

Reports

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1969

## **Estimation of Parameters of Striped Bass Populations and Description of the Fishery of Lower Chesapeake Bay : Annual Progress Reports**

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1967

~~Bill Kairsta~~  
Bill Kairsta

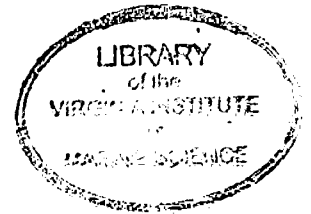
ANNUAL PROGRESS REPORT  
ANADROMOUS FISH PROJECT

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PROJECT TITLE: ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATIONS  
AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE  
BAY.

PROJECT NO: FA-VIRGINIA - AFS-4-1

PROJECT PERIOD: May 1, 1967 - December 31, 1969  
Covers 1967



NOT FOR PUBLICATION

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This project was financed in part with Anadromous Fish Act (P.L. 89-304)  
funds through the Bureau of Sport Fisheries and Wildlife.

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## INTRODUCTION

There are five principal objectives included in the design of this project: (1) to obtain an estimate of age composition of the stocks of striped bass in lower Chesapeake Bay, with special reference to seasonal variation, (2) to determine the age selectivity of major types of fishing gear, (3) to measure the proportion of total catch contributed by each type of fishing gear, and to estimate the magnitude of the recreational catch, (4) to estimate mortality rates for striped bass during the resident phase, and (5) to estimate abundance of individual year classes during their resident phase.

During the initial six-month contract period, 1 May - 30 November 1967, some progress has been made toward attainment of objectives 1, 2, and 5. These results will encompass the body of this report. Objectives 3 and 4 depend on a tagging study not yet begun. Tag types have been selected on the basis of published experience in striped bass tagging, and an initial supply of 3000 streamer disc tags and 300 double-barbed dart tags procured. Tying materials for the streamer tags and retention of the dart tags will be tested in holding tanks in the near future. Field tagging will commence in January or February 1968.

### OBJECTIVE 1

Due to the lag time introduced by the processing of scale samples, final readings of samples are presently complete through August 1967, thereby limiting this report to the first four months of the contract period. An exception to this will be found in results under Objective 5, where data from minnow seine surveys, July - October, 1967 are complete.

The estimate of age composition of local stocks is to be gained from pound net and fyke net samples. These gear have been found to be "non-selective", essentially catching all available ages of striped bass, and presumably in proportion to their availability. Although fished more nearly year-round than are other types of gear, the employment of pound nets and fyke nets is still somewhat erratic. Thus, fyke nets were used only in the James River during this reported period, while pound nets were continually fished in the York River, not until August in the Rappahannock, and not at all in the James River. Setting and removal of nets depended on fishing success, fouling by jellyfish, and the whims of individual fishermen. The period of this report includes a season of poor catches, with many small samples comprising, in many cases, the entire striped bass catch from an individual net fishing 48-72 hours.

James River (fyke nets)	Month	Number of Fish in Year Class							Total
		1966	1965	1964	1963	1962	1961	1960	
	June	0	20	21	8	2	0	1	52
	July	0	16	14	0	1	1	1	33
	August	0	13	8	1	0	0	0	22
	June-Aug (%)	0	45.8	40.2	8.4	2.8	0.9	1.9	107 (100%)

York River (pound nets)	Month	Number of Fish in Year Class			Total
		1966	1965	1964	
	June	2	0	2	4
	July	69	8	2	79
	August	158	6	2	166
	June-Aug (%)	92.0	5.6	2.4	249 (100%)

Rappahannock River (pound nets)	Month	Number of Fish in Year Class			Total
		1966	1965	1964	
	August	47	2	2	51
	%	92.2	3.9	3.9	100%

The number of scale samples from "non-selective" gear taken over the remainder of the contract period, pressed in plastic, and awaiting final aging are as follows:

