 4 |
| | 401-450 Days | 6 |
| | 451-500 Days | 2 |
| | 501-550 Days | 0 |
| | 551-600 Days | 0 |
| | 601-650 Days | 0 |
| | 651-700 Days | 0 |
| | 701-750 Days | 4 |
| | 751-800 Days | 0 |
| | 801-850 Days | 1 |
| | 851-900 Days | 0 |
| | 901-950 Days | 0 |
| | 951-1000 Days | 0 |
| | 1001-1050 Days | 0 |
| | 1051-1100 Days | 0 |
| | 1101-1150 Days | 1 |
| | 1151-1200 Days | 0 |
| | 1201-1250 Days | 1 |
| | >1251 Days | 2 |

[a] Contains fish tagged and released in a 9 m trawl in the 1985-1986 through 1999-2000 programs.
[b] Examined during 2000-2001 program.

**Table 3-14. Striped Bass Recaptured in the Hudson River with other Agency Tags, 6 November 2000 through 20 April 2001.**

| Agency | Tag Number | Tag Condition | | | | | | Recapture | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site | Tag No. | Address | Reward | Orientation | Anchor Protrusion | Date | River Mile | Length |
| U.S. Fish & Wildlife | 298482 | 1 | 4 | 4 | 4 | 2 | N | 10 Nov 00 | 3 | 434 |
| U.S. Fish & Wildlife | 320939 | 1 | 4 | 4 | 4 | 2 | N | 10 Nov 00 | 3 | 325 |
| Littoral Society | 526614 | 1 | 4 | 4 | 4 | | | 17 Nov 00 | 2 | 392 |
| Littoral Society | 522139 | 1 | 4 | 4 | 4 | | | 27 Nov 00 | 8 | 488 |
| Littoral Society | 499129 | 2 | 4 | 4 | 4 | 4 | N | 28 Dec 00 | 7 | 501 |
| Littoral Society | 505328 | 2 | 4 | 4 | 4 | 4 | N | 28 Dec 00 | 7 | 387 |
| U.S. Fish & Wildlife | 299492 | 1 | 4 | 4 | 4 | 2 | N | 18 Jun 01 | 8 | 296 |
| U.S. Fish & Wildlife | 374011 | 1 | 4 | 4 | 4 | 2 | N | 11 Apr 01 | 9 | 389 |

| Tag Variable | Comment Description | Tag Site |
|---|---|---|
| Number | 1 = Legend completely missing | 1 = Tag present, wound healed |
| Address | 2 = Abraded and partly missing | 2 = Tag present, wound poorly healed, evidence of infection or swelling |
| Reward | 3 = Abraded but completely legible | |
| | 4 = Completely legible | |
| Number orientation | A = Tag number facing anterior (Head) | |
| | P = Tag number facin posterior (Tail) | |
| Anchor protrusion | Y = Yes | |
| | N = No | |

**Table 3-15. Incidence of Fish in Poor Condition Among Unmarked vs. Recaptured Striped Bass Captured by a 9 m Trawl in the Hudson River, 6 November 2000 through 20 April 2001.**

| Type(s) of Injury or Abnormality[a] | Incidence Among 18,387 Unmarked Fish Captured | | Incidence Among 13,944 Tagged[b] | | Incidence Among 209 Recaptured Fish[c] | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| Blind only | 72 | 0.39 | 72 | 0.52 | 3 | 1.44 |
| Stress only | 127 | 0.69 | 39 | 0.28 | | |
| Fin rot only | 155 | 0.84 | 153 | 1.10 | 8 | 3.83 |
| Fungus only | 11 | 0.06 | 10 | 0.07 | 1 | 0.48 |
| Skeleton only | 24 | 0.13 | 22 | 0.16 | | |
| Other only | 172 | 0.94 | 167 | 1.20 | 2 | 0.96 |
| Blind/stress | 2 | 0.01 | 1 | 0.01 | | |
| Blind/fin rot/other | 1 | 0.01 | 1 | 0.01 | | |
| Blind/skeleton | 3 | 0.02 | 2 | 0.01 | | |
| Blind/other | 4 | 0.02 | 4 | 0.03 | | |
| Skeleton/stress | 2 | 0.01 | 1 | 0.01 | | |
| Stress/other | 2 | 0.01 | | | | |
| Fin rot/fungus | 11 | 0.06 | 11 | 0.08 | 10 | 4.78 |
| Fin rot/skeleton | 4 | 0.02 | 4 | 0.03 | | |
| Fin rot/other | 4 | 0.02 | 4 | 0.03 | | |
| Skeleton/other | 2 | 0.01 | 2 | 0.01 | | |
| Finrot/skeleton/stress | 1 | 0.01 | | | | |
| Finrot/stress | 10 | 0.05 | 7 | 0.05 | | |
| Fungus/stress | 1 | 0.01 | 1 | 0.01 | | |
| Unclassified | 21 | 0.11 | 20 | 0.14 | | |
| **Total** | **629** | **3.42** | **521** | **3.74** | **24** | **11.48** |

[a]Categories are described in more detail in Table 3-16.
[b]Excludes 4,443 not tagged.
[c]Including fish with suspected tag wounds.

**Table 3-16. Nature of Injuries and Abnormalities Observed in Striped Bass Captured by a 9 m Trawl in the Hudson River, 6 November 2000 through 20 April 2001.**

| General Category | Specific Condition | Incidence Among 18,387 Unmarked Fish Captured | Incidence Among 13,944 Fish Tagged | Incidence Among 209 Recaptured Fish[a] |
|---|---|---|---|---|
| Blindness | Blind in one eye | 29 | 28 | 1 |
| | Blind in both eyes | 53 | 52 | 2 |
| Stress | Net rash | 31 | 30 | |
| | Crushed | 1 | 1 | |
| | Handling stress | 112 | 18 | |
| Fin rot | On caudal fin | 142 | 138 | 6 |
| | On pectoral fin(s) | 8 | 8 | 2 |
| | On pelvic fin | 1 | 1 | |
| | On dorsal fin(s) | 6 | 6 | |
| | On multiple fins | 29 | 27 | 10 |
| Fungus | On one side of body | 5 | 5 | 1 |
| | On both sides of body | 18 | 17 | 10 |
| Skeleton | Side to side spine curvature | 6 | 5 | |
| | Top to bottom spine curvature | 4 | 4 | |
| | Head abnormalities | 10 | 8 | |
| | Fish hook damage to mouth/gills | 16 | 14 | |
| Other | Body wounds, damaged fins, etc. | 185 | 178 | 2 |
| **Total[b]** | | **657** | **540** | **34** |

[a]Includes individuals tagged by another agency and suspected tag wounds.
[b]Totals exceed those in Table 3-15 because some fish exhibited more than one condition.

**Table 3-17. Estimated Population of Age 1+ and Older Striped Bass ≥ 150 mm by Age Cohort in the Lower Hudson River, Winter 2000-2001.**

| Age | Total Number Collected | Total Catch ≥150 mm | Proportion of ≥150 mm Collected | Estimated Population[a] |
|---|---|---|---|---|
| 1+ | 11,498 | 11,238 | 0.7886 | 306,000 |
| 2+ | 2,437 | 2,437 | 0.1710 | 66,000 |
| 3+ | 200 | 200 | 0.0140 | 5,000 |
| >3+ | 165 | 165 | 0.0116 | 4,000 |
| **Total** | **14,300** | **14,040** | **0.9852** | **381,000** |

[a] Estimated population is based on a Schumacher-Eschmeyer estimate of the number of Age 1+ and older striped bass ≥150 mm marked, released and recaptured in the Upper Harbor and Battery regions of the Hudson River from 6 November 2000 through 20 April 2001. Age 0+ striped bass were 1.5% (5,800) of the population ≥ 150 mm. Estimated total population of striped bass ≥ 150 mm was 388,000.

**Table 3-18. Estimated Population of Age 1+ and Older Striped Bass ≥ 200 mm by Age Cohort in the Lower Hudson River, Winter 2000-01.**

| Age | Total Catch ≥150 mm | Total Catch ≥200 mm | Proportion of ≥200 mm Collected | Estimated Population[a] |
|---|---|---|---|---|
| 1+ | 11,238 | 8,945 | 0.6277 | 244,000 |
| 2+ | 2,437 | 2,437 | 0.1710 | 66,000 |
| 3+ | 200 | 200 | 0.0140 | 5,000 |
| >3+ | 165 | 165 | 0.0116 | 4,000 |
| **Total** | **14,040** | **11,747** | **0.8243** | **319,000** |

[a]The total population estimate based on fish ≥150 mm (388,000) was adjusted for the estimated proportion of striped bass ≥ 200 mm (11,747/14,251= 0.8243).

**Table 3-19. Estimated Number of Striped Bass ≥200 mm and ≥150 mm Present in the Lower Hudson River during the Winters of 1985-1986 through 2000-2001.**

| Program | Estimated Number ≥200 mm | Estimated Number ≥150 mm |
|---|---|---|
| 2000-2001 | 319,000 | 388,000 |
| 1999-2000 | 1,180,000 | 1,377,000 |
| 1998-1999 | 280,000 | 333,000 |
| 1997-1998 | 427,000 | 453,000 |
| 1996-1997 | 694,000 | 768,000 |
| 1995-1996 | 786,000 | 949,000 |
| 1994-1995 | 325,000 | 350,000 |
| 1993-1994 | 379,000 | 443,000 |
| 1992-1993 | 717,000 | 920,000 |
| 1991-1992 | 967,000 | 1,163,000 |
| 1990-1991 | 786,000 | 858,000 |
| 1989-1990 | 528,000 | 776,000 |
| 1988-1989 | 890,000 | 1,190,000 |
| 1987-1988 | 295,000 | a |
| 1986-1987 | 394,000 | a |
| 1985-1986 | 540,000 | a |

1994-1995, 1995-1996, and 1996-1997 estimates from LMS (1997)

[a]Fish <200 mm were not tagged and we did not extrapolate to estimate the population of fish ≥150 mm for the 1987-1988, 1986-1987 and 1985-1986 programs.

# APPENDIX A

## Gear Characteristics

**Appendix Table A-1. Specifications of the 9-m Trawl.**

| | 9-m Trawl |
|---|---|
| Head rope length | 6.9 m |
| Foot rope length (sweep) | 9.0 m |
| Legs (between doors and net) | 6.0 m |
| Approximate vertical lift | 3.6 m |
| Doors (steel V-doors) | 1.0 m |
| Net body length | 5.2 m |
| Cod end section | 2.3 m |
| Mesh - body of net | 7.6-cm (stretch) mesh polypropylene; polypropylene; 3-mm diameter twine |
| - cod end | 3.8-cm (stretch) mesh, knotless poly-propylene; 3-mm diameter twine |
| Roller gear | 25.4-cm rollers spaced with 5-cm cookie disks |

# APPENDIX B

## Water Quality

**Appendix Table B-1. Weekly Regional Average Water Temperature and Conductivity During Trawl Sampling in the Hudson River, Winter 2000-2001.**

| Sample Week | Surface Water Temperature (Deg C) | Surface Water Conductivity (umhos) | Bottom Water Temperature (Deg C) | Bottom Water Conductivity (umhos) |
|---|---|---|---|---|
| **Upper Harbor** | | | | |
| 6-Nov-2000 | 13.0 | 35970 | 13.0 | 39451 |
| 13-Nov-2000 | 11.8 | 29467 | 12.0 | 36915 |
| 20-Nov-2000 | 10.0 | 31655 | 10.6 | 36190 |
| 27-Nov-2000 | 8.3 | 27796 | 8.7 | 37140 |
| 4-Dec-2000 | 6.5 | 31113 | 7.5 | 39644 |
| 8-Jan-2001 | 3.5 | 36095 | 3.5 | 39886 |
| **The Battery** | | | | |
| 6-Nov-2000 | 13.0 | 26626 | 12.8 | 35123 |
| 13-Nov-2000 | 12.2 | 27872 | 12.3 | 34471 |
| 20-Nov-2000 | 9.8 | 24555 | 10.7 | 31289 |
| 27-Nov-2000 | 8.4 | 23508 | 8.6 | 35609 |
| 4-Dec-2000 | 5.9 | 21004 | 7.7 | 37543 |
| 11-Dec-2000 | 5.6 | 27097 | 5.9 | 34136 |
| 18-Dec-2000 | 4.6 | 8751 | 5.2 | 20459 |
| 25-Dec-2000 | 1.5 | 18226 | 4.3 | 36664 |
| 1-Jan-2001 | 0.6 | 18387 | 2.4 | 34580 |
| 8-Jan-2001 | 2.2 | 27001 | 2.5 | 33931 |
| 15-Jan-2001 | 1.9 | 18330 | 2.7 | 31879 |
| 22-Jan-2001 | 2.6 | 24015 | 3.4 | 34307 |
| 29-Jan-2001 | 2.5 | 19898 | 3.2 | 33362 |
| 5-Feb-2001 | 3.3 | 26524 | 3.3 | 33410 |
| 12-Feb-2001 | 3.1 | 14433 | 3.3 | 27758 |
| 19-Feb-2001 | 3.2 | 21604 | 3.6 | 33746 |
| 26-Feb-2001 | 2.8 | 15028 | 3.5 | 30704 |
| 5-Mar-2001 | 3.4 | 24716 | 3.5 | 30798 |
| 12-Mar-2001 | 3.8 | 17811 | 3.5 | 27451 |
| 19-Mar-2001 | 5.1 | 11961 | 4.9 | 31833 |
| 26-Mar-2001 | 5.1 | 12587 | 5.1 | 28558 |
| 2-Apr-2001 | 5.8 | 11804 | 5.5 | 27371 |
| 9-Apr-2001 | 7.8 | 1699 | 6.9 | 5293 |
| 16-Apr-2001 | 6.7 | 5818 | 5.7 | 31175 |

# APPENDIX C

## Striped Bass Catch Characteristics

**Appendix Table C-1. Regional and Weekly Mean Catch of Striped Bass per Ten Minute Tow (CPUE) For the 9 M Trawl in the Lower Hudson River, 6 November 2000 Through 20 April 2001.**

| Region and Week | | CPUE | | | | | |
|---|---|---|---|---|---|---|---|
| | | Tows | N | Lower 95% CI | Mean | Upper 95% CI | S.E. |
| **Upper Harbor** | | | | | | | |
| | 6-Nov-00 | 2 | 19 | -111.2 | 9.5 | 130.2 | 9.5 |
| | 13-Nov-00 | 4 | 139 | 3.9 | 34.8 | 65.6 | 9.7 |
| | 20-Nov-00 | 6 | 235 | 15.5 | 39.2 | 62.9 | 9.2 |
| | 27-Nov-00 | 12 | 533 | 15.1 | 44.4 | 73.7 | 13.3 |
| | 4-Dec-00 | 1 | 0 | | 0.0 | | |
| | 11-Dec-00 | 0 | | | | | |
| | 18-Dec-00 | 0 | | | | | |
| | 25-Dec-00 | 0 | | | | | |
| | 1-Jan-01 | 0 | | | | | |
| | 8-Jan-01 | 1 | 0 | | 0 | | |
| | 15-Jan-01 | 0 | | | | | |
| | 22-Jan-01 | 0 | | | | | |
| | 29-Jan-01 | 0 | | | | | |
| | 5-Feb-01 | 0 | | | | | |
| | 12-Feb-01 | 0 | | | | | |
| | 19-Feb-01 | 0 | | | | | |
| | 26-Feb-01 | 0 | | | | | |
| | 5-Mar-01 | 0 | | | | | |
| | 12-Mar-01 | 0 | | | | | |
| | 19-Mar-01 | 0 | | | | | |
| | 26-Mar-01 | 0 | | | | | |
| | 2-Apr-01 | 0 | | | | | |
| | 9-Apr-01 | 0 | | | | | |
| | 16-Apr-01 | 0 | | | | | |
| | **Total** | **26** | **926** | **21.1** | **35.6** | **50.1** | **7** |
| **The Battery** | | | | | | | |
| | 6-Nov-00 | 25 | 238 | 1.9 | 9.5 | 17.1 | 3.7 |
| | 13-Nov-00 | 57 | 88 | 0.9 | 1.5 | 2.2 | 0.3 |
| | 20-Nov-00 | 18 | 193 | 1.2 | 10.7 | 20.2 | 4.5 |
| | 27-Nov-00 | 26 | 428 | 9.6 | 16.5 | 23.3 | 3.3 |
| | 4-Dec-00 | 35 | 1529 | 24.6 | 43.7 | 62.8 | 9.4 |
| | 11-Dec-00 | 34 | 594 | 13.3 | 17.5 | 21.6 | 2.0 |
| | 18-Dec-00 | 43 | 625 | 7.0 | 14.5 | 22.1 | 3.8 |
| | 25-Dec-00 | 10 | 357 | 19.5 | 35.7 | 51.9 | 7.2 |
| | 1-Jan-01 | 28 | 497 | 13.3 | 17.8 | 22.2 | 2.2 |
| | 8-Jan-01 | 43 | 907 | 16.0 | 21.1 | 26.2 | 2.5 |
| | 15-Jan-01 | 42 | 872 | 14.4 | 20.8 | 27.1 | 3.1 |
| | 22-Jan-01 | 35 | 1088 | 22.8 | 31.1 | 39.4 | 4.1 |
| | 29-Jan-01 | 43 | 1458 | 27.2 | 33.9 | 40.6 | 3.3 |
| | 5-Feb-01 | 33 | 605 | 13.6 | 18.3 | 23.1 | 2.3 |
| | 12-Feb-01 | 45 | 1211 | 21.3 | 26.9 | 32.5 | 2.8 |
| | 19-Feb-01 | 34 | 1024 | 21.3 | 30.1 | 38.9 | 4.3 |
| | 26-Feb-01 | 42 | 1611 | 31.9 | 38.4 | 44.8 | 3.2 |
| | 5-Mar-01 | 14 | 301 | 15.4 | 21.5 | 27.6 | 2.8 |
| | 12-Mar-01 | 41 | 1189 | 23.1 | 29.0 | 34.9 | 2.9 |
| | 19-Mar-01 | 35 | 771 | 16.2 | 22.0 | 27.9 | 2.9 |
| | 26-Mar-01 | 29 | 689 | 17.9 | 23.8 | 29.6 | 2.8 |
| | 2-Apr-01 | 40 | 782 | 12.2 | 19.6 | 26.9 | 3.6 |
| | 9-Apr-01 | 23 | 108 | 1.8 | 4.7 | 7.6 | 1.4 |
| | 16-Apr-01 | 25 | 470 | 9.1 | 18.8 | 28.5 | 4.7 |
| | **Total** | **800** | **17635** | **20.4** | **22** | **23.7** | **0.8** |

**Appendix Table C-2. Number of Samples, Striped Bass Caught, and Striped Bass Tagged in the Hudson River Cross-Classified By *Region* and *Use_Code* for the 9 m Trawl, 6 November 2000 Through 20 April 2001.**

| Region | Use Code | Number of Samples | Number of Striped Bass Caught | Number of Striped Bass Tagged[a] |
|---|---|---|---|---|
| Upper Harbor | 1 | 26 | 926 | 863 |
| | 2 | 2 | 18 | 17 |
| | **Total:** | **28** | **944** | **880** |
| The Battery | 1 | 800 | 17635 | 12467 |
| | 2 | 1 | 17 | 16 |
| | 5 | 1 | 0 | 0 |
| | **Total:** | **802** | **17652** | **12483** |
| **Total Over All Regions:** | | **830** | **18596** | **13363** |

[a] Includes fish tagged and released in good condition (Rel_Rec = 1).

**Appendix Table C-3. Regional and River Mile Mean Catch of Striped Bass Per Ten Minute Tow (CPUE) For the 9 m Trawl in the Lower Hudson River, 6 November 2000 Through 20 April 2001.**

| Region and River Mile | Tows[a] | N | LCL | CPUE | UCL | S.E. |
|---|---|---|---|---|---|---|
| **Upper Harbor** | | | | | | |
| 2 | 11 | 466 | 11.6 | 42.4 | 73.1 | 13.8 |
| 3 | 15 | 460 | 15.6 | 30.7 | 45.7 | 7.0 |
| **Total** | **26** | **926** | **21.1** | **35.6** | **50.1** | **7.0** |
| **The Battery** | | | | | | |
| 1 | 45 | 1065 | 10.4 | 23.7 | 36.9 | 6.6 |
| 3 | 1 | 32 | | 32.0 | | |
| 5 | 86 | 2344 | 20.2 | 27.3 | 34.3 | 3.6 |
| 6 | 1 | 0 | | 0.0 | | |
| 7 | 156 | 3375 | 18.7 | 21.6 | 24.6 | 1.5 |
| 8 | 263 | 6751 | 22.9 | 25.7 | 28.4 | 1.4 |
| 9 | 233 | 3896 | 14.6 | 16.7 | 18.8 | 1.1 |
| 10 | 15 | 172 | 4.3 | 11.5 | 18.6 | 3.3 |
| **Total** | **800** | **17635** | **20.4** | **22.0** | **23.7** | **0.8** |
| **Total Over All Regions** | **826** | **18561** | **20.8** | **22.5** | **24.1** | **0.8** |

[a] Includes Use_Code = 1 tows only

**Appendix Table C-4. Weekly Report of Striped Bass Caught in a 9m Trawl in the Combined Battery and Upper Harbor Regions of the Hudson River, 6 November 2000 through 20 April 2001.**

| Sample Week | Temp (degC) | Cond (umhos) | No. Valid Samples | No. Void Samples | Number of Fish in Length Group (mm) | | | | | | | | | Missing | Total Caught | Number Tagged | Number of Recaps | Not Tagged Small | Not Tagged Other | Mortality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | <150 | 150-200 | 201-300 | 301-400 | 401-500 | 501-600 | 601-700 | 701-800 | 801+ | | | | | | | |
| 6Nov00 | 12.8 | 35443 | 27 | 0 | 0 | 0 | 154 | 86 | 14 | 1 | 1 | 0 | 1 | 0 | 257 | 253 | 2 | 0 | 1 | 1 |
| 13Nov00 | 12.3 | 34631 | 61 | 0 | 2 | 5 | 83 | 103 | 29 | 5 | 0 | 0 | 0 | 0 | 227 | 219 | 5 | 2 | 1 | 0 |
| 20Nov00 | 10.6 | 32514 | 24 | 0 | 1 | 9 | 239 | 157 | 19 | 1 | 0 | 2 | 0 | 0 | 428 | 421 | 2 | 1 | 2 | 2 |
| 27Nov00 | 8.6 | 36119 | 39 | 0 | 2 | 12 | 466 | 428 | 53 | 7 | 6 | 2 | 0 | 0 | 976 | 959 | 9 | 2 | 5 | 1 |
| 4Dec00 | 7.7 | 37657 | 37 | 0 | 26 | 109 | 1097 | 280 | 20 | 0 | 0 | 0 | 0 | 0 | 1532 | 1432 | 17 | 25 | 47 | 11 |
| 11Dec00 | 5.9 | 34136 | 34 | 0 | 59 | 42 | 314 | 144 | 29 | 5 | 1 | 0 | 0 | 0 | 594 | 529 | 5 | 59 | 0 | 1 |
| 18Dec00 | 5.2 | 20459 | 43 | 0 | 81 | 52 | 314 | 140 | 30 | 6 | 1 | 1 | 0 | 0 | 625 | 533 | 5 | 81 | 0 | 6 |
| 25Dec00 | 4.3 | 36664 | 11 | 0 | 23 | 6 | 35 | 130 | 136 | 32 | 9 | 2 | 1 | 0 | 374 | 343 | 6 | 23 | 1 | 1 |
| 1Jan01 | 2.4 | 34580 | 28 | 0 | 215 | 30 | 85 | 120 | 37 | 4 | 6 | 0 | 0 | 0 | 497 | 280 | 1 | 215 | 1 | 0 |
| 8Jan01 | 2.6 | 34066 | 44 | 0 | 424 | 159 | 278 | 40 | 4 | 0 | 0 | 1 | 1 | 0 | 907 | 473 | 4 | 424 | 2 | 4 |
| 15Jan01 | 2.7 | 31879 | 42 | 0 | 368 | 175 | 284 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 872 | 501 | 2 | 368 | 0 | 1 |
| 22Jan01 | 3.4 | 34307 | 35 | 0 | 197 | 201 | 547 | 118 | 17 | 5 | 1 | 2 | 0 | 0 | 1088 | 877 | 7 | 197 | 0 | 7 |
| 29Jan01 | 3.2 | 33362 | 43 | 0 | 715 | 296 | 387 | 51 | 7 | 0 | 1 | 1 | 0 | 0 | 1458 | 734 | 5 | 715 | 1 | 3 |
| 5Feb01 | 3.3 | 33410 | 33 | 0 | 161 | 159 | 244 | 38 | 2 | 0 | 1 | 0 | 0 | 0 | 605 | 438 | 5 | 161 | 1 | 0 |
| 12Feb01 | 3.3 | 27758 | 45 | 0 | 465 | 275 | 408 | 57 | 4 | 1 | 0 | 1 | 0 | 0 | 1211 | 709 | 13 | 465 | 22 | 2 |
| 19Feb01 | 3.6 | 33746 | 34 | 0 | 200 | 177 | 494 | 137 | 10 | 3 | 3 | 0 | 0 | 0 | 1024 | 801 | 17 | 200 | 5 | 1 |
| 26Feb01 | 3.5 | 30704 | 42 | 0 | 561 | 323 | 595 | 121 | 9 | 1 | 0 | 0 | 0 | 1 | 1611 | 1017 | 21 | 561 | 4 | 8 |
| 5Mar01 | 3.5 | 30798 | 14 | 0 | 73 | 65 | 141 | 21 | 1 | 0 | 0 | 0 | 0 | 0 | 301 | 219 | 6 | 71 | 0 | 5 |
| 12Mar01 | 3.5 | 27451 | 41 | 0 | 392 | 246 | 462 | 83 | 6 | 0 | 0 | 0 | 0 | 0 | 1189 | 777 | 13 | 392 | 1 | 6 |
| 19Mar01 | 4.9 | 31833 | 35 | 0 | 89 | 69 | 329 | 254 | 23 | 7 | 0 | 0 | 0 | 0 | 771 | 642 | 17 | 89 | 16 | 7 |
| 26Mar01 | 5.1 | 28558 | 29 | 0 | 140 | 92 | 251 | 195 | 10 | 1 | 0 | 0 | 0 | 0 | 689 | 529 | 11 | 140 | 4 | 5 |
| 2Apr01 | 5.5 | 27371 | 40 | 0 | 95 | 70 | 255 | 344 | 12 | 2 | 4 | 0 | 0 | 0 | 782 | 667 | 10 | 95 | 4 | 6 |
| 9Apr01 | 6.9 | 5293 | 23 | 1 | 14 | 4 | 30 | 42 | 16 | 2 | 0 | 0 | 0 | 0 | 108 | 92 | 1 | 14 | 0 | 1 |
| 16Apr01 | 5.7 | 31175 | 25 | 0 | 6 | 11 | 253 | 178 | 21 | 1 | 0 | 0 | 0 | 0 | 470 | 431 | 11 | 6 | 15 | 7 |
| **Total** | | | **829** | **1** | **4309** | **2587** | **7745** | **3312** | **509** | **84** | **34** | **12** | **3** | **1** | **18596** | **13876** | **195** | **4306** | **133** | **86** |

**Appendix Table C-5. Weekly Mean Catch of Striped Bass Per Ten Minute Tow in a 9 m Trawl for 50 mm Length Groups in the Battery and Upper Harbor Regions of the Hudson River, 6 November 2000 through 20 April 2001.**

| Upper Harbor | | Length Group (mm) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week and Number of Tows | | 151-200 | 201-250 | 251-300 | 301-350 | 351-400 | 401-450 | 451-500 | 501-550 | 551-600 | 601-650 | 651-700 | 701-750 | 751-800 | >800 |
| 6-Nov-00 | 2 | | | 5 | 3 | 0.5 | 1 | | | | | | | | |
| 13-Nov-00 | 4 | | 0.8 | 8.3 | 9.3 | 10.5 | 4.3 | 1.5 | | 0.3 | | | | | |
| 20-Nov-00 | 6 | | 2.3 | 18.7 | 9.7 | 6.5 | 1.3 | 0.3 | 0.2 | | | | 0.2 | | |
| 27-Nov-00 | 12 | 0.2 | 3 | 14.1 | 15.8 | 7.7 | 2.3 | 0.7 | 0.2 | 0.1 | 0.3 | 0.2 | 0.1 | | |
| **Total** | **26** | **0.1** | **2** | **12.5** | **11.2** | **6.7** | **2.1** | **0.6** | **0.1** | **0.1** | **0.1** | **0.1** | **0.1** | **0.0** | **0.02** |

(continued)

## Appendix Table C-5. (Continued)

| Battery | | Length Group (mm) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week and Number of Tows | | 51-100 | 101-150 | 151-200 | 201-250 | 251-300 | 301-350 | 351-400 | 401-450 | 451-500 | 501-550 | 551-600 | 601-650 | 651-700 | 701-750 | 751-800 | >800 |
| 6-Nov-00 | 25 | | | | 0.7 | 5.1 | 2 | 1.1 | 0.3 | 0.2 | <0.1 | | | <0.1 | | | <0.1 |
| 13-Nov-00 | 57 | <0.1 | <0.1 | 0.1 | 0.3 | 0.5 | 0.2 | 0.2 | 0.1 | 0.1 | | 0.1 | | | | | |
| 20-Nov-00 | 18 | | 0.1 | 0.5 | 1.9 | 4.4 | 2.4 | 0.9 | 0.4 | 0.1 | | | | | | 0.1 | |
| 27-Nov-00 | 26 | <0.1 | <0.1 | 0.4 | 2 | 7.9 | 4 | 1.2 | 0.3 | 0.2 | 0.1 | 0.1 | | | <0.1 | | |
| 4-Dec-00 | 35 | 0.1 | 0.6 | 3.1 | 10.3 | 21 | 7 | 1 | 0.4 | 0.1 | | | | | | | |
| 11-Dec-00 | 34 | 0.6 | 1.1 | 1.2 | 3.2 | 6 | 3.1 | 1.1 | 0.6 | 0.2 | 0.1 | <0.1 | <0.1 | | | | |
| 18-Dec-00 | 43 | 0.5 | 1.4 | 1.2 | 2.3 | 5 | 2.3 | 1 | 0.5 | 0.2 | <0.1 | 0.1 | <0.1 | | | <0.1 | |
| 25-Dec-00 | 10 | 1.5 | 0.8 | 0.6 | 1.3 | 2.2 | 3.8 | 8.6 | 10.5 | 2.5 | 1.4 | 1.4 | 0.7 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1-Jan-01 | 28 | 5.5 | 2.1 | 1.1 | 1 | 2 | 2.4 | 1.9 | 1.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | | | |
| 8-Jan-01 | 43 | 5.3 | 4.6 | 3.7 | 3.8 | 2.6 | 0.6 | 0.3 | 0.1 | <0.1 | | | | | | <0.1 | <0.1 |
| 15-Jan-01 | 42 | 4.7 | 4.2 | 4.1 | 4.3 | 2.4 | 0.9 | 0.2 | | | | | | | | | |
| 22-Jan-01 | 35 | 2.7 | 3 | 5.7 | 7.4 | 8.2 | 2.7 | 0.7 | 0.3 | 0.2 | 0.1 | 0.1 | <0.1 | | 0.1 | | |
| 29-Jan-01 | 43 | 10.6 | 6.2 | 6.8 | 5.4 | 3.6 | 0.9 | 0.3 | 0.1 | <0.1 | | | | <0.1 | | <0.1 | |
| 5-Feb-01 | 33 | 2.2 | 2.8 | 4.7 | 4.1 | 3.3 | 0.9 | 0.2 | <0.1 | <0.1 | | | <0.1 | | | | |
| 12-Feb-01 | 45 | 5.8 | 4.6 | 6 | 5.2 | 3.8 | 1.1 | 0.2 | 0.1 | <0.1 | <0.1 | | | | <0.1 | | |
| 19-Feb-01 | 34 | 2.4 | 3.6 | 5.2 | 7.4 | 7.1 | 3.4 | 0.6 | 0.3 | <0.1 | 0.1 | | 0.1 | <0.1 | | | |
| 26-Feb-01 | 42 | 8 | 5.5 | 7.5 | 7.2 | 7 | 2.4 | 0.5 | 0.1 | 0.1 | | <0.1 | | | | | |
| 5-Mar-01 | 14 | 2.9 | 2.4 | 4.6 | 5.4 | 4.7 | 1.3 | 0.2 | 0.1 | | | | | | | | |
| 12-Mar-01 | 41 | 5.2 | 4.5 | 5.9 | 5.8 | 5.4 | 1.7 | 0.3 | 0.1 | <0.1 | | | | | | | |
| 19-Mar-01 | 35 | 0.8 | 1.7 | 1.9 | 2.3 | 7.1 | 5.2 | 2.1 | 0.4 | 0.3 | 0.1 | 0.1 | | | | | |
| 26-Mar-01 | 29 | 2.3 | 2.5 | 3.1 | 2.7 | 5.9 | 5.5 | 1.2 | 0.3 | | <0.1 | | | | | | |
| 2-Apr-01 | 40 | 0.9 | 1.5 | 1.7 | 1.7 | 4.7 | 6.3 | 2.4 | 0.2 | 0.1 | <0.1 | <0.1 | <0.1 | 0.1 | | | |
| 9-Apr-01 | 23 | 0.2 | 0.4 | 0.2 | 0.4 | 0.9 | 0.7 | 1.1 | 0.6 | 0.1 | 0.1 | | | | | | |
| 16-Apr-01 | 25 | | 0.2 | 0.4 | 1.2 | 8.9 | 4.8 | 2.3 | 0.7 | 0.2 | <0.1 | | | | | | |
| **Total** | **800** | **2.9** | **2.5** | **3.2** | **3.8** | **5.4** | **2.6** | **0.9** | **0.4** | **0.1** | **0.1** | **<0.1** | **<0.1** | **<0.1** | **<0.1** | **<0.1** | **<0.1** |

**Appendix Table C-6. Weekly Mean Length (mm) of Striped Bass Captured by a 9 m Trawl in the Upper Harbor and Battery Regions of the Hudson River, 6 November 2000 Through 20 April 2001.**

| Region and Week | Number of Fish | Mean Length | S.D | S.E. |
|---|---|---|---|---|
| **Upper Harbor** | | | | |
| 6-Nov-00 | 19 | 309 | 49.49 | 11.35 |
| 13-Nov-00 | 139 | 347 | 60.4 | 5.12 |
| 20-Nov-00 | 235 | 312 | 56.37 | 3.68 |
| 27-Nov-00 | 533 | 323 | 65.31 | 2.83 |
| 4-Dec-00 | 0 | | | |
| 8-Jan-01 | 0 | | | |
| **All Weeks** | **926** | **324** | **62.96** | **2.07** |
| **The Battery** | | | | |
| 6-Nov-00 | 238 | 307 | 64.63 | 4.19 |
| 13-Nov-00 | 88 | 302 | 92.87 | 9.9 |
| 20-Nov-00 | 193 | 292 | 67.25 | 4.84 |
| 27-Nov-00 | 428 | 296 | 61.09 | 2.95 |
| 4-Dec-00 | 1529 | 266 | 48.5 | 1.24 |
| 11-Dec-00 | 594 | 269 | 83.52 | 3.43 |
| 18-Dec-00 | 625 | 265 | 92.92 | 3.72 |
| 25-Dec-00 | 357 | 381 | 116.73 | 6.18 |
| 1-Jan-01 | 497 | 222 | 136.12 | 6.11 |
| 8-Jan-01 | 907 | 171 | 82.67 | 2.74 |
| 15-Jan-01 | 872 | 174 | 73.94 | 2.5 |
| 22-Jan-01 | 1088 | 225 | 83.8 | 2.54 |
| 29-Jan-01 | 1458 | 162 | 77.99 | 2.04 |
| 5-Feb-01 | 605 | 196 | 74.35 | 3.02 |
| 12-Feb-01 | 1211 | 178 | 77.6 | 2.23 |
| 19-Feb-01 | 1024 | 224 | 80.24 | 2.51 |
| 26-Feb-01 | 1610 | 189 | 81.07 | 2.02 |
| 5-Mar-01 | 301 | 203 | 73.02 | 4.21 |
| 12-Mar-01 | 1189 | 192 | 78.02 | 2.26 |
| 19-Mar-01 | 771 | 271 | 86.53 | 3.12 |
| 26-Mar-01 | 689 | 240 | 88.99 | 3.39 |
| 2-Apr-01 | 782 | 275 | 87.85 | 3.14 |
| 9-Apr-01 | 108 | 306 | 106.3 | 10.23 |
| 16-Apr-01 | 470 | 301 | 55.23 | 2.55 |
| **All Weeks** | **17634** | **225** | **94.77** | **0.71** |

**Appendix Table C-7. Mean Length at Age and 95% Confidence Intervals for Age 0+ through Age 3+ Wild Striped Bass Captured by a 9 m Trawl in the Hudson River during the 1986-87 through 2000-2001 Striped Bass Programs.**

| Age | Cohort | Program | N[a] | Stratified Mean Length (mm) | Lower 95% Confidence Limit | Upper 95% Confidence Limit |
|---|---|---|---|---|---|---|
| 0+ | 2000 | 2000-01 | 400 | 116 | 114 | 117 |
| | 1999 | 1999-00 | 708 | 126 | 124 | 128 |
| | 1998 | 1998-99 | 306 | 117 | 113 | 120 |
| | 1997 | 1997-98 | 273 | 115 | 112 | 118 |
| | 1996 | 1996-97 | 51 | 120 | 119 | 121 |
| | 1995 | 1995-96 | 207 | 127 | 126 | 128 |
| | 1994 | 1994-95 | 216 | 104 | 104 | 105 |
| | 1993 | 1993-94 | 828 | 123 | 121 | 125 |
| | 1992 | 1992-93 | 473 | 116 | 114 | 118 |
| | 1991[b] | 1991-92 | 818 | 131 | 127 | 135 |
| | 1990[b] | 1990-91 | 206 | 119 | 116 | 122 |
| | 1989 | 1989-90 | 368 | 112 | 109 | 115 |
| | 1988 | 1988-89 | 1,007 | 121 | 117 | 125 |
| | 1987 | 1987-88 | 190 | 108 | 104 | 112 |
| | 1986 | 1986-87 | 83 | 128 | 123 | 134 |
| 1+ | 1999 | 2000-01 | 2,679 | 245 | 243 | 247 |
| | 1998 | 1999-00 | 2,403 | 266 | 264 | 268 |
| | 1997 | 1998-99 | 1,860 | 236 | 233 | 238 |
| | 1996 | 1997-98 | 2,041 | 250 | 248 | 252 |
| | 1995 | 1996-97 | 1,410 | 260 | 258 | 263 |
| | 1994 | 1995-96 | 1,501 | 246 | 244 | 248 |
| | 1993 | 1994-95 | 1,216 | 260 | 258 | 262 |
| | 1992 | 1993-94 | 2,695 | 237 | 236 | 238 |
| | 1991[b] | 1992-93 | 3,899 | 231 | 229 | 233 |
| | 1990[b] | 1991-92 | 3,675 | 245 | 244 | 246 |
| | 1989 | 1990-91 | 2,174 | 239 | 237 | 241 |
| | 1988 | 1989-90 | 3,514 | 214 | 213 | 215 |
| | 1987 | 1988-89 | 3,623 | 227 | 226 | 229 |
| | 1986 | 1987-88 | 1,503 | 253 | 251 | 255 |
| | 1985 | 1986-87 | 285 | 221 | 215 | 227 |
| 2+ | 1998 | 2000-01 | 1009 | 347 | 344 | 351 |
| | 1997 | 1999-00 | 622 | 357 | 355 | 359 |
| | 1996 | 1998-99 | 935 | 328 | 321 | 336 |
| | 1995 | 1997-98 | 1,901 | 337 | 334 | 339 |
| | 1994 | 1996-97 | 686 | 306 | 302 | 310 |
| | 1993 | 1995-96 | 355 | 312 | 306 | 318 |
| | 1992 | 1994-95 | 455 | 312 | 308 | 316 |
| | 1991[b] | 1993-94 | 1,631 | 317 | 307 | 328 |
| | 1990[b] | 1992-93 | 1,378 | 329 | 325 | 333 |
| | 1989 | 1991-92 | 961 | 324 | 319 | 328 |
| | 1988 | 1990-91 | 2,109 | 321 | 317 | 324 |
| | 1987 | 1989-90 | 1,216 | 298 | 295 | 301 |
| | 1986 | 1988-89 | 361 | 325 | 318 | 331 |
| | 1985 | 1987-88 | 574 | 317 | 312 | 322 |
| | 1984 | 1986-87 | 359 | 299 | 293 | 305 |

(continued)

## Appendix Table C-7. Continued)

| Age | Cohort | Program | N[a] | Stratified Mean Length (mm) | Lower 95% Confidence Limit | Upper 95% Confidence Limit |
|---|---|---|---|---|---|---|
| 3+ | 1997 | 2000-01 | 62 | 425 | 404 | 445 |
| | 1996 | 1999-00 | 84 | 438 | 422 | 454 |
| | 1995 | 1998-99 | 219 | 383 | 330 | 437 |
| | 1994 | 1997-98 | 154 | 407 | 396 | 418 |
| | 1993 | 1996-97 | 82 | 334 | 320 | 348 |
| | 1992 | 1995-96 | 53 | 346 | 332 | 360 |
| | 1991 | 1994-95 | 99 | 356 | 346 | 366 |
| | 1990[b] | 1993-94 | 152 | 424 | 246 | 602 |
| | 1989 | 1992-93 | 125 | 414 | 400 | 428 |
| | 1988 | 1991-92 | 153 | 386 | 378 | 394 |
| | 1987 | 1990-91 | 69 | 381 | 360 | 401 |
| | 1986 | 1989-90 | 55 | 382 | 362 | 403 |
| | 1985 | 1988-89 | 57 | 396 | 378 | 415 |
| | 1984 | 1987-88 | 273 | 367 | 360 | 375 |
| | 1983 | 1986-87 | 54 | 369 | 354 | 385 |

[a] number of fish aged from use_code = 1 Tows

[b] Stratified mean length for the 1990 and 1991 wild cohorts of striped bass represents hatchery and wild fish combined, because hatchery fish were not tagged prior to stocking and therefore could not be distinguished from wild fish.

# APPENDIX D

## Striped Bass Mark/Recapture Studies

**Appendix Table D-1. Release and Recapture Data for Striped Bass Marked, Released and Recaptured in the Hudson River, 6 November 2000 through 20 April 2001.**

| Recapture | | | | | Release | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | Date | Length (mm) | Region | Mile | km | Days At Large | Distance Traveled (Miles) | Distance Traveled (Km) | Tag Number |
| 13-Nov-00 | 324 | The Battery | 1 | 2 | 13-Nov-00 | 324 | The Battery | 1 | 2 | 0 | 0 | 0 | 478198 |
| 13-Nov-00 | 262 | The Battery | 1 | 2 | 13-Nov-00 | 262 | The Battery | 1 | 2 | 0 | 0 | 0 | 486222 |
| 17-Nov-00 | 363 | Upper Harbor | 2 | 3 | 8-Nov-00 | 362 | The Battery | 1 | 2 | 9 | 3 | 5 | 478134 |
| 21-Nov-00 | 281 | Upper Harbor | 3 | 5 | 9-Nov-00 | 281 | The Battery | 1 | 2 | 12 | 4 | 6 | 486184 |
| 28-Nov-00 | 314 | Upper Harbor | 2 | 3 | 28-Nov-00 | 313 | Upper Harbor | 2 | 3 | 0 | 0 | 0 | 478597 |
| 28-Nov-00 | 300 | The Battery | 5 | 8 | 28-Nov-00 | 300 | The Battery | 5 | 8 | 0 | 0 | 0 | 478629 |
| 30-Nov-00 | 275 | Upper Harbor | 3 | 5 | 8-Nov-00 | 272 | The Battery | 1 | 2 | 22 | 4 | 6 | 486068 |
| 1-Dec-00 | 395 | Upper Harbor | 3 | 5 | 9-Nov-00 | 406 | The Battery | 1 | 2 | 22 | 4 | 6 | 478158 |
| 1-Dec-00 | 315 | Upper Harbor | 3 | 5 | 29-Nov-00 | 316 | Upper Harbor | 2 | 3 | 2 | 1 | 2 | 478798 |
| 1-Dec-00 | 360 | Upper Harbor | 3 | 5 | 1-Dec-00 | 360 | The Battery | 3 | 5 | 0 | 6 | 10 | 478939 |
| 1-Dec-00 | 288 | The Battery | 5 | 8 | 30-Nov-00 | 288 | The Battery | 5 | 8 | 1 | 0 | 0 | 486865 |
| 5-Dec-00 | 245 | The Battery | 5 | 8 | 5-Dec-00 | 245 | The Battery | 5 | 8 | 0 | 0 | 0 | 487190 |
| 6-Dec-00 | 328 | The Battery | 5 | 8 | 5-Dec-00 | 329 | The Battery | 8 | 13 | 1 | 3 | 5 | 479065 |
| 6-Dec-00 | 211 | The Battery | 5 | 8 | 5-Dec-00 | 211 | The Battery | 5 | 8 | 1 | 0 | 0 | 487206 |
| 6-Dec-00 | 219 | The Battery | 5 | 8 | 5-Dec-00 | 220 | The Battery | 5 | 8 | 1 | 0 | 0 | 487248 |
| 6-Dec-00 | 263 | The Battery | 5 | 8 | 6-Dec-00 | 266 | The Battery | 5 | 8 | 0 | 0 | 0 | 487311 |
| 6-Dec-00 | 271 | The Battery | 5 | 8 | 6-Dec-00 | 271 | The Battery | 5 | 8 | 0 | 0 | 0 | 487313 |
| 6-Dec-00 | 289 | The Battery | 5 | 8 | 6-Dec-00 | 291 | The Battery | 5 | 8 | 0 | 0 | 0 | 487459 |
| 6-Dec-00 | 275 | The Battery | 5 | 8 | 6-Dec-00 | 277 | The Battery | 5 | 8 | 0 | 0 | 0 | 487476 |
| 7-Dec-00 | 233 | The Battery | 5 | 8 | 30-Nov-00 | 235 | The Battery | 5 | 8 | 7 | 0 | 0 | 486907 |
| 7-Dec-00 | 217 | The Battery | 5 | 8 | 4-Dec-00 | 218 | The Battery | 5 | 8 | 3 | 0 | 0 | 487024 |
| 7-Dec-00 | 232 | The Battery | 5 | 8 | 6-Dec-00 | 233 | The Battery | 5 | 8 | 1 | 0 | 0 | 487379 |
| 7-Dec-00 | 270 | The Battery | 1 | 2 | 6-Dec-00 | 267 | The Battery | 5 | 8 | 1 | 4 | 6 | 487547 |
| 7-Dec-00 | 215 | The Battery | 5 | 8 | 6-Dec-00 | 214 | The Battery | 5 | 8 | 1 | 0 | 0 | 487684 |
| 7-Dec-00 | 280 | The Battery | 5 | 8 | 7-Dec-00 | 280 | The Battery | 5 | 8 | 0 | 0 | 0 | 487751 |
| 8-Dec-00 | 262 | The Battery | 5 | 8 | 7-Dec-00 | 260 | The Battery | 5 | 8 | 1 | 0 | 0 | 487809 |
| 8-Dec-00 | 202 | The Battery | 1 | 2 | 7-Dec-00 | 199 | The Battery | 1 | 2 | 1 | 0 | 0 | 487861 |
| 14-Dec-00 | 297 | The Battery | 8 | 13 | 28-Nov-00 | 300 | The Battery | 5 | 8 | 16 | 3 | 5 | 478654 |
| 15-Dec-00 | 270 | The Battery | 5 | 8 | 15-Dec-00 | 270 | The Battery | 5 | 8 | 0 | 0 | 0 | 488401 |

(continued)

## Appendix Table D-1. (Continued)

| Recapture | | | | | Release | | | | | Days at Large | Distance Traveled (Miles) | Distance Traveled (km) | Tag Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | Date | Length (mm) | Region | Mile | km | | | | |
| 18-Dec-00 | 207 | The Battery | 9 | 14 | 18-Dec-00 | 207 | The Battery | 10 | 16 | 0 | 1 | 2 | 488512 |
| 21-Dec-00 | 355 | The Battery | 5 | 8 | 21-Nov-00 | 351 | Upper Harbor | 3 | 5 | 30 | 8 | 13 | 478443 |
| 21-Dec-00 | 259 | The Battery | 5 | 8 | 5-Dec-00 | 260 | The Battery | 5 | 8 | 16 | 0 | 0 | 487241 |
| 21-Dec-00 | 289 | The Battery | 5 | 8 | 20-Dec-00 | 287 | The Battery | 9 | 14 | 1 | 4 | 6 | 488597 |
| 21-Dec-00 | 295 | The Battery | 5 | 8 | 21-Dec-00 | 298 | The Battery | 5 | 8 | 0 | 0 | 0 | 488682 |
| 28-Dec-00 | 312 | The Battery | 7 | 11 | 20-Dec-00 | 314 | The Battery | 7 | 11 | 8 | 0 | 0 | 479594 |
| 29-Dec-00 | 407 | The Battery | 9 | 14 | 29-Dec-00 | 407 | The Battery | 7 | 11 | 0 | 2 | 3 | 479930 |
| 5-Jan-01 | 298 | The Battery | 7 | 11 | 5-Jan-01 | 299 | The Battery | 7 | 11 | 0 | 0 | 0 | 488959 |
| 8-Jan-01 | 368 | The Battery | 8 | 13 | 29-Dec-00 | 368 | The Battery | 9 | 14 | 10 | 1 | 2 | 479973 |
| 12-Jan-01 | 216 | The Battery | 7 | 11 | 12-Jan-01 | 221 | The Battery | 7 | 11 | 0 | 0 | 0 | 489379 |
| 12-Jan-01 | 272 | The Battery | 7 | 11 | 12-Jan-01 | 273 | The Battery | 7 | 11 | 0 | 0 | 0 | 489383 |
| 12-Jan-01 | 272 | The Battery | 7 | 11 | 12-Jan-01 | 273 | The Battery | 7 | 11 | 0 | 0 | 0 | 489383 |
| 17-Jan-01 | 291 | The Battery | 8 | 13 | 12-Jan-01 | 295 | The Battery | 8 | 13 | 5 | 0 | 0 | 489309 |
| 22-Jan-01 | 291 | The Battery | 9 | 14 | 11-Dec-00 | 292 | The Battery | 5 | 8 | 42 | 4 | 6 | 488153 |
| 22-Jan-01 | 212 | The Battery | 7 | 11 | 22-Jan-01 | 212 | The Battery | 8 | 13 | 0 | 1 | 2 | 489890 |
| 22-Jan-01 | 197 | The Battery | 7 | 11 | 22-Jan-01 | 197 | The Battery | 8 | 13 | 0 | 1 | 2 | 489894 |
| 25-Jan-01 | 512 | The Battery | 8 | 13 | 25-Jan-01 | 512 | The Battery | 8 | 13 | 0 | 0 | 0 | 480333 |
| 25-Jan-01 | 275 | The Battery | 8 | 13 | 9-Jan-01 | 274 | The Battery | 9 | 14 | 16 | 1 | 2 | 489072 |
| 25-Jan-01 | 250 | The Battery | 8 | 13 | 25-Jan-01 | 252 | The Battery | 8 | 13 | 0 | 0 | 0 | 490265 |
| 26-Jan-01 | 262 | The Battery | 8 | 13 | 26-Jan-01 | 262 | The Battery | 9 | 14 | 0 | 1 | 2 | 490550 |
| 31-Jan-01 | 207 | The Battery | 8 | 13 | 7-Dec-00 | 205 | The Battery | 5 | 8 | 55 | 3 | 5 | 487847 |
| 1-Feb-01 | 187 | The Battery | 8 | 13 | 26-Jan-01 | 187 | The Battery | 9 | 14 | 6 | 1 | 2 | 490544 |
| 2-Feb-01 | 273 | The Battery | 8 | 13 | 21-Nov-00 | 275 | Upper Harbor | 3 | 5 | 73 | 11 | 18 | 486354 |
| 2-Feb-01 | 248 | The Battery | 7 | 11 | 31-Jan-01 | 250 | The Battery | 8 | 13 | 2 | 1 | 2 | 490982 |
| 7-Feb-01 | 253 | The Battery | 7 | 11 | 7-Feb-01 | 253 | The Battery | 7 | 11 | 0 | 0 | 0 | 491476 |
| 7-Feb-01 | 234 | The Battery | 7 | 11 | 7-Feb-01 | 234 | The Battery | 7 | 11 | 0 | 0 | 0 | 491479 |
| 8-Feb-01 | 232 | The Battery | 8 | 13 | 22-Dec-00 | 238 | The Battery | 9 | 14 | 48 | 1 | 2 | 488813 |
| 9-Feb-01 | 202 | The Battery | 7 | 11 | 30-Nov-00 | 202 | The Battery | 5 | 8 | 71 | 2 | 3 | 486901 |
| 12-Feb-01 | 220 | The Battery | 8 | 13 | 22-Jan-01 | 221 | The Battery | 9 | 14 | 21 | 1 | 2 | 489922 |
| 12-Feb-01 | 198 | The Battery | 9 | 14 | 2-Feb-01 | 198 | The Battery | 7 | 11 | 10 | 2 | 3 | 491213 |

(continued)

## Appendix Table D-1. (Continued)

| Recapture | | | | | Release | | | | | Days at Large | Distance Traveled (Miles) | Distance Traveled (km) | Tag Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | Date | Length (mm) | Region | Mile | km | | | | |
| 12-Feb-01 | 182 | The Battery | 8 | 13 | 6-Feb-01 | 182 | The Battery | 7 | 11 | 6 | 1 | 2 | 491318 |
| 13-Feb-01 | 186 | The Battery | 8 | 13 | 5-Jan-01 | 188 | The Battery | 7 | 11 | 39 | 1 | 2 | 488963 |
| 13-Feb-01 | 212 | The Battery | 8 | 13 | 29-Jan-01 | 215 | The Battery | 9 | 14 | 15 | 1 | 2 | 490702 |
| 13-Feb-01 | 239 | The Battery | 8 | 13 | 31-Jan-01 | 241 | The Battery | 8 | 13 | 13 | 0 | 0 | 490984 |
| 14-Feb-01 | 204 | The Battery | 8 | 13 | 17-Jan-01 | 207 | The Battery | 8 | 13 | 28 | 0 | 0 | 489646 |
| 14-Feb-01 | 151 | The Battery | 8 | 13 | 9-Feb-01 | 151 | The Battery | 8 | 13 | 5 | 0 | 0 | 491656 |
| 16-Feb-01 | 232 | The Battery | 7 | 11 | 6-Dec-00 | 233 | The Battery | 5 | 8 | 72 | 2 | 3 | 487336 |
| 16-Feb-01 | 237 | The Battery | 7 | 11 | 1-Feb-01 | 240 | The Battery | 8 | 13 | 15 | 1 | 2 | 491091 |
| 16-Feb-01 | 200 | The Battery | 7 | 11 | 13-Feb-01 | 200 | The Battery | 8 | 13 | 3 | 1 | 2 | 491869 |
| 20-Feb-01 | 310 | The Battery | 8 | 13 | 20-Feb-01 | 310 | The Battery | 8 | 13 | 0 | 0 | 0 | 480935 |
| 20-Feb-01 | 289 | The Battery | 8 | 13 | 20-Feb-01 | 289 | The Battery | 8 | 13 | 0 | 0 | 0 | 480936 |
| 20-Feb-01 | 250 | The Battery | 8 | 13 | 20-Feb-01 | 250 | The Battery | 8 | 13 | 0 | 0 | 0 | 481127 |
| 20-Feb-01 | 243 | The Battery | 8 | 13 | 4-Dec-00 | 242 | The Battery | 1 | 2 | 78 | 7 | 11 | 487143 |
| 20-Feb-01 | 234 | The Battery | 8 | 13 | 20-Dec-00 | 232 | The Battery | 8 | 13 | 62 | 0 | 0 | 488602 |
| 20-Feb-01 | 250 | The Battery | 8 | 13 | 24-Jan-01 | 252 | The Battery | 9 | 14 | 27 | 1 | 2 | 490166 |
| 20-Feb-01 | 253 | The Battery | 8 | 13 | 8-Feb-01 | 255 | The Battery | 7 | 11 | 12 | 1 | 2 | 491613 |
| 20-Feb-01 | 156 | The Battery | 8 | 13 | 16-Feb-01 | 155 | The Battery | 7 | 11 | 4 | 1 | 2 | 491986 |
| 21-Feb-01 | 240 | The Battery | 9 | 14 | 6-Feb-01 | 240 | The Battery | 7 | 11 | 15 | 2 | 3 | 491312 |
| 22-Feb-01 | 318 | The Battery | 8 | 13 | 3-Jan-01 | 319 | The Battery | 8 | 13 | 50 | 0 | 0 | 480126 |
| 22-Feb-01 | 256 | The Battery | 8 | 13 | 14-Feb-01 | 260 | The Battery | 8 | 13 | 8 | 0 | 0 | 480692 |
| 23-Feb-01 | 156 | The Battery | 8 | 13 | 20-Feb-01 | 155 | The Battery | 8 | 13 | 3 | 0 | 0 | 481031 |
| 23-Feb-01 | 231 | The Battery | 8 | 13 | 20-Feb-01 | 232 | The Battery | 8 | 13 | 3 | 0 | 0 | 488602 |
| 26-Feb-01 | 177 | The Battery | 9 | 14 | 14-Feb-01 | 180 | The Battery | 8 | 13 | 12 | 1 | 2 | 480725 |
| 26-Feb-01 | 157 | The Battery | 8 | 13 | 21-Feb-01 | 155 | The Battery | 7 | 11 | 5 | 1 | 2 | 481358 |
| 27-Feb-01 | 236 | The Battery | 10 | 16 | 5-Dec-00 | 234 | The Battery | 5 | 8 | 84 | 5 | 8 | 487249 |
| 27-Feb-01 | 156 | The Battery | 10 | 16 | 12-Feb-01 | 155 | The Battery | 8 | 13 | 15 | 2 | 3 | 491754 |
| 27-Feb-01 | 158 | The Battery | 8 | 13 | 14-Feb-01 | 160 | The Battery | 8 | 13 | 13 | 0 | 0 | 491945 |
| 28-Feb-01 | 191 | The Battery | 8 | 13 | 21-Feb-01 | 185 | The Battery | 9 | 14 | 7 | 1 | 2 | 481307 |
| 28-Feb-01 | 240 | The Battery | 8 | 13 | 21-Feb-01 | 239 | The Battery | 7 | 11 | 7 | 1 | 2 | 481347 |
| 28-Feb-01 | 340 | The Battery | 8 | 13 | 22-Feb-01 | 341 | The Battery | 8 | 13 | 6 | 0 | 0 | 481497 |

(continued)

