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Striped Bass Research, Virginia: Characterization of Virginia's Striped Bass Commercial Fisheries Annual Report 1988-89

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Characterization of Virginia's Striped Bass Commercial Fisheries

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PREFACE

The research reported herein (and in the 1982 through 1987 annual reports) is directly related to Priority III stated in the "Action Plan" (p. 15) of the Emergency Striped Bass Study (Anadromous Fish Conservation Act Amendment, Public Law 96-118). The amendment was the result of a decline in striped bass (Morone saxatilis) landings from Maine to North Carolina since the mid-1970's. This report summarizes the results of the Fall 1988 and Spring 1989 sampling periods and compares these results with the previous work.

The specific objectives executed during the 1988 program were to:

1. Characterize the composition of striped bass in Virginia's inshore fisheries in the Rappahannock River.
2. Cooperate in a multi-state development of a program to monitor striped bass stocks in the eastern United States.
3. Make continuing contributions to the study of growth rates through back calculations of size at age.

Our data, in conjunction with those of other states investigating coastal stocks of striped bass, will contribute to the general knowledge necessary for evaluation of rational management alternatives, both in Virginia's waters and coastal waters of the eastern United States.

ACKNOWLEDGMENTS

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We are grateful for the many commercial fishermen in the Rappahannock River from whom we obtained the commercial striped bass samples. Striped bass landings data were obtained from the Virginia Marine Resources Commission (VMRC).

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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SUMMARY

1. A total of 1,754 striped bass was sampled from Virginia's Rappahannock River pound net fisheries between 22 September and 30 November 1988. Only 14 fish were obtained from gill netters.

2. Between 20 March and 12 June 1989, 455 striped bass were sampled from Virginia's Rappahannock River pound net fisheries.

INTRODUCTION

The Chesapeake Bay supports some of the east coast's principal spawning populations of striped bass. A drastic decline in commercial landings of striped bass in Virginia has occurred since 1974 (Fig. 1). 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 typical 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 River and the Roanoke River were small accessories to the fishery. Van Winkle et al. (1988) reanalyzed Berggren and Lieberman's work and concluded various stock contributions from the Chesapeake, Hudson and Roanoke are highly variable. Van Winkle et al. (1988) estimated that Hudson stocks constituted over 40% of the striped bass captured in the coastal fishery during 1975. The central force of management efforts is the restoration of the Chesapeake Bay stock, which historically is believed to be a rather large contributor to coastal fishery. Toward that end, the Virginia Marine Resources Commission (VMRC) and the Potomac River Fisheries Commission implemented an annual six-month moratorium (1 December through 31 May) on striped bass fishing, and the state of Maryland imposed a full moratorium.

Because of a low stock level the Chesapeake Bay stocks may not be contributing their 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

Samples were obtained from cooperating commercial fishermen on the Rappahannock River. Prior to the six-month moratorium in Virginia, the Rappahannock River was the site of the largest striped bass fishery in the state. Buyers and fishermen were telephoned daily during the prime months of the season and several times a week at non-peak times to ascertain the availability of striped bass. On the days that samples were collected, the entire unculled catch constituted the sample in Fall 1988 and Spring 1989. Single "heart" pound nets are fished upstream in the relatively narrow area of the river and we assume the samples from these nets reflect the characteristics of the stock (i.e. age structure, sex ratio etc.); in contrast, anchor gill nets are biased by mesh size. With a 61 cm total length minimum in effect during the Fall fishery in Virginia, most of commercial fishermen used 13.34 cm stretch mesh gill nets or larger during

the Fall fishery. However, the size-specific effort and the selection curves for the various size gill nets are unknown.