"Non-selective" gear	<u>September</u>			<u>October</u>			<u>November</u>			Total
	J	Y	R	J	Y	R	J	Y	R	
Fyke net	8	0	0	30	0	0	0	0	0	38
Pound net	0	98	86	77	53	144	50	50	100	658
Total	8	98	86	107	53	144	50	50	100	696

Age composition of catches from the two "non-selective" types of gear appear quite distinct. Although these data might indicate a selection of larger fish by the fyke net, evidence pointing toward a deficiency of the 1966 year class in the James River is accumulating, and will be referred to again in this report. Both types of gear would be expected to catch the one-year-old, normally most abundant, year-class (in this case, the 1966 year class).

Although pound net catches in the York and Rappahannock Rivers during summer months included a very large percentage of one-year-olds, total commercial catches were extremely small. It is expected that, with the addition of data collected from September-November, a change in the percent age composition will be evident. The much larger catches of this period included a greater proportion of older fish.

OBJECTIVE 2

The age selectivity of the various major types of fishing gear will be determined by comparing catches with those from non-selective gear. The limited data thus far available are given below: - - - -

<u>James River</u> May-June 1967	Number of Fish in Year Class									
	'66	'65	'64	'63	'62	'61	'60	'59	'58	Total
Non-selective: fyke	0	20	21	8	2	0	1	0	0	52
Selective: sport catch	0	17	10	2	1	2	3	2	1	38
haul seine	1	17	0	0	0	0	0	0	0	18

July-Aug 1967	Number of Fish in Year Class									
	'66	'65	'64	'63	'62	'61	'60	'59	'58	Total
Non-selective: fyke	0	29	22	1	1	1	1	0	0	55
Selective: sport catch	3	47	40	12	12	7	3	2	1	127

<u>York River</u> July-August 1967	Number of Fish in Year Class							
	'66	'65	'64	'63	'62	'61	'60	Total
Non-selective: pound	227	14	4	0	0	0	0	245
Selective: sport catch	84	61	10	0	0	0	1	156
haul seine	133	3	1	0	0	0	0	137

<u>Rappahannock River</u> August 1967	Number of Fish in Year Class			
	'66	'65	'64	Total
Non-selective: pound	47	2	2	51
Selective: sport catch	5	1	1	7

Compared with non-selective catches within the same river system and at the same season, catches from commercial haul seines are composed of greater numbers of young fish. These limited data reflect the schooling and shoaling of young fish during the warm months. Length frequencies of haul seine striped bass were highly peaked, indicating a schooling by size of those fish vulnerable to haul seines. Haul seine operations in the Rappahannock River were hindered and finally halted by an excessive abundance of the jellyfish Chrysaora quinquecirrha and Aurelia aurita.

Sport fishing by hook and line selects older fish. Although the youngest three catchable year-classes contribute the majority of hooked fish, disproportionate numbers of large fish were taken. Differences between river systems are evident, with a low abundance of the 1966 year class in the James River again noticeable in sport catches.

#### OBJECTIVE 5

Although the principal means of estimating the abundance of individual year classes will be the examination of tag returns, two other sources of information are available. One of these is a minnow seine survey of current year classes, conducted this year on the 1967 year class; the other is data resulting from young fish trawl surveys routinely conducted by this laboratory. Indices of abundance obtained from these two different sources will eventually be related to tag return estimates and, if found to be consistent, ultimately replace the use of tagging.

Minnow seine survey 1967

From six to eight standard seining stations have been established in each of the three rivers of interest. These were sampled, using a 100' X 6' X 1/4" minnow seine, twice a month during the period July through October. Seining was delayed until July to avoid killing excessive numbers of seasonally small fish, while continuation of sampling beyond October would be inefficient because of both escape-ment of larger individuals and seasonal movements of striped bass out of the shallows.

