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EVALUATION OF STRIPED BASS STOCKS IN VIRGINIA: TAGGING AND MONITORING STUDIES

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PREFACE

The overall purpose of an extant data base to assist fishery regulators in their managerial deliberations. Toward this end, VIMS personnel in the anadromous program have monitored striped bass each year since 1986, and in 1987 instituted the continuing mark-recapture study. We currently provide information that meets or exceeds the current interstate fishery management data requirements for striped bass.

Objectives

Fall 1993

Monitoring striped bass:

- Characterize the composition of the striped bass population in the Rappahannock River by random samples of catches by pound nets.

Tagging striped bass:

- 1,000 in the James River.
- 125 each in the Mattaponi and Pamunkey rivers.
- 334 each at the mouth of the York and Rappahannock rivers, and at Gwynn's Island.
- 250 in the upper Rappahannock River.

In addition, a limited number of striped bass with $100 reward tags will be released as follows:

- 200 in the James River.
- 25 each in the Mattaponi and Pamunkey rivers.
- 66 each at the mouth of the York and Rappahannock rivers, and at Gwynn's Island; and 50 in the upper Rappahannock River.

Tag Retention

- Estimate tag loss and tagging mortality by holding tagged striped bass for 72 hours.

Spring 1994

Monitoring striped bass:

- Characterize the composition of the Rappahannock River striped bass population in pound nets and multi-sized mesh anchor gill nets in spring 1994.

- Characterize the composition of the James River striped bass population in fyke nets and a multi-sized mesh anchor gill net in spring 1994.

Tagging striped bass:

As available, tag striped bass ≥ 24 inches (610 mm) total length (TL) in the following quantities:

- 500 in the Rappahannock River.

ACKNOWLEDGMENTS

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The project was funded, in part, by the Anadromous Fish Conservation Act Amendment, Public Law 96-118, and administered by the National Marine Fisheries Service (Northeast Region).

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EXECUTIVE SUMMARY

1. The instantaneous fishing mortality rate (F) and population size estimates from the fall 1993 tagging program for Chesapeake Bay striped bass ≥ 457 mm total length (18 inches TL) were, respectively, F = 0.090, with 95% confidence limits of 0.068 and 0.113, and 6,561,882 fish with 95% confidence limits of 5,280,858 and 8,658,508.

2. The F and population size estimates from the fall 1993 striped bass tagging program in Virginia were, respectively, F = 0.046 with 95% confidence limits of 0.034 and 0.057, and 1,393,028 fish with 95% confidence limits of 1,123,806 and 1,803,849 for striped bass ≥457 mm TL.

3. The fall pound net samples were composed of young striped bass (ages ≤ 3); in contrast, the samples collected in the spring primarily contained large mature fish. The difference in the temporal distributions is an annual pattern.

4. The length frequency of striped bass captured in the two multi-sized mesh gill nets on the Rappahannock River was significantly smaller than the length frequency obtained from the samples collected from the pound nets. There was no significant difference between the length frequencies of striped bass sampled in the fyke nets and gill net in the James River.

5. A pen (holding) study of tagged striped bass conducted in early November 1993 indicated no mortality due to tagging or handling stress.

INTRODUCTION

Striped bass (*Morone saxatilis*) have been an economically and socially important component of the commercial and recreational catch in the Chesapeake Bay area. The Chesapeake Bay supports one of the principal spawning populations of striped bass on the East Coast. A drastic decline in commercial landings of striped bass in Virginia has occurred since 1974. The commercial landings in Virginia averaged approximately 203 metric tons (MT), from 1978 through 1981. During 1982 through 1983 the landings averaged only 70.4 MT. The decline in Virginia's striped bass landings is representative of the situation from Maine to North Carolina. In a morphological study conducted by Berggren and Lieberman (1978), they concluded that the Chesapeake Bay was the major contributor (>90%) to the coastal fishery, and the Hudson and the Roanoke rivers were a small contributor to the fishery. Van Winkle et al. (1988) reanalyzed Berggren and Lieberman's work and concluded that stock contributions from the Chesapeake Bay and the Hudson and Roanoke rivers are highly variable. Van Winkle et al. (1988) estimated that Hudson stock constituted over 40% of the striped bass captured in the coastal fishery during 1975. The central force of management effort is the restoration of the Chesapeake Bay stock, which historically has been an important contributor to the coastal fishery.

Toward this end, the Virginia Marine Resources Commission (VMRC) has changed its regulations concerning the commercial and recreational harvest of striped bass. In December of 1982, VMRC closed the spawning areas of the James, Mattaponi, Pamunkey and Rappahannock rivers from 10 April through 21 May. Drift gill nets could be fished as long as they were constantly attended, and all striped bass captured were to be released. In March 1984, a five fish per day creel limit for hook and line fishing in tidal waters was enacted, and spawning area closure was changed to 1 April through 31 May. In June 1985, VMRC acted to initiate closed season on all of Virginia's tidal waters from 1 December through 31 May, and an 18 inch (457 mm) minimum size limit in tidal waters, with two fish or 5% bycatch allowed during the harvest season. A 24 inch (610 mm) minimum in the Territorial Sea with no bycatch allowed was also instituted. In June of 1986, VMRC again acted to increase the Territorial Sea minimum to 30 inches (762 mm), and the bycatch for the tidal waters was repealed. In September 1986, the 18 inch (457 mm) minimum size in tidal waters was increased to 24 inches (610 mm). Based on a new maturity schedule the Territorial Sea size increased to 38 inches (965 mm) in January 1989. A complete moratorium in tidal waters and the Territorial Sea was enacted in June 1989. A restricted commercial harvest of striped bass has been allowed since November 1990. The harvest

ceiling was fixed at 95.7 MT (211,000 lb). The total reported commercial tonnage for 1990-1992 was 157.3 MT (346,846 lb), 105.4 MT (232,407 lb),and 124.7 MT (274,964 lb), respectively. These totals also include striped bass landed in the Virginia portion of the Potomac River.

Because of low stock levels of striped bass in the recent past, the Chesapeake Bay stocks may not have contributed to its full potential to the coastal migratory population which supports the fisheries north of the Chesapeake. Therefore, the information obtained in this study is crucial for the development and implementation of a coordinated management plan for striped bass in Virginia, and along the eastern seaboard.

METHODS

Monitoring

Striped bass samples were obtained from cooperating pound net fishermen on the Rappahannock River at river mile 44 and 47 in November 1993, and in April 1994. Samples were also obtained from a fyke net fisherman on the James River at river mile 56 between mid-March and early May 1994. On the days that fish were collected, the entire unculled catch of striped bass in a pound net or fyke net constituted the sample. The pound net fished continuously for either three or four days, but the fyke net was fished on a 24-hour basis on the James River.

Two clear monofilament gill nets were used in conjunction with a pound net in the upper Rappahannock River. In this region of the river, commercial fishermen use a maximum length of 91.4 m (300 feet) for gill netting because of the strong currents and the narrowness of the river. Two gill nets, each containing 10 panels, were deployed. Each panel was 9.14 m (30 feet) in length and 3.05 m (10 feet) deep. The 10 stretched mesh sizes (in inches) were 3, 3.75, 4.5, 5.25, 6, 6.5, 7, 8, 9, and 10. These mesh sizes corresponded to those used by the Maryland Department of Natural Resources. The hanging ratio of the two gill nets used in this study was 0.50. The position of each panel was determined by a stratified randomization scheme. The mesh sizes was divided into two groups, the five smallest and the five largest meshes. One of the two groups was randomly selected as the first group, and one mesh size was randomly chosen from it for the first panel in the net. The second panel was randomly chosen from the second group, the third panel from the first group, the fourth panel from the second group, and so forth. The

method of randomization excluded the possibility of similar mesh sizes clustering in the net. The order of panels in gill net no. 1 was (in inches) 8, 5.25, 9, 3.75, 7, 4.5, 6.5, 6, 10 and 3, and for gill net no. 2 the order was 8, 3, 10, 5.25, 9, 6, 6.5, 3.75, 7, and 4.5. The gill nets were generally deployed twice a week, on Sunday and Wednesday, and recovered the following Monday and Thursday, respectively.

On the James River, the experimental gill net's array of panels was that of no. 1 described above. The net was deployed on Sundays and recovered on Mondays.

The striped bass samples were returned to the VIMS laboratory. Fork length (FL) and total length (TL) were recorded to 1 mm with an electronic fish-measuring board. Weight was taken with a Mettler balance to a 0.1 g. Sex was ascertained by visual inspection of the gonad. Scales were removed from each specimen in the area just above the lateral line midway between the insertion of the first dorsal fin and the origin of the second (Merriman 1941). Scales were prepared for reading by utilizing the method described by Merriman (1941), except that an acetate sheet replaced the glass slide and acetone. All scales were aged using the microcomputer program (DISBCAL) of Frie (1982), in conjunction with a sonic digitizer-microcomputer complex (Loesch et al. 1985). Growth increments were measured from the focus to the posterior edge of each annulus. A second reader randomly re-aged 10 percent of the scales. If his readings were statistically different (χ^2 contingency test) from those of the principal reader, all scales were read twice. The scales were aged only once if the statistical test was insignificant. There was little difficulty in reading the scales when a clear focus was found. With fish older than age 6, the first and sometimes the second annuli were difficult to define. In the back calculation of lengths from scales two assumptions were made: 1) scale growth is proportional to growth in length; and 2) annuli are formed yearly and at the same time. Striped Bass scale annuli are formed between April and June in Virginia waters; however, year classes, other than 0 year class, are considered to be a year older on 1 January so that our aging methodology conform to that used by Maryland and North Carolina.

The data were processed with SAS and then managed by Paradox. Striped bass fisheries in Virginia were differentiated by season and gear. Each sex was divided into two age categories, fish less than or equal to age 3 and greater than or equal to age 4. The rationale of this dichotomy is that most fish less than or equal to age 3 have traditionally contributed the largest numbers to

the Virginia landings and these ages are not fully recruited into the coastal fishery. Total catch was recorded for each gear, when possible.

The Atlantic States Marine Fisheries Commission (ASMFC) interstate management plan for striped bass, as amended in October 1986, calls for the protection of young females. Specifically, females of the 1982 year class, and following year classes, are to be protected from fishing mortality until at least 95% have had the opportunity to spawn at least once. Thus, size-at-age and growth rate data are needed if management measures, other than a total moratorium, are used to accomplish this objective.

The acetate impressions of the scales were stored for back calculations of size-at-age and subsequent growth analysis. Estimates of the Gompertz weight-length relationship, and the allometric growth parameters were made using FishParm (Prager 1987), which utilizes the Marquardt's (1963) algorithm for nonlinear least squares.

Weights at age for striped bass age 1 - 15 were estimated using the Gompertz function (Ricker 1975).

$$W_t = W_o e^{G(1 - e^{-gt})}$$

where W_t = Weight at time t; W_o = hypothetical weight at t = 0;
G = growth parameter; g = second growth parameter; and t = age.

The allometric growth function (Ricker 1975) was used to estimate striped bass growth, were

$$W = aL^b$$

where W = weight; L = length; and a nad b are parameters of the model.

Catch per unit of effort was calculated as the number of striped bass captured per net day.

$$CPUE = \frac{C}{D}$$

where CPUE = catch per net day; C = total catch and D = total net days.

Tagging

In fall 1993, our efforts were divided into three components: 1) Striped bass were collected for tagging from commercial pound nets (Rappahannock River, York River mouth, Gwynn's Island, fyke nets (James River), haul seine (James River) and drift gill netting and electro-fishing on the Mattaponi, Pamunkey and James rivers. The striped bass were tagged with internal-anchor/external streamer tags (described below); 2) About every fifth fish was tagged with a $100.00 reward tag; it is assumed that all striped bass captured with $100 reward tags will be reported and the tags returned. The reported percentage for the $100 tags was used to adjust the return rate of the $5.00 tags. Tagging data together with the VMRC/NMFS recreational survey data were used to estimate population size and fishing mortality; and 3) There was a short term pen study to ascertain if there was mortality due to tagging or handling within that time frame.

In spring 1994, striped bass were obtained from cooperating commercial fishermen. Fish were captured with pound nets at river km 70 to 76 on the Rappahannock River. A Floy internal anchor tag 5 mm X 20 mm, with an 85 mm external tube was used for all fish tagged. The anchor tag was inserted into the body cavity through a small surgical incision made just posterior to the apex of the pectoral fin on the museum (left) side of the fish. Thus, the anchor was inserted into the peritoneal cavity posterior to the pericardial cavity and anterior to the spleen. The tags were treated by the Floy Company with an algicide which reduces algae build-up, reduces drag, and increases retention (Hillman and Werme 1983).

The VIMS tagging personnel followed the fisherman to the pound net in the Rappahannock River. One side of the pound head was lowered and the fisherman's skiff was pulled inside the head. The bottom of the head was gradually pulled into the boat, thereby concentrating the fish in the remaining portion of the head. Fish were dipped from the pound head and placed in the fisherman's boat, except for striped bass which were placed in a VIMS "live car" (floating pocket) attached to the net. The net was kept open by a float line around the outside of the surface perimeter, a spreader board (1.2 m) inside of the surface perimeter at each end, and lead lines on the bottom of the net. After the fisherman finished, the tagging vessel retrieved the live car and together the vessel and live car drifted with the current while the fish were tagged and released. Taggers retrieved a fish from the live car, implanted a tag, and

recorded its fork length (FL), and, if possible, sex. Several scales were removed from the area above the lateral line midway between the insertion of the first dorsal fin and the origin of the second. Striped bass had to be at least 571 mm FL, which corresponds to a TL of 610 mm (24 inches).

Currently, there is only one commercial pound netter on the striped bass spawning grounds in the Rappahannock River. Therefore, the length of the tagging season is determined by two factors. First, the end of gill netting season for white perch, and second, the beginning of the blue crab season. Tagging commenced 7 April 1994 and ended 28 April 1994.

RESULTS AND DISCUSSION

Monitoring

A total of 10,813 striped bass have been sampled between December 1986 and June 1994 from pound nets in the Rappahannock River (Table 1); 2,351 individuals were captured from the experimental gill net employed from spring 1990 through spring 1994 (Table 1) and 102 individuals sampled from gill nets in the fall 1986, 1987, and 1988 programs combined (Table 1). Samples of striped bass were collected on the James River during the spawning season in spring 1994; 112 were from fyke nets and 128 the experimental gill net.