Fork and total lengths, weights, sex, gonad condition, and scales were obtained from most of the striped bass sampled. Lengths were measured to the nearest 1 mm and weights to 28.4 g (0.06 lb). Scales were removed from 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 collected and 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), as modified for a sonic digitizer-microcomputer complex (Loesch et al. 1985). Growth increments were measured from the focus to the posterior edge of each annulus. There was little difficulty in reading the scales when a clear focus was found. On fish that are older than age 6 the first and sometimes the second annulus is difficult to define. In back calculation of lengths from scales the assumptions made were: (1) Scale growth were proportional to growth in length; (2) Annuli were formed yearly and at the same time; and (3) Scales that were aged came from the same area of the body. Sex were ascertained by visual observation. During the Fall 1988 we sampled 14 striped bass caught in gill nets. Since the dealers had sold these fish to various markets the fish could not be cut to determine sex.

Because scale annuli form between April and June in Virginia waters, year classes, other than 0 year class, are considered to be a year older on July 1 (Grant 1974). This aging scheme differs significantly from that utilized in Maryland and North Carolina where age is incremented on 1 January. Therefore, the same year class is designated a year older in Maryland and North Carolina six months before age designations are equalized for all three states.

Striped bass fisheries in Virginia are differentiated by season and gear. Each sex was divided into two age categories, fish $\leq$ age 3 and $\geq$ age 4. The rationale of this dichotomy is that most fish of $\leq$ 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 interstate management plan for striped bass, as amended in October 1985, 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 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. Herein, a preliminary

assessment of growth was made using both sexes combined, and separated. Estimates of the Gompertz weight-length relationship, and the allometric growth parameters were made using FishParm (Prager et al., 1987), which utilizes the Marquardt's (1963) algorithm for nonlinear least squares.

Weights at age for striped bass age 1-7 were estimated using the Gompertz function (Ricker 1975).

$$W_t = W_0 \exp\left(G\left(1 - \exp(-gt)\right)\right)$$

where:

W_t = Weight at time t

W_0 = Weight at t = 0

G = Instantaneous growth rate at t = 0

g = Second instantaneous growth rate at t = 0

t = Age

Allometry growth parameters for striped bass were estimated using the allometry function (Ricker 1975).

$$W = aL^b$$

where:

W = Weight of the fish

L = Length of the fish

a = Parameter of model

b = Parameter of model

Results and Discussion

Sampling Statistics

A total of 2,223 striped bass were sampled between 22 September 1988 and 30 June 1989 in the Rappahannock River (Table 1). All except 14 individuals taken in gill nets were captured from pound nets. A ban on the possession of striped bass from 1 December until 31 May imposed by the VMRC has reduced the number of fish available for sampling.

Based on season and gear there were three striped bass fisheries in the Rappahannock River, the Fall and Spring pound net and Fall gill net fisheries (Table 1). However, very few 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). Although the ban was in effect during the Spring of 1989, samples were obtained by special collection permits granted by the VMRC.

The pound net catches in the Rappahannock River reflect the age and sex ratio compositions of stocks by seasons. In the Fall 89% of the catch were young striped bass (ages $\leq$ 3) (Tables 2 and 3). The sex ratio of this group was 1:1 ($X^2 = 3.07$; $P > 0.05$). In the older age group (ages $\geq$ 4) the sex ratio was 2.2:1 ($X^2 = 26.5$; $P < 0.001$). The 1984 males accounted for 62% of the older age group. In the Spring fishery the percentage of young striped

bass decreased to 72% due to the presence of mature fish migrating to the spawning grounds. Males dominated the $\leq$ 3 age group (X^2= 20.7; $P < 0.001$). In the older age group (ages $\geq$ 4), the sex ratio was not significantly different from 1:1 (X^2= 0.5; $P < 30.0$).

Size Analysis

We aged 1,713 individuals of the Fall samples, 429 from the Spring pound net samples, and 13 from the Fall gill net samples. Size data (fork length and weight) were partitioned by season, gear, age, and sex (Tables 2 - 5). Mean length and weights for year classes in each of the fisheries and give insight into the size frequencies. It is evident that mean size-at-age values for striped bass captured in gill nets exceeded the means estimates obtained from samples from pound nets due to gill net selectivity (Tables 2 - 5).