## Appendix Table D-1. (Continued)

| Recapture | | | | | Release | | | | | Days at Large | Distance Traveled (Miles) | Distance Traveled (km) | Tag Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | date | length (mm) | Region | Mile | km | | | | |
| 28-Feb-01 | 210 | The Battery | 9 | 14 | 27-Feb-01 | 209 | The Battery | 8 | 13 | 1 | 1 | 2 | 481847 |
| 28-Feb-01 | 225 | The Battery | 8 | 13 | 12-Jan-01 | 222 | The Battery | 8 | 13 | 47 | 0 | 0 | 489272 |
| 28-Feb-01 | 167 | The Battery | 8 | 13 | 24-Jan-01 | 170 | The Battery | 8 | 13 | 35 | 0 | 0 | 490245 |
| 28-Feb-01 | | The Battery | 8 | 13 | 7-Feb-01 | 258 | The Battery | 8 | 13 | 21 | 0 | 0 | 491444 |
| 1-Mar-01 | 364 | The Battery | 9 | 14 | 8-Jan-01 | 372 | The Battery | 8 | 13 | 52 | 1 | 2 | 480174 |
| 1-Mar-01 | 191 | The Battery | 7 | 11 | 27-Feb-01 | 190 | The Battery | 9 | 14 | 2 | 2 | 3 | 481905 |
| 2-Mar-01 | 360 | The Battery | 9 | 14 | 7-Dec-00 | 366 | The Battery | 1 | 2 | 85 | 8 | 13 | 479262 |
| 2-Mar-01 | 264 | The Battery | 8 | 13 | 2-Mar-01 | 263 | The Battery | 8 | 13 | 0 | 0 | 0 | 482680 |
| 2-Mar-01 | 230 | The Battery | 8 | 13 | 8-Dec-00 | 236 | The Battery | 1 | 2 | 84 | 7 | 11 | 488097 |
| 2-Mar-01 | 222 | The Battery | 8 | 13 | 12-Jan-01 | 220 | The Battery | 8 | 13 | 49 | 0 | 0 | 489257 |
| 2-Mar-01 | 266 | The Battery | 8 | 13 | 22-Jan-01 | 268 | The Battery | 7 | 11 | 39 | 1 | 2 | 489930 |
| 2-Mar-01 | 181 | The Battery | 8 | 13 | 6-Feb-01 | 182 | The Battery | 7 | 11 | 24 | 1 | 2 | 491363 |
| 2-Mar-01 | 226 | The Battery | 8 | 13 | 12-Feb-01 | 225 | The Battery | 8 | 13 | 18 | 0 | 0 | 491776 |
| 8-Mar-01 | 210 | The Battery | 8 | 13 | 14-Feb-01 | 211 | The Battery | 8 | 13 | 22 | 0 | 0 | 480632 |
| 8-Mar-01 | 164 | The Battery | 8 | 13 | 27-Feb-01 | 163 | The Battery | 8 | 13 | 9 | 0 | 0 | 481867 |
| 8-Mar-01 | 200 | The Battery | 8 | 13 | 8-Mar-01 | 200 | The Battery | 8 | 13 | 0 | 0 | 0 | 482751 |
| 9-Mar-01 | 220 | The Battery | 7 | 11 | 26-Feb-01 | 218 | The Battery | 9 | 14 | 11 | 2 | 3 | 481795 |
| 9-Mar-01 | 303 | The Battery | 7 | 11 | 28-Feb-01 | 300 | The Battery | 8 | 13 | 9 | 1 | 2 | 482121 |
| 9-Mar-01 | 233 | The Battery | 10 | 16 | 31-Jan-01 | 231 | The Battery | 8 | 13 | 37 | 2 | 3 | 490957 |
| 12-Mar-01 | 276 | The Battery | 8 | 13 | 26-Feb-01 | 275 | The Battery | 8 | 13 | 14 | 0 | 0 | 481729 |
| 12-Mar-01 | 248 | The Battery | 7 | 11 | 13-Nov-00 | 246 | The Battery | 1 | 2 | 119 | 6 | 10 | 486234 |
| 12-Mar-01 | 191 | The Battery | 8 | 13 | 8-Feb-01 | 195 | The Battery | 8 | 13 | 32 | 0 | 0 | 491606 |
| 12-Mar-01 | 164 | The Battery | 8 | 13 | 14-Feb-01 | 163 | The Battery | 7 | 11 | 26 | 1 | 2 | 491917 |
| 13-Mar-01 | 312 | The Battery | 7 | 11 | 8-Nov-00 | 313 | The Battery | 1 | 2 | 125 | 6 | 10 | 478119 |
| 13-Mar-01 | 264 | The Battery | 7 | 11 | 8-Dec-00 | 267 | The Battery | 1 | 2 | 95 | 6 | 10 | 488089 |
| 14-Mar-01 | 231 | The Battery | 9 | 14 | 26-Feb-01 | 230 | The Battery | 9 | 14 | 16 | 0 | 0 | 481763 |
| 14-Mar-01 | 180 | The Battery | 9 | 14 | 26-Feb-01 | 180 | The Battery | 9 | 14 | 16 | 0 | 0 | 481804 |
| 14-Mar-01 | 180 | The Battery | 8 | 13 | 1-Mar-01 | 179 | The Battery | 9 | 14 | 13 | 1 | 2 | 482358 |
| 14-Mar-01 | 164 | The Battery | 8 | 13 | 25-Jan-01 | 166 | The Battery | 8 | 13 | 48 | 0 | 0 | 490414 |
| 15-Mar-01 | 208 | The Battery | 8 | 13 | 13-Feb-01 | 206 | The Battery | 7 | 11 | 30 | 1 | 2 | 491812 |

(continued)

## Appendix Table D-1. (Continued)

| Recapture | | | | | Release | | | | | Days at Large | Distance Traveled (Miles) | Distance Traveled (km) | Tag Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | Date | Length (mm) | Region | Mile | Km | | | | |
| 15-Mar-01 | 170 | The Battery | 8 | 13 | 16-Feb-01 | 170 | The Battery | 7 | 11 | 27 | 1 | 2 | 491981 |
| 19-Mar-01 | 289 | The Battery | 7 | 11 | 1-Mar-01 | 294 | The Battery | 9 | 14 | 18 | 2 | 3 | 482331 |
| 19-Mar-01 | 154 | The Battery | 7 | 11 | 13-Mar-01 | 151 | The Battery | 7 | 11 | 6 | 0 | 0 | 483195 |
| 19-Mar-01 | 202 | The Battery | 8 | 13 | 7-Feb-01 | 201 | The Battery | 7 | 11 | 40 | 1 | 2 | 491495 |
| 20-Mar-01 | 315 | The Battery | 7 | 11 | 21-Feb-01 | 310 | The Battery | 8 | 13 | 27 | 1 | 2 | 481311 |
| 20-Mar-01 | 335 | The Battery | 8 | 13 | 16-Mar-01 | 337 | The Battery | 8 | 13 | 4 | 0 | 0 | 483354 |
| 20-Mar-01 | 280 | The Battery | 7 | 11 | 15-Dec-00 | 281 | The Battery | 8 | 13 | 95 | 1 | 2 | 488422 |
| 22-Mar-01 | 310 | The Battery | 9 | 14 | 16-Jan-01 | 309 | The Battery | 8 | 13 | 65 | 1 | 2 | 480223 |
| 22-Mar-01 | 190 | The Battery | 7 | 11 | 8-Jan-01 | 190 | The Battery | 8 | 13 | 73 | 1 | 2 | 488990 |
| 22-Mar-01 | 193 | The Battery | 8 | 13 | 25-Jan-01 | 193 | The Battery | 8 | 13 | 56 | 0 | 0 | 490320 |
| 22-Mar-01 | 160 | The Battery | 8 | 13 | 6-Feb-01 | 158 | The Battery | 7 | 11 | 44 | 1 | 2 | 491382 |
| 23-Mar-01 | 310 | The Battery | 7 | 11 | 15-Feb-01 | 307 | The Battery | 8 | 13 | 36 | 1 | 2 | 480823 |
| 23-Mar-01 | 180 | The Battery | 9 | 14 | 28-Feb-01 | 178 | The Battery | 8 | 13 | 23 | 1 | 2 | 482216 |
| 23-Mar-01 | 265 | The Battery | 7 | 11 | 23-Mar-01 | 264 | The Battery | 9 | 14 | 0 | 2 | 3 | 492671 |
| 23-Mar-01 | 218 | The Battery | 7 | 11 | 23-Mar-01 | 218 | The Battery | 8 | 13 | 0 | 1 | 2 | 492701 |
| 26-Mar-01 | 193 | The Battery | 8 | 13 | 9-Mar-01 | 195 | The Battery | 7 | 11 | 17 | 1 | 2 | 482904 |
| 26-Mar-01 | 303 | The Battery | 7 | 11 | 15-Mar-01 | 305 | The Battery | 7 | 11 | 11 | 0 | 0 | 483323 |
| 26-Mar-01 | 263 | The Battery | 8 | 13 | 6-Dec-00 | 263 | The Battery | 5 | 8 | 110 | 3 | 5 | 487474 |
| 26-Mar-01 | 177 | The Battery | 9 | 14 | 19-Mar-01 | 176 | The Battery | 7 | 11 | 7 | 2 | 3 | 492430 |
| 27-Mar-01 | 192 | The Battery | 9 | 14 | 25-Jan-01 | 194 | The Battery | 8 | 13 | 61 | 1 | 2 | 490283 |
| 27-Mar-01 | 152 | The Battery | 9 | 14 | 23-Mar-01 | 156 | The Battery | 9 | 14 | 4 | 0 | 0 | 492696 |
| 28-Mar-01 | 305 | The Battery | 7 | 11 | 30-Nov-00 | 306 | Upper Harbor | 3 | 5 | 118 | 10 | 16 | 478872 |
| 28-Mar-01 | 166 | The Battery | 8 | 13 | 27-Mar-01 | 161 | The Battery | 9 | 14 | 1 | 1 | 2 | 492849 |
| 29-Mar-01 | 286 | The Battery | 9 | 14 | 19-Mar-01 | 290 | The Battery | 7 | 11 | 10 | 2 | 3 | 492434 |
| 2-Apr-01 | 180 | The Battery | 7 | 11 | 16-Feb-01 | 182 | The Battery | 7 | 11 | 45 | 0 | 0 | 480874 |
| 2-Apr-01 | 310 | The Battery | 8 | 13 | 2-Apr-01 | 310 | The Battery | 8 | 13 | 0 | 0 | 0 | 483872 |
| 3-Apr-01 | 367 | The Battery | 7 | 11 | 12-Mar-01 | 367 | The Battery | 8 | 13 | 22 | 1 | 2 | 483120 |
| 5-Apr-01 | 269 | The Battery | 9 | 14 | 20-Feb-01 | 265 | The Battery | 9 | 14 | 44 | 0 | 0 | 481165 |
| 5-Apr-01 | 174 | The Battery | 8 | 13 | 12-Jan-01 | 170 | The Battery | 8 | 13 | 83 | 0 | 0 | 489299 |
| 5-Apr-01 | 286 | The Battery | 9 | 14 | 22-Mar-01 | 295 | The Battery | 7 | 11 | 14 | 2 | 3 | 492658 |

(continued)

## Appendix Table D-1. (Continued)

| Recapture | | | | | Release | | | | | Days at Large | Distance Traveled (Miles) | Distance Traveled (km) | Tag Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | Date | Length (mm) | Region | Mile | km | | | | |
| 5-Apr-01 | 251 | The Battery | 8 | 13 | 5-Apr-01 | 251 | The Battery | 8 | 13 | 0 | 0 | 0 | 493408 |
| 17-Apr-01 | 246 | The Battery | 5 | 8 | 13-Mar-01 | 246 | The Battery | 7 | 11 | 35 | 2 | 3 | 483276 |
| 17-Apr-01 | 210 | The Battery | 5 | 8 | 6-Dec-00 | 210 | The Battery | 5 | 8 | 132 | 0 | 0 | 487282 |
| 17-Apr-01 | 295 | The Battery | 5 | 8 | 22-Mar-01 | 295 | The Battery | 9 | 14 | 26 | 4 | 6 | 492595 |
| 18-Apr-01 | 351 | The Battery | 7 | 11 | 23-Mar-01 | 356 | The Battery | 7 | 11 | 26 | 0 | 0 | 483630 |
| 18-Apr-01 | 270 | The Battery | 7 | 11 | 6-Dec-00 | 269 | The Battery | 5 | 8 | 133 | 2 | 3 | 487587 |
| 19-Apr-01 | 350 | The Battery | 5 | 8 | 22-Dec-00 | 358 | The Battery | 8 | 13 | 118 | 3 | 5 | 479694 |
| 19-Apr-01 | 224 | The Battery | 5 | 8 | 25-Jan-01 | 224 | The Battery | 8 | 13 | 84 | 3 | 5 | 490293 |
| 19-Apr-01 | 265 | The Battery | 5 | 8 | 19-Mar-01 | 261 | The Battery | 8 | 13 | 31 | 3 | 5 | 492399 |
| 20-Apr-01 | 300 | The Battery | 7 | 11 | 22-Mar-01 | 303 | The Battery | 9 | 14 | 29 | 2 | 3 | 483561 |
| 20-Apr-01 | 362 | The Battery | 7 | 11 | 23-Mar-01 | 362 | The Battery | 9 | 14 | 28 | 2 | 3 | 483590 |
| 20-Apr-01 | 289 | The Battery | 8 | 13 | 5-Dec-00 | 287 | The Battery | 5 | 8 | 136 | 3 | 5 | 487242 |

**Appendix Table D-2. Release and Recapture Data for Striped Bass Marked Prior to, and Recaptured During, the 2000-2001 Hudson River Striped Bass Program.**

| Recapture | | | | | Release | | | | | Days at Large | Distance Traveled (Miles) | Distance Traveled (km) | Tag Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Length (mm) | Region | Mile | km | Date | Length (mm) | Region | Mile | km | | | | |
| 17-Nov-00 | 293 | Upper Harbor | 2 | 3 | 31-Mar-00 | 233 | The Battery | 8 | 13 | 231 | 10 | 16 | 484989 |
| 21-Nov-00 | 355 | Upper Harbor | 3 | 5 | 12-Apr-00 | 256 | Upper Harbor | 3 | 5 | 223 | 0 | 0 | 465970 |
| 29-Nov-00 | 334 | Upper Harbor | 2 | 3 | 11-Apr-00 | 254 | Upper Harbor | 3 | 5 | 232 | 1 | 2 | 465036 |
| 30-Nov-00 | 350 | Upper Harbor | 3 | 5 | 20-Jan-00 | 248 | The Battery | 9 | 14 | 315 | 12 | 19 | 475551 |
| 8-Dec-00 | 364 | The Battery | 5 | 8 | 9-Mar-00 | 237 | The Battery | 9 | 14 | 274 | 4 | 6 | 477124 |
| 13-Dec-00 | 289 | The Battery | 5 | 8 | 6-Jan-00 | 238 | The Battery | 9 | 14 | 342 | 4 | 6 | 474214 |
| 13-Dec-00 | 308 | The Battery | 5 | 8 | 6-Jan-00 | 231 | The Battery | 5 | 8 | 342 | 0 | 0 | 474273 |
| 14-Dec-00 | 452 | The Battery | 8 | 13 | 23-Dec-98 | 337 | Upper Harbor | 2 | 3 | 722 | 10 | 16 | 454774 |
| 29-Dec-00 | 351 | The Battery | 9 | 14 | 18-Nov-99 | 273 | Upper Harbor | 3 | 5 | 407 | 12 | 19 | 471374 |
| 29-Dec-00 | 621 | The Battery | 9 | 14 | 8-Dec-97 | 396 | The Battery | 8 | 13 | 1117 | 1 | 2 | 428034 |
| 30-Jan-01 | 335 | The Battery | 9 | 14 | 24-Jan-97 | 194 | The Battery | 10 | 16 | 1467 | 1 | 2 | 437688 |
| 9-Feb-01 | 343 | The Battery | 8 | 13 | 20-Mar-00 | 283 | The Battery | 8 | 13 | 326 | 0 | 0 | 477974 |
| 13-Feb-01 | 344 | The Battery | 8 | 13 | 6-Apr-00 | 247 | Upper Harbor | 3 | 5 | 313 | 11 | 18 | 485612 |
| 14-Feb-01 | 328 | The Battery | 8 | 13 | 10-Dec-99 | 199 | Upper Harbor | 3 | 5 | 432 | 11 | 18 | 472584 |
| 20-Feb-01 | 339 | The Battery | 8 | 13 | 15-Dec-99 | 307 | Upper Harbor | 3 | 5 | 433 | 11 | 18 | 463328 |
| 20-Feb-01 | 392 | The Battery | 8 | 13 | 4-Jan-00 | 296 | The Battery | 5 | 8 | 413 | 3 | 5 | 474035 |
| 22-Feb-01 | 305 | The Battery | 8 | 13 | 8-Mar-00 | 205 | The Battery | 9 | 14 | 351 | 1 | 2 | 477042 |
| 22-Feb-01 | 349 | The Battery | 8 | 13 | 16-Mar-99 | 196 | The Battery | 7 | 11 | 709 | 1 | 2 | 461620 |
| 22-Feb-01 | 550 | The Battery | 7 | 11 | 6-Feb-97 | 428 | The Battery | 10 | 16 | 1477 | 3 | 5 | 394193(1) |
| 27-Feb-01 | 356 | The Battery | 8 | 13 | 1-Mar-00 | 332 | The Battery | 9 | 14 | 363 | 1 | 2 | 464247 |
| 13-Mar-01 | 315 | The Battery | 7 | 11 | 3-Mar-99 | 170 | The Battery | 5 | 8 | 741 | 2 | 3 | 460316 |
| 19-Mar-01 | 365 | The Battery | 8 | 13 | 10-Mar-00 | 322 | The Battery | 1 | 2 | 374 | 7 | 11 | 464327 |
| 19-Mar-01 | 302 | The Battery | 7 | 11 | 20-Mar-00 | 228 | The Battery | 7 | 11 | 364 | 0 | 0 | 464476 |
| 22-Mar-01 | 435 | The Battery | 7 | 11 | 8-Dec-99 | 395 | Upper Harbor | 3 | 5 | 470 | 10 | 16 | 462856 |
| 22-Mar-01 | 343 | The Battery | 9 | 14 | 12-Mar-99 | 204 | The Battery | 7 | 11 | 741 | 2 | 3 | 458248(2) |
| 26-Mar-01 | 382 | The Battery | 8 | 13 | 17-Dec-98 | 182 | The Battery | 1 | 2 | 830 | 7 | 11 | 468482 |
| 28-Mar-01 | 260 | The Battery | 8 | 13 | 8-Dec-99 | 240 | Upper Harbor | 3 | 5 | 476 | 11 | 18 | 472227 |
| 4-Apr-01 | 355 | The Battery | 8 | 13 | 21-Jan-00 | 286 | The Battery | 8 | 13 | 439 | 0 | 0 | 475668 |
| 4-Apr-01 | 283 | The Battery | 8 | 13 | 27-Jan-00 | 213 | The Battery | 8 | 13 | 433 | 0 | 0 | 475757 |
| 5-Apr-01 | 530 | The Battery | 9 | 14 | 11-Dec-97 | 380 | Upper Harbor | 3 | 5 | 1211 | 12 | 19 | 436983(3) |

(1) Fish 394193 was first captured and released on December 21, 1993, with a length of 189 mm.
(2) Fish 458248 was first captured and released on January 27, 1999, with a length of 2
04 mm.
(3) Fish 436983 was first captured and released on January 16, 1997, with a length of 282 mm.

## Appendix Table D-3. Recapture of Tagged Striped Bass Cross-Classified by Release and Recapture Week for Fish Released and Recaptured by Trawls in the Combined Upper New York Harbor and Battery Regions of the Hudson River, 6 Nov 2000 through 20 April 2001.

| Recapture Week | Number Examined for Marks [C] | Statistic | Release Week: 6-Nov M= 242 | 13-Nov M= 212 | 20-Nov M= 408 | 27-Nov M= 917 | 4-Dec M= 1410 | 11-Dec M= 514 | 18-Dec M= 517 | 25-Dec M= 329 | 1-Jan M= 275 | 8-Jan M= 464 | 15-Jan M= 473 | 22-Jan M= 841 | 29-Jan M= 709 | 5-Feb M= 420 | 12-Feb M= 675 | 19-Feb M= 767 | 26-Feb M= 987 | 5-Mar M= 213 | 12-Mar M= 763 | 19-Mar M= 605 | 26-Mar M= 501 | 2-Apr M= 625 | 9-Apr M= 87 | 16-Apr M= 409 | Total M= 13363 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Nov | 257 | R | 0 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | | R/M | 0.00000 | | | | | | | | | | | | | | | | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | | | | | | | | | | | | | | | | | | | | | | | | 0.00000 |
| 13-Nov | 225 | R | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | 3 |
| | | R/M | 0.00413 | 0.00943 | | | | | | | | | | | | | | | | | | | | | | | 0.00661 |
| | | R/C | 0.00444 | 0.00889 | | | | | | | | | | | | | | | | | | | | | | | 0.01333 |
| 20-Nov | 427 | R | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | 1 |
| | | R/M | 0.00413 | 0.00000 | | | | | | | | | | | | | | | | | | | | | | | 0.00116 |
| | | R/C | 0.00234 | 0.00000 | | | | | | | | | | | | | | | | | | | | | | | 0.00234 |
| 27-Nov | 974 | R | 2 | 0 | 0 | 4 | | | | | | | | | | | | | | | | | | | | | 6 |
| | | R/M | 0.00826 | 0.00000 | 0.00000 | 0.00436 | | | | | | | | | | | | | | | | | | | | | 0.00337 |
| | | R/C | 0.00205 | 0.00000 | 0.00000 | 0.00411 | | | | | | | | | | | | | | | | | | | | | 0.00616 |
| 4-Dec | 1506 | R | 0 | 0 | 0 | 1 | 15 | | | | | | | | | | | | | | | | | | | | 16 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00109 | 0.01064 | | | | | | | | | | | | | | | | | | | | 0.00502 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00066 | 0.00996 | | | | | | | | | | | | | | | | | | | | 0.01062 |
| 11-Dec | 535 | R | 0 | 0 | 0 | 1 | 0 | 1 | | | | | | | | | | | | | | | | | | | 2 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00109 | 0.00000 | 0.00195 | | | | | | | | | | | | | | | | | | | 0.00054 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00187 | 0.00000 | 0.00187 | | | | | | | | | | | | | | | | | | | 0.00374 |
| 18-Dec | 544 | R | 0 | 0 | 1 | 0 | 1 | 0 | 3 | | | | | | | | | | | | | | | | | | 5 |
| | | R/M | 0.00000 | 0.00000 | 0.00245 | 0.00000 | 0.00071 | 0.00000 | 0.00580 | | | | | | | | | | | | | | | | | | 0.00118 |
| | | R/C | 0.00000 | 0.00000 | 0.00184 | 0.00000 | 0.00184 | 0.00000 | 0.00551 | | | | | | | | | | | | | | | | | | 0.00919 |
| 25-Dec | 351 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00304 | | | | | | | | | | | | | | | | | 0.00022 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00285 | | | | | | | | | | | | | | | | | 0.00285 |
| 1-Jan | 282 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00364 | | | | | | | | | | | | | | | | 0.00021 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00355 | | | | | | | | | | | | | | | | 0.00355 |
| 8-Jan | 483 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | | | | | | | | | | | | | | | 4 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00304 | 0.00000 | 0.00647 | | | | | | | | | | | | | | | 0.00076 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00207 | 0.00000 | 0.00621 | | | | | | | | | | | | | | | 0.00828 |
| 15-Jan | 504 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | | | | | | | | | | | | | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00216 | 0.00000 | | | | | | | | | | | | | | 0.00017 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00198 | 0.00000 | | | | | | | | | | | | | | 0.00198 |
| 22-Jan | 891 | R | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 5 | | | | | | | | | | | | | 7 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00195 | 0.00000 | 0.00000 | 0.00000 | 0.00216 | 0.00000 | 0.00595 | | | | | | | | | | | | | 0.00106 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00112 | 0.00000 | 0.00000 | 0.00000 | 0.00112 | 0.00000 | 0.00561 | | | | | | | | | | | | | 0.00786 |
| 29-Jan | 743 | R | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | | | | | | | | | | | 4 |
| | | R/M | 0.00000 | 0.00000 | 0.00245 | 0.00000 | 0.00071 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00119 | 0.00141 | | | | | | | | | | | | 0.00055 |
| | | R/C | 0.00000 | 0.00000 | 0.00135 | 0.00000 | 0.00135 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00135 | 0.00135 | | | | | | | | | | | | 0.00538 |
| 5-Feb | 444 | R | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | | | 3 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00109 | 0.00000 | 0.00000 | 0.00193 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00238 | | | | | | | | | | | 0.00039 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00225 | 0.00000 | 0.00000 | 0.00225 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00225 | | | | | | | | | | | 0.00676 |
| 12-Feb | 746 | R | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 4 | 2 | 1 | | | | | | | | | | 11 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00071 | 0.00000 | 0.00000 | 0.00000 | 0.00364 | 0.00000 | 0.00211 | 0.00119 | 0.00564 | 0.00476 | 0.00148 | | | | | | | | | | 0.00131 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00134 | 0.00000 | 0.00000 | 0.00000 | 0.00134 | 0.00000 | 0.00134 | 0.00134 | 0.00536 | 0.00268 | 0.00134 | | | | | | | | | | 0.01475 |
| 19-Feb | 824 | R | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 2 | 4 | | | | | | | | | 13 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00071 | 0.00000 | 0.00387 | 0.00000 | 0.00364 | 0.00000 | 0.00000 | 0.00119 | 0.00000 | 0.00476 | 0.00296 | 0.00522 | | | | | | | | | 0.00142 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00121 | 0.00000 | 0.00243 | 0.00000 | 0.00121 | 0.00000 | 0.00000 | 0.00121 | 0.00000 | 0.00243 | 0.00243 | 0.00485 | | | | | | | | | 0.01578 |
| 26-Feb | 1050 | R | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 0 | 2 | 4 | 3 | 3 | | | | | | | | 20 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00213 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00647 | 0.00000 | 0.00238 | 0.00000 | 0.00476 | 0.00593 | 0.00391 | 0.00304 | | | | | | | | 0.00197 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00286 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00286 | 0.00000 | 0.00190 | 0.00000 | 0.00190 | 0.00381 | 0.00286 | 0.00286 | | | | | | | | 0.01905 |
| 5-Mar | 228 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 3 | 1 | | | | | | | 6 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00141 | 0.00000 | 0.00148 | 0.00000 | 0.00304 | 0.00469 | | | | | | | 0.00058 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00439 | 0.00000 | 0.00439 | 0.00000 | 0.01316 | 0.00439 | | | | | | | 0.02632 |
| 12-Mar | 797 | R | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 3 | 0 | 0 | | | | | | 11 |
| | | R/M | 0.00413 | 0.00472 | 0.00000 | 0.00000 | 0.00071 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00119 | 0.00000 | 0.00238 | 0.00444 | 0.00000 | 0.00304 | 0.00000 | 0.00000 | | | | | | 0.00099 |
| | | R/C | 0.00125 | 0.00125 | 0.00000 | 0.00000 | 0.00125 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00125 | 0.00000 | 0.00125 | 0.00376 | 0.00000 | 0.00376 | 0.00000 | 0.00000 | | | | | | 0.01380 |
| 19-Mar | 682 | R | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 2 | 0 | 2 | 2 | | | | | 14 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00195 | 0.00000 | 0.00000 | 0.00000 | 0.00216 | 0.00211 | 0.00119 | 0.00000 | 0.00476 | 0.00148 | 0.00130 | 0.00203 | 0.00000 | 0.00262 | 0.00331 | | | | | 0.00119 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00147 | 0.00000 | 0.00000 | 0.00000 | 0.00147 | 0.00147 | 0.00147 | 0.00000 | 0.00293 | 0.00147 | 0.00147 | 0.00293 | 0.00000 | 0.00293 | 0.00293 | | | | | 0.02053 |
| 26-Mar | 549 | R | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 1 | | | | 9 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00109 | 0.00071 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00119 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00469 | 0.00131 | 0.00496 | 0.00200 | | | | 0.00074 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00182 | 0.00182 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00182 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00182 | 0.00182 | 0.00546 | 0.00182 | | | | 0.01639 |
| 2-Apr | 687 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 2 | | | 7 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00216 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00148 | 0.00130 | 0.00000 | 0.00000 | 0.00131 | 0.00165 | 0.00000 | 0.00320 | | | 0.00054 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00146 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00146 | 0.00146 | 0.00000 | 0.00000 | 0.00146 | 0.00146 | 0.00000 | 0.00291 | | | 0.01019 |
| 9-Apr | 94 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00000 |
| 16-Apr | 464 | R | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 10 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00213 | 0.00000 | 0.00193 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00119 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00131 | 0.00661 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00075 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00647 | 0.00000 | 0.00216 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00216 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00216 | 0.00862 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.02155 |
| Total | 14287 | R | 5 | 3 | 2 | 8 | 27 | 3 | 7 | 2 | 3 | 10 | 2 | 14 | 6 | 10 | 13 | 9 | 11 | 2 | 5 | 10 | 1 | 2 | 0 | 0 | 155 |
| | | R/M | 0.02066 | 0.01415 | 0.00490 | 0.00872 | 0.01915 | 0.00584 | 0.01354 | 0.00608 | 0.01091 | 0.02155 | 0.00423 | 0.01665 | 0.00846 | 0.02381 | 0.01926 | 0.01173 | 0.01114 | 0.00939 | 0.00655 | 0.01653 | 0.00200 | 0.00320 | 0.00000 | 0.00000 | 0.01160 |
| | | R/C | 0.00035 | 0.00021 | 0.00014 | 0.00056 | 0.00189 | 0.00021 | 0.00049 | 0.00014 | 0.00021 | 0.00070 | 0.00014 | 0.00098 | 0.00042 | 0.00070 | 0.00091 | 0.00063 | 0.00077 | 0.00014 | 0.00035 | 0.00070 | 0.00007 | 0.00014 | 0.00000 | 0.00000 | 0.01085 |

**Appendix Table D-4. Intermediate Computational Data used in the Calculation of a Schumacher-Eschmeyer Population Estimate of the Striped Bass Population Size in the Combined Upper Harbor and Battery Regions of the Hudson River, Winter 2000-2001.**

| Sampling Week | (>150 mm) C total | (>150 mm) M total | Cum M Total | R Total | R/C |
|---|---|---|---|---|---|
| 1 Jan 01 | 282 | 275 | 0 | 0 | 0.00000 |
| 8 Jan 01 | 483 | 464 | 275 | 0 | 0.00000 |
| 15 Jan 01 | 504 | 473 | 739 | 1 | 0.00198 |
| 22 Jan 01 | 891 | 841 | 1212 | 1 | 0.00112 |
| 29 Jan 01 | 743 | 709 | 2053 | 1 | 0.00135 |
| 5 Feb 01 | 444 | 420 | 2762 | 0 | 0.00000 |
| 12 Feb 01 | 746 | 675 | 3182 | 9 | 0.01206 |
| 19 Feb 01 | 824 | 767 | 3857 | 6 | 0.00728 |
| 26 Feb 01 | 1050 | 987 | 4624 | 14 | 0.01333 |
| 5 Mar 01 | 228 | 213 | 5611 | 5 | 0.02193 |
| **Total** | **6195** | **5824** | **24315** | **37** | **0.05906** |

**Appendix Table D-5. Analysis of Variance for the Unweighted Regression of Weekly Recapture Proportion (R/C) Against the Weekly Cumulative Number of Striped Bass Tagged and Released (m) in the Battery and Upper Harbor Regions of the lower Hudson River from the Week of 6 November 2000 through 20 April 2001.**

| Source | df | SS | MS | F | p>F |
|---|---|---|---|---|---|
| Model | 1 | 0.000443 | 0.000443 | 68.05 | <0.001 |
| Error | 8 | 0.000052 | 0.000007 | | |
| Total | 9 | 0.000495 | | | |

Regression Equation: R/C = (Cumulative M) X + error,

where,

$X = 3.68 \times 10^{-6}$ and
Standard Error of $X = 4.46 \times 10^{-7}$

$R^2$ = coefficient of determination = 0.895

df = degrees of freedom
SS = sum of squares
MS = mean square
F = calculated F-ratio
p>F = probability of obtaining a larger F-ratio

## Appendix Table D-6. Tag Type and Number of Striped Bass Tagged and Released during the Hudson River Striped Bass Program, 1984 to Present.

| Program Year | Number Tagged by Rel_Rec | | | Number Tagged by Tag Type | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rel_Rec 1 | Rel_Rec 6 | Total | Anchor | Internal Anchor (Floy) | Internal Anchor Tube (Floy) | Internal Anchor (Hall)[a] | Modified Internal Anchor (Hall)[a] | Small Dart (Hall)[a] |
| 1984 | 737 | 0 | 737 | 737[b] | 737 | – | – | – | – |
| 1985-1986 | 18,448[c] | 0 | 18,448 | – | 18,448 | – | – | – | – |
| 1986-1987 | 9,473[d] | 0 | 9,473 | – | 7,258 | 2,215 | – | – | – |
| 1987-1988 | 12,433[e] | 0 | 12,433 | – | 1,598 | 2,360 | 8,475 | – | – |
| 1988-1989 | 24,393 | 0 | 24,393 | – | – | – | 7,927 | 16,466 | 819[b] |
| 1989-1990 | 24,362 | 0 | 24,362 | – | – | – | – | 24,362 | 659[b] |
| 1990-1991 | 22,406 | 0 | 22,406 | – | – | – | – | 22,406 | – |
| 1991-1992 | 23,514 | 793 | 24,307 | – | – | – | – | 24,307 | – |
| 1992-1993 | 20,847 | 899 | 21,746 | – | – | – | – | 21,746 | – |
| 1993-1994 | 17,500 | 810 | 18,310 | – | – | – | – | 18,310 | – |
| 1994-1995 | 6,837 | 0 | 6,837 | – | – | – | – | 6,837 | – |
| 1995-1996 | 10,889 | 126 | 11,015 | – | – | – | – | 11,015 | – |
| 1996-1997 | 12,794 | 217 | 13,011 | – | – | – | – | 13,011 | – |
| 1997-1998 | 14,428 | 558 | 14,986 | – | – | – | – | 14,986 | – |
| 1998-1999 | 11,203 | 439 | 11,642 | – | – | – | – | 11,642 | – |
| 1999-2000 | 12,587 | 335 | 12,922 | – | – | – | – | 12,922 | – |
| 2000-2001 | 13,363 | 513 | 13,876 | – | – | – | – | 13,876 | – |
| **Total** | **256,214** | **4,690** | **260,904** | **737[b]** | **28,041** | **4,575** | **16,402** | **211,886** | **1,478[b]** |

[a] Hall = Hallprint

[b] Not included in row total because fish were double tagged.

[c] Differences between the 1985-86 total number of fish tagged and released (18,448) and the number reported in Normandeau (1986) of 18,487 (see Table 1-1) is explained in Normandeau (1990) as follows:

18,487 fish tagged and released in the 1985-86 Program
+ 23 fish tagged and released during 1985-86 hatchery broodfish capture effort (EA)
+ 1 fish with tag number verified by recapture
- 63 fish released with missing tag numbers, or with missing alive/dead status code
Total: 18,448

[d] Differences between the 1986-87 total number of fish tagged and released (9,473) and the number reported in Normandeau (1987) of 9,388 (see Table 1-1) is explained in Normandeau (1990) as follows:

9,388 fish tagged and released in the 1986-87 Program
+ 65 fish tagged and released by a sport fisherman (Tom Lake)
+ 27 fish discovered with wrong alive/dead status
+ 2 fish with status changed due to recapture information
- 9 fish with missing tag numbers
Total: 9,473

[e] Three fish were tagged and released without the tag number recorded and could not be classified by tag type or reward value. 12,436 fish were tagged and released in 1987-88: 12,436-3 = 12,433.

**Appendix Table D-7. Description of the Different Types of Internal Anchor External Streamer Tags and Reward Values for Striped Bass Caught, Tagged and Released during the 2000-2001 Hudson River Striped Bass Program.**

| Tag | Anchor* | Streamer | Reward Value | Number of Fish Tagged and Released |
|---|---|---|---|---|
| Hallprint Internal Anchor | Small, yellow, legend | Yellow polypropylene with covered filament | $5-$1000 | 3,900 |
| Hallprint Internal Anchor | Small, yellow, legend | Yellow polypropylene with covered filament | $10-$1000 | 4,029 |
| Hallprint Internal Anchor | Large, yellow, legend | Yellow polypropylene with covered filament | $5-$1000 | 2,968 |
| Hallprint Internal Anchor | Large, yellow, legend | Yellow polypropylene with covered filament | $10-$1000 | 2,979 |
| **2000–2001 Total:** | | | | **13,876** |

*Striped bass >150 mm TL and < 300 mm TL in good condition were tagged with small anchor (20 mm) tags and released.

Striped bass >300 mm TL in good condition were tagged with large anchor (25 mm) tags and released.

Total includes 13,363 fish that were tagged and released in good condition (REL_REC = 1) and 513 fish tagged and released with one or more external anomalies (REL_REC = 6).

# APPENDIX E

## Striped Bass Biocharacteristics and Food Habits

## E.1.0 INTRODUCTION

Striped bass that died during collection and tagging operations conducted between 6 November 2000 and 20 April 2001 were taken to the laboratory and examined in fresh condition to determine length, weight, sex, sexual conditions, and food habits. This laboratory program gathered incidental data on striped bass biocharacteristics and food habits without sacrificing fish specifically for these observations. Similar biocharacteristics data were obtained during the 1985-1986 through 1999-2000 programs (Normandeau 1986, 1987, 1988, 1990, 1991, 1992, 1994, 1996a, 1996b, 1999, 2000; LMS 1995, 1996, 1997). Analysis of striped bass food habits was initiated in 1985-1986 at the request of the New York State Department of Environmental Conservation (letter from Horn to Dunning dated 7 November 1985), specifically to determine the predominance of Atlantic tomcod as a winter food item for striped bass. Merriman (1941) observed Atlantic tomcod to be rare in the diet of Hudson River striped bass during the spring, but striped bass with tomcod present in their stomachs were found to consume tomcod approximately 50% of their body length (200 mm tomcod).

## E.2.0 LABORATORY METHODS

### E.2.1 Length, Weight, Sex, and Sexual Condition of Striped Bass

Length, weight, sex, and sexual condition were determined for 82 striped bass that either died during field sample processing or had suspected tag wounds and were brought back to the lab. Total length was measured to the nearest mm. Total weight was measured to the nearest 50.0 g for fish less than or equal to 10 kg, and to the nearest 100.0 g for fish greater than 10 kg. Sex and sexual condition were determined through examination of the gonads using the criteria in Table E-1.

### E.2.2 STRIPED BASS STOMACH CONTENTS ANALYSIS

A sample of 82 striped bass that were processed as described above in Section E.2.1 were also examined for stomach contents. Stomachs were excised from fresh striped bass and analyzed in the laboratory. The presence of invertebrates and vertebrates in the stomach was determined. If vertebrates were present, it was determined if they were fish, and if so, if they were Atlantic tomcod. The presence of bony structures (vertebrae) was used to separate fish and invertebrate remains in striped bass stomach contents. Atlantic tomcod were differentiated from other fish species by comparing vertebral counts and, if necessary, vertebral shape from fish specimens in the stomach contents to stained and cleared specimens of Atlantic tomcod.

## E.3.0 RESULTS AND DISCUSSION

### E.3.1 Striped Bass Sexual Condition

Immature striped bass were most abundant in the biocharacteristics samples from the 2000-2001 striped bass program (Tables E-2 and E-3). Forty-two of the forty-three female striped bass examined were in the immature stage, one was in the resting stage. Thirty of the thirty-nine male striped bass examined were immature, nine were in the resting stage. No examined striped bass had gonads in the developing stage.

The lack of ripe or ripe and running striped bass in the 2000-2001 biocharacteristics samples agrees with the findings of the 1985-1986 through 1999-2000 programs (Table E-4). The majority of female fish examined, including previous programs, were immature (96%) and none of the females were found to be ripe or ripe and running. The majority of male fish examined, including the previous programs, were also in the immature (65%) and resting (21%) stages with the remainder in the developing stage (14%). The lack of ripe or ripe and running striped bass is not surprising because the majority of the fish captured in these programs were of pre-spawning size (< 400 mm) and the programs terminated before the onset of peak spawning (Normandeau 1986; TI 1981). The general increase from November to April in the percentage of males in the developing stage during the 1985-1986 through 2000-2001 programs indicated the approach of the spawning season, and that male striped bass may undergo a longer period of gonadal development prior to spawning than females. Due to both the small size of striped bass sampled, and the time period during which the program was conducted, the majority of the fish sampled were immature or resting.

### E.3.2 Striped Bass Food Habits

Food habits were determined from 82 striped bass, that died during collection in the 2000-2001 program, by identifying stomach contents as invertebrates, vertebrates, or Atlantic tomcod. Only 3 fish were captured in the larger (> 400 mm) length groups and one of these fish had empty stomachs (Table E-5). Presence of Atlantic tomcod in striped bass stomachs was of specific interest, because both striped bass and Atlantic tomcod are present in the Hudson River estuary during the winter, and as a result, Atlantic tomcod may be a winter food item of striped bass. No Atlantic tomcod were observed in any of the striped bass stomachs examined. All vertebrate remains were identifiable as fish, and those that could be identified included blueback herring and other unidentified clupeid and gobiid species as incidentally noted by laboratory personnel.

In the 2000-2001 program the majority of fish < 200 mm had empty stomachs (Table E-5). The percentage of striped bass with food items in their stomachs increased for fish in the 201-300 mm and 301-400 mm length groups. Among striped bass < 400 mm with non empty stomachs, invertebrate remains were the predominate prey items. Only three striped bass > 400 mm were examined for stomach contents and only two of those had prey items. The two fish > 500 mm with non empty stomachs had consumed invertebrates (sand shrimp and blue crab) although it is not feasible to discern any differential preferences in diet between the smaller length groups and fish > 500 mm with the 2000-2001 data because of the small sample size of larger striped bass.

The sample sizes for food habit analyses from individual programs were generally too small to identify trends. However, when the foods habit data from the 1985-1986 through 2000-2001 programs were pooled several trends became evident (Table E-6). Invertebrates were the dominant prey item as 74% of nonempty striped bass stomachs examined only contained invertebrate remains. A change in food habits was apparent when striped bass reached about 300 mm as the importance of invertebrates as a prey item decreased while vertebrate prey items increased. About 80% of the striped bass less than 300 mm with food items present in their stomachs had invertebrates only, while 50% of the stomachs of striped bass greater than 300 mm with food items present contained invertebrates only. This trend of increasing importance of fish as food items as striped bass length increases has been observed elsewhere (Schaefer 1970; Westin and Rogers 1978; Rulifson and McKenna 1987). No Atlantic tomcod were observed in any of the 2,687 striped bass stomachs examined since 1985.

**Appendix Table E-1. Criteria for Determining Sex and State of Maturity of Striped Bass[a].**

| State of Maturity | Code | Females | Males |
|---|---|---|---|
| Gravid or milting (ripe) | 1 | Ovaries full of yellowish granular eggs that are partially translucent. Eggs can be released when ovary is compressed. | Testes white, less firm in texture, and if compressed will readily milt. |
| Ripe and running | 2 | Adult prepared to spawn immediately; expulsion of eggs with little provocation. | Adult prepared to spawn immediately; expulsion of milt with little provocation. |
| Partially spent | 3 | Ovaries somewhat flaccid and convoluted, with a variable number of eggs left. Ovarian membrane somewhat vascular. | Testes whitish, somewhat flaccid and convoluted, with free flow of milt. |
| Spent | 4 | Ovaries flaccid, few translucent eggs left. Ovarian membrane very vascular or sac-like. | Testes brownish white, flaccid, convoluted, with no flow of milt upon compression. |
| Immature | 5 | Ovaries very small and string-like, thicker than testes, somewhat opaque and gelatinous in appearance. | Testes very small and stringlike, thinner than ovaries, somewhat translucent, and extremely tender. |
| Not gravid or not milting (Resting) | 6 | Underdeveloped ovaries in an adult female. Ovaries larger, more firm, opaque, and relatively thick. No eggs discernible to naked eye. | Underdeveloped testes in an adult male. Testes larger, more firm, opaque, but still tender. |
| Semi-gravid semi-milting (developing) | 7 | Subripe females heading into spawning season. Ovaries considerably larger, yellow, granular in consistency. Eggs discernible to naked eye, but not readily released when ovary is compressed. | Subripe males heading into spawning season. Testes considerably larger, white, firm in exture, but milt not running. |

[a] From Con Edison Data Dictionary

**Appendix Table E-2. Sexual Condition of Hudson River Striped Bass Examined from a Sample of Fish that Died During the 2000-2001 Program.**

| Month | Male | | | | | | Female | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sexual Condition | | | | All | | Sexual Condition | | | | All | |
| | Immature | | Resting | | | | Immature | | Resting | | | |
| | N | % | N | % | N | % | N | % | N | % | N | % |
| Jan | 6 | 100 | 0 | 0 | 6 | 100 | 5 | 83 | 1 | 17 | 6 | 100 |
| Feb | 5 | 83 | 1 | 17 | 6 | 100 | 6 | 100 | | | 6 | 100 |
| Mar | 7 | 88 | 1 | 13 | 8 | 100 | 12 | 100 | | | 12 | 100 |
| Apr | 4 | 67 | 2 | 33 | 6 | 100 | 6 | 100 | | | 6 | 100 |
| Nov | 1 | 33 | 2 | 67 | 3 | 100 | 6 | 100 | | | 6 | 100 |
| Dec | 7 | 70 | 3 | 30 | 10 | 100 | 7 | 100 | | | 7 | 100 |
| **All** | **30** | **77** | **9** | **23** | **39** | **100** | **42** | **98** | **1** | **2** | **43** | **100** |

**Appendix Table E-3. Length, Weight, Sexual Condition and Food Habits of Hudson River Striped Bass that Died During the 2000-2001 Program.**

| Date | River Mile | Length (mm) | Weight (g) | Sex | Sexual Condition | Gut Contents |
|---|---|---|---|---|---|---|
| **Upper Harbor** | | | | | | |
| 21-Nov-00 | 3 | 385 | 602.0 | Female | Immature | Empty |
| 21-Nov-00 | 3 | 381 | 667.1 | Male | Resting | Verts |
| 29-Nov-00 | 2 | 334 | 375.6 | Male | Immature | Empty |
| **Battery** | | | | | | |
| 8-Nov-00 | 1 | 363 | 486.5 | Female | Immature | Empty |
| 10-Nov-00 | 1 | 260 | 181.6 | Female | Immature | Inverts & Verts |
| 15-Nov-00 | 9 | 363 | 503.0 | Male | Resting | Inverts |
| 20-Nov-00 | 9 | 327 | 314.4 | Female | Immature | Empty |
| 22-Nov-00 | 1 | 206 | 85.3 | Female | Immature | Inverts |
| 27-Nov-00 | 9 | 190 | 56.4 | Female | Immature | Verts |
| 4-Dec-00 | 5 | 195 | 63.8 | Female | Immature | Inverts |
| 5-Dec-00 | 5 | 173 | 39.8 | Female | Immature | Inverts |
| 5-Dec-00 | 5 | 217 | 90.2 | Male | Immature | Empty |
| 5-Dec-00 | 5 | 220 | 93.1 | Male | Resting | Inverts |
| 6-Dec-00 | 5 | 312 | 277.1 | Male | Immature | Inverts |
| 6-Dec-00 | 5 | 292 | 254.6 | Female | Immature | Empty |
| 6-Dec-00 | 5 | 206 | 73.6 | Male | Immature | Inverts |
| 6-Dec-00 | 5 | 229 | 110.6 | Female | Immature | Inverts |
| 7-Dec-00 | 1 | 286 | 295.3 | Female | Immature | Empty |
| 8-Dec-00 | 1 | 186 | 54.5 | Female | Immature | Inverts |
| 8-Dec-00 | 1 | 392 | 568.2 | Male | Immature | Inverts |
| 21-Dec-00 | 5 | 310 | 291.9 | Male | Immature | Empty |
| 22-Dec-00 | 5 | 252 | 157.4 | Female | Immature | Empty |
| 22-Dec-00 | 5 | 170 | 41.7 | Male | Immature | Inverts |
| 22-Dec-00 | 5 | 208 | 71.7 | Male | Immature | Inverts |
| 22-Dec-00 | 5 | 206 | 111.8 | Male | Resting | Inverts |
| 28-Dec-00 | 7 | 437 | 1081.8 | Male | Resting | Empty |
| 8-Jan-01 | 9 | 208 | 85.9 | Male | Immature | Inverts |
| 8-Jan-01 | 9 | 166 | 38.2 | Male | Immature | Empty |
| 10-Jan-01 | 1 | 824 | 5250.0 | Female | Resting | Inverts |
| 12-Jan-01 | 9 | 151 | 29.6 | Female | Immature | Empty |
| 17-Jan-01 | 8 | 334 | 388.6 | Female | Immature | Inverts |
| 23-Jan-01 | 8 | 279 | 225.0 | Male | Immature | Empty |
| 24-Jan-01 | 8 | 210 | 81.3 | Female | Immature | Empty |
| 24-Jan-01 | 8 | 172 | 45.5 | Male | Immature | Empty |
| 24-Jan-01 | 8 | 254 | 158.3 | Female | Immature | Empty |
| 25-Jan-01 | 8 | 167 | 40.9 | Male | Immature | Empty |
| 25-Jan-01 | 8 | 182 | 50.4 | Female | Immature | Empty |
| 26-Jan-01 | 9 | 232 | 114.7 | Male | Immature | Inverts |
| 1-Feb-01 | 8 | 210 | 79.9 | Male | Immature | Empty |
| 2-Feb-01 | 8 | 270 | 189.9 | Female | Immature | Inverts |
| 13-Feb-01 | 8 | 243 | 135.5 | Female | Immature | Empty |

(continued)

**Appendix Table E-3. (Continued)**

| Date | River Mile | Length (mm) | Weight (g) | Sex | Sexual Condition | Gut Contents |
|---|---|---|---|---|---|---|
| 14-Feb-01 | 8 | 174 | 45.0 | Male | Immature | Empty |
| 22-Feb-01 | 8 | 300 | 287.6 | Female | Immature | Inverts |
| 22-Feb-01 | 7 | 550 | 1956.8 | Male | Resting | Inverts |
| 23-Feb-01 | 9 | 184 | 56.0 | Male | Immature | Empty |
| 27-Feb-01 | 8 | 234 | 140.5 | Female | Immature | Empty |
| 28-Feb-01 | 10 | 150 | 27.0 | Female | Immature | Empty |
| 28-Feb-01 | 8 | 196 | 65.4 | Male | Immature | Empty |
| 28-Feb-01 | 8 | 180 | 45.5 | Female | Immature | Empty |
| 28-Feb-01 | 8 | 225 | 96.5 | Male | Immature | Inverts |
| 2-Mar-01 | 8 | 215 | 91.3 | Female | Immature | Inverts |
| 9-Mar-01 | 10 | 307 | 309.7 | Female | Immature | Inverts |
| 9-Mar-01 | 10 | 288 | 227.3 | Female | Immature | Empty |
| 15-Mar-01 | 8 | 174 | 41.3 | Male | Immature | Empty |
| 16-Mar-01 | 9 | 184 | 51.9 | Male | Immature | Empty |
| 16-Mar-01 | 9 | 172 | 46.4 | Female | Immature | Empty |
| 16-Mar-01 | 8 | 256 | 157.3 | Male | Immature | Inverts |
| 19-Mar-01 | 8 | 365 | 448.9 | Female | Immature | Empty |
| 19-Mar-01 | 8 | 245 | 129.3 | Male | Immature | Empty |
| 20-Mar-01 | 9 | 303 | 264.2 | Male | Immature | Inverts |
| 22-Mar-01 | 8 | 274 | 187.9 | Female | Immature | Empty |
| 22-Mar-01 | 9 | 274 | 182.6 | Female | Immature | Empty |
| 22-Mar-01 | 9 | 310 | 268.2 | Male | Resting | Inverts |
| 22-Mar-01 | 9 | 305 | 312.2 | Female | Immature | Empty |
| 22-Mar-01 | 7 | 331 | 391.6 | Female | Immature | Empty |
| 26-Mar-01 | 9 | 167 | 39.5 | Male | Immature | Empty |
| 26-Mar-01 | 8 | 239 | 124.9 | Female | Immature | Inverts |
| 26-Mar-01 | 8 | 230 | 113.0 | Female | Immature | Empty |
| 29-Mar-01 | 9 | 158 | 35.2 | Female | Immature | Empty |
| 29-Mar-01 | 9 | 164 | 36.8 | Male | Immature | Empty |
| 2-Apr-01 | 8 | 192 | 57.0 | Female | Immature | Empty |
| 5-Apr-01 | 9 | 294 | 255.9 | Male | Resting | Inverts |
| 6-Apr-01 | 9 | 170 | 43.3 | Male | Immature | Empty |
| 6-Apr-01 | 9 | 339 | 402.0 | Female | Immature | Empty |
| 11-Apr-01 | 9 | 260 | 171.9 | Female | Immature | Inverts |
| 17-Apr-01 | 5 | 270 | 188.1 | Male | Immature | Inverts & Verts |
| 17-Apr-01 | 5 | 305 | 287.9 | Female | Immature | Inverts & Verts |
| 17-Apr-01 | 5 | 310 | 252.1 | Male | Immature | Inverts |
| 17-Apr-01 | 5 | 255 | 170.9 | Male | Resting | Inverts & Verts |
| 19-Apr-01 | 5 | 290 | 243.8 | Female | Immature | Empty |
| 19-Apr-01 | 5 | 339 | 336.2 | Male | Immature | Inverts |
| 20-Apr-01 | 7 | 310 | 290.0 | Female | Immature | Empty |

**Appendix Table E-4. Sexual Condition of Hudson River Striped Bass Examined from Samples of Fish that Died During the 1985-1986 Through 2000-2001 Programs.**

| Sex | Stage | Program | Number of Striped Bass in Month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nov | Dec | Jan | Feb | Mar | Apr | May | Total |
| Males | Immature | 1985-86 | 0 | 16 | 13 | 8 | 11 | 12 | 0 | 60 |
| | | 1986-87 | 0 | 2 | 7 | 9 | 10 | 14 | 0 | 42 |
| | | 1987-88 | 1 | 2 | 5 | 17 | 8 | 0 | 0 | 33 |
| | | 1988-89 | 1 | 7 | 10 | 6 | 5 | 2 | 0 | 31 |
| | | 1989-90 | 4 | 2 | 5 | 1 | 2 | 2 | 0 | 16 |
| | | 1990-91 | 6 | 12 | 16 | 11 | 7 | 3 | 0 | 55 |
| | | 1991-92 | 6 | 13 | 57 | 24 | 3 | 27 | 0 | 130 |
| | | 1992-93 | 8 | 18 | 9 | 9 | 36 | 48 | 0 | 128 |
| | | 1993-94 | 1 | 9 | 34 | 2 | 83 | 69 | 0 | 198 |
| | | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1995-96 | 3 | 7 | 8 | 7 | 10 | 4 | 0 | 39 |
| | | 1996-97 | 0 | 10 | 13 | 14 | 5 | 0 | 0 | 42 |
| | | 1997-98 | 1 | 9 | 12 | 6 | 6 | 0 | 0 | 34 |
| | | 1998-99 | 0 | 4 | 31 | 6 | 3 | 0 | 0 | 44 |
| | | 1999-00 | 1 | 3 | 13 | 1 | 12 | 2 | 0 | 32 |
| | | 2000-01 | 1 | 7 | 6 | 5 | 7 | 4 | 0 | 30 |
| | | **Total** | **33** | **121** | **239** | **126** | **208** | **187** | **0** | **914** |
| | | **Percent** | **53.2** | **61.7** | **71.6** | **64.9** | **72.2** | **57.9** | **0** | **65.2** |
| Males | Resting | 1985-86 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 6 |
| | | 1986-87 | 0 | 0 | 1 | 1 | 8 | 45 | 0 | 55 |
| | | 1987-88 | 1 | 4 | 9 | 0 | 0 | 0 | 0 | 14 |
| | | 1988-89 | 1 | 5 | 1 | 0 | 0 | 0 | 0 | 7 |
| | | 1989-90 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | 1990-91 | 1 | 6 | 2 | 9 | 3 | 2 | 0 | 23 |
| | | 1991-92 | 4 | 7 | 14 | 9 | 6 | 10 | 0 | 50 |
| | | 1992-93 | 5 | 12 | 14 | 12 | 2 | 4 | 0 | 49 |
| | | 1993-94 | 4 | 10 | 8 | 1 | 13 | 4 | 0 | 40 |
| | | 1994-95 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | 1995-96 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 |
| | | 1996-97 | 1 | 2 | 6 | 1 | 0 | 0 | 0 | 10 |
| | | 1997-98 | 2 | 6 | 6 | 5 | 4 | 0 | 0 | 23 |
| | | 1998-99 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| | | 1999-00 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| | | 2000-01 | 2 | 3 | 0 | 1 | 1 | 2 | 0 | 9 |
| | | **Total** | **25** | **58** | **64** | **39** | **39** | **67** | **5** | **297** |
| | | **Percent** | **40.3** | **29.6** | **19.2** | **20.1** | **13.5** | **20.7** | **100.0** | **21.2** |

(continued)

## Appendix Table E-4. Continued

| Sex | Stage | Program | Number of Striped Bass in Month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nov | Dec | Jan | Feb | Mar | Apr | May | Total |
| Males | Developing | 1985-86 | 1 | 11 | 9 | 10 | 7 | 50 | 0 | 88 |
| | | 1986-87 | 0 | 1 | 6 | 1 | 12 | 2 | 0 | 22 |
| | | 1987-88 | 1 | 1 | 1 | 7 | 2 | 3 | 0 | 15 |
| | | 1988-89 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 6 |
| | | 1989-90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1990-91 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 |
| | | 1991-92 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| | | 1992-93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1993-94 | 0 | 0 | 3 | 0 | 6 | 10 | 0 | 19 |
| | | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1995-96 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 |
| | | 1996-97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1997-98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1998-99 | 1 | 3 | 6 | 8 | 7 | 0 | 0 | 25 |
| | | 1999-00 | 1 | 1 | 4 | 0 | 2 | 1 | 0 | 9 |
| | | 2000-01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Total** | **4** | **17** | **31** | **29** | **41** | **69** | **0** | **191** |
| | | **Percent** | **6.5** | **8.7** | **9.3** | **14.9** | **14.2** | **21.4** | **0.0** | **13.6** |
| Females | Immature | 1985-86 | 1 | 28 | 17 | 9 | 16 | 24 | 1 | 96 |
| | | 1986-87 | 0 | 1 | 3 | 10 | 16 | 9 | 0 | 39 |
| | | 1987-88 | 4 | 4 | 11 | 18 | 8 | 0 | 0 | 45 |
| | | 1988-89 | 1 | 9 | 9 | 7 | 9 | 3 | 0 | 38 |
| | | 1989-90 | 4 | 3 | 6 | 3 | 3 | 1 | 0 | 20 |
| | | 1990-91 | 1 | 10 | 8 | 14 | 13 | 8 | 0 | 54 |
| | | 1991-92 | 4 | 13 | 55 | 29 | 6 | 8 | 0 | 115 |
| | | 1992-93 | 11 | 20 | 32 | 25 | 46 | 57 | 0 | 191 |
| | | 1993-94 | 5 | 17 | 19 | 3 | 82 | 69 | 0 | 195 |
| | | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1995-96 | 1 | 9 | 18 | 6 | 8 | 6 | 0 | 48 |
| | | 1996-97 | 0 | 14 | 38 | 54 | 24 | 0 | 0 | 130 |
| | | 1997-98 | 2 | 11 | 16 | 8 | 17 | 1 | 0 | 55 |
| | | 1998-99 | 2 | 7 | 19 | 13 | 3 | 0 | 0 | 44 |
| | | 1999-00 | 1 | 4 | 11 | 4 | 9 | 4 | 0 | 33 |
| | | 2000-01 | 6 | 7 | 5 | 6 | 12 | 6 | 0 | 42 |
| | | **Total** | **43** | **157** | **267** | **209** | **272** | **196** | **1** | **1145** |
| | | **Percent** | **97.7** | **95.2** | **94.3** | **98.1** | **97.1** | **94.7** | **50.0** | **95.9** |

(continued)

## Appendix Table E-4. Continued

| Sex | Stage | Program | Number of striped bass in month | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nov | Dec | Jan | Feb | Mar | Apr | May | Total |
| **Females** | **Resting** | 1985-86 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | | 1986-87 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | 1987-88 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| | | 1988-89 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 |
| | | 1989-90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1990-91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1991-92 | 1 | 2 | 8 | 0 | 2 | 8 | 0 | 21 |
| | | 1992-93 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 5 |
| | | 1993-94 | 0 | 0 | 1 | 0 | 6 | 1 | 0 | 8 |
| | | 1994-95 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | 1995-96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1996-97 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 3 |
| | | 1997-98 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | 1998-99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1999-00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 2000-01 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | **Total** | **1** | **8** | **15** | **2** | **8** | **11** | **1** | **46** |
| | | **Percent** | **2.3** | **4.8** | **5.3** | **0.9** | **2.9** | **5.3** | **50.0** | **3.9** |
| **Females** | **Developing** | 1985-86 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1986-87 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1987-88 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1988-89 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1989-90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1990-91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1991-92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1992-93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1993-94 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1995-96 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| | | 1996-97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1997-98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1998-99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1999-00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 2000-01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Total** | **0** | **0** | **1** | **2** | **0** | **0** | **0** | **3** |
| | | **Percent** | **0.0** | **0.0** | **0.4** | **0.9** | **0.0** | **0.0** | **0.0** | **0.3** |

**Appendix Table E-5. Percentage of Hudson River Striped Bass with Invertebrate, Vertebrate, Vertebrate and Invertebrate Remains, or Empty Stomachs, Cross-Classified by Length Group for Fish that Died During the 2000-2001 Program.**

| Length Group (mm Tl) | Percentage (Number) of Striped Bass with Stomach Contents | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Invertebrate Remains | | Vertebrate Remains | | Vertebrate and Invertebrate | | Empty | | Total | |
| ≤200 | 17.4 | (4) | 4.3 | (1) | 0.0 | (0) | 78.3 | (18) | 100.0 | (23) |
| 201-300 | 45.7 | (16) | 0.0 | (0) | 8.6 | (3) | 45.7 | (16) | 100.0 | (35) |
| 301-400 | 42.9 | (9) | 4.8 | (1) | 4.8 | (1) | 47.6 | (10) | 100.0 | (21) |
| 401-500 | 0.0 | (0) | 0.0 | (0) | 0.0 | (0) | 100 | (1) | 100.0 | (1) |
| ≥501 | 100 | (2) | 0.0 | (0) | 0.0 | (0) | 0.0 | (0) | 100.0 | (2) |
| **Total** | **37.8** | **(31)** | **2.4** | **(2)** | **4.9** | **(4)** | **54.9** | **(45)** | **100.0** | **(82)** |

**Appendix Table E-6. Food Habits of Hudson River Striped Bass Cross Classified by Length Group for Fish that Died During the 1985-1986 Through 2000-2001 Programs.**

| Food Category | Program | Striped Bass Total Length (mm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | <201 | 201-300 | 301-400 | 401-500 | >500 | Total |
| Invertebrates | 1985-86 | 5 | 88 | 18 | 3 | 1 | 115 |
| | 1986-87 | 8 | 25 | 16 | 2 | 0 | 51 |
| | 1987-88 | 3 | 39 | 12 | 2 | 1 | 57 |
| | 1988-89 | 2 | 9 | 2 | 0 | 0 | 13 |
| | 1989-90 | 16 | 3 | 1 | 0 | 0 | 20 |
| | 1990-91 | 3 | 29 | 7 | 0 | 0 | 39 |
| | 1991-92 | 52 | 85 | 18 | 1 | 0 | 156 |
| | 1992-93 | 74 | 40 | 12 | 2 | 0 | 128 |
| | 1993-94 | 35 | 81 | 10 | 0 | 0 | 126 |
| | 1994-95 | 2 | 2 | 1 | 0 | 0 | 5 |
| | 1995-96 | 14 | 26 | 2 | 2 | 1 | 45 |
| | 1996-97 | 21 | 26 | 6 | 1 | 0 | 54 |
| | 1997-98 | 7 | 8 | 5 | 1 | 0 | 21 |
| | 1998-99 | 16 | 15 | 4 | 1 | 0 | 36 |
| | 1999-00 | 2 | 20 | 5 | 1 | 0 | 28 |
| | 2000-01 | 4 | 16 | 9 | 0 | 2 | 31 |
| | **Total** | **264** | **512** | **128** | **16** | **5** | **925** |
| | **Percent** | **35.6** | **40.2** | **24.2** | **14.4** | **15.6** | **34.4** |
| Vertebrates | 1985-86 | 1 | 4 | 5 | 3 | 1 | 14 |
| | 1986-87 | 0 | 0 | 1 | 0 | 0 | 1 |
| | 1987-88 | 0 | 0 | 3 | 1 | 0 | 4 |
| | 1988-89 | 1 | 6 | 8 | 0 | 0 | 15 |
| | 1989-90 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1990-91 | 0 | 8 | 8 | 0 | 0 | 16 |
| | 1991-92 | 2 | 13 | 9 | 2 | 1 | 27 |
| | 1992-93 | 3 | 4 | 3 | 2 | 2 | 14 |
| | 1993-94 | 0 | 2 | 6 | 1 | 0 | 9 |
| | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1995-96 | 1 | 2 | 0 | 0 | 0 | 3 |
| | 1996-97 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1997-98 | 0 | 5 | 4 | 0 | 0 | 9 |
| | 1998-99 | 0 | 0 | 2 | 2 | 1 | 5 |
| | 1999-00 | 0 | 0 | 3 | 0 | 0 | 3 |
| | 2000-01 | 1 | 0 | 1 | 0 | 0 | 2 |
| | **Total** | **9** | **44** | **53** | **11** | **5** | **122** |
| | **Percent** | **1.2** | **3.5** | **10.0** | **9.9** | **15.6** | **4.5** |
| Invertebrates and Vertebrates | 1985-86 | 1 | 4 | 8 | 1 | 0 | 14 |
| | 1986-87 | 0 | 3 | 6 | 3 | 1 | 13 |
| | 1987-88 | 0 | 4 | 3 | 1 | 0 | 8 |
| | 1988-89 | 1 | 2 | 7 | 2 | 0 | 12 |
| | 1989-90 | 0 | 0 | 2 | 1 | 0 | 3 |
| | 1990-91 | 0 | 8 | 4 | 1 | 0 | 13 |
| | 1991-92 | 2 | 25 | 21 | 1 | 0 | 49 |
| | 1992-93 | 8 | 11 | 11 | 3 | 1 | 34 |
| | 1993-94 | 0 | 6 | 5 | 0 | 0 | 11 |
| | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1995-96 | 0 | 2 | 1 | 0 | 0 | 3 |
| | 1996-97 | 2 | 8 | 0 | 0 | 1 | 11 |
| | 1997-98 | 2 | 3 | 3 | 2 | 0 | 10 |
| | 1998-99 | 3 | 0 | 5 | 3 | 0 | 11 |
| | 1999-00 | 1 | 4 | 0 | 0 | 1 | 6 |
| | 2000-01 | 0 | 3 | 1 | 0 | 0 | 4 |
| | **Total** | **20** | **83** | **77** | **18** | **4** | **202** |
| | **Percent** | **2.7** | **6.5** | **14.6** | **16.2** | **12.5** | **7.5** |

(continued)

## Appendix Table E-6. Continued

| Food Category | Program | Striped Bass Total Length (mm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | <201 | 201-300 | 301-400 | 401-500 | >500 | Total |
| Empty | 1985-86 | 2 | 43 | 41 | 12 | 11 | 109 |
| | 1986-87 | 20 | 18 | 8 | 3 | 0 | 49 |
| | 1987-88 | 1 | 15 | 12 | 7 | 3 | 38 |
| | 1988-89 | 13 | 26 | 13 | 2 | 0 | 54 |
| | 1989-90 | 11 | 9 | 1 | 0 | 0 | 21 |
| | 1990-91 | 7 | 35 | 23 | 3 | 0 | 68 |
| | 1991-92 | 38 | 43 | 18 | 2 | 1 | 102 |
| | 1992-93 | 88 | 77 | 39 | 11 | 1 | 216 |
| | 1993-94 | 95 | 209 | 36 | 10 | 0 | 350 |
| | 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1995-96 | 28 | 12 | 1 | 1 | 0 | 42 |
| | 1996-97 | 57 | 50 | 10 | 2 | 1 | 120 |
| | 1997-98 | 24 | 45 | 35 | 8 | 1 | 113 |
| | 1998-99 | 30 | 19 | 16 | 2 | 0 | 67 |
| | 1999-00 | 17 | 18 | 7 | 2 | 0 | 44 |
| | 2000-01 | 18 | 16 | 10 | 1 | 0 | 45 |
| | **Total** | **449** | **635** | **270** | **66** | **18** | **1,438** |
| | **Percent** | **60.5** | **49.8** | **51.1** | **59.5** | **56.3** | **53.5** |

# ENCLOSURE 2 TO NL-08-006

Atlantic Tomcod Spawning Stock Survey
(Table with mark and recapture data)

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 and 3
DOCKETS 50-247 and 50-286

# ABUNDANCE AND STOCK CHARACTERISTICS OF THE ATLANTIC TOMCOD SPAWNING POPULATION IN THE HUDSON RIVER WINTER 2004-2005

**November 2007**

# ABUNDANCE AND STOCK CHARACTERISTICS OF THE ATLANTIC TOMCOD SPAWNING POPULATION IN THE HUDSON RIVER WINTER 2004-2005

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**Abundance and Stock Characteristics of the Atlantic Tomcod Spawning Population in the Hudson River, Winter 2004-2005**

## EXECUTIVE SUMMARY

- The population estimate of Atlantic tomcod spawning in the Hudson River during the winter of 2004-2005 was 1.7 million fish, with 95% confidence limits of 0.96 and 3.3 million fish. This Petersen estimate used Atlantic tomcod that were caught and marked between river miles 25 and 76 in box traps between 20 December 2004 and 30 January 2005 and recaptured by trawls in the Battery region during 31 January through 17 April 2005.