Historically, based on season and gear, there were three striped bass fisheries in the Rappahannock River: the fall and spring pound net fisheries, and the fall gill net fishery, when the VMRC regulation permitted harvest. During the years that gill net samples were collected, very few fish were caught in gill nets due to the 61 cm (24 inch) minimum total length regulation and the scarcity of larger fish during the legal season (1 June - 30 November). The ban on the possession of striped bass was in effect during the spring of 1987 through spring 1989; however, a complete moratorium was enacted in June 1989. However, a limited striped bass fishery has existed since fall 1990. Samples were obtained by special permits granted by the VMRC to cooperating commercial fishermen on the Rappahannock River for the sole purpose of obtaining striped bass for VIMS research. The pound nets fish continuously for either 3 or 4 days, over several tidal cycles, before we obtain a sample from the commercial fisherman who brings the sample to the dock, therefore, we do not measure water temperature, tide stage or salinity.

Fall 1993

In fall 1993, a total of 654 striped bass were sampled between 8 November -30 November from pound nets in the Rappahannock River (Table 1). In fall 1992, striped bass samples, 90% were young fish (ages $\leq$ 3) and 10% were older fish (ages $\geq$ 4). In fall 1991, striped bass samples, 69% were young fish (ages $\leq$ 3) and 31% were older fish (ages $\geq$ 4) (Hill and Loesch 1992). Due to scale regeneration 16 striped bass from the fall samples of 1993 could not be aged. Males dominated both age groups (ages $\leq$ 3 and ages $\geq$ 4) and the sex ratio was significantly different from 1:1 [(X^2 = 18.1, 1 df, P < 0.005) and (X^2 = 82.5; 1 df; P < 0.005), respectively] (Tables 2 and 3). This was contrary to what Hill and Loesch (1987; 1988) found in the fall of 1987 and 1988 when the sex ratio was 1:1 for the younger age group.

All of the samples for fall 1993 were collected in November. With the sexes pooled, the 1991 year class (age 2) was the modal group in the pound net samples (Tables 2 and 3). Males of the 1991 year class (age 2) were the dominant cohort (28.6%), and males of the 1992 year class (age 1) were second (19.6%) and females of the 1991 year class 14.8% (Tables 2 and 3). The males of the 1991 year class had the largest CPUE (8.9 fish/day), and the males of the 1992 year class had the second largest CPUE with 5.81 fish/day (Tables 2 and 3; Fig. 1). The females showed a similar trend with the 1991 year class having a CPUE of 4.6 fish/day, and for the 1992 year class the CPUE was 3.4 fish/day (Tables 2 and 3; Fig. 1).

Spring 1994: Rappahannock River

A total of 375 striped bass were sampled between 7 April 1994 and 28 April 1994 from pound nets in the Rappahannock River between river miles 44 - 47. An additional 112 striped bass were sampled from fyke nets in the James River at river mile from 7 March 1994 - 9 May 1994 (Table 1). Due to scale regeneration 19 striped bass from the spring samples could not be aged.

The null hypothesis (H_0) tested for both age categories of striped bass was: the sex ratio is 1:1, with the alternate hypothesis (H_a) the sex ratio is not 1:1. In the pound net catches in the Rappahannock River, 14% of the catch were young (ages $\leq$ 3) striped bass (Tables 4 and 5) with a sex ratio strongly favoring males (4:1). In the older age group (ages $\geq$ 4) males were

marginally more numerous than females with a sex ratio of 1.2:1 (X^2 = 3.75 with 1 df; P = 0.044).

With sexes pooled, the 1989 year class was the modal group in the pound net samples, accounting for 34.4% of the samples. However, males of the 1989 year class were the dominant cohort (26.4%) and the males of the 1990 year class were the second most numerous cohort (9.7%). The maximum CPUE for males was the 1989 year class, with 3.65 fish/net-day, and for females the maximum CPUE was also the 1988 year class, with 1.15 fish/day, (Fig. 2). The oldest male and female year class present in the spring spawning was, respectively, 1982 and 1979.

The total number of striped bass captured in the Rappahannock River experimental gill nets no. 1 and no. 2 were 262 and 296, respectively (Tables 6 and 7). The total effort in gill nets no. 1 and no. 2 were 11.98 and 13.04 net days, respectively (Tables 6 and 7). We aged all striped bass captured in gill no. 1 except two from the 5.25 inch mesh and one each from the 8.0 and 9.0 inch mesh panels (Table 8). We aged all striped bass from gill net no. 2 except two from the 3.75 inch mesh and six form the 5.25 and 6.0 inch mesh panel, one from the 6.5 inch mesh panel (Table 9). These scales would have been aged, also, but they were all regenerated scales, where the focus and early annuli were totally obliterated.

The 1989 males were the dominant cohort captured in gill net no. 1 and gill net no. 2 (Tables 8, 9, 10, and 11 and Fig. 3). The striped bass year classes captured by both nets ranged from 1992-1982 (Tables 8, 9, 10, and 11).

To compare net no. 1 with net no. 2, the following null hypothesis (H_o) was: the length frequency composition of the catch was independent of the nets, with the alternate hypothesis (H_a) the length frequency compositions of the catch were not independent of the nets. To test this hypothesis the two length frequencies were divided into five FL categories: 1) ≤14.9 inches (≤ 380 mm) FL; 2) 15 - 19 inches (381 - 509 mm) FL; 3) 20 - 24.9 inches (510 - 635 mm) FL; 4) 25 - 29.9 inches (636 - 763 mm) FL; and 5) ≥30 inches (≥764 mm) FL. The null hypothesis was rejected (X^2 = 26.32; 4 df; P < 0.0001). Even though the length frequency of the striped bass captured in the two multi-sized mesh gill nets were significantly different, data were combined to test the differences between striped bass length frequencies obtained from the multi-sized mesh gill nets and the pound net. The null hypothesis (H_o): was the length frequency composition was

independent of the type of net, with the alternate hypothesis (H_a) length frequencies were not independent of the type of net. The null hypothesis was rejected, ($X^2 = 40.64$; 4 df; $P < 0.0001$).

Spring 1994: James River

In spring 1994, 21.3% of the striped bass caught in the fyke net were all young males (ages $\leq$ 3) (Tables 12 and 13). However, in the older age group (ages $\geq$ 4) females were the dominant sex (3:1).

With data for the sexes combined, the 1990 year class was the modal group in the fyke net samples, accounting for 32.4% of the samples (Tables 12 and 13). Males of the 1990 year class were the dominant cohort (32.4%) and the males of the 1989 year class were the second most numerous cohort (20.41%). The maximum CPUE for males was the 1990 year class, with 3.5 fish/net-day, and for females the maximum CPUE was also the 1990 year class, 0.545 fish/day, (Fig. 4). The oldest male and female year class present in the spring spawning was, respectively, 1987 and 1982.

The total number of striped bass captured in experimental gill net was 128, with a total effort of 9.38 net days (Table 14). We were able to age all striped bass captured in the gill net except one each from the 4.5, 5.25 and 6.0 inch mesh panel and two from the 3.75 inch mesh panel (Table 15 and 16). These scales would have been aged, also, but they were all regenerated scales, where the focus and early annuli were totally obliterated. The 1989 males were the dominant cohort captured (Tables 15, and 16 and Fig 5). The striped bass year classes captured by both nets ranged from 1992-1982 (Tables 15 and 16).

The length frequencies for striped bass samples from the fyke net and the gill net were compared. The null hypothesis (H_o) was: the length frequency composition was independent of the type of net, with the alternate hypothesis (H_a) length frequency was not independent of the type of net. To test this hypothesis the two length frequencies were divided into five FL categories: 1) $\leq$14.9 inches ($\leq$ 380 mm) FL; 2) 15 - 19 inches (381 - 509 mm) FL; 3) 20 - 24.9 inches (510 - 635 mm) FL; 4) 25 - 29.9 inches (636 - 763 mm) FL; and 5) $\geq$30 inches ($\geq$764 mm) FL. The null hypothesis was accepted ($X^2 = 8.88$; 4 df; $P = 0.0643$).

Estimates of Growth

The estimates of the striped bass allometric and Gompertz parameters for the spring fishery on the Rappahannock and James rivers are presented in Tables 17 - 18. Striped bass less than 150 mm FL are not retained by either the pound or fyke net and older fish (≥ age 7) are under represented. Therefore, we are missing the toe and the heel of the von Bertalanffy curve.

The back-calculated lengths for each age year class, sex and river are reported in Tables 19 -24 for both the Rappahannock and James rivers, respectively. The average back-calculated for lengths to annulus formation shows linear growth increments from age 1 through age 5 (Tables 19 -24). Generally, male and female striped bass grow at similar rates for the first five years of life.

Catch per unit of effort (CPUE) is an indicator of spawning stock abundance for some species, for others, it is not. It is used herein although the presence or absence of the relationship will not be established until there are at least several more years of data. CPUE is defined as the total number of female striped bass ≥ age 4, divided by the total effort in the sampling season; thus, CPUE = number of fish/day.

Historically, the CPUE derived from pound nets ranged from 0.80 - 8.00 for the Rappahannock River (Hill and Loesch 1992). In contrast, the experimental gill nets' CPUE ranged from 3.19 - 1.33 for the Rappahannock River (Hill and Loesch 1992). In spring 1994 the Rappahannock river spawning index from pound nets and experimental gill nets was 5.38 and 4.66, respectively. However, on the James River the spawning index from fyke nets and the experimental gill net was 1.64 and 3.86, respectively.

Estimates of CPUE can be influenced by non-intrinsic factors. Commercial fishermen remove their least productive nets and only keep their most productive nets when stocks are low and when only a limited amount of fishing is permitted. This action, which changes the definition of mean unit of fishing effort, occurred in the Rappahannock River in the years just prior to the recent total moratorium. A change in the sampling design may also influence the CPUE. Prior to 1991 striped bass samples were taken on a mean 15 day interval, usually commencing in early April and continuing through June. Since 1991, striped bass samples have been obtained weekly,

from 1 April through mid-May, and gives a more complete assessment of the spawning population. Such perturbations are less troublesome to long term data sets.

Tagging

The management of the east coast striped bass fishery is based on a target annual fishing mortality rate (F) by all jurisdictions that exploit the coastal striped resource. The purpose of the fall tagging program is the direct measurement of F (fishing mortality). VIMS, the Maryland Department of Natural Resources, and the Potomac River Fisheries Commission co-operated in a coordinated measurement of F for a bay-wide F.

The analytical methodology was determined by Rugolo et al. (1994) and the Virginia information was reported therein. However, a brief summary of the findings follows as it relates to the Commonwealth of Virginia.

Electro-fishing and drift gill net fishing were unsuccessful on the Pamunkey and Mattaponi rivers. Seven days of electro-fishing yielded no fish and five gill netting events on each river yielded only three striped bass for tagging. Three hundred and fifty anchor/external streamer tags originally allocated to these rivers were re-allocated to Rappahannock River, York River and Gwynn's Island, equally. All striped bass tagged were at least 457 mm (18 inches) TL. Standard USFWS internal anchor/external streamer tags and special reward tags were applied to 2,564 striped bass. Every fifth fish received a special $100 reward tag. A total of 1,789 fish were tagged from pound nets, 739 from fyke nets, 27 from a haul seine and nine from gill nets.

Tagging in the James River began on 20 September and ended on 8 November. A total of 474 striped bass were tagged and released. The mean TL of the tagged fish was 523 mm. Initially, our intent was to tag and release 1,000 fish in the James River. The commercial fishermen limited their effort, due the rapid decline of the catfish market which, in turn, had a direct impact on the tagging program.

Tagging in the York River began on 20 September and ended on 29 October. The total number of striped bass tagged and released in the York River was 475 and the mean TL of the tagged fish was 578 mm.

Tagging in the Rappahannock River began on 4 October and ended on 8 November. The total number of striped bass tagged and released in the Rappahannock River was 843 and the mean

TL of the tagged fish was 551 mm. This total represents fish that were tagged at river mile 8 and miles 44 and 47. Tagging at Gwynn's Island commenced on 14 October and ended 29 October. There, VIMS personnel tagged 772 striped bass. The mean TL of the fish was 543 mm. The 1990 year class was the dominant year class across all tagging areas (Fig. 6). We were unable to age 156 striped bass specimens from the fall tagging program due to scale regeneration.

A total of 66 $100 reward tags were returned - all from Virginia waters. A total of 39 reward tags were returned from the Rappahannock River, 17 from the York River, 13 from the James River, and two from Gwynn's Island. All of the recovered special reward tags from Gwynn's Island were all recaptured at the mouth of the Rappahannock River. A large majority of the recoveries from the fish tagged in the York River were recovered within the system. There were 282 standard tag recoveries from all areas combined. Combining all recaptures, 98.8% were recovered in Virginia waters, 0.06% each in the Potomac River and Maryland waters. According to tag recovery information reported from USFWS, most Virginia striped bass remained within state waters. Assuming 100% reporting of the $100 tags, the reporting rate for standard tags is 75.1% bay-wide with 95% confidence limits of 60.4% and 99.2%. The reporting rate was used to estimate exploitation and population abundance.

The rate of exploitation of striped bass in Virginia due to the direct harvest in the recreational and charter boat fisheries, combined, was estimated to be 0.0298 with 95% confidence limits of 0.023 and 0.037 (Rugolo et al., 1994).

The directed fishing mortality for Virginia was determined to be 0.046 for all fishing activities with 95% confidence limits of 0.034 and 0.057 (Rugolo et al. 1994). Partitioned by fisheries, the recreational and charter boat fisheries combined F was estimated to be 0.03 with 95% confidence limits of 0.023 and 0.038; the F value for commercial fishing in Virginia was noticeably lower with a mean rate of 0.015 and limits of 0.012 and 0.019. The bay-wide F 0.090 with 95% confidence limits of 0.068 and 0.113.

Using a modified Peterson approach, Rugolo et al. (1994), estimated the number of striped bass 457 mm TL and longer in the Virginia waters to be 1,393,028, with 95% confidence limits of 1,123,806 and 1,803,849. The corresponding values for the bay-wide estimates are 6,561,882 with 5,280,858 and 8,658,508 confidence limits.

A total of 195 striped bass were tagged in spring 1994. Most of the fish were tagged on 21 April (35%). The largest female striped bass tagged measured 1,055 mm FL and the largest male, 880 mm FL. We were unable to age 21 striped bass due to regenerated scale samples. The dominant male cohort was the 1988 year class and the 1983 year class was the dominant cohort for the females. As of the last update there has been no recaptures reported for this season.