Back-Calculated Lengths

Mean back-calculated lengths for each age class and sex are reported in Table 6. Back calculations of fish growth from scale measurements are usually estimated by: (1) straight line through the origin; (2) straight line with intercept; (3) logarithmic line. The method we used to generate the body scale constant is a modification of the Fraser-Lee equation (Duncan 1980). The average back-calculated lengths at age from samples collected in

the Spring pound net fishery were similar to those reported by Merriman 1941 and Mansueti 1961. Table 6 shows that the females are generally larger than the males by age 3.

Fall Fisheries

The 1986 year class (age 2) of striped bass was the modal group in the 1988 Fall pound net fishery and accounted for 53.4% of the samples (Fig. 2). Males of the 1986 year class (age 2) dominated the samples and accounted for 27% of the fishery.

The fishermen targeted the legal size fish with a 13.34 cm or larger stretch mesh gill nets during the Fall fishery. The 1983 (age 5) year class was the modal group and accounted for 53.8% of the sample (Tables 2 and 4).

Spring Fishery

Of samples from the Spring fishery 46.6% were collected in June. The 1986 year class (age 2) was the modal age group in the pound net samples and accounted for 45.5% of the samples (Fig. 3). The 1986 year class males (age 2) dominated the collections 27.7% (Fig. 3). The females from the 1986 year class accounted for 17.8% of the samples (Fig. 3).

General Comments

We experienced difficulty when we tried to generate a von Bertalanffy growth curve. The samples that we collected during the Fall 1988 and the Spring 1989 were composed of younger fish; therefore, we were unable to generate a realistic L maximum. The Gompertz and the allometric growth equations function adequately in forecasting weights and lengths for both Fall 1988 and Spring 1989 collections.

Female and male striped bass, ages 1 and 2, are usually segregated on a seasonal basis. The proportion of females in the 1982-83, 1983-84, 1985-86, and 1987-88 Fall pound net fisheries was relative strong compared to their presence in the Spring fisheries (Hill and Loesch, 1987; Loesch and Kriete 1986, 1985, 1984, and 1983; and Figs. 2 and 3 herein). Loesch and Kriete (1983 and 1982), previously documented the relative strong presence of females in the coastal waters of Virginia in the Spring, and these findings support prior studies that indicated that most age 2 females do not participate in the spawning runs.

Merriman (1941), stated, from an examination of striped bass from Long Island and New England waters that many young males are resident within the Chesapeake Bay to spawn while a larger proportion of the females of their respective cohorts migrate northward. Schaefer (1968) also reached the same conclusion from an investigation of sex and size composition of striped bass

in Long Island surf waters. Raney (1952) cited several investigations that indicated that the proportion of age 2 striped bass in northern waters increased when the corresponding year classes in the Chesapeake Bay were large.

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Table 1. The numbers of striped bass sampled from the Rappahannock River in 1988-1989.

	Fall	Spring
Pound Net	1,754	455
Gill Net	14	

Gill Net Season
Fall = October 1988

Pound Net Seasons
Fall = September-November 1988
Spring = March-June 1989

Table 2. The mean fork lengths ($\bar{L}$) and standard deviation (SD) for striped bass in the Rappahannock River samples, Fall 1988.

Season	Gear*	Year Class	Sex	N	$\bar{L}$ (mm)	SD
Fall 1988	PN	1981	M	1	650	
			F	1	680	
		1982	M	1	677	
			F	2	636	14.8
		1983	M	11	542	28.9
			F	20	562	26.0
		1984	M	115	483	29.8
			F	34	493	32.1
		1985	M	251	382	28.8
			F	222	382	41.2
		1986	M	473	308	26.6
			F	456	307	25.6
		1987	M	61	238	17.7
			F	39	237	17.7
			I	13	230	12.7
	GN	1982	a	6	637	25.2
		1983		7	602	26.1

*PN : Pound Net
GN : Stake Gill Net

F : Female
I : Immature
M : Male

a : Sexes not determined for stake gill net specimens.