Catch per unit effort, calculated on a monthly basis for the three rivers, is shown in Fig. 1. Indices of abundance may be obtained either from these monthly figures, or from the total catch per total effort for each river (see insert, Fig. 1). The unit of effort here used is one seine haul, and the relatively few 1966 year class striped bass caught by this means have been excluded from calculations. No older fish were caught.

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Figure 1. Indices to abundance of the 1967 year class of striped bass in the York, James, and Rappahannock Rivers, Virginia, as monthly estimates and (inset) as seasonal totals.

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The importance of estimating year class abundance separately for each river system is reaffirmed by the apparent failure of the 1966 year class in the James River, as reported above in the age composition analysis. Neighboring rivers may greatly differ in production of any given year class.

The coefficient of proportionality for each river, relating catch per unit effort data to absolute abundance will not be available until the stocks are tagged and returns are evaluated. These systematic

FIG. 1

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7 X 10 INCHES MADE IN U.S.A.

Catch per unit effort

20

15

10

5

total catch per total effort

5

4

3

2

1

0

James

York

Rappahannock

York River

James R.

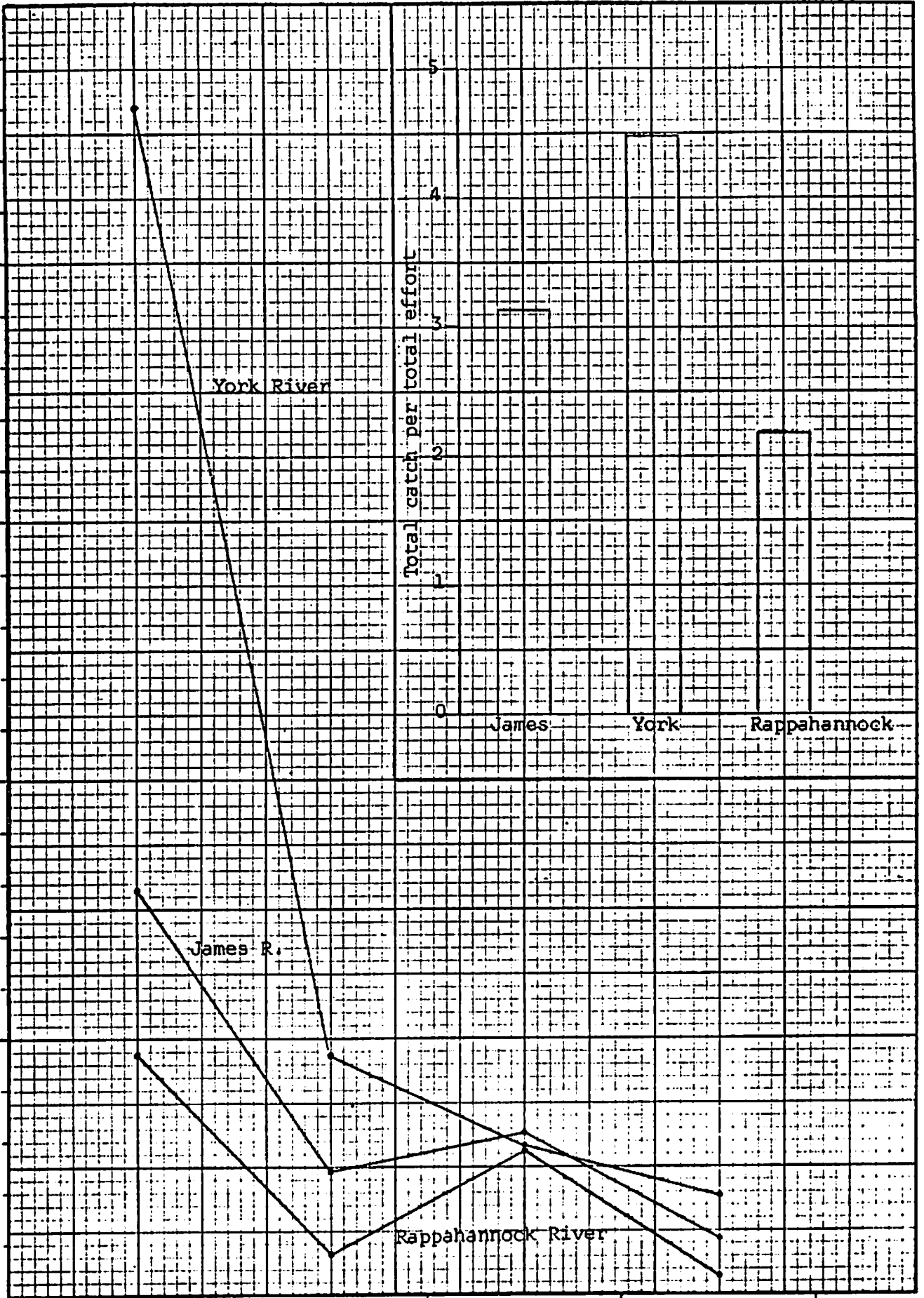
Rappahannock River

July

August

September

October





seining surveys should be continued over several years, in the same manner, to obtain relative indices of abundance for successive year classes in the three rivers.

Young-fish trawl surveys

The Virginia Institute of Marine Science conducts a monthly trawl survey for young fish over a series of stations extending from the mouth of Chesapeake Bay to fresh water in the Pamunkey River, a principal tributary to the York River. These surveys have been regularly conducted for several years. Similar surveys in the James and Rappahannock Rivers have been more sporadic.