Maximum-likelihood estimates for annual survival rate for striped bass, with sexes combined and TL ≥ 610 mm during the spring Rappahannock River tagging program, 1988 - 1993 are reported in Table 25. According to Dr. David Smith (Department of Interior, Kearneysville, West Virginia, personal communication), the statistical model upon which the estimates are based allows for a mean survival rate, year-specific recovery rates and recovery rates specific to the first year after tagging (Brownie et al. 1985). This model was better than a similar model that did not allow for first year recovery rates to differ ($X^2 = 15.15$, 5 df, $P < 0.01$), and had the lowest AIC (139.61). The model fitted the data ($X^2 = 14.366$, 9 df, $P < 0.1099$). The survival models seem too sensitive to changes in effort. The commercial effort on the Rappahannock has reduced drastically since 1987. When VIMS started tagging on the Rappahannock River there were over 12 pound nets from Tappahannock to Carter's Wharf. The next step is to look at the sport fishery recovery rates only; the sport fishing effort may have remained constant during this time.

In-season Peterson population estimates for the Rappahannock River fall tagging program of 1987-1990 and the James River fall of 1990-1992 and the 95% confidence intervals (Seber 1982) appear in Appendix 1. The population estimates are a first cut. The estimates are only valid for the area of the river in which VIMS was tagging. The estimates assume that immigration rate equals emigration rate.

CONCLUSION

The Interstate Management Plan of Striped Bass states the east coast stock should be monitored for F. The only way to accomplish this is by a tagging program. Tagging of striped bass, and monitoring the spawning stock should continue. In addition, a spawning stock

assessment was attempted on the James River for the first time; this data base should be futher developed. The pen study conducted in fall 1993 should be repeated in the spring, late in the tagging period, when water temperatures usually are higher than in the fall.

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Table 1. The number of striped bass sampled from the Rappahannock River, Virginia, fall 1986 - spring 1994 and the James River, Virginia, spring 1994.

Rappahannock River			
Season	Pound Nets	Gill Nets	Experimental Gill Net
Fall 1986	779	9	
Spring 1987	620		
Fall 1987	1,140	79	
Spring 1988	363		
Fall 1988	1,661	14	
Spring 1989	455		
Fall 1989	1,643		
Spring 1990	172		460
Spring 1991	270		583
Fall 1991	1,270		
Spring 1992	279		180
Fall 1992	567		
Spring 1993	565		570
Fall 1993	654		
Spring 1994	375		558
Total Rappahannock River	10,813	102	2,351
James River			
Season	Fyke Nets	Gill Nets	Experimental Gill Net
Spring 1994	112		128
Total James River	112		128

Table 2. Mean fork length ($\bar{L}$), standard deviation (SD), and CPUE (number of fish per day), pound nets, fall 1993, Rappahannock River.

Year Class	River Mile	Sex	N	$\bar{L}$ (mm)	SD	CPUE
1988	44	M	5	651.8	28.09	0.312
		F	1	638		0.062
1989	44	M	37	544.1	24.27	2.312
		F	15	550.4	17.83	0.938
	47	M	7	540.3	14.41	1.4
		F	2	558.5	9.19	0.4
1990	44	M	55	485.4	21.82	3.438
		F	6	483.7	27.93	0.375
	47	M	23	483.1	25.69	4.6
		F	1	509		0.2
1991	44	M	132	388.7	25.43	8.25
		F	68	395.6	28.30	4.25
	47	M	55	389.18	27.14	11.0
		F	29	399.4	27.41	5.8
1992	44	M	106	284.0	36.55	6.625
		F	57	293.1	37.3	3.562
1992	47	M	22	312.9	41.00	4.4
		F	14	307.86	39.64	2.8
1993	44	M	4	215.0	8.29	0.25
		F	1	225		0.062
	47	F	2	228.0	0.0	0.4
NA	44	M	4	454.4	69.15	0.25
		F	4	380.0	109.26	0.25
	47	M	4	396.8	62.74	0.8

Table 3. Mean weight ($\bar{W}$), standard deviation (SD), and CPUE (number of fish per day), pound nets, fall 1993, Rappahannock River.

Year Class	River Mile	Sex	N	$\bar{W}$(gm)	SD	CPUE
1988	44	M	5	2469.68	1291.43	0.312
		F	1	2878.20		0.062
1989	44	M	37	1656.97	693.23	2.312
		F	15	1932.09	363.32	0.938
	47	M	7	1545.26	149.39	1.4
		F	2	1656.15	169.21	0.4
1990	44	M	55	1473.05	234.35	3.438
		F	6	1312.37	192.42	0.375
	47	M	23	1335.84	186.63	4.6
		F	1	1255.20		0.2
1991	44	M	132	808.78	199.35	8.25
		F	68	798.25	180.27	4.25
	47	M	55	841.50	214.33	11.0
		F	29	796.03	166.33	5.8
1992	44	M	106	334.26	137.54	6.625
		F	57	348.44	123.16	3.562
1992	47	M	22	453.55	161.26	4.4
		F	14	416.47	148.26	2.8
1993	44	M	4	141.15	18.51	0.25
		F	1	140.1		0.062
	47	F	2	137.50	3.39	0.4
NA	44	M	4	1380.58	413.64	0.25
		F	4	1119.6	711.79	0.25
	47	M	4	723.42	264.84	0.8

Table 4. Mean fork length ($\bar{L}$), standard deviation (SD), and CPUE (number of fish per day), pound net, spring 1994, Rappahannock River.

Year Class	River Mile	Sex	N	$\bar{L}$ (mm)	SD	CPUE
1979	47	F	1	1080.0		0.111
1980	47	F	1	1110.0		0.111
1981	47	F	2	1025.0	7.07	0.222
1982	44	M	1	1061		0.059
	47	F	4	967.0	43.33	0.444
1983	44	F	3	941.3	12.10	0.176
	47	F	6	932.5	24.13	0.667
1984	44	F	1	888.0		0.059
	47	F	8	897.1	9.92	0.889
1985	44	M	1	885.0		0.059
		F	5	859.4	17.2	0.294
	47	F	8	857.4	10.01	0.889
1986	44	M	2	812.0	11.31	0.118
		F	2	805.0	35.36	0.118
	47	M	1	791.0		0.111
		F	11	818.3	20.20	1.222
1987	44	M	3	760.7	10.78	0.176
1987	44	F	5	742.4	33.80	0.294
	47	M	3	744.3	32.00	0.333
		F	20	746.2	30.74	2.222
1988	44	M	10	645.3	29.23	0.588
		F	8	675.9	22.90	0.470
	47	M	20	629.90	19.13	2.222
		F	22	656.4	32.69	2.444
1989	44	M	22	561.0	18.56	1.294
		F	5	592.4	21.47	0.227
	47	M	73	557.0	26.09	8.111

Table 4. (Cont.)

Year Class	River Mile	Sex	N	$\bar{L}$ (mm)	SD	CPUE
1989		F	24	582.9	20.03	2.667
1990	44	M	9	513.8	25.82	0.529
	47	M	26	503.5	20.70	2.889
		F	1	480.0		0.111
1991	44	M	2	417.5	6.36	0.118
	47	M	11	408.5	31.67	1.222
1992	44	M	3	283.0	3.00	0.176
		F	1	276.0		0.059
1992	47	M	30	272.3	39.59	3.333
		F	5	237.6	14.22	0.556
NA	44	M	6	657.5	103.30	0.353
		F	1	623.0		0.059
	47	M	5	570.2	200.27	0.555
		F	2	699.5	26.16	0.222

Table 5. Mean weight ($\bar{W}$), standard deviation (SD), and CPUE (number of fish per day), pound net, spring 1994, Rappahannock River.

Year Class	River Mile	Sex	N	$\bar{W}$ (grams)	SD	CPUE
1979	47	F	1	16654.6		0.111
1980	47	F	1	20157.9		0.111
1981	47	F	2	13040.05	1815.64	0.222
1982	44	M	1	13636.1		0.059
	47	F	4	12888.0	3201.18	0.444
1983	44	F	3	9021.9		0.176
	47	F	6	10323.18	3362.55	0.667
1984	44	F	1	9799.0		0.059
	47	F	8	9786.69	1322.36	0.889
1985	44	M	1	9021.90		0.059
		F	5	8506.84	1104.37	0.294
	47	F	8	7816.05	1775.62	0.889
1986	44	M	2	6813.85	797.54	0.118
		F	2	7159.60	1276.33	0.118
	47	M	1	6190.7		0.111
		F	11	7604.14	1056.69	0.222
1987	44	M	3	5698.23	758.52	0.176
	44	F	5	5475.66	908.15	0.294
	47	M	3	4554.23	1493.90	0.333
		F	20	5633.25	890.08	2.222
1988	44	M	10	3282.94	588.26	0.588
		F	8	3892.36	530.69	0.470
	47	M	20	2988.91	460.74	2.222
		F	22	3988.15	632.58	0.444
1989	44	M	22	2140.14	278.36	1.294
		F	5	2789.26	517.59	0.227
	47	M	73	2230.10	397.36	8.111

Table 5. (Cont.)

Year Class	River Mile	Sex	N	$\bar{W}$ (grams)	SD	CPUE
1989		F	24	2737.46	376.46	2.667
1990	44	M	9	1634.97	199.15	0.529
	47	M	26	1656.98	201.19	2.889
		F	1	1528.0		0.111
1991	44	M	2	806.60	34.65	0.118
	47	M	11	854.65	162.86	1.222
1992	44	M	3	249.13	37.75	0.176
		F	1	266.8		0.059
	47	M	30	266.69	117.75	3.333
		F	5	167.66	32.80	0.556
NA	44	M	6			0.353
		F	1	3361.9		0.059
	47	M	5	570.20	992.77	0.555
		F	2	4390.25	179.39	0.222

Table 6. Number of striped bass captured in experimental gill net #1, in the Rappahannock River, spring 1994.

	Mesh Size (inches)											
	3	3.75	4.5	5.25	6	6.5	7	8	9	10	Total	Effort
Date												
03/21/94		1	1								2	1.0208
03/24/94				1	1	1					3	1
3/28/94		2		7	2	1					12	0.9583
03/31/94		1	2	6			1	1	1		12	0.9583
04/04/94	1	3	2	1	2		1				10	0.9792
04/07/94	1			2							3	1
04/11/94			8	36	4	4	4	2	2		60	0.9836
04/14/94		2	1	11	3	3	5	2	1		28	1
04/18/94				31	1		2	1	1		36	1.0417
04/21/94	3	6	8	48	1						66	1.0208
04/25/94		3	5	12	1	2	1			1	25	1.0486
04/28/94		2	1			2					5	0.9688
Total	5	20	28	155	15	13	14	6	5	1	262	11.9801

Table 7. Number of striped bass captured in experimental gill net #2, in the Rappahannock River, spring 1994.

	Mesh Size (inches)											
Date	3	3.75	4.5	5.25	6	6.25	7	8	9	10	Total	Effort
03/21/94		2	3	1	2			1			9	1.0208
03/24/94		1	1	1	2	1					6	1.0208
3/28/94	3	1		3		2		2	1		12	1.0417
03/31/94			2	3	1	2	1	3		1	13	1.0417
04/04/94	1		1	3	1	1	3	3			13	1.0417
04/07/94	1	1		1							3	1.0208
04/11/94	35	1	2	42	6	2		2	2	1	93	0.9653
04/14/94	1	1		4	3	1	2				12	1
04/18/94	3	2		9	3	2		1		1	21	1.0625
04/21/94	15	4	4	52	3	5	1	1			85	0.9896
04/25/94	4		3	6	2		2				17	0.9653
04/28/94	1		1	4	4	1	1				12	0.875
Total	64	13	17	129	27	17	10	13	3	3	296	12.0452

Table 8. Mean fork length ($\bar{L}$), standard deviation (SD), and CPUE (number of fish per day), experimental gill net # 1, spring 1994, Rappahannock River.

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
3.0	1989	M	1	547.0		0.083
	1990	M	1	518.0		0.083
	1992	M	3	309.3	25.00	0.250
3.75	1987	F	1	750.0		0.083
	1988	M	1	698.0		0.083
		F	1	665.0		0.083
	1989	M	6	550.0	17.99	0.501
		F	1	542.0		0.083
	1990	M	4	512.5	10.38	0.333
	1991	M	5	413.8	16.18	0.417
	1992	M	1	346.0		0.083
4.5	1988	M	3	646.0	18.52	0.250
		F	2	659.0	1.41	0.167
	1989	M	7	555.1	23.65	0.584
	1990	M	16	500.4	19.97	1.336
5.25	1985	M	1	778.0		0.083
	1988	M	14	630.28	20.00	1.686
5.25	1988	F	3	672.0	33.29	0.250
	1989	M	103	555.9	23.81	8.598
		F	9	579.6	28.57	0.751
	1990	M	19	515.58	11.31	1.586
		F	1	518.0		0.083
	NA	M	5	589.0	88.27	0.417
6.0	1987	F	2	726.0	8.48	0.167
	1988	M	3	628.3	14.57	0.250
		F	3	683.0	28.83	0.250

Table 8. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
	1989	M	6	594.17	16.11	0.501
		F	1	608.00		0.083
6.5	1985	M	2	845.0	7.07	0.167
	1988	M	3	647.33	15.53	0.250
		F	4	667.5	28.87	0.334
	1989	M	3	544.7	26.27	0.250
		F	1	626.0		0.083
7.0	1983	F	1	968		0.083
	1986	F	2	822	22.63	0.167
	1987	M	1	720.0		0.083
		F	6	750.0	20.64	0.501
	1988	F	2	679.5	2.12	0.167
	NA	F	2	764.0	107.48	0.167
8.0	1984	F	1	900.0		0.083
	1985	F	1	880.0		0.083
	1986	F	1	783.0		0.083
	1988	F	1	718.0		0.083
	1989	F	1	621.0		0.083
	NA	F	1	848.0		0.083
9.0	1984	F	3	904.33	9.29	0.250
	1988	M	1	692.0		0.083
	NA	M	1	880.0		0.083
10.0	1984	M	1	895.0		0.083

Table 9. Mean fork length ($\bar{L}$), standard deviation (SD), and CPUE (number of fish per day), experimental gill net # 2, spring 1994, Rappahannock River.