Table 3. The mean fork lengths ($\bar{L}$) and standard deviation (SD) for striped bass in the Rappahannock River samples, Spring 1989.

Season	Gear*	Year Class	Sex	N	$\bar{L}$ (mm)	SD
Spring 1989	PN	1980	F	1	822	
		1981	M	1	730	
			F	6	744	40.2
		1982	M	6	665	16.4
			F	7	653	38.5
		1983	M	18	566	29.0
			F	34	583	24.6
		1984	M	36	498	45.2
			F	11	490	31.0
		1985	M	57	394	37.9
			F	26	383	34.2
		1986	M	126	307	28.2
			F	81	307	26.7
		1987	M	12	237	16.7
			F	7	252	14.0

*PN : Pound Net

F : Female
M : Male

Table 4. The mean weights ($\bar{W}$) and standard deviation (SD) for striped bass in Rappahannock River samples, Fall 1988.

Season	Gear*	Year Class	Sex	N	$\bar{W}$ (kg)	SD
Fall 1988	PN					
		1981	M	1	3.97	
			F	1	4.82	
		1982	M	1	4.40	
			F	2	3.52	0.60
		1983	M	11	2.16	0.28
			F	20	2.23	0.38
		1984	M	115	1.58	0.29
			F	34	1.63	0.31
		1985	M	250	0.82	0.22
			F	222	0.79	0.23
		1986	M	473	0.42	0.12
			F	454	0.41	0.12
		1987	M	61	0.18	0.09
			F	39	0.17	0.05
			I	13	0.19	0.10
	GN	1982	a	6	3.01	0.67
		1983		7	2.81	0.34

PN : Pound Net
GN : Stake Gill Net

F : Female
I : Immature
M : Male

a : Sexes not determined for stake gill net specimens.

Table 5. The mean weights ($\bar{W}$) and standard deviation (SD) for striped bass in Rappahannock River samples, Spring 1989.

Season	Gear*	Year Class	Sex	N	$\bar{W}$ (kg)	SD
Spring 1989	PN	1980	F	1	8.62	
		1981	M	1	5.02	
			F	6	5.58	0.84
		1982	M	6	4.08	0.29
			F	7	4.01	0.83
		1983	M	18	2.61	0.47
			F	34	2.97	0.42
		1984	M	36	1.75	0.29
			F	11	1.93	0.32
		1985	M	57	0.89	0.34
			F	26	0.86	0.28
		1986	M	126	0.40	0.12
			F	80	0.40	0.13
		1987	M	12	0.18	0.04
			F	7	0.20	0.05

PN : Pound Net

F : Female
M : Male

Table 6. Average back-calculated fork length (mm) at age for striped bass in the Rappahannock River, Spring 1989.

* Both Sexes:

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8
1987	1	19	176.92							
1986	2	207	171.93	250.33						
1985	3	83	178.99	255.91	335.65					
1984	4	47	190.45	274.67	354.79	435.70				
1983	5	52	195.27	281.75	365.36	445.08	517.61			
1982	6	13	201.65	290.29	380.83	463.33	531.00	596.82		
1981	7	7	206.58	299.37	387.16	475.18	551.07	627.64	689.10	
1980	8	1	204.79	298.99	396.90	493.57	580.32	648.49	711.70	773.66
All Classes		429	180.40	261.14	353.14	445.36	523.78	609.79	691.61	773.66

* Females:

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8
1987	1	7	195.38							
1986	2	81	188.87	255.53						
1985	3	26	194.08	263.17	334.18					
1984	4	11	210.06	291.07	362.42	431.47				
1983	5	34	218.38	299.47	382.71	458.64	526.13			
1982	6	7	220.12	300.00	387.86	467.61	537.82	597.91		
1981	7	6	233.18	318.44	406.13	486.98	560.47	633.24	693.20	
1980	8	1	229.34	319.79	413.80	506.63	589.93	655.39	716.08	775.59
All Classes		173	200.10	272.62	367.68	458.33	533.45	617.16	696.47	775.59