Beginning in June 1967 trawl surveys have been, and will continue to be during the life of this project, run on a monthly basis on all three rivers. Striped bass obtained on these surveys are processed just as are those from commercial and sport samples, thereby providing comparative length and age data. These samples can provide an index to the abundance of year classes.

A number of fish caught on surveys early in 1967 were frozen in anticipation of this project and subsequently processed. These data are summarized in quarterly periods (Jan-Mar, April-June 1967):

1st quarter 1967

River system	Percent of fish in yr class				Total # Aged	Total Catch	Total Effort (hours)
	1966	1965	1964	1963			
James	25.9	63.8	10.3	0	58	66	4.50
York	82.9	15.7	0.3	1.0	299	606	4.54
Rappahannock	78.7	18.4	2.9	0	381	494	3.25

2nd quarter 1967

River system	Percent of fish in year class			Total # Aged	Total Catch	Total Effort (hours)
	1966	1965	Unknown			
James	-	-	100.0	0	4	5.88
York	38.0	62.0	-	50	66	4.50
Rappahannock	96.4	3.6	-	28	28	3.20

Trawl catches in July and August were small, due to the seasonal dispersal of striped bass into waters shoaler than the channels regularly trawled. Results from monthly cruises are therefore combined:

July-Aug 1967 River system	Percent of fish in year class			Total # Aged	Total Catch	Total Effort (hours)
	1967	1966	1965			
James	25.0	75.0	0	4	4	2.61
York	22.7	54.6	22.7	22	22	3.00
Rappahannock	0	100.0	0	8	8	3.20

Assuming that, where total catches exceed the actual number of fish aged, the fish aged are representative of the total sample, the proportions of the aged samples within year classes may be used to obtain total catches within these year classes. This is considered a reasonable assumption in this case and the calculated catch per unit effort, using one hour of trawling time as the unit of effort, is presented below.

1st quarter 1967 River system	Catch per unit effort in year class				Catch, all ages, per unit effort
	1966	1965	1964	1963	
James	3.8	9.4	1.5	0	14.67
York	110.7	21.0	0.4	1.3	133.48
Rappahannock	119.7	27.9	4.4	0	152.00

2nd quarter 1967 River system	Catch per unit effort in year class			Catch, all ages, per unit effort
	1966	1965	Unknown	
James	-	-	0.68	0.68
York	5.6	9.1	-	14.67
Rappahannock	15.4	0.6	-	16.00