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
3.0	1988	M	1	623.0		0.083
	1989	M	6	547.0	10.14	0.498
		F	1	529.0		0.083
	1990	M	15	500.2	15.44	1.245
	1991	M	17	402.9	34.54	1.411
	1992	M	23	315.8	17.48	1.909
	NA	M	1	512.0		0.083
3.75	1988	M	1	670.0		0.083
	1989	M	2	545.5	7.78	0.166
	1990	M	5	489.4	20.27	0.415
	1991	M	2	375.0	25.45	0.166
		F	1	409.0		0.083
	NA	M	1	278.0		0.083
		F	1	536.0		0.083
4.5	1988	M	2	622.5	24.75	0.166
	1989	M	6	557.2	23.07	0.498
	1990	M	8	502.4	14.79	0.664
	1991	M	1	440.0		0.083
5.25	1982	F	1	995.0		0.083
	1986	M	1	800.0		0.083
	1987	M	2	745.0		0.166
		F	2	746.5	51.62	0.166
	1988	M	9	629.2	46.87	0.747
		F	3	682.3	26.54	0.249
	1989	M	81	560.4	22.18	6.725
		F	6	573.7	15.08	0.498

Table 9. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
	1990	M	19	511.0	15.70	1.577
	NA	M	5	560.4	39.58	0.415
		F	1	600.0		0.083
6.0	1985	F	3	845.7	28.75	0.249
	1986	F	1	835.0		0.083
	1987	F	2	753.0	24.04	0.166
	1988	M	4	634.0	20.51	0.332
		F	6	652.0	26.22	0.498
	1989	M	7	592.4	18.69	0.581
	1989	F	2	586.5	27.58	0.166
	NA	M	1	531.0		0.083
		F	1	673.0		0.083
6.5	1982	F	1	978.0		0.083
	1984	F	1	906.0		0.083
	1987	F	1	748.0		0.083
	1988	M	3	672.9	35.04	0.249
		F	4	674.2	10.69	0.332
	1989	M	4	617.8	5.19	0.332
		F	2	587.5	7.78	0.166
	NA	M	1	544.0		0.083
7.0	1983	F	1	935.0		0.083
	1984	F	1	894.0		0.083
	1985	F	1	882.0		0.083
	1987	M	1	734.0		0.083
		F	1	730.0		0.083
	1988	M	1	700.0		0.083
		F	3	677.7	15.31	0.249

Table 9. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
7.0	1989	M	1	618.0		0.083
8.0	1983	F	2	943.0	1.41	0.166
	1985	F	7	868.14	18.44	0.581
	1987	F	2	768.5	40.30	0.166
	NA	F	1	876.0		0.083
9.0	1983	F	1	930.0		0.083
	1985	F	1	863.0		0.083
	1989	M	1	568.0		0.083
10.0	1985	F	1	876.0		0.083
	1988	M	1	648.0		0.083
		F	1	714.0		0.083

Table 10. Mean weight ($\bar{W}$), standard deviation (SD), and CPUE (number of fish per day), experimental gill net # 1, spring 1994, Rappahannock River.

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
3.0	1989	M	1	2281.0		0.083
	1990	M	1	1790.5		0.083
	1992	M	3	385.73	82.66	0.250
3.75	1987	F	1	5088.1		0.083
	1988	M	1	4640.2		0.083
		F	1	3715.2		0.083
	1989	M	6	2160.92	199.82	0.501
		F	1	1941.1		0.083
	1990	M	4	1864.65	216.00	0.333
	1991	M	5	876.80	116.84	0.417
	1992	M	1	585.5		0.083
4.5	1988	M	3	3187.43	302.83	0.250
		F	2	3953.10	13.15	0.167
	1989	M	7	2234.74	276.76	0.584
	1990	M	16	1665.79		1.336
5.25	1985	M	1	5692.0		0.083
	1988	M	1	3217.29	513.58	1.686
5.25	1988	F	3	3801.70	485.09	0.250
	1989	M	103	2219.05	297.27	8.598
		F	9	2689.98	454.30	0.751
	1990	M	19	1801.55	123.97	1.586
		F	1	1911.6		0.083
	NA	M	5	2192.64	389.88	0.417
6.0	1987	F	2	5581.70	180.88	0.167
	1988	M	3	3533.27	338.09	0.250
		F	3	4585.27	775.50	0.250

Table 10. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
	1989	M	6	3188.13	909.47	0.501
		F	1	3158.4		0.083
6.5	1985	M	2	8169.50	880.63	0.167
	1988	M	3	3934.57	440.91	0.250
		F	4	4073.88	811.31	0.334
	1989	M	3	2040.60	359.35	0.250
		F	1	3348.80		0.083
7.0	1983	F	1	10431.1		0.083
	1986	F	2	8174.5		0.167
7.0	1987	M	1	5257.80		0.083
		F	6	5812.63	476.50	0.501
	1988	F	2	4565.90	307.45	0.167
	NA	F	2	6640.80	2590.56	0.167
8.0	1984	F	1	9980.9		0.083
	1985	F	1	9200.7		0.083
	1986	F	1	6638.6		0.083
	1988	F	1	2619.0		0.083
	1989	F	1	3270.4		0.083
	NA	F	1	8447.1		0.083
9.0	1984	F	3	10682.07	710.85	0.250
	1988	M	1	5587.6		0.083
	NA	M	1	9492.9		0.083
10.0	1984	M	1	8854.0		0.083

Table 11. Mean weight ($\bar{W}$), standard deviation (SD), and CPUE (number of fish per day), experimental gill net # 2, spring 1994, Rappahannock River.

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
3.0	1988	M	1	3297.2		0.083
	1989	M	6	2237.30	280.35	0.498
		F	1	1690.5		0.083
	1990	M	15	1605.36	198.07	1.245
	1991	M	17	808.82	188.49	1.411
	1992	M	23	418.64	62.14	1.909
	NA	M	1	1707.9		0.083
3.75	1988	M	1	4090.9		0.083
	1989	M	2	2031.05	70.92	0.166
	1990	M	5	1550.78	209.37	0.415
	1991	M	2	781.95	77.85	0.166
		F	1	935.4		0.083
	NA	M	1	711.7		0.083
		F	1	6490.8		0.083
4.5	1988	M	2	3139.05	379.79	0.166
	1989	M	6	2248.95	395.30	0.498
	1990	M	8	1680.44	161.36	0.664
	1991	M	1	1101.0		0.083
5.25	1982	F	1	11921.7		0.083
	1986	M	1	6523.7		0.083
	1987	M	2	5672.8		0.166
		F	2	6300.95	961.45	0.166
	1988	M	9	3290.57	687.50	0.747
		F	3	4418.90	587.46	0.249
	1989	M	81	2274.34	301.49	6.725
		F	6	2614.72	116.18	0.498

Table 11. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
	1990	M	19	1816.02	149.66	1.577
	NA	M	5	2324.06	462.77	0.415
		F	1	3054.5		0.083
6.0	1985	F	3	9453.33	1116.78	0.249
	1986	F	1	7584.3		0.083
	1987	F	2	6552.95	542.56	0.166
	1988	M	4	3601.73	586.06	0.332
		F	6	3953.55	495.52	0.498
	1989	M	7	2892.59	299.22	0.581
	1989	F	2	2735.85	578.48	0.166
	NA	M	1	1856.4		0.083
		F	1	3781.9		0.083
6.5	1982	F	1	14369.3		0.083
	1984	F	1	10556.0		0.083
	1987	F	1	5456.2		0.083
	1988	M	3	3900.87	502.03	0.249
		F	4	3752.78		0.332
	1989	M	4	3190.93	281.92	0.332
		F	2	2742.3		0.166
	NA	M	1	2301.2		0.083
7.0	1983	F	1	NA		0.083
	1984	F	1	10057.1		0.083
	1985	F	1	9712.0		0.083
	1987	M	1	6707.3		0.083
		F	1	5357.3		0.083
	1988	M	1	5322.1		0.083
		F	3	4684.9		0.249

Table 11. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
7.0	1989	M	1	3162.4		0.083
8.0	1983	F	2	11045.6		0.166
	1985	F	7	9161.7	550.79	0.581
	1987	F	2	6779.05	668.00	0.166
	NA	F	1	10714.5		0.083
9.0	1983	F	1	11515.0		0.083
	1985	F	1	9287.0		0.083
	1989	M	1	2603.0		0.083
10.0	1985	F	1	9392.0		0.083
	1988	M	1	3440.0		0.083
		F	1	4937.2		0.083

Table 12. Mean fork length ($\bar{L}$), standard deviation (SD), and CPUE (number of fish per day), fyke net, spring 1994, James River.

Year Class	River Mile	Sex	N	$\bar{L}$ (mm)	SD	CPUE
1982	56	F	1	1000		0.091
1984	56	F	2	908.0	14.14	0.182
1985	56	F	1	865.0		0.091
1986	56	F	3	797.7	36.11	0.273
1987	56	M	2	729.0	29.70	0.182
1988	56	M	3	593.0	57.71	0.273
		F	4	651.50	32.17	0.364
1989	56	M	22	555.0	23.90	2.000
		F	5	555.8	16.83	0.455
1990	56	M	35	488.77	21.02	3.182
		F	6	494.0	26.11	0.545
1991	56	M	21	418.2	27.53	1.909
1992	56	M	2	304.0	29.70	0.182
NA	56	M	2	497.0	7.07	0.182
		F	2	581.5	26.16	0.182

Table 13. Mean weight ($\bar{W}$), standard deviation (SD), and CPUE (number of fish per day), fyke net, spring 1994, James River.

Year Class	River Mile	Sex	N	$\bar{W}$ (grams)	SD	CPUE
1982	56	F	1	12109.5		0.091
1984	56	F	2	7999.75	93.27	0.182
1985	56	F	1	9105.5		0.091
1986	56	F	3	6532.00	956.11	0.273
1987	56	M	2	4491.30	592.70	0.182
1988	56	M	3	3143.13	276.91	0.273
		F	4	4168.3	783.80	0.364
1989	56	M	22	2264.46	382.10	2.000
		F	5	2433.08	302.04	0.455
1990	56	M	35	1591.05	257.27	3.182
		F	6	1690.77	314.66	0.545
1991	56	M	21	1007.50	200.88	1.909
1992	56	M	2	389.35	171.33	0.182
NA	56	M	2	1580.35	70.92	0.182
		F	2	2760.40	565.12	0.182

Table 14. Number of striped bass captured in experimental gill net #1, in the James River, spring 1994.

	Mesh Size (inches)											
Date	3	3.75	4.5	5.25	6	6.25	7	8	9	10	Total	Effort
3/7/94					1	1		1			3	0.7708
3/14/94		2	2	3	1	1					9	0.8333
3/21/94		1		1							2	1
3/28/94			2		4	3	2				11	0.9063
4/4/94						1	1	1	1		4	0.9762
4/11/94		1	7	11	6	2	4	1	1		33	0.9931
4/18/94	1	1	11	16	5						34	0.9876
4/25/94			5	2	1	1	1	1			11	0.9931
5/2/94		10	4	2	1						17	1
5/9/94		3	1								4	0.9167
Totals	1	18	32	35	18	10	8	4	2	0	128	9.3771

Table 15. Mean fork length ($\bar{L}$), standard deviation (SD), and CPUE (number of fish per day), experimental gill net # 1, spring 1994, James River.

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
3.0	1989	M	1	525.0		0.107
3.75	1989	M	3	536.7	17.62	0.320
		F	1	577.0		0.107
	1990	M	5	478.4	13.88	0.533
	1991	M	6	405.8	31.34	0.640
	1992	M	1	335.0		0.107
	NA	M	1	508.0		0.107
		F	1	637.0		0.107
4.5	1984	F	1	920.0		0.107
	1989	M	9	550.67	27.94	0.960
		F	1	585.0		0.107
	1990	M	12	480.1	21.32	1.28
		F	4	506.2	28.79	0.426
	1991	M	4	429.8	5.80	0.426
	NA	M	1	513.0		0.107
5.25	1988	F	1	644.0		0.107
	1989	M	9	552.7	18.99	0.960
	1989	F	7	563.1	18.30	0.746
	1990	F	4	506.25	28.79	0.426
	NA	M	1	492.0		0.107
6.0	1983	F	1	958.0		0.107
	1988	M	3	645.0	16.10	0.320
		F	4	674.2	17.85	0.426
	1989	M	6	560.0	21.59	0.640
		F	3	588.7	11.02	0.320
	NA	M	1	635.0		0.107

Table 15. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{L}$ (mm)	SD	CPUE
6.5	1987	F	2	717.0	21.21	0.213
	1988	M	2	668.0	60.81	0.213
		F	1	690.0		0.107
	1989	M	2	570.0	41.72	0.213
		F	1	610.0		0.107
	1990	M	2	481.5	14.85	0.213
7.0	1983	F	1	912.0		0.107
	1984	F	1	885.0		0.107
	1985	F	1	872.0		0.107
	1986	F	2	811.0	1.41	0.213
	1988	F	2	697.0	9.90	0.213
	1989	M	1	598.0		0.107
8.0	1984	F	1	870.0		0.107
	1985	F	1	880.0		0.107
	1988	F	1	694.0		0.107
	1989	M	1	558.0		0.107
9.0	1982	F	1	953.0		0.107
	1983	F	1	945.0		0.107

Table 16. Mean weight ($\bar{W}$), standard deviation (SD), and CPUE (number of fish per day), experimental gill net # 1, spring 1994, James River.

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
3.0	1989	M	1	2205.5		0.107
3.75	1989	M	3	1931.93	263.83	0.320
		F	1	2198.6		0.107
	1990	M	5	1452.34	111.33	0.533
	1991	M	6	944.23	232.13	0.640
	1992	M	1	553.3		0.107
	NA	M	1	2012.0		0.107
		F	1	3870.0		0.107
4.5	1984	F	1	9742.1		0.107
	1989	M	9	2343.44	398.96	0.960
		F	1	3184.3		0.107
	1990	M	12	1581.94	213.36	1.28
		F	4	1800.10	237.75	0.426
	1991	M	4	1128.85	74.16	0.426
	NA	M	1	1902.6		0.107
5.25	1988	F	1	3001.2		0.107
	1989	M	9	2464.42	295.37	0.960
	1989	F	7	2648.59	328.98	0.746
	1990	F	4	2044.15	342.03	0.426
	NA	M	1	1775.1		0.107
6.0	1983	F	1	11823.0		0.107
	1988	M	3	4093.27	327.00	0.320
		F	4	4435.93	480.40	0.426
	1989	M	6	2604.83	270.36	0.640
		F	3	3008.93	284.66	0.320
	NA	M	1	4464.1		0.107

Table 16. (Cont.).