- The estimated 2004-2005 Atlantic tomcod spawning population in the Hudson River was tied for the ninth lowest observed among 21 recent years of Petersen estimates. Previous estimates, in millions of fish, were 12.5 in 1982-1983, 6.7 in 1983-1984, 2.1 in 1985-1986, 3.5 in 1987-1988, 5.9 in 1988-1989, 6.8 in 1989-1990, 3.2 in 1990-1991, 0.4 in 1991-1992, 2.6 in 1992-1993, 0.7 in 1993-1994, 2.4 in 1994-1995, 0.09 in 1995-1996, 3.3 in 1996-1997, 1.3 in 1997-1998, 0.6 in 1998-1999, 0.2 in 1999-2000, 2.5 in 2000-2001, 0.04 in 2001-2002, 0.1 in 2002-2003, and 1.7 in 2003-2004.

- Approximately 87% of the 2004-2005 Atlantic tomcod winter population were Age 1 fish. This was near average compared to the previous 19 winter surveys, when Age 1 fish were 63-98% of the population.

- The sex composition, determined from Petersen estimates of the male and female population size, was approximately 39% males and 61% females. This was within the range observed in the 19 previous winter surveys, when males were 22-65% of the population.

- Fecundity of Age 1 and Age 2 females in 2004-2005 was average compared to previous winter surveys. An above average proportion of age 2 fish was offset by a lower than average population, and total egg deposition for 2004-2005 was 27 billion eggs, which was about average compared with 28 billion eggs in 2003-2004, 1 billion eggs in 2002-2003, 1 billion eggs in 2001-2002, 28 billion eggs in 2000-2001, 3 billion eggs in 1999-2000, 10 billion eggs in 1998-1999, 23 billion eggs in 1997-1998, 47 billion eggs in 1996-1997, 2 billion eggs in 1995-96, 31 billion eggs in 1994-1995, 7 billion eggs in 1993-1994, 30 billion eggs in 1992-1993, 7 billion eggs in 1991-1992, 52 billion eggs in 1990-1991, 87 billion eggs in 1989-1990, 41 billion eggs in 1988-1989, 43 billion eggs in 1987-1988, 25 billion eggs in 1985-1986, and 75 billion eggs in 1983-1984.

- Atlantic tomcod peak spawning activity occurred during the two-week period from 27 December 2004 through 9 January 2005, which included the peak catch per hour of females in box trap samples, mainly from the West Point region.

- Trawl catch of Atlantic tomcod per ten-minute tow in the Battery region declined from early November through early January, then peaked sharply in the week beginning 31 January.

- Condition factors (weight at a given length) for both male and female Atlantic tomcod were generally comparable in 2004-2005 to condition factors observed in previous winter surveys.

- All Atlantic tomcod marked and released during this 2004-2005 survey were marked with visual implant tags. Finclips, which were the principal method of marking in 1997-1998 and the only method of marking for several years prior to that, were not used in 2004-2005.

# 1.0 INTRODUCTION

This report presents the findings of the 2004-2005 winter survey of the Atlantic tomcod (*Microgadus tomcod*) spawning population in the lower Hudson River. Data obtained by this survey were used to estimate (1) the size of the Atlantic tomcod spawning population in the Hudson River by the Petersen mark-recapture method (Ricker 1975); (2) population age and sex composition; (3) sexual maturity and the timing of peak spawning activity; (4) length, weight and condition of male and female fish; (5) individual, age-specific and population fecundity; (6) prespawning and postspawning population movements; (7) the validity of the population estimate; and (8) an annual index of Atlantic tomcod abundance based on trawl catch per unit of effort.

Surveys conducted during 1974-1975 through 1979-1980 (TI 1981) and during 1980-1981 and 1981-1982 (EA 1983) used Carlin tags or combinations of tags and finclips to mark Atlantic tomcod caught in box traps throughout the survey area. Box traps, impingement collections at Indian Point, Bowline, and Lovett generating stations, sport and commercial fishing returns, and incidental trawl catches provided recapture sampling efforts for those surveys (TI 1981). Examination of the movements of tagged fish (TI 1981) suggested that the Atlantic tomcod spawning population moved south into the lower Hudson and upper New York Harbor areas following peak spawning activity, which occurred during late December through early January in the West Point region. The present survey, as well as previous surveys, used this downriver population movement to provide random mixing of marked and unmarked fish for the Petersen mark-recapture statistic.

In 1982-1983 (NAI 1984a), the survey was modified to include (1) marking of Atlantic tomcod only in box traps set north of the Bear Mountain Bridge using finclip codes specific for one-week periods, and (2) trawl sampling, primarily south of the George Washington Bridge, to maximize the recapture of marked Atlantic tomcod in downriver regions. Marked fish were absent from the first peak of emigrating Atlantic tomcod caught in trawls south of the George Washington Bridge. The absence of marked fish implied that the first peak consisted largely of unmarked fish that had spawned south of the Bear Mountain Bridge. To evaluate this hypothesis, Atlantic tomcod were marked and released from box traps during the 1983-1984 survey both north and south of the Bear Mountain Bridge (NAI 1984b), extending the total marking area to Croton Point. Atlantic tomcod were finclipped using combinations of dorsal, anal and pelvic fins to designate four marking periods and four release zones. Recaptured fish were obtained from box traps, both north and south of the Bear Mountain Bridge, and from trawls sampling south of Croton Point.

Results from the 1983-1984 survey confirmed the hypothesis that Atlantic tomcod spawned south of the Bear Mountain Bridge. Atlantic tomcod marked and released between Croton Point and the Bear Mountain Bridge moved offshore and downriver where they were recaptured by trawling. Atlantic tomcod marked and released south of the Bear Mountain Bridge were generally recaptured before fish marked and released north of the bridge. Observations of the change in sex ratios across sampling weeks and recapture rates for marked fish among the release/recapture regions and time periods demonstrated that the best Petersen population estimate was obtained using all Atlantic tomcod marked in box traps north of Croton Point and recaptured by trawling south of the George Washington Bridge (NAI 1984b).

A spawning stock survey for Atlantic tomcod in the Hudson River was not conducted during the winter of 1984-1985. The survey was reinstated during the winter of 1985-1986 concurrent with a winter-spring striped bass mark-recapture program (NAI 1986, 1987). The 1985-1986 Atlantic tomcod spawning stock

survey was similar to the 1983-1984 survey and was expanded to provide two population estimates: (1) a prespawning population estimate based on fish marked in trawls south of the George Washington Bridge and recaptured in box traps north of Yonkers, and (2) a spawning population estimate based on fish marked in box traps at or north of Yonkers and recaptured in trawls south of the George Washington Bridge. Prespawning and spawning population estimates were not significantly different. The population estimate decreased from 12.5 million fish in 1982-1983 to 6.7 million fish in 1983-1984, and was lower still in 1985-1986 (2.1 million fish).

A mark-recapture survey for Atlantic tomcod was not conducted during the winter of 1986-1987. The Atlantic tomcod spawning stock mark-recapture survey was conducted concurrently with a striped bass hatchery evaluation program during the winter of 1987-1988 (NAI 1988). This Atlantic tomcod survey was similar to the 1985-1986 survey except weekly and biweekly marking periods were used instead of monthly periods to provide a more precise description of the temporal pattern of Atlantic tomcod movements during the spawning period. Prespawning and spawning population estimates were not significantly different. The spawning population estimate of 3.5 million fish represented an increase in abundance since 1985-1986. An Atlantic tomcod survey was conducted during the winters of 1988-1989 and 1989-1990 with no changes in methods. The resulting spawning population estimates were 5.9 million fish in 1988-1989 (NAI 1990) and 6.8 million fish in 1989-1990 (NAI 1991).

The 1990-1991, 1991-1992, 1992-1993, 1993-1994, 1994-1995, 1995-1996, 1996-1997, and 1997-1998 surveys (NAI 1992, 1994a, 1994b, 1995, 1998; LMS 1999a, 1999b, 1999c) were identical in design to the 1987-1988 through 1989-1990 surveys with the exception that Atlantic tomcod were not finclipped in the trawl program. The trawl effort was used primarily to recover fish in the Battery and Upper Harbor regions that had been marked and released from box traps fished north of Yonkers. The spawning population estimate was 3.2 million fish in 1990-1991, 0.4 million fish in 1991-1992, 2.6 million fish in 1992-1993, 0.7 million fish in 1993-1994, 2.4 million fish in 1994-1995, 0.09 million fish in 1995-1996, 3.3 million fish in 1996-1997, and 1.3 million fish in 1997-1998.

A new aspect of the Atlantic tomcod program in 1997-1998 was visual implant (VI) tagging of approximately 24% of the fish that were caught in box traps and released with finclips. The purpose of these tags was to provide specific information on the distribution, movement rates, and growth of individual fish. Tag retention and legibility were 100% after 2.5 months for tags inserted under the skin of the right operculum, which was superior to the results of the other two tagging sites (below the right eye and on the right pectoral fin). Based on the success of the VI tags in 1997-1998, VI tags were used for all (or nearly all) marking of Atlantic tomcod beginning with the 1998-1999 program, replacing the finclip method used in previous programs (with finclips used only as a backup procedure). Individually numbered tags make it possible to determine the exact release date and station of each recaptured fish, compared to the previous finclip method in which large batches of released fish were marked identically over a period of at least a week in one of two regions (north or south) each containing several stations. The spawning population estimate was 0.6 million fish in 1998-1999, 0.2 million fish in 1999-2000, 2.5 million fish in 2000-2001, 41,000 fish in 2001-2002, 110,000 fish in 2002-2003, and 1.7 million fish in 2003-2004.

Similar to previous surveys, the 2004-2005 Atlantic tomcod spawning stock mark-recapture survey was conducted concurrently with a striped bass stock assessment. For the 2004-2005 program, VI tags were used for all of the marking. While most of the tagging was of fish captured in box traps, approximately 1,000 fish captured in trawls were also tagged in 2004-2005.

# 2.0 METHODS

## 2.1 FIELD PROCEDURES

Gear deployment and sample handling procedures are described in detail in a standard operating procedures manual (NAI 2004), and are summarized below.

### 2.1.1 Box Trap Program

From the week of 6 December 2004 through the week of 28 February 2005, box traps (Appendix Table A-1) were set in 1 to 12 m of water at 18 sites along the east and west banks of the Hudson River (Figure 2-1). The traps were lowered into the water by wire cable and firmly attached to a solid shore structure (e.g. dock, pier, bulkhead). The traps were generally checked and reset daily, Monday through Friday. Sites sampled in 2004-2005 included ones at or near all but four of the original 17 box trap sampling sites used consistently in all annual surveys from 1974-1975 through 1997-1998 (there were some minor shifts in position of a few of the sites). Two of the exceptions were sites with historically low catch rates in River Miles (RM) 18 and 19 in the Yonkers region, which were discontinued after 1997-1998. Another exception was the Tarrytown trap site in RM 27 in the Tappan Zee region, which was abandoned after 1999-2000. The fourth exception was the Milton trap site in RM 71 in the Poughkeepsie region, which was abandoned after 2002-2003.

Extra traps have been used at various times since the 1997-1998 program to augment low catches, either at existing sampling sites or at new sites. In 1998-1999 an extra trap was added in RM 51 of the West Point region and an extra one in RM 56 of the Cornwall region. Four new trap sites were sampled in the West Point region during 1999-2000, one in RM 52 and the others in previously unsampled RM 54, 50, and 49. Traps in three locations were relocated slightly to a nearby site in the same RM. Two in RM 51 were relocated in December 1998 because access was denied by a new property owner and one in RM 41 where the site had become too shallow due to siltation was relocated in December 1999. In 2000-2001, additional changes were made to some of the trap locations. The extra trap in RM 51 and the recently established trap sites in RM 54, 50, and 49 were eliminated because they had been unproductive in 1999-2000. Extra traps were added in 2001-2002 at the Garrison site (RM 51, two more traps) and the Irvington site (RM 25, three more traps). Changes during the 2002-2003 program were the addition of an extra trap in RM 76 of the Poughkeepsie region, the elimination of two of the four traps in RM 51 at the Garrison site, and the elimination of two of the five traps in RM 25 at the Irvington site. Changes during the 2003-2004 program were the abandonment of the original Highland trap site in RM 76 of the Poughkeepsie region (retaining a newer site nearby in the same RM), the abandonment of the Milton site previously mentioned, and the addition of a second trap at the Marlboro site in RM 68 of the Poughkeepsie region. No changes were made to trap locations during the 2004-2005 program.

The Hudson River from Tappan Zee north to Poughkeepsie was used as the box trap release/recapture zone in this survey. All Atlantic tomcod that were marked and released in this zone were tagged with Northwest Marine Technology soft Vialpha fish tags. This tag is a small (1 mm x 3 mm), brightly-colored tag preprinted with a "tag number," a unique three-character identification code consisting of a letter followed by two digits or letters. The tag was inserted with a tag injector into the right cheek muscle of the fish. The length of each fish tagged was recorded and the degree of external parasite infestation was noted before the fish was released. Fish recaptured with tags were released again as quickly as possible, approximately 25 to 50 meters away from the capture site, after recording the length,

condition of the tag insertion site (healed or infected), tag number, and condition of the fish (e.g., blind, fungus, finrot, stress). Recaptured fish with illegible tags, with tag wounds but no tags, or with other unusual features of the tag or tag wound were taken back to the laboratory for mark verification. Tags applied during this 2004-2005 survey were yellow (with numbers between 095 and YZZ). No fish were finclipped in 2004-2005.

### 2.1.2 Trawl Program

The Hudson River south of the George Washington Bridge and a portion of upper New York Harbor between Battery Park and Liberty Island were sampled by trawls (Figure 2-1). This region is collectively referred to as the Battery in this report.

A 9 m high-rise trawl (Appendix Table A-2) was deployed each weekday (weather permitting) in the Battery from Monday, 1 November 2004, through Friday, 15 April 2005. The 9 m trawl was the same trawl used in all Atlantic tomcod surveys since 1982-1983. An average of 15 tows were scheduled to be made each day. Each tow was scheduled to last ten minutes, and the trawl was towed against the current at a boat speed (through water) of between 1.2 and 1.7 m per second. The towing wire was set with a length-to-depth ratio of between 2:1 and 4:1.

All Atlantic tomcod collected in trawls were examined for the presence of VI tags and for clipped fins, individually measured, examined for external parasites, and released. Suspected Atlantic tomcod recaptures from the current box trap program (Section 2.1.1 above) or from previous years were taken to the laboratory fresh or frozen for tag or finclip verification. All previously unmarked Atlantic tomcod collected in trawls and released between 1 November 2004 and 21 January 2005 were tagged with VI tags.

### 2.1.3 Biocharacteristics Samples

Once a week between 6 December 2004 and 4 March 2005, an entire day's Atlantic tomcod catch from each of five standard box trap sites (Table 2-1) was taken in fresh condition to the laboratory and examined for biocharacteristics, which included enumeration of all Atlantic tomcod and determination of the age, length, weight, sex, and reproductive condition. These standard box trap sites were used in previous years' surveys and were selected to provide comparable biocharacteristics data for the Atlantic tomcod spawning stock. Additional samples from non-standard stations were used to supplement the biocharacteristics samples when catches at standard stations were low.

On one randomly assigned day during each week between 1 November 2004 and 15 April 2005, the entire catch from at least three 9-m trawl samples was taken in fresh condition to the laboratory for biocharacteristics analysis. Fish were taken to the laboratory from more than one day during weeks with low abundance of Atlantic tomcod in the trawl catch in an attempt to obtain a weekly sample of about 100 fish. The same data were recorded as for box trap biocharacteristics analysis.

### 2.1.4 Water Quality Measurements

Conductivity and water temperature were measured *in situ*, with measurements corresponding to each box trap or trawl sample collection. Readings were made at the water surface and at sampling depth at box trap sites, and at the surface and sampling depth immediately after the completion of each 9 m trawl tow. Water quality data are summarized in Appendix Table B-1 for box trap samples and in Appendix Table B-2 for trawl samples. Bottom water salinity is summarized for box trap stations in Appendix Table B-3.

## 2.2 LABORATORY PROCEDURES

The Atlantic tomcod in each biocharacteristics sample (box trap or trawl) were received in fresh condition in the laboratory. Date and place of recapture were recorded for any tagged or finclipped Atlantic tomcod included with the laboratory samples. Tag number or finclip type, age, length, and sex were also recorded for each verified recapture.

Total length (mm), weight (nearest 0.1 g), sex, reproductive condition, age, and presence of external parasites were recorded for all Atlantic tomcod in the weekly biocharacteristics samples. Atlantic tomcod were not subsampled by length group for biocharacteristics analysis. Reproductive condition categories included immature, developing, ripe, ripe and running, partially spent, spent, and resting (Table 2-2). Age was determined from one spawning season to the next. Atlantic tomcod over 150 mm were aged by counting the annuli of the otoliths (number of dark annual growth rings using reflected light), aided by a dissection microscope. Individuals 150 mm and under were considered to be Age 1 fish (TI 1980). The degree of external parasite infestation was categorized as none, light (1-5 parasites), moderate (6-20 parasites), or heavy (>20 parasites). Assignment to length group (Table 2-3) was done by computer based on the individual measurements.

Ovaries were collected from up to 15 Atlantic tomcod females per length group (Table 2-3) for fecundity analysis from box trap biocharacteristics samples. Ovaries were removed only from female Atlantic tomcod determined to be in or approaching ripe condition. Excised ovaries were preserved in 10% formalin. After at least one month of preservation, the egg mass was separated from the rest of the ovarian tissue, and weighed to the nearest hundredth of a gram. A randomly selected subsample of approximately 2 g was weighed (nearest 0.01 g) and the eggs in it were counted.

## 2.3 ANALYTICAL METHODS

All box trap and trawl samples were assigned a Use Code (1, 2, or 5) that defined their use in analytical tasks. Use Code 1 samples were samples for which valid data were collected and no sampling problems were encountered. These data were used for all analytic tasks. Use Code 2 samples were samples in which Atlantic tomcod were captured, but sampling problems were encountered. Sampling problems were generally related to gear deployment that would affect computation of catch per unit of effort, such as noticing a tear in the net after a tow, or stopping a tow before the required 10-minute duration. Use Code 2 samples were included with Use Code 1 samples for mark-recapture or biocharacteristics analyses only. Use Code 5 samples were samples where sampling problems were encountered but no Atlantic tomcod were caught. Use Code 5 samples were excluded from all analyses. The number of samples assigned to each Use Code is presented for box traps and trawls in Appendix Table C-1.

Most data analyses were conducted using the Statistical Analysis System (SAS) software (SAS 1989). No rounding of data was done prior to the final step in each analysis. This prevented introduction of rounding error in the final result, and may present the appearance in a table that a column of data does not sum exactly to the total shown in the last row.

### 2.3.1 Estimates of Box Trap and Trawl Catch Per Unit of Effort (CPUE)

All box trap catch statistics were expressed as catch per hour using the following formula:

$$CPUE_{Trap} = (C_i/D_i) \times 60$$

where

$C_i$ = number of Atlantic tomcod caught in box trap i, and
$D_i$ = duration in minutes over which trap i was fished.

Box trap sample durations approximated a 24-h period for the Tuesday through Friday samples (weekdays) and a 72-h period for the Monday samples (weekend), with occasional longer durations due to weather (ice) conditions.

All trawl catch statistics were expressed as catch per ten-minute tow using the following formula:

$$CPUE_{Trawl} = (C_i/D_i) \times 10$$

where

$C_i$ = number of Atlantic tomcod caught in trawl sample i, and
$D_i$ = duration of tow i in minutes. All Use Code 1 trawl tows were ten minutes in duration.

### 2.3.2 Age Distributions and Sex Ratios

Atlantic tomcod age distributions and sex ratios were obtained from laboratory biocharacteristics samples collected during each week of field sampling (Sections 2.1.3 and 2.2). The proportion of each age and sex was determined from the totals for all biocharacteristics samples and extrapolated to the total catch of Atlantic tomcod using the following equations:

$$P_{ij} = n_{ij}/n$$
$$N_{ij} = P_{ij}N$$

where

$P_{ij}$ = proportion of Atlantic tomcod in biocharacteristics samples that were age i and sex j,
$n_{ij}$ = number of Atlantic tomcod in biocharacteristics samples that were age i and sex j,
$n$ = total number of Atlantic tomcod of known age and sex in biocharacteristics samples,
$N_{ij}$ = estimated number of Atlantic tomcod in the total catch that were age i and sex j, and
$N$ = total number of Atlantic tomcod caught.

For calculation of sex ratios used in population estimates, the number and proportion of each sex for Atlantic tomcod was first determined within weekly intervals from the biocharacteristics data and then weighted by the weekly catch of Atlantic tomcod using the following equations:

$$Pm_j = m_j/n_j$$
$$Pf_j = f_j/n_j$$
$$M_j = Pm_j N_j$$
$$F_j = Pf_j N_j$$

where

$Pm_j$ or $Pf_j$ = proportion of male or female Atlantic tomcod in week j in biocharacteristics samples,
$m_j$ or $f_j$ = number of Atlantic tomcod males or females in week j in biocharacteristics samples,
$n_j$ = number of Atlantic tomcod in week j in biocharacteristics samples,

$M_j$ or $F_j$ = estimated total number of male or female Atlantic tomcod caught in week j, and

$N_j$ = total number of Atlantic tomcod caught in week j.

Weekly estimates of the number of each sex in the catch were then summed to provide an estimate for the entire sampling season.

### 2.3.3 Atlantic Tomcod Condition

#### 2.3.3.1 Regression

Regression analyses were used to characterize the relationship between fish length and weight for male and for female Atlantic tomcod, and between length and fecundity for ripe female Atlantic tomcod. All regression analyses were performed using the PROC GLM procedures of the Statistical Analysis System (SAS 1989). Logarithmic transformations (log to the base ten) were used to normalize length (total length in millimeters), weight (nearest 0.1 gram), and fecundity (number of eggs per female) variables. The following $\log_{10}$-linear regression models were calculated:

$\text{Log}_{10}$ weight = $b_0 + b_1$ ($\text{Log}_{10}$ length)

$\text{Log}_{10}$ fecundity = $b_0 + b_1$ ($\text{Log}_{10}$ length)

where

$b_1$ = regression slope coefficient, and

$b_0$ =y-axis intercept for the calculated regression line.

Confidence limits for values of weight or fecundity predicted for a given length from regression equations were calculated by the following equation (Neter and Wasserman 1974):

$$C_{95} = \hat{Y}_h \pm t_{(.05,n-2)} \sqrt{MSE} \sqrt{1 + \frac{1}{n} + \frac{(X_h - \bar{X})^2}{\Sigma(X_i - \bar{X})^2}}$$

where

$C_{95}$ = 95% confidence limits for $_h$,

$_h$ = predicted value for dependent variable Y (e.g. $\log_{10}$ weight or $\log_{10}$ fecundity) corresponding to a $\log_{10}$ length of $X_h$,

n = number of observations in the regression data set,

MSE = regression mean square error,

$\bar{X}$ = mean $\log_{10}$ length within the regression data set, and

$\Sigma(X_i - \bar{X})^2$ = sum of squared deviations for the independent variable ($\log_{10}$ length).

#### 2.3.3.2 Pre- and Postspawning Condition

The well-being or condition of Atlantic tomcod can be compared among groups of fish using condition factor indices or regression analysis and analysis of covariance (ANCOVA). Each approach has

advantages and disadvantages that are best judged by the question being asked of the data. Condition factor indices represent a relative measure of "fatness" of fish at a given length (the greater the weight is at a given length, the higher the condition factor). Condition factors are particularly useful when tracking seasonal changes in subpopulations (Gabelhouse 1991) or comparing populations among regions (Gutreuter and Childress 1990, Springer et al. 1990). All condition factor indices require an assumption of isometric or allometric growth, and their formulation is dependent on the form of the age-length-weight relationship for individual fish (Ricker 1975, Anderson and Gutreuter 1983, Gutreuter 1987, Cone 1989). The assumption may be less critical if comparisons are made within the same age cohort and river system. If the form of the length-weight relationship is not known for the "standard" population, ANCOVA is recommended as a better approach than assuming a certain length-weight relationship (Ricker 1975, Anderson and Gutreuter 1983, Springer et al. 1990). The ANCOVA approach statistically compares regression lines for the length-weight relationships among several groups of fish, and tests for differences based on both the slope (form) and intercept coefficients. Regression lines can be significantly different due to differences in slope, intercept or both, while condition factor indices evaluate differences in slope and assume the intercepts are not significantly different. ANCOVA would be cumbersome, however, for tracking seasonal (weekly) trends or other contrasts with a large number of groups.

We used ANCOVA (SAS 1989) to compare differences in condition of prespawning and postspawning males and females. Weekly biocharacteristics data for Atlantic tomcod were subset based on reproductive condition (Table 2-2). Ripe fish were selected to represent the prespawning condition and spent fish were selected to represent the postspawning condition. Fish classified as immature, developing, or ripe and running were not used to characterize prespawning Atlantic tomcod because they are transitory stages and may have a wide range of gonadal weights that could increase the variability of the length-weight relationship. Similarly, fish classified as partially spent or resting were not used to describe the postspawning condition. The data were examined using scatter diagrams of $\log_{10}$ weight vs. $\log_{10}$ length to insure an adequate sample (10 or more fish) and a representative range of sizes (points not clustered). ANCOVA was then used to compare $\log_{10}$ length vs. $\log_{10}$ weight regressions of the pre- and postspawning male and female Atlantic tomcod from the trawl and box trap biocharacteristics samples. Predicted weight at a common length of 125 mm or 175 mm was back-transformed from the $\log_{10}$ models and used to compare regression lines. The analysis was conducted within each of the past 17 surveys (1988-1989, 1989-1990, 1990-1991, 1991-1992, 1992-1993, 1993-1994, 1994-1995, 1995-1996, 1996-1997, 1997-1998, 1998-1999, 1999-2000, 2000-2001, 2001-2002, 2002-2003, 2003-2004, and 2004-2005) to evaluate differences in Atlantic tomcod condition.

### 2.3.4 Petersen Estimate of Population Size

An adjusted Petersen estimator (Ricker 1975) was the single census method used to calculate the size of the Atlantic tomcod spawning population in the Hudson River. For the Petersen estimates of the spawning population that have been calculated since 1982-1983, a known number of Atlantic tomcod were caught in box traps, marked, and released between Tappan Zee and Poughkeepsie during the spawning period. The fraction of Atlantic tomcod marked in box traps and recaptured by trawls in the Battery was used to estimate the spawning population size. The formula for the adjusted Petersen estimator (Ricker 1975) is

$$\hat{N} = [(M + 1)(C + 1)] / (R + 1)$$

where

$\hat{N}$ = estimated population size,

M = number of marked fish, adjusted for handling mortality,

C = number of fish examined for marks, and

R = number of marked fish recaptured.

Confidence intervals around the Petersen estimate were calculated by considering the number of recaptures as a Poisson variable (Ricker 1975):

$$\hat{N}_L = [(M + 1)(C + 1)] / (R_U + 1)$$

$$\hat{N}_U = [(M + 1)(C + 1)] / (R_L + 1)$$

where

$\hat{N}_U$ and $\hat{N}_L$ = upper and lower limits for the estimated population size, and

$R_U$ and $R_L$ = upper and lower 95% limits for a Poisson variable (R).

#### 2.3.4.1 Handling Mortality Adjustment

The number of Atlantic tomcod marked and released (M) from box trap samples was adjusted for short-term handling mortality in two time periods using the following formula:

$$M = M_I - [(M_I)(m_t)]$$

where

M = number of Atlantic tomcod marked, adjusted for handling mortality,
$M_I$ = number of marked fish released into the river, and
$m_t$ = short-term handling mortality for time interval t, expressed as a decimal percentage: 0.10 in December and 0.025 in January and February.

The values and time periods used for these short-term handling mortality adjustments for box traps were the same as used in previous surveys (TI 1981), in which finclipped (or Carlin tagged) and control fish were obtained weekly from box trap samples and held for 14 days in 190-liter aquaria supplied with spring-fed quarry water at the Verplank hatchery. Periods of time with similar handling mortality of finclipped Atlantic tomcod had been identified, and the actual percent mortality had been determined in each period.

### 2.3.5 Distance and Rate of Movement for Tagged Atlantic Tomcod

Visual implant tags used to mark all of the Atlantic tomcod in 2004-2005 allowed more precise calculations of distance and rate of movement, compared to the finclipping method used in programs prior to 1998-1999. Distance moved was represented by the linear distance traveled by VI-tagged Atlantic tomcod between the release and recapture river miles.

### 2.3.6 Fecundity

The number of eggs in the gonads of randomly selected ripe or ripe and running female Atlantic tomcod was estimated using a subsample-weight extrapolation. The following formula was used to estimate the number of eggs in the entire ovary of each fish:

$$\text{Fecundity} = \frac{\text{Number of eggs x Gonad weight (g)}}{\text{Subsample weight (g)}}$$

### 2.3.7 Annual Trawl Index of Abundance

An annual trawl index of abundance was calculated as an additional measure of annual changes in Atlantic tomcod population size. Catch per unit of effort (CPUE) in the 9 m trawl was previously used to develop an index of Atlantic tomcod abundance for the 1982-1983 through 1998-1999 surveys (NAI 1995, NAI 2000). The 9 m trawl was selected because it was designed specifically to catch Atlantic tomcod, and has remained unchanged in mesh size and dimensions (Appendix Table A-2) since it was first used during the 1982-1983 survey. It has been fished with the same deployment procedures in the same region of the Hudson River across all sampling surveys. The CPUE index for the 9 m trawl in the Battery region was calculated for 2004-2005 using all river miles for the weeks of the Petersen estimate trawl recapture period, and was compared to the Atlantic tomcod population estimates derived from the Petersen estimator.

### 2.3.8 Salinity

Movement of the salt front in the Hudson River during the spawning period may influence Atlantic tomcod distribution, egg survival, and fertilization success, since Atlantic tomcod eggs resemble those of freshwater fishes in regard to salt tolerance and require salinities less than 15 ppt for successful fertilization (Peterson et al. 1980). Year to year differences in adult distribution and survival of eggs may be related to salt front intrusion in the lower Hudson River. Eggs spawned in the lower Hudson River, particularly between Yonkers and Indian Point, may be exposed to relatively high salinity water in some winters with low freshwater flows. Therefore, the movement of saline water during the winter spawning period may be an important covariate that helps explain annual variation in adult distribution and possibly the relationship between the Petersen population estimate and a trawl index of abundance. Weekly mean salinity levels in parts per thousand (ppt) were calculated from observed conductivity levels at the box trap sampling depth to determine the relationship between salt front position and annual variation in Atlantic tomcod distribution during the spawning period in the Tappan Zee, Croton-Haverstraw and Indian Point regions. Salinity was calculated following the method of TI (1976):

$$S = -100 \ln (1 - C_{25}/178{,}500)$$

where

$S$ = Salinity in ppt, and

$C_{25}$ = Conductivity in µmho/cm at 25°C.

# 3.0 RESULTS AND DISCUSSION

## 3.1 SEASONAL ABUNDANCE PATTERNS

Atlantic tomcod abundance in box trap samples from piers and bulkheads between Tappan Zee and Poughkeepsie increased to a peak in the week beginning 27 December 2004. The West Point and Tappan Zee regions contributed most to this peak (Figure 3-2), with C/H averages of 3.95 and 0.79 for that week. Seasonally, box trap C/H was highest during the six-week period from 20 December 2004 through the week of 24 January 2005 (0.40-3.23 fish per hour). The weekly C/H in the West Point region during the week of 27 December 2004 was the largest for a single region in any week (Figure 3-2).

Trawl catch of Atlantic tomcod per ten-minute tow (CPUE) in the Battery region declined from early November through early January, then rose to a sharp peak in late January (Figure 3-1; Appendix Table C-3). The highest CPUE during November-December was 11.1 fish per tow in the week beginning 1 November 2004. Catches during late December 2004 through late January 2005 were consistently low (<2 fish per tow). Trawling was not conducted in the last full week in January. When sampling was resumed, the CPUE peaked at the season's high of 25.2 fish per tow in the week beginning 31 January 2005. In the remaining 10 weeks of trawling, the trawl CPUE varied between 0.6 and 7.5 fish per tow during February through mid-April.

The timing of the peaks in CPUE in the box traps and the trawls during the winter of 2004-2005 (Figure 3-1) is consistent with the Atlantic tomcod spawning migration described in previous winter population studies (NAI 1984a, 1984b, 1987, 1988, 1990, 1991, 1992, 1994a, 1994b, 1995, 1998, 2000, 2006a, 2006b, 2006c, 2006d, 2006e; LMS 1999a, 1999b, 1999c). The November through early December trawl CPUE between 6 and 11 fish per tow probably corresponds with the movement of prespawning Atlantic tomcod into and through the Battery region of the lower Hudson River estuary. The box trap peak C/H in early to mid-January during a period of low trawl CPUE represents movement of spawning Atlantic tomcod into and through nearshore areas farther upriver, especially in the Tappan Zee and West Point regions. The increase in trawl CPUE and decline in box trap C/H in late January corresponds with movement of Atlantic tomcod back down river into the Battery region following spawning.

## 3.2 STOCK CHARACTERISTICS

### 3.2.1 Age and Sex Composition

The majority of the 2004-2005 winter spawning population of Atlantic tomcod were Age 1 fish, accounting for an estimated 89% of the fish collected in box traps and 82% of the fish captured in 9 m trawls (Table 3-1). Most, if not all, of the remaining fish were Age 2, as no fish observed in box trap and trawl samples were Age 3.

The weekly catch per unit of effort (CPUE) of male and female Atlantic tomcod in the 9 m trawl and box traps is a measure of the weekly sex ratio. In the 9 m trawl, the CPUE of female Atlantic tomcod was higher than the CPUE of males in most weeks (Figure 3-3). Conversely, male CPUE in box traps was usually higher than female CPUE.

The difference in sex ratios between box traps and trawls is clarified by comparison of weekly trends. Male CPUE in trawls gradually diminished during November through early December and was very low

from mid-December through late January. CPUE for males was modest but variable from early February through mid-April. The period of lowest CPUE for males in trawls corresponded to the period when catch rates for males in box traps was the highest (mid-December through late January). The pattern of weekly change in male CPUE in the 9 m trawls and box traps indicated a movement of males upriver throughout December. More than a month after their upriver migration, males had moved downriver, as evidenced by increased numbers in trawls in early February. CPUE for males in box traps decreased during January but significant numbers were still present in the week beginning 24 January, indicating that some males delayed their migration downriver until after that time. CPUE of female Atlantic tomcod in trawls also declined during the fall, lagging somewhat behind the decrease in male CPUE. The period of lowest CPUE of females in trawls, late December through mid-January, corresponded to the period of highest CPUE of females in box traps (Figure 3-3). Female Atlantic tomcod CPUE in box traps was minimal beginning in the week 17 January 2005. These patterns of change in female CPUE in the 9 m trawl and box trap samples indicated a movement of females upriver in late December. After a brief period upriver, the females migrated downriver again. The sex ratio in trawls in the peak CPUE week of 31 January 2005 is unknown because no fish were returned to the laboratory in that week. The fairly high value of trawl CPUE in the week beginning 7 February (Figure 3-1) was composed primarily of females (Figure 3-3), indicating that female migration downriver occurred earlier than for males. Thus male and female Atlantic tomcod tended to be spatially segregated during prespawning and postspawning periods with males upriver and females downriver at these times.

The sex composition of the Atlantic tomcod spawning population can be estimated from the proportion of males and females derived from separate Petersen estimates of population size for males and females in the spawning population. This spawning estimate uses Atlantic tomcod caught, marked and released from box traps and recaptured by trawls. This procedure ensures that comparable numbers of both male and female fish are recaptured. Six marked Atlantic tomcod males from the box traps were recaptured in the trawls, providing a Petersen spawning population estimate of 480,000 males with 95% confidence limits of 240,000 and 1,100,000. Four marked female Atlantic tomcod from the box traps were recaptured in the trawls, resulting in a Petersen estimate of 770,000 females with 95% confidence limits of 340,000 and 1,900,000. These estimates imply a proportion of males of 0.39, which was considerably lower than the proportion observed in the box traps during the late December to early January period of peak spawning (Appendix Table D-1), although it was higher than the proportion observed throughout most of the trawling program (Appendix Table D-1).

### 3.2.2 Maturity

Ripe and running male Atlantic tomcod were first collected in box traps during the week of 20 December 2004 (Figure 3-4, Appendix Table D-2). By the week of 3 January 2005 most of the males appearing in box traps were either partially spent or they were spent. During their period of peak abundance, ripe and running males were most abundant in box traps located in the West Point and Tappan Zee regions (Appendix Table D-3). Ripe females and ripe and running females were collected in box traps in greatest abundance during the three-week period from the week of 20 December 2004 through the week of 3 January 2005. Partially spent female Atlantic tomcod were first collected in box traps during the week of 20 December 2004 and had increased to a substantial proportion of the catch by the week of 27 December. By the week of 10 January 2005 more than half of the females were in spent condition and the proportion of ripe and ripe and running females was substantially reduced. These data indicate that peak spawning occurred during the two-week period of 27 December 2004 through the week of 3 January

2005, when substantial numbers of both prespawning (ripe or ripe and running) and partially spent females were present (Figure 3-4).

Most of the fish captured in the Battery region by the trawl were in developing condition in November and early December and were spent or resting by the middle of January 2005 (Figure 3-5, Appendix Table D-4). These data collectively suggest an upriver prespawning migration with peak spawning beginning during the week of 27 December 2004 through the week of 3 January 2005, followed by a downriver postspawning migration.

### 3.2.3 Atlantic Tomcod Condition

#### 3.2.3.1 Length-Weight Relationships

Regression equations developed from biocharacteristics samples for the relationship between $\log_{10}$ weight in grams and $\log_{10}$ total length in millimeters for male Atlantic tomcod (n=986; Appendix Figure D-1) and for females (n=1,394; Appendix Figure D-2) were highly significant (Appendix Table D-5). Predicted weights for females tended to be heavier for a given length than for males (Table 3-2).

#### 3.2.3.2 Pre- and Postspawning Condition

Male and female Atlantic tomcod captured by box traps and trawls were significantly heavier for a given length when in prespawning condition than when in postspawning condition in 2004-2005 (Table 3-3 and Appendix Table D-6). This was not surprising since total body weight included the weight of the gonad, which would be greatest when fish were in ripe condition and least when fish were in spent condition. Somatic weight was not used in this study because gonad weight was not determined for males, and gonads were only weighed for fecundity analysis from a small sample of females from the box traps.

Condition of Atlantic tomcod was compared not only between prespawning and postspawning fish, but also between fish caught upriver in box traps and fish caught downriver in trawls (Figure 3-6). Females captured in postspawning condition upriver in traps weighed approximately 25-30% less than when they were captured upriver in traps in prespawning condition two weeks earlier. Four weeks later when captured downriver in trawls, the females had regained about a third of the lost weight. The postspawning increase in weight was similar for 125-mm females and 175-mm females.

Male Atlantic tomcod captured downriver in trawls in prespawning condition were heavier for their length than males captured upriver in box traps one week later while still in prespawning condition. Males captured upriver in traps in postspawning condition weighed about 10-15% less than when they were captured upriver in box traps in prespawning condition about five weeks earlier. When males in postspawning condition were captured downriver in trawls three weeks later, they had regained some of their lost weight (Figure 3-6).

In most previous surveys, males and females both exhibited weight loss during the upstream migration while in prespawning condition. This held true for males in 2004-2005, but females did not show any appreciable change in weight with only one week separating downriver trawl samples and upriver box trap samples. Females typically lose a higher proportion of their body weight while upstream during the peak spawning weeks, reflecting differences in weight of discharged gametes and this held true in 2004-2005. Females also regained a slightly larger proportion of the weight lost during spawning by the time they were recaptured downriver several weeks after peak spawning. Differences between males and females in the timing of their downriver movement after spawning could affect the rates of regaining lost

weight if food availability or feeding rates changed as the fish entered the warmer, higher salinity waters of the Battery region (Appendix Table B-3).

### 3.2.4 Fecundity

$Log_{10}$ fecundity was a linear function of $log_{10}$ length for female Atlantic tomcod (Appendix Figure D-3; Appendix Table D-5). The regression model accounted for 90% of the observed variation in fecundity ($r^2$ = 0.90; Appendix Table D-5). Predicted fecundities for female Atlantic tomcod ranged from 4,900 to 30,600 eggs per fish for fish between 125 and 225 mm total length (Table 3-4).

Age-specific fecundity of Atlantic tomcod was estimated at approximately 16,800 eggs for Age 1 females and 50,700 eggs for Age 2 females during the 2004-2005 winter spawning survey (Table 3-5). Since fecundity is related to length, the greater mean fecundity for Age 2 fish was primarily due to their larger size compared to Age 1 fish. When the total 2004-2005 Atlantic tomcod population estimate (1.7 million spawning fish, Section 3.4) was multiplied by the percentage of females (61%, Section 3.2.1), the weighted mean fecundity (Table 3-5), and the percent composition of females in each age group (71.8% Age 1, 28.2% Age 2, Table 3-1), Age 1 females deposited an estimated 13 billion eggs and Age 2 females deposited approximately 15 billion eggs.

### 3.2.5 Parasites

External parasites observed on Atlantic tomcod beginning in the 2002-2003 season are shown in Tables 3-6 through 3-8. In the winter of 2002-2003, the incidence of parasites was 2.4% for Atlantic tomcod captured in box traps and 9.8% for those captured in trawls (Table 3-6). On all but one of the 37 fish found with parasites, the infestation was categorized as "light" (1-5 external parasites). One of the trawl-caught fish was observed with "heavy" parasite infestation (>20 external parasites). In 2003-2004, 8.9% of Atlantic tomcod caught in box traps and 38.3% of fish caught in trawls were observed with external parasites (Table 3-7). Among the fish observed with parasites in 2003-2004, 93.8% were lightly infested, 5.7% moderately infested (6-20 external parasites), and 0.5% were heavily infested. During the 2004-2005 sampling season, 16.1% of fish caught in box traps and 44.5% of the fish caught in trawls had external parasites (Table 3-8). Among the fish observed with parasites in 2004-2005, 86.3% were lightly infested, 12.8% were moderately infested, and 0.9% were heavily infested.

## 3.3 Population Distribution and Movements

Recapture of tagged Atlantic tomcod provided direct evidence of the duration, distance, and rate of movement of fish (Table 3-9, Appendix Tables E-2 through E-6). The 10 Atlantic tomcod marked and released in box traps set between Tappan Zee and Poughkeepsie that were recaptured by trawls in the Battery region required 26 to 112 days to migrate downriver an average minimum distance of 40 river miles (64 km). Eight of those fish were tagged and released in the North region and two in the South region. Four males tagged and released in the North region migrated downriver an average of 44 miles in 49-112 days after they were released. Four females tagged and released in the North region migrated downriver an average of 48 miles in 26-84 days after they were released. Two males tagged and released in the South region migrated downriver an average of 18 miles in 39-50 days after they were released. No females tagged and released in the South region were recaptured downriver in trawls.

Most (266/291 or 91%) of the recaptured Atlantic tomcod were caught, marked, released, and recaptured in the same Hudson River region (Table 3-10). Movement within the North region accounted for 62% of

the within-region movement of the recaptured Atlantic tomcod (165 of 266 fish), with 35 fish being released and recaptured within the South region and 66 fish being released and recaptured in the Battery region. The North region exhibited the highest recapture rate (R/M) and the highest recapture proportion (R/C). Ten fish marked and released in the North box trap region were recaptured in the South box trap region, but no fish marked and released in the South box trap region were recaptured in the North box trap region.

There were 13,446 Atlantic tomcod tagged and released from the box traps between 6 December 2004 and 27 February 2005 and 2,010 Atlantic tomcod that were captured in the trawls and examined for tags between 6 December 2004 and 17 April 2005 (Table 3-11). All 10 tagged Atlantic tomcod that were released in box traps and recaptured in the trawls were tagged and released in the five-week period 20 December 2004-23 January 2005, which included the two-week period of peak spawning. The trawl recaptures occurred over an 11-week period beginning in the week of 31 January 2005. The highest recapture proportion (R/C row in Table 3-8) was in the week of 21 February 2005.

Peak Atlantic tomcod spawning occurred between 27 December 2004 and 9 January 2005 (Figure 3-4). The timing of this event is evident in the recapture patterns. All 10 of the trap-to-trawl recaptures were caught after the period of peak spawning, after being at large from four to 16 weeks. The 35 fish that were tagged in the South region and recaptured in box traps in the South region during 13 December 2004-13 February 2005 had been at large for an average of about 1.5 weeks (Appendix Table E-4). The 165 fish that were tagged in the North region and recaptured in box traps in the North region during 13 December 2004-20 February 2005 had been at large for an average of about 1.3 weeks (Appendix Table E-5). The 10 fish that were tagged in the North region and recaptured in box traps in the South region during 17 January-20 February 2005 had been at large for an average of about 2.5 weeks (Appendix Table E-6). All 10 of those fish were recaptured after the two peak spawning weeks, suggesting that they had begun their migration downriver. The relative timing of peaks in trawl CPUE and box trap C/H (Figure 3-1), the relative recapture locations (Table 3-10), and the dates and timing of the recapture of box-trap released Atlantic tomcod within and among Hudson River regions (Table 3-11, Appendix Tables E-2 through E-6) collectively support the assertion that the spawning population of Atlantic tomcod migrated from the Battery to shoal sites above Tappan Zee and then back to the Battery between December 2004 and April 2005.

## 3.4 PETERSEN POPULATION ESTIMATE

Six assumptions must be satisfied to estimate the Atlantic tomcod population size in the Hudson River using the Petersen method or related methods (Cormack 1968, Ricker 1975, Seber 1982):

1. tagged Atlantic tomcod suffer the same mortality as untagged fish,
2. tagging does not affect Atlantic tomcod catchability,
3. tagged Atlantic tomcod do not lose their tags,
4. all tags are recognized and reported,
5. immigration and/or emigration is negligible in the study area i.e., the population is closed, and
6. tagged Atlantic tomcod are randomly distributed among untagged Atlantic tomcod or the distribution of recapture fishing effort is proportional to the abundance of fish in various river regions.

Handling mortality studies for box traps (TI 1981) addressed the first assumption (above) by providing percent mortality data which were used to adjust the number of marked Atlantic tomcod (M) in the population during each marking period. Mortality adjustments were 10% or less (Section 2.3.4.1) and were intended to compensate for differential mortality of marked and unmarked fish. Handling mortality for VI-tagged fish was tested in the 1997-1998 program and found to be comparable to the earlier handling mortality estimates for finclipped fish (NAI 1998). Assumption 2 (above) generally is applied to tagged fish that are recaptured by entanglement gear (e.g., gill nets or trammel nets; Ricker 1975), and it is unlikely that tagged Atlantic tomcod are more or less vulnerable to capture by box traps or trawls than untagged fish because the tag is not external. Additionally, tagged Atlantic tomcod recaptured by trawls in the 1997-1998 survey (NAI 1998) migrated an average of 40 river miles (64 km) or more, suggesting that swimming ability was not appreciably impaired by the tags and that they migrate along with untagged fish.

Assumptions affecting the recognition, reporting and loss of tags from marked Atlantic tomcod (Assumptions 3 and 4 above) were addressed by testing during the 1997-1998 program in which VI-tagged fish were held and observed over periods ranging from 10 to 19 weeks to observe tag loss and legibility problems (NAI 1998). Tag retention rates and proportion of legible tags were very high, particularly for tags inserted in the right operculum (the location used for the 2004-2005 program). In 42 test fish observed over a 10-week period, both tag retention and tag legibility were 100% for tags inserted in the right operculum site.

No finclips were encountered during the 2004-2005 program. VI tags were the only means used to mark all fish during the 2004-2005 program. Finclips had not been used since the 1997-1998 program except for two samples with very large catches during the 2000-2001 program and one sample with a very large catch during the 2003-2004 program.

Marked Atlantic tomcod apparently do not violate Assumption 5 (above) by migrating out of the Hudson River during the survey period. Relatively few fish (and no marked fish) were caught in 16 tows taken outside the Battery region during the 1985-1986 study period (NAI 1987). Incidental observations by the field crew during a striped bass trawling effort which conducted more than 89 tows in areas adjacent to the Battery region after the 1985-1986 Atlantic tomcod survey ended (21 March - 16 May 1986; NAI 1987) also suggested little emigration of Atlantic tomcod had occurred since only eight Atlantic tomcod were caught and no marked fish were observed.

In the annual Atlantic tomcod spawning stock surveys, box trap-released and trawl-recaptured Atlantic tomcod are used to satisfy Assumption 6. Separation of the mark and release effort from the recapture effort in both distance and time was used to satisfy the assumption of random mixing (Schaefer 1951, Cormack 1968, Ricker 1975). The use of one sampling gear to mark the fish and a second gear to recapture them reduces the likelihood of a consistent bias in the probability of capture (Cormack 1968, Ricker 1975).

For the Atlantic tomcod surveys up through the 1993-1994 program, the sampling weeks used to represent the marking period and the recapture period for estimating population size were chosen on the basis of stable R/M and R/C ratios in order to satisfy Assumption 6 (NAI 1990). This approach has not been feasible for defining the marking and recapture periods in several of the more recent years because the number of recaptures was too low to allow a meaningful comparison of R/M and R/C ratios among sampling weeks (those ratios were zero in some weeks). Examination of eight previous surveys of M and R/M data (the 1987-1988 through 1993-1994 and 1997-1998 surveys) showed that the weeks of stable

R/M ratios included about 91-98% (mean of 95%) of the total M for the year, excluding a few weeks early and late in the box trapping season when catches (and consequently the values of M) were low. Based on this pattern, the marking period for the 2004-2005 estimate was selected as the six-week period in which 93% of the tagged fish were released, from the week beginning 20 December 2004 through the week beginning 24 January 2005.

For determining the 2004-2005 recapture period, the historical pattern of C and R/C over the same eight previous surveys (1987-1988 through 1993-1994 and 1997-1998) was more variable, with the stable R/C period including from 57% to 100% (mean of 92%) of all trawl recaptures starting with the first week in January. The stable R/C weeks typically began with a week in which trawl catch rates began to rise after an extended period of low catches when the fish were mostly upriver. Based on this pattern, an 11-week trawl recapture period was identified for the 2004-2005 estimate, from the week beginning 31 January through the week beginning 11 April 2005. This recapture period included 93% of the trawl catch after 2 January. This trawl recapture period began six weeks after the beginning of the box trap marking period, which would allow enough time for fish to migrate downriver based on previously observed movement rates on the order of 35-40 days. The resulting population estimate was very insensitive to different choices of marking and recapture periods, as changing the periods by a week or two on either end would change the estimate by less than 5%.

The spawning estimate of the Atlantic tomcod population size in the Hudson River used fish marked in box traps north of Yonkers during the period of 20 December 2004 through 30 January 2005 and recaptured by trawls in the Battery during the period of 31 January through 17 April 2005 (Table 3-12). The 2004-2005 population estimate for the Atlantic tomcod spawning stock in the Hudson River was 1.7 million fish with lower and upper 95% confidence limits (Poisson) of 960,000 fish and 3.3 million fish.