* Males:

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7
1987	1	12	190.46						
1986	2	126	195.46	261.27					
1985	3	57	206.62	274.00	343.84				
1984	4	36	217.21	292.58	365.07	441.19			
1983	5	18	221.19	300.04	370.83	444.45	512.17		
1982	6	6	236.29	322.81	406.03	481.66	537.91	605.83	
1981	7	1	229.93	332.36	408.27	492.62	563.71	632.40	683.01
All Classes		256	203.67	273.53	358.14	446.98	520.41	609.62	683.01

*: Birthdate is July 1.

Table 7. Gompertz model parameters for striped bass in the Rappahannock River, Fall 1988.

	Parameter	Estimate	S.E.	C.V.
Sexes combined				
	W_0	50.53	4.22	0.0814
	G	5.58	0.06	0.0117
	g	0.23	0.01	0.0515
Females				
	W_0	56.13	6.36	0.1133
	G	5.76	0.12	0.0212
	g	0.21	0.02	0.0822
Males				
	W_0	48.30	5.59	0.1158
	G	5.46	0.08	0.01562
	g	0.25	0.02	0.06956

$$W_t = W_0 \exp (G (1 - \exp(-gt)))$$

where:

W_t = Weight at time t

W_0 = Weight at t = 0

G = Instantaneous growth rate at t = 0

g = Second instantaneous growth rate at t = 0

t = Age

Table 8. Gompertz model parameters for striped bass in the Rappahannock River, Spring 1989.

	Parameter	Estimate	S.E.	C.V.
Sexes combined				
	W_0	43.43	7.16	0.1648
	G	6.10	0.09	0.0246
	g	0.23	0.01	0.0650
Females				
	W_0	44.12	12.36	0.2802
	G	6.07	0.16	0.0269
	g	0.23	0.02	0.0974
Males				
	W_0	33.32	8.39	0.0252
	G	5.94	0.13	0.0220
	g	0.27	0.03	0.0967

$$W_t = W_0 \exp(G(1 - \exp(-gt)))$$

where:

W_t = Weight at time t

W_0 = Weight at t = 0

G = Instantaneous growth rate at t = 0

g = Second instantaneous growth rate at t = 0

t = Age

Table 9. Allometry growth parameters for striped bass in the Rappahannock River, Fall 1988.

	Parameter	Estimate	S.E.	C.V.
Sexes Combined	a	2.32×10^{-5}	1.91×10^{-6}	0.0822
	b	2.91	1.33×10^{-2}	0.0046
Females	a	2.13×10^{-5}	2.40×10^{-6}	0.1129
	b	2.92	1.83×10^{-2}	0.0062
Males	a	1.49×10^{-5}	4.05×10^{-6}	0.271
	b	2.99	4.40×10^{-2}	0.015

$$W = aL^b$$

where:

W = Weight of the fish
L = Length of the fish
a = Parameter of model
b = Parameter of model

Table 10. Allometry growth parameters of striped bass in the Rappahannock River, Spring 1989.

	Parameter	Estimate	S.E.	C.V.
Sexes Combined	a	1.84×10^{-5}	2.57×10^{-6}	0.1392
	b	2.96	2.15×10^{-2}	0.0073
Females	a	3.07×10^{-5}	7.34×10^{-6}	0.2393
	b	2.88	3.67×10^{-2}	0.0127
Males	a	1.627×10^{-5}	2.79×10^{-6}	0.1714
	b	2.98	2.69×10^{-2}	0.0090

$$W = aL^b$$

where:

W = Weight of the fish
L = Length of the fish
a = Parameter of model
b = Parameter of model