Mesh Size (inches)	Year Class	Sex	N	$\bar{W}$ (grams)	SD	CPUE
6.5	1987	F	2	6550.25	1869.66	0.213
	1988	M	2	3936.00	791.39	0.213
		F	1	4072.3		0.107
	1989	M	2	2770.30	308.72	0.213
		F	1	3199.4		0.107
	1990	M	2	1601.80	113.70	0.213
7.0	1983	F	1	10354.9		0.107
	1984	F	1	11796.4		0.107
	1985	F	1	9178.7		0.107
7.0	1986	F	2	7510.75	336.51	0.213
	1988	F	2	5140.95	167.37	0.213
	1989	M	1	3388.8		0.107
8.0	1984	F	1	9724.2		0.107
	1985	F	1	10262.0		0.107
	1988	F	1	4965.0		0.107
	1989	M	1	2315.0		0.107
9.0	1982	F	1	12154.5		0.107
	1983	F	1	12194.7		0.107

Table 17. Allometry growth parameters for the Rappahannock and James rivers.

Rappahannock River			
Sexes Combined			
Parameter	Estimate	Asymptotic Std. Error	CV
a	9.795×10^{-6}	2.672×10^{-6}	2.728×10^{-1}
b	3.044	4.013×10^{-2}	1.319×10^{-2}
Females			
a	1.565×10^{-5}	9.124×10^{-6}	5.834×10^{-1}
b	2.977	8.529×10^{-2}	2.865×10^{-2}
Males			
a	2.244×10^{-5}	4.413×10^{-6}	1.967×10^{-1}
b	2.908	2.984×10^{-2}	1.026×10^{-2}
James River			
Sexes Combined			
Parameter	Estimate	Asymptotic Std. Error	CV
a	5.993×10^{-5}	1.502×10^{-5}	2.506×10^{-1}
b	2.764	3.766×10^{-2}	1.362×10^{-2}
Females			
a	1.856×10^{-4}	1.440×10^{-4}	7.762×10^{-1}
b	2.599	1.144×10^{-1}	4.403×10^{-2}
Males			
a	2.44×10^{-5}	4.413×10^{-6}	$1.967 \text{ X } 10^{-1}$
b	2.908	$2.984 \text{ X } 10^{-2}$	$1.026 \text{ X } 10^{-2}$

Table 18. Gompertz growth parameters estimates for the Rappahannock and James rivers.

Rappahannock River			
Sexes Combined			
Parameter	Estimate	Asymptotic Std. Error	CV
W_0	1.397×10^{2}	3.0545×10^{1}	2.186×10^{-1}
G	5.021	1.668×10^{-1}	3.321×10^{-2}
g	2.104×10^{-1}	1.336×10^{-2}	6.350×10^{-2}
Females			
W_0	3.636×10^{2}	1.355×10^{2}	3.726×10^{-1}
G	4.213	2.451×10^{-1}	5.818×10^{-2}
g	1.696×10^{-1}	2.586×10^{-2}	1.535×10^{-1}
Males			
W_0	1.860×10^{2}	2.830×10^{1}	1.522×10^{-1}
G	5.180	8.560×10^{-2}	1.652×10^{-2}
g	1.633×10^{-1}	1.286×10^{-2}	7.874×10^{-2}
James River			
Sexes Combined			
Parameter	Estimate	Asymptotic Std. Error	CV
W_0	2.81 x 102	4.235 x 101	1.857 x 10-1
G	4.532	9.957 x 10-2	2.197 x 10-2
g	1.854 x 10-1	1.851 X 10-2	9.986 X 10-2

Table 18. (Cont.)

James River			
Females			
Parameter	Estimate	Asymptotic Std. Error	CV
W_0	2.053×10^{2}	1.461×10^{2}	7.116×10^{-1}
G	4.419	5.164×10^{-1}	1.169×10^{-1}
g	2.175×10^{-1}	5.417×10^{-2}	2.491×10^{-1}
Males			
W_0	3.655×10^{2}	8.447×10^{1}	2.311×10^{-1}
G	5.109	1.554	3.042×10^{-1}
g	1.113×10^{-1}	5.991×10^{-2}	5.384×10^{-1}

Table 19. Average back-calculated fork lengths for striped bass (sexes combined) captured in pound nets on the Rappahannock River, spring 1994.

Average Back-calculated Lengths for Each Age Class

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
92	1	0	0.00														
91	2	39	205.87	268.79													
90	3	13	230.50	336.83	409.92												
89	4	36	234.01	352.56	443.78	505.42											
88	5	124	233.96	347.24	445.56	516.03	563.70										
87	6	62	236.66	351.20	457.08	539.86	602.08	648.53									
86	7	31	253.01	376.92	489.00	587.89	667.80	729.89	744.61								
85	8	18	247.20	360.60	466.43	558.69	639.78	704.16	761.79	808.50							
84	9	12	249.45	360.71	453.42	542.60	619.79	688.99	751.34	807.76	859.25						
83	10	8	251.41	363.85	454.18	537.42	615.31	688.65	751.09	806.63	851.84	897.13					
82	11	8	257.67	369.26	469.71	558.62	635.17	708.23	775.53	839.67	895.02	941.96	933.00				
81	12	5	257.00	373.28	473.72	562.57	647.84	719.61	786.18	852.21	908.83	955.39	1023.44	985.80			
80	13	2	265.84	387.84	489.00	579.01	654.27	736.79	805.76	883.63	951.66	1034.92	1054.61	1054.61	1025.00		
79	14	1	257.34	365.14	474.47	552.37	626.91	702.71	779.05	853.21	919.04	984.09	913.70	1109.46	1110.00	1110.00	
78	15	1	240.76	354.21	436.45	549.99	637.22	701.58	769.71	827.62	886.38	945.69	940.24	940.24	889.51	889.51	1080.00
All Classes			235.58	344.77	453.39	533.40	598.16	685.33	757.16	820.47	879.43	939.57	973.20	1009.77	1012.38	999.76	1080.00
N		360	360	360	321	308	272	148	86	55	37	25	17	9	4	2	1

Table 20. Average back-calculated fork lengths of male striped bass captured in pound nets on the Rappahannock River, spring 1994.

Average Back-calculated Lengths for of Each Age Class

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9	10	11	12
92	1	0	0.00											
91	2	32	199.81	273.06										
90	3	13	217.82	331.65	409.92									
89	4	36	220.21	344.89	440.88	503.56								
88	5	95	217.77	335.21	437.36	509.11	557.93							
87	6	30	218.20	336.96	443.58	528.16	587.88	635.03						
86	7	6	231.97	351.34	459.87	561.66	643.54	707.72	752.50					
85	8	3	222.26	347.02	445.99	537.51	628.37	695.10	752.72	805.00				
84	9	1	238.47	365.10	468.83	546.55	628.97	707.82	764.48	820.78	885.00			
83	10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
82	11	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
81	12	1	226.07	323.57	422.29	512.27	610.33	691.80	772.63	839.57	905.75	969.77	1019.89	1061.00
All Classes			216.18	328.37	438.09	513.83	570.77	653.23	755.48	815.07	895.37	969.77	1019.89	1061.00
N		217	217	217	185	172	136	41	11	5	2	1	1	1

Table 21. Average back-calculated fork lengths of female striped bass captured in pound nets on the Rappahannock River, spring 1994.

Average Back-calculated Lengths for Each Age Class

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9	10	11	12	13
92	1	0	0.00												
91	2	6	194.53	244.17											
90	3	0	0.00	0.00	0.00										
89	4	1	217.67	318.96	402.43	480.00									
88	5	29	238.98	354.67	455.15	531.73	582.62								
87	6	32	240.84	355.19	463.73	547.50	613.90	661.19							
86	7	26	244.34	361.78	466.93	559.20	634.37	691.51	743.58						
85	8	15	251.09	362.48	469.82	562.38	641.72	705.75	763.48	809.20					
84	9	11	251.32	361.05	452.64	542.68	619.29	687.53	750.28	806.62	856.91				
83	10	8	253.91	365.91	455.89	538.82	616.40	689.46	751.65	806.98	852.02	897.13			
82	11	8	260.17	371.35	471.43	560.01	636.27	709.06	776.11	840.02	895.17	941.92	933.00		
81	12	3	272.19	398.14	497.85	592.46	677.15	748.46	814.53	884.07	940.43	985.63	1034.86	948.67	
80	13	1	286.26	411.67	534.20	636.21	710.18	806.33	882.32	972.77	1047.90	1140.43	1089.52	1089.52	1030.00
All Classes			243.72	355.39	463.09	549.02	618.31	687.75	758.14	822.00	879.76	940.49	971.51	983.88	1030.00
N		140	140	140	134	134	133	104	72	46	31	20	12	4	1

Table 22. Average back-calculated fork lengths for striped bass (sexes combined) captured in fyke nets on the James River, spring 1994.

Average Back-calculated Lengths for Each Age Class Sexes Combined

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9	10	11
92	1	2	230.33										
91	2	21	232.45	340.12									
90	3	41	233.48	339.56	428.89								
89	4	27	235.15	344.28	440.86	509.07							
88	5	7	229.16	343.97	449.77	539.97	595.47						
87	6	2	249.67	357.68	457.01	537.54	617.40	677.11					
86	7	3	234.93	338.65	447.16	546.26	621.31	691.27	743.94				
85	8	1	267.13	369.11	479.19	569.31	649.12	710.99	771.81	811.97			
84	9	2	245.66	360.82	456.68	543.43	623.08	692.71	756.60	808.16	849.35		
83	10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
82	11	1	224.72	345.91	425.96	528.55	629.71	706.03	778.08	833.68	887.00	931.12	961.26
All Classes			234.16	342.24	437.03	521.47	612.00	692.27	756.42	815.49	861.90	931.12	961.26
N		107	107	105	84	43	16	9	7	4	3	1	1

Table 23. Average back-calculated fork lengths of male striped bass captured in fyke nets on the James River, spring 1994.

****
Average Back-calculated Lengths for Each Age Class
****

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6
92	1	2	226.41					
91	2	21	226.08	337.45				
90	3	35	226.04	335.90	427.87			
89	4	21	227.37	339.84	439.97	509.56		
88	5	3	222.48	341.63	452.54	532.60	582.02	
87	6	2	241.32	351.21	452.28	534.21	615.46	676.21
All Classes			226.62	337.89	434.05	514.11	595.40	676.21
N		84	84	82	61	26	5	2

Table 24. Average back-calculated fork lengths of female striped bass captured in fyke nets on the James River, spring 1994.

Average Back-calculated Lengths for Each Age Class

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9	10	11
92	1	0	0.00										
91	2	0	0.00	0.00									
90	3	6	232.37	334.89	424.46								
89	4	5	235.89	342.88	434.78	505.87							
88	5	4	224.93	339.13	443.53	543.29	604.53						
87	6	0	0.00	0.00	0.00	0.00	0.00	0.00					
86	7	3	231.71	336.02	445.16	544.83	620.31	690.66	743.64				
85	8	1	264.01	366.52	477.18	567.77	648.00	710.19	771.32	811.70			
84	9	2	242.38	358.11	454.45	541.63	621.67	691.64	755.85	807.66	849.06		
83	10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
82	11	1	221.28	343.00	423.41	526.46	628.07	704.72	777.10	832.94	886.50	930.81	961.08
All Classes			233.57	341.55	438.17	532.15	618.04	695.74	755.86	814.99	861.54	930.81	961.08
N		22	22	22	22	16	11	7	7	4	3	1	1

Table 25. Maximum-Likelihood estimates (MLE) of annual survival for striped bass ≥ 610 mm TL (24 inches) tagged during the spring Rappahannock River Tagging Program 1988-1993.

Parameter	MLE Estimates	Std. Error	95% Confidence Interval
Mean Survival	0.7410	0.05225	0.63856 0.84339
Recovery for Year			
2	0.1169	0.02253	0.07277 0.16109
3	0.1159	0.01904	0.07854 0.15318
4	0.0677	0.01164	0.04490 0.09055
5	0.6796	0.01126	0.04589 0.09000
6	0.0581	0.01315	0.03229 0.08386
Recovery during 1st year after tagging for year			
1	0.1554	0.01943	0.11728 0.19344
2	0.0889	0.01407	0.06138 0.11652
3	0.1341	0.01318	0.10826 0.15992
4	0.1207	0.01140	0.09837 0.14308
5	0.1163	0.02982	0.05783 0.17471
6	0.1090	0.01286	0.08383 0.13424

Figure 1. CPUE of Striped Bass Year Classes in the Rappahannock River Pound Net Samples, Fall 1993

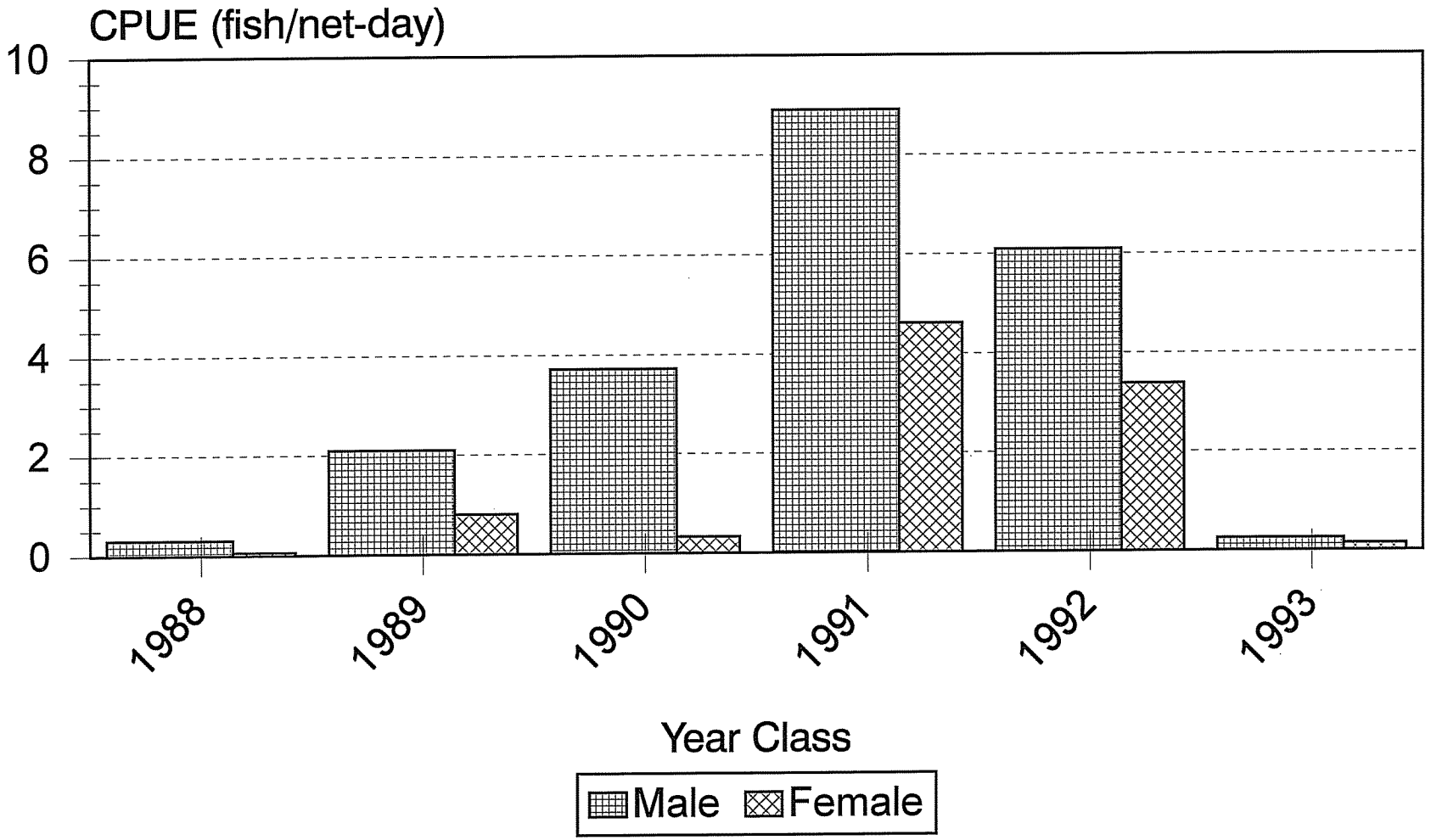

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Figure 2. CPUE of Striped Bass Year Classes in the Rappahannock River Pound Net Samples, Spring 1994