July-August 1967 River system	Catch per unit effort in year class			Catch, all ages, per unit effort
	1967	1966	1965	
James	0.4	1.1	0	1.53
York	1.7	4.0	1.7	7.33
Rappahannock	0	2.5	0	2.50

And, finally, a combining of catches and effort within age classes and river systems for the period January - August 1967 provides an overall index to the abundance of year classes thus far sampled by trawl:

Jan-Aug 1967 River system	Calculated total catch per year class (nos)						Total Catch	Total Effort (hours)
	1967	1966	1965	1964	1963	Unknown		
James	1.0	20.1	42.1	6.8	0	4.0	74.0	12.99
York	5.0	539.7	141.2	2.0	6.1	-	694.0	12.04
Rappahannock	0	424.0	91.7	14.3	0	-	530.0	8.20
River system	Total catch per total effort in year class						Total catch, all ages, per total effort	
	1967	1966	1965	1964	1963	Unknown		
James	0.1	1.5	3.2	0.5	0	0.3	5.70	
York	0.4	44.8	11.7	0.2	0.5	-	57.64	
Rappahannock	0	51.7	11.2	1.7	0	-	64.63	

The choice of total catch/total effort over the whole or a part of a year on the one hand, and monthly estimates of catch per unit effort on the other, as indices of abundance of individual year classes must await additional data from other sources. However, comparison of these data with age analysis of commercial and sport samples does show a comparable deficiency in the James River 1966 year class, and a close similarity in the age composition of York and Rappahannock River populations. The order of magnitude difference in total striped bass catches between the James and both the York and Rappahannock Rivers is created mainly by differences in abundance of the 1966 year class. These similar conclusions lend confidence to the proposed use of trawl survey data in the estimation of individual year class strength.

Wm. Kriete

1968

ANNUAL PROGRESS REPORT  
ANADROMOUS FISH PROJECT

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## INTRODUCTION

The five principal objectives included in the design of this project are 1) to obtain an estimate of seasonal age composition of the striped bass stocks in lower Chesapeake Bay, 2) to determine the age selectivity of the principal types of fishing gear, 3) to measure the proportion of total catch taken by each type of fishing gear, including the recreational catch, 4) to estimate mortality rates for striped bass during the resident phase, and 5) to estimate abundance of individual year classes during their residence in the James, York, and Rappahannock rivers.

This is the second annual report on progress made in this project. A previous report has summarized results from the initial contract period May 1 - November 1967. This report includes results from the contract period December 1, 1967 - August 31, 1968 as well as that portion of the previous contract period for which scale processing and analysis were incomplete.

### OBJECTIVE 1

The age composition of local striped bass stocks is being monitored through age analysis of scales taken from samples of pound net and fyke net catches. These commercial nets are considered to be "non-selective", catching all available sizes of striped bass.

Our previous report, covering the period of sampling from June - August 1967, revealed the absence of the 1966 year class from James River non-selective samples. During the same period, samples

from both the York and Rappahannock rivers were composed predominantly (92%) of the 1966 year class. Results from age analysis during the period September 1967 - June 1968 are summarized in Table 1.

Table 1. Age composition of non-selective commercial striped bass catches in the James, York and Rappahannock rivers, September 1967 - June 1968.