## 3.5 ANNUAL TRENDS 1974-1975 TO PRESENT

The condition and fecundity of the 2004-2005 Atlantic tomcod winter spawning population were fairly typical among recent (1982-1983 and later) surveys. The proportion of males in 2004-2005 was higher than average based on laboratory biocharacteristics samples, but about average based on separate male and female Petersen population estimates. The proportion of Age 2 fish was the tenth highest observed among the 20 most recent years of data. Weighted mean fecundity was about average for both Age 1 females and Age 2 females. The timing of peak spawning during the last week of December and the first week of January was comparable to the timing in most previous years. Atlantic tomcod CPUE in the 9 m trawl and the Petersen population estimate were both lower than average. The population estimate was tied for tenth lowest among the 27 annual surveys compared.

### 3.5.1 Stock Characteristics

#### 3.5.1.1 Age and Sex Composition

The estimated proportion of Age 2 fish in the 2004-2005 spawning stock (12.6%; Table 3-13) was the tenth highest proportion of Age 2 fish observed among the 20 surveys since 1983-1984. Males were found in greater proportion and abundance than females in 2004-2005, a pattern also observed in 1983-1984, 1990-1991, 1993-1994, 1997-1998, 1998-1999, 2000-2001, 2002-2003, and 2003-2004. Females predominated in 1985-1986, 1987-1988, 1994-1995, and 2001-2002. Males were found in approximately equal numbers as females in 1988-1989, 1989-1990, 1991-1992, 1992-1993, 1995-1996, 1996-1997, and 1999-2000. During the years with high male:female ratios, trawl catches were typically low, increasing

the relative importance of box trap data. The 2004-2005 trawl catches were not low, but they were substantially lower than the box trap catches. Atlantic tomcod surveys before 1983-1984, which relied on sex ratios derived from box trap biocharacteristics samples pooled for the entire season (NAI 1984a), also generally captured a high proportion of males, ranging from 61 to 79% of the total population. Although a trawling program was conducted during the winter of 1982-1983, no sex ratio data were obtained. Based on the evaluation of four different methods for calculating the population sex ratio (NAI 1987), the proportion of males calculated prior to 1983-1984 was probably biased by (1) the timing and movements of males and females into and out of the box trap sampling area and (2) pooling of data across the entire season to obtain a population sex ratio. The predominance of males in data from previous years can be explained as an artifact of sampling during the times when males preceded the females onto the spawning grounds and when the males lingered there after most of the females had moved into the channel and downriver.

Among the estimators previously examined (NAI 1987), the Petersen method may be the least biased by sexual segregation in the Atlantic tomcod population, since each sex is treated as a separate subpopulation. The 1988-1989 through 1997-1998 surveys adopted a recommendation from the 1985-1986 survey to use weekly or biweekly finclip codes throughout most of the sampling season to provide more specific temporal data to evaluate the exposure of each sex to the spatially separated box trap and trawl sampling efforts. Similar total population estimates among the 1983-1984 through 1997-1998 surveys derived from either the sum of separate estimates of the male and female populations (Table 3-14) or the total population (Section 3.5.3), suggest the accuracy of sex ratio estimates derived from Petersen estimates was not affected by relatively long (monthly) marking periods used in 1982-1983 and 1983-1984. During 1983-1984 through 2003-2004, the proportion of males for sex-based Petersen estimates varied between 22% and 65% and the proportion of females varied from 35% to 78%. The 2004-2005 proportion of males based on the Petersen estimates was 39%, which was close to the average observed in previous years (Table 3-14).

### 3.5.1.2 Length-Weight

Length-weight relationships for male and female Atlantic tomcod from the 2004-2005 survey were similar to results from previous years, with predicted weights being about average (Table 3-15). Females were, on average, heavier at a given length than were males. This was true in every year at all three lengths compared (125, 175, and 225 mm).

### 3.5.1.3 Fecundity

The fecundity-length relation determined for the 2004-2005 spawning population was similar to that of previous surveys (EA 1983; NAI 1984a, 1984b, 1987, 1988, 1990, 1991, 1992, 1994a, 1994b, 1995, 1998, 2000, 2006a, 2006b, 2006c, 2006d, 2006e; LMS 1999a, 1999b, 1999c). The predicted fecundity for female Atlantic tomcod between 125 mm and 225 mm was well within the confidence intervals for most of the previous predictions (Table 3-16).

The mean Age 1 fecundity of 16,800 eggs per female for the 2004-2005 Atlantic tomcod population (Table 3-5) was about average compared to previous years (EA 1983; NAI 1984a, 1984b, 1987, 1988, 1990, 1991, 1992, 1994a, 1994b, 1995, 1998, 2000, 2006a, 2006b, 2006c, 2006d, 2006e; LMS 1999a, 1999b, 1999c). Age specific mean fecundity for Age 2 females of 50,700 eggs per female (Table 3-5) was also about average among the years compared.

The estimated Atlantic tomcod egg deposition of 27 billion eggs during the 2004-2005 program was about average compared to the 19 previous surveys (Table 3-17). The average egg deposition estimate in 2004-2005 despite a somewhat lower than average population size reflects a higher than average proportion of age 2 fish, with higher fecundity than age 1 fish. Egg deposition was not compared with surveys prior to 1983-1984 because these earlier estimates were based on sex ratios derived exclusively from box trap samples which may underestimate egg deposition due to an under-representation of female Atlantic tomcod in the box trap catch (Section 3.5.1.1).

### 3.5.2 Population Distribution During the Spawning Run

In previous surveys, relative abundance (C/H) of Atlantic tomcod in box traps has peaked in the late-December through mid-January period. In 2004-2005, C/H peaked during the week of 27 December 2004 in the West Point region. The West Point region has generally had the highest relative abundance of Atlantic tomcod during the spawning run and may be the center of spawning activity in the Hudson River (TI 1981; EA 1983; NAI 1984a, 1984b, 1987, 1988, 1990, 1991, 1992, 1994a, 1994b, 1995, 1998, 2000, 2006a, 2006b, 2006c, 2006d, 2006e; LMS 1999a, 1999b, 1999c). Relatively high C/H for Atlantic tomcod indicates that spawning activity may also be centered in the Tappan Zee and Croton-Haverstraw regions in certain years. Substantial catch and spawning activity were observed in both North and South box trap regions in the 1982-1983, 1983-1984 and 1985-1986 surveys, but then C/H was low in the South box trap region from 1987-1988 through 1997-1998. The contribution of the Tappan Zee region to the total box trap catch increased in 1998-1999 (NAI 2000), but it returned to low levels in 1999-2000 and 2000-2001 (NAI 2006a, 2006b). Catches in the Croton-Haverstraw and/or Tappan Zee regions were high in 2001-2002 (NAI 2006c), 2002-2003 (NAI 2006d), and 2003-2004 (NAI 2006e). In 2004-2005 the West Point region contributed the highest box trap catches, but there was still a moderate contribution from the Tappan Zee region (Figure 3-2).

Atlantic tomcod spawning activity occurs in low salinity water (<15 ppt, Peterson et al. 1980). The observed inter-annual variation in the distribution of Atlantic tomcod as indicated by peaks in box trap C/H in both the South and North regions in some years, while only one C/H peak in the North region is observed in other years, was hypothesized to be related to salinity intrusion (NAI 1988). This hypothesis was evaluated by comparing predicted salinity isopleths for the river channel with weekly mean Atlantic tomcod C/H during periods of peak spawning abundance (NAI 1988). Results from this comparison for the 1974-1975 through 1987-1988 surveys were inconclusive, and it was hypothesized that the predicted, mid-channel salinity isopleths may not accurately reflect the bottom salinity experienced by Atlantic tomcod in the near-shore areas where the box traps are set. Furthermore, surface salinity measurements obtained in the box trap survey may be lower than the actual salinity experienced by Atlantic tomcod near the river bottom due to vertical stratification of saline and fresh water. Therefore, the box trap survey field methods were modified in 1988-1989 to obtain both surface and bottom conductivity (salinity) measurements, so that the original hypothesis could be reexamined.

Mean bottom salinities observed in the weeks of peak spawning activity never exceeded 15 ppt, and observed bottom salinities were generally less than 3 ppt higher than surface salinities during 1988-1989 through 2004-2005 (Table 3-18). Bottom water salinities also never exceeded 15 ppt when the average ratio of weekly mean surface to bottom water salinities for 1988-1989, 1989-1990 and 1990-1991 were used to estimate bottom salinities for 1982-1983 through 1987-1988. A change occurred after 1985-1986 in the ratio of weekly mean Atlantic tomcod catch per hour (C/H) for the period of peak abundance in the North and South box trap regions (Table 3-18). North/South C/H ratios for the 1982-1983, 1983-1984

and 1985-1986 surveys were near one, indicating similar peak densities of Atlantic tomcod during peak spawning in both the North and South regions. Both C/H and (estimated) bottom water salinity were relatively high in the South region during 1985-1986, suggesting that salinity intrusion does not influence Atlantic tomcod abundance during the period of peak spawning in the South region. The ratios for surveys conducted from 1987-1988 through 2000-2001 were usually much greater than one, reflecting higher weekly mean C/H in the North region than in the South region. Ratios of 0.6 in 2001-2002, 0.1 in 2002-2003, and 0.8 in 2003-2004 indicate a recent downstream shift in the location of spawning fish, but in 2004-2005 the North to South catch ratio increased to 5.0 (Table 3-18).

### 3.5.3 Population Size

Prior to 1982-1983, estimates of Atlantic tomcod spawning population size relied on fish finclipped or Carlin-tagged and released from box traps above the Bear Mountain Bridge (North) and recaptured in Yonkers through Indian Point (South) by box traps, impingement and a limited trawling effort (TI 1981, EA 1983). In the 1982-1983 and 1983-1984 winter surveys, trawling was conducted in the Battery region of the Hudson River (NAI 1984b). The winter trawling effort was initially implemented because of declining impingement catches and recapture rates of Atlantic tomcod at Indian Point Station (Table 3-19). Indian Point Station impingement collections of Atlantic tomcod during the winter spawning season increased to a peak during the 1978-1979 survey, and declined each year following the peak until a low point was reached in 1983-1984 (Table 3-19). Not enough Atlantic tomcod were collected in impingement at Indian Point Station after the 1982-1983 survey to provide an adequate recapture effort compared to box traps, while in years prior to 1979-1980, impingement annually contributed between 57% and 100% of the recaptured fish (Table 3-19). Trawl sampling has replaced impingement as the most important source of recaptures of marked Atlantic tomcod.

Trawl sampling in the Battery region also increased the likelihood that random mixing of marked and unmarked Atlantic tomcod has occurred prior to recapture. Random mixing of recaptured fish in the box trap catch is not likely to occur because the box traps sample the near-shore areas. Fish caught and marked in the box traps have moved upriver and inshore to spawn. Recapture proportions (R/C) from trawl sampling demonstrate that most of the Atlantic tomcod marked in box traps move downriver in the channel after spawning. Therefore, the box traps would recapture a lower proportion of marked fish by under-sampling the postspawning population.

A consequence of under-sampling the postspawning Atlantic tomcod is that mark-recapture estimates of the population size based on box trap recaptures in the South region would be biased high. Petersen population estimates based on fish finclipped and released from box traps set in the North region and recaptured in the South region using box traps were an average of 4.7 times higher compared to the corresponding estimates based on trawl recaptures of postspawning fish in the Battery (NAI 1988, 1992). The potential bias in population estimates prior to 1978-1979 may not be this high because most (57%-100%) of the Atlantic tomcod recaptured in the South region came from impingement at Indian Point Station (Table 3-19), and the withdrawal zone of the Indian Point intake includes a portion of the river channel. Atlantic tomcod population estimates reported for 1974-1975 through 1979-1980 (TI 1981) were an average of 1.6 times higher than Petersen population estimates based on fish marked and released in the North region and recaptured exclusively by Indian Point impingement (NAI 1992). In 1979-1980 and subsequent years, impingement has contributed less than 19% of the Atlantic tomcod recaptured in the South region.

The Atlantic tomcod population estimates reported prior to 1982-1983 were adjusted downward in each survey using the corresponding impingement bias adjustment (NAI 1992). Based on these adjusted population estimates, the Hudson River Atlantic tomcod population has ranged in size from 0.04 to 12.7 million fish between 1974-1975 and 2004-2005 (Table 3-20). The population was highest in 1976-1977 and 1982-1983, and lowest in 2001-2002.

### 3.5.4 Trawl Catch Per Unit of Effort as an Index of Atlantic Tomcod Abundance

Trawl catch per unit of effort (CPUE) has been considered as a potential annual index of Atlantic tomcod abundance in the lower Hudson River. Trawl CPUE is a measure of C (catch) in the Petersen mark-recapture estimator that is standardized for variation in fishing effort. If C varies in constant proportion with total population size, then CPUE can be used as a reliable index of population abundance. The CPUE index of Atlantic tomcod population abundance during the 9 m trawl recapture period exhibited a similar among-year pattern to that of the population estimates calculated by the Petersen estimator, except for 1985-1986 (Figure 3-7; Appendix Table E-8). The 1985-1986 datum was considered an outlier because the trawl CPUE index was biased high due to a more southerly distribution of the Atlantic tomcod population (NAI 1992). Linear regression of the relationship between the Atlantic tomcod population estimates and the corresponding 9 m trawl CPUE index during the recapture period for 20 of the 21 surveys from 1982-1983 to present (1985-1986 excluded) had a correlation coefficient ($r^2$) of 0.890 (Figure 3-7).

Although the regression of trawl CPUE indices and Atlantic tomcod population estimates (with 1985-1986 excluded) explained 89% of the variation about the predicted line, predictions of population size based on the trawl CPUE index should be made with caution. The slope of the equation presented in Figure 3-7 is strongly influenced by one point, the high value for 1982-1983. There is a considerable gap between the 1982-1983 datum and the nearest cluster of data along the line (1989-1990, 1983-1984, and 1988-1989). The confidence interval width (precision) of the regression equation is not very different with the 1982-1983 datum ($r^2$=0.890) as without it ($r^2$=0.790). The 2004-2005 datum generally fit the pattern established by the earlier years. The Y-intercept for the regression using data through 1990-1991 was 2.239 million fish, and was significantly ($p<0.05$) greater than zero (NAI 1992). With 14 additional years of data, the intercept was 0.608 million fish (Figure 3-7) and was not significantly different from zero ($p<0.05$). Therefore, the 95% confidence bands about the regression equation now include the realistic possibility that the predicted population size is zero when the trawl CPUE index is zero. Years like 1985-1986, with an unusually high CPUE index and a southerly distribution of the Atlantic tomcod population, fall outside of the regression relationship and can only be recognized with a box trap program and a mark-recapture estimate. Thus, caution is recommended in relying on trawl CPUE to predict Atlantic tomcod population size until more empirical observations supplement the regression equation at intermediate population sizes and outliers like 1985-1986 can be reliably predicted.

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# FIGURES

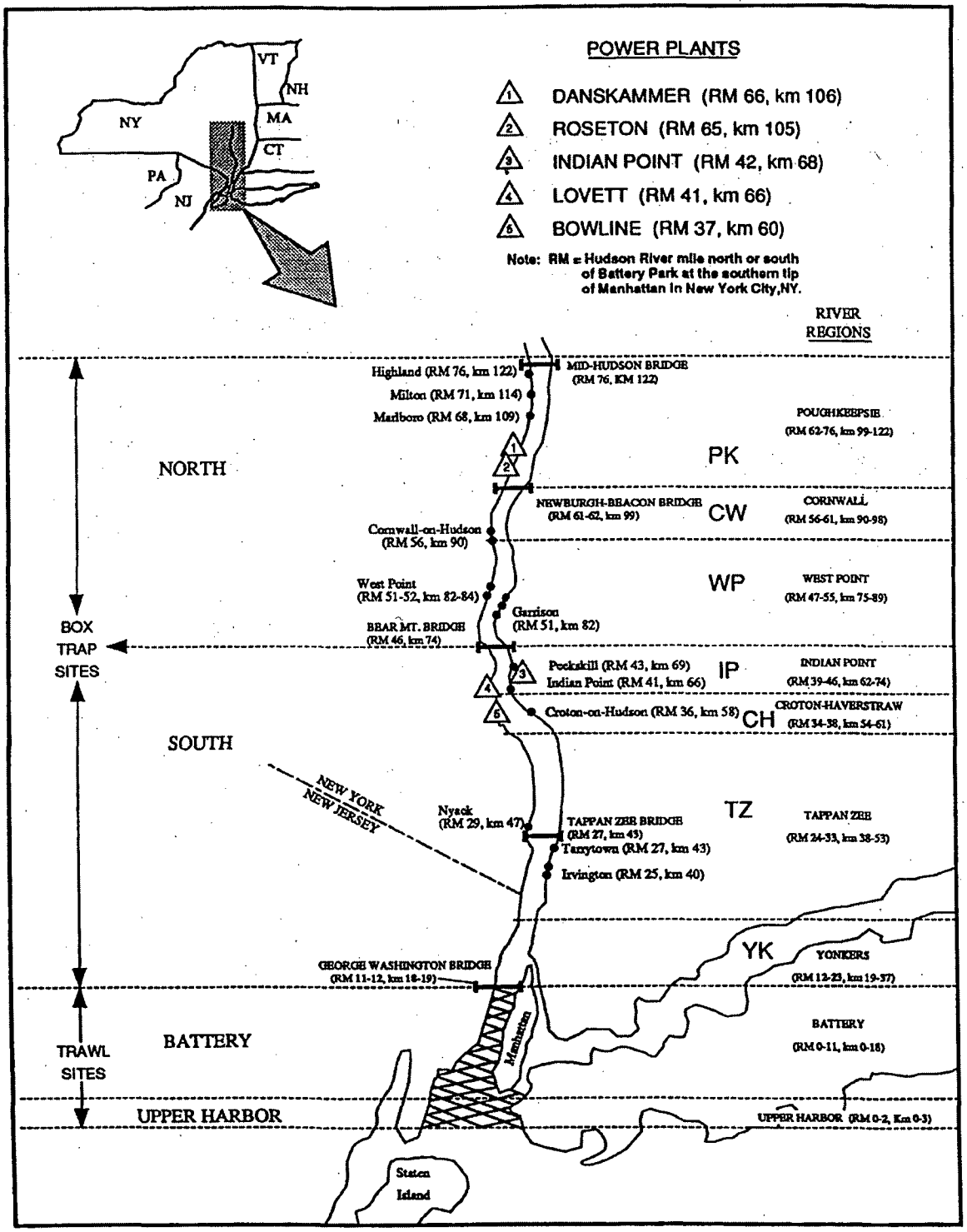



Figure 2-1. Box trap and trawl sampling sites and Hudson River regions used during the 2004-2005 Atlantic tomcod spawning survey.

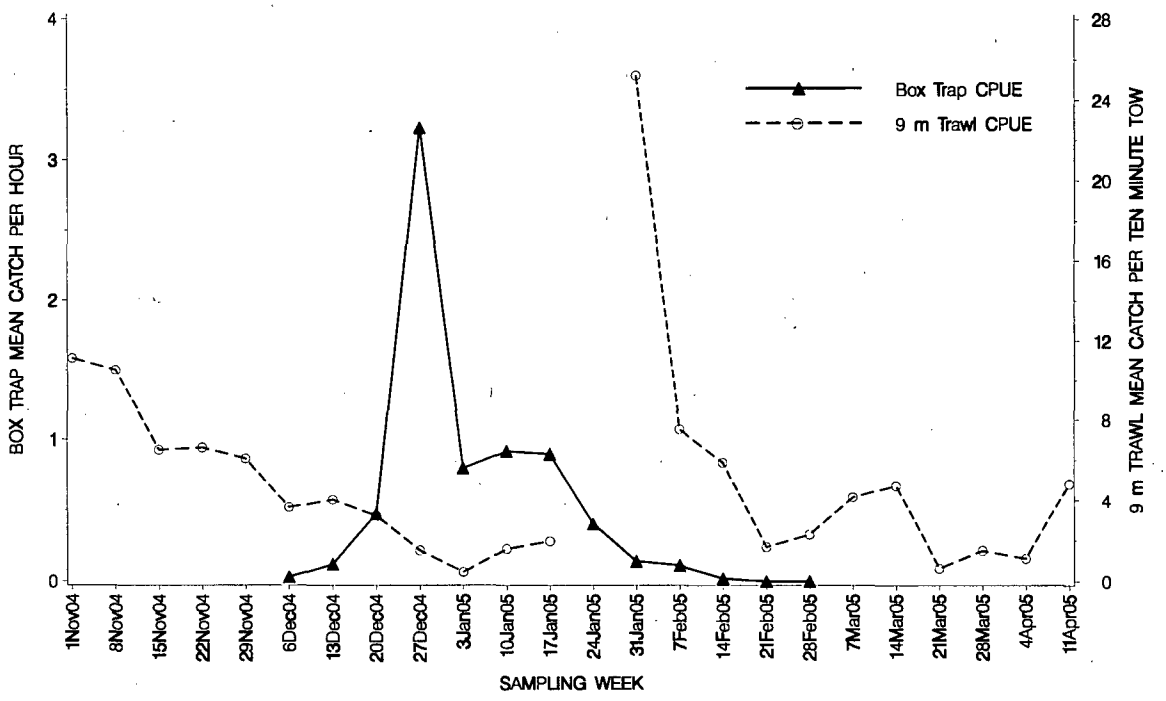



Figure 3-1. Weekly changes in Atlantic tomcod catch per unit of effort for box trap and 9 m trawl samples in the Hudson River, winter 2004-2005.

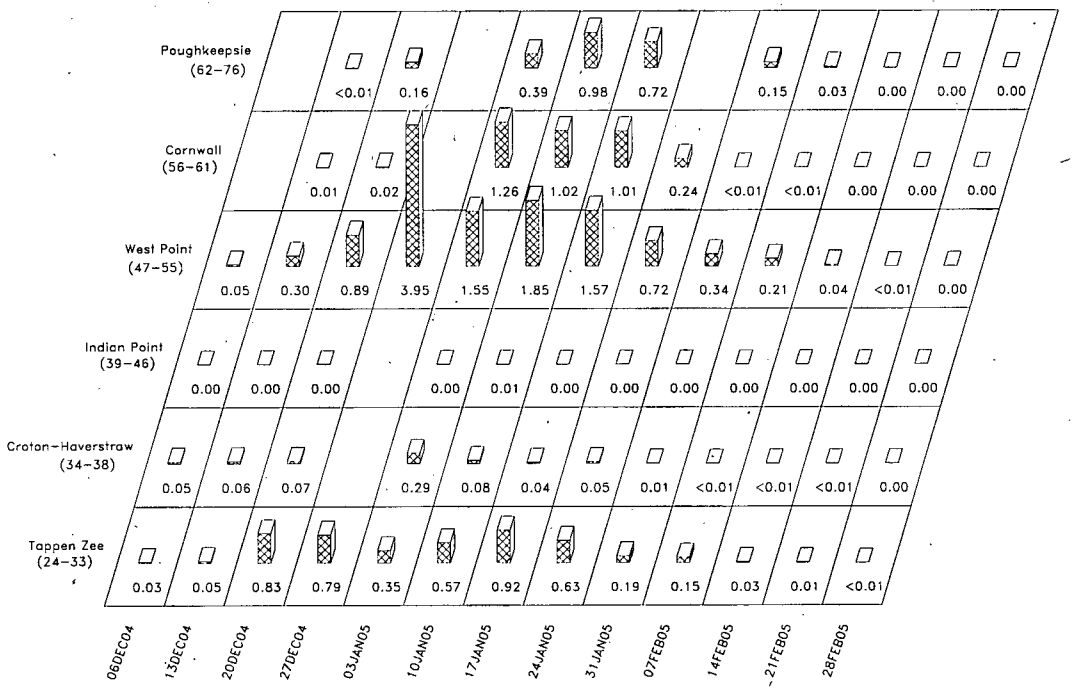



Figure 3-2. Box trap catch per hour of Atlantic tomcod in the Hudson River, winter 2004-2005.

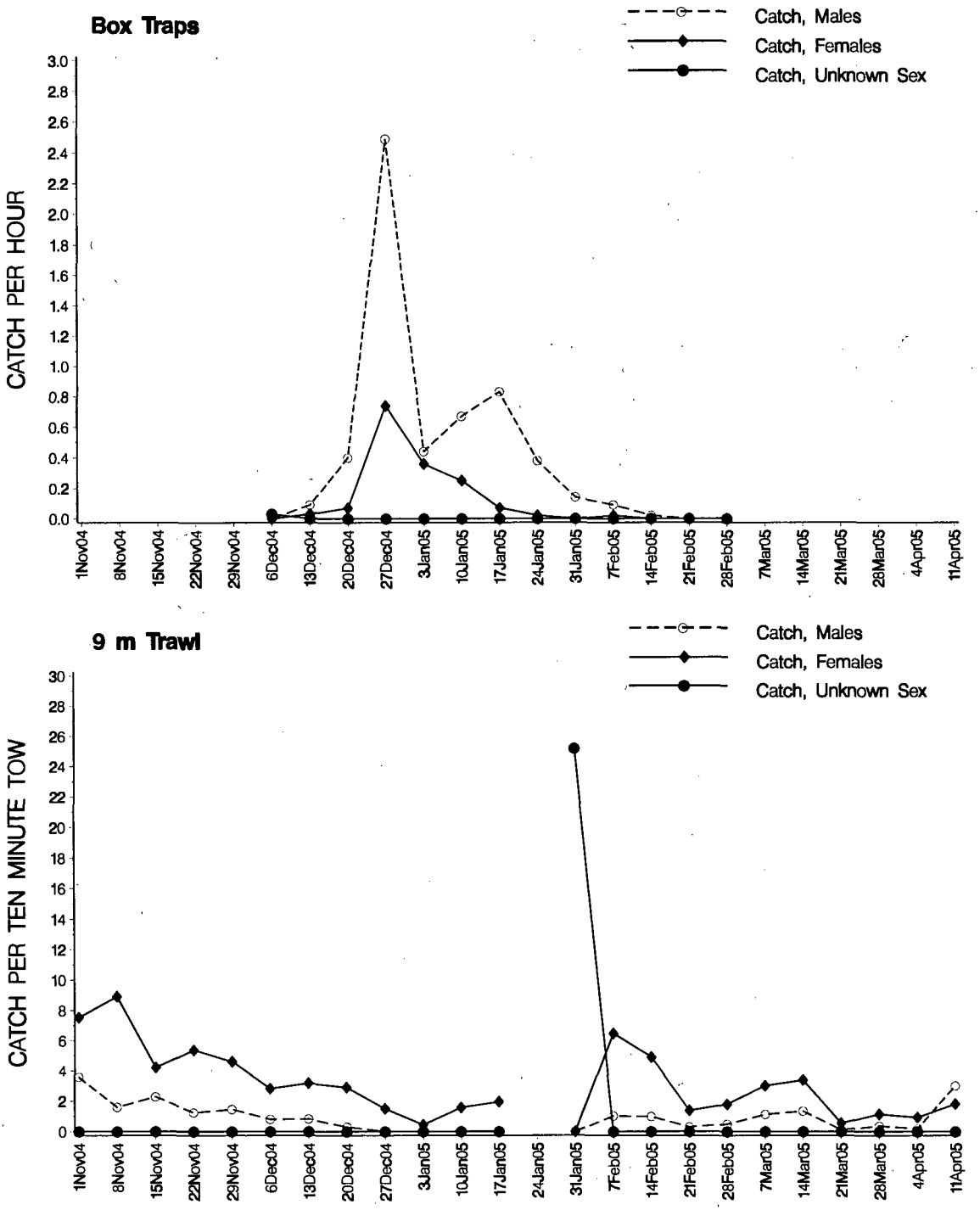



Figure 3-3. Weekly change in mean catch per unit of effort for male and female Atlantic tomcod caught by box traps or a 9 m trawl in the Hudson River, winter 2004-2005.

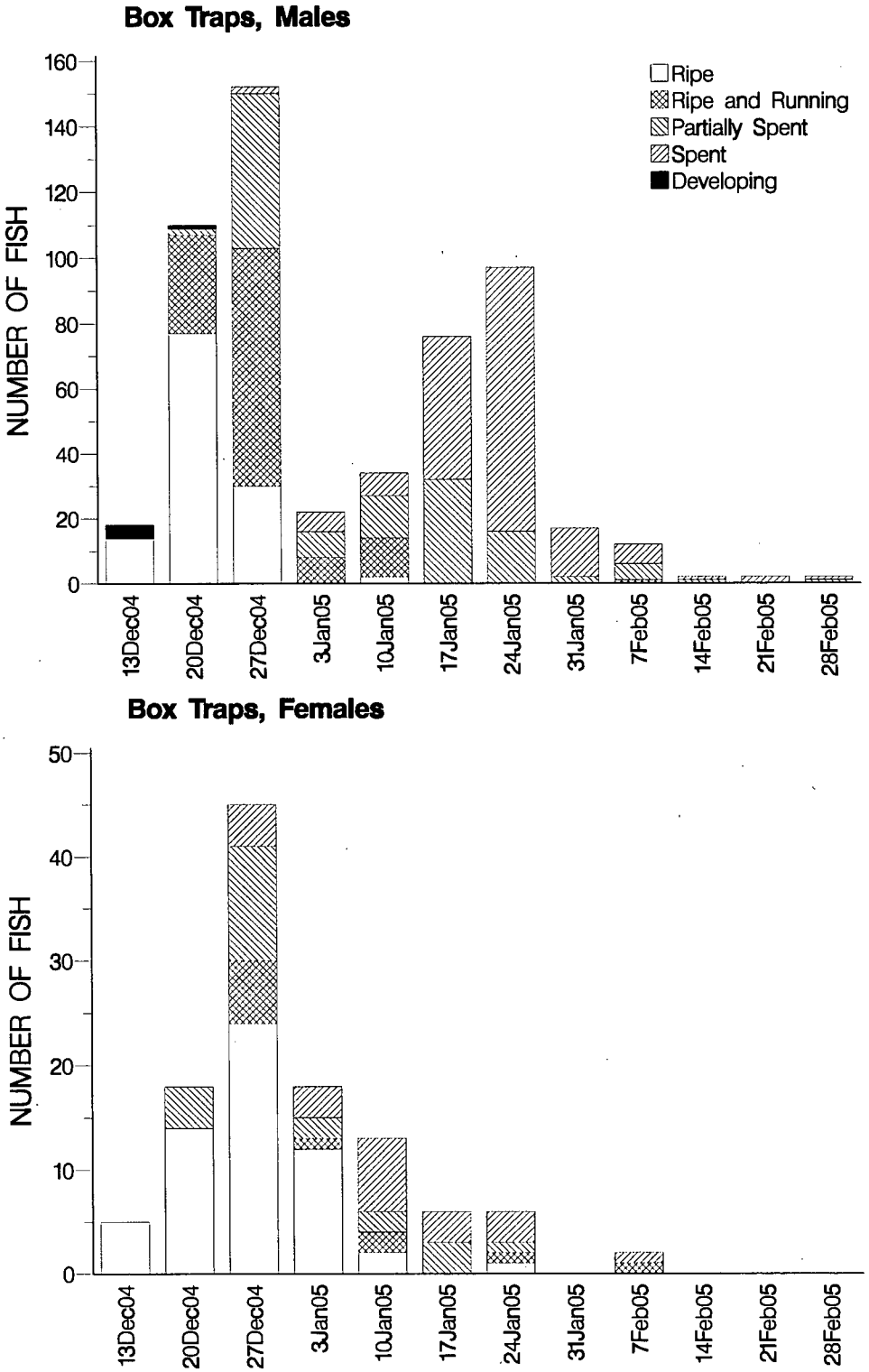



Figure 3-4. Sexual condition of male and female Atlantic tomcod in box trap biocharacteristics samples collected in the Hudson River, winter 2004-2005 (ages 1 and 2 combined).

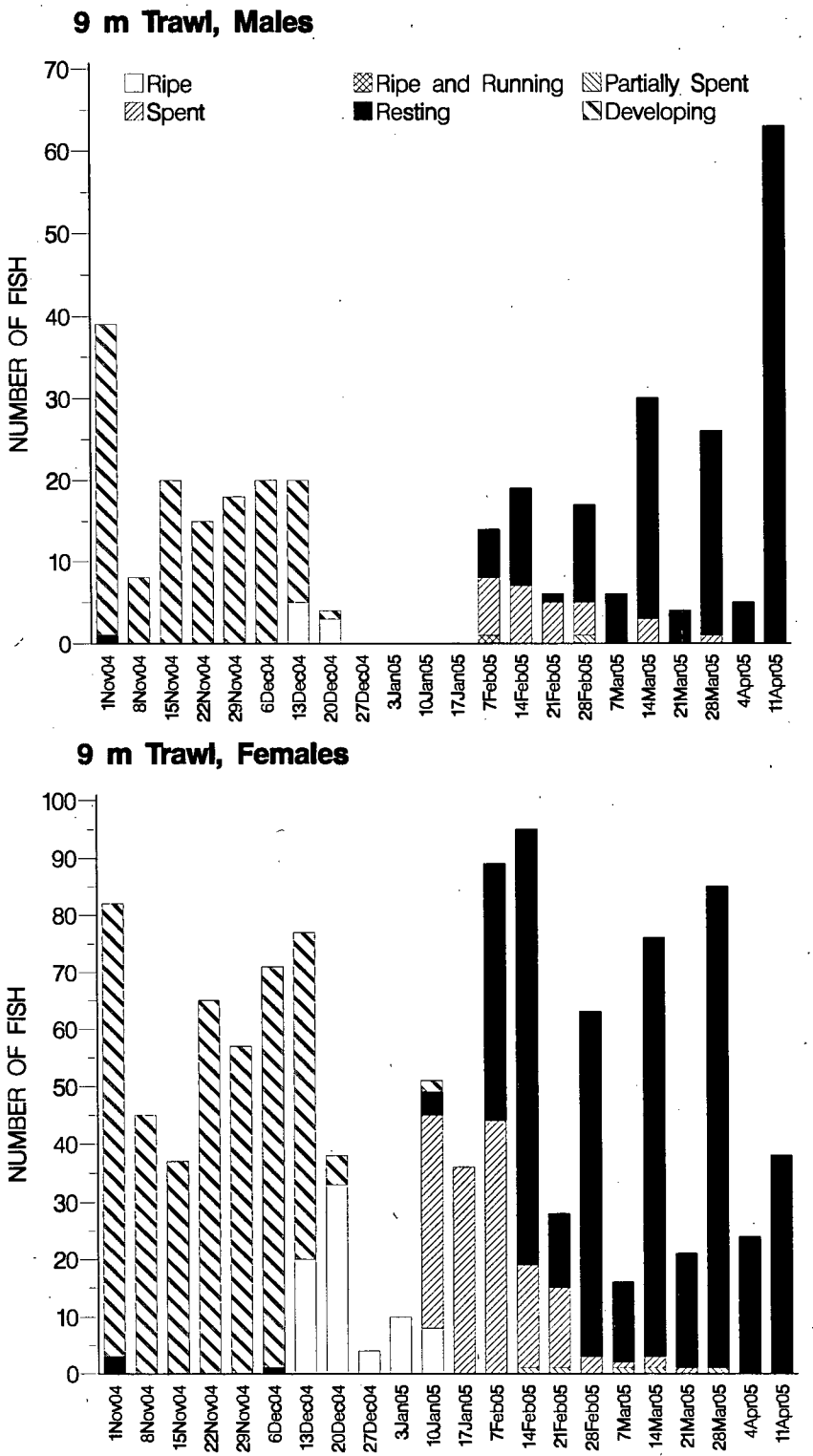



Figure 3-5. Sexual condition of male and female Atlantic tomcod in 9 m trawl biocharacteristics samples collected in the Hudson River, winter 2004-2005 (ages 1 and 2 combined).

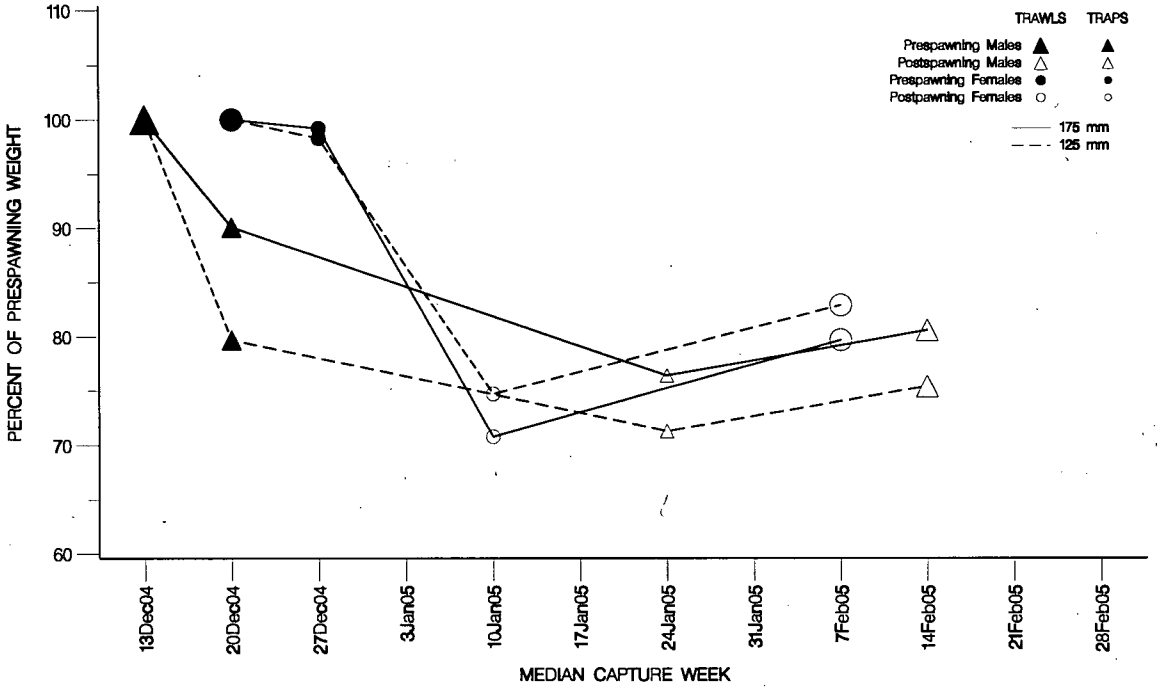



Figure 3-6. Changes in predicted weight for pre-and postspawning male and female Atlantic tomcod caught by 9 m trawls and box traps in the Hudson River, winter 2004-2005.

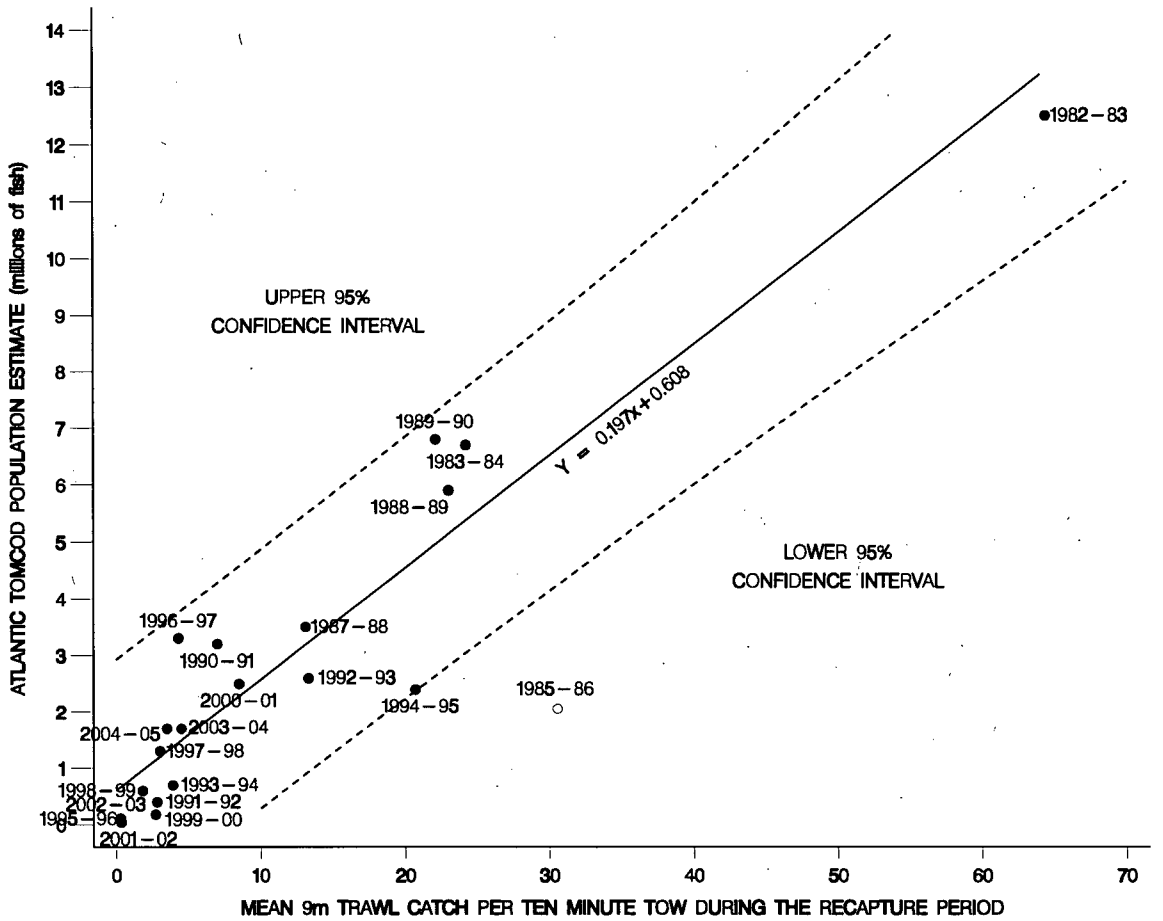



Figure 3-7. Predictive relationship between mean 9 m trawl CPUE during the recapture period and Atlantic tomcod population estimates for the 1982-1983 through 2004-2005 winter spawning surveys (1985-1986 excluded from analysis).

# TABLES

**Table 2-1. Standard Hudson River box trap sites for weekly collection of Atlantic tomcod used in biocharacteristics analysis.**

| River Mile | Kilometer | Site | Location |
|---|---|---|---|
| 27 | 43 | East | Tarrytown |
| 36 | 58 | East | Croton Yacht Club |
| 41 | 66 | East | Indian Point Hatchery |
| 51 | 82 | East | Garrison |
| 51-52 | 82-84 | West | West Point |
| 56 | 90 | West | Cornwall Yacht Club |

**Table 2-2. Atlantic tomcod sexual condition criteria.**

| Condition | Description |
|---|---|
| Immature | A specimen which is either male or female, but too young to spawn (sub-adult). Transparent or pinkish gonads, not developed. |
| Developing (Intermediate) | Applicable to sub-ripe fish heading into spawning season. Testes are opaque and reddish to reddish white. Ovaries may appear orange and eggs visible to the naked eye, granular, and whitish to orange-reddish. May or may not spawn. |
| Ripe | Adult in spawning condition; gonads well developed but no milt or eggs extruded upon application of pressure to gonadal area. Will spawn in current season. |
| Ripe and Running | Adult prepared to spawn immediately; expulsion of eggs or milt from body with little provocation. |
| Partially Spent | Sexual products partially discharged; gonads somewhat flaccid as opposed to the firmness of a developing gonad. Genital aperture usually inflamed, some hemorrhaging present. |
| Spent | Applied to adult specimens at completion of spawning activity. The sexual products have been discharged; genital aperture usually inflamed and hemorrhaging present. The gonads have the appearance of deflated sacs, the ovaries usually containing a few leftover eggs in a state of reabsorption and the testes have some residual sperm. Ovarian walls will become leathery. |
| Resting | Applies to adult fish with underdeveloped gonads. |

**Table 2-3. Atlantic tomcod length groups.**

| Length Group | Millimeter Range (Total Length) |
|---|---|
| 1 | 125 |
| 2 | 126-150 |
| 3 | 151-175 |
| 4 | 176-200 |
| 5 | 201-225 |
| 6 | 226-250 |
| 7 | 251-275 |
| 8 | 276 |

**Table 3-1. Estimated age and sex composition of Atlantic tomcod collected in the Hudson River during the spawning period, winter 2004-2005.**

| | | | Male | Female | Sexes Combined |
|---|---|---|---|---|---|
| **Box Traps** | Age 1 | Number | 11,693 | 1,651 | 13,344 |
| | | Percent | 77.6 | 11.0 | 88.6 |
| | Age 2 | Number | 780 | 940 | 1,720 |
| | | Percent | 5.2 | 6.2 | 11.4 |
| | Age 3 | Number | 0 | 0 | 0 |
| | | Percent | 0.0 | 0.0 | 0.0 |
| | **Total** | Number | 12,473 | 2,591 | 15,064 |
| | | Percent | 82.8 | 17.2 | 100.0 |
| **9 m Trawl** | Age 1 | Number | 739 | 2,124 | 2,863 |
| | | Percent | 21.3 | 61.2 | 82.5 |
| | Age 2 | Number | 65 | 544 | 609 |
| | | Percent | 1.9 | 15.7 | 17.5 |
| | Age 3 | Number | 0 | 0 | 0 |
| | | Percent | 0.0 | 0.0 | 0.0 |
| | **Total** | Number | 804 | 2,668 | 3,472 |
| | | Percent | 23.2 | 76.8 | 100.0 |
| **Box Traps and 9 m Trawl Combined** | Age 1 | Number | 12,432 | 3,775 | 16,207 |
| | | Percent | 67.1 | 20.4 | 87.4 |
| | Age 2 | Number | 845 | 1,484 | 2,329 |
| | | Percent | 4.6 | 8.0 | 12.6 |
| | Age 3 | Number | 0 | 0 | 0 |
| | | Percent | 0.0 | 0.0 | 0.0 |
| | **Total** | Number | 13,277 | 5,259 | 18,536 |
| | | Percent | 71.6 | 28.4 | 100.0 |

**Table 3-2. Predicted weight for male and female Atlantic tomcod collected in the Hudson River during the spawning season, winter 2004-2005.**

| Total Length (mm) | Predicted Weight in Grams[a] (95% Confidence Limits) | |
|---|---|---|
| | Males | Females |
| 125 | 15.9 (12.4–20.4) | 17.3 (13.5–22.0) |
| 175 | 45.3 (35.4–57.9) | 49.7 (38.9–63.4) |
| 225 | 98.9 (77.2–126.6) | 109.5 (85.8–139.8) |

[a] Predicted using the following regression equation (Appendix Table D-3): $\log_{10}$ weight = $b_0 + b_1$ ($\log_{10}$ length).

**Table 3-3. Comparison of condition between pre- and postspawning male and female Atlantic tomcod caught by 9 m trawls or box traps in the Hudson River, winter 2004-2005.**

| Sex | Gear | ANCOVA Model | | | | Reproductive Stage | |
|---|---|---|---|---|---|---|---|
| | | df | F Value | Pr>F | $r^2$ | F Value | Pr>F |
| Male | Box trap | 293 | 3,234 | <0.0001 | 0.97 | 178 | <0.0001 |
| Male | 9 m trawl | 33 | 305 | <0.0001 | 0.95 | 24 | <0.0001 |
| Female | Box trap | 93 | 1,913 | <0.0001 | 0.98 | 197 | <0.0001 |
| Female | 9 m trawl | 226 | 2,876 | <0.0001 | 0.96 | 194 | <0.0001 |

**Table 3-4. Predicted fecundity for female Atlantic tomcod collected in the Hudson River during the spawning season, winter 2004-2005.**

| Total Length (mm) | Predicted Mean Number of Eggs per Fish[a] (95% Confidence Limits) |
|---|---|
| 125 | 4,900 (3,000–8,100) |
| 175 | 14,000 (8,700–22,600) |
| 225 | 30,600 (19,000–49,400) |

[a] Predicted using the following regression equation (Appendix Table D-5):
$\log_{10}$ fecundity = $b_0 + b_1$ ($\log_{10}$ length).

**Table 3-5. Mean fecundity presented by 25-mm length group for age 1 and age 2 Atlantic tomcod collected in the Hudson River during the spawning season, winter 2004-2005.**

| | Age 1 | | | Age 2 | | |
|---|---|---|---|---|---|---|
| Length Group (mm) | Mean Fecundity | Number of Females Examined | Percent Composition[a] | Mean Fecundity | Number of Females Examined | Percent Composition[a] |
| 125 | 4,800[b] | 0 | 0.1 | | | |
| 126-150 | 7,600 | 9 | 8.0 | | | |
| 151-175 | 12,200 | 12 | 26.9 | | | |
| 176-200 | 18,300 | 13 | 45.9 | 17,500[b] | 0 | 0.4 |
| 201-225 | 23,400 | 9 | 18.8 | 15,800 | 1 | 4.2 |
| 226-250 | 36,500[b] | 0 | 0.3 | 42,100 | 4 | 21.5 |
| 251-275 | | | | 51,000 | 10 | 55.5 |
| 276 | | | | 68,600 | 5 | 18.5 |
| Weighted Mean Fecundity | 16,800 | | | 50,700 | | |

[a] Percent composition for Age 1 or Age 2 females was derived from the combined box trap and trawl biocharacteristics samples and used to weight the fecundity in each length group to calculate the mean fecundity.

[b] Estimated fecundities for Atlantic tomcod with lengths of 124 mm, 188 mm, and 238 mm were calculated from the fecundity-length regression (Appendix Table D-5) and were used in calculating weighted mean fecundity for unsampled length groups. Those are the midpoint of the 176–200 mm and 226-250 mm length groups and the mean length for females in the 125 length group.

**Table 3-6. External parasites observed on Atlantic tomcod by gear and week in the Hudson River, winter 2002-2003.**

| Gear | Week beginning Monday | No Parasites Observed | Light, 1 to 5 External Parasites | Heavy, >20 External Parasites | Not Examined for Parasites | Number of Fish Caught |
|---|---|---|---|---|---|---|
| **Small Trawl** | 14 Apr 2003 | | | | 1 | 1 |
| | **Total** | **0** | **0** | **0** | **1** | **1** |
| **Box Traps** | 9 Dec 2002 | 1 | | | | 1 |
| | 16 Dec 2002 | 6 | | | | 6 |
| | 23 Dec 2002 | 262 | 8 | | 21 | 291 |
| | 30 Dec 2002 | 242 | 3 | | 6 | 251 |
| | 6 Jan 2003 | 153 | 11 | | 1 | 165 |
| | 13 Jan 2003 | 299 | 3 | | 10 | 312 |
| | 20 Jan 2003 | 107 | 3 | | 27 | 137 |
| | 27 Jan 2003 | 31 | | | 1 | 32 |
| | 3 Feb 2003 | 12 | | | | 12 |
| | 10 Feb 2003 | 14 | | | 2 | 16 |
| | 17 Feb 2003 | 5 | | | | 5 |
| | **Total** | **1,132** | **28** | **0** | **68** | **1,228** |
| **9 m Trawl** | 11 Nov 2002 | | | | 1 | 1 |
| | 18 Nov 2002 | 1 | | | 1 | 2 |
| | 25 Nov 2003 | | | | 1 | 1 |
| | 2 Dec 2002 | 2 | | 1 | 4 | 7 |
| | 9 Dec 2002 | 2 | 1 | | | 3 |
| | 16 Dec 2002 | 2 | 1 | | 1 | 4 |
| | 23 Dec 2002 | 2 | | | | 2 |
| | 3 Feb 2003 | 3 | | | | 3 |
| | 10 Feb 2003 | | | | 3 | 3 |
| | 24 Feb 2003 | 24 | 3 | | 1 | 28 |
| | 3 Mar 2003 | 2 | | | | 2 |
| | 10 Mar 2003 | | | | 1 | 1 |
| | 17 Mar 2003 | 2 | | | | 2 |
| | 24 Mar 2003 | 34 | 3 | | 25 | 62 |
| | 31 Mar 2003 | 8 | | | 4 | 12 |
| | 14 Apr 2003 | 1 | | | | 1 |
| | **Total** | **83** | **8** | **1** | **42** | **134** |
| **All Gears** | **Total** | **1,215** | **36** | **1** | **111** | **1,363** |

**Table 3-7. External parasites observed on Atlantic tomcod by gear and week in the Hudson River, winter 2003-2004.**

| Gear | Week beginning Monday | No Parasites Observed | Light, 1 to 5 External Parasites | Moderate, 6-20 External Parasites | Heavy, >20 External Parasites | Not Examined for Parasites | Number of Fish Caught |
|---|---|---|---|---|---|---|---|
| **Box Traps** | 1 Dec 2003 | | | | | 2 | 2 |
| | 8 Dec 2003 | 15 | 2 | | | 1 | 18 |
| | 15 Dec 2003 | 243 | 18 | | | 2 | 263 |
| | 22 Dec 2003 | 1,630 | 77 | 7 | 1 | | 1,715 |
| | 29 Dec 2003 | 2,643 | 260 | 12 | 1 | 3 | 2,919 |
| | 5 Jan 2004 | 3,703 | 400 | 27 | 5 | | 4,135 |
| | 12 Jan 2004 | 1,419 | 139 | 9 | 4 | | 1,571 |
| | 19 Jan 2004 | 490 | 28 | | | | 518 |
| | 26 Jan 2004 | 151 | 5 | 2 | | | 158 |
| | 2 Feb 2004 | 13 | 1 | | | | 14 |
| | 9 Feb 2004 | 11 | 4 | | | | 15 |
| | 16 Feb 2004 | 17 | 2 | | | | 19 |
| | 23 Feb 2004 | 10 | | | | | 10 |
| | **Total** | **10,345** | **936** | **57** | **11** | **8** | **11,357** |
| **9 m Trawl** | 3 Nov 2003 | 42 | 63 | 6 | | 185 | 296 |
| | 10 Nov 2003 | 33 | 74 | 5 | | 331 | 443 |
| | 17 Nov 2003 | 59 | 219 | 9 | | 224 | 511 |
| | 24 Nov 2003 | 92 | 135 | 4 | | 3 | 234 |
| | 1 Dec 2003 | 96 | 170 | 21 | | 4 | 291 |
| | 8 Dec 2003 | 102 | 230 | 17 | | | 349 |
| | 15 Dec 2003 | 85 | 106 | 11 | | | 202 |
| | 22 Dec 2003 | 51 | 59 | 5 | 1 | | 116 |
| | 29 Dec 2003 | 15 | 14 | | | 1 | 30 |
| | 5 Jan 2004 | 8 | 1 | | | 4 | 13 |
| | 12 Jan 2004 | 80 | 14 | 1 | | | 95 |
| | 19 Jan 2004 | 209 | 44 | 1 | | 13 | 267 |
| | 2 Feb 2004 | 148 | 16 | 1 | | | 165 |
| | 9 Feb 2004 | 354 | 30 | 2 | | | 386 |
| | 16 Feb 2004 | 153 | 32 | 2 | | | 187 |
| | 23 Feb 2004 | 288 | 44 | 1 | | | 333 |
| | 1 Mar 2004 | 118 | 31 | 2 | | | 151 |
| | 8 Mar 2004 | 90 | 11 | 1 | | | 102 |
| | 15 Mar 2004 | 44 | 34 | | | 1 | 79 |
| | 22 Mar 2004 | 123 | 45 | 1 | | | 169 |
| | 29 Mar 2004 | 163 | 45 | | | | 208 |
| | 5 Apr 2004 | 140 | 56 | | | 1 | 197 |
| | 12 Apr 2004 | 98 | 38 | 3 | | | 139 |
| | **Total** | **2,591** | **1,511** | **93** | **1** | **767** | **4,963** |
| **All Gears** | **Total** | **12,936** | **2,447** | **150** | **12** | **775** | **16,320** |

**Table 3-8. External parasites observed on Atlantic tomcod by gear and week in the Hudson River, winter 2004-2005.**

| Gear | Week beginning Monday | No Parasites Observed | Light, 1 to 5 External Parasites | Moderate, 6-20 External Parasites | Heavy, >20 External Parasites | Not Examined for Parasites | Number of Fish Caught |
|---|---|---|---|---|---|---|---|
| **Box Traps** | 5 Dec 2004 | 14 | 5 | | | | 19 |
| | 12 Dec 2004 | 270 | 38 | 2 | | 1 | 311 |
| | 19 Dec 2004 | 951 | 102 | 10 | 1 | 60 | 1,124 |
| | 26 Dec 2004 | 1,692 | 445 | 91 | | 95 | 2,323 |
| | 2 Jan 2005 | 3,644 | 663 | 139 | 8 | 17 | 4,471 |
| | 9 Jan 2005 | 2,319 | 445 | 102 | 9 | 28 | 2,903 |
| | 16 Jan 2005 | 2,191 | 193 | 20 | 2 | | 2,406 |
| | 23 Jan 2005 | 682 | 55 | 4 | 1 | | 742 |
| | 30 Jan 2005 | 370 | 25 | 2 | | | 397 |
| | 6 Feb 2005 | 272 | 32 | 2 | | 2 | 308 |
| | 13 Feb 2005 | 49 | 1 | | | | 50 |
| | 20 Feb 2005 | 6 | 1 | | | | 7 |
| | 27 Feb 2005 | 1 | 1 | | | | 2 |
| | **Total** | **12,461** | **2,006** | **372** | **21** | **203** | **15,063** |
| **9 m Trawl** | 31 Oct 2004 | 186 | 197 | 23 | 3 | 2 | 411 |
| | 7 Nov 2004 | 162 | 288 | 25 | 5 | 3 | 483 |
| | 14 Nov 2004 | 50 | 137 | 6 | | 2 | 195 |
| | 21 Nov 2004 | 23 | 93 | 3 | | | 119 |
| | 28 Nov 2004 | 70 | 158 | 23 | 2 | 2 | 255 |
| | 5 Dec 2004 | 33 | 107 | 15 | 1 | | 156 |
| | 12 Dec 2004 | 59 | 109 | 15 | 2 | | 185 |
| | 19 Dec 2004 | 12 | 26 | 5 | 2 | | 45 |
| | 26 Dec 2004 | 8 | 1 | 1 | | | 10 |
| | 2 Jan 2005 | 16 | | | | | 16 |
| | 9 Jan 2005 | 35 | 21 | 4 | 1 | 1 | 62 |
| | 16 Jan 2005 | 6 | 27 | 6 | | | 39 |
| | 30 Jan 2005 | 113 | 13 | | | | 126 |
| | 6 Feb 2005 | 231 | 52 | 1 | | 1 | 285 |
| | 13 Feb 2005 | 174 | 60 | 5 | | 1 | 240 |
| | 20 Feb 2005 | 42 | 8 | | | | 50 |
| | 27 Feb 2005 | 80 | 18 | | | | 98 |
| | 6 Mar 2005 | 128 | 9 | | | | 137 |
| | 13 Mar 2005 | 163 | 15 | | | | 178 |
| | 20 Mar 2005 | 23 | 5 | | | | 28 |
| | 27 Mar 2005 | 103 | 22 | | | | 125 |
| | 3 Apr 2005 | 30 | 12 | | | | 42 |
| | 10 Apr 2005 | 175 | 13 | | | | 188 |
| | **Total** | **1,922** | **1,391** | **132** | **16** | **12** | **3,473** |
| **All Gears** | **Total** | **14,383** | **3,397** | **504** | **37** | **215** | **18,536** |

**Table 3-9. Movement of Atlantic tomcod marked and released from box traps and recaptured by trawls in the Hudson River, winter 2004-2005.**

| Sex | N[a] | Gear | | Region[b] | | Minimum Distance Moved[c] | | | | Days at Large[d] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Release | Recapture | Release | Recapture | Min | Max | Mean | ±S.E. | Min | Max | Mean | ±S.E. |
| Combined | 10 | Box Trap | Trawl | YK-PK | Battery | 10 | 51 | 40 | 4 | 26 | 112 | 58 | 9 |
| | 8 | Box Trap | Trawl | North | Battery | 43 | 51 | 46 | 1 | 26 | 112 | 61 | 11 |
| | 2 | Box Trap | Trawl | South | Battery | 17 | 18 | 18 | 1 | 39 | 50 | 45 | 6 |
| Male | 6 | Box Trap | Trawl | YK-PK | Battery | 17 | 45 | 35 | 5 | 39 | 112 | 66 | 11 |
| | 4 | Box Trap | Trawl | North | Battery | 43 | 45 | 44 | 1 | 49 | 112 | 77 | 14 |
| | 2 | Box Trap | Trawl | South | Battery | 17 | 18 | 18 | 1 | 39 | 50 | 45 | 6 |
| Female | 4 | Box Trap | Trawl | YK-PK | Battery | 43 | 51 | 48 | 2 | 26 | 84 | 45 | 13 |
| | 4 | Box Trap | Trawl | North | Battery | 43 | 51 | 48 | 2 | 26 | 84 | 45 | 13 |
| | 0 | Box Trap | Trawl | South | Battery | – | – | – | – | – | – | – | – |

[a] N = number of Atlantic tomcod recaptured.
[b] Region (Miles): Battery = RM 2-11 (km 3-18)
YK-PK = Yonkers-Poughkeepsie, RM 18-76 (km 29-122)
North = RM 51-76 (km 82-122)
South = RM 18-43 (km 29-69)
[c] Distance Moved: difference in river miles between the release location and the trawl recapture river mile.
[d] Days at Large: Number of days between the mark date and the recapture date.