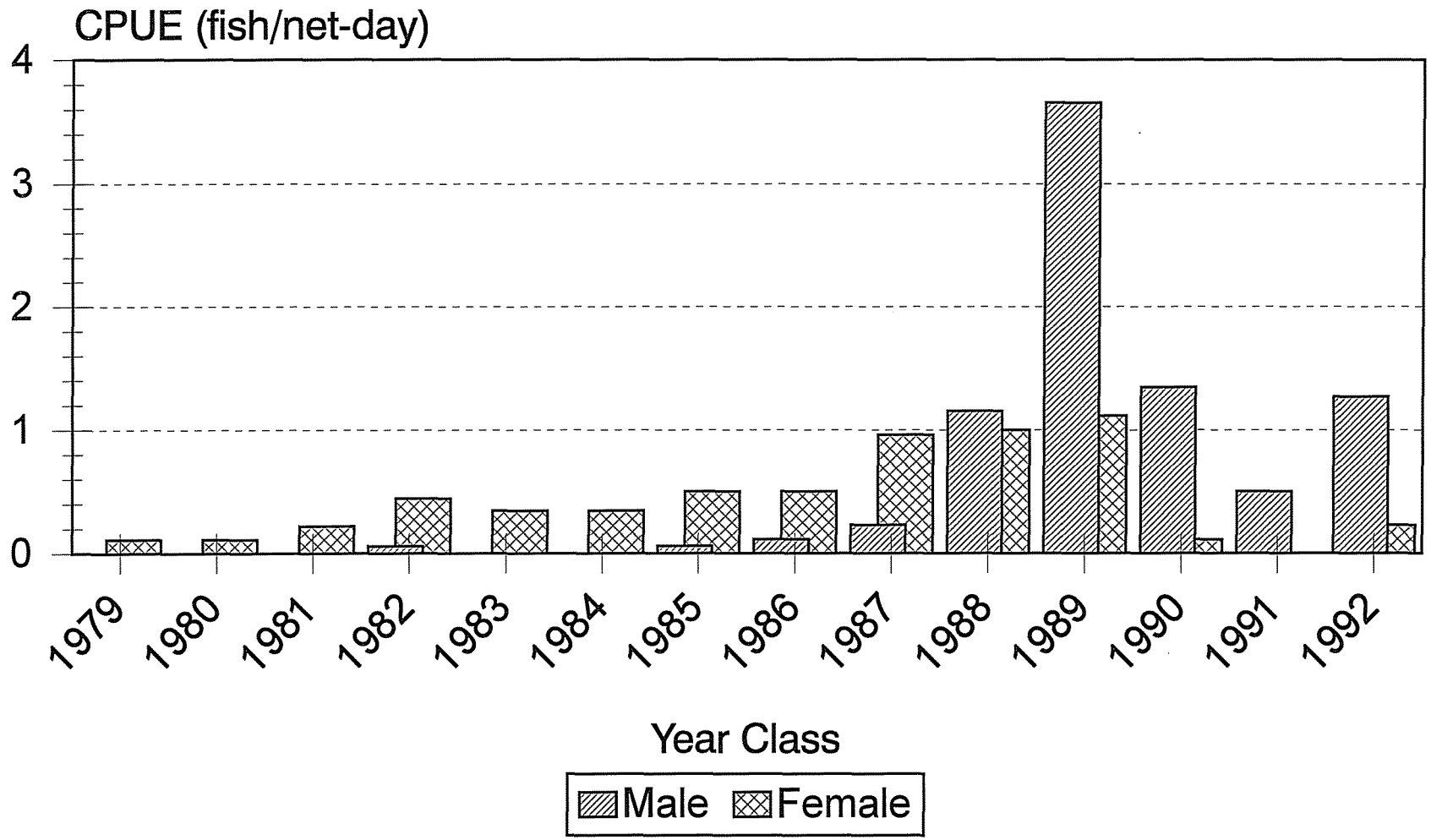

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Figure 3. CPUE of Striped Bass Year Classes in the Rappahannock River Experimental Gill Samples, Spring 1994

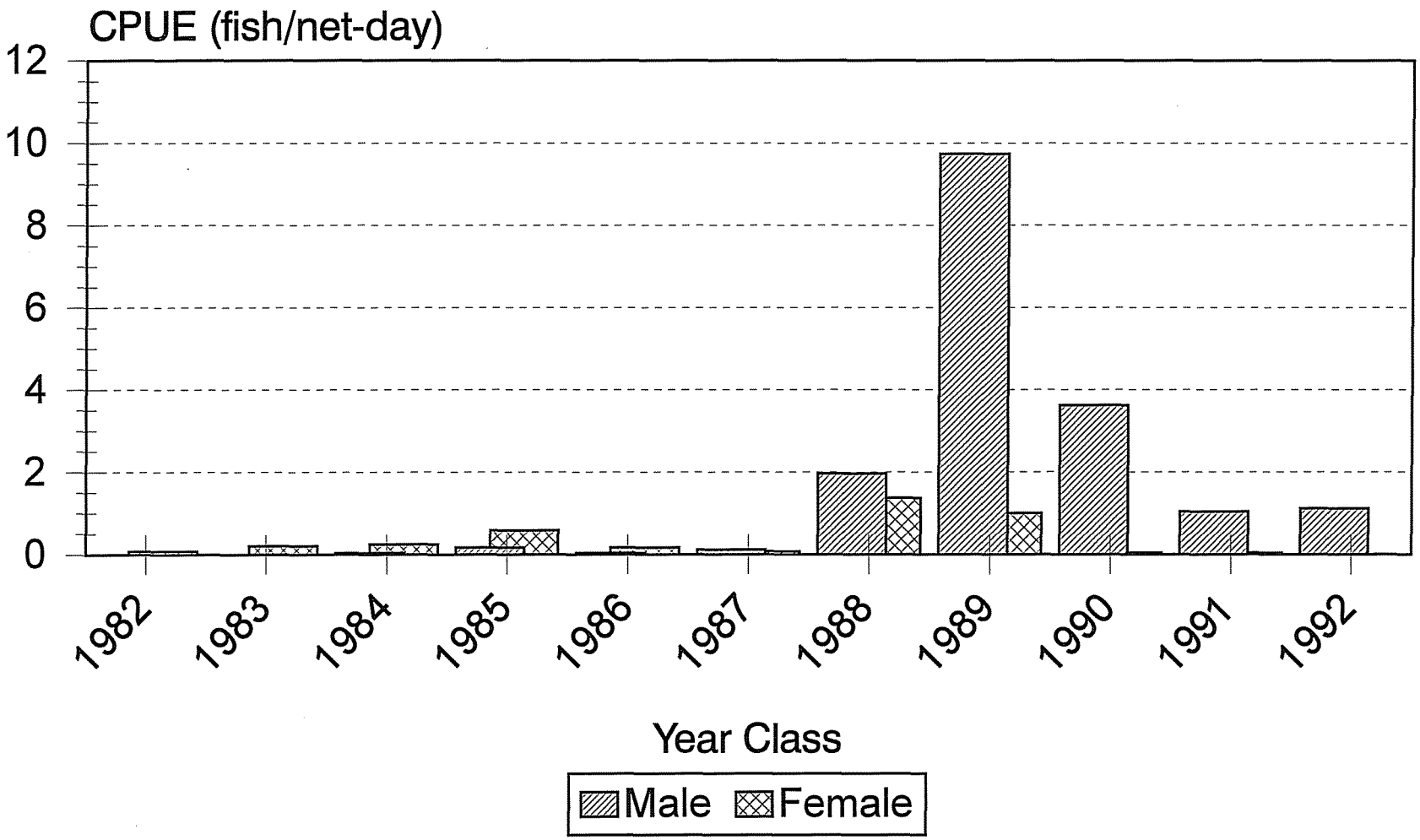

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Figure 4. CPUE of Striped Bass Year Classes in the James River Fyke Net Samples, Spring 1994

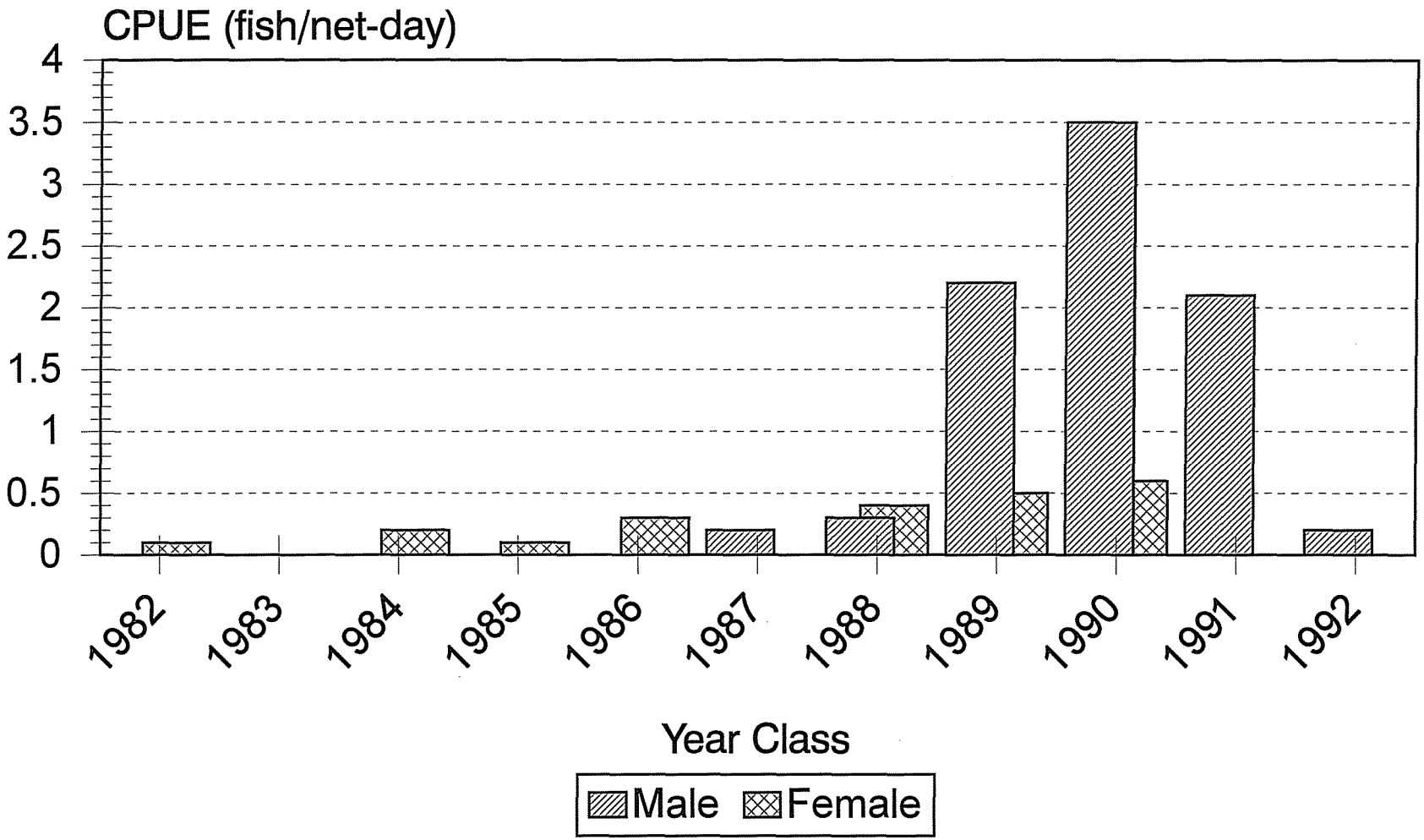

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Figure 5. CPUE of Striped Bass Year Classes in the James River Experimental Gill Net Samples, Spring 1994