River System	Month	Number of Fish in Year Class											Total
		1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	older	
James River	Sept.	0	0	6	2	0	0	0	0	0	0	0	8
	Oct.	0	6	88	8	2	0	3	0	0	0	0	107
	Nov.	1	13	34	2	0	0	0	0	0	0	0	50
	Dec.-Feb.	(None)											0
	Mar.	0	9	8	4	0	1	0	0	1	2	1	26
	Apr.	0	7	24	12	5	2	3	10	6	2	1	72
	May	0	1	3	15	0	1	4	2	2	2	1	31
	June	0	14	12	7	2	0	1	0	0	0	0	36
Percent Total	Sept.- June	0.3	15.2	53.0	15.2	2.7	1.2	3.3	3.6	2.7	1.8	0.9	330
York River	Sept.	0	90	8	0	0	0	0	0	0	0	0	98
	Oct.	0	47	6	0	0	0	0	0	0	0	0	53
	Nov.	0	47	2	1	0	0	0	0	0	0	0	50
	Dec.	0	18	12	0	0	0	0	0	0	0	0	30
	Jan-Feb	(None)											
	Mar.	0	16	13	11	0	0	0	0	0	0	0	40
	Apr.	0	27	4	0	0	0	0	0	0	0	1	32
	May	0	20	10	2	0	0	0	0	0	1	0	33
June	2	72	7	0	0	0	0	0	0	0	0	81	
Percent Total	Sept.- June	0.5	80.8	14.9	3.4	0	0	0	0	0	0.2	0.2	417
Rappahannock	Sept.	0	77	9	0	0	0	0	0	0	0	0	86
	Oct.	0	118	25	1	0	0	0	0	0	0	0	144
	Nov.	0	90	10	0	0	0	0	0	0	0	0	100
	Dec.	2	72	13	10	2	0	0	0	0	1	0	100
	Jan.	0	40	7	2	0	0	0	0	0	1	0	50
	Feb.	(None)											0
	Mar.	0	44	18	15	4	6	19	6	1	13	2	128
	Apr.	0	76	3	1	0	1	0	1	0	0	0	82
	May	0	48	7	0	0	0	0	0	0	0	0	55
	June	6	93	2	1	0	0	0	0	0	0	0	102
Percent Total	Sept.- June	0.9	77.7	11.1	3.5	0.7	0.8	2.2	0.8	0.1	1.8	0.2	847

Pound nets were fished in all three rivers and fyke nets in the James and York, during this 10-month period. Data in Table 1 are for the combined catches of these two gear types, where both were sampled. The 1966 year class continued its dominance in catches from the York and Rappahannock rivers, where it contributed about 80 percent of the total numbers of striped bass. The youngest four year-classes (1967-1964) were present in remarkably similar proportions in these two rivers. However, differences between the two rivers in catches of older year classes were evident. The spring spawning run of larger striped bass, so obvious in the Rappahannock River, was either missed by pound nets or of low magnitude in the York River.

The age composition of non-selective catches sampled in the James River, on the other hand, is quite distinct from that observed in the York and Rappahannock. Although finally appearing in October 1967 catches, the 1966 year class was relatively deficient in the James River, and this is reflected in its low contribution to numbers of striped bass caught during this 10-month sampling period (15.2 percent of total sample in Table 1).

The first full year of data from non-selective catch samples is presented in Figure 1, where the percent age composition within river systems is summarized by quarterly periods. The close similarity of York and Rappahannock stocks in age structure is apparent, as is the continuing importance of the 1966 year class. The apparent deficiency of this year class in James River populations shifted dominance in catches to the earlier year classes, with the majority of individuals coming from the 1965 and 1964 year classes. A few older fish appear

in James River catches throughout the year, although the seasonal appearance of large fish on the way to spawning grounds is evident by the first quarter of 1968.

Other seasonal differences in age composition are not very striking. Apparent trends, such as the decrease in importance of the 1966 year class from July 1967 - March 1968 in the York and Rappahannock and the shift in dominance to younger fish in the James, were reversed in the second quarter of 1968. This resulted in essentially the same age composition during spring months of 1968 as was observed in the summer of 1967. An exception to this was the entry of small numbers of the 1966 year class and the presence of a spawning run of large striped bass in the James River.

Scales from July and August 1968 samples are not yet fully processed. Age composition from these months will be included in the next report.

#### OBJECTIVE 2

The age composition of striped bass caught by gear types considered to be selective is compared to that of non-selective catches for the same time period and river system in Table 2. The limited amount of data collected in the early months of this project and reported on in the previous annual report indicated that haul seines selected somewhat smaller fish in warm months and that the sport fishery selected larger fish than those found in non-selective catches. Some of this data is again utilized in Table 2 in order to establish a quarterly summary of age composition.