**Table 3-10. Recaptured Atlantic tomcod cross-classified by release and recapture region in the Hudson River estuary, winter 2004-2005.**

| Recapture Region | Number Examined for Marks (C) | Statistic | Recaptured Atlantic Tomcod from Release Region | | | |
|---|---|---|---|---|---|---|
| | | | North M=10,415 | South M=3.031 | Battery M=1,655 | Total M=15,101 |
| North (km 75-122; RM 47-76) | 11,562 | R | 165 | 0 | 4 | 169 |
| | | R/M | 0.01584 | 0.00000 | 0.00242 | 0.01119 |
| | | R/C | 0.01427 | 0.00000 | 0.00035 | 0.01462 |
| South (km 19-74; RM 12-46) | 3,501 | R | 10 | 35 | 1 | 46 |
| | | R/M | 0.00096 | 0.01155 | 0.00060 | 0.00305 |
| | | R/C | 0.00286 | 0.01000 | 0.00029 | 0.01314 |
| Battery (km 0-18; RM 1-11)[a] | 2,010[b] | R | 8 | 2 | 66 | 76 |
| | | R/M | 0.00077 | 0.00066 | 0.03988 | 0.00503 |
| | | R/C | 0.00398 | 0.00100 | 0.01900 | 0.03781 |
| **Total** | **17,073** | **R** | **183** | **37** | **71** | **291** |
| | | **R/M** | **0.01757** | **0.01221** | **0.04290** | **0.01927** |
| | | **R/C** | **0.01072** | **0.00217** | **0.00416** | **0.01704** |

R = number of marked Atlantic tomcod recaptured from the 2004-2005 program.
M = number of fish marked and released, adjusted for handling mortality as follows: box traps, 10.0% prior to 1 January and 2.5% on and after 1 January.
C = number of fish examined for marks. Box traps were used in North and South regions. In the Battery, trawl sampling was used to capture fish.
R/M = recapture rate.
R/C = recapture proportion.
[a] Battery region in this table includes trawls in the Upper Harbor, up to 4 miles south of Battery Park.
[b] Excludes catch in weeks before tagging began in box traps, except for the Battery Release Region column (C=3,473 for that column only).

**Table 3-11. Recaptured Atlantic tomcod cross-classified by release and recapture period for fish marked and released from box traps north of Yonkers and recaptured in a 9 m trawl south of the George Washington Bridge in the Hudson River, winter 2004-2005.**

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec-13 Dec M = 268 | 20 Dec M = 891 | 27 Dec-M = 1,856 | 3 Jan M = 4,246 | 10 Jan M = 2,701 | 17 Jan M = 2,205 | 24 Jan M = 593 | 31 Jan M = 360 | 7 Feb M = 277 | 14 Feb-21 Feb M = 49 | Total M = 13,446 |
| 6-13 Dec | 341 | R | 0 | | | | | | | | | | 0 |
| | | R/M | 0.00000 | | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | | | | | | | | | | 0.00000 |
| 20 Dec | 45 | R | 0 | 0 | | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| 27 Dec | 10 | R | 0 | 0 | 0 | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| 3 Jan | 16 | R | 0 | 0 | 0 | 0 | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| 10 Jan | 62 | R | 0 | 0 | 0 | 0 | 0 | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| 17 Jan | 39 | R | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | 0.00000 |
| 24 Jan | 0 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | 0.00000 |
| | | R/C | | | | | | | | | | | |
| 31 Jan | 126 | R | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00054 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | 0.00008 |
| | | R/C | 0.00000 | 0.00000 | 0.00794 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | 0.00794 |
| 7 Feb | 285 | R | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | | 3 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00047 | 0.00037 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00022 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00702 | 0.00351 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.01053 |

(continued)

## Table 3-11. (Continued)

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec-13 Dec M = 268 | 20 Dec M = 891 | 27 Dec M = 1,856 | 3 Jan M = 4,246 | 10 Jan M = 2,701 | 17 Jan M = 2,205 | 24 Jan M = 593 | 31 Jan M = 360 | 7 Feb M = 277 | 14 Feb-21 Feb M = 49 | Total M = 13,446 |
| 14 Feb | 240 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 21 Feb | 50 | R | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00024 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00007 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.02000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.02000 |
| 28 Feb | 98 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 7 Mar | 137 | R | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00045 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00007 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00730 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00730 |
| 14 Mar | 178 | R | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00037 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00007 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00562 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00562 |
| 21 Mar | 28 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 28 Mar | 125 | R | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00024 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00007 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00800 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00800 |
| 4 Apr | 42 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 11 Apr | 188 | R | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| | | R/M | 0.00000 | 0.00112 | 0.00000 | 0.00000 | 0.00000 | 0.00045 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00015 |
| | | R/C | 0.00000 | 0.00532 | 0.00000 | 0.00000 | 0.00000 | 0.00532 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.01064 |
| **Total** | **2,010** | **R** | **0** | **1** | **1** | **4** | **2** | **2** | **0** | **0** | **0** | **0** | **10** |
| | | **R/M** | **0.00000** | **0.00112** | **0.00054** | **0.00094** | **0.00074** | **0.00091** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00074** |
| | | **R/C** | **0.00000** | **0.00050** | **0.00050** | **0.00199** | **0.00100** | **0.00100** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00498** |

M = number of fish tagged and released from box traps north of Yonkers, adjusted for handling mortality of 10.0% prior to 1 January, and 2.5% on and after 1 January.
C = number of fish caught and examined for tags from a 9 m trawl in the Battery region.
R = number of Atlantic tomcod tagged and released from box traps north of Yonkers and recaptured from a 9 m trawl in the Battery region.
R/M = recapture rate.
R/C = recapture proportion.

**Table 3-12. Mark-recapture statistics and spawning population estimate for Atlantic tomcod in the Hudson River, winter 2004-2005.**

| Statistics[a] | Sampling Gear | Dates | Spawning Estimate (Trap-Trawl) |
|---|---|---|---|
| Number Marked (M) | Box Traps | 20 Dec – 30 Jan | 12,492 |
| Number Examined (C) | Trawls | 31 Jan – 17 Apr | 1,497 |
| Number Recaptured (R) | Trawls | 31 Jan – 17 Apr | 10 |
| Recapture Rate (R/M) | | | 0.00080 |
| Recapture Proportion (R/C) | | | 0.00668 |
| Petersen Population Estimate | | | 1,700,000 |
| Upper 95% Confidence Limit | | | 3,300,000 |
| Lower 95% Confidence Limit | | | 960,000 |

[a] Statistics:
R = number of marked Atlantic tomcod recaptured.
M = number of fish marked and released, adjusted for handling mortality.
C = number of fish caught and examined for marks.

**Table 3-13. Estimated age and sex composition of Atlantic tomcod collected in the Hudson River, winters of 1983-1984 through 2004-2005.**

| | | | 1983-1984[b] | | | 1985-1986[c] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 19,909 | 10,761 | 30,670 | 7,785 | 7,573 | 15,358 |
| | | Percent | 56.6 | 30.6 | 87.2 | 47.6 | 46.2 | 93.8 |
| | Age 2 | Number[a] | 3,020 | 1,477 | 4,497 | 513 | 496 | 1,009 |
| | | Percent | 8.6 | 4.2 | 12.8 | 3.1 | 3.1 | 6.2 |
| | **Total** | Number[a] | 22,929 | 12,238 | 35,167 | 8,298 | 8,069 | 16,367 |
| | | Percent | 65.2 | 34.8 | 100.0 | 50.7 | 49.3 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 1,575 | 3,790 | 5,365 | 5,918 | 22,211 | 28,129 |
| | | Percent | 26.5 | 63.9 | 90.4 | 20.2 | 76.0 | 96.2 |
| | Age 2 | Number[a] | 193 | 375 | 568 | 259 | 852 | 1,111 |
| | | Percent | 3.3 | 6.3 | 9.6 | 0.9 | 2.9 | 3.8 |
| | **Total** | Number[a] | 1,768 | 4,165 | 5,933 | 6,177 | 23,063 | 29,240 |
| | | Percent | 29.8 | 70.2 | 100.0 | 21.1 | 78.9 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 21,484 | 14,551 | 36,035 | 13,703 | 29,784 | 43,487 |
| | | Percent | 52.3 | 35.4 | 87.7 | 30.0 | 65.3 | 95.3 |
| | Age 2 | Number[a] | 3,213 | 1,852 | 5,065 | 772 | 1,348 | 2,120 |
| | | Percent | 7.8 | 4.5 | 12.3 | 1.7 | 3.0 | 4.7 |
| | **Total** | Number[a] | 24,697 | 16,403 | 41,100 | 14,475 | 31,132 | 45,607 |
| | | Percent | 60.1 | 39.9 | 100.0 | 31.7 | 68.3 | 100.0 |

| | | | 1987-1988[d] | | | 1988-1989[e] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 7,883 | 5,745 | 13,628 | 33,119 | 15,547 | 48,666 |
| | | Percent | 51.7 | 37.7 | 89.4 | 60.7 | 28.5 | 89.2 |
| | Age 2 | Number[a] | 340 | 1,288 | 1,628 | 3,564 | 2,343 | 5,907 |
| | | Percent | 2.2 | 8.4 | 10.6 | 6.5 | 4.3 | 10.8 |
| | **Total** | Number[a] | 8,223 | 7,033 | 15,256 | 36,683 | 17,890 | 54,573 |
| | | Percent | 53.9 | 46.1 | 100.0 | 67.2 | 32.8 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 3,499 | 8,008 | 11,507 | 3,071 | 22,806 | 25,877 |
| | | Percent | 26.7 | 61.1 | 87.8 | 11.0 | 81.6 | 92.6 |
| | Age 2 | Number[a] | 220 | 1,383 | 1,603 | 142 | 1,932 | 2,074 |
| | | Percent | 1.7 | 10.5 | 12.2 | 0.5 | 6.9 | 7.4 |
| | **Total** | Number[a] | 3,719 | 9,391 | 13,110 | 3,213 | 24,738 | 27,951 |
| | | Percent | 28.4 | 71.6 | 100.0 | 11.5 | 88.5 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 11,382 | 13,753 | 25,135 | 36,190 | 38,353 | 74,543 |
| | | Percent | 40.0 | 48.6 | 88.6 | 43.9 | 46.5 | 90.3 |
| | Age 2 | Number[a] | 560 | 2,671 | 3,231 | 3,706 | 4,275 | 7,981 |
| | | Percent | 2.0 | 9.4 | 11.4 | 4.5 | 5.2 | 9.7 |
| | **Total** | Number[a] | 11,942 | 16,424 | 28,366 | 39,896 | 42,628 | 82,524 |
| | | Percent | 42.0 | 58.0 | 100.0 | 48.3 | 51.7 | 100.0 |

(continued)

**Table 3-13. (Continued)**

| | | | 1989-1990[f] | | | 1990-1991[g] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 17,985 | 9,480 | 27,465 | 16,354 | 6,046 | 22,400 |
| | | Percent | 50.2 | 26.5 | 76.7 | 63.4 | 23.4 | 86.8 |
| | Age 2 | Number[a] | 4,046 | 4,317 | 8,363 | 1,676 | 1,739 | 3,415 |
| | | Percent | 11.3 | 12.0 | 23.3 | 6.5 | 6.7 | 13.2 |
| | **Total** | Number[a] | 22,031 | 13,797 | 35,828 | 18,030 | 7,785 | 25,815 |
| | | Percent | 61.5 | 38.5 | 100.0 | 69.8 | 30.2 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 5,349 | 13,646 | 18,995 | 1,184 | 5,122 | 6,306 |
| | | Percent | 21.6 | 55.0 | 76.6 | 16.3 | 70.3 | 86.6 |
| | Age 2 | Number[a] | 898 | 4,920 | 5,818 | 98 | 880 | 978 |
| | | Percent | 3.6 | 19.8 | 23.4 | 1.3 | 12.1 | 13.4 |
| | **Total** | Number[a] | 6,247 | 18,566 | 24,813 | 1,282 | 6,002 | 7,284 |
| | | Percent | 25.2 | 74.8 | 100.0 | 17.6 | 82.4 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 23,334 | 23,126 | 46,460 | 17,538 | 11,168 | 28,706 |
| | | Percent | 38.5 | 38.1 | 76.6 | 53.0 | 33.7 | 86.7 |
| | Age 2 | Number[a] | 4,944 | 9,237 | 14,181 | 1,774 | 2,619 | 4,393 |
| | | Percent | 8.2 | 15.2 | 23.4 | 5.4 | 7.9 | 13.3 |
| | **Total** | Number[a] | 28,278 | 32,363 | 60,641 | 19,312 | 13,787 | 33,099 |
| | | Percent | 46.6 | 53.4 | 100.0 | 58.3 | 41.7 | 100.0 |

| | | | 1991-1992[h] | | | 1992-1993[i] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 2,995 | 1,276 | 4,271 | 17,479 | 7,669 | 25,148 |
| | | Percent | 54.3 | 23.1 | 77.4 | 64.7 | 28.4 | 93.1 |
| | Age 2 | Number[a] | 570 | 676 | 1,246 | 490 | 1,367 | 1,857 |
| | | Percent | 10.3 | 12.2 | 22.6 | 1.8 | 5.1 | 6.9 |
| | **Total** | Number[a] | 3,565 | 1,952 | 5,517 | 17,969 | 9,036 | 27,005 |
| | | Percent | 64.6 | 35.4 | 100.0 | 66.5 | 33.5 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 413 | 1,383 | 1,796 | 2,524 | 7,480 | 10,004 |
| | | Percent | 18.7 | 62.6 | 81.3 | 22.2 | 65.8 | 88.0 |
| | Age 2 | Number[a] | 29 | 385 | 414 | 41 | 1,318 | 1,359 |
| | | Percent | 1.3 | 17.4 | 18.7 | 0.4 | 11.6 | 12.0 |
| | **Total** | Number[a] | 442 | 1,768 | 2,210 | 2,565 | 8,798 | 11,363 |
| | | Percent | 20.0 | 80.0 | 100.0 | 22.6 | 77.4 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 3,408 | 2,659 | 6,067 | 20,003 | 15,149 | 35,152 |
| | | Percent | 44.1 | 34.4 | 78.5 | 52.1 | 39.5 | 91.6 |
| | Age 2 | Number[a] | 599 | 1,061 | 1,660 | 531 | 2,685 | 3,216 |
| | | Percent | 7.8 | 13.7 | 21.5 | 1.4 | 7.0 | 8.4 |
| | **Total** | Number[a] | 4,007 | 3,720 | 7,727 | 20,534 | 17,834 | 38,368 |
| | | Percent | 51.8 | 48.1 | 100.0 | 53.5 | 46.5 | 100.0 |

(continued)

**Table 3-13. (Continued)**

| | | | 1993-1994[j] | | | 1994-1995[k] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 7,138 | 1,985 | 9,123 | 5,482 | 3,633 | 9,115 |
| | | Percent | 66.7 | 18.5 | 85.2 | 55.5 | 36.8 | 92.3 |
| | Age 2 | Number[a] | 667 | 920 | 1,587 | 431 | 326 | 1,757 |
| | | Percent | 6.2 | 8.6 | 14.8 | 4.4 | 33.0 | 76.7 |
| | **Total** | Number[a] | 7,805 | 2,905 | 10,710 | 5,913 | 3,959 | 9,872 |
| | | Percent | 72.9 | 27.1 | 100.0 | 59.9 | 40.1 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 440 | 1,150 | 1,590 | 910 | 4,173 | 5,083 |
| | | Percent | 18.8 | 49.1 | 67.9 | 16.3 | 74.8 | 91.1 |
| | Age 2 | Number[a] | 68 | 684 | 752 | 20 | 479 | 499 |
| | | Percent | 2.9 | 29.2 | 32.1 | 0.4 | 8.6 | 8.9 |
| | **Total** | Number[a] | 508 | 1,834 | 2,342 | 930 | 4,652 | 5,582 |
| | | Percent | 21.7 | 78.3 | 100.0 | 16.7 | 83.3 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 7,578 | 3,135 | 10,713 | 6,392 | 7,806 | 14,198 |
| | | Percent | 58.1 | 24.0 | 82.1 | 41.4 | 50.5 | 91.9 |
| | Age 2 | Number[a] | 735 | 1,604 | 2,339 | 451 | 805 | 1,256 |
| | | Percent | 5.6 | 12.3 | 17.9 | 2.9 | 5.2 | 8.1 |
| | **Total** | Number[a] | 8,313 | 4,739 | 13,052 | 6,843 | 8,611 | 15,454 |
| | | Percent | 63.7 | 36.3 | 100.0 | 44.3 | 55.7 | 100.0 |

| | | | 1995-1996[l] | | | 1996-1997[m] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 971 | 501 | 1,472 | 6,256 | 2,094 | 8,350 |
| | | Percent | 41.6 | 21.5 | 63.1 | 70.5 | 23.6 | 94.0 |
| | Age 2 | Number[a] | 300 | 562 | 862 | 270 | 257 | 527 |
| | | Percent | 12.9 | 24.1 | 36.9 | 3.0 | 2.9 | 6.0 |
| | **Total** | Number[a] | 1,271 | 1,063 | 2,334 | 6,526 | 2,351 | 8,877 |
| | | Percent | 54.5 | 45.5 | 100.0 | 73.5 | 26.5 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 43 | 73 | 116 | 525 | 2,962 | 3,487 |
| | | Percent | 23.4 | 39.6 | 63.0 | 10.9 | 61.7 | 72.7 |
| | Age 2 | Number[a] | 15 | 53 | 68 | 305 | 1,005 | 1,310 |
| | | Percent | 8.2 | 28.8 | 37.0 | 6.3 | 21.0 | 27.3 |
| | **Total** | Number[a] | 58 | 126 | 184 | 830 | 3,967 | 4,797 |
| | | Percent | 31.5 | 68.5 | 100.0 | 17.3 | 82.7 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 1,014 | 574 | 1,588 | 6,781 | 5,056 | 11,837 |
| | | Percent | 40.3 | 22.8 | 63.1 | 49.6 | 37.0 | 86.6 |
| | Age 2 | Number[a] | 315 | 615 | 930 | 575 | 1,262 | 1,837 |
| | | Percent | 12.5 | 24.4 | 36.9 | 4.2 | 9.2 | 13.4 |
| | **Total** | Number[a] | 1,329 | 1,189 | 2,518 | 7,356 | 6,318 | 13,674 |
| | | Percent | 52.8 | 47.2 | 100.0 | 53.8 | 46.2 | 100.0 |

(continued)

**Table 3-13. (Continued)**

| | | | 1997-1998[n] | | | 1998-1999[o] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 8,535 | 2,684 | 11,219 | 2,987 | 751 | 3,738 |
| | | Percent | 56.2 | 17.7 | 73.9 | 65.4 | 16.4 | 81.8 |
| | Age 2 | Number[a] | 1,217 | 2,746 | 3,963 | 288 | 543 | 831 |
| | | Percent | 8.0 | 18.1 | 26.1 | 6.3 | 11.9 | 18.2 |
| | **Total** | Number[a] | 9,752 | 5,430 | 15,182 | 3,275 | 1,294 | 4,569 |
| | | Percent | 64.2 | 35.8 | 100.0 | 71.7 | 28.3 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 534 | 1,443 | 1,977 | 168 | 708 | 876 |
| | | Percent | 18.7 | 50.4 | 69.1 | 15.6 | 65.9 | 81.6 |
| | Age 2 | Number[a] | 48 | 838 | 886 | 3 | 195 | 198 |
| | | Percent | 1.7 | 29.3 | 30.9 | 0.3 | 18.2 | 18.4 |
| | **Total** | Number[a] | 582 | 2,281 | 2,863 | 171 | 903 | 1,074 |
| | | Percent | 20.3 | 79.7 | 100.0 | 15.9 | 84.1 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 9,069 | 4,127 | 13,196 | 3,155 | 1,459 | 4,614 |
| | | Percent | 50.3 | 22.9 | 73.1 | 55.9 | 25.9 | 81.8 |
| | Age 2 | Number[a] | 1,265 | 3,584 | 4,849 | 291 | 738 | 1,029 |
| | | Percent | 7.0 | 19.9 | 26.9 | 5.2 | 13.1 | 18.2 |
| | **Total** | Number[a] | 10,334 | 7,711 | 18,045 | 3,446 | 2,197 | 5,643 |
| | | Percent | 57.3 | 42.7 | 100.0 | 61.1 | 38.9 | 100.0 |

| | | | 1999-2000[p] | | | 2000-2001[q] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 1,054 | 367 | 1,421 | 9,061 | 2,529 | 11,590 |
| | | Percent | 61.4 | 21.4 | 82.8 | 76.3 | 21.3 | 97.6 |
| | Age 2 | Number[a] | 80 | 215 | 295 | 81 | 203 | 284 |
| | | Percent | 4.7 | 12.5 | 17.2 | 0.7 | 1.7 | 2.4 |
| | **Total** | Number[a] | 1,134 | 582 | 1,716 | 9,142 | 2,732 | 11,874 |
| | | Percent | 66.1 | 33.9 | 100.0 | 77.0 | 23.0 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 311 | 737 | 1,048 | 1,146 | 3,114 | 4,260 |
| | | Percent | 28.1 | 66.6 | 94.8 | 25.7 | 69.8 | 95.5 |
| | Age 2 | Number[a] | 5 | 53 | 58 | 10 | 190 | 200 |
| | | Percent | 0.5 | 4.8 | 5.2 | 0.2 | 4.3 | 4.5 |
| | **Total** | Number[a] | 316 | 790 | 1,106 | 1,156 | 3,304 | 4,460 |
| | | Percent | 28.6 | 71.4 | 100.0 | 25.9 | 74.1 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 1,365 | 1,104 | 2,469 | 10,207 | 5,643 | 15,850 |
| | | Percent | 48.4 | 39.1 | 87.5 | 62.5 | 34.5 | 97.0 |
| | Age 2 | Number[a] | 85 | 268 | 353 | 91 | 393 | 484 |
| | | Percent | 3.0 | 9.5 | 12.5 | 0.6 | 2.4 | 3.0 |
| | **Total** | Number[a] | 1,450 | 1,372 | 2,822 | 10,298 | 6,036 | 16,334 |
| | | Percent | 51.4 | 48.6 | 100.0 | 63.0 | 37.0 | 100.0 |

(continued)

**Table 3-13. (Continued)**

| | | | 2001-2002[r] | | | 2002-2003[s] | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 164 | 205 | 369 | 971 | 233 | 1,204 |
| | | Percent | 40.0 | 50.0 | 90.0 | 79.1 | 19.0 | 98.0 |
| | Age 2 | Number[a] | 16 | 25 | 41 | 8 | 16 | 24 |
| | | Percent | 3.9 | 6.1 | 10.0 | 0.7 | 1.3 | 2.0 |
| | **Total** | Number[a] | 180 | 230 | 410 | 979 | 249 | 1,228 |
| | | Percent | 43.9 | 56.1 | 100.0 | 79.7 | 20.3 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 32 | 72 | 104 | 45 | 87 | 132 |
| | | Percent | 23.0 | 51.8 | 74.8 | 33.8 | 65.4 | 99.2 |
| | Age 2 | Number[a] | 2 | 33 | 35 | 0 | 1 | 1 |
| | | Percent | 1.4 | 23.7 | 25.2 | 0.0 | 0.8 | 0.8 |
| | **Total** | Number[a] | 34 | 105 | 139 | 45 | 88 | 133 |
| | | Percent | 24.5 | 75.5 | 100.0 | 33.8 | 66.2 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 196 | 277 | 473 | 1,016 | 320 | 1,336 |
| | | Percent | 35.7 | 50.5 | 86.2 | 74.7 | 23.5 | 98.2 |
| | Age 2 | Number[a] | 18 | 58 | 76 | 8 | 17 | 25 |
| | | Percent | 3.3 | 10.6 | 13.8 | 0.6 | 1.2 | 1.8 |
| | **Total** | Number[a] | 214 | 335 | 549 | 1,024 | 337 | 1,361 |
| | | Percent | 39.0 | 61.0 | 100.0 | 75.2 | 24.8 | 100.0 |

| | | | 2003-2004[t] | | | 2004-2005 | | |
|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Sexes Combined | Male | Female | Sexes Combined |
| Box Traps | Age 1 | Number[a] | 7,768 | 3,228 | 10,996 | 11,693 | 1,651 | 13,344 |
| | | Percent | 68.4 | 28.4 | 96.8 | 77.6 | 11.0 | 88.6 |
| | Age 2 | Number[a] | 98 | 262 | 360 | 780 | 940 | 1,720 |
| | | Percent | 0.9 | 2.3 | 3.2 | 5.2 | 6.2 | 11.4 |
| | **Total** | Number[a] | 7,866 | 3,490 | 11,356 | 12,473 | 2,591 | 15,064 |
| | | Percent | 69.3 | 30.7 | 100.0 | 82.8 | 17.2 | 100.0 |
| 9 m Trawl | Age 1 | Number[a] | 1,137 | 3,726 | 4,863 | 739 | 2,124 | 2,863 |
| | | Percent | 22.9 | 75.1 | 98.0 | 21.3 | 61.2 | 82.5 |
| | Age 2 | Number[a] | 8 | 92 | 100 | 65 | 544 | 609 |
| | | Percent | 0.2 | 1.9 | 2.0 | 1.9 | 15.7 | 17.5 |
| | **Total** | Number[a] | 1,145 | 3,818 | 4,963 | 804 | 2,668 | 3,472 |
| | | Percent | 23.1 | 76.9 | 100.0 | 23.2 | 76.8 | 100.0 |
| Box Traps and Trawl Combined | Age 1 | Number[a] | 8,905 | 6,954 | 15,859 | 12,432 | 3,775 | 16,207 |
| | | Percent | 54.6 | 42.6 | 97.2 | 67.1 | 20.4 | 87.4 |
| | Age 2 | Number[a] | 106 | 354 | 460 | 845 | 1,484 | 2,329 |
| | | Percent | 0.6 | 2.2 | 2.8 | 4.6 | 8.0 | 12.6 |
| | **Total** | Number[a] | 9,011 | 7,308 | 16,319 | 13,277 | 5,259 | 18,536 |
| | | Percent | 55.2 | 44.8 | 100.0 | 71.6 | 28.4 | 100.0 |

[a] Number = estimated number caught, excluding Age 3 fish.
[b] NAI 1984b
[c] NAI 1987
[d] NAI 1988
[e] NAI 1990
[f] NAI 1991
[g] NAI 1992
[h] NAI 1994a
[i] NAI 1994b
[j] NAI 1995
[k] LMS 1999a
[l] LMS 1999b
[m] LMS 1999c
[n] NAI 1998a
[o] NAI 2000
[p] NAI 2006a
[q] NAI 2006b
[r] NAI 2006c
[s] NAI 2006d
[t] NAI 2006c

**Table 3-14. Estimated population size and proportions for male and female Atlantic tomcod in the Hudson River based on sex-specific Petersen estimates, winters of 1983-1984 through 2004-2005.**

| Spawning Survey | Atlantic Tomcod Population Size with 95% Confidence Limits in Millions | | | | | | | | | Proportion of Males | Proportion of Females |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | | Females | | | Total[a] | | | | |
| | Lower | Estimate | Upper | Lower | Estimate | Upper | Lower[b] | Estimate | Upper[b] | | |
| 1983-1984 | 1.32 | 2.16 | 3.72 | 2.10 | 3.70 | 7.13 | 3.42 | 5.86 | 10.85 | 0.37 | 0.63 |
| 1985-1986 | 0.48 | 0.61 | 0.79 | 1.08 | 1.33 | 1.64 | 1.56 | 1.94 | 2.43 | 0.31 | 0.69 |
| 1987-1988 | 0.79 | 1.29 | 2.22 | 1.31 | 1.95 | 3.03 | 2.10 | 3.24 | 5.25 | 0.40 | 0.60 |
| 1988-1989 | 1.53 | 2.12 | 3.01 | 1.65 | 2.03 | 2.50 | 3.18 | 4.15 | 5.51 | 0.51 | 0.49 |
| 1989-1990 | 1.54 | 2.38 | 3.87 | 2.44 | 4.31 | 8.32 | 3.98 | 6.69 | 12.19 | 0.36 | 0.64 |
| 1990-1991 | 0.44 | 0.77 | 1.49 | 0.98 | 1.58 | 2.70 | 1.42 | 2.35 | 4.19 | 0.33 | 0.67 |
| 1991-1992 | 0.06 | 0.11 | 0.23 | 0.10 | 0.17 | 0.31 | 0.16 | 0.28 | 0.54 | 0.41 | 0.59 |
| 1992-1993 | 0.67 | 0.93 | 1.33 | 0.92 | 1.31 | 1.95 | 1.59 | 2.24 | 3.28 | 0.41 | 0.59 |
| 1993-1994 | 0.17 | 0.36 | 0.83 | 0.11 | 0.19 | 0.36 | 0.28 | 0.55 | 1.19 | 0.65 | 0.35 |
| 1994-1995 | 0.26 | 0.54 | 1.25 | 0.65 | 1.31 | 2.84 | 1.07 | 1.85 | 3.47 | 0.29 | 0.71 |
| 1995-1996 | 0.01[c] | 0.04[c] | 0.07[c] | 0.01[c] | 0.05[c] | 0.09[c] | 0.03 | 0.09 | 0.16 | 0.45[c] | 0.55[c] |
| 1996-1997 | 0.22 | 0.71 | 1.29 | 0.28 | 0.92 | 1.67 | 0.50 | 1.63 | 2.96 | 0.44 | 0.56 |
| 1997-1998 | 0.22 | 0.46 | 1.05 | 0.34 | 0.59 | 1.10 | 0.56 | 1.05 | 2.15 | 0.44 | 0.56 |
| 1998-1999 | 0.04 | 0.14 | 0.25 | 0.06 | 0.16 | 0.39 | 0.10 | 0.29 | 0.64 | 0.47 | 0.53 |
| 1999-2000 | 0.02 | 0.05 | 0.14 | 0.03 | 0.06 | 0.16 | 0.05 | 0.12 | 0.30 | 0.46 | 0.54 |
| 2000-2001 | 0.46 | 0.81 | 1.56 | 0.46 | 1.04 | 2.59 | 0.92 | 1.84 | 4.15 | 0.44 | 0.56 |
| 2001-2002 | <0.01 | <0.01 | —[d] | <0.01 | 0.02 | —[d] | <0.01 | 0.02 | —[d] | 0.22 | 0.78 |
| 2002-2003 | 0.01 | 0.03 | —[d] | <0.01 | 0.02 | —[d] | 0.01 | 0.05 | —[d] | 0.60 | 0.40 |
| 2003-2004 | 0.20 | 0.37 | 0.76 | 0.46 | 0.96 | 2.22 | 0.65 | 1.34 | 2.98 | 0.28 | 0.72 |
| 2004-2005 | 0.24 | 0.48 | 1.06 | 0.34 | 0.77 | 1.92 | 0.58 | 1.25 | 2.98 | 0.39 | 0.61 |

[a] Total population estimates were based on the sum of independent male and female Petersen population estimates.

[b] The upper and lower 95% confidence limits about the total are based on the sum of independent male and female Petersen population estimates, and should be slightly wider than presented.

[c] Estimated directly from proportion of male and female Atlantic tomcod collected in combined trawl and box trap samples. Sex-specific Petersen estimates not calculated.

[d] A meaningful upper confidence limit could not be calculated because there were fewer than two recaptures.

**Table 3-15. Predicted weight for male and female Atlantic tomcod collected in the Hudson River during the spawning season, winters of 1980-1981 through 2004-2005.**

| Year[a] | Total Length (mm) | Predicted Weight In Grams (95% Confidence Limits)[b] | |
|---|---|---|---|
| | | Males | Females |
| 1980-1981 | 125 | 14.8 | 16.5 |
| | 175 | 44.4 | 49.4 |
| | 225 | 101.0 | 112.0 |
| 1981-1982 | 125 | 14.4 | 16.6 |
| | 175 | 42.3 | 49.7 |
| | 225 | 94.5 | 112.7 |
| 1982-1983 | 125 | 13.4 | 16.5 |
| | 175 | 38.4 | 48.0 |
| | 225 | 84.3 | 106.5 |
| 1983-1984 | 125 | 14.3 (11.2- 18.1) | 16.2 (11.7- 22.5) |
| | 175 | 41.2 (32.4- 52.3) | 46.8 (33.8- 64.9) |
| | 225 | 90.8 (71.5-115.4) | 103.3 (74.5-143.2) |
| 1985-1986 | 125 | 15.0 ( 9.2- 24.3) | 16.6 (10.1- 27.6) |
| | 175 | 43.4 (26.2- 72.0) | 49.2 (29.2- 82.8) |
| | 225 | 96.2 (57.0-162.1) | 110.6 (64.9-188.5) |
| 1987-1988 | 125 | 14.4 (10.9- 19.1) | 15.1 (11.1- 20.7) |
| | 175 | 41.5 (31.3- 55.1) | 47.0 (34.3- 64.2) |
| | 225 | 91.5 (69.0-121.4) | 109.4 (79.9-149.6) |
| 1988-1989 | 125 | 14.4 (11.3- 18.3) | 15.6 (11.9- 20.3) |
| | 175 | 40.8 (31.9- 52.4) | 45.3 (34.3- 59.7) |
| | 225 | 89.0 (69.1-115.0) | 100.7 (75.8-133.6) |
| 1989-1990 | 125 | 15.6 (12.0- 20.1) | 16.4 (12.2- 21.9) |
| | 175 | 43.5 (33.7- 56.3) | 47.2 (35.3- 63.2) |
| | 225 | 93.8 (72.6-121.3) | 104.3 (77.9-139.6) |
| 1990-1991 | 125 | 14.6 (11.3- 18.8) | 16.8 (12.4- 22.7) |
| | 175 | 43.7 (33.8- 56.5) | 49.9 (37.0- 67.4) |
| | 225 | 99.4 (76.9-128.4) | 112.7 (83.5-152.0) |
| 1991-1992 | 125 | 14.5 (11.1- 18.9) | 16.4 (12.6- 21.5) |
| | 175 | 43.2 (33.2- 56.2) | 49.9 (38.2- 65.1) |
| | 225 | 97.6 (75.0-127.0) | 114.3 (87.6-149.2) |
| 1992-1993 | 125 | 14.6 (11.3- 18.8) | 16.6 (12.4- 22.3) |
| | 175 | 41.3 (32.1- 53.1) | 47.0 (35.1- 62.9) |
| | 225 | 89.7 (69.7-115.4) | 102.0 (76.1-136.6) |
| 1993-1994 | 125 | 14.8 (11.6- 18.9) | 16.3 (12.0- 22.3) |
| | 175 | 42.4 (33.3- 54.0) | 48.0 (35.2- 65.4) |
| | 225 | 93.0 (73.0-118.5) | 107.4 (78.8-146.4) |
| 1994-1995 | 125 | 13.7 (11.4-18.2) | 15.4 (10.9-21.8) |
| | 175 | 40.5 (28.7-45.6) | 45.9 (32.5-64.8) |
| | 225 | 91.0 (72.1-114.7) | 103.7 (72.4-144.4) |
| 1995-1996 | 125 | 15.9 (15.1-16.8) | 19.0 (17.6-20.5) |
| | 175 | 45.1 (44.3-45.9) | 54.1 (52.1-56.1) |
| | 225 | 98.2 (95.4-101.0) | 118.1 (115.6-120.6) |
| 1996-1997 | 125 | 15.7 (15.4-16.0) | 18.0 (17.7-18.2) |
| | 175 | 42.6 (42.1-43.2) | 50.6 (50.3-50.9) |
| | 225 | 90.1 (87.8-92.4) | 109.6 (108.7-110.5) |
| 1997-1998 | 125 | 15.5 (11.3-21.4) | 16.4 (12.1-22.1) |
| | 175 | 42.6 (30.9-58.6) | 48.0 (35.5-64.9) |
| | 225 | 90.3 (65.5-124.4) | 107.2 (79.3-144.8) |

(continued)

**Table 3-15. (Continued)**

| Year[a] | Total Length (mm) | Predicted Weight In Grams (95% Confidence Limits)[b] | |
|---|---|---|---|
| | | Males | Females |
| 1998-1999 | 125 | 14.3 (10.0-20.5) | 17.2 (12.6-23.4) |
| | 175 | 41.1 (28.8 (58.5) | 50.0 (36.8-67.8) |
| | 225 | 90.1 (63.1-128.7) | 110.9 (81.7-150.5) |
| 1999-2000 | 125 | 16.7 (12.5-22.4) | 19.7 (14.3-27.3) |
| | 175 | 44.7 (33.7-59.4) | 54.0 (39.3-74.1) |
| | 225 | 93.1 (70.0-123.9) | 114.4 (83.4-157.0) |
| 2000-2001 | 125 | 14.6 (11.4-18.6) | 16.5 (12.3-22.2) |
| | 175 | 42.5 (33.2-54.3) | 48.4 (36.0-65.0) |
| | 225 | 94.5 (73.9-120.8) | 107.8 (80.1-145.0) |
| 2001-2002 | 125 | 16.1 (12.1-21.6) | 18.2 (13.7-24.2) |
| | 175 | 46.9 (36.4-60.4) | 54.4 (41.4-71.4) |
| | 225 | 103.9 (80.4-134.3) | 123.3 (94.2-161.3) |
| 2002-2003 | 125 | 12.9 (10.2-16.4) | 18.5 (12.7-27.0) |
| | 175 | 39.9 (31.7-50.0) | 50.7 (35.9-71.7) |
| | 225 | 92.5 (73.2-116.7) | 107.8 (76.5-152.1) |
| 2004-2005 | 125 | 16.7 (12.8-21.8) | 17.4 (13.4-22.7) |
| | 175 | 43.7 (33.5-57.1) | 49.7 (38.3-64.5) |
| | 225 | 89.9 (68.8-117.4) | 108.5 (83.6-140.9) |
| 2004-2005 | 125 | 15.9 (12.4-20.4) | 17.3 (13.5-22.0) |
| | 175 | 45.3 (35.4-57.9) | 49.7 (38.9-63.4) |
| | 225 | 98.9 (77.2-126.6) | 109.5 (85.8-139.8) |

[a] Surveys were not conducted in 1984-1985 or 1986-1987

[b] Data sources (confidence limits not reported for earlier years):

1980-1981: EA (1983)
1981-1982: EA (1983)
1982-1983: NAI (1984a)
1983-1984: NAI (1984b)
1985-1986: NAI (1987)
1987-1988: NAI (1988)
1988-1989: NAI (1990)
1989-1990: NAI (1991)
1990-1991: NAI (1992)
1991-1992: NAI (1994a)
1992-1993: NAI (1994b)
1993-1994: NAI (1995)
1994-1995: LMS (1999a)
1995-1996: LMS (1999b)
1996-1997: LMS (1999c)
1997-1998: NAI (1998a)
1998-1999: NAI (2000)
1999-2000: NAI (2006a)
2000-2001: NAI (2006b)
2001-2002: NAI (2006c)
2002-2003: NAI (2006d)
2003-2004: NAI (2006e)

**Table 3-16. Predicted fecundity for female Atlantic tomcod collected in the Hudson River during the spawning season, winters of 1980-1981 through 2004-2005.**

| Year[a] | Total Length (mm) | Predicted Mean Number of Eggs per Fish (95% Confidence Limits)[b] |
|---|---|---|
| 1980-1981 | 125 | 6,200 |
| | 175 | 7,000 |
| | 225 | 36,200 |
| 1981-1982 | 125 | 4,000 |
| | 175 | 11,500 |
| | 225 | 25,100 |
| 1982-1983 | 125 | 4,100 |
| | 175 | 12,100 |
| | 225 | 27,400 |
| 1983-1984 | 125 | 5,200 ( 3,600-7,600) |
| | 175 | 14,900 (10,200-21,700) |
| | 225 | 32,600 (22,300-47,000) |
| 1985-1986 | 125 | 4,900 ( 1,200-24,200) |
| | 175 | 14,400 ( 3,300-74,300) |
| | 225 | 32,000 ( 7,100-171,800) |
| 1987-1988 | 125 | 4,800 ( 3,100-7,500) |
| | 175 | 15,400 ( 9,900-23,900) |
| | 225 | 36,900 (24,100-58,100) |
| 1988-1989 | 125 | 4,100 ( 400-40,600) |
| | 175 | 12,000 ( 1,100-127,900) |
| | 225 | 27,000 ( 2,400-301,400) |
| 1989-1990 | 125 | 5,100 ( 2,300-11,200) |
| | 175 | 13,400 ( 6,200-29,000) |
| | 225 | 27,500 (12,700-59,400) |
| 1990-1991 | 125 | 5,200 ( 2,800-9,500) |
| | 175 | 14,800 ( 8,200-27,000) |
| | 225 | 32,600 (17,900-59,400) |
| 1991-1992 | 125 | 4,300 ( 2,300-8,000) |
| | 175 | 13,400 ( 8,000-23,800) |
| | 225 | 31,200 (17,700-54,800) |
| 1992-1993 | 125 | 4,800 ( 3,000-7,600) |
| | 175 | 13,600 ( 8,600-21,600) |
| | 225 | 29,800 (18,800-47,300) |
| 1993-1994 | 125 | 4,500 ( 2,900-7,200) |
| | 175 | 14,200 ( 9,100-22,400) |
| | 225 | 33,500 (21,300-52,700) |
| 1994-1995 | 125 | 4,400 ( 2,600-7,400) |
| | 175 | 12,800 ( 7,700-21,100) |
| | 225 | 28,200 (16,800-46,000) |
| 1995-1996 | 125 | 4,900 ( 3,900-6,400) |
| | 175 | 15,000 (13,300-17,100) |
| | 225 | 34,600 (32,300-37,200) |
| 1996-1997 | 125 | 4,900 ( 4,200-5,700) |
| | 175 | 14,200 (13,200-15,300) |
| | 225 | 31,400 (29,000-34,000) |

(continued)

**Table 3-16. (Continued)**

| Year[a] | Total Length (mm) | Predicted Mean Number of Eggs per Fish (95% Confidence Limits)[b] |
|---|---|---|
| 1997-1998 | 125 | 5,700 ( 3,800-8,500) |
| | 175 | 15,000 (10,100-22,400) |
| | 225 | 31,000 (20,800-46,200) |
| 1998-1999 | 125 | 4,500 ( 2,500-8,100) |
| | 175 | 14,000 ( 8,000-24,300) |
| | 225 | 32,700 (18,900-56,600) |
| 1999-2000 | 125 | 2,400 (1,000-5,600) |
| | 175 | 9,500 (4,500-20,200) |
| | 225 | 27,100 (13,200-55,500) |
| 2000-2001 | 125 | 4,300 (1,800-10,300) |
| | 175 | 13,500 (5,800-31,600) |
| | 225 | 31,600 (13,400-74,200) |
| 2001-2002 | 125 | 4,900 (2,900-8,200) |
| | 175 | 14,400 (9,100-22,600) |
| | 225 | 32,200 (20,700-50,100) |
| 2002-2003 | 125 | 4,100 (2,100-8,300) |
| | 175 | 14,100 (8,300-23,900) |
| | 225 | 35,400 (20,700-60,400) |
| 2003-2004 | 125 | 4,800 (3,100-7,600) |
| | 175 | 14,300 (9,300-22,100) |
| | 225 | 32,400 (21,000-49,800) |
| 2004-2005 | 125 | 4,900 (3,000-8,100) |
| | 175 | 14,000 (8,700-22,600) |
| | 225 | 30,600 (19,000-49,400) |

[a] Surveys were not conducted in 1984-1985 or 1986-1987

[b] Data sources (confidence limits not reported for earlier years):

1980-1981: EA (1983)
1981-1982: EA (1983)
1982-1983: NAI (1984a)
1983-1984: NAI (1984b)
1985-1986: NAI (1987)
1987-1988: NAI (1988)
1988-1989: NAI (1990)
1989-1990: NAI (1991)
1990-1991: NAI (1992)
1991-1992: NAI (1994a)
1992-1993: NAI (1994b)
1993-1994: NAI (1995)
1994-1995: LMS (1999a)
1995-1996: LMS (1999b)
1996-1997: LMS (1999c)
1997-1998: NAI (1998a)
1998-1999: NAI (2000)
1999-2000: NAI (2006a)
2000-2001: NAI (2006b)
2001-2002: NAI (2006c)
2002-2003: NAI (2006d)
2003-2004: NAI (2006e)

**Table 3-17. Estimated population egg deposition for age 1 and age 2 Atlantic tomcod in the Hudson River, winters of 1983-1984 through 2004-2005.**

| Spawning Survey | Atlantic Tomcod Population Size (Millions)[a] | Proportion Females[b] | Age 1 | | | Age 2 | | | Population Egg Deposition (Billions)[f] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Proportion Age 1[c] | Weighted Mean Fecundity[d] | Egg Deposition (Billions)[e] | Proportion Age 2[c] | Weighted Mean Fecundity[d] | Egg Deposition (Billions)[e] | |
| 1983-1984 | 6.7 | 0.63 | 0.887 | 14,100 | 53 | 0.113 | 46,100 | 22 | 75 |
| 1985-1986 | 2.1 | 0.69 | 0.957 | 16,700 | 23 | 0.043 | 37,900 | 2 | 25 |
| 1987-1988 | 3.5 | 0.60 | 0.837 | 16,200 | 28 | 0.163 | 44,600 | 15 | 43 |
| 1988-1989 | 5.9 | 0.49 | 0.900 | 12,400 | 32 | 0.100 | 32,500 | 9 | 41 |
| 1989-1990 | 6.8 | 0.64 | 0.715 | 14,700 | 46 | 0.285 | 33,400 | 41 | 87 |
| 1990-1991 | 3.2 | 0.67 | 0.810 | 18,600 | 32 | 0.190 | 48,100 | 20 | 52 |
| 1991-1992 | 0.4 | 0.59 | 0.715 | 22,500 | 4 | 0.285 | 53,100 | 3 | 7 |
| 1992-1993 | 2.6 | 0.59 | 0.849 | 14,200 | 18 | 0.151 | 52,700 | 12 | 30 |
| 1993-1994 | 0.7 | 0.35 | 0.662 | 15,800 | 3 | 0.338 | 50,500 | 4 | 7 |
| 1994-1995 | 2.4 | 0.71 | 0.907 | 16,200 | 25 | 0.093 | 38,000 | 6 | 31 |
| 1995-1996 | 0.09 | 0.55[g] | 0.483 | 24,000 | 0.6 | 0.517 | 62,600 | 1.6 | 2 |
| 1996-1997 | 3.3 | 0.56 | 0.800 | 19,600 | 30 | 0.200 | 45,400 | 17 | 47 |
| 1997-1998 | 1.3 | 0.56 | 0.535 | 16,400 | 6 | 0.465 | 51,100 | 17 | 23 |
| 1998-1999 | 0.6 | 0.53 | 0.664 | 18,900 | 4 | 0.336 | 60,600 | 6 | 10 |
| 1999-2000 | 0.2 | 0.54 | 0.805 | 21,700 | 2 | 0.195 | 74,800 | 1 | 3 |
| 2000-2001 | 2.5 | 0.56 | 0.935 | 15,800 | 21 | 0.065 | 80,900 | 7 | 28 |
| 2001-2002 | 0.041 | 0.78 | 0.827 | 26,000 | 0.7 | 0.173 | 76,600 | 0.4 | 1 |
| 2002-2003 | 0.11 | 0.40 | 0.950 | 25,100 | 1 | 0.050 | 82,800 | 0.2 | 1 |
| 2003-2004 | 1.7 | 0.72 | 0.952 | 21,200 | 24 | 0.048 | 69,000 | 4 | 28 |
| 2004-2005 | 1.7 | 0.61 | 0.718 | 16,800 | 13 | 0.282 | 50,700 | 15 | 27 |

[a] Petersen estimate of the spawning population from fish marked and released in box traps and recaptured in trawls.

[b] From the proportion of separate Petersen estimates of male and female subpopulations using the same release and recapture periods and gear as was used for Footnote [a]

[c] From laboratory biocharacteristics data for females, pooled across all weeks in the sampling season and across box traps and trawls, excluding Age 3 fish.

[d] Mean fecundity by 25 mm length group within each age weighted by the total number of fish caught in each 25 mm length group, box traps and trawls combined.

[e] Egg Deposition = population size x proportion females x proportion Age 1 or 2 x weighted mean fecundity.

[f] Population Egg Deposition = Age 1 egg deposition + Age 2 egg deposition.

[g] Estimated directly from proportion of male and female Atlantic tomcod collected in trawl and box trap samples combined.

**Table 3-18. Maximum weekly mean Atlantic tomcod catch per hour (C/H) and salinity observed during the weeks of peak spawning activity in the North and South Hudson River box trap regions, 1982-1983 through 2004-2005.**

| Survey | Weeks of Peak Spawning | Depth | Maximum Weekly Mean Salinity (ppt) in Region | | Maximum Weekly Mean C/H in Region | | |
|---|---|---|---|---|---|---|---|
| | | | North | South | North | South | Ratio North/South |
| 1982-1983 | 3 Jan–24 Jan | Surface<br>Bottom[a] | 1.2<br>1.5 | 6.4<br>8.1 | 4.3 | 4.0 | 1.1 |
| 1983-1984 | 19 Dec–9 Jan | Surface<br>Bottom[a] | 0.1<br>0.1 | 3.6<br>4.6 | 6.2 | 4.8 | 1.3 |
| 1985-1986 | 23 Dec–13 Jan | Surface<br>Bottom[a] | 1.1<br>1.4 | 11.1<br>14.0 | 4.2 | 4.5 | 0.9 |
| 1987-1988 | 21 Dec–4 Jan | Surface<br>Bottom[a] | 0.4<br>0.5 | 9.5<br>12.0 | 3.3 | 0.8 | 4.1 |
| 1988-1989 | 19 Dec–9 Jan | Surface<br>Bottom | 2.3<br>3.3 | 9.4<br>12.9 | 14.7 | 2.6 | 5.7 |
| 1989-1990 | 18 Dec–8 Jan | Surface<br>Bottom | 4.9<br>5.8 | 10.5<br>13.1 | 13.0 | 1.5 | 8.7 |
| 1990-1991 | 31 Dec–14 Jan | Surface<br>Bottom | 1.6<br>2.0 | 8.4<br>9.2 | 5.0 | 1.4 | 3.6 |
| 1991-1992 | 23 Dec–30 Dec | Surface<br>Bottom | 0.4<br>0.4 | 8.5<br>9.1 | 1.7 | 0.5 | 3.4 |
| 1992-1993 | 28 Dec–4 Jan | Surface<br>Bottom | 0.1<br>0.1 | 7.2<br>7.3 | 6.2 | 0.6 | 10.3 |
| 1993-1994 | 27 Dec–3 Jan | Surface<br>Bottom | 0.1<br>0.2 | 5.2<br>6.0 | 6.2 | 3.0 | 2.0 |
| 1994-1995 | 2Jan–9 Jan | Surface<br>Bottom | 0.1<br>0.1 | 2.3<br>2.4 | 3.8 | 0.9 | 4.2 |
| 1995-1996 | 25 Dec–8 Jan | Surface<br>Bottom | 0.4<br>0.4 | 4.3<br>4.4 | 2.8 | 0.1 | 25.4 |
| 1996-1997 | 6 Jan–13 Jan | Surface<br>Bottom | 0.1<br>0.1 | 3.4<br>3.5 | 1.8 | 0.2 | 9.0 |
| 1997-1998 | 22 Dec–5 Jan | Surface<br>Bottom | 1.3<br>1.5 | 13.3<br>13.5 | 5.0 | 0.1 | 53.9 |
| 1998-1999 | 28 Dec–11 Jan | Surface<br>Bottom | 1.1<br>1.2 | 7.2<br>8.7 | 0.7 | 0.4 | 1.7 |
| 1999-2000 | 27 Dec–3 Jan | Surface<br>Bottom | 0.2<br>0.3 | 4.6<br>6.2 | 0.5 | 0.1 | 8.1 |
| 2000-2001 | 25 Dec–8 Jan | Surface<br>Bottom | 0.4<br>0.4 | 12.0<br>12.9 | 3.9 | 2.4 | 1.6 |
| 2001-2002 | 7 Jan–14 Jan | Surface<br>Bottom | 1.9<br>2.5 | 9.0<br>10.0 | 0.1 | 0.2 | 0.6 |

(continued)

**Table 3-18. (Continued)**

| Survey | Weeks of Peak Spawning | Depth | Maximum Weekly Mean Salinity (ppt) in Region | | Maximum Weekly Mean C/H in Region | | |
|---|---|---|---|---|---|---|---|
| | | | North | South | North | South | Ratio North/South |
| 2002-2003 | 6 Jan–13 Jan | Surface<br>Bottom | 0.4<br>0.4 | 2.6<br>3.4 | 0.1 | 0.6 | 0.1 |
| 2003-2004 | 29 Dec–12 Jan | Surface<br>Bottom | 0.2<br>0.1 | 3.0<br>3.5 | 2.0 | 2.3 | 0.8 |
| 2004-2005 | 27 Dec–3 Jan | Surface<br>Bottom | 0.1<br>0.1 | 2.2<br>2.4 | 4.0 | 0.8 | 5.0 |

[a] Bottom water salinities were not measured during 1982-1983, 1983-1984, 1985-1986 or 1987-1988 and were estimated from the ratio of weekly mean bottom to surface water salinities observed during 1988-1989, 1989-1990 and 1990-1991 using the following equation: Estimated bottom salinity (ppt) = observed surface salinity x 1.264.

**Table 3-19. Number of Atlantic tomcod caught (C), marked and released (M), and recaptured (R) in the box trap survey, Indian Point impingement, and other sampling efforts for estimates of adult population size, winters of 1974-1975 through 2004-2005.**

| Sampling Effort | Atlantic Tomcod Winter Spawning Stock Survey[a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1974-1975 | 1975-1976 | 1976-1977 | 1977-1978 | 1978-1979 | 1979-1980 | 1980-1981 | 1981-1982 | 1982-1983 | 1983-1984 | 1985-1986 | 1987-1988 |
| North Box Traps (RM 47; km75) | | | | | | | | | | | | |
| Number Marked (M)[b] | 14,786 | 38,202 | 55,881 | 6,501 | 8,174 | 15,378 | 2,264 | 9,314 | 17,552 | 23,786 | 8,495 | 10,905 |
| South Box Traps (RM<47; km75) | | | | | | | | | | | | |
| Catch (C) | 2,108 | 4,909 | 8,571 | 5,922 | 17,103 | 11,626 | 511 | 3,971 | 16,391 | 8,356 | 6,618 | 2,570 |
| Recaptures (R) | 4 | 21 | 11 | 0 | 4 | 19 | 0 | 1 | 2 | 5 | 1 | 0 |
| R/C | 0.0019 | 0.0043 | 0.0013 | 0.0 | 0.0002 | 0.0016 | 0.0 | 0.0 | 0.00012 | 0.00060 | 0.00015 | 0.00000 |
| Percent of Total Catch | 29 | 54 | 53 | 59 | 60 | 70 | 24 | 74 | 52 | 55 | 18 | 13 |
| Indian Point Impingement[c] | | | | | | | | | | | | |
| Catch (C) | 4,385 | 3,700 | 6,140 | 4,409 | 10,497 | 4,784 | 1,483 | 1,240 | 998 | 257 | 312 | |
| Recaptures (R) | 23 | 71 | 26 | 26 | 31 | 5 | 0 | 0 | 0 | 1 | 0 | |
| R/C | 0.0052 | 0.0192 | 0.0042 | 0.0059 | 0.0030 | 0.0010 | 0.0 | 0.0 | 0.0 | 0.00389 | 0.0 | |
| Percent of Total Catch | 61 | 41 | 38 | 44 | 36 | 29 | 71 | 23 | 3 | 2 | 1 | |
| Other[d] | | | | | | | | | | | | |
| Catch (C) | 696 | 465 | 1,445 | 223 | 825 | 209 | 101 | 170 | 14,053 | 6,655 | 29,507 | 16,936 |
| Recaptures (R) | 1 | 1 | 9 | 0 | 4 | 3 | 0 | 0 | 18 | 19 | 80 | 34 |
| R/C | 0.0014 | 0.0022 | 0.0062 | 0.0 | 0.0048 | 0.0144 | 0.0 | 0.0 | 0.00128 | 0.00285 | 0.00271 | 0.00201 |
| Percent of Total Catch | 10 | 5 | 9 | 2 | 3 | 2 | 5 | 3 | 45 | 43 | 81 | 87 |
| Total | | | | | | | | | | | | |
| Catch (C) | 7,189 | 9,054 | 16,156 | 10,108 | 28,841 | 16,619 | 2,095 | 5,381 | 31,442 | 15,268 | 36,437 | 19,506 |
| Recaptures (R) | 28 | 93 | 46 | 26 | 39 | 27 | 0 | 1 | 20 | 25 | 81 | 34 |
| R/C | 0.0039 | 0.0103 | 0.0028 | 0.0026 | 0.0014 | 0.0016 | 0 | 0.00019 | 0.00064 | 0.00196 | 0.00222 | 0.00174 |

(continued)

**Table 3-19. (Continued)**

| Sampling Effort | Atlantic Tomcod Winter Spawning Stock Survey[a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1988-1989 | 1989-1990 | 1990-1991 | 1991-1992 | 1992-1993 | 1993-1994 | 1994-1995 | 1995-1996 | 1996-1997 | 1997-1998 | 1998-1999 | 1999-2000 |
| North Box Traps (RM 47;km75) | | | | | | | | | | | | |
| Number Marked (M)[b] | 39,315 | 24,339 | 19,235 | 3,802 | 21,291 | 6,934 | 6,240 | 1,703 | 5,944 | 12,593 | 3,254 | 1,461 |
| South Box Traps (RM<47;km75) | | | | | | | | | | | | |
| Catch (C) | 5,980 | 4,117 | 2,312 | 693 | 2,611 | 1,575 | 2,494 | 203 | 1,851 | 455 | 784 | 152 |
| Recaptures (R) | 5 | 4 | 9 | 1 | 16 | 0 | 1 | 0 | 0 | 1 | 2 | 0 |
| R/C | 0.00084 | 0.00097 | 0.00389 | 0.00144 | 0.00613 | 0.00000 | 0.00040 | 0.00000 | 0.00000 | 0.00220 | 0.00255 | 0.00000 |
| Percent of Total Catch | 18 | 14 | 24 | 25 | 19 | 47 | 31 | 53 | 34 | 16 | 47 | 13 |
| Indian Point Impingement[c] | | | | | | | | | | | | |
| Catch (C) | | | | | | | | | | | | |
| Recaptures (R) | | | | | | | | | | | | |
| R/C | | | | | | | | | | | | |
| Percent of Total Catch | | | | | | | | | | | | |
| Other[d] | | | | | | | | | | | | |
| Catch (C) | 27,962 | 24,833 | 7,295 | 2,107 | 11,398 | 1,759 | 5,433 | 180 | 3,609 | 2,416 | 890 | 1,029 |
| Recaptures (R) | 99 | 29 | 24 | 17 | 50 | 12 | 6 | 1 | 0 | 15 | 4 | 6 |
| R/C | 0.00354 | 0.00117 | 0.00329 | 0.00807 | 0.00439 | 0.00682 | 0.00110 | 0.00556 | 0.00000 | 0.00621 | 0.00449 | 0.00583 |
| Percent of Total Catch | 82 | 86 | 76 | 75 | 81 | 53 | 69 | 47 | 66 | 84 | 53 | 87 |
| Total | | | | | | | | | | | | |
| Catch (C) | 33,942 | 28,950 | 9,607 | 2,800 | 14,009 | 3,334 | 7,927 | 383 | 5,460 | 2,871 | 1,674 | 1,181 |
| Recaptures (R) | 104 | 33 | 33 | 18 | 66 | 12 | 7 | 1 | 0 | 16 | 6 | 6 |
| R/C | 0.00306 | 0.00114 | 0.00343 | 0.00643 | 0.00471 | 0.00360 | 0.00088 | 0.00261 | 0.00000 | 0.00557 | 0.00358 | 0.00508 |

(continued)

**Table 3-19. (Continued)**

| Sampling Effort | Atlantic Tomcod Winter Spawning Stock Survey[a] | | | | |
|---|---|---|---|---|---|
| | 2000-2001 | 2001-2002 | 2002-2003 | 2003-2004 | 2004-2005 |
| North Box Traps (RM 47;km75) | | | | | |
| Number Marked (M)[b] | 6,758 | 139 | 373 | 5,034 | 10,415 |
| South Box Traps (RM<47;km75) | | | | | |
| Catch (C) | 4,289 | 265 | 762 | 5,600 | 3,501 |
| Recaptures (R) | 6 | 1 | 1 | 2 | 10 |
| R/C | 0.00140 | 0.00377 | 0.00131 | 0.00036 | 0.00286 |
| Percent of Total Catch | 50 | 67 | 86 | 62 | 64 |
| Indian Point Impingement[c] | | | | | |
| Catch (C) | | | | | |
| Recaptures (R) | | | | | |
| R/C | | | | | |
| Percent of Total Catch | | | | | |
| Other[d] | | | | | |
| Catch (C) | 4,236 | 130 | 122 | 3,479 | 2,010 |
| Recaptures (R) | 9 | 0 | 0 | 6 | 8 |
| R/C | 0.00212 | 0.00000 | 0.00000 | 0.00172 | 0.00398 |
| Percent of Total Catch | 50 | 33 | 14 | 38 | 36 |
| Total | | | | | |
| Catch (C) | 8,525 | 395 | 884 | 9,079 | 5,511 |
| Recaptures (R) | 15 | 1 | 1 | 8 | 18 |
| R/C | 0.00176 | 0.00253 | 0.00113 | 0.00088 | 0.00327 |

[a] Survey was not conducted during the 1984-1985 and 1986-1987 spawning seasons.