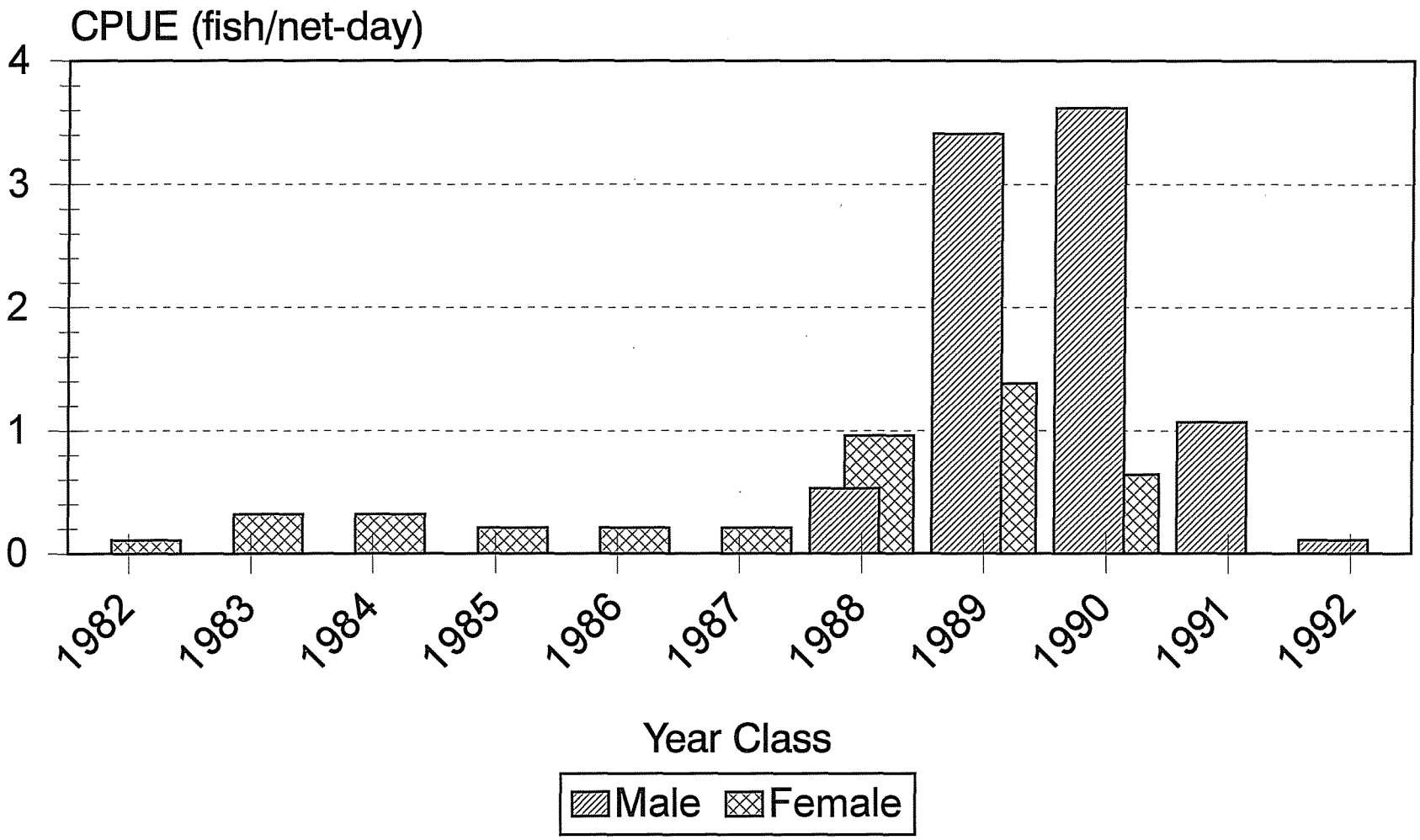

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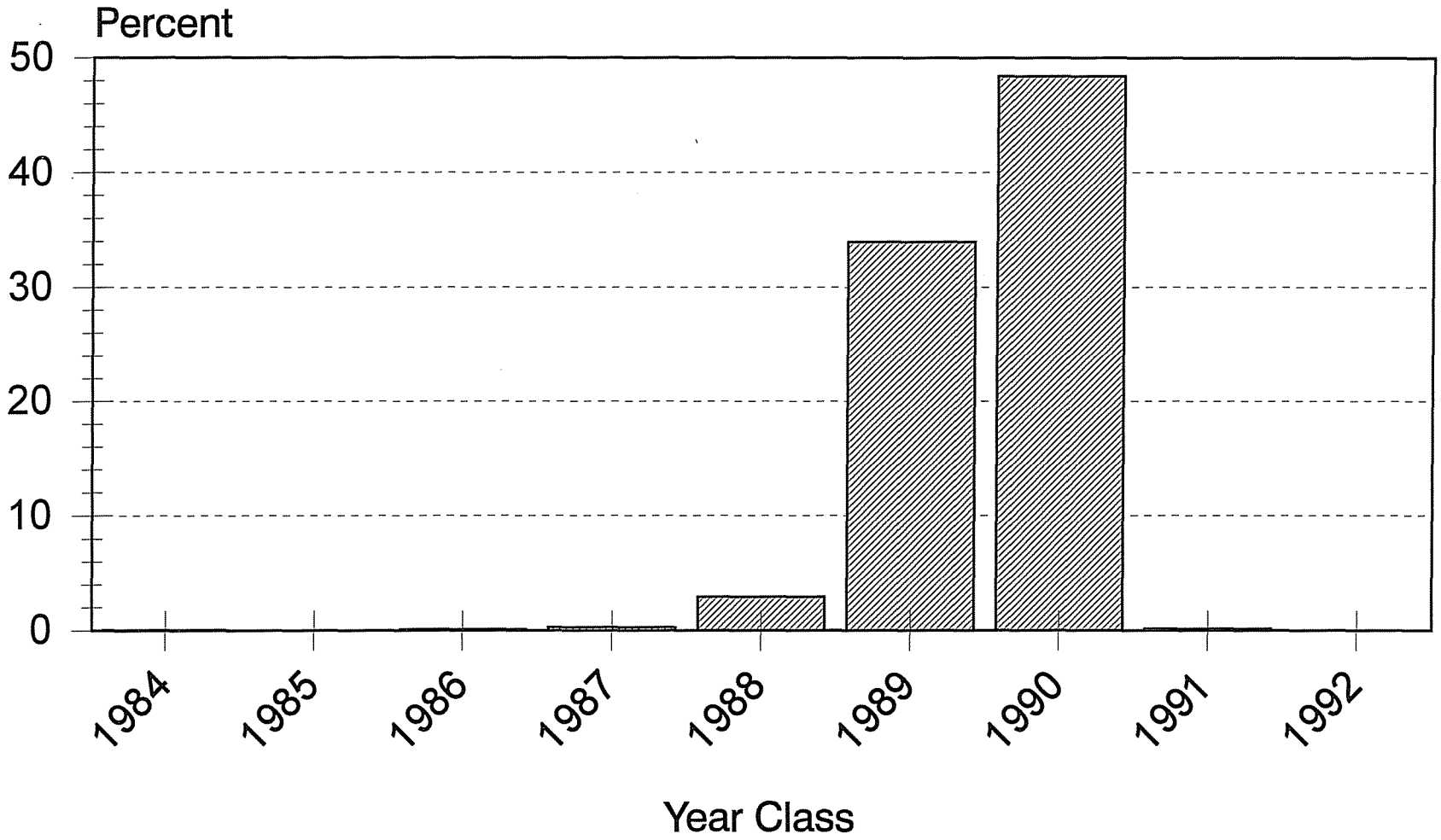
Figure 6. Year Class Structure from the Fall 1993 Tagging Program (across all areas)



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APPENDIX

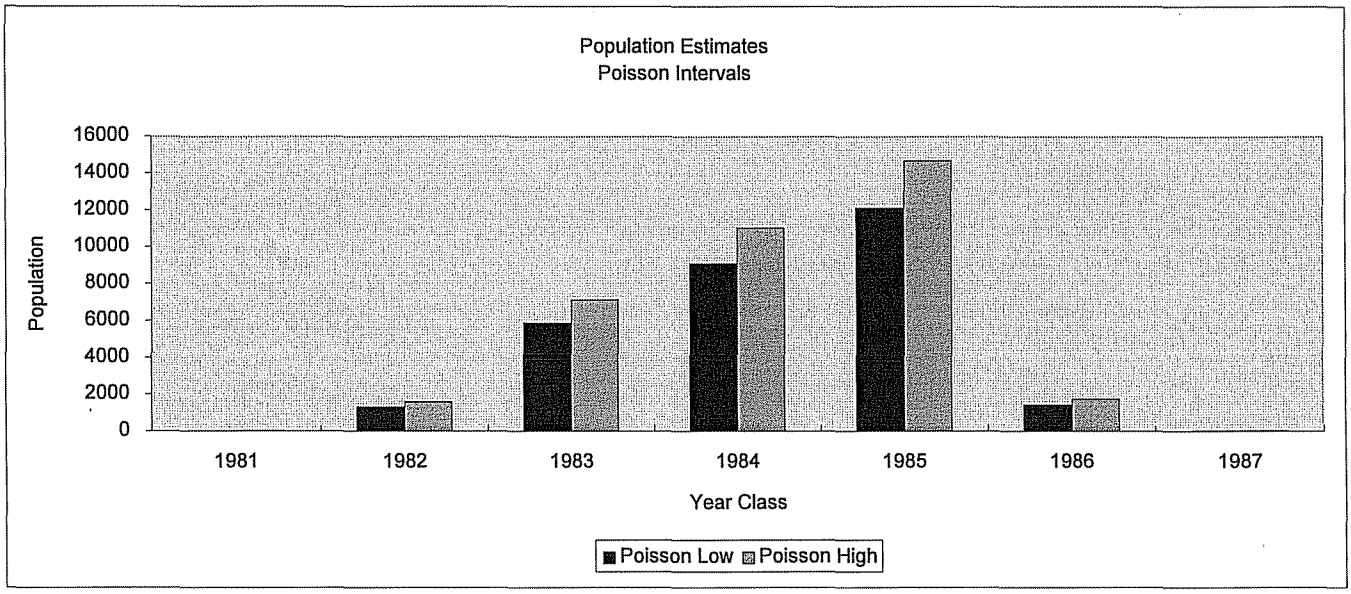
FALL 1987 Striped Bass Tagging Program on the Rappahannock River, Virginia

Date	Sum Dead	Sum Tossed	Sum of Recaptures Sacrificed	Sum of Recaptures Released	Sum Tagged	Sum of Effective Tags	Sum of Catch	Estimate of Population
Seasonal Totals	12	981	412	5	3319	2907	4729	32967

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
459	29954
379	36282

Year Class	N	Percent	Poisson Low	Poisson High
1981	2	0.072332731	22	26
1982	122	4.412296564	1322	1601
1983	544	19.67450271	5893	7138
1984	840	30.37974684	9100	11022
1985	1119	40.47016275	12122	14684
1986	134	4.846292948	1452	1758
1987	4	0.144665461	43	52
Total	2765	100	29954	36282



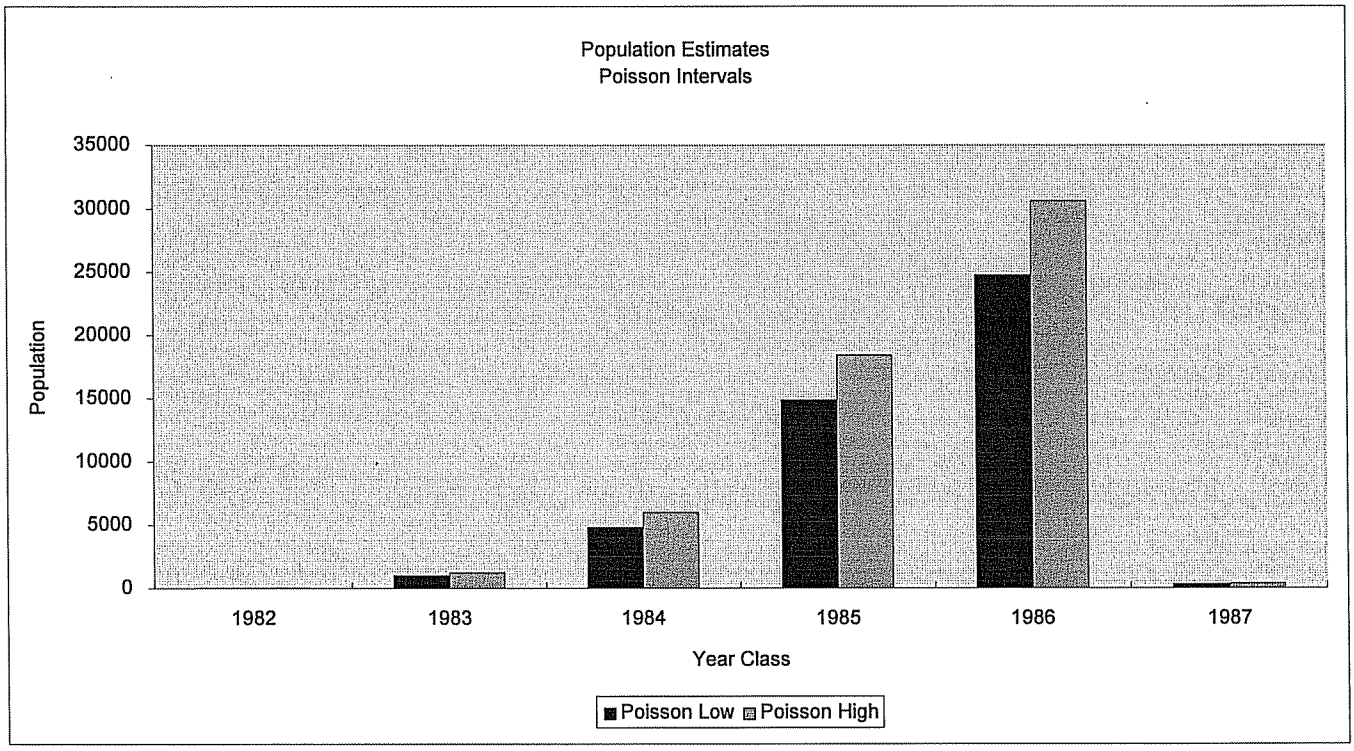
FALL 1988 Striped Bass Tagging Program on the Rappahannock River, Virginia

Date	Sum Dead	Sum Tossed	Sum of Recaptures Sacrificed	Sum of Recaptures Released	Sum Tagged	Sum of Effective Tags	Sum of Catch	Estimate of Population
Seasonal Totals	5	631	341	0	3892	3579	4869	51103

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
379	45959
307	56823

Year Class	N	Percent	Poisson Low	Posson High
1982	4	0.106666667	49	61
1983	84	2.24	1029	1273
1984	397	10.58666667	4866	6016
1985	1216	32.42666667	14903	18426
1986	2022	53.92	24781	30639
1987	27	0.72	331	409
Total	3750	100	45959	56823