Table 2. Age distribution of striped bass sampled from "selective" catches in the James, York, and Rappahannock rivers, July 1967 - June 1968.

<u>James River</u> <u>July-Sept. 1967</u>	Nuner of Fish in Year Class											
	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	Older	Total
Non-selective	0	0	35	24	1	1	1	1	0	0	0	63
Selective:												
Haul seine	0	5	61	3	0	0	0	0	0	0	0	69
Gill nets	0	1	19	5	0	0	1	0	1	0	0	27
Sport Catch	0	5	123	62	15	12	9	3	3	1	0	233
<u>Oct-Dec 1967</u>												
Non-selective	1	19	122	10	2	0	3	0	0	0	0	157
Selective:												
Haul seine	0	2	43	9	1	2	1	0	0	0	0	58
Gill nets	0	18	145	122	6	3	0	1	0	0	0	295
Sport Catch	0	1	40	14	1	1	2	1	2	0	0	62
<u>Jan-Mar. 1968</u>												
Non-selective	0	9	8	4	0	1	0	0	1	2	1	26
Selective:												
Haul seine	0	17	9	17	0	0	0	0	0	0	0	43
Gill nets	0	9	123	131	5	2	1	2	0	0	1	274
<u>Apr-June 1968</u>												
Non-selective	0	22	39	34	7	3	8	12	8	4	2	139
Selective:												
Haul seine	1	63	8	21	0	0	0	1	2	1	0	97
Gill nets	0	0	1	20	1	0	0	0	0	0	0	22
Sport catch	0	2	3	6	2	0	0	0	1	0	0	14
<u>York River</u> <u>July-Sept. 1967</u>												
Non-selective	0	317	22	4	0	0	0	0	0	0	0	343
Selective												
Haul seine	0	133	3	1	0	0	0	0	0	0	0	137
Sport catch	0	338	101	13	1	0	0	1	0	0	0	454
<u>Oct-Dec 1967</u>												
Non-selective	0	112	20	1	0	0	0	0	0	0	0	133
Selective:												
Gill nets	0	6	2	0	0	0	0	0	0	0	0	8
Sport Catch	5	517	75	10	1	0	0	0	0	0	0	608
<u>Jan-Mar. 1968</u>												

(No samples from selective gear)

Table 2 - Continued

York River Apr.-June 1968	Number of Fish in Year Class											
	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	Older	Total
Non-selective	2	97	19	2	0	0	0	0	0	1	0	121
Selective:												
Haul seine	11	136	1	2	0	0	0	0	0	1	0	151
Gill nets	0	172	12	5	3	0	1	0	0	2	0	195
Sport catch	27	225	22	3	0	0	0	0	0	0	0	277
<u>Rappahannock River</u>												
<u>July-Sept. 1967</u>												
Non-selective	0	124	11	2	0	0	0	0	0	0	0	137
Selective:												
Haul seine	0	63	4	0	0	0	0	0	0	0	0	67
Gill nets	0	25	3	4	0	0	0	0	0	0	0	32
Sport catch	0	11	1	1	0	0	0	0	0	0	0	13
<u>Oct-Dec 1967</u>												
Non-selective	2	280	48	11	2	0	0	0	0	1	0	344
Selective:												
Gill nets	0	10	0	0	0	0	0	0	0	0	0	10
<u>Jan-Mar 1968</u>												
	No samples from selective gear types											
<u>Apr.-June 1968</u>												
Non-selective	6	217	12	2	0	1	0	1	0	0	0	239
Selective:												
Gill nets	0	191	6	3	0	0	0	0	0	0	0	200

Haul seines appear to have selected somewhat younger striped bass in the warm months, compared with non-selective catches in the same months and river system. However, there are indications that October-March haul-seining selected older fish. It is hypothesized that this is caused by the same factor that depressed the relative contribution of younger fish in non-selective pound and fyke net catches in winter months (Fig. 1). Smaller individuals in the population are seemingly more restricted to the deep channels, and in movements, during cold months than are large fish. This is probably a function of their different feeding requirements.