[b] Number marked and released was adjusted for handling mortality of 10% prior to 1 January and 2.5% on and after 1 January of each year.

[c] Impingement collections were not examined for marked Atlantic tomcod from 1987-1988 to present.

[d] Includes Bowline and Lovett impingement collections (1976-1977 through 1981-1982); bottom trawls, beach seines, and try trawl below RM 47 (km 75) (1974-1975 through 1980-1981); high-rise trawl and LMS trawl data (1982-1983 and 1983-1984); 9 m and 12 m trawl data (1985-1986 and 1987-1988), and 9 m trawl data (1988-1989 to present). Number of trawl recaptures includes only fish marked and released in North box traps for consistency among years.

**Table 3-20. Petersen estimates of the Hudson River Atlantic tomcod spawning population, winters of 1974-1975 through 2004-2005.**

| Spawning Survey | Atlantic Tomcod Petersen Population Estimate (Millions of Fish) | | |
|---|---|---|---|
| | Reported Estimate[a] | Adjusted Estimate[d] | Trawl Estimate[f] |
| 1974-1975 | 3.8 | 2.7 | |
| 1975-1976 | 3.7 | 2.0 | |
| 1976-1977 | 10.4[b] | 12.7 | |
| 1977-1978 | 2.5 | 1.1 | |
| 1978-1979 | 6.0 | 2.7 | |
| 1979-1980 | 9.1 | 5.4[e] | |
| 1980-1981 | --[c] | | |
| 1981-1982 | --[c] | | |
| 1982-1983 | | | 12.5 |
| 1983-1984 | | | 6.7 |
| 1984-1985 | | | NS[g] |
| 1985-1986 | | | 2.1 |
| 1986-1987 | | | NS[g] |
| 1987-1988 | | | 3.5 |
| 1988-1989 | | | 5.9 |
| 1989-1990 | | | 6.8 |
| 1990-1991 | | | 3.2 |
| 1991-1992 | | | 0.4 |
| 1992-1993 | | | 2.6 |
| 1993-1994 | | | 0.7 |
| 1994-1995 | | | 2.4 |
| 1995-1996 | | | 0.09 |
| 1996-1997 | | | 3.3 |
| 1997-1998 | | | 1.3 |
| 1998-1999 | | | 0.6 |
| 1999-2000 | | | 0.2 |
| 2000-2001 | | | 2.5 |
| 2001-2002 | | | 0.04 |
| 2002-2003 | | | 0.1 |
| 2003-2004 | | | 1.7 |
| 2004-2005 | | | 1.7 |

[a] TI (1981)
[b] Adjusted Schaefer estimate
[c] Insufficient number of recaptured fish (<2)
[d] Adjusted estimate = impingement recapture estimate from Table 3-22 in NAI (1992)
[e] Adjusted estimate = reported estimate/1.7
[f] Trawl estimate from Appendix Table E-8
[g] No survey

# APPENDIX A

## Gear Characteristics

**Appendix Table A-1. Specifications of the box traps used in the Atlantic tomcod survey.**

| | |
|---|---|
| Frame | 3 x 3 x 6 ft (0.9 x 0.9 x 1.8 m) |
| Number of wings | None |
| Number of leads | None |
| Number of fykes | 2 |
| Fyke opening | 4 x 4 in. (10 x 10 cm) |
| Body mesh | 3/8 in. (1 cm) |

**Appendix Table A-2. Specifications of the 9 m trawl.**

| | |
|---|---|
| Head rope length | 6.9 m |
| Foot rope length (Sweep) | 9.0 m |
| Legs | 6.0 m |
| Net body length | 5.2 m |
| Cod end section | 2.3 m |
| Doors (steel V-doors) | 1.0 m |
| Mesh – body | 7.6 cm (stretch) mesh, knotless polypropylene |
| – cod end | 3.8 cm (stretch) mesh, knotless polypropylene |
| Roller Gear | 25.4 cm rollers spaced with 5 cm cookie disks |

# APPENDIX B

## Water Quality

**Appendix Table B-1. Weekly and regional average water temperature and conductivity during box trap sampling for Atlantic tomcod in the Hudson River, 2004-2005.**

| Hudson River Region | Week (Beginning Monday) | Surface Water Temperature (°C) | Surface Water Conductivity ( S/cm) | Bottom Water Temperature (°C) | Bottom Water Conductivity ( S/cm) |
|---|---|---|---|---|---|
| Tappan Zee | 6 Dec 2004 | 7.8 | 8474 | 7.8 | 8996 |
| | 13 Dec 2004 | 4.0 | 859 | 4.2 | 862 |
| | 20 Dec 2004 | 2.8 | 4150 | 2.8 | 4454 |
| | 27 Dec 2004 | 2.0 | 3945 | 2.5 | 3934 |
| | 3 Jan 2005 | 3.7 | 3806 | 3.6 | 3856 |
| | 10 Jan 2005 | 3.0 | 6533 | 2.9 | 6683 |
| | 17 Jan 2005 | 0.1 | 1408 | 0.3 | 2219 |
| | 24 Jan 2005 | 0.2 | 8717 | 0.2 | 9274 |
| | 31 Jan 2005 | 0.1 | 8856 | 0.1 | 9012 |
| | 7 Feb 2005 | 1.5 | 9142 | 1.6 | 9802 |
| | 14 Feb 2005 | 2.1 | 3585 | 2.2 | 3636 |
| | 21 Feb 2005 | 2.0 | 6598 | 2.0 | 6653 |
| | 28 Feb 2005 | 1.9 | 9111 | 2.3 | 10382 |
| Croton-Haverstraw | 6 Dec 2004 | 7.0 | 3415 | 7.0 | 3412 |
| | 13 Dec 2004 | 3.5 | 333 | 3.7 | 334 |
| | 20 Dec 2004 | 1.8 | 474 | 1.8 | 613 |
| | 3 Jan 2005 | 3.9 | 504 | 3.9 | 536 |
| | 10 Jan 2005 | 2.3 | 3088 | 2.3 | 3149 |
| | 17 Jan 2005 | 0.1 | 1743 | 0.1 | 1765 |
| | 24 Jan 2005 | 0.5 | 4807 | 0.6 | 4827 |
| | 31 Jan 2005 | 0.4 | 3710 | 0.6 | 5122 |
| | 7 Feb 2005 | 1.1 | 5956 | 1.1 | 6181 |
| | 14 Feb 2005 | 2.1 | 1791 | 2.0 | 1843 |
| | 21 Feb 2005 | 1.9 | 4555 | 1.8 | 4588 |
| | 28 Feb 2005 | 1.8 | 6121 | 1.9 | 6271 |
| Indian Point | 6 Dec 2004 | 7.0 | 3406 | 7.0 | 3376 |
| | 13 Dec 2004 | 3.8 | 243 | 3.8 | 245 |
| | 20 Dec 2004 | 2.6 | 405 | 2.7 | 404 |
| | 3 Jan 2005 | 3.1 | 698 | 3.0 | 744 |
| | 10 Jan 2005 | 1.9 | 1353 | 1.9 | 1453 |
| | 17 Jan 2005 | 0.2 | 261 | 0.2 | 262 |
| | 24 Jan 2005 | 0.5 | 3683 | 0.5 | 3719 |
| | 31 Jan 2005 | 0.9 | 2451 | 0.9 | 2553 |
| | 7 Feb 2005 | 1.1 | 2468 | 1.2 | 2569 |
| | 14 Feb 2005 | 1.7 | 750 | 1.8 | 757 |
| | 21 Feb 2005 | 1.9 | 3644 | 2.0 | 4357 |
| | 28 Feb 2005 | 2.3 | 3143 | 2.4 | 3496 |

(continued)

**Appendix Table B-1. (Continued)**

| Hudson River Region | Week (Beginning Monday) | Surface Water Temperature (°C) | Surface Water Conductivity ( S/cm) | Bottom Water Temperature (°C) | Bottom Water Conductivity ( S/cm) |
|---|---|---|---|---|---|
| West Point | 6 Dec 2004 | 6.0 | 234 | 6.0 | 234 |
| | 13 Dec 2004 | 4.0 | 202 | 4.0 | 202 |
| | 20 Dec 2004 | 2.4 | 216 | 2.4 | 216 |
| | 27 Dec 2004 | 1.1 | 228 | 1.0 | 229 |
| | 3 Jan 2005 | 1.1 | 221 | 1.2 | 221 |
| | 10 Jan 2005 | 0.8 | 245 | 0.7 | 251 |
| | 17 Jan 2005 | 0.4 | 247 | 0.4 | 250 |
| | 24 Jan 2005 | 0.2 | 1147 | 0.2 | 1248 |
| | 31 Jan 2005 | 0.2 | 602 | 0.2 | 620 |
| | 7 Feb 2005 | 0.4 | 726 | 0.4 | 740 |
| | 14 Feb 2005 | 0.6 | 259 | 0.6 | 262 |
| | 21 Feb 2005 | 0.6 | 610 | 0.6 | 697 |
| | 28 Feb 2005 | 0.5 | 409 | 0.9 | 432 |
| Cornwall | 13 Dec 2004 | 3.7 | 220 | 3.7 | 220 |
| | 20 Dec 2004 | 2.5 | 236 | 2.5 | 238 |
| | 3J an 2005 | 1.9 | 249 | 1.8 | 253 |
| | 10 Jan 2005 | 1.5 | 256 | 1.5 | 258 |
| | 17 Jan 2005 | 0.2 | 257 | 0.4 | 257 |
| | 24 Jan 2005 | 0.0 | 297 | 0.1 | 294 |
| | 31 Jan 2005 | 0.2 | 262 | 0.3 | 265 |
| | 7 Feb 2005 | 0.4 | 297 | 0.3 | 300 |
| | 14 Feb 2005 | 1.0 | 277 | 1.1 | 279 |
| | 21 Feb 2005 | 0.5 | 263 | 0.4 | 263 |
| | 28 Feb 2005 | 0.6 | 269 | 1.6 | 262 |
| Poughkeepsie | 13 Dec 2004 | 3.6 | 211 | 3.6 | 211 |
| | 20 Dec 2004 | 2.3 | 225 | 2.3 | 225 |
| | 3 Jan 2005 | 0.6 | 226 | 0.7 | 227 |
| | 10 Jan 2005 | 1.4 | 219 | 1.3 | 218 |
| | 17 Jan 2005 | 0.8 | 237 | 0.8 | 237 |
| | 24 Jan 2005 | 0.0 | 288 | 0.3 | 285 |
| | 31 Jan 2005 | 0.2 | 232 | 0.3 | 232 |
| | 7 Feb 2005 | 0.4 | 234 | 0.4 | 233 |
| | 14 Feb 2005 | 0.6 | 246 | 0.6 | 245 |
| | 21 Feb 2005 | 0.4 | 251 | 0.3 | 251 |
| | 28 Feb 2005 | 0.3 | 263 | 0.9 | 267 |

(continued)

**Appendix Table B-1. (Continued)**

| Hudson River Region | Week (Beginning Monday) | Surface Water Temperature (°C) | Surface Water Conductivity ( S/cm) | Bottom Water Temperature (°C) | Bottom Water Conductivity ( S/cm) |
|---|---|---|---|---|---|
| All | 6 Dec 2004 | 6.8 | 3775 | 6.8 | 3946 |
| | 13 Dec 2004 | 3.9 | 356 | 3.9 | 357 |
| | 20 Dec 2004 | 2.4 | 1171 | 2.5 | 1260 |
| | 27 Dec 2004 | 1.2 | 692 | 1.2 | 693 |
| | 3 Jan 2005 | 2.4 | 1315 | 2.4 | 1338 |
| | 10 Jan 2005 | 1.6 | 1758 | 1.6 | 1804 |
| | 17 Jan 2005 | 0.3 | 606 | 0.4 | 792 |
| | 24 Jan 2005 | 0.2 | 2594 | 0.2 | 2733 |
| | 31 Jan 2005 | 0.3 | 2967 | 0.3 | 3169 |
| | 7 Feb 2005 | 0.8 | 3161 | 0.8 | 3343 |
| | 14 Feb 2005 | 1.3 | 1077 | 1.3 | 1094 |
| | 21 Feb 2005 | 1.2 | 2487 | 1.1 | 2623 |
| | 28 Feb 2005 | 1.4 | 4041 | 1.7 | 4447 |

**Appendix Table B-2. Weekly and regional average water temperature and conductivity during trawl sampling for Atlantic tomcod in the Hudson River, 2004-2005.**

| Region | Sampling Week (beginning Monday) | Surface Water Temperature (°C) | Surface Water Conductivity ( S/cm) | Bottom Water Temperature (°C) | Bottom Water Conductivity ( S/cm) |
|---|---|---|---|---|---|
| Upper Harbor | 20 Dec 2004 | 5.0 | 22679 | 6.2 | 32533 |
| | 27 Dec 2004 | 3.8 | 22118 | 5.0 | 32127 |
| | 3 Jan 2005 | 4.5 | 17085 | 5.4 | 28249 |
| | 10 Jan 2005 | 5.1 | 27727 | 5.6 | 34063 |
| | 17 Jan 2005 | 1.0 | 14033 | 3.8 | 35841 |
| | 7 Feb 2005 | 2.5 | 33224 | 2.4 | 36638 |
| | 14 Feb 2005 | 2.7 | 22473 | 2.7 | 30892 |
| | 28 Feb 2005 | 1.9 | 25396 | 2.4 | 32987 |
| | 14 Mar 2005 | 2.9 | 17456 | 3.6 | 40096 |
| | 21 Mar 2005 | 4.0 | 31504 | 4.0 | 39136 |
| | 28 Mar 2005 | 4.8 | 9145 | 5.0 | 27212 |
| Battery | 1 Nov 2004 | 13.5 | 17465 | 14.0 | 32116 |
| | 8 Nov 2004 | 11.8 | 20866 | 12.7 | 29701 |
| | 15 Nov 2004 | 10.0 | 20265 | 10.3 | 30161 |
| | 22 Nov 2004 | 10.2 | 22496 | 10.5 | 32272 |
| | 29 Nov 2004 | 9.3 | 12252 | 10.2 | 30794 |
| | 6 Dec 2004 | 7.5 | 11589 | 9.1 | 29685 |
| | 13 Dec 2004 | 6.5 | 9726 | 7.9 | 25866 |
| | 20 Dec 2004 | 4.5 | 12318 | 5.9 | 24943 |
| | 27 Dec 2004 | 3.8 | 16003 | 5.0 | 33176 |
| | 3 Jan 2005 | 3.9 | 9745 | 5.2 | 28719 |
| | 10 Jan 2005 | 4.4 | 19027 | 5.1 | 28994 |
| | 17 Jan 2005 | 0.7 | 9453 | 4.3 | 33156 |
| | 31 Jan 2005 | 0.9 | 16233 | 1.4 | 29629 |
| | 7 Feb 2005 | 2.3 | 24958 | 2.4 | 31555 |
| | 14 Feb 2005 | 2.4 | 11354 | 2.6 | 24476 |
| | 21 Feb 2005 | 2.2 | 18162 | 2.9 | 32997 |
| | 28 Feb 2005 | 2.0 | 19441 | 2.3 | 29087 |
| | 7 Mar 2005 | 2.7 | 25164 | 2.5 | 30057 |
| | 14 Mar 2005 | 2.9 | 12227 | 2.9 | 29306 |
| | 21 Mar 2005 | 4.3 | 15659 | 4.0 | 33866 |
| | 28 Mar 2005 | 4.8 | 10497 | 4.5 | 18827 |
| | 4 Apr 2005 | 6.5 | 3150 | 6.0 | 18284 |
| | 11 Apr 2005 | 8.8 | 4650 | 7.9 | 20022 |

**Appendix Table B-3. Weekly mean bottom water salinity for box trap stations during the 2004-2005 Atlantic tomcod survey.**

| | Tappan Zee | | Croton-Haverstraw | Indian Point | | West Point | | | Cornwall | Poughkeepsie | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25[a] | 29 | 36 | 41 | 43 | 51 | | 52 | 56 | 68 | 76 |
| Week | East[a] | West | East | East | East | West | East | West | West | West | West |
| 6 Dec 2004 | 6.14 | 2.33 | 1.93 | 1.91 | – | 0.13 | 0.13 | 0.13 | – | – | – |
| 13 Dec 2004 | 0.43 | 0.64 | 0.19 | 0.15 | 0.13 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 |
| 20 Dec 2004 | 3.42 | 0.77 | 0.34 | 0.33 | 0.13 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.12 |
| 27 Dec 2004 | 2.23 | – | – | – | – | 0.13 | – | 0.13 | – | – | – |
| 3 Jan 2005 | 2.41 | 1.18 | 0.30 | 0.70 | 0.14 | 0.13 | 0.12 | 0.12 | 0.14 | 0.13 | 0.13 |
| 10 Jan 2005 | 3.92 | 3.01 | 1.78 | 1.38 | 0.26 | 0.13 | 0.15 | 0.14 | 0.14 | 0.12 | 0.14 |
| 17 Jan 2005 | 1.57 | 0.46 | 0.99 | 0.15 | 0.15 | 0.15 | 0.13 | 0.14 | 0.14 | 0.13 | 0.13 |
| 24 Jan 2005 | 6.30 | 3.91 | 2.74 | 2.11 | 2.10 | 0.60 | 1.09 | 0.50 | 0.16 | 0.17 | 0.14 |
| 31 Jan 2005 | 5.74 | 3.70 | 2.91 | 1.62 | 1.27 | 0.46 | 0.36 | 0.24 | 0.15 | 0.13 | – |
| 7 Feb 2005 | 5.99 | 4.67 | 3.52 | 1.67 | 1.23 | 0.36 | 0.55 | 0.27 | 0.17 | 0.13 | – |
| 14 Feb 2005 | 2.14 | 1.81 | 1.04 | 0.55 | 0.26 | 0.15 | 0.15 | 0.15 | 0.16 | 0.14 | – |
| 21 Feb 2005 | 4.12 | 2.84 | 2.61 | 3.03 | 1.92 | 0.46 | 0.50 | 0.25 | 0.15 | 0.14 | – |
| 28 Feb 2005 | 6.48 | 4.55 | 3.58 | 2.33 | 1.63 | 0.28 | 0.27 | 0.19 | 0.15 | 0.15 | – |
| **All** | **3.82** | **2.48** | **1.85** | **1.37** | **0.86** | **0.25** | **0.31** | **0.20** | **0.15** | **0.13** | **0.13** |

[a] Stations labeled by river mile and site (east or west shore) within region; may include more than one trap.

# APPENDIX C

## Atlantic Tomcod Catch Characteristics

**Appendix Table C-1. Number of samples, Atlantic tomcod caught, and Atlantic tomcod marked in the Hudson River cross-classified by use code and region for the 9 m trawl and box traps, winter 2004-2005.**

| Region | Gear | Use Code | Number of Samples | Number of Atlantic Tomcod Caught | Number of Atlantic Tomcod Marked |
|---|---|---|---|---|---|
| Upper Harbor | 9 m trawl | 1 | 69 | 119 | 1 |
| | | 5 | 2 | 0 | 0 |
| Battery | 9 m trawl | 1 | 762 | 3,351 | 1,022 |
| | | 2 | 7 | 3 | 0 |
| | | 5 | 5 | 0 | 0 |
| Tappan Zee | Box trap | 1 | 104 | 2,187 | 1,862 |
| | | 2 | 6 | 1,028 | 1,023 |
| | | 5 | 1 | 0 | 0 |
| Croton-Haverstraw | Box trap | 1 | 57 | 284 | 262 |
| | | 5 | 1 | 0 | 0 |
| Indian Point | Box trap | 1 | 60 | 2 | 2 |
| West Point | Box trap | 1 | 182 | 8,714 | 8,176 |
| | | 5 | 2 | 0 | 0 |
| Cornwall | Box trap | 1 | 60 | 1,683 | 1,570 |
| Poughkeepsie | Box trap | 1 | 44 | 1,129 | 1,117 |
| | | 2 | 3 | 36 | 35 |
| | | 5 | 3 | 0 | 0 |

**Appendix Table C-2. Box trap catch per hour of Atlantic tomcod in the Hudson River, winter 2004-2005.**

| Sampling Week (beginning Monday) | | Hudson River Regions | | | | | | All Regions Combined |
|---|---|---|---|---|---|---|---|---|
| | | TZ | CH | IP | WP | CW | PK | |
| 6 Dec 2004 | C/H | 0.03 | 0.05 | 0.00 | 0.05 | – | – | 0.03 |
| | Duration | 315.5 | 93.0 | 44.8 | 102.8 | – | – | 556.0 |
| 13 Dec 2004 | C/H | 0.05 | 0.06 | 0.00 | 0.30 | 0.01 | <0.01 | 0.12 |
| | Duration | 682.8 | 341.4 | 340.9 | 845.6 | 191.2 | 240.1 | 2,642.1 |
| 20 Dec 2004 | C/H | 0.83 | 0.07 | 0.00 | 0.89 | 0.02 | 0.16 | 0.47 |
| | Duration | 555.7 | 284.7 | 288.6 | 648.1 | 242.0 | 364.5 | 2,383.5 |
| 27 Dec 2004 | C/H | 0.79 | – | – | 3.95 | – | – | 3.23 |
| | Duration | 165.2 | – | – | 554.9 | – | – | 720.1 |
| 3 Jan 2005 | C/H | 0.35 | 0.29 | 0.00 | 1.55 | 1.26 | 0.39 | 0.80 |
| | Duration | 440.6 | 624.4 | 620.2 | 1,217.0 | 771.6 | 674.4 | 4,348.1 |
| 10 Jan 2005 | C/H | 0.57 | 0.08 | 0.01 | 1.85 | 1.02 | 0.98 | 0.92 |
| | Duration | 723.5 | 339.1 | 388.9 | 889.2 | 331.2 | 457.6 | 3,129.4 |
| 17 Jan 2005 | C/H | 0.92 | 0.04 | 0.00 | 1.57 | 1.01 | 0.72 | 0.90 |
| | Duration | 586.4 | 283.3 | 282.0 | 796.9 | 290.9 | 436.9 | 2,676.3 |
| 24 Jan 2005 | C/H | 0.63 | 0.05 | 0.00 | 0.72 | 0.24 | – | 0.40 |
| | Duration | 287.1 | 288.2 | 292.6 | 618.1 | 311.6 | – | 1,797.6 |
| 31 Jan 2005 | C/H | 0.19 | 0.01 | 0.00 | 0.34 | <0.01 | 0.15 | 0.14 |
| | Duration | 692.8 | 476.3 | 475.7 | 664.7 | 409.0 | 215.9 | 2,934.3 |
| 7 Feb 2005 | C/H | 0.15 | <0.01 | 0.00 | 0.21 | <0.01 | 0.03 | 0.11 |
| | Duration | 687.0 | 338.9 | 336.5 | 955.8 | 327.6 | 234.5 | 2,880.3 |
| 14 Feb 2005 | C/H | 0.03 | <0.01 | 0.00 | 0.04 | 0.00 | 0.00 | 0.02 |
| | Duration | 664.4 | 335.8 | 338.0 | 625.2 | 239.3 | 240.1 | 2,442.7 |
| 21 Feb 2005 | C/H | 0.01 | <0.01 | 0.00 | <0.01 | 0.00 | 0.00 | <0.01 |
| | Duration | 564.1 | 281.8 | 337.2 | 1,088.1 | 436.2 | 386.7 | 3,094.0 |
| 28 Feb 2005 | C/H | <0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | <0.01 |
| | Duration | 572.6 | 293.0 | 238.3 | 830.8 | 140.2 | 70.0 | 2,144.8 |

**Appendix Table C-3. Average catch per ten-minute tow for Atlantic tomcod caught in the 9 m trawl in the Hudson River south of the George Washington Bridge, winter 2004-2005.**

| Sampling Week (beginning Monday) | Upper Harbor | | | Battery | | |
|---|---|---|---|---|---|---|
| | Tows | CPUE | S.E. | Tows | CPUE | S.E. |
| 1 Nov 2004 | 0 | | | 37 | 11.11 | 1.88 |
| 8 Nov 2004 | 0 | | | 46 | 10.50 | 1.57 |
| 15 Nov 2004 | 0 | | | 30 | 6.50 | 1.12 |
| 22 Nov 2004 | 0 | | | 18 | 6.61 | 1.31 |
| 29 Nov 2004 | 0 | | | 42 | 6.07 | 0.88 |
| 6 Dec 2004 | 0 | | | 43 | 3.63 | 0.47 |
| 13 Dec 2004 | 0 | | | 46 | 4.02 | 0.46 |
| 20 Dec 2004 | 10 | 0.00 | 0.00 | 14 | 3.21 | 0.90 |
| 27 Dec 2004 | 14 | 0.07 | 0.07 | 6 | 1.50 | 0.85 |
| 3 Jan 2004 | 7 | 0.14 | 0.14 | 33 | 0.45 | 0.12 |
| 10 Jan 2005 | 8 | 0.25 | 0.16 | 38 | 1.58 | 0.25 |
| 17 Jan 2005 | 3 | 0.00 | 0.00 | 20 | 1.95 | 0.78 |
| 24 Jan 2005 | 0 | | | 0 | | |
| 31 Jan 2005 | 0 | | | 5 | 25.20 | 11.88 |
| 7 Feb 2005 | 11 | 5.45 | 4.31 | 30 | 7.50 | 1.43 |
| 14 Feb 2005 | 9 | 0.56 | 0.38 | 40 | 5.88 | 1.22 |
| 21 Feb 2005 | 0 | | | 30 | 1.67 | 0.33 |
| 28 Feb 2005 | 2 | 0.00 | 0.00 | 43 | 2.28 | 0.43 |
| 7 Mar 2005 | 0 | | | 33 | 4.15 | 1.22 |
| 14 Mar 2005 | 1 | 0.00 | | 37 | 4.73 | 0.62 |
| 21 Mar 2005 | 1 | 0.00 | | 44 | 0.64 | 0.16 |
| 28 Mar 2005 | 3 | 16.67 | 2.73 | 50 | 1.50 | 0.33 |
| 4 Apr 2005 | 0 | | | 38 | 1.11 | 0.16 |
| 11 Apr 2005 | 0 | | | 39 | 4.82 | 0.84 |
| **Total CPUE** | **69** | **1.72** | **0.81** | **762** | **4.40** | **0.24** |

**Appendix Table C-4. Weekly report of Atlantic tomcod caught in the Hudson River in a 9 m trawl and in box traps during the *spawning period, winter 2004-2005.***

| Sampling Week | Gear | Water | | N Tows | | Number of Atlantic Tomcod Caught by Size Group (mm TL) | | | | | | | | | Fish per Tow | Number of Fish | | | | Mortality | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Temp | Cond. | Valid | Void | <126 | 126-150 | 151-175 | 176-200 | 201-225 | 226-250 | 251-275 | 276+ | Total | | Released | Recaptured | Lab | Old Recapture | N | % |
| 1 Nov 2004 | 9m | 14.0 | 32116 | 37 | 0 | 7 | 48 | 183 | 113 | 12 | 22 | 21 | 3 | 411 | 11.1 | 289 | 0 | 121 | 1 | 0 | 0.0 |
| 8 Nov 2004 | 9m | 12.7 | 29701 | 46 | 1 | 2 | 28 | 223 | 172 | 16 | 16 | 21 | 5 | 483 | 10.5 | 357 | 16 | 109 | 1 | 0 | 0.0 |
| 15 Nov 2004 | 9m | 10.3 | 30161 | 30 | 0 | 2 | 18 | 80 | 75 | 9 | 4 | 4 | 3 | 195 | 6.5 | 70 | 17 | 107 | 1 | 0 | 0.0 |
| 22 Nov 2004 | 9m | 10.5 | 32272 | 18 | 0 | 0 | 4 | 29 | 61 | 7 | 8 | 9 | 0 | 119 | 6.6 | 16 | 2 | 101 | 0 | 0 | 0.0 |
| 29 Nov 2004 | 9m | 10.2 | 30794 | 42 | 0 | 0 | 13 | 76 | 100 | 26 | 11 | 19 | 9 | 255 | 6.1 | 144 | 10 | 100 | 1 | 0 | 0.0 |
| 6 Dec 2004 | 9m | 9.1 | 29685 | 43 | 0 | 0 | 7 | 35 | 77 | 18 | 5 | 11 | 3 | 156 | 3.6 | 45 | 7 | 104 | 0 | 0 | 0.0 |
| 13 Dec 2004 | 9m | 7.9 | 25866 | 46 | 0 | 0 | 21 | 34 | 81 | 20 | 8 | 15 | 6 | 185 | 4.0 | 74 | 4 | 105 | 2 | 0 | 0.0 |
| 20 Dec 2004 | 9m | 6.0 | 28105 | 24 | 0 | 1 | 2 | 9 | 18 | 9 | 1 | 4 | 1 | 45 | 1.9 | 3 | 0 | 42 | 0 | 0 | 0.0 |
| 27 Dec 2004 | 9m | 5.0 | 32441 | 20 | 1 | 0 | 1 | 3 | 3 | 2 | 0 | 1 | 0 | 10 | 0.5 | 6 | 0 | 4 | 0 | 0 | 0.0 |
| 3 Jan 2005 | 9m | 5.2 | 28635 | 40 | 0 | 0 | 3 | 5 | 6 | 0 | 1 | 0 | 1 | 16 | 0.4 | 5 | 0 | 11 | 0 | 0 | 0.0 |
| 10 Jan 2005 | 9m | 5.2 | 29875 | 46 | 0 | 0 | 5 | 9 | 21 | 15 | 4 | 6 | 2 | 62 | 1.3 | 11 | 0 | 50 | 1 | 0 | 0.0 |
| 17 Jan 2005 | 9m | 4.2 | 33465 | 26 | 0 | 0 | 0 | 2 | 8 | 9 | 4 | 9 | 7 | 39 | 1.5 | 3 | 0 | 36 | 0 | 0 | 0.0 |
| 31 Jan 2005 | 9m | 1.4 | 29629 | 5 | 0 | 1 | 21 | 37 | 39 | 13 | 2 | 4 | 9 | 126 | 25.2 | 124 | 2 | 0 | 0 | 0 | 0.0 |
| 7 Feb 2005 | 9m | 2.4 | 32918 | 41 | 0 | 3 | 39 | 92 | 90 | 35 | 5 | 13 | 8 | 285 | 7.0 | 180 | 4 | 101 | 0 | 0 | 0.0 |
| 14 Feb 2005 | 9m | 2.6 | 25654 | 49 | 0 | 0 | 27 | 58 | 60 | 44 | 12 | 28 | 11 | 240 | 4.9 | 125 | 0 | 114 | 1 | 0 | 0.0 |
| 21 Feb 2005 | 9m | 2.9 | 32997 | 30 | 1 | 0 | 1 | 10 | 14 | 6 | 4 | 14 | 1 | 50 | 1.7 | 11 | 2 | 37 | 0 | 0 | 0.0 |
| 28 Feb 2005 | 9m | 2.3 | 29260 | 45 | 0 | 2 | 12 | 14 | 29 | 11 | 3 | 18 | 9 | 98 | 2.2 | 17 | 1 | 79 | 1 | 0 | 0.0 |
| 7 Mar 2005 | 9m | 2.5 | 30057 | 33 | 1 | 0 | 34 | 51 | 26 | 15 | 3 | 7 | 1 | 137 | 4.2 | 114 | 2 | 20 | 1 | 2 | 1.5 |
| 14 Mar 2005 | 9m | 3.0 | 29705 | 40 | 3 | 0 | 34 | 55 | 44 | 16 | 6 | 18 | 5 | 178 | 4.5 | 71 | 2 | 105 | 0 | 0 | 0.0 |
| 21 Mar 2005 | 9m | 4.0 | 33983 | 45 | 0 | 0 | 1 | 4 | 7 | 10 | 1 | 5 | 0 | 28 | 0.6 | 3 | 0 | 25 | 0 | 0 | 0.0 |
| 28 Mar 2005 | 9m | 4.6 | 19197 | 53 | 0 | 0 | 10 | 17 | 40 | 28 | 12 | 14 | 4 | 125 | 2.4 | 14 | 1 | 109 | 1 | 0 | 0.0 |
| 4 Apr 2005 | 9m | 6.0 | 18395 | 40 | 0 | 0 | 2 | 4 | 7 | 9 | 6 | 11 | 3 | 42 | 1.1 | 12 | 1 | 29 | 0 | 0 | 0.0 |
| 11 Apr 2005 | 9m | 7.9 | 20022 | 39 | 0 | 0 | 32 | 54 | 53 | 29 | 7 | 8 | 5 | 188 | 4.8 | 83 | 5 | 100 | 0 | 0 | 0.0 |
| **Trawl Totals** | | **6.1** | **28910** | **838** | **7** | **18** | **363** | **1084** | **1144** | **359** | **145** | **260** | **96** | **3473** | **4.1** | **1777** | **76** | **1609** | **11** | **2** | **0.1** |

(continued)

## Appendix Table C-4. (Continued)

| Sampling Week | Gear | Region | Water | | Number of Atlantic Tomcod Caught by Size Group (mm TL) | | | | | | | | | Number of Fish | | | | Mortality | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Temp. | Cond. | <126 | 126-150 | 151-175 | 176-200 | 201-225 | 226-250 | 251-275 | 276+ | Total | Released | Recaptured | Lab | Old Recapture | N | % |
| 6 Dec 2004 | Bx | N | 6.0 | 234 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0.0 |
| | Bx | S | 7.4 | 6598 | 0 | 3 | 2 | 3 | 4 | 1 | 1 | 0 | 14 | 14 | 0 | 0 | 0 | 0 | 0.0 |
| 13 Dec 2004 | Bx | N | 3.9 | 206 | 6 | 116 | 87 | 26 | 8 | 9 | 4 | 1 | 257 | 231 | 4 | 21 | 1 | 0 | 0.0 |
| | Bx | S | 4.0 | 576 | 2 | 17 | 11 | 10 | 4 | 9 | 1 | 0 | 54 | 48 | 3 | 2 | 1 | 0 | 0.0 |
| 20 Dec 2004 | Bx | N | 2.4 | 222 | 25 | 226 | 192 | 94 | 41 | 43 | 15 | 7 | 643 | 525 | 0 | 116 | 2 | 0 | 0.0 |
| | Bx | S | 2.5 | 2200 | 19 | 144 | 167 | 81 | 31 | 16 | 14 | 9 | 481 | 465 | 2 | 12 | 2 | 0 | 0.0 |
| 27 Dec 2004 | Bx | N | 1.0 | 229 | 82 | 602 | 582 | 384 | 189 | 149 | 151 | 49 | 2192 | 2062 | 9 | 66 | 5 | 0 | 0.0 |
| | Bx | S | 2.5 | 3934 | 8 | 39 | 46 | 18 | 7 | 7 | 6 | 0 | 131 | 0 | 0 | 131 | 0 | 0 | 0.0 |
| 3 Jan 2005 | Bx | N | 1.3 | 232 | 292 | 1007 | 716 | 429 | 265 | 199 | 160 | 78 | 3146 | 3053 | 33 | 52 | 8 | 0 | 0.0 |
| | Bx | S | 3.5 | 2502 | 69 | 428 | 397 | 247 | 97 | 30 | 34 | 23 | 1325 | 1302 | 7 | 14 | 2 | 0 | 0.0 |
| 10 Jan 2005 | Bx | N | 1.0 | 246 | 148 | 829 | 629 | 413 | 185 | 145 | 65 | 18 | 2432 | 2328 | 40 | 55 | 9 | 0 | 0.0 |
| | Bx | S | 2.4 | 4179 | 11 | 121 | 173 | 97 | 26 | 18 | 15 | 9 | 471 | 442 | 6 | 22 | 1 | 0 | 0.0 |
| 17 Jan 2005 | Bx | N | 0.4 | 249 | 183 | 714 | 495 | 243 | 93 | 101 | 23 | 4 | 1856 | 1753 | 43 | 56 | 4 | 0 | 0.0 |
| | Bx | S | 0.2 | 1781 | 42 | 208 | 175 | 74 | 20 | 23 | 4 | 4 | 550 | 509 | 15 | 26 | 0 | 0 | 0.0 |
| 24 Jan 2005 | Bx | N | 0.2 | 883 | 50 | 218 | 133 | 66 | 32 | 30 | 5 | 2 | 536 | 479 | 24 | 30 | 3 | 0 | 0.0 |
| | Bx | S | 0.4 | 7051 | 14 | 94 | 53 | 28 | 8 | 5 | 4 | 0 | 206 | 129 | 5 | 70 | 2 | 0 | 0.0 |
| 31 Jan 2005 | Bx | N | 0.2 | 463 | 40 | 108 | 68 | 22 | 9 | 12 | 1 | 0 | 260 | 241 | 6 | 12 | 1 | 0 | 0.0 |
| | Bx | S | 0.4 | 6366 | 13 | 64 | 41 | 8 | 5 | 3 | 3 | 0 | 137 | 128 | 5 | 4 | 0 | 0 | 0.0 |
| 7 Feb 2005 | Bx | N | 0.4 | 533 | 30 | 84 | 46 | 19 | 15 | 6 | 5 | 2 | 207 | 196 | 8 | 3 | 0 | 0 | 0.0 |
| | Bx | S | 1.4 | 7089 | 10 | 46 | 33 | 7 | 1 | 3 | 0 | 1 | 101 | 88 | 2 | 11 | 0 | 0 | 0.0 |
| 14 Feb 2005 | Bx | N | 0.7 | 262 | 5 | 11 | 6 | 2 | 2 | 1 | 0 | 0 | 27 | 25 | 2 | 0 | 0 | 0 | 0.0 |
| | Bx | S | 2.0 | 2164 | 3 | 9 | 6 | 2 | 2 | 1 | 0 | 0 | 23 | 20 | 1 | 2 | 0 | 0 | 0.0 |
| 21 Feb 2005 | Bx | N | 0.5 | 508 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0.0 |
| | Bx | S | 1.9 | 5470 | 0 | 4 | 1 | 0 | 0 | 1 | 0 | 0 | 6 | 4 | 0 | 2 | 0 | 0 | 0.0 |
| 28 Feb 2005 | Bx | N | 1.0 | 393 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | Bx | S | 2.2 | 7083 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0.0 |
| **Totals** | **Bx** | **N** | **1.5** | **358** | **861** | **3916** | **2956** | **1701** | **839** | **695** | **429** | **161** | **11562** | **10899** | **169** | **411** | **33** | **0** | **0.0** |
| | **Bx** | **S** | **2.4** | **4384** | **191** | **1178** | **1105** | **575** | **206** | **117** | **82** | **46** | **3501** | **3149** | **46** | **298** | **8** | **0** | **0.0** |
| | **Bx** | **All** | **1.9** | **2371** | **1052** | **5094** | **4061** | **2276** | **1045** | **812** | **511** | **207** | **15063** | **14048** | **215** | **709** | **41** | **0** | **0.0** |

(continued)

## Appendix Table C-4. (Continued)

| | | |
|---|---|---|
| SAMPLING WEEK | = | Date of Monday beginning each week |
| GEAR | = | 9 m trawl (9m) or box traps (Bx) |
| REGION | = | North box trap region (N) or south box trap region (S) |
| WATER: | | |
| TEMP. | = | Mean river bottom water temperature in °C |
| COND. | = | Mean river bottom conductivity in microSiemens/cm at 25° |
| N TOWS: | | |
| VALID | = | Total number of valid tows (USE_CODEs 1 and 2 combined) by the specified gear in the specified week |
| VOID | = | Total number of void tows (USE_CODE = 5) by the specified gear in the specified week |
| FISH PER TOW | = | Number of fish caught per valid tow (trawl) |
| NUMBER OF FISH: | | |
| RELEASED | = | Number of Atlantic tomcod marked and released |
| RECAPTURED | = | Number of Atlantic tomcod recaptured from the current program |
| LAB | = | Number of fish taken to the laboratory for biocharacteristics and/or fecundity analyses |
| OLD RECAPTURE | = | Number of Atlantic tomcod recaptured from previous years' programs |
| MORTALITY: | | |
| N | = | Number of dead fish in samples |
| % | = | Percent of dead fish in samples |

**Appendix Table C-5. Length frequencies of Atlantic tomcod by gear and week in the Hudson River, winter 2004-2005.**

| Gear | Sampling Week (Beginning Mon) | Number of Samples | Length Group 1 | Length Group 2 | Length Group 3 | Length Group 4 | Length Group 5 | Length Group 6 | Length Group 7 | Length Group 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Box traps | 6 Dec 2004 | 12 | | 4 | 4 | 5 | 4 | 1 | 1 | |
| | 13 Dec 2004 | 59 | 8 | 133 | 98 | 36 | 12 | 18 | 5 | 1 |
| | 20 Dec 2004 | 40 | 44 | 370 | 359 | 175 | 72 | 59 | 29 | 16 |
| | 27 Dec 2004 | 8 | 90 | 641 | 628 | 402 | 196 | 156 | 157 | 49 |
| | 3 Jan 2005 | 39 | 361 | 1,435 | 1,113 | 676 | 362 | 229 | 194 | 101 |
| | 10 Jan 2005 | 54 | 159 | 950 | 802 | 510 | 211 | 163 | 80 | 27 |
| | 17 Jan 2005 | 31 | 225 | 922 | 670 | 317 | 113 | 124 | 27 | 8 |
| | 24 Jan 2005 | 31 | 64 | 312 | 186 | 94 | 40 | 35 | 9 | 2 |
| | 31 Jan 2005 | 49 | 53 | 172 | 109 | 30 | 14 | 15 | 4 | |
| | 7 Feb 2005 | 58 | 40 | 130 | 79 | 26 | 16 | 9 | 5 | 3 |
| | 14 Feb 2005 | 48 | 8 | 20 | 12 | 4 | 4 | 2 | | |
| | 21 Feb 2005 | 61 | | 4 | 1 | 1 | | 1 | | |
| | 28 Feb 2005 | 33 | | 1 | | | 1 | | | |
| | **Total** | 523 | 1,052 | 5,094 | 4,061 | 2,276 | 1,045 | 812 | 511 | 207 |
| Trawls | 1 Nov 2004 | 37 | 7 | 48 | 183 | 113 | 12 | 22 | 21 | 3 |
| | 8 Nov 2004 | 47 | 2 | 28 | 223 | 172 | 16 | 16 | 21 | 5 |
| | 15 Nov 2004 | 30 | 2 | 18 | 80 | 75 | 9 | 4 | 4 | 3 |
| | 22 Nov 2004 | 18 | | 4 | 29 | 61 | 7 | 8 | 9 | |
| | 9 Nov 2004 | 42 | | 13 | 76 | 100 | 26 | 11 | 19 | 9 |
| | 6 Dec 2004 | 43 | | 7 | 35 | 77 | 18 | 5 | 11 | 3 |
| | 13 Dec 2004 | 46 | | 21 | 34 | 81 | 20 | 8 | 15 | 6 |
| | 20 Dec 2004 | 24 | 1 | 2 | 9 | 18 | 9 | 1 | 4 | 1 |
| | 27 Dec 2004 | 21 | | 1 | 3 | 3 | 2 | | 1 | |
| | 3 Jan 2005 | 40 | | 3 | 5 | 6 | | 1 | | 1 |
| | 10 Jan 2005 | 46 | | 5 | 9 | 21 | 15 | 4 | 6 | 2 |
| | 17 Jan 2005 | 26 | | | 2 | 8 | 9 | 4 | 9 | 7 |
| | 24 Jan 2005 | 0 | | | | | | | | |
| | 31 Jan 2005 | 5 | 1 | 21 | 37 | 39 | 13 | 2 | 4 | 9 |
| | 7 Feb 2005 | 41 | 3 | 39 | 92 | 90 | 35 | 5 | 13 | 8 |

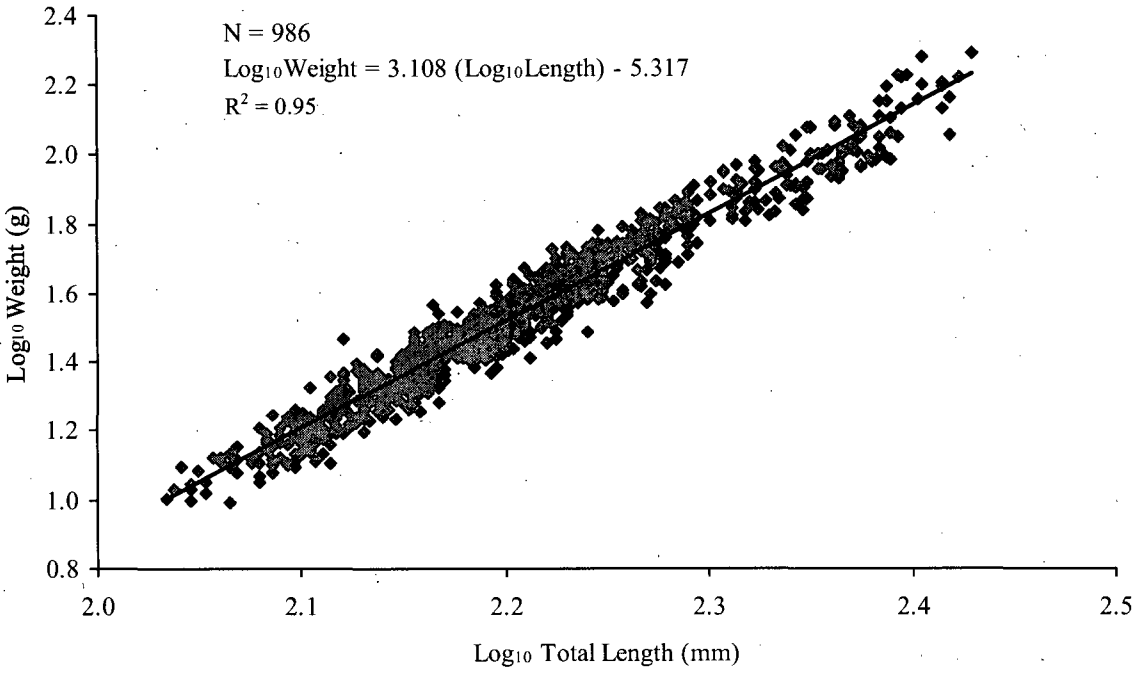
(continued)

## Appendix Table C-5. (Continued)

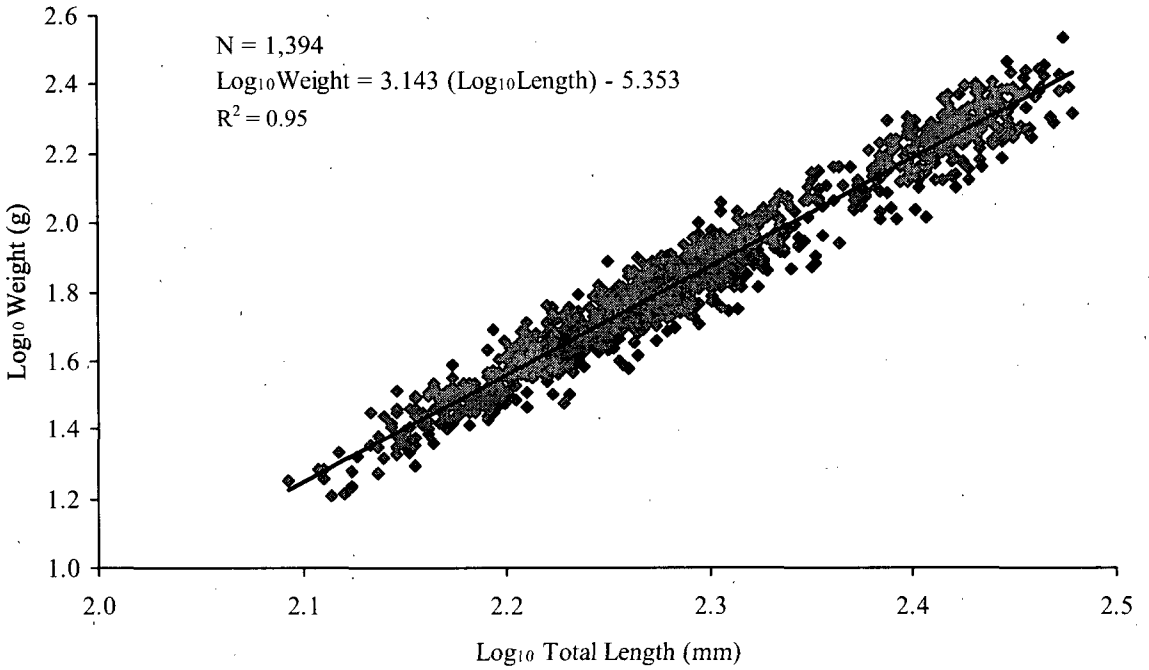
| Gear | Sampling Week (Beginning Mon) | Number of Samples | Length Group 1 | Length Group 2 | Length Group 3 | Length Group 4 | Length Group 5 | Length Group 6 | Length Group 7 | Length Group 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Trawls (cont'd) | 14 Feb 2005 | 49 | | 27 | 58 | 60 | 44 | 12 | 28 | 11 |
| | 21 Feb 2005 | 31 | | 1 | 10 | 14 | 6 | 4 | 14 | 1 |
| | 28 Feb 2005 | 45 | 2 | 12 | 14 | 29 | 11 | 3 | 18 | 9 |
| | 7 Mar 2005 | 34 | | 34 | 51 | 26 | 15 | 3 | 7 | 1 |
| | 14 Mar 2005 | 43 | | 34 | 55 | 44 | 16 | 6 | 18 | 5 |
| | 21 Mar 2005 | 45 | | 1 | 4 | 7 | 10 | 1 | 5 | |
| | 28 Mar 2005 | 51 | | 10 | 17 | 40 | 28 | 12 | 14 | 4 |
| | 4 Apr 2005 | 42 | | 2 | 4 | 7 | 9 | 6 | 11 | 3 |
| | 11 Apr 2005 | 39 | | 32 | 54 | 53 | 29 | 7 | 8 | 5 |
| | **Total** | 845 | 18 | 363 | 1,084 | 1,144 | 359 | 145 | 260 | 96 |
| **All Gears** | | **1,368** | **1,070** | **5,457** | **5,145** | **3,420** | **1,404** | **957** | **771** | **303** |

# Appendix D

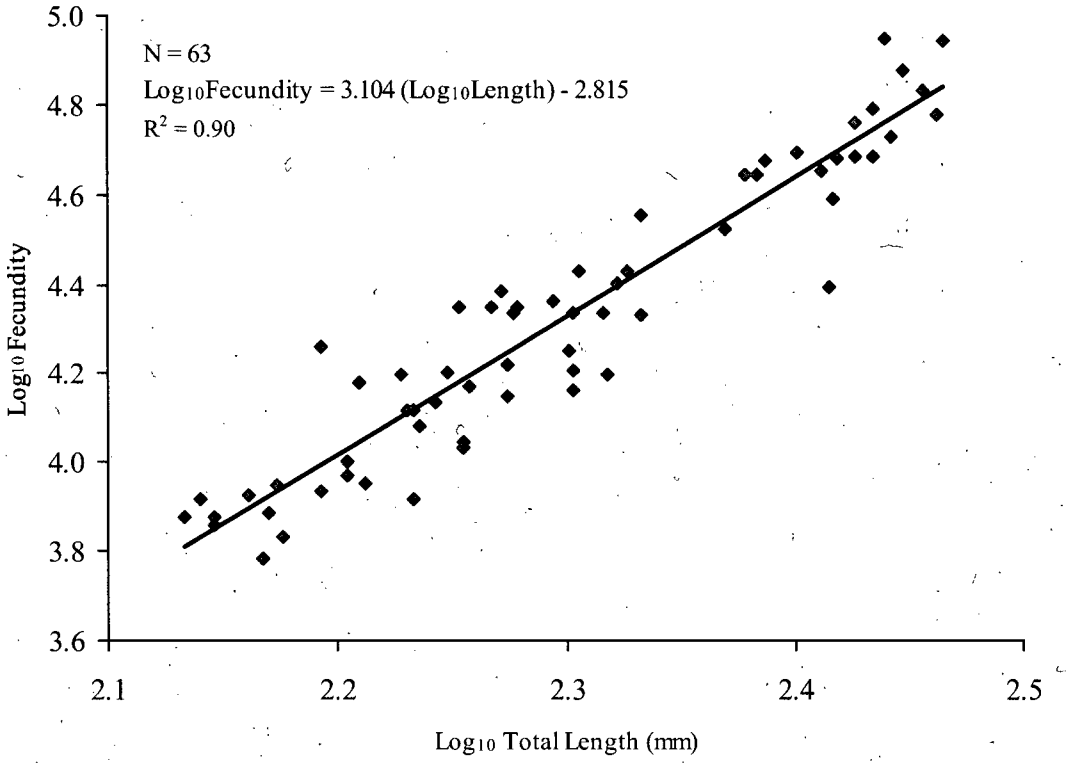
## Atlantic Tomcod Biocharacteristics




Appendix Figure D-1. Length-weight regression for male Atlantic tomcod collected in the Hudson River during the spawning season, winter 2004-2005.




Appendix Figure D-2. Length-weight regression for female Atlantic tomcod collected in the Hudson River during the spawning season, winter 2004-2005.




Appendix Figure D-3. Relationship between fecundity and length for female Atlantic tomcod collected in the Hudson River during the spawning season, winter 2004-2005.