FALL 1989 Striped Bass Tagging Program on the Rappahannock River, Virginia

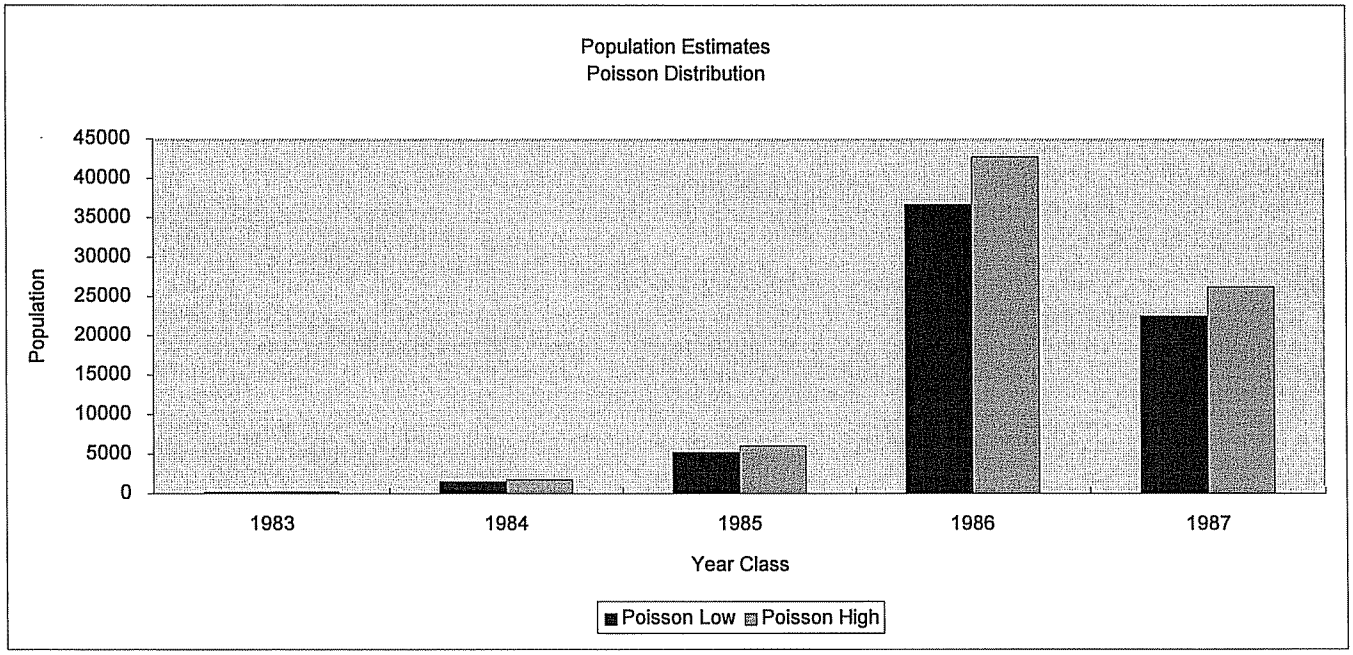
Date	Dead	Tossed	Recaptures Sacrificed	Recaptures Released	Daily Tagged	Effective Tags	Daily Catch	Estimate of Population
Seasonal Totals	22	854	42	626	6203	6161	7747	71451

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
722	66146
619	77074

Explotation 0.097818129

Year Class	N	Percent	Poisson Low	Poisson High
1983	18	0.31082715	206	240
1984	134	2.31393542	1531	1783
1985	459	7.92609221	5243	6109
1986	3210	55.430841	36665	42723
1987	1970	34.0183043	22502	26219
Total	5791	100	66146	77074



FALL 1990 Striped Bass Tagging Program on the Rappahannock River, Virginia

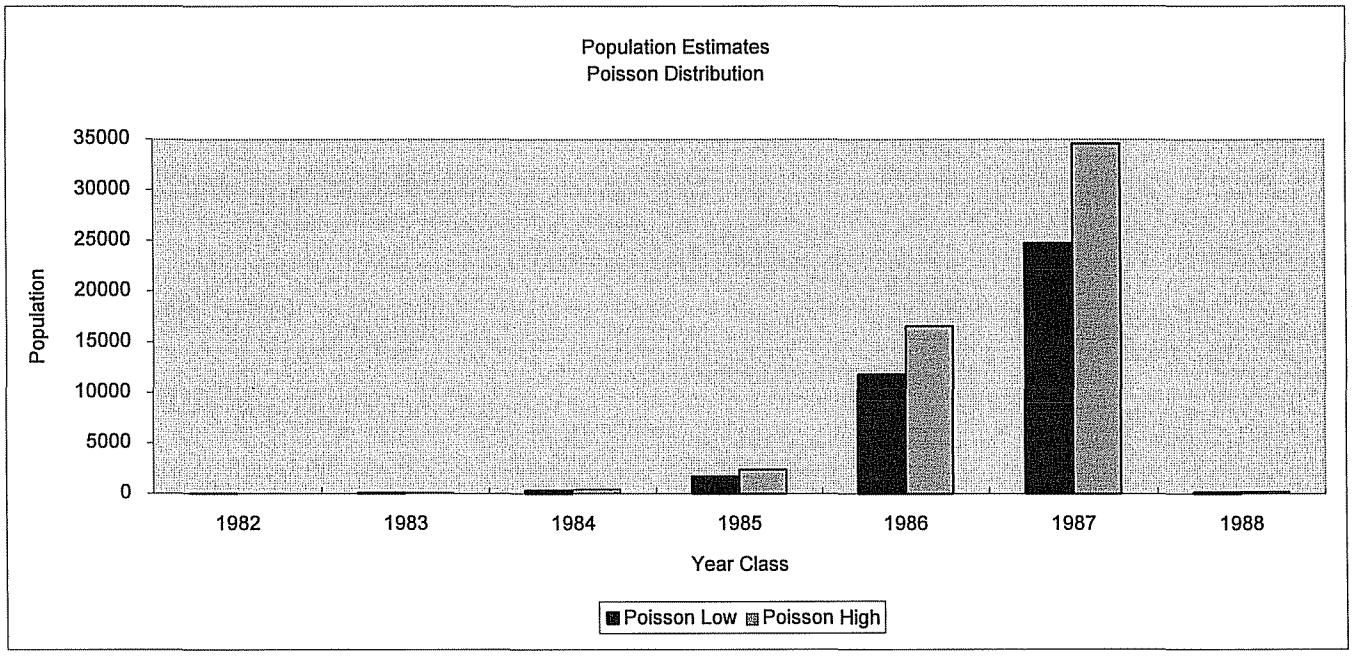
Date	Dead	Tossed	Recaptures Sacrificed	Recaptures Released	Daily Tagged	Effective Tags	Daily Catch	Estimate of Population
Seasonal Totals	0	1262	0	174	1903	1903	3339	36518

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
163	38976
117	54396

Explotation 0.083774675

Year Class	N	Percent	Poisson Low	Poisson High
1982	1	0.05473454	21	30
1983	4	0.21893815	85	119
1984	16	0.8757526	341	476
1985	81	4.43349754	1728	2412
1986	555	30.3776683	11840	16524
1987	1161	63.546798	24768	34567
1988	9	0.49261084	192	268
Total	1827	100	38976	54396



FALL 1990 Striped Bass Tagging Program on the James River, Virginia (Fyke Net & Haul Seine Combined)

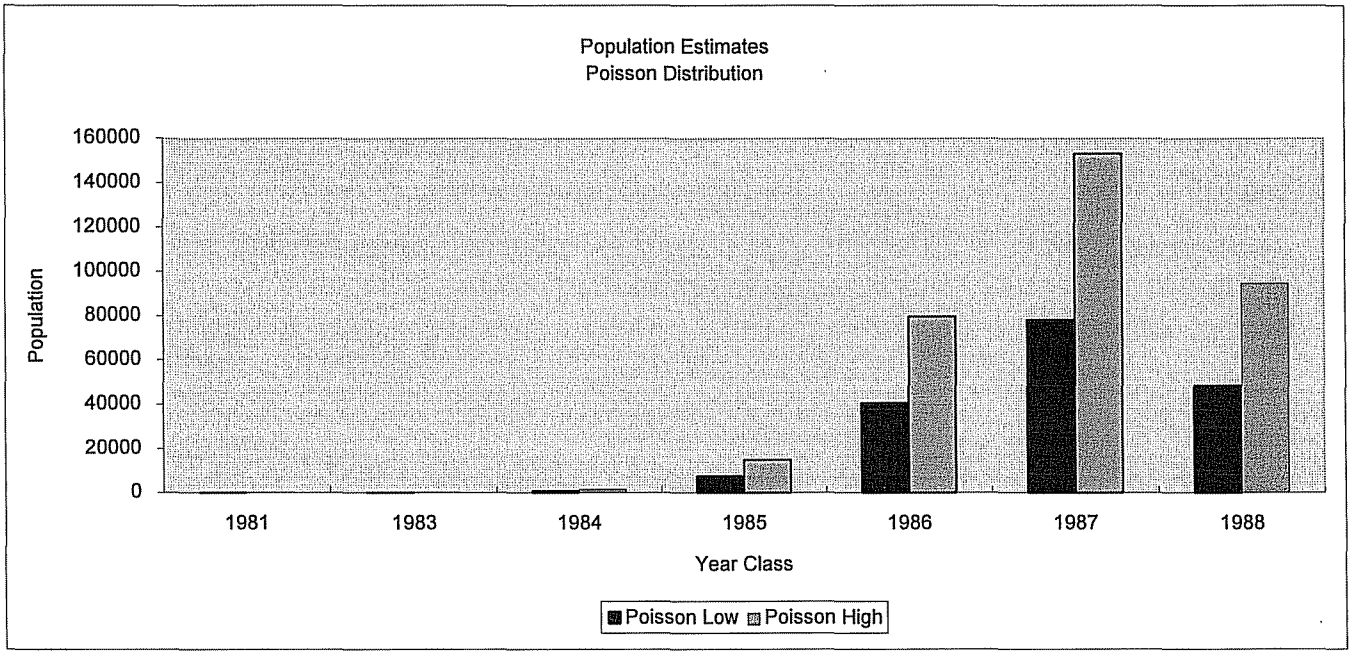
Date	Dead	Tossed	Recaptures Sacrificed	Recaptures Released	Daily Tagged	Effective Tags	Daily Catch	Estimate of Population
Seasonal Totals	0	1071	18	16	2405	2387	3510	246423

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
48	176329
24	344442

Explotation 0.014043784

Year Class	N	Percent	Poisson Low	Poisson High
1981	1	0.04178855	74	144
1983	2	0.0835771	147	288
1984	11	0.45967405	811	1583
1985	103	4.30422064	7590	14826
1986	554	23.1508567	40822	79741
1987	1063	44.4212286	78328	153005
1988	659	27.5386544	48559	94855
Total	2393	100	176329	344442



FALL 1991 Striped Bass Tagging Program on the James River, Virginia (Fyke Nets)

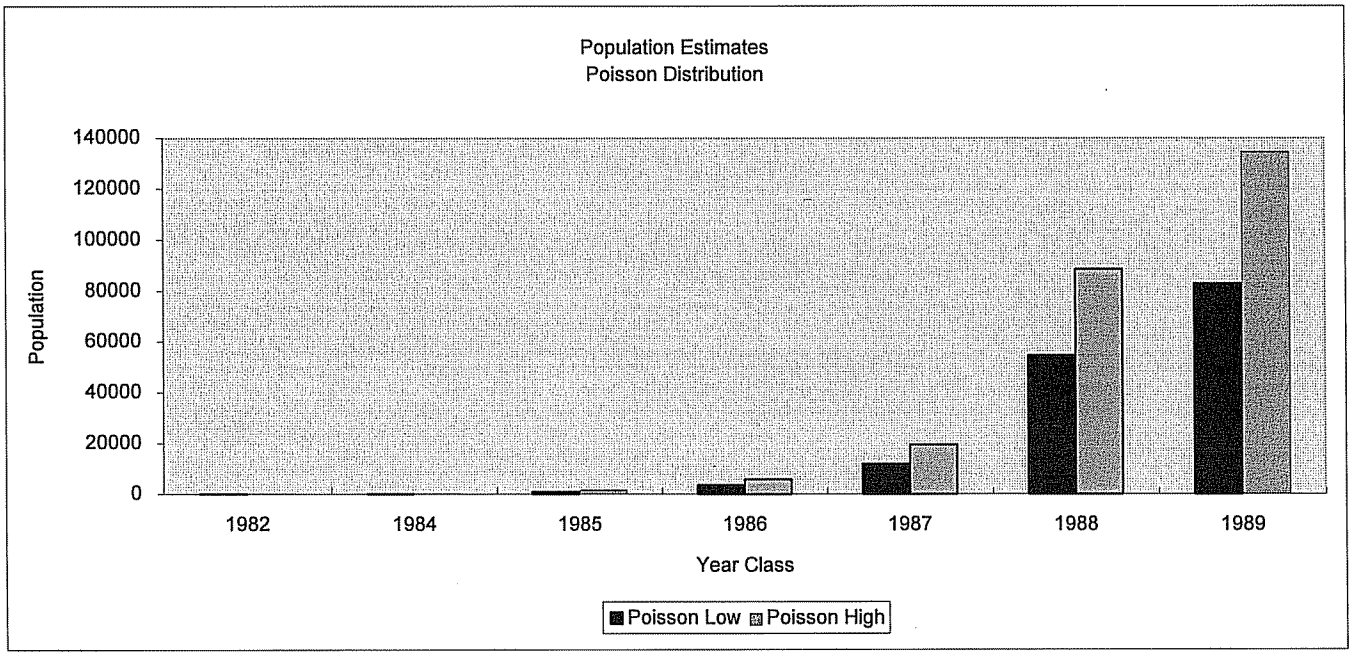
Date	Dead	Tossed	Recaptures Sacrificed	Recaptures Released	Daily Tagged	Effective Tags	Daily Catch	Estimate of Population
Seasonal Totals	76	2971	10	55	2348	2338	5460	196392

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
83	154092
51	250319

Explotation 0.027049521

Year Class	N	Percent	Poisson Low	Poisson High
1982	1	0.04349717	67	109
1984	1	0.04349717	67	109
1985	15	0.65245759	1005	1633
1986	54	2.34884732	3619	5880
1987	179	7.78599391	11998	19490
1988	813	35.3632014	54492	88521
1989	1236	53.7625054	82844	134578
Total	2299	100	154092	250319



FALL 1992 Striped Bass Tagging Program on the James River, Virginia

Date	Sum Dead	Sum Tossed	Sum of Recaptures Sacrificed	Sum of Recaptures Released	Sum Tagged	Sum of Effective Tags	Sum of Catch	Estimate of Population
Seasonal Totals	8	278	2	4	491	493	783	64337

Confidence limits for Petersen estimates are determined by the Poisson Distribution.
For 95% Interval = Sum of Recaptures + 1.92+1.960*Sqrt (Sum of Recaptures + 1.0)
For 95% Interval = Sum of Recaptures + 1.92-1.960*Sqrt (Sum of Recaptures + 1.0)

Poisson Interval Recaptures	Poisson Interval Population
13	29454
3	141175

Year Class	N	Percent	Poisson Low	Posson High
1983	1	0.209643606	62	296
1986	1	0.209643606	62	296
1987	16	3.354297694	988	4735
1988	100	20.96436059	6175	29596
1989	183	38.36477987	11300	54162
1990	176	36.89727463	10868	52090
Total	477	100	29454	141175