Fig. 1. Annual Landings of Striped Bass In Virginia, 1962 - 1988

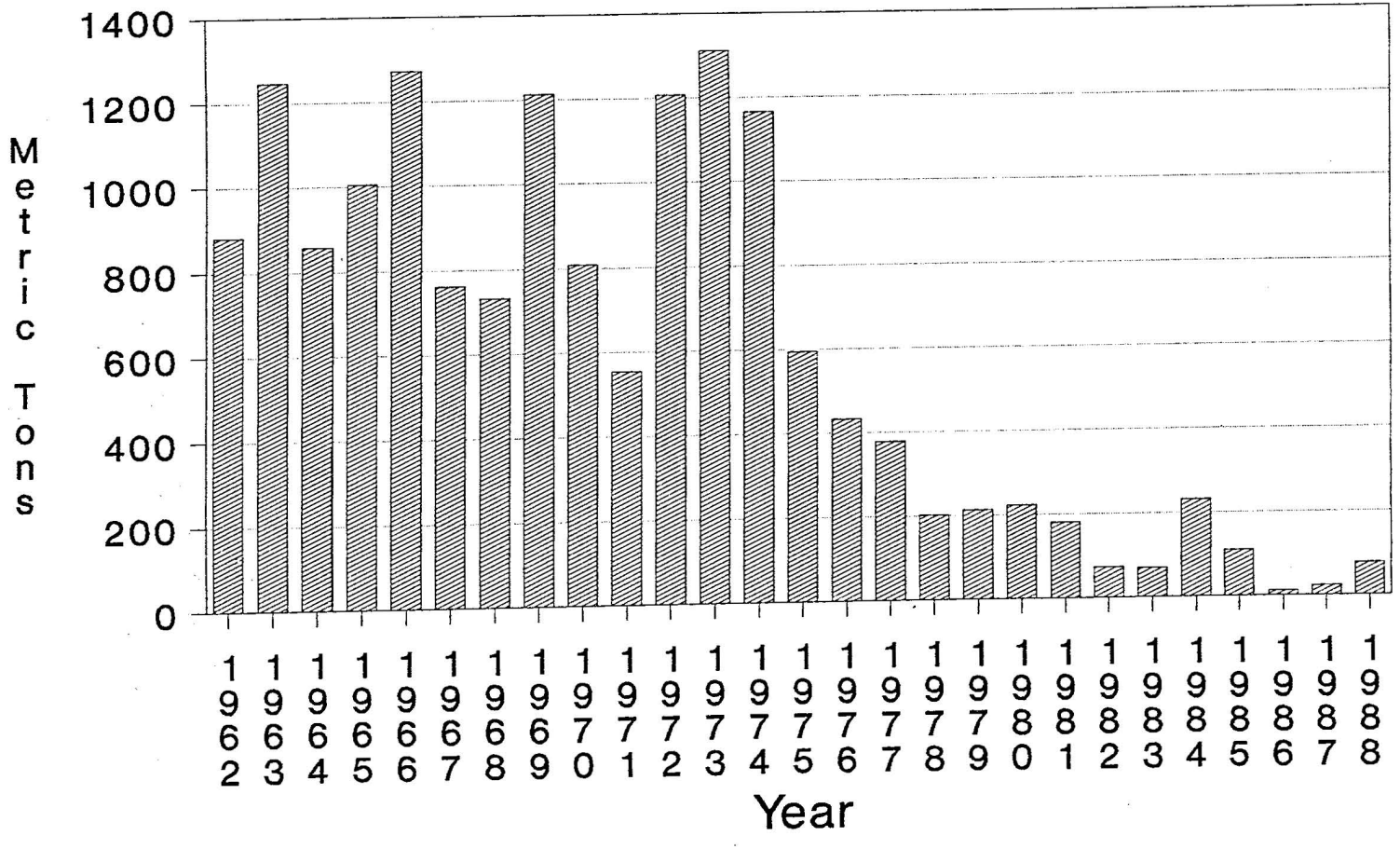

Fig. 2. Distribution of Striped Bass Year Classes by Sex in the Rappahannock River Pound Net Samples, Fall 1988