**Appendix Table D-1. Sex ratio and proportion of males in weekly samples of Atlantic tomcod in the Hudson River estuary, winter 2004-2005.**

| Gear | Sampling Week (Beginning Monday) | Laboratory Samples | | | | | | Total Catch | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Males | Females | Total | Ratio (Males/ Females) | Proportion Males | Proportion Females | Males | Females | Total |
| **Box Traps** | 6 Dec 2004 | 0 | 0 | 0 | – | – | – | – | – | 19 |
| | 13 Dec 2004 | 18 | 5 | 23 | 3.600 | 0.783 | 0.217 | 243.4 | 67.6 | 311 |
| | 20 Dec 2004 | 110 | 18 | 128 | 6.111 | 0.859 | 0.141 | 965.9 | 158.1 | 1,124 |
| | 27 Dec 2004 | 152 | 45 | 197 | 3.378 | 0.772 | 0.228 | 1,792.4 | 530.6 | 2,323 |
| | 3 Jan 2005 | 22 | 18 | 40 | 1.222 | 0.550 | 0.450 | 2,459.1 | 2,012.0 | 4,471 |
| | 10 Jan 2005 | 34 | 13 | 47 | 2.615 | 0.723 | 0.277 | 2,100.0 | 803.0 | 2,903 |
| | 17 Jan 2005 | 76 | 6 | 82 | 12.667 | 0.927 | 0.073 | 2,230.0 | 176.0 | 2,406 |
| | 24 Jan 2005 | 97 | 6 | 103 | 16.167 | 0.942 | 0.058 | 698.8 | 43.2 | 742 |
| | 31 Jan 2005 | 17 | 0 | 17 | – | 1.000 | 0.000 | 397.0 | 0.0 | 397 |
| | 7 Feb 2005 | 12 | 2 | 14 | 6.000 | 0.857 | 0.143 | 264.0 | 44.0 | 308 |
| | 14 Feb 2005 | 2 | 0 | 2 | – | 1.000 | 0.000 | 50.0 | 0.0 | 50 |
| | 21 Feb 2005 | 2 | 0 | 2 | – | 1.000 | 0.000 | 7.0 | 0.0 | 7 |
| | 28 Feb 2005 | 2 | 0 | 2 | – | 1.000 | 0.000 | 2.0 | 0.0 | 2 |
| | **Total** | **544** | **113** | **657** | | | | **11,209.5** | **3,834.5** | **15,063** |
| **Trawls** | 1 Nov 2004 | 39 | 82 | 121 | 0.476 | 0.322 | 0.678 | 132.5 | 278.5 | 411 |
| | 8 Nov 2004 | 8 | 45 | 53 | 0.178 | 0.151 | 0.849 | 72.9 | 410.1 | 483 |
| | 15 Nov 2004 | 20 | 37 | 57 | 0.541 | 0.351 | 0.649 | 68.4 | 126.6 | 195 |
| | 22 Nov 2004 | 15 | 65 | 80 | 0.231 | 0.188 | 0.813 | 22.3 | 96.7 | 119 |
| | 29 Nov 2004 | 18 | 57 | 75 | 0.316 | 0.240 | 0.760 | 61.2 | 193.8 | 255 |
| | 6 Dec 2004 | 20 | 71 | 91 | 0.282 | 0.220 | 0.780 | 34.3 | 121.7 | 156 |
| | 13 Dec 2004 | 20 | 77 | 97 | 0.260 | 0.206 | 0.794 | 38.1 | 146.9 | 185 |
| | 20 Dec 2004 | 4 | 38 | 42 | 0.105 | 0.095 | 0.905 | 4.3 | 40.7 | 45 |
| | 27 Dec 2004 | 0 | 4 | 4 | 0.000 | 0.000 | 1.000 | 0.0 | 10.0 | 10 |
| | 3 Jan 2005 | 0 | 10 | 10 | 0.000 | 0.000 | 1.000 | 0.0 | 16.0 | 16 |
| | 10 Jan 2005 | 0 | 51 | 51 | 0.000 | 0.000 | 1.000 | 0.0 | 62.0 | 62 |
| | 17 Jan 2005 | 0 | 36 | 36 | 0.000 | 0.000 | 1.000 | 0.0 | 39.0 | 39 |
| | 24 Jan 2005 | 0 | 0 | 0 | – | – | – | 0.0 | 0.0 | 0 |
| | 31 Jan 2005 | 0 | 0 | 0 | – | – | – | – | – | 126 |

(continued)

**Appendix Table D-1. (Continued)**

| Gear | Sampling Week (Beginning Monday) | Laboratory Samples | | | | | | Total Catch | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Males | Females | Total | Ratio (Males/ Females) | Proportion Males | Proportion Females | Males | Females | Total |
| **Trawls** (cont'd) | 7 Feb 2005 | 14 | 89 | 103 | 0.157 | 0.136 | 0.864 | 38.7 | 246.3 | 285 |
| | 14 Feb 2005 | 19 | 95 | 114 | 0.200 | 0.167 | 0.833 | 40.0 | 200.0 | 240 |
| | 21 Feb 2005 | 6 | 28 | 34 | 0.214 | 0.176 | 0.824 | 8.8 | 41.2 | 50 |
| | 28 Feb 2005 | 17 | 63 | 80 | 0.270 | 0.213 | 0.788 | 20.8 | 77.2 | 98 |
| | 7 Mar 2005 | 6 | 16 | 22 | 0.375 | 0.273 | 0.727 | 37.4 | 99.6 | 137 |
| | 14 Mar 2005 | 30 | 76 | 106 | 0.395 | 0.283 | 0.717 | 50.4 | 127.6 | 178 |
| | 21 Mar 2005 | 4 | 21 | 25 | 0.190 | 0.160 | 0.840 | 4.5 | 23.5 | 28 |
| | 28 Mar 2005 | 26 | 83 | 109 | 0.313 | 0.239 | 0.761 | 29.8 | 95.2 | 125 |
| | 4 Apr 2005 | 5 | 26 | 31 | 0.192 | 0.161 | 0.839 | 6.8 | 35.2 | 42 |
| | 11 Apr 2005 | 63 | 38 | 101 | 1.658 | 0.624 | 0.376 | 117.3 | 70.7 | 188 |
| | **Total** | **334** | **1108** | **1442** | | | | **788.5** | **2,558.5** | **3,473** |
| **All Gears** | **Total** | **878** | **1221** | **2099** | | | | **11,998.0** | **6,393.0** | **18,536** |

**Appendix Table D-2.** ***Sexual condition of male and female Atlantic tomcod in box trap biocharacteristics samples collected in the Hudson River during the spawning season, winter 2004-2005.***

| Sampling Week (Beginning Monday) | | Male | | | | | | | Female | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ripe | Ripe and Running | Partially Spent | Spent | Resting | Develop-ing | Total | Ripe | Ripe and Running | Partially Spent | Spent | Resting | Develop-ing | Total |
| **Age 1** | 13 Dec 2004 | 12 | | | | | 4 | 16 | 5 | | | | | | 5 |
| | 20 Dec 2004 | 73 | 28 | 2 | | | 1 | 104 | 10 | | 2 | | | | 12 |
| | 27 Dec 2004 | 30 | 72 | 41 | 2 | | | 145 | 13 | 4 | 8 | 2 | | | 27 |
| | 3 Jan 2005 | | 7 | 7 | 5 | | | 19 | 8 | 1 | 1 | | | | 10 |
| | 10 Jan 2005 | 2 | 12 | 12 | 7 | | | 33 | 2 | 1 | 2 | 6 | | | 11 |
| | 17 Jan 2005 | | | 30 | 41 | | | 71 | | | 1 | 2 | | | 3 |
| | 24 Jan 2005 | | | 15 | 74 | | | 89 | 1 | | | 2 | | | 3 |
| | 31 Jan 2005 | | | 1 | 15 | | | 16 | | | | | | | 0 |
| | 7 Feb 2005 | | 1 | 5 | 6 | | | 12 | | | | 1 | | | 1 |
| | 14 Feb 2005 | | | 1 | 1 | | | 2 | | | | | | | 0 |
| | 21 Feb 2005 | | | | 1 | | | 1 | | | | | | | 0 |
| | 28 Feb 2005 | | | 1 | 1 | | | 2 | | | | | | | 0 |
| | **Total** | **117** | **120** | **115** | **153** | **0** | **5** | **510** | **39** | **6** | **14** | **13** | **0** | **0** | **72** |
| **Age 2** | 13 Dec 2004 | 2 | | | | | | 2 | | | | | | | 0 |
| | 20 Dec 2004 | 4 | 2 | | | | | 6 | 4 | | 2 | | | | 6 |
| | 27 Dec 2004 | | 1 | 6 | | | | 7 | 11 | 2 | 3 | 2 | | | 18 |
| | 3 Jan 2005 | | 1 | 1 | 1 | | | 3 | 4 | | 1 | 3 | | | 8 |
| | 10 Jan 2005 | | | 1 | | | | 1 | | 1 | | 1 | | | 2 |
| | 17 Jan 2005 | | | 2 | 3 | | | 5 | | | 2 | 1 | | | 3 |
| | 24 Jan 2005 | | | 1 | 7 | | | 8 | | 1 | 1 | 1 | | | 3 |
| | 31 Jan 2005 | | | 1 | | | | 1 | | | | | | | 0 |
| | 7 Feb 2005 | | | | | | | 0 | | 1 | | | | | 1 |
| | 21 Feb 2005 | | | | 1 | | | 1 | | | | | | | 0 |
| | **Total** | **6** | **4** | **12** | **12** | **0** | **0** | **34** | **19** | **5** | **9** | **8** | **0** | **0** | **41** |

**Appendix Table D-3.** ***Sexual condition by station of male and female Atlantic tomcod in box trap biocharacteristics samples collected in the Hudson River during the spawning season, winter 2004-2005.***

| Station | Age | Sampling Week (beginning Monday) | Male | | | | | | Female | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ripe | Ripe and Running | Partially Spent | Spent | Developing | Total | Ripe | Ripe and Running | Partially Spent | Spent | Developing | Total |
| **Marlboro** | Age 1 | 20 Dec 2004 | 1 | | | | | 1 | | | | | | 0 |
| | | Total | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | | **1** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Cornwall** | Age 1 | 20 Dec 2004 | 2 | | | | | 2 | 1 | | | | | 1 |
| | | 10 Jan 2005 | | 1 | | | | 1 | 1 | | 1 | 3 | | 5 |
| | | 17 Jan 2005 | | | 11 | 14 | | 25 | | | | | | 0 |
| | | 24 Jan 2005 | | | 1 | 2 | | 3 | | | | | | 0 |
| | | 31 Jan 2005 | | | | 1 | | 1 | | | | | | 0 |
| | | Total | 2 | 1 | 12 | 17 | 0 | 32 | 2 | 0 | 1 | 3 | 0 | 6 |
| | Age 2 | 20 Dec 2004 | 1 | | | | | 1 | | | | | | 0 |
| | | 17 Jan 2005 | | | | 2 | | 2 | | | 2 | 1 | | 3 |
| | | 31 Jan 2005 | | | 1 | | | 1 | | | | | | 0 |
| | | Total | 1 | 0 | 1 | 2 | 0 | 4 | | 0 | 2 | 1 | 0 | 3 |
| | **Total** | | **3** | **1** | **13** | **19** | **0** | **36** | **2** | **0** | **3** | **4** | **0** | **9** |
| **West Point** | Age 1 | 13 Dec 2004 | 11 | | | | 4 | 15 | 4 | | | | | 4 |
| | | 20 Dec 2004 | 66 | 22 | 2 | | | 90 | 8 | | 2 | | | 10 |
| | | 27 Dec 2004 | 3 | 8 | 31 | 2 | | 44 | 7 | 1 | 3 | 1 | | 12 |
| | | 3 Jan 2005 | | 4 | 3 | 4 | | 11 | 4 | 1 | 1 | | | 6 |
| | | 10 Jan 2005 | 2 | 11 | 12 | 7 | | 32 | 1 | 1 | 1 | 3 | | 6 |
| | | 17 Jan 2005 | | | 6 | 6 | | 12 | | | | | | 0 |
| | | 24 Jan 2005 | | | 1 | 15 | | 16 | 1 | | | | | 1 |
| | | 31 Jan 2005 | | | 1 | 8 | | 9 | | | | | | 0 |
| | | 7 Feb 2005 | | | 1 | 1 | | 2 | | | | | | 0 |
| | | Total | 82 | 45 | 57 | 43 | 4 | 231 | 25 | 3 | 7 | 4 | 0 | 39 |
| | Age 2 | 13 Dec 2004 | 2 | | | | | 2 | | | | | | 0 |
| | | 20 Dec 2004 | 3 | 2 | | | | 5 | 2 | | 2 | | | 4 |
| | | 27 Dec 2004 | | | 1 | | | 1 | 4 | 1 | 3 | 1 | | 9 |
| | | 3 Jan 2005 | | 1 | 1 | 1 | | 3 | 2 | | 1 | 3 | | 6 |
| | | 10 Jan 2005 | | | 1 | | | 1 | | 1 | | 1 | | 2 |
| | | 17 Jan 2005 | | | 1 | 1 | | 2 | | | | | | 0 |
| | | Total | 5 | 3 | 4 | 2 | 0 | 14 | 8 | 2 | 6 | 5 | 0 | 21 |
| | **Total** | | **87** | **48** | **61** | **45** | **4** | **245** | **33** | **5** | **13** | **9** | **0** | **60** |

(continued)

## Appendix Table D-3. (Continued)

| Station | Age | Sampling Week (beginning Monday) | Male | | | | | | Female | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ripe | Ripe and Running | Partially Spent | Spent | Developing | Total | Ripe | Ripe and Running | Partially Spent | Spent | Developing | Total |
| **Garrison** | Age 1 | 20 Dec 2004 | | | | | 1 | 1 | | | | | | 0 |
| | | 3 Jan 2005 | | 1 | 2 | 1 | | 4 | 2 | | | | | 2 |
| | | 17 Jan 2005 | | | 5 | 6 | | 11 | | | 1 | 1 | | 2 |
| | | 24 Jan 2005 | | | 3 | 4 | | 7 | | | | | | 0 |
| | | 31 Jan 2005 | | | | 2 | | 2 | | | | | | 0 |
| | | 7 Feb 2005 | | | | 1 | | 1 | | | | | | 0 |
| | | Total | 0 | 1 | 10 | 14 | 1 | 26 | 2 | 0 | 1 | 1 | 0 | 4 |
| | Age 2 | 20 Dec 2004 | | | | | | 0 | 1 | | | | | 1 |
| | | 3 Jan 2005 | | | | | | 0 | 2 | | | | | 2 |
| | | 17 Jan 2005 | | | 1 | | | 1 | | | | | | 0 |
| | | 24 Jan 2005 | | | | 1 | | 1 | | 1 | | | | 1 |
| | | Total | 0 | 0 | 1 | 1 | 0 | 2 | 3 | 1 | 0 | 0 | 0 | 4 |
| | **Total** | | **0** | **1** | **11** | **15** | **1** | **28** | **5** | **1** | **1** | **1** | **0** | **8** |
| **Croton** | Age 1 | 20 Dec 2004 | 1 | | | | | 1 | | | | | | 0 |
| | | 3 Jan 2005 | | 2 | 2 | | | 4 | 2 | | | | | 2 |
| | | 17 Jan 2005 | | | 5 | 6 | | 11 | | | | | | 0 |
| | | 14 Feb 2005 | | | 1 | | | 1 | | | | | | 0 |
| | | Total | 1 | 2 | 8 | 6 | 0 | 17 | 2 | 0 | 0 | 0 | 0 | 2 |
| | Age 2 | 21 Feb 2005 | | | | 1 | | 1 | | | | | | 0 |
| | | Total | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | | **1** | **2** | **8** | **7** | **0** | **18** | **2** | **0** | **0** | **0** | **0** | **2** |
| **Nyack** | Age 1 | 20 Dec 2004 | | 1 | | | | 1 | | | | | | 0 |
| | | Total | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Total** | | **0** | **1** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** |

(continued)

## Appendix Table D-3. (Continued)

| Station | Age | Sampling Week (beginning Monday) | Male | | | | | | Female | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ripe | Ripe and Running | Partially Spent | Spent | Developing | Total | Ripe | Ripe and Running | Partially Spent | Spent | Developing | Total |
| **Irvington** | Age 1 | 13 Dec 2004 | 1 | | | | | 1 | 1 | | | | | 1 |
| | | 20 Dec 2004 | 3 | 5 | | | | 8 | 1 | | | | | 1 |
| | | 27 Dec 2004 | 27 | 64 | 10 | | | 101 | 6 | 3 | 5 | 1 | | 15 |
| | | 17 Jan 2005 | | | 3 | 9 | | 12 | | | | 1 | | 1 |
| | | 24 Jan 2005 | | | 10 | 53 | | 63 | | | | 2 | | 2 |
| | | 31 Jan 2005 | | | | 4 | | 4 | | | | | | 0 |
| | | 7 Feb 2005 | | 1 | 4 | 4 | | 9 | | | | 1 | | 1 |
| | | 14 Feb 2005 | | | | 1 | | 1 | | | | | | 0 |
| | | 21 Feb 2005 | | | | 1 | | 1 | | | | | | 0 |
| | | 28 Feb 2005 | | | 1 | 1 | | 2 | | | | | | 0 |
| | | Total | 31 | 70 | 28 | 73 | 0 | 202 | 8 | 3 | 5 | 5 | 0 | 21 |
| | Age 2 | 20 Dec 2004 | | | | | | 0 | 1 | | | | | 1 |
| | | 27 Dec 2004 | | 1 | 5 | | | 6 | 7 | 1 | | 1 | | 9 |
| | | 17 Jan 2005 | | | 1 | 1 | | 2 | | | | | | 0 |
| | | 24 Jan 2005 | | | | 5 | | 5 | | | 1 | 1 | | 2 |
| | | 7 Feb 2005 | | | | | | 0 | | 1 | | | | 1 |
| | | Total | 0 | 1 | 6 | 6 | 0 | 13 | 8 | 2 | 1 | 2 | 0 | 13 |
| | **Total** | | **31** | **71** | **34** | **79** | **0** | **215** | **16** | **5** | **6** | **7** | **0** | **34** |

**Appendix Table D-4. Sexual condition of male and female Atlantic tomcod in trawl biocharacteristics samples collected in the Hudson River during the spawning season, winter 2004-2005.**

| Sampling Week (beginning Monday) | | Male | | | | | | | Female | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ripe | Ripe and Running | Partially Spent | Spent | Resting | Develop-ing | Total | Ripe | Ripe and Running | Partially Spent | Spent | Resting | Develop-ing | Total |
| Age 1 | 1 Nov 2004 | | | | | 1 | 35 | 36 | | | | | 3 | 64 | 67 |
| | 8 Nov 2004 | | | | | | 8 | 8 | | | | | | 40 | 40 |
| | 15 Nov 2004 | | | | | | 20 | 20 | | | | | | 34 | 34 |
| | 22 Nov 2004 | | | | | | 12 | 12 | | | | | | 57 | 57 |
| | 29 Nov 2004 | | | | | | 16 | 16 | | | | | | 50 | 50 |
| | 6 Dec 2004 | | | | | | 20 | 20 | | | | | 1 | 63 | 64 |
| | 13 Dec 2004 | 5 | | | | | 15 | 20 | 17 | | | | | 48 | 65 |
| | 20 Dec 2004 | 3 | | | | | 1 | 4 | 27 | | | | | 4 | 31 |
| | 27 Dec 2004 | | | | | | | 0 | 4 | | | | | | 4 |
| | 3 Jan 2005 | | | | | | | 0 | 9 | | | | | | 9 |
| | 10 Jan 2005 | | | | | | | 0 | 7 | | | 28 | 4 | 1 | 40 |
| | 17 Jan 2005 | | | | | | | 0 | | | | 16 | | | 16 |
| | 7 Feb 2005 | | 1 | | 6 | 6 | | 13 | | | | 34 | 44 | | 78 |
| | 14 Feb 2005 | | | | 7 | 11 | | 18 | | | 1 | 15 | 67 | | 83 |
| | 21 Feb 2005 | | | | 3 | 1 | | 4 | | | 1 | 6 | 9 | | 16 |
| | 28 Feb 2005 | | | 1 | 3 | 12 | | 16 | | | | | 37 | | 37 |
| | 7 Mar 2005 | | | | | 5 | | 5 | | | | 1 | 11 | | 12 |
| | 14 Mar 2005 | | | | 3 | 25 | | 28 | | | | | 53 | | 53 |
| | 21 Mar 2005 | | | | | 2 | | 2 | | | | | 15 | | 15 |
| | 28 Mar 2005 | | | | | 22 | | 22 | | | | | 64 | | 64 |
| | 4 Apr 2005 | | | | | 1 | | 1 | | | | | 12 | | 12 |
| | 11 Apr 2005 | | | | | 62 | | 62 | | | | | 35 | | 35 |
| | **Total** | **8** | **1** | **1** | **22** | **148** | **127** | **307** | **64** | **0** | **2** | **100** | **355** | **361** | **882** |

(continued)

## Appendix Table D-4. (Continued)

| Sampling Week (beginning Monday) | | Male | | | | | | | Female | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ripe | Ripe and Running | Partially Spent | Spent | Resting | Develop-ing | Total | Ripe | Ripe and Running | Partially Spent | Spent | Resting | Develop-ing | Total |
| Age 2 | 1 Nov 2004 | | | | | | 3 | 3 | | | | | | 15 | 15 |
| | 8 Nov 2004 | | | | | | | 0 | | | | | | 5 | 5 |
| | 15 Nov 2004 | | | | | | | 0 | | | | | | 3 | 3 |
| | 22 Nov 2004 | | | | | | 3 | 3 | | | | | | 8 | 8 |
| | 29 Nov 2004 | | | | | | 2 | 2 | | | | | | 7 | 7 |
| | 6 Dec 2004 | | | | | | | 0 | | | | | | 7 | 7 |
| | 13 Dec 2004 | | | | | | | 0 | 3 | | | | | 9 | 12 |
| | 20 Dec 2004 | | | | | | | 0 | 6 | | | | | 1 | 7 |
| | 3 Jan 2005 | | | | | | | 0 | 1 | | | | | | 1 |
| | 10 Jan 2005 | | | | | | | 0 | 1 | | | 9 | | 1 | 11 |
| | 17 Jan 2005 | | | | | | | 0 | | | | 20 | | | 20 |
| | 7 Feb 2005 | | | | 1 | | | 1 | | | | 10 | 1 | | 11 |
| | 14 Feb 2005 | | | | | 1 | | 1 | | | | 3 | 9 | | 12 |
| | 21 Feb 2005 | | | | 2 | | | 2 | | | | 8 | 4 | | 12 |
| | 28 Feb 2005 | | | | 1 | | | 1 | | | | 3 | 23 | | 26 |
| | 7 Mar 2005 | | | | | 1 | | 1 | | | 1 | | 3 | | 4 |
| | 14 Mar 2005 | | | | | 2 | | 2 | | | 1 | 2 | 20 | | 23 |
| | 21 Mar 2005 | | | | | 2 | | 2 | | | | 1 | 5 | | 6 |
| | 28 Mar 2005 | | | | 1 | 3 | | 4 | | | 1 | | 20 | | 21 |
| | 4 Apr 2005 | | | | | 4 | | 4 | | | | | 12 | | 12 |
| | 11 Apr 2005 | | | | | 1 | | 1 | | | | | 3 | | 3 |
| | **Total** | **0** | **0** | **0** | **5** | **14** | **8** | **27** | **11** | **0** | **3** | **56** | **100** | **56** | **226** |

**Appendix Table D-5. Analysis of variance results from least squares regression on 2004-2005 Atlantic tomcod data.**

| Appendix Figure Number | Model | | Analysis of Variance | | | | | | | Estimated Regression Coefficients | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dependent Variable | Independent Variable | Source | df | SS | MS | F | P > F | R-Squared | Slope ±S.E. | Intercept ±S.E. |
| D-1 (male) | $Log_{10}$ Weight | $Log_{10}$ Length | Model | 1 | 54.96 | 54.96 | 18,452 | <0.0001 | 0.95 | 3.108 ±0.023 | -5.317 ±0.050 |
| | | | Error | 984 | 2.93 | 0.003 | | | | | |
| | | | **Total** | **985** | **57.89** | | | | | | |
| D-2 (female) | $Log_{10}$ Weight | $Log_{10}$ Length | Model | 1 | 85.33 | 85.33 | 29,246 | <0.0001 | 0.95 | 3.143 ±0.018 | -5.353 ±0.042 |
| | | | Error | 1392 | 4.06 | 0.003 | | | | | |
| | | | **Total** | **1393** | **89.39** | | | | | | |
| D-3 (female) | $Log_{10}$ Fecundity | $Log_{10}$ Length | Model | 1 | 5.63 | 5.63 | 534 | <0.0001 | 0.90 | 3.104 ±0.134 | -2.815 ±0.309 |
| | | | Error | 61 | 0.64 | 0.011 | | | | | |
| | | | **Total** | **63** | **6.28** | | | | | | |

Df = degrees of freedom
SS = sum of squares
MS = mean square
F = calculated F-ratio
p>F = probability of obtaining a larger F-ratio
S.E. = standard error

**Appendix Table D-6. Predicted weight for pre- and postspawning male and female Atlantic tomcod caught by 9 m trawls or box traps in the Hudson River, winter 2004-2005.**

| Sex | Reproductive Stage | Gear | Predicted Weight (Grams) at Length[a] | | |
|---|---|---|---|---|---|
| | | | N | 125 mm | 175 mm |
| Male | Prespawning | 9 m trawl | 8 | 20.3 | 52.3 |
| | | Box trap | 126 | 16.1 | 47.1 |
| | Postspawning | Box trap | 168 | 14.5 | 39.9 |
| | | 9 m trawl | 26 | 15.3 | 42.1 |
| Female | Prespawning | 9 m trawl | 73 | 19.1 | 56.4 |
| | | Box trap | 69 | 18.8 | 56.0 |
| | Postspawning | Box trap | 25 | 14.3 | 40.0 |
| | | 9 m trawl | 154 | 15.9 | 45.0 |

[a] Back-transformed from $Log_{10}$ weight, which was predicted using the following regression equation: $Log_{10}$ weight = $b_0 + b_1$ ($Log_{10}$ length).

# APPENDIX E

## Atlantic Tomcod Distribution and Movements

**Appendix Table E-1. Atlantic tomcod marked with visual implant tags in box traps between Yonkers and Poughkeepsie and recaptured in a 9 m trawl south of the George Washington Bridge in the Hudson River, winter 2004-2005.**

| Tag Number | Release | | Recapture | | Days at Large | Distance Moved | | Sex | Total Length (mm) | Age |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | River Mile | Date | River Mile | | Miles | Km | | | |
| BLI | 22 Dec 2004 | 52 | 13 Apr 2005 | 9 | 112 | 43 | 69 | M | 157 | 1 |
| EKA | 30 Dec 2004 | 52 | 4 Feb 2005 | 9 | 36 | 43 | 69 | F | 260 | 2 |
| MDP | 3 Jan 2005 | 25 | 11 Feb 2005 | 8 | 39 | 17 | 27 | M | 168 | 1 |
| MEG | 3 Jan 2005 | 25 | 22 Feb 2005 | 7 | 50 | 18 | 29 | M | 189 | 1 |
| MZK | 4 Jan 2005 | 56 | 8 Feb 2005 | 5 | 35 | 51 | 82 | F | 158 | 1 |
| OHZ | 4 Jan 2005 | 56 | 29 Mar 2005 | 8 | 84 | 48 | 77 | F | 250 | 2 |
| UZD | 12 Jan 2005 | 51 | 7 Feb 2005 | -3 | 26 | 53 | 85 | F | 195 | 1 |
| VKM | 18 Jan 2005 | 52 | 8 Mar 2005 | 7 | 49 | 45 | 72 | M | 200 | 1 |
| WHP | 12 Jan 2005 | 52 | 16 Mar 2005 | 9 | 63 | 43 | 69 | M | 138 | 1 |
| YAE | 18 Jan 2005 | 52 | 13 Apr 2005 | 9 | 85 | 43 | 69 | M | 248 | 2 |

UZD was recaptured in the Upper Harbor between 2 and 3 miles south of the Battery.

**Appendix Table E-2. Recaptured Atlantic tomcod cross-classified by release and recapture period for fish marked and released from box traps north of the Bear Mountain Bridge and recaptured in a 9 m trawl south of the George Washington Bridge in the Hudson River, winter 2004-2005.**

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 212 | 20 Dec M = 473 | 27 Dec M = 1,856 | 3 Jan M = 2,977 | 10 Jan M = 2,270 | 17 Jan M = 1,709 | 24 Jan M = 467 | 31 Jan M = 235 | 7 Feb M = 191 | 14 Feb–21 Feb M = 25 | Total M = 10,415 |
| 6-13 Dec | 341 | R | 0 | | | | | | | | | | 0 |
| | | R/M | 0.00000 | | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | | | | | | | | | | 0.00000 |
| 20 Dec | 45 | R | 0 | 0 | | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| 27 Dec | 10 | R | 0 | 0 | 0 | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| 3 Jan | 16 | R | 0 | 0 | 0 | 0 | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| 10 Jan | 62 | R | 0 | 0 | 0 | 0 | 0 | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| 17 Jan | 39 | R | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | 0.00000 |
| 24 Jan | 0 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | 0.00000 |
| | | R/C | | | | | | | | | | | |
| 31 Jan | 126 | R | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00054 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | 0.00010 |
| | | R/C | 0.00000 | 0.00000 | 0.00794 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | 0.00794 |
| 7 Feb | 285 | R | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | 2 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00034 | 0.00044 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00019 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00351 | 0.00351 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00702 |

(continued)

## Appendix Table E-2. (Continued)

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 212 | 20 Dec M = 473 | 27 Dec M = 1,856 | 3 Jan M = 2,977 | 10 Jan M = 2,270 | 17 Jan M = 1,709 | 24 Jan M = 467 | 31 Jan M = 235 | 7 Feb M = 191 | 14 Feb–21 Feb M = 25 | Total M = 10,415 |
| 14 Feb | 240 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 21 Feb | 50 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 28 Feb | 98 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 7 Mar | 137 | R | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00059 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00010 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00730 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00730 |
| 14 Mar | 178 | R | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00044 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00010 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00562 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00562 |
| 21 Mar | 28 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 28 Mar | 125 | R | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00034 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00010 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00800 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00800 |
| 4 Apr | 42 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 11 Apr | 188 | R | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| | | R/M | 0.00000 | 0.00212 | 0.00000 | 0.00000 | 0.00000 | 0.00059 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00019 |
| | | R/C | 0.00000 | 0.00532 | 0.00000 | 0.00000 | 0.00000 | 0.00532 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.01064 |
| **Total** | **2,010** | **R** | **0** | **1** | **1** | **2** | **2** | **2** | **0** | **0** | **0** | **0** | **8** |
| | | **R/M** | **0.00000** | **0.00212** | **0.00054** | **0.00067** | **0.00088** | **0.00117** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00077** |
| | | **R/C** | **0.00000** | **0.00050** | **0.00050** | **0.00100** | **0.00100** | **0.00100** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00398** |

M = number of fish tagged and released from box traps north of the Bear Mountain Bridge, adjusted for handling mortality of 10.0% prior to 1 January, and 2.5% on and after 1 January.

C = number of fish caught and examined for tags from a 9 m trawl in the Battery region.

R = number of Atlantic tomcod tagged and released from box traps north of the Bear Mountain Bridge and recaptured from a 9 m trawl in the Battery region.

R/M = recapture rate.

R/C = recapture proportion.

**Appendix Table E-3. Recaptured Atlantic tomcod cross-classified by release and recapture period for fish marked and released from box traps in the Yonkers-Indian Point region and recaptured in a 9 m trawl south of the George Washington Bridge in the Hudson River, winter 2004-2005.**

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 56 | 20 Dec M = 419 | 27 Dec M = 0 | 3 Jan M = 1,269 | 10 Jan M = 431 | 17 Jan M = 496 | 24 Jan M = 126 | 31 Jan M = 125 | 7 Feb M = 86 | 14 Feb–21 Feb M = 23 | Total M = 3,031 |
| 6-13 Dec | 341 | R | 0 | | | | | | | | | | 0 |
| | | R/M | 0.00000 | | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | | | | | | | | | | 0.00000 |
| 20 Dec | 45 | R | 0 | 0 | | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| 27 Dec | 10 | R | 0 | 0 | 0 | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| 3 Jan | 16 | R | 0 | 0 | 0 | 0 | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| 10 Jan | 62 | R | 0 | 0 | 0 | 0 | 0 | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| 17 Jan | 39 | R | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | 0.00000 |
| 24 Jan | 0 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | 0.00000 |
| | | R/C | | | | | | | | | | | |
| 31 Jan | 126 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | 0.00000 |
| 7 Feb | 285 | R | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | 1 |
| | | R/M | 0.00000 | 0.00000 | | 0.00079 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00033 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00351 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00351 |
| 14 Feb | 240 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |

(continued)

## Appendix Table E-3. (Continued)

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 56 | 20 Dec M = 419 | 27 Dec M = 0 | 3 Jan M = 1,269 | 10 Jan M = 431 | 17 Jan M = 496 | 24 Jan M = 126 | 31 Jan M = 125 | 7 Feb M = 86 | 14 Feb–21 Feb M = 23 | Total M = 3,031 |
| 21 Feb | 50 | R | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | | 0.00079 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00033 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.02000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.02000 |
| 28 Feb | 98 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 7 Mar | 137 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 14 Mar | 178 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 21 Mar | 28 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 28 Mar | 125 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 4 Apr | 42 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 11 Apr | 188 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| **Total** | **2,010** | **R** | **0** | **0** | **0** | **2** | **0** | **0** | **0** | **0** | **0** | **0** | **2** |
| | | **R/M** | **0.00000** | **0.00000** | | **0.00158** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00066** |
| | | **R/C** | **0.00000** | **0.00000** | **0.00000** | **0.00100** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00000** | **0.00100** |

M = number of fish tagged and released from box traps south of the Bear Mountain Bridge, adjusted for handling mortality of 10.0% prior to 1 January, and 2.5% on and after 1 January.

C = number of fish caught and examined for tags from a 9 m trawl in the Battery region.

R = number of Atlantic tomcod tagged and released from box traps south of the Bear Mountain Bridge and recaptured from a 9 m trawl in the Battery region.

R/M = recapture rate.

R/C = recapture proportion.

**Appendix Table E-4.** ***Recaptured Atlantic tomcod cross-classified by release and recapture period for fish marked, released, and recaptured in box traps in the Yonkers-Indian Point region of the Hudson River, winter 2004-2005.***

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 56 | 20 Dec M = 419 | 27 Dec M = 0 | 3 Jan M = 1,269 | 10 Jan M = 431 | 17 Jan M = 496 | 24 Jan M = 126 | 31 Jan M = 125 | 7 Feb M = 86 | 14 Feb–21 Feb M = 23 | Total M = 3,031 |
| 6-13 Dec | 68 | R | 3 | | | | | | | | | | 3 |
| | | R/M | 0.05376 | | | | | | | | | | 0.05376 |
| | | R/C | 0.04412 | | | | | | | | | | 0.04412 |
| 20 Dec | 481 | R | 0 | 1 | | | | | | | | | 1 |
| | | R/M | 0.00000 | 0.00239 | | | | | | | | | 0.00211 |
| | | R/C | 0.00000 | 0.00208 | | | | | | | | | 0.00208 |
| 27 Dec | 131 | R | 0 | 0 | 0 | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| 3 Jan | 1,325 | R | 0 | 2 | 0 | 5 | | | | | | | 7 |
| | | R/M | 0.00000 | 0.00478 | | 0.00394 | | | | | | | 0.00401 |
| | | R/C | 0.00000 | 0.00151 | 0.00000 | 0.00377 | | | | | | | 0.00528 |
| 10 Jan | 471 | R | 0 | 0 | 0 | 3 | 3 | | | | | | 6 |
| | | R/M | 0.00000 | 0.00000 | | 0.00236 | 0.00696 | | | | | | 0.00276 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00637 | 0.00637 | | | | | | 0.01274 |
| 17 Jan | 550 | R | 1 | 2 | 0 | 6 | 1 | 0 | | | | | 10 |
| | | R/M | 0.01792 | 0.00478 | | 0.00473 | 0.00232 | 0.00000 | | | | | 0.00374 |
| | | R/C | 0.00182 | 0.00364 | 0.00000 | 0.01091 | 0.00182 | 0.00000 | | | | | 0.01818 |
| 24 Jan | 206 | R | 0 | 0 | 0 | 2 | 1 | 0 | 1 | | | | 4 |
| | | R/M | 0.00000 | 0.00000 | | 0.00158 | 0.00232 | 0.00000 | 0.00795 | | | | 0.00143 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00971 | 0.00485 | 0.00000 | 0.00485 | | | | 0.01942 |
| 31 Jan | 137 | R | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | | | 2 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00201 | 0.00000 | 0.00801 | | | 0.00068 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00730 | 0.00000 | 0.00730 | | | 0.01460 |
| 7 Feb | 101 | R | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | | 2 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00403 | 0.00000 | 0.00000 | 0.00000 | | 0.00067 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.01980 | 0.00000 | 0.00000 | 0.00000 | | 0.01980 |
| 14 Feb | 23 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 21 Feb | 6 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |

(continued)

## Appendix Table E-4. (Continued)

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 56 | 20 Dec M = 419 | 27 Dec M = 0 | 3 Jan M = 1,269 | 10 Jan M = 431 | 17 Jan M = 496 | 24 Jan M = 126 | 31 Jan M = 125 | 7 Feb M = 86 | 14 Feb–21 Feb M = 23 | Total M = 3,031 |
| 28 Feb | 2 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| **Total** | **3,501** | **R** | **4** | **5** | **0** | **16** | **5** | **3** | **1** | **1** | **0** | **0** | **35** |
| | | **R/M** | **0.07168** | **0.01195** | | **0.01260** | **0.01160** | **0.00604** | **0.00795** | **0.00801** | **0.00000** | **0.00000** | **0.01155** |
| | | **R/C** | **0.00114** | **0.00143** | **0.00000** | **0.00457** | **0.00143** | **0.00086** | **0.00029** | **0.00029** | **0.00000** | **0.00000** | **0.01000** |

M = number of fish tagged and released from box traps south of the Bear Mountain Bridge, adjusted for handling mortality of 10.0% prior to 1 January, and 2.5% on and after 1 January.
C = number of fish caught and examined for tags in box traps south of the Bear Mountain Bridge.
R = number of Atlantic tomcod tagged, released, and recaptured from box traps south of the Bear Mountain Bridge.
R/M = recapture rate.
R/C = recapture proportion.

**Appendix Table E-5. Recaptured Atlantic tomcod cross-classified by release and recapture period for fish marked, released, and recaptured in box traps north of the Bear Mountain Bridge in the Hudson River, winter 2004-2005.**

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 212 | 20 Dec M = 473 | 27 Dec M =1,856 | 3 Jan M = 2,977 | 10 Jan M = 2,270 | 17 Jan M = 1,709 | 24 Jan M = 467 | 31 Jan M = 235 | 7 Feb M = 191 | 14 Feb–21 Feb M = 25 | Total M = 10,415 |
| 6-13 Dec | 262 | R | 4 | | | | | | | | | | 4 |
| | | R/M | 0.01883 | | | | | | | | | | 0.01883 |
| | | R/C | 0.01527 | | | | | | | | | | 0.01527 |
| 20 Dec | 643 | R | 0 | 0 | | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| 27 Dec | 2,192 | R | 0 | 2 | 7 | | | | | | | | 9 |
| | | R/M | 0.00000 | 0.00423 | 0.00377 | | | | | | | | 0.00354 |
| | | R/C | 0.00000 | 0.00091 | 0.00319 | | | | | | | | 0.00411 |
| 3 Jan | 3,146 | R | 0 | 1 | 9 | 21 | | | | | | | 31 |
| | | R/M | 0.00000 | 0.00212 | 0.00485 | 0.00705 | | | | | | | 0.00562 |
| | | R/C | 0.00000 | 0.00032 | 0.00286 | 0.00668 | | | | | | | 0.00985 |
| 10 Jan | 2,432 | R | 0 | 0 | 10 | 13 | 15 | | | | | | 38 |
| | | R/M | 0.00000 | 0.00000 | 0.00539 | 0.00437 | 0.00661 | | | | | | 0.00488 |
| | | R/C | 0.00000 | 0.00000 | 0.00411 | 0.00535 | 0.00617 | | | | | | 0.01563 |
| 17 Jan | 1,856 | R | 0 | 0 | 8 | 15 | 15 | 5 | | | | | 43 |
| | | R/M | 0.00000 | 0.00000 | 0.00431 | 0.00504 | 0.00661 | 0.00293 | | | | | 0.00453 |
| | | R/C | 0.00000 | 0.00000 | 0.00431 | 0.00808 | 0.00808 | 0.00269 | | | | | 0.02317 |
| 24 Jan | 536 | R | 0 | 0 | 4 | 9 | 3 | 7 | 1 | | | | 24 |
| | | R/M | 0.00000 | 0.00000 | 0.00216 | 0.00302 | 0.00132 | 0.00410 | 0.00214 | | | | 0.00241 |
| | | R/C | 0.00000 | 0.00000 | 0.00746 | 0.01679 | 0.00560 | 0.01306 | 0.00187 | | | | 0.04478 |
| 31 Jan | 260 | R | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 2 | | | 6 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00034 | 0.00088 | 0.00000 | 0.00214 | 0.00851 | | | 0.00059 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00385 | 0.00769 | 0.00000 | 0.00385 | 0.00769 | | | 0.02308 |
| 7 Feb | 207 | R | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 0 | 2 | | 8 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00044 | 0.00234 | 0.00214 | 0.00000 | 0.01047 | | 0.00077 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00483 | 0.01932 | 0.00483 | 0.00000 | 0.00966 | | 0.03865 |
| 14 Feb | 27 | R | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00034 | 0.00044 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00019 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.03704 | 0.03704 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.07407 |
| 21 Feb | 1 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |

(continued)

## Appendix Table E-5. (Continued)

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 212 | 20 Dec M = 473 | 27 Dec M =1,856 | 3 Jan M = 2,977 | 10 Jan M = 2,270 | 17 Jan M = 1,709 | 24 Jan M = 467 | 31 Jan M = 235 | 7 Feb M = 191 | 14 Feb–21 Feb M = 25 | Total M = 10,415 |
| 28 Feb | 0 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | | | | | | | | | | | |
| **Total** | **11,562** | **R** | **4** | **3** | **38** | **60** | **37** | **16** | **3** | **2** | **2** | **0** | **165** |
| | | **R/M** | **0.01883** | **0.00635** | **0.02048** | **0.02016** | **0.01630** | **0.00936** | **0.00642** | **0.00851** | **0.01047** | **0.00000** | **0.01584** |
| | | **R/C** | **0.00035** | **0.00026** | **0.00329** | **0.00519** | **0.00320** | **0.00138** | **0.00026** | **0.00017** | **0.00017** | **0.00000** | **0.01427** |

M = number of fish tagged and released from box traps north of the Bear Mountain Bridge, adjusted for handling mortality of 10.0% prior to 1 January, and 2.5% on and after 1 January.
C = number of fish caught and examined for tags in box traps north of the Bear Mountain Bridge.
R = number of Atlantic tomcod tagged, released, and recaptured from box traps north of the Bear Mountain Bridge.
R/M = recapture rate.
R/C = recapture proportion.

**Appendix Table E-6. Recaptured Atlantic tomcod cross-classified by release and recapture period for fish marked and released from box traps north of the Bear Mountain Bridge and recaptured in box traps in the Yonkers-Indian Point region of the Hudson River, winter 2004-2005.**

| Recapture Period | Number Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 212 | 20 Dec M = 473 | 27 Dec M =1,856 | 3 Jan M = 2,977 | 10 Jan M = 2,270 | 17 Jan M = 1,709 | 24 Jan M = 467 | 31 Jan M = 235 | 7 Feb M = 191 | 14 Feb–21 Feb M = 25 | Total M = 10,415 |
| 6-13 Dec | 68 | R | 0 | | | | | | | | | | 0 |
| | | R/M | 0.00000 | | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | | | | | | | | | | 0.00000 |
| 20 Dec | 481 | R | 0 | 0 | | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | | | | | | | | | 0.00000 |
| 27 Dec | 131 | R | 0 | 0 | 0 | | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | | | | | | | | 0.00000 |
| 3 Jan | 1,325 | R | 0 | 0 | 0 | 0 | | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | | 0.00000 |
| 10 Jan | 471 | R | 0 | 0 | 0 | 0 | 0 | | | | | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | | | | | 0.00000 |
| 17 Jan | 550 | R | 1 | 0 | 0 | 2 | 2 | 0 | | | | | 5 |
| | | R/M | 0.00471 | 0.00000 | 0.00000 | 0.00067 | 0.00088 | 0.00000 | | | | | 0.00053 |
| | | R/C | 0.00182 | 0.00000 | 0.00000 | 0.00364 | 0.00364 | 0.00000 | | | | | 0.00909 |
| 24 Jan | 206 | R | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | | | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00034 | 0.00000 | 0.00000 | 0.00000 | | | | 0.00010 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00485 | 0.00000 | 0.00000 | 0.00000 | | | | 0.00485 |
| 31 Jan | 137 | R | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | | | 3 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00034 | 0.00088 | 0.00000 | 0.00000 | 0.00000 | | | 0.00029 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00730 | 0.01460 | 0.00000 | 0.00000 | 0.00000 | | | 0.02190 |
| 7 Feb | 101 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | 0.00000 |
| 14 Feb | 23 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00523 | 0.00000 | 0.00010 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.04348 | 0.00000 | 0.04348 |

## Appendix Table E-6. (Continued)

| Recapture Period | *Number* Examined for Tags (C) | Statistic | Recaptured Atlantic Tomcod from Release Week(s) Beginning | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 6 Dec–13 Dec M = 212 | 20 Dec M = 473 | 27 Dec M =1,856 | 3 Jan M = 2,977 | 10 Jan M = 2,270 | 17 Jan M = 1,709 | 24 Jan M = 467 | 31 Jan M = 235 | 7 Feb M = 191 | 14 Feb–21 Feb M = 25 | *Total* M = 10,415 |
| 21 Feb | 6 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 28 Feb | 2 | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | R/M | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| | | R/C | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| **Total** | **3,501** | **R** | **1** | **0** | **0** | **4** | **4** | **0** | **0** | **0** | **1** | **0** | **10** |
| | | **R/M** | **0.00471** | **0.00000** | **0.00000** | **0.00134** | **0.00176** | **0.00000** | **0.00000** | **0.00000** | **0.00523** | **0.00000** | **0.00096** |
| | | **R/C** | **0.00029** | **0.00000** | **0.00000** | **0.00114** | **0.00114** | **0.00000** | **0.00000** | **0.00000** | **0.00029** | **0.00000** | **0.00286** |

M = number of fish tagged and released from box traps north of the Bear Mountain Bridge, adjusted for handling mortality of 10.0% prior to 1 January, and 2.5% on and after 1 January.
C = number of fish caught and examined for tags in box traps south of the Bear Mountain Bridge.
R = number of Atlantic tomcod tagged and released from box traps north of the Bear Mountain Bridge and recaptured in box traps south of the Bear Mountain Bridge.
R/M = recapture rate.
R/C = recapture proportion.

**Appendix Table E-7. Atlantic tomcod marked and released during winter 2003-2004 and recaptured during winter 2004-2005 in the Hudson River.**

| Tag Number | Recapture | | | | Release | | | | Sex | Total Length (mm) | Age |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | Gear | Mile | Km | Date | Gear | Mile | Km | | | |
| AAM | 3 Jan 2005 | Box trap | 25 | 40 | 22 Jan 2004 | Box trap | 29 | 47 | 1 | 222 | 2 |
| AFM | 25 Jan 2005 | Box trap | 29 | 47 | 23 Jan 2004 | Box trap | 29 | 47 | 1 | 220 | 2 |
| ALC | 13 Jan 2005 | Box trap | 25 | 40 | 27 Jan 2004 | Box trap | 29 | 47 | 2 | 280 | 2 |
| BRB | 20 Jan 2005 | Box trap | 52 | 84 | 8 Jan 2004 | Box trap | 52 | 84 | 1 | 262 | 2 |
| BSZ | 28 Dec 2004 | Box trap | 51 | 82 | 8 Jan 2004 | Box trap | 43 | 69 | 2 | 268 | 2 |
| CSU | 23 Dec 2004 | Box trap | 25 | 40 | 22 Dec2003 | Box trap | 25 | 40 | 2 | 264 | 2 |
| CUY | 14 Jan 2005 | Box trap | 68 | 109 | 22 Dec2003 | Box trap | 25 | 40 | 1 | 243 | 2 |
| DVK | 11 Jan 2005 | Box trap | 52 | 84 | 23 Dec2003 | Box trap | 52 | 84 | 1 | 247 | 2 |
| IFG | 12 Jan 2005 | 9 m trawl | 8 | 13 | 11 Nov2003 | 9 m trawl | 9 | 14 | 2 | 253 | 2 |
| IHS | 26 Jan 2005 | Box trap | 25 | 40 | 11 Nov2003 | 9 m trawl | 7 | 11 | 2 | 258 | 2 |
| IIS | 15 Dec 2004 | 9 m trawl | 9 | 14 | 11 Nov2003 | 9 m trawl | 7 | 11 | 2 | 267 | 2 |
| ISE | 11 Jan 2005 | Box trap | 52 | 84 | 14 Nov2003 | 9 m trawl | 8 | 13 | 1 | 231 | 2 |
| IUM | 15 Dec 2004 | 9 m trawl | 8 | 13 | 18 Nov2003 | 9 m trawl | 7 | 11 | 2 | 269 | 2 |
| IWH | 3 Nov 2004 | 9 m trawl | 8 | 13 | 18 Nov2003 | 9 m trawl | 7 | 11 | 1 | 232 | 2 |
| JDH | 12 Jan 2005 | Box trap | 68 | 109 | 20 Nov2003 | 9 m trawl | 7 | 11 | 1 | 245 | 2 |
| JHX | 19 Nov 2004 | 9 m trawl | 9 | 14 | 21 Nov2003 | 9 m trawl | 9 | 14 | 2 | 277 | 2 |
| JUK | 8 Nov 2004 | 9 m trawl | 8 | 13 | 5 Dec2003 | 9 m trawl | 8 | 13 | 2 | 266 | 2 |
| KBL | 7 Mar 2005 | 9 m trawl | 8 | 13 | 11 Dec2003 | 9 m trawl | 8 | 13 | 2 | 300 | 2 |
| KHN | 18 Feb 2005 | 9 m trawl | 8 | 13 | 18 Dec2003 | 9 m trawl | 7 | 11 | 2 | 275 | 2 |
| KXX | 22 Dec 2004 | Box trap | 52 | 84 | 24 Dec2003 | Box trap | 52 | 84 | 1 | 206 | 2 |
| LUJ | 12 Jan 2005 | Box trap | 68 | 109 | 29 Dec2003 | Box trap | 52 | 84 | 1 | 211 | 2 |
| LZL | 1 Feb 2005 | Box trap | 56 | 90 | 29 Dec2003 | Box trap | 52 | 84 | 1 | 229 | 2 |
| MCN | 5 Jan 2005 | Box trap | 51 | 82 | 29 Dec2003 | Box trap | 25 | 40 | 1 | 235 | 2 |
| MMT | 30 Dec 2004 | Box trap | 52 | 84 | 29 Dec2003 | Box trap | 25 | 40 | 1 | 231 | 2 |
| MWZ | 26 Jan 2005 | Box trap | 52 | 84 | 30 Dec2003 | Box trap | 25 | 40 | 1 | 241 | 2 |
| NKB | 16 Dec 2004 | Box trap | 25 | 40 | 30 Dec2003 | Box trap | 25 | 40 | 1 | 244 | 2 |
| NKN | 5 Jan 2005 | Box trap | 52 | 84 | 30 Dec2003 | Box trap | 25 | 40 | 1 | 260 | 2 |
| NYM | 29 Dec 2004 | Box trap | 51 | 82 | 30 Dec2003 | Box trap | 52 | 84 | 1 | 223 | 2 |
| OLW | 20 Dec 2004 | Box trap | 51 | 82 | 31 Dec2003 | Box trap | 68 | 109 | 1 | 254 | 2 |
| ONU | 4 Jan 2005 | Box trap | 56 | 90 | 31 Dec2003 | Box trap | 56 | 90 | 2 | 265 | 2 |
| PMY | 21 Jan 2005 | Box trap | 52 | 84 | 2 Jan 2004 | Box trap | 52 | 84 | 1 | 226 | 2 |
| PNX | 13 Jan 2005 | Box trap | 68 | 109 | 2 Jan 2004 | Box trap | 52 | 84 | 1 | 232 | 2 |
| RIW | 4 Jan 2005 | Box trap | 56 | 90 | 5 Jan 2004 | Box trap | 52 | 84 | 1 | 222 | 2 |
| RLH | 20 Jan 2005 | Box trap | 52 | 84 | 5 Jan 2004 | Box trap | 56 | 90 | 1 | 205 | 2 |
| RUX | 4 Jan 2005 | Box trap | 56 | 90 | 5 Jan 2004 | Box trap | 56 | 90 | 2 | 272 | 2 |
| RXH | 7 Jan 2005 | Box trap | 52 | 84 | 5 Jan 2004 | Box trap | 56 | 90 | 2 | 247 | 2 |
| RZW | 13 Dec 2004 | Box trap | 51 | 82 | 5 Jan 2004 | Box trap | 56 | 90 | 1 | 224 | 2 |
| SVH | 30 Dec 2004 | Box trap | 52 | 84 | 6 Jan 2004 | Box trap | 25 | 40 | 1 | 245 | 2 |

(continued)

## Appendix Table E-7. (Continued)

| Tag Number | Recapture | | | | Release | | | | Sex | Total Length (mm) | Age |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | Gear | Mile | Km | Date | Gear | Mile | Km | | | |
| SWB | 26 Jan 2005 | Box trap | 56 | 90 | 6 Jan 2004 | Box trap | 25 | 40 | 1 | 235 | 2 |
| TDO | 21 Dec 2004 | Box trap | 25 | 40 | 6 Jan 2004 | Box trap | 25 | 40 | 2 | 271 | 2 |
| TSY | 30 Mar 2005 | 9 m trawl | 9 | 14 | 6 Jan 2004 | Box trap | 25 | 40 | 1 | 229 | 2 |
| UJE | 29 Dec 2004 | Box trap | 51 | 82 | 7 Jan 2004 | Box trap | 68 | 109 | 1 | 228 | 2 |
| UKN | 12 Jan 2005 | Box trap | 68 | 109 | 7 Jan 2004 | Box trap | 68 | 109 | 1 | 240 | 2 |
| USK | 26 Jan 2005 | Box trap | 52 | 84 | 7 Jan 2004 | Box trap | 68 | 109 | 1 | 231 | 2 |
| VGD | 3 Mar 2005 | 9 m trawl | 1 | 2 | 9 Jan 2004 | Box trap | 52 | 84 | 2 | 263 | 2 |
| VGG | 11 Jan 2005 | Box trap | 52 | 84 | 9 Jan 2004 | Box trap | 52 | 84 | 1 | 210 | 2 |
| XEP | 4 Jan 2005 | Box trap | 56 | 90 | 13 Jan 2004 | Box trap | 52 | 84 | 1 | 222 | 2 |
| XLC | 18 Jan 2005 | Box trap | 52 | 84 | 13 Jan 2004 | Box trap | 52 | 84 | 2 | 268 | 2 |
| XSH | 12 Jan 2005 | Box trap | 56 | 90 | 13 Jan 2004 | Box trap | 56 | 90 | 2 | 235 | 2 |
| YHR | 30 Nov 2004 | 9 m trawl | 9 | 14 | 16 Jan 2004 | Box trap | 29 | 47 | 2 | 261 | 2 |
| YWZ | 7 Jan 2005 | Box trap | 52 | 84 | 20 Jan 2004 | Box trap | 25 | 40 | 1 | 237 | 2 |
| YZX | 3 Jan 2005 | Box trap | 25 | 40 | 22 Jan 2004 | Box trap | 29 | 47 | 1 | 218 | 2 |

**Appendix Table E-8. Mean 9 m trawl catch per ten minute tow during the trawl recapture period as an index of the Petersen estimate of Atlantic tomcod population size in the Hudson River, winters of 1982-1983 through 2004-2005.**

| Petersen Trap-Trawl Estimate | | | | | | | | | | 9 m Trawl CPUE during the Trawl Recapture Period | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mark/Recapture Statistics[b] | | | | | Population Estimate (Millions with 95% Confidence Limits)[c] | | | | | |
| Box Trap Marking Period[a] | Trawl Recapture Period | M | C | R | R/M | R/C | Lower | Estimate | Upper | No. Tows | *Mean CPUE* (Geometric Mean) | *SE* (*SE of* Mean Log CPUE) |
| 29 Nov 1982–26 Feb 1983 | 2 Jan–18 Mar 1983 | 17,552 | 14,053 | 18 | 0.00103 | 0.00128 | 8.1 | 12.5 | 20.3 | 157 | 64.4 (35.6) | 4.9 (0.1) |
| 28 Nov 1983–6 Mar 1984 | 2 Jan–25 Mar 1984 | 25,004 | 6,655 | 24 | 0.00096 | 0.00361 | 4.6 | 6.7 | 10.2 | 242 | 24.2 (12.6) | 2.0 (0.1) |
| 2 Dec 1985–3 Jan 1986 | 30 Dec 1985-21 Mar 1986 | 13,953 | 21,755 | 144 | 0.01032 | 0.00662 | 1.8 | 2.1 | 2.5 | 619 | 30.4 (12.5) | 1.6 (0.1) |
| 14 Dec 1987–29 Jan 1988 | 4 Jan–22 Apr 1988 | 12,458 | 10,473 | 36 | 0.00289 | 0.00344 | 2.6 | 3.5 | 5.0 | 624 | 13.1 (7.3) | 0.7 (<0.1) |
| 12 Dec 1988–29 Jan 1989 | 9 Jan–15 Apr 1989 | 43,589 | 16,776 | 123 | 0.00282 | 0.00733 | 5.0 | 5.9 | 7.0 | 730 | 23.0 (12.5) | 1.1 (<0.1) |
| 11 Dec 1989–28 Jan 1990 | 26 Feb–13 Apr 1990 | 26,227 | 7,523 | 28 | 0.00107 | 0.00372 | 4.8 | 6.8 | 10.1 | 334 | 22.1 (10.1) | 1.7 (0.031) |
| 17 Dec 1990–27 Jan 1991 | 21 Jan–19 Apr 1991 | 20,006 | 4,169 | 25 | 0.00125 | 0.00600 | 2.2 | 3.2 | 4.9 | 587 | 7.0 (3.9) | 0.3 (0.019) |
| 23 Dec 1991–23 Feb 1992 | 20 Jan–26 Apr 1992 | 4,186 | 1,856 | 19 | 0.00454 | 0.01024 | 0.2 | 0.4 | 0.6 | 642 | 2.8 (1.8) | 0.1 (0.014) |
| 7 Dec 1992–7 Feb 1993 | 11 Jan–18 Apr 1993 | 23,100 | 6,853 | 61 | 0.00264 | 0.00890 | 2.0 | 2.6 | 3.3 | 478 | 13.3 (6.8) | 0.7 (0.024) |
| 13 Dec 1993–30 Jan 1994 | 7 Feb–17 Apr 1994 | 7,661 | 1,471 | 16 | 0.00209 | 0.01088 | 0.4 | 0.7 | 1.1 | 353 | 3.9 (2.2) | 0.3 (0.022) |
| 12 Dec 1994–12 Feb 1995 | 13 Feb–19 Mar 1995 | 8,367 | 3,418 | 11 | 0.00131 | 0.00322 | 1.4 | 2.4 | 4.5 | 165 | 20.7 (15.1) | 1.9 (0.038) |
| 11 Dec 1995–19 Feb 1996 | 26 Feb–15 Apr 1996 | 1,862 | 94 | 1 | 0.00054 | 0.01064 | 0.03 | 0.09 | 0.16 | 376 | 0.26 (0.03) | 0.08 (0.02) |
| 23 Dec 1996–2 Feb 1997 | 27 Jan–30 Mar 1997 | 5,743 | 1,711 | 2 | 0.00035 | 0.00117 | 1.0 | 3.3 | 6.1 | 396 | 4.32 (0.58) | 0.20 (0.020) |
| 22 Dec 1997–15 Feb 1998 | 12 Jan–19 Apr 1998 | 11,738 | 1,870 | 16 | 0.00136 | 0.00856 | 0.8 | 1.3 | 2.2 | 575 | 3.0 (2.0) | 0.14 (0.014) |
| 28 Dec 1998–21 Feb 1999 | 1 Feb–11 Apr 1999 | 3,834 | 772 | 4 | 0.00104 | 0.00518 | 0.3 | 0.6 | 1.5 | 304 | 1.8 (0.83) | 0.25 (0.019) |
| 27 Dec 1999–30 Jan 2000 | 14 Feb–9 Apr 2000 | 1,475 | 981 | 7 | 0.00475 | 0.00714 | 0.1 | 0.2 | 0.4 | 344 | 2.7 (0.94) | 0.37 (0.022) |
| 11 Dec 2000–11 Feb 2001 | 15 Jan–8 Apr 2001 | 10,240 | 3,667 | 14 | 0.00137 | 0.00382 | 1.5 | 2.5 | 4.3 | 433 | 8.5 (5.3) | 0.45 (0.020) |

(continued)

## Table E-8. (Continued)

| Petersen Trap-Trawl Estimate | | | | | | | | | | 9 m Trawl CPUE during the Trawl Recapture Period | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mark/Recapture Statistics[b] | | | | | | | | | | |
| | | | | | | | Population Estimate (Millions with 95% Confidence Limits)[c] | | | | | |
| Box Trap Marking Period[a] | Trawl Recapture Period | M | C | R | R/M | R/C | Lower | Estimate | Upper | No. Tows | Mean CPUE (Geometric Mean) | SE (SE of Mean Log CPUE) |
| 31 Dec 2001–17 Feb 2002 | 4 Feb–21 Apr 2002 | 326 | 124 | 0 | 0.00000 | 0.00000 | 0.009 | 0.04 | —[d] | 374 | 0.33 (0.20) | 0.042 (0.009) |
| 23 Dec 2002–23 Feb 2003 | 3 Feb–20 Apr 2003 | 951 | 113 | 0 | 0.00000 | 0.00000 | 0.02 | 0.1 | —[d] | 345 | 0.28 (0.14) | 0.055 (0.009) |
| 15 Dec 2003–1 Feb 2004 | 5 Jan–11 Apr 2004 | 9,836 | 2,352 | 13 | 0.00132 | 0.00553 | 1.0 | 1.7 | 2.9 | 481 | 4.5 (2.4) | 0.34 (0.018) |
| 20 Dec 2004–30 Jan 2005 | 31 Jan–17 Apr 2005 | 12,492 | 1,497 | 10 | 0.00080 | 000668 | 1.0 | 1.7 | 3.3 | 389 | 3.5 (1.9) | 0.31 (0.019) |

[a] The winter survey was not conducted during 1984-1985 and 1986-1987.
[b] R = number of marked Atlantic tomcod released from box traps and recaptured by trawls.
M = number of fish marked and released in box traps, adjusted for handling mortality of 10% prior to 1 January and 2.5% on and after 1 January.
C = number of fish caught and examined for marks.
[c] Preferred estimate.
[d] A meaningful upper confidence limit could not be calculated because there were fewer than two recaptures.

# APPENDIX F

## Atlantic Tomcod Tagging Program

**Appendix Table F-1. Release and recapture statistics for Atlantic tomcod marked with visual implant tags in box traps between Yonkers and Poughkeepsie or in trawls south of the George Washington Bridge and recaptured in box traps or a 9 m trawl in the Hudson River, winter 2004-2005.**

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| RZG | Highland | 6 Jan 2005 | 76 | 250 | Marlboro | 12 Jan 2005 | 68 | 255 | 8 | 6.0 | 5 |
| XXT | Highland | 14 Jan 2005 | 76 | 226 | West Point-N | 18 Jan 2005 | 52 | 231 | 24 | 3.8 | 5 |
| KTR | Highland | 20 Jan 2005 | 76 | 136 | West Point-N | 8 Feb 2005 | 52 | 142 | 24 | 18.7 | 6 |
| KVV | Highland | 20 Jan 2005 | 76 | 255 | Highland | 24 Jan 2005 | 76 | 261 | 0 | 4.0 | 6 |
| ORX | Marlboro | 4 Jan 2005 | 68 | 248 | Cornwall | 20 Jan 2005 | 56 | 245 | 12 | 15.9 | -3 |
| OVS | Marlboro | 4 Jan 2005 | 68 | 130 | Marlboro | 6 Jan 2005 | 68 | 134 | 0 | 2.0 | 4 |
| RXR | Marlboro | 6 Jan 2005 | 68 | 138 | Marlboro | 12 Jan 2005 | 68 | 137 | 0 | 6.0 | -1 |
| WZV | Marlboro | 12 Jan 2005 | 68 | 134 | West Point-N | 8 Feb 2005 | 52 | 134 | 16 | 26.8 | 0 |
| XXM | Marlboro | 14 Jan 2005 | 68 | 145 | Irvington | 4 Feb 2005 | 25 | 150 | 43 | 20.9 | 5 |
| KMP | Marlboro | 20 Jan 2005 | 68 | 208 | West Point-N | 27 Jan 2005 | 52 | 214 | 16 | 6.8 | 6 |
| KOM | Marlboro | 20 Jan 2005 | 68 | 205 | N/A[a] | 19 Apr 2005 | 21 | 212 | 47 | 89 | 7 |
| KPS | Marlboro | 20 Jan 2005 | 68 | 148 | West Point-N | 8 Feb 2005 | 52 | 149 | 16 | 18.8 | 1 |
| C86 | Marlboro | 1 Feb 2005 | 68 | 140 | Marlboro | 2 Feb 2005 | 68 | 141 | 0 | 1.0 | 1 |
| F53 | Marlboro | 8 Feb 2005 | 68 | 148 | Marlboro | 11 Feb 2005 | 68 | 147 | 0 | 2.9 | -1 |
| MNN | Cornwall | 4 Jan 2005 | 56 | 139 | Cornwall | 5 Jan 2005 | 56 | 268 | 0 | 1.0 | ?[b] |
| MOE | Cornwall | 4 Jan 2005 | 56 | 235 | Cornwall | 5 Jan 2005 | 56 | 243 | 0 | 1.0 | 8 |
| MPN | Cornwall | 4 Jan 2005 | 56 | 220 | West Point-N | 7 Jan 2005 | 52 | 232 | 4 | 3.1 | 12 |
| MZB | Cornwall | 4 Jan 2005 | 56 | 250 | Cornwall | 5 Jan 2005 | 56 | 251 | 0 | 1.0 | 1 |
| MZG | Cornwall | 4 Jan 2005 | 56 | 162 | Cornwall | 20 Jan 2005 | 56 | 167 | 0 | 16.1 | 5 |
| MZK | Cornwall | 4 Jan 2005 | 56 | 154 | Battery | 8 Feb 2005 | 5 | 158 | 51 | 35.2 | 4 |
| OBD | Cornwall | 4 Jan 2005 | 56 | 200 | Cornwall | 7 Jan 2005 | 56 | 208 | 0 | 3.2 | 8 |
| ODT | Cornwall | 4 Jan 2005 | 56 | 256 | Cornwall | 5 Jan 2005 | 56 | 256 | 0 | 0.9 | 0 |
| ODW | Cornwall | 4 Jan 2005 | 56 | 271 | Cornwall | 12 Jan 2005 | 56 | 281 | 0 | 8.1 | 10 |
| OFN | Cornwall | 4 Jan 2005 | 56 | 165 | Cornwall | 7 Jan 2005 | 56 | 169 | 0 | 3.1 | 4 |
| OHI | Cornwall | 4 Jan 2005 | 56 | 239 | West Point-N | 11 Jan 2005 | 52 | 243 | 4 | 7.1 | 4 |
| OHZ | Cornwall | 4 Jan 2005 | 56 | 248 | Battery | 29 Mar 2005 | 8 | 250 | 48 | 84.1 | 2 |
| OIS | Cornwall | 4 Jan 2005 | 56 | 219 | Cornwall | 5 Jan 2005 | 56 | 213 | 0 | 0.9 | -6 |
| OLG | Cornwall | 4 Jan 2005 | 56 | 260 | Cornwall | 5 Jan 2005 | 56 | 265 | 0 | 0.9 | 5 |

[a] Recaptured by the Long River Survey ichthyoplankton program in an epibenthic sled.
[b] Growth unknown due to a length recording error.

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| OLO | Cornwall | 4 Jan 2005 | 56 | 228 | West Point-N | 24 Jan 2005 | 52 | 229 | 4 | 20.0 | 1 |
| OLU | Cornwall | 4 Jan 2005 | 56 | 183 | West Point-S | 11 Jan 2005 | 51 | 186 | 5 | 6.9 | 3 |
| NNN | Cornwall | 5 Jan 2005 | 56 | 151 | Cornwall | 7 Jan 2005 | 56 | 154 | 0 | 2.2 | 3 |
| NNX | Cornwall | 5 Jan 2005 | 56 | 140 | West Point-S | 31 Jan 2005 | 51 | 139 | 5 | 26.2 | -1 |
| NOT | Cornwall | 5 Jan 2005 | 56 | 120 | West Point-N | 27 Jan 2005 | 52 | 121 | 4 | 22.1 | 1 |
| RDT | Cornwall | 7 Jan 2005 | 56 | 219 | Cornwall | 12 Jan 2005 | 56 | 220 | 0 | 4.9 | 1 |
| SPH | Cornwall | 7 Jan 2005 | 56 | 138 | Cornwall | 20 Jan 2005 | 56 | 144 | 0 | 12.9 | 6 |
| SPL | Cornwall | 7 Jan 2005 | 56 | 147 | West Point-N | 18 Jan 2005 | 52 | 147 | 4 | 10.8 | 0 |
| SVJ | Cornwall | 7 Jan 2005 | 56 | 179 | Cornwall | 24 Jan 2005 | 56 | 176 | 0 | 16.9 | -3 |
| SVK | Cornwall | 7 Jan 2005 | 56 | 154 | West Point-N | 26 Jan 2005 | 52 | 164 | 4 | 18.9 | 10 |
| WJL | Cornwall | 12 Jan 2005 | 56 | 260 | West Point-N | 13 Jan 2005 | 52 | 257 | 4 | 0.9 | -3 |
| WLT | Cornwall | 12 Jan 2005 | 56 | 145 | Cornwall | 20 Jan 2005 | 56 | 157 | 0 | 8.0 | 12 |
| WLU | Cornwall | 12 Jan 2005 | 56 | 187 | Cornwall | 20 Jan 2005 | 56 | 187 | 0 | 8.0 | 0 |
| WME | Cornwall | 12 Jan 2005 | 56 | 210 | Cornwall | 14 Jan 2005 | 56 | 204 | 0 | 2.0 | -6 |
| WNX | Cornwall | 12 Jan 2005 | 56 | 181 | West Point-N | 14 Jan 2005 | 52 | 179 | 4 | 1.9 | -2 |
| WOI | Cornwall | 12 Jan 2005 | 56 | 174 | Cornwall | 20 Jan 2005 | 56 | 180 | 0 | 8.0 | 6 |
| WPF | Cornwall | 12 Jan 2005 | 56 | 148 | West Point-N | 31 Jan 2005 | 52 | 150 | 4 | 19.1 | 2 |
| WRE | Cornwall | 12 Jan 2005 | 56 | 161 | Cornwall | 20 Jan 2005 | 56 | 164 | 0 | 8.0 | 3 |
| WSF | Cornwall | 12 Jan 2005 | 56 | 167 | Cornwall | 14 Jan 2005 | 56 | 167 | 0 | 2.0 | 0 |
| WTR | Cornwall | 12 Jan 2005 | 56 | 130 | Cornwall | 20 Jan 2005 | 56 | 135 | 0 | 8.0 | 5 |
| XHO | Cornwall | 13 Jan 2005 | 56 | 263 | Garrison | 1 Feb 2005 | 51 | 272 | 5 | 19.1 | 9 |
| XUL | Cornwall | 14 Jan 2005 | 56 | 163 | West Point-N | 24 Jan 2005 | 52 | 166 | 4 | 10.0 | 3 |
| XUS | Cornwall | 14 Jan 2005 | 56 | 150 | Cornwall | 20 Jan 2005 | 56 | 153 | 0 | 6.0 | 3 |
| XVB | Cornwall | 14 Jan 2005 | 56 | 145 | West Point-N | 26 Jan 2005 | 52 | 145 | 4 | 12.0 | 0 |
| KAU | Cornwall | 20 Jan 2005 | 56 | 137 | West Point-N | 8 Feb 2005 | 52 | 135 | 4 | 18.9 | -2 |
| KCB | Cornwall | 20 Jan 2005 | 56 | 200 | Cornwall | 24 Jan 2005 | 56 | 201 | 0 | 4.0 | 1 |
| KDP | Cornwall | 20 Jan 2005 | 56 | 175 | Cornwall | 24 Jan 2005 | 56 | 175 | 0 | 4.0 | 0 |
| KGA | Cornwall | 20 Jan 2005 | 56 | 148 | West Point-N | 21 Jan 2005 | 52 | 148 | 4 | 1.0 | 0 |
| SPH | Cornwall | 20 Jan 2005 | 56 | 144 | Cornwall | 24 Jan 2005 | 56 | 141 | 0 | 4.0 | -3 |
| LUW | Cornwall | 24 Jan 2005 | 56 | 154 | West Point-N | 8 Feb 2005 | 52 | 156 | 4 | 14.9 | 2 |
| AFY | West Point-N | 15 Dec 2004 | 52 | 180 | West Point-N | 16 Dec 2004 | 52 | 180 | 0 | 1.0 | 0 |
| AGE | West Point-N | 15 Dec 2004 | 52 | 130 | West Point-N | 16 Dec 2004 | 52 | 136 | 0 | 1.0 | 6 |
| AHU | West Point-N | 16 Dec 2004 | 52 | 228 | West Point-N | 17 Dec 2004 | 52 | 230 | 0 | 0.9 | 2 |
| AIF | West Point-N | 16 Dec 2004 | 52 | 145 | West Point-N | 17 Dec 2004 | 52 | 146 | 0 | 0.9 | 1 |

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| AKY | West Point-N | 17 Dec 2004 | 52 | 146 | Irvington | 21 Jan 2005 | 25 | 145 | 27 | 35.0 | -1 |
| AUO | West Point-N | 20 Dec 2004 | 52 | 221 | West Point-N | 30 Dec 2004 | 52 | 223 | 0 | 10.0 | 2 |
| AUT | West Point-N | 20 Dec 2004 | 52 | 131 | Cornwall | 7 Jan 2005 | 56 | 133 | 4 | 18.1 | 2 |
| BLI | West Point-N | 22 Dec 2004 | 52 | 150 | Battery | 13 Apr 2005 | 9 | 157 | 43 | 112.2 | 7 |
| CLU | West Point-N | 28 Dec 2004 | 52 | 254 | West Point-N | 30 Dec 2004 | 52 | 258 | 0 | 2.0 | 4 |
| CMP | West Point-N | 28 Dec 2004 | 52 | 194 | West Point-N | 20 Jan 2005 | 52 | 191 | 0 | 23.0 | -3 |
| COE | West Point-N | 28 Dec 2004 | 52 | 212 | West Point-N | 30 Dec 2004 | 52 | 216 | 0 | 2.0 | 4 |
| CVC | West Point-N | 29 Dec 2004 | 52 | 141 | Cornwall | 5 Jan 2005 | 56 | 142 | 4 | 7.0 | 1 |
| EDZ | West Point-N | 30 Dec 2004 | 52 | 168 | West Point-N | 20 Jan 2005 | 52 | 169 | 0 | 20.9 | 1 |
| EEH | West Point-N | 30 Dec 2004 | 52 | 148 | West Point-N | 5 Jan 2005 | 52 | 150 | 0 | 6.1 | 2 |
| EGS | West Point-N | 30 Dec 2004 | 52 | 150 | Cornwall | 5 Jan 2005 | 56 | 149 | 4 | 5.9 | -1 |
| EGV | West Point-N | 30 Dec 2004 | 52 | 136 | West Point-N | 20 Jan 2005 | 52 | 137 | 0 | 20.9 | 1 |
| EKA | West Point-N | 30 Dec 2004 | 52 | 258 | Battery | 4 Feb 2005 | 9 | 260 | 43 | 36.1 | 2 |
| EKD | West Point-N | 30 Dec 2004 | 52 | 188 | Cornwall | 12 Jan 2005 | 56 | 185 | 4 | 13.1 | -3 |
| ELP | West Point-N | 30 Dec 2004 | 52 | 151 | West Point-N | 20 Jan 2005 | 52 | 150 | 0 | 20.9 | -1 |
| ELW | West Point-N | 30 Dec 2004 | 52 | 247 | Cornwall | 12 Jan 2005 | 56 | 242 | 4 | 13.1 | -5 |
| EMK | West Point-N | 30 Dec 2004 | 52 | 250 | West Point-N | 11 Jan 2005 | 52 | 250 | 0 | 12.1 | 0 |
| ENE | West Point-N | 30 Dec 2004 | 52 | 194 | Cornwall | 7 Jan 2005 | 56 | 196 | 4 | 8.1 | 2 |
| EPZ | West Point-N | 30 Dec 2004 | 52 | 180 | West Point-N | 20 Jan 2005 | 52 | 185 | 0 | 20.9 | 5 |
| ESH | West Point-N | 30 Dec 2004 | 52 | 177 | Cornwall | 14 Jan 2005 | 56 | 173 | 4 | 15.0 | -4 |
| ESR | West Point-N | 30 Dec 2004 | 52 | 247 | Cornwall | 7 Jan 2005 | 56 | 250 | 4 | 8.1 | 3 |
| ETE | West Point-N | 30 Dec 2004 | 52 | 130 | West Point-N | 27 Jan 2005 | 52 | 129 | 0 | 28.0 | -1 |
| EVM | West Point-N | 30 Dec 2004 | 52 | 165 | West Point-S | 14 Jan 2005 | 51 | 163 | 1 | 14.9 | -2 |
| EWU | West Point-N | 30 Dec 2004 | 52 | 154 | West Point-N | 11 Jan 2005 | 52 | 155 | 0 | 11.9 | 1 |
| EYL | West Point-N | 30 Dec 2004 | 52 | 174 | West Point-N | 5 Jan 2005 | 52 | 181 | 0 | 6.1 | 7 |
| FCC | West Point-N | 30 Dec 2004 | 52 | 180 | West Point-N | 11 Jan 2005 | 52 | 179 | 0 | 12.1 | -1 |
| FDA | West Point-N | 30 Dec 2004 | 52 | 146 | West Point-N | 27 Jan 2005 | 52 | 146 | 0 | 28.0 | 0 |
| FFH | West Point-N | 30 Dec 2004 | 52 | 185 | West Point-N | 5 Jan 2005 | 52 | 185 | 0 | 6.1 | 0 |
| FFZ | West Point-N | 30 Dec 2004 | 52 | 224 | Cornwall | 20 Jan 2005 | 56 | 223 | 4 | 21.1 | -1 |
| PEX | West Point-N | 5 Jan 2005 | 52 | 128 | West Point-S | 6 Jan 2005 | 51 | 130 | 1 | 1.1 | 2 |
| PFS | West Point-N | 5 Jan 2005 | 52 | 127 | West Point-N | 14 Feb 2005 | 52 | 220 | 0 | 40.0 | 93 |
| PKW | West Point-N | 5 Jan 2005 | 52 | 132 | Cornwall | 20 Jan 2005 | 56 | 131 | 4 | 15.1 | -1 |
| POC | West Point-N | 5 Jan 2005 | 52 | 134 | West Point-S | 11 Jan 2005 | 51 | 133 | 1 | 5.9 | -1 |
| POY | West Point-N | 5 Jan 2005 | 52 | 127 | West Point-N | 24 Jan 2005 | 52 | 133 | 0 | 19.0 | 6 |

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| PSI | West Point-N | 5 Jan 2005 | 52 | 144 | West Point-N | 12 Jan 2005 | 52 | 146 | 0 | 7.0 | 2 |
| PST | West Point-N | 5 Jan 2005 | 52 | 133 | West Point-N | 26 Jan 2005 | 52 | 135 | 0 | 21.1 | 2 |
| PUB | West Point-N | 5 Jan 2005 | 52 | 240 | West Point-N | 11 Jan 2005 | 52 | 244 | 0 | 5.9 | 4 |
| PUK | West Point-N | 5 Jan 2005 | 52 | 133 | West Point-N | 7 Jan 2005 | 52 | 134 | 0 | 1.9 | 1 |
| PVC | West Point-N | 5 Jan 2005 | 52 | 135 | West Point-N | 7 Jan 2005 | 52 | 132 | 0 | 1.9 | -3 |
| PVM | West Point-N | 5 Jan 2005 | 52 | 182 | West Point-N | 7 Jan 2005 | 52 | 184 | 0 | 1.9 | 2 |
| PZE | West Point-N | 5 Jan 2005 | 52 | 220 | Cornwall | 7 Jan 2005 | 56 | 224 | 4 | 2.1 | 4 |
| PZZ | West Point-N | 5 Jan 2005 | 52 | 150 | West Point-N | 7 Jan 2005 | 52 | 147 | 0 | 1.9 | -3 |
| RBR | West Point-N | 5 Jan 2005 | 52 | 168 | West Point-N | 20 Jan 2005 | 52 | 170 | 0 | 14.9 | 2 |
| RCE | West Point-N | 5 Jan 2005 | 52 | 120 | West Point-N | 20 Jan 2005 | 52 | 122 | 0 | 14.9 | 2 |
| RDT | West Point-N | 5 Jan 2005 | 52 | 215 | Cornwall | 7 Jan 2005 | 56 | 219 | 4 | 2.1 | 4 |
| RHZ | West Point-N | 5 Jan 2005 | 52 | 138 | West Point-N | 18 Jan 2005 | 52 | 146 | 0 | 12.9 | 8 |
| RIF | West Point-N | 5 Jan 2005 | 52 | 144 | Garrison | 11 Jan 2005 | 51 | 146 | 1 | 6.1 | 2 |
| RJO | West Point-N | 5 Jan 2005 | 52 | 238 | West Point-N | 21 Jan 2005 | 52 | 240 | 0 | 16.0 | 2 |
| RKC | West Point-N | 5 Jan 2005 | 52 | 210 | West Point-N | 18 Jan 2005 | 52 | 212 | 0 | 13.0 | 2 |
| RKH | West Point-N | 5 Jan 2005 | 52 | 190 | West Point-N | 20 Jan 2005 | 52 | 190 | 0 | 14.9 | 0 |
| RNL | West Point-N | 5 Jan 2005 | 52 | 139 | West Point-N | 7 Jan 2005 | 52 | 138 | 0 | 1.9 | -1 |
| RPB | West Point-N | 5 Jan 2005 | 52 | 273 | West Point-N | 11 Jan 2005 | 52 | 270 | 0 | 5.9 | -3 |
| RRU | West Point-N | 5 Jan 2005 | 52 | 156 | West Point-N | 20 Jan 2005 | 52 | 154 | 0 | 14.9 | -2 |
| RSL | West Point-N | 5 Jan 2005 | 52 | 245 | West Point-N | 24 Jan 2005 | 52 | 245 | 0 | 18.9 | 0 |
| RTT | West Point-N | 5 Jan 2005 | 52 | 153 | West Point-N | 7 Jan 2005 | 52 | 155 | 0 | 1.9 | 2 |
| NXZ | West Point-N | 7 Jan 2005 | 52 | 180 | West Point-N | 11 Jan 2005 | 52 | 177 | 0 | 4.1 | -3 |
| NYV | West Point-N | 7 Jan 2005 | 52 | 128 | Cornwall | 20 Jan 2005 | 56 | 127 | 4 | 13.1 | -1 |
| NZW | West Point-N | 7 Jan 2005 | 52 | 218 | Nyack | 21 Jan 2005 | 29 | 218 | 23 | 14.0 | 0 |
| SBT | West Point-N | 7 Jan 2005 | 52 | 175 | Nyack | 19 Jan 2005 | 29 | 175 | 23 | 12.2 | 0 |
| SKK | West Point-N | 7 Jan 2005 | 52 | 245 | West Point-N | 18 Jan 2005 | 52 | 246 | 0 | 11.1 | 1 |
| SLB | West Point-N | 7 Jan 2005 | 52 | 255 | Nyack | 4 Feb 2005 | 29 | 255 | 23 | 28.0 | 0 |
| SLE | West Point-N | 7 Jan 2005 | 52 | 129 | Nyack | 25 Jan 2005 | 29 | 130 | 23 | 18.0 | 1 |
| SMU | West Point-N | 7 Jan 2005 | 52 | 159 | West Point-S | 11 Jan 2005 | 51 | 159 | 1 | 3.9 | 0 |
| TPV | West Point-N | 11 Jan 2005 | 52 | 181 | West Point-S | 12 Jan 2005 | 51 | 181 | 1 | 1.0 | 0 |
| TTB | West Point-N | 11 Jan 2005 | 52 | 195 | West Point-N | 18 Jan 2005 | 52 | 195 | 0 | 7.1 | 0 |
| TTE | West Point-N | 11 Jan 2005 | 52 | 122 | West Point-N | 20 Jan 2005 | 52 | 125 | 0 | 9.0 | 3 |
| TTM | West Point-N | 11 Jan 2005 | 52 | 113 | West Point-N | 14 Feb 2005 | 52 | 113 | 0 | 34.1 | 0 |
| TWY | West Point-N | 11 Jan 2005 | 52 | 174 | Nyack | 19 Jan 2005 | 29 | 176 | 23 | 8.2 | 2 |

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| TYK | West Point-N | 11 Jan 2005 | 52 | 220 | West Point-N | 13 Jan 2005 | 52 | 219 | 0 | 2.0 | -1 |
| UDN | West Point-N | 11 Jan 2005 | 52 | 156 | Irvington | 31 Jan 2005 | 25 | 153 | 27 | 20.0 | -3 |
| UDS | West Point-N | 11 Jan 2005 | 52 | 260 | West Point-N | 12 Jan 2005 | 52 | 261 | 0 | 1.0 | 1 |
| UJF | West Point-N | 11 Jan 2005 | 52 | 173 | West Point-N | 20 Jan 2005 | 52 | 174 | 0 | 8.9 | 1 |
| UKA | West Point-N | 11 Jan 2005 | 52 | 157 | West Point-S | 12 Jan 2005 | 51 | 158 | 1 | 0.8 | 1 |
| UMT | West Point-N | 11 Jan 2005 | 52 | 225 | Cornwall | 20 Jan 2005 | 56 | 225 | 4 | 9.0 | 0 |
| UTH | West Point-N | 11 Jan 2005 | 52 | 170 | Nyack | 21 Jan 2005 | 29 | 166 | 23 | 9.9 | -4 |
| UVF | West Point-N | 11 Jan 2005 | 52 | 190 | West Point-N | 12 Jan 2005 | 52 | 180 | 0 | 0.9 | -10 |
| WAH | West Point-N | 12 Jan 2005 | 52 | 231 | West Point-N | 13 Jan 2005 | 52 | 230 | 0 | 1.0 | -1 |
| WEC | West Point-N | 12 Jan 2005 | 52 | 178 | West Point-N | 14 Jan 2005 | 52 | 176 | 0 | 2.0 | -2 |
| WEF | West Point-N | 12 Jan 2005 | 52 | 137 | West Point-N | 13 Jan 2005 | 52 | 137 | 0 | 1.0 | 0 |
| WFJ | West Point-N | 12 Jan 2005 | 52 | 141 | West Point-N | 20 Jan 2005 | 52 | 144 | 0 | 8.0 | 3 |
| WHP | West Point-N | 12 Jan 2005 | 52 | 138 | Battery | 16 Mar 2005 | 9 | 138 | 43 | 63.0 | 0 |
| WHW | West Point-N | 12 Jan 2005 | 52 | 185 | West Point-N | 27 Jan 2005 | 52 | 185 | 0 | 15.0 | 0 |
| XFU | West Point-N | 13 Jan 2005 | 52 | 168 | West Point-N | 14 Jan 2005 | 52 | 168 | 0 | 1.0 | 0 |
| XGU | West Point-N | 13 Jan 2005 | 52 | 127 | West Point-N | 21 Jan 2005 | 52 | 126 | 0 | 8.2 | -1 |
| WEC | West Point-N | 14 Jan 2005 | 52 | 176 | West Point-N | 18 Jan 2005 | 52 | 178 | 0 | 4.1 | 2 |
| VKG | West Point-N | 18 Jan 2005 | 52 | 175 | West Point-N | 24 Jan 2005 | 52 | 173 | 0 | 6.0 | -2 |
| VKM | West Point-N | 18 Jan 2005 | 52 | 198 | Battery | 8 Mar 2005 | 7 | 200 | 45 | 49.1 | 2 |
| VLU | West Point-N | 18 Jan 2005 | 52 | 150 | West Point-N | 20 Jan 2005 | 52 | 151 | 0 | 2.0 | 1 |
| VZN | West Point-N | 18 Jan 2005 | 52 | 181 | West Point-N | 20 Jan 2005 | 52 | 182 | 0 | 2.0 | 1 |
| WEC | West Point-N | 18 Jan 2005 | 52 | 176 | West Point-N | 21 Jan 2005 | 52 | 178 | 0 | 3.0 | 0 |
| YAE | West Point-N | 18 Jan 2005 | 52 | 247 | Battery | 13 Apr 2005 | 9 | 248 | 43 | 85.1 | 1 |
| YDN | West Point-N | 18 Jan 2005 | 52 | 128 | West Point-S | 27 Jan 2005 | 51 | 128 | 1 | 8.9 | 0 |
| ELP | West Point-N | 20 Jan 2005 | 52 | 150 | West Point-N | 21 Jan 2005 | 52 | 150 | 0 | 1.2 | 0 |
| JPC | West Point-N | 20 Jan 2005 | 52 | 123 | West Point-N | 21 Jan 2005 | 52 | 125 | 0 | 1.2 | 2 |
| YWH | West Point-N | 20 Jan 2005 | 52 | 156 | West Point-N | 21 Jan 2005 | 52 | 157 | 0 | 1.2 | 1 |
| LED | West Point-N | 21 Jan 2005 | 52 | 208 | West Point-N | 24 Jan 2005 | 52 | 202 | 0 | 2.9 | -6 |
| LEH | West Point-N | 21 Jan 2005 | 52 | 146 | West Point-N | 8 Feb 2005 | 52 | 145 | 0 | 17.9 | -1 |
| LSA | West Point-N | 24 Jan 2005 | 52 | 179 | West Point-S | 26 Jan 2005 | 51 | 177 | 1 | 2.1 | -2 |
| IFE | West Point-N | 27 Jan 2005 | 52 | 261 | West Point-N | 31 Jan 2005 | 52 | 166 | 0 | 4.2 | -95 |
| C57 | West Point-N | 31 Jan 2005 | 52 | 143 | West Point-N | 1 Feb 2005 | 52 | 143 | 0 | 0.8 | 0 |
| F21 | West Point-N | 8 Feb 2005 | 52 | 220 | Irvington | 18 Feb 2005 | 25 | 218 | 27 | 10.1 | -2 |

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| G46 | West Point-N | 9 Feb 2005 | 52 | 197 | West Point-N | 10 Feb 2005 | 52 | 196 | 0 | 0.8 | -1 |
| AND | West Point-S | 20 Dec 2004 | 51 | 177 | West Point-N | 30 Dec 2004 | 52 | 180 | 1 | 10.1 | 3 |
| DHF | West Point-S | 29 Dec 2004 | 51 | 174 | Cornwall | 14 Jan 2005 | 56 | 171 | 5 | 16.0 | -3 |
| DIH | West Point-S | 29 Dec 2004 | 51 | 181 | West Point-N | 30 Dec 2004 | 52 | 186 | 1 | 1.0 | 5 |
| DKZ | West Point-S | 29 Dec 2004 | 51 | 202 | West Point-N | 18 Jan 2005 | 52 | 205 | 1 | 19.9 | 3 |
| DMI | West Point-S | 29 Dec 2004 | 51 | 160 | West Point-N | 11 Jan 2005 | 52 | 165 | 1 | 13.0 | 5 |
| DOS | West Point-S | 29 Dec 2004 | 51 | 228 | West Point-N | 30 Dec 2004 | 52 | 235 | 1 | 1.0 | 7 |
| DPL | West Point-S | 29 Dec 2004 | 51 | 141 | West Point-N | 30 Dec 2004 | 52 | 141 | 1 | 1.0 | 0 |
| DTU | West Point-S | 29 Dec 2004 | 51 | 181 | Cornwall | 24 Jan 2005 | 56 | 182 | 5 | 26.0 | 1 |
| DTY | West Point-S | 29 Dec 2004 | 51 | 143 | West Point-N | 27 Jan 2005 | 52 | 192 | 1 | 29.0 | 49 |
| DWM | West Point-S | 29 Dec 2004 | 51 | 245 | West Point-N | 5 Jan 2005 | 52 | 245 | 1 | 6.9 | 0 |
| DXG | West Point-S | 29 Dec 2004 | 51 | 250 | West Point-N | 30 Dec 2004 | 52 | 256 | 1 | 1.0 | 6 |
| DYX | West Point-S | 29 Dec 2004 | 51 | 162 | West Point-N | 30 Dec 2004 | 52 | 161 | 1 | 1.0 | -1 |
| EBP | West Point-S | 30 Dec 2004 | 51 | 145 | West Point-N | 11 Jan 2005 | 52 | 145 | 1 | 12.0 | 0 |
| EDK | West Point-S | 30 Dec 2004 | 51 | 145 | West Point-N | 7 Jan 2005 | 52 | 127 | 1 | 8.0 | -18 |
| OXH | West Point-S | 5 Jan 2005 | 51 | 297 | West Point-S | 6 Jan 2005 | 51 | 294 | 0 | 1.1 | -3 |
| OXL | West Point-S | 5 Jan 2005 | 51 | 163 | West Point-N | 24 Jan 2005 | 52 | 164 | 1 | 19.1 | 1 |
| PAZ | West Point-S | 5 Jan 2005 | 51 | 137 | West Point-N | 20 Jan 2005 | 52 | 139 | 1 | 15.0 | 2 |
| THI | Garrison | 10 Jan 2005 | 51 | 136 | West Point-N | 14 Jan 2005 | 52 | 137 | 1 | 3.8 | 1 |
| UXN | West Point-S | 12 Jan 2005 | 51 | 175 | West Point-N | 13 Jan 2005 | 52 | 174 | 1 | 1.0 | -1 |
| UZD | West Point-S | 12 Jan 2005 | 51 | 195 | Upper Harbor | 7 Feb 2005 | -3 | 195 | 53 | 26.2 | 0 |
| B20 | West Point-S | 31 Jan 2005 | 51 | 139 | N/A[a] | 11May 2005 | 39 | 164 | 12 | 100 | 25 |
| NCL | Croton | 4 Jan 2005 | 36 | 145 | Croton | 12 Jan 2005 | 36 | 145 | 0 | 8.1 | 0 |
| NER | Croton | 4 Jan 2005 | 36 | 165 | Croton | 25 Jan 2005 | 36 | 166 | 0 | 21.0 | 1 |
| NGW | Croton | 4 Jan 2005 | 36 | 145 | N/A[a] | 3Jun 2005 | 39 | 172 | 3 | 150 | 27 |
| VAB | Nyack | 12 Jan 2005 | 29 | 166 | Nyack | 28 Jan 2005 | 29 | 168 | 0 | 15.9 | 2 |
| VAM | Nyack | 12 Jan 2005 | 29 | 149 | Nyack | 19 Jan 2005 | 29 | 153 | 0 | 7.2 | 4 |
| YSZ | Nyack | 19 Jan 2005 | 29 | 255 | Nyack | 1 Feb 2005 | 29 | 254 | 0 | 13.0 | -1 |
| YUI | Nyack | 19 Jan 2005 | 29 | 148 | Nyack | 9 Feb 2005 | 29 | 149 | 0 | 20.7 | 1 |
| LXG | Nyack | 25 Jan 2005 | 29 | 180 | Nyack | 28 Jan 2005 | 29 | 182 | 0 | 3.0 | 2 |
| D42 | Nyack | 1 Feb 2005 | 29 | 141 | Nyack | 4 Feb 2005 | 29 | 144 | 0 | 2.7 | 3 |
| AAL | Irvington | 10 Dec 2004 | 25 | 212 | Irvington | 15 Dec 2004 | 25 | 215 | 0 | 5.0 | 3 |

[a] Recaptured by the Long River Survey ichthyoplankton program in an epibenthic sled.

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| AAP | Irvington | 10 Dec 2004 | 25 | 255 | Irvington | 19 Jan 2005 | 25 | 257 | 0 | 40.1 | 2 |
| ADL | Irvington | 15 Dec 2004 | 25 | 146 | Irvington | 17 Dec 2004 | 25 | 147 | 0 | 2.1 | 1 |
| AGG | Irvington | 16 Dec 2004 | 25 | 151 | Irvington | 17 Dec 2004 | 25 | 153 | 0 | 1.2 | 2 |
| AXR | Irvington | 21 Dec 2004 | 25 | 170 | Irvington | 19 Jan 2005 | 25 | 174 | 0 | 29.1 | 4 |
| AYA | Irvington | 21 Dec 2004 | 25 | 244 | Irvington | 3 Jan 2005 | 25 | 250 | 0 | 12.9 | 6 |
| BBG | Irvington | 21 Dec 2004 | 25 | 158 | Irvington | 23 Dec 2004 | 25 | 158 | 0 | 1.9 | 0 |
| BWC | Irvington | 23 Dec 2004 | 25 | 178 | Irvington | 19 Jan 2005 | 25 | 182 | 0 | 27.2 | 4 |
| BYH | Irvington | 23 Dec 2004 | 25 | 143 | N/A[c] | 3Aug 2005 | 15 | 201 | 10 | 223 | 58 |
| BYT | Irvington | 23 Dec 2004 | 25 | 260 | Irvington | 3 Jan 2005 | 25 | 261 | 0 | 10.9 | 1 |
| FLE | Irvington | 3 Jan 2005 | 25 | 139 | Irvington | 12 Jan 2005 | 25 | 138 | 0 | 9.1 | -1 |
| FLW | Irvington | 3 Jan 2005 | 25 | 126 | Irvington | 19 Jan 2005 | 25 | 126 | 0 | 16.2 | 0 |
| FSF | Irvington | 3 Jan 2005 | 25 | 171 | Irvington | 19 Jan 2005 | 25 | 172 | 0 | 16.2 | 1 |
| FUC | Irvington | 3 Jan 2005 | 25 | 114 | Irvington | 12 Jan 2005 | 25 | 119 | 0 | 9.1 | 5 |
| FUI | Irvington | 3 Jan 2005 | 25 | 147 | Irvington | 4 Jan 2005 | 25 | 145 | 0 | 1.0 | -2 |
| FWG | Irvington | 3 Jan 2005 | 25 | 185 | Irvington | 26 Jan 2005 | 25 | 184 | 0 | 23.0 | -1 |
| FYX | Irvington | 3 Jan 2005 | 25 | 166 | Irvington | 19 Jan 2005 | 25 | 167 | 0 | 16.1 | 1 |
| JCM | Irvington | 3 Jan 2005 | 25 | 152 | Irvington | 4 Jan 2005 | 25 | 152 | 0 | 1.0 | 0 |
| JKN | Irvington | 3 Jan 2005 | 25 | 151 | Irvington | 4 Jan 2005 | 25 | 153 | 0 | 1.0 | 2 |
| JKU | Irvington | 3 Jan 2005 | 25 | 156 | Irvington | 4 Jan 2005 | 25 | 220 | 0 | 1.0 | 64 |
| JLC | Irvington | 3 Jan 2005 | 25 | 135 | Irvington | 21 Jan 2005 | 25 | 136 | 0 | 18.0 | 1 |
| MBJ | Irvington | 3 Jan 2005 | 25 | 145 | Irvington | 4 Jan 2005 | 25 | 141 | 0 | 1.0 | -4 |
| MDP | Irvington | 3 Jan 2005 | 25 | 169 | Battery | 11 Feb 2005 | 8 | 168 | 17 | 39.0 | -1 |
| MEG | Irvington | 3 Jan 2005 | 25 | 188 | Battery | 22 Feb 2005 | 7 | 189 | 18 | 50.1 | 1 |
| MEO | Irvington | 3 Jan 2005 | 25 | 130 | Irvington | 19 Jan 2005 | 25 | 130 | 0 | 16.1 | 0 |
| MGJ | Irvington | 3 Jan 2005 | 25 | 156 | Irvington | 19 Jan 2005 | 25 | 159 | 0 | 16.1 | 3 |
| SYT | Irvington | 10 Jan 2005 | 25 | 140 | Irvington | 12 Jan 2005 | 25 | 141 | 0 | 2.1 | 1 |
| TDB | Irvington | 10 Jan 2005 | 25 | 167 | Irvington | 12 Jan 2005 | 25 | 168 | 0 | 2.0 | 1 |
| VDB | Irvington | 12 Jan 2005 | 25 | 127 | Irvington | 13 Jan 2005 | 25 | 128 | 0 | 1.2 | 1 |
| YMP | Irvington | 19 Jan 2005 | 25 | 143 | Irvington | 9 Feb 2005 | 25 | 144 | 0 | 20.8 | 1 |
| GEH | Battery | 2 Nov 2004 | 9 | 167 | Battery | 8 Nov 2004 | 9 | 171 | 0 | 5.9 | 4 |
| GFV | Battery | 3 Nov 2004 | 9 | 163 | Battery | 9 Nov 2004 | 8 | 170 | 1 | 6.1 | 7 |
| GFW | Battery | 3 Nov 2004 | 9 | 157 | Battery | 12 Apr 2005 | 9 | 192 | 0 | 160.1 | 35 |

[c] Recaptured by the Fall Shoals Survey juvenile fish sampling program in a 3 m beam trawl.

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| GGH | Battery | 3 Nov 2004 | 9 | 200 | Battery | 18 Nov 2004 | 9 | 209 | 0 | 15.0 | 9 |
| GHF | Battery | 4 Nov 2004 | 9 | 173 | Battery | 18 Nov 2004 | 9 | 181 | 0 | 13.9 | 8 |
| GHH | Battery | 4 Nov 2004 | 9 | 195 | Battery | 8 Dec 2004 | 8 | 208 | 1 | 34.0 | 13 |
| GHU | Battery | 4 Nov 2004 | 9 | 224 | Battery | 10 Feb 2005 | 8 | 230 | 1 | 97.9 | 6 |
| GIK | Battery | 4 Nov 2004 | 9 | 182 | Battery | 10 Nov 2004 | 9 | 186 | 0 | 5.9 | 4 |
| GIN | Battery | 4 Nov 2004 | 9 | 250 | Battery | 17 Nov 2004 | 9 | 260 | 0 | 13.0 | 10 |
| GIU | Battery | 4 Nov 2004 | 9 | 172 | Battery | 9 Nov 2004 | 9 | 176 | 0 | 5.0 | 4 |
| GIZ | Battery | 4 Nov 2004 | 9 | 166 | Battery | 8 Nov 2004 | 9 | 172 | 0 | 3.8 | 6 |
| GMK | Battery | 9 Nov 2004 | 9 | 193 | Battery | 18 Nov 2004 | 9 | 201 | 0 | 9.1 | 8 |
| GNL | Battery | 9 Nov 2004 | 9 | 188 | Battery | 19 Nov 2004 | 9 | 195 | 0 | 10.0 | 7 |
| GNM | Battery | 9 Nov 2004 | 9 | 189 | Battery | 12 Nov 2004 | 9 | 190 | 0 | 3.1 | 1 |
| GOT | Battery | 9 Nov 2004 | 9 | 216 | Battery | 10 Nov 2004 | 9 | 215 | 0 | 0.9 | -1 |
| GOZ | Battery | 9 Nov 2004 | 9 | 171 | Battery | 10 Nov 2004 | 9 | 171 | 0 | 1.0 | 0 |
| GOZ | Battery | 10 Nov 2004 | 9 | 171 | Battery | 15 Apr 2005 | 9 | 204 | 0 | 156.0 | 33 |
| GTB | Battery | 10 Nov 2004 | 9 | 177 | Battery | 17 Mar 2005 | 9 | 206 | 0 | 127.0 | 29 |
| GTD | Battery | 10 Nov 2004 | 9 | 180 | Battery | 17 Nov 2004 | 9 | 186 | 0 | 7.1 | 6 |
| GTG | Battery | 10 Nov 2004 | 9 | 165 | Battery | 11 Mar 2005 | 9 | 183 | 0 | 121.0 | 18 |
| GTI | Battery | 10 Nov 2004 | 9 | 174 | Battery | 18 Nov 2004 | 9 | 181 | 0 | 8.1 | 7 |
| GTL | Battery | 10 Nov 2004 | 9 | 153 | Battery | 17 Dec 2004 | 5 | 172 | 4 | 37.1 | 19 |
| GTV | Battery | 10 Nov 2004 | 9 | 179 | Battery | 19 Nov 2004 | 9 | 182 | 0 | 9.0 | 3 |
| GUG | Battery | 10 Nov 2004 | 9 | 173 | Battery | 18 Nov 2004 | 9 | 180 | 0 | 7.9 | 7 |
| GUH | Battery | 10 Nov 2004 | 9 | 166 | Battery | 18 Nov 2004 | 9 | 169 | 0 | 7.9 | 3 |
| GXI | Battery | 11 Nov 2004 | 9 | 186 | West Point-N | 7 Jan 2005 | 52 | 198 | 43 | 57.1 | 12 |
| GYJ | Battery | 11 Nov 2004 | 9 | 270 | West Point-N | 11 Jan 2005 | 52 | 273 | 43 | 61.0 | 3 |
| GZK | Battery | 11 Nov 2004 | 9 | 151 | Battery | 19 Nov 2004 | 8 | 155 | 1 | 7.8 | 4 |
| GNM | Battery | 12 Nov 2004 | 9 | 190 | Battery | 19 Nov 2004 | 9 | 195 | 0 | 7.0 | 5 |
| HAP | Battery | 12 Nov 2004 | 9 | 161 | Battery | 23 Nov 2004 | 9 | 166 | 0 | 10.9 | 5 |
| HBB | Battery | 12 Nov 2004 | 9 | 194 | Battery | 18 Nov 2004 | 9 | 189 | 0 | 6.0 | -5 |
| HBM | Battery | 12 Nov 2004 | 9 | 179 | Battery | 18 Nov 2004 | 9 | 187 | 0 | 5.8 | 8 |
| HBS | Battery | 12 Nov 2004 | 9 | 164 | Battery | 18 Nov 2004 | 8 | 170 | 1 | 5.9 | 6 |
| GGH | Battery | 18 Nov 2004 | 9 | 209 | Battery | 10 Dec 2004 | 9 | 213 | 0 | 21.9 | 4 |
| HCI | Battery | 19 Nov 2004 | 9 | 192 | Battery | 19 Nov 2004 | 9 | 191 | 0 | 0.1 | -1 |
| GFV | Battery | 30 Nov 2004 | 9 | 183 | Battery | 8 Dec 2004 | 9 | 185 | 0 | 8.1 | 2 |
| GEX | Battery | 1 Dec 2004 | 9 | 207 | Battery | 10 Dec 2004 | 9 | 206 | 0 | 9.1 | -1 |

(continued)

## Appendix Table F-1. (Continued)

| Tag Number | Release | | | | Recapture | | | | Distance Moved (miles) | Days at Large | Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Date | River Mile | Length (mm) | Station | Date | River Mile | Length (mm) | | | |
| HHB | Battery | 2 Dec 2004 | 9 | 252 | Battery | 24 Feb 2005 | 8 | 263 | 1 | 83.9 | 11 |
| HKE | Battery | 3 Dec 2004 | 9 | 210 | Battery | 28 Feb 2005 | 8 | 218 | 1 | 86.9 | 8 |
| HEZ | Battery | 6 Dec 2004 | 9 | 195 | Battery | 7 Apr 2005 | 9 | 209 | 0 | 122.0 | 14 |
| HML | Battery | 10 Dec 2004 | 9 | 179 | Battery | 13 Apr 2005 | 9 | 192 | 0 | 123.8 | 13 |
| GEX | Battery | 3 Nov 2004 | 8 | | Battery | 1 Dec 2004 | 9 | 207 | 1 | 28.1 | |
| GFG | Battery | 3 Nov 2004 | 8 | 256 | Battery | 29 Nov 2004 | 9 | 260 | 1 | 26.0 | 4 |
| GGP | Battery | 4 Nov 2004 | 8 | 205 | Battery | 11 Nov 2004 | 9 | 210 | 1 | 7.2 | 5 |
| GLH | Battery | 5 Nov 2004 | 8 | 185 | Battery | 13 Dec 2004 | 9 | 195 | 1 | 38.0 | 10 |
| GLN | Battery | 5 Nov 2004 | 8 | 165 | Battery | 9 Nov 2004 | 8 | 165 | 0 | 4.0 | 0 |
| GFV | Battery | 9 Nov 2004 | 8 | 170 | Battery | 30 Nov 2004 | 9 | 183 | 1 | 20.8 | 13 |
| GPU | Battery | 9 Nov 2004 | 8 | 140 | Battery | 3 Dec 2004 | 9 | 152 | 1 | 23.8 | 12 |
| GPW | Battery | 9 Nov 2004 | 8 | 179 | Battery | 10 Dec 2004 | 7 | 185 | 1 | 30.8 | 6 |
| GRS | Battery | 10 Nov 2004 | 8 | 173 | Battery | 11 Nov 2004 | 8 | 174 | 0 | 1.1 | 1 |
| GZN | Battery | 11 Nov 2004 | 8 | 165 | Battery | 2 Dec 2004 | 9 | 175 | 1 | 20.9 | 10 |
| GZU | Battery | 11 Nov 2004 | 8 | 168 | Battery | 30 Nov 2004 | 9 | 179 | 1 | 18.9 | 11 |
| HBX | Battery | 19 Nov 2004 | 8 | 154 | Battery | 3 Dec 2004 | 9 | 159 | 1 | 14.1 | 5 |
| HEZ | Battery | 24 Nov 2004 | 8 | 193 | Battery | 6 Dec 2004 | 9 | 195 | 1 | 11.9 | 2 |
| HFB | Battery | 24 Nov 2004 | 8 | 186 | Battery | 29 Nov 2004 | 8 | 194 | 0 | 5.0 | 8 |
| HMH | Battery | 10 Dec 2004 | 8 | 206 | Marlboro | 4 Jan 2005 | 68 | 215 | 60 | 25.1 | 9 |
| GJA | Battery | 5 Nov 2004 | 7 | 230 | Irvington | 21 Dec 2004 | 25 | 240 | 18 | 46.0 | 10 |
| GJF | Battery | 5 Nov 2004 | 7 | 188 | Battery | 19 Nov 2004 | 8 | 196 | 1 | 14.2 | 8 |
| GJH | Battery | 5 Nov 2004 | 7 | 152 | Battery | 8 Nov 2004 | 9 | 165 | 2 | 3.2 | 13 |
| GJU | Battery | 5 Nov 2004 | 7 | 176 | Battery | 6 Dec 2004 | 9 | 189 | 2 | 30.9 | 13 |
| GKB | Battery | 5 Nov 2004 | 7 | 180 | Battery | 22 Nov 2004 | 8 | 187 | 1 | 16.9 | 7 |
| GKJ | Battery | 5 Nov 2004 | 7 | 170 | Battery | 8 Nov 2004 | 7 | 173 | 0 | 3.0 | 3 |
| GKK | Battery | 5 Nov 2004 | 7 | 169 | Battery | 8 Nov 2004 | 7 | 170 | 0 | 3.0 | 1 |
| GKO | Battery | 5 Nov 2004 | 7 | 154 | Battery | 16 Dec 2004 | 9 | 177 | 2 | 41.1 | 23 |
| GKY | Battery | 5 Nov 2004 | 7 | 180 | Battery | 8 Nov 2004 | 7 | 181 | 0 | 2.9 | 1 |
| GLE | Battery | 5 Nov 2004 | 7 | 155 | Battery | 29 Nov 2004 | 8 | 160 | 1 | 24.0 | 5 |
| GKY | Battery | 8 Nov 2004 | 7 | 181 | Battery | 16 Dec 2004 | 8 | 198 | 1 | 38.0 | 17 |
| GVC | Battery | 10 Nov 2004 | 7 | 162 | Battery | 29 Nov 2004 | 9 | 174 | 2 | 18.8 | 12 |
| GVI | Battery | 10 Nov 2004 | 7 | 172 | Battery | 11 Nov 2004 | 9 | 175 | 2 | 1.0 | 3 |
| HMB | Battery | 10 Dec 2004 | 7 | 201 | West Point-N | 12 Jan 2005 | 52 | 205 | 45 | 32.9 | 4 |
| HRP | Battery | 14 Jan 2005 | 7 | 191 | Battery | 4 Feb 2005 | 9 | 184 | 2 | 20.9 | -7 |

**Appendix Table F-2. Summary by box trap station of the mark/recapture statistics, days at large, and distance moved for Atlantic tomcod tagged with visual implant tags and released into the Hudson River, 6 December 2004–27 February 2005.**

| Release Week | Station Name | River Mile | Mark/Recapture Statistics | | | Days at Large | | | Distance between Release and Recapture Sites (RM) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Same Station | | | | Movement North | | | | Movement South | | | |
| | | | M | C | R | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min |
| 6 Dec 2004 | Highland | 76 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Cornwall | 56 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | West Point North | 52 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| | West Point South | 51 | 4 | 4 | 0 | | | | | | | | | | | | | | | |
| | Garrison | 51 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **5** | **5** | **0** | | | | | | | | | | | | | | | |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 5 | 5 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 8 | 9 | 2 | 40 | 23 | 5 | 2 | 0 | 0 | 0 | | | | | | | | |
| | **SOUTH** | **43-25** | **13** | **14** | **2** | **40** | **23** | **5** | **2** | **0** | **0** | **0** | | | | | | | | |
| 13 Dec 2004 | Highland | 76 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Cornwall | 56 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| | West Point North | 52 | 58 | 68 | 5 | 35 | 8 | 1 | 4 | 0 | 0 | 0 | | | | | 1 | 27 | 27 | 27 |
| | West Point South | 51 | 149 | 187 | 0 | | | | | | | | | | | | | | | |
| | Garrison | 51 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **208** | **257** | **5** | **35** | **8** | **1** | **4** | **0** | **0** | **0** | | | | | **1** | **27** | **27** | **27** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 17 | 19 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 25 | 34 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | | | | | | | | |
| | **SOUTH** | **43-25** | **43** | **54** | **2** | **2** | **2** | **1** | **2** | **0** | **0** | **0** | | | | | | | | |

(continued)

## Appendix Table F-2. (Continued)

| Release Week | Station Name | River Mile | Mark/Recapture Statistics | | | Days at Large | | | Distance between Release and Recapture Sites (RM) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Same Station | | | | Movement North | | | | Movement South | | | |
| | | | M | C | R | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min |
| 20 Dec 2004 | Highland | 76 | 51 | 57 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 1 | 2 | 0 | | | | | | | | | | | | | | | |
| | Cornwall | 56 | 0 | 4 | 0 | | | | | | | | | | | | | | | |
| | West Point North | 52 | 269 | 300 | 3 | 112 | 47 | 10 | 1 | 0 | 0 | 0 | 1 | 4 | 4 | 4 | 1 | 43 | 43 | 43 |
| | West Point South | 51 | 145 | 271 | 1 | 10 | 10 | 10 | | | | | 1 | 1 | 1 | 1 | | | | |
| | Garrison | 51 | 6 | 9 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **473** | **643** | **4** | **112** | **38** | **10** | **1** | **0** | **0** | **0** | **2** | **4** | **3** | **1** | **1** | **43** | **43** | **43** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 17 | 20 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 2 | 3 | 0 | | | | | | | | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 400 | 458 | 5 | 29 | 16 | 2 | 5 | 0 | 0 | 0 | | | | | | | | |
| | **SOUTH** | **43-25** | **419** | **481** | **5** | **29** | **16** | **2** | **5** | **0** | **0** | **0** | | | | | | | | |
| 27 Dec 2004 | Highland | 76 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Cornwall | 56 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | West Point North | 52 | 1155 | 1411 | 26 | 36 | 14 | 1 | 16 | 0 | 0 | 0 | 8 | 4 | 4 | 4 | 2 | 43 | 22 | 1 |
| | West Point South | 51 | 700 | 781 | 13 | 29 | 10 | 1 | | | | | 13 | 5 | 2 | 1 | | | | |
| | Garrison | 51 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **1855** | **2192** | **39** | **36** | **13** | **1** | **16** | **0** | **0** | **0** | **21** | **5** | **3** | **1** | **2** | **43** | **22** | **1** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 0 | 131 | 0 | | | | | | | | | | | | | | | |
| | **SOUTH** | **43-25** | **0** | **131** | **0** | | | | | | | | | | | | | | | |

(continued)

## Appendix Table F-2. (Continued)

| Release Week | Station Name | River Mile | Mark/Recapture Statistics | | | Days at Large | | | Distance between Release and Recapture Sites (RM) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Same Station | | | | Movement North | | | | Movement South | | | |
| | | | M | C | R | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min |
| 3 Jan 2005 | Highland | 76 | 22 | 22 | 1 | 6 | 6 | 6 | | | | | | | | | 1 | 8 | 8 | 8 |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 257 | 266 | 3 | 16 | 8 | 2 | 2 | 0 | 0 | 0 | | | | | 1 | 12 | 12 | 12 |
| | Cornwall | 56 | 907 | 970 | 25 | 84 | 12 | 1 | 15 | 0 | 0 | 0 | | | | | 10 | 51 | 13 | 4 |
| | West Point North | 52 | 1530 | 1585 | 34 | 40 | 11 | 1 | 22 | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 8 | 23 | 12 | 1 |
| | West Point South | 51 | 203 | 235 | 3 | 19 | 12 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | | | | |
| | Garrison | 51 | 59 | 68 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **2977** | **3146** | **66** | **84** | **11** | **1** | **40** | **0** | **0** | **0** | **6** | **4** | **3** | **1** | **20** | **51** | **12** | **1** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 168 | 178 | 2 | 21 | 15 | 8 | 2 | 0 | 0 | 0 | | | | | | | | |
| | Nyack | 29 | 37 | 38 | 0 | | | | | | | | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 1065 | 1109 | 16 | 50 | 15 | 1 | 14 | 0 | 0 | 0 | | | | | 2 | 18 | 18 | 17 |
| | **SOUTH** | **43-25** | **1270** | **1325** | **18** | **50** | **15** | **1** | **16** | **0** | **0** | **0** | | | | | **2** | **18** | **18** | **17** |
| 10 Jan 2005 | Highland | 76 | 80 | 82 | 1 | 4 | 4 | 4 | | | | | | | | | 1 | 24 | 24 | 24 |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 352 | 368 | 2 | 27 | 24 | 21 | | | | | | | | | 2 | 43 | 30 | 16 |
| | Cornwall | 56 | 314 | 337 | 14 | 19 | 8 | 1 | 8 | 0 | 0 | 0 | | | | | 6 | 5 | 4 | 4 |
| | West Point North | 52 | 1280 | 1339 | 23 | 63 | 9 | 1 | 16 | 0 | 0 | 0 | 1 | 4 | 4 | 4 | 6 | 43 | 20 | 1 |
| | West Point South | 51 | 184 | 236 | 2 | 26 | 14 | 1 | | | | | 1 | 1 | 1 | 1 | 1 | 48 | 48 | 48 |
| | Garrison | 51 | 60 | 70 | 1 | 4 | 4 | 4 | | | | | 1 | 1 | 1 | 1 | | | | |
| | **NORTH** | **76-51** | **2270** | **2432** | **43** | **63** | **10** | **1** | **24** | **0** | **0** | **0** | **3** | **4** | **2** | **1** | **16** | **48** | **17** | **1** |
| | Peekskill | 43 | 2 | 2 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 26 | 28 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 23 | 24 | 2 | 16 | 11 | 7 | 2 | 0 | 0 | 0 | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 379 | 417 | 3 | 2 | 2 | 1 | 3 | 0 | 0 | 0 | | | | | | | | |
| | **SOUTH** | **43-25** | **431** | **471** | **5** | **16** | **6** | **1** | **5** | **0** | **0** | **0** | | | | | | | | |

(continued)

## Appendix Table F-2. (Continued)

| Release Week | Station Name | River Mile | Mark/Recapture Statistics | | | Days at Large | | | Distance between Release and Recapture Sites (RM) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Same Station | | | | Movement North | | | | Movement South | | | |
| | | | M | C | R | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min |
| 17 Jan 2005 | Highland | 76 | 138 | 141 | 2 | 19 | 11 | 4 | 1 | 0 | 0 | 0 | | | | | 1 | 24 | 24 | 24 |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 169 | 173 | 2 | 19 | 13 | 7 | | | | | | | | | 2 | 16 | 16 | 16 |
| | Cornwall | 56 | 244 | 293 | 4 | 19 | 7 | 1 | 2 | 0 | 0 | 0 | | | | | 2 | 4 | 4 | 4 |
| | West Point North | 52 | 1119 | 1182 | 10 | 85 | 18 | 1 | 7 | 0 | 0 | 0 | | | | | 3 | 45 | 30 | 1 |
| | West Point South | 51 | 29 | 42 | 0 | | | | | | | | | | | | | | | |
| | Garrison | 51 | 11 | 25 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **1709** | **1856** | **18** | **85** | **14** | **1** | **10** | **0** | **0** | **0** | | | | | **8** | **45** | **19** | **1** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 0 | 11 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 190 | 200 | 2 | 21 | 17 | 13 | 2 | 0 | 0 | 0 | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 306 | 339 | 1 | 21 | 21 | 21 | 1 | 0 | 0 | 0 | | | | | | | | |
| | **SOUTH** | **43-25** | **496** | **550** | **3** | **21** | **18** | **13** | **3** | **0** | **0** | **0** | | | | | | | | |
| 24 Jan 2005 | Highland | 76 | 4 | 5 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 9 | 9 | 0 | | | | | | | | | | | | | | | |
| | Cornwall | 56 | 64 | 75 | 1 | 15 | 15 | 15 | | | | | | | | | 1 | 4 | 4 | 4 |
| | West Point North | 52 | 339 | 366 | 2 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | | | | | 1 | 1 | 1 | 1 |
| | West Point South | 51 | 20 | 40 | 0 | | | | | | | | | | | | | | | |
| | Garrison | 51 | 31 | 41 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **467** | **536** | **3** | **15** | **7** | **2** | **1** | **0** | **0** | **0** | | | | | **2** | **4** | **3** | **1** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 13 | 14 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 92 | 98 | 1 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 22 | 94 | 0 | | | | | | | | | | | | | | | |
| | **SOUTH** | **43-25** | **126** | **206** | **1** | **3** | **3** | **3** | **1** | **0** | **0** | **0** | | | | | | | | |

(continued)

## Appendix Table F-2. (Continued)

| Release Week | Station Name | River Mile | Mark/Recapture Statistics | | | Days at Large | | | Distance between Release and Recapture Sites (RM) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Same Station | | | | Movement North | | | | Movement South | | | |
| | | | M | C | R | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min | N | Max | Mean | Min |
| 31 Jan 2005 | Highland | 76 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 30 | 32 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | | | | | | | | |
| | Cornwall | 56 | 0 | 2 | 0 | | | | | | | | | | | | | | | |
| | West Point North | 52 | 157 | 164 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | | | | | | | | |
| | West Point South | 51 | 36 | 47 | 0 | | | | | | | | | | | | | | | |
| | Garrison | 51 | 12 | 15 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **235** | **260** | **2** | **1** | **1** | **1** | **2** | **0** | **0** | **0** | | | | | | | | |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 6 | 6 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 36 | 40 | 1 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 83 | 91 | 0 | | | | | | | | | | | | | | | |
| | **SOUTH** | **43-25** | **125** | **137** | **1** | **3** | **3** | **3** | **1** | **0** | **0** | **0** | | | | | | | | |
| 7 Feb 2005 | Highland | 76 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Milton | 71 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Marlboro | 68 | 6 | 7 | 1 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | | | | | | | | |
| | Cornwall | 56 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| | West Point North | 52 | 176 | 187 | 2 | 10 | 5 | 1 | 1 | 0 | 0 | 0 | | | | | 1 | 27 | 27 | 27 |
| | West Point South | 51 | 9 | 11 | 0 | | | | | | | | | | | | | | | |
| | Garrison | 51 | 0 | 1 | 0 | | | | | | | | | | | | | | | |
| | **NORTH** | **76-51** | **191** | **207** | **3** | **10** | **5** | **1** | **2** | **0** | **0** | **0** | | | | | **1** | **27** | **27** | **27** |
| | Peekskill | 43 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Indian Point | 41 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Croton | 36 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| | Nyack | 29 | 11 | 12 | 0 | | | | | | | | | | | | | | | |
| | Tarrytown | 27 | 0 | 0 | 0 | | | | | | | | | | | | | | | |
| | Irvington | 25 | 74 | 88 | 0 | | | | | | | | | | | | | | | |
| | **SOUTH** | **43-25** | **86** | **101** | **0** | | | | | | | | | | | | | | | |