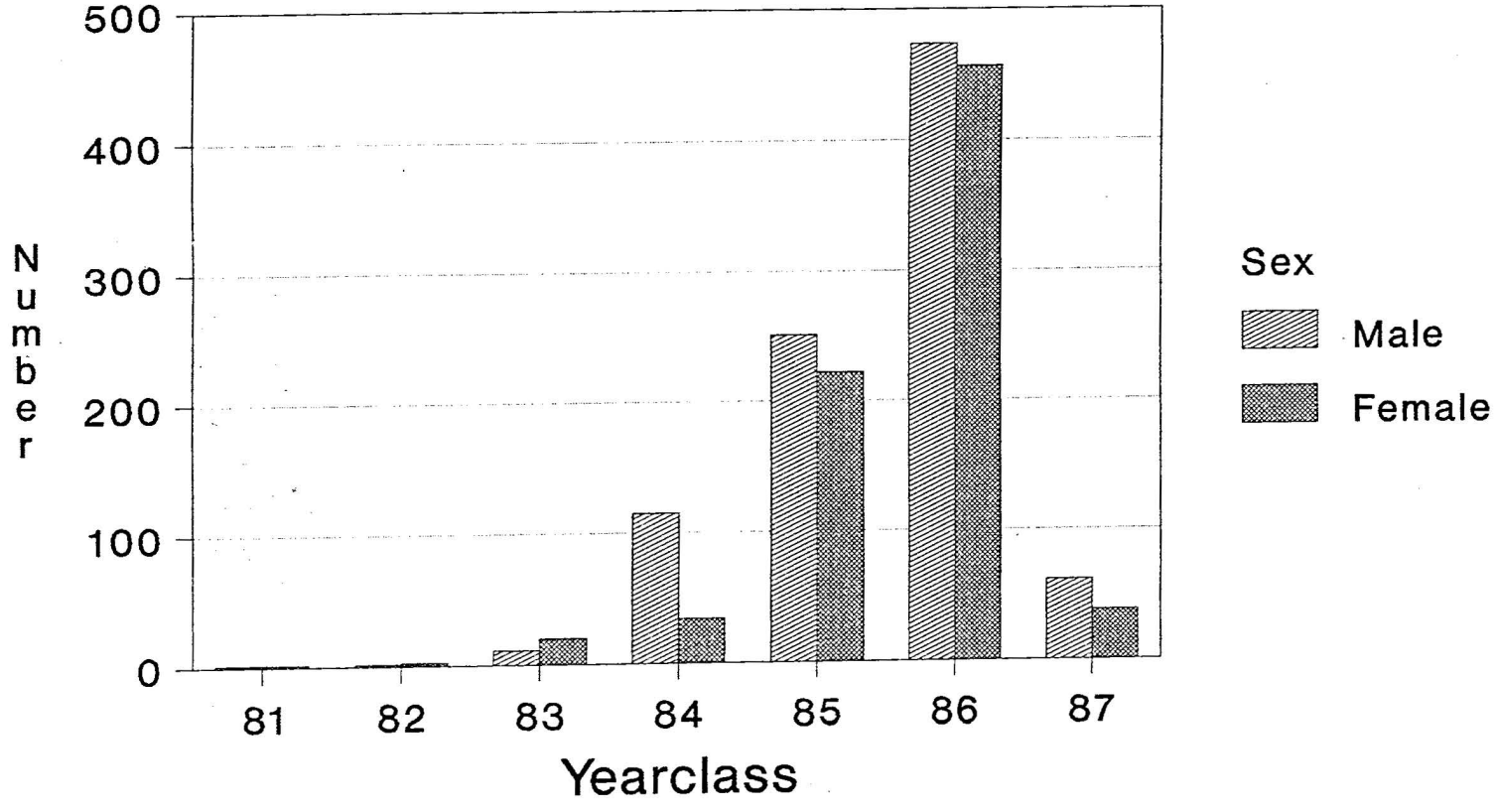

Fig. 3. Distribution of Striped Bass Year Classes in the Rappahannock River Pound Net Samples, Spring 1989