Gill nets generally selected larger fish than those found in non-selective catches. James River gill net catches, where sample sizes are adequate, were dominated by two year classes, 1965 and 1964, while comparable non-selective catches were dominated by the 1965 year class alone. In the York and Rappahannock rivers, the abundant 1966 year class predominated in both types of gear, so that selectivity is less demonstrable. The several mesh sizes in use in Virginia waters obviously confuse this comparison, so that an expanded effort directed toward a further breakdown of data from gill nets of various sizes is indicated. This needed information will be obtained during the current fiscal year. Mesh sizes in use vary from three to five inches, the latter referred to as "shad nets".

Sport catches generally contained a larger proportion of older year classes than comparable non-selective catches. James River sport catches, although dominated by the 1965 year class, included large numbers of older fish (1964-1958 year classes). The York River, on the other hand, showed a dominance of the abundant 1966 year class in sport catches, with selectivity for older fish expressed only by a slight increase in the 1965 and 1964 year classes, compared with non-selective catches. During the spring months of 1968, York River sport catches actually selected somewhat smaller fish than non-selective nets. This difference between rivers is believed due to the practice of fishing with artificial lures (feathers or bucktails) and light tackle from the numerous well-lighted military and industrial piers on the York River. Smaller striped bass appear to be attracted most strongly to these lights

and the occasional large individual hooked on the usually light tackle is often lost. The method is less common in the James River, where bait-fishing is the more usual practice.

### OBJECTIVES 3-5

These objectives of our project all require, to a greater or lesser degree, an abundance of information to be gained from a tagging program. Whereas returns from winter 1968 tagging are not yet complete, discussion of progress towards these three objectives will here be limited mostly to a description of this tagging.

Selection of a tag to be applied to striped bass was aided by an abundant literature on tag testing, especially that stemming from the 1957-1958 Chesapeake Bay Cooperative Striped Bass Program (Davis 1959, Lewis 1961). Nylon streamer tags were reported to be non-selective, an important consideration for meaningful attainment of our objectives, so were chosen as the principal tag type to be used. Disadvantages of this tag include the time necessary for pre-tagging attachment of line to disc, the slowness of tag application produced by knot-tying in cold weather, and a known loss of tags after a relatively short period of time (about nine months according to Chadwick, 1963). Two types of fishing line were used in tying tags, in alternating lots of 100 tags. Both were 27 pound test, one of spliceable braided dacron, the other of nylon. The method of tying, except for one lot of 100 dacron-tied tags, which were spliced and attached to fish with a bowline knot, was identical to that employed previously in the Chesapeake Cooperative Striped Bass Program, 1957-1958.

A lesser quantity (300) of a more easily applied tag was purchased for comparison. These were double-barbed dart tags (Floy Tag No. 6-B). About 200 of these were released, mostly on larger fish. Further use of this particular tag was discouraged by the size of wound caused by the large-bore applicator and because of poor-quality plastic and resulting breakage of barbs.

The desirability of an immediate tagging of river populations prior to the spawning season precluded any extensive testing for tag-induced mortality and retention of tags. However, instruction in tagging techniques was combined with a limited tank study begun in January and terminated in March 1968. A child's ten-foot circular wading pool was provided with screened outlets and circulating river water (17.63 - 20.46‰ salinity and 7.3 - 14.8° C during the course of the experiment) and stocked with 15 young striped bass (143-258 mm fork length) on January 8. After allowing eight days for adaptation to tank conditions and initial mortality to cease, there were nine relatively healthy survivors. Treatment and survival of these fish are given in Table 3.

Table 3. Size, type of tag, and survival of experimental tank-held striped bass, winter 1968.

<u>Fork length (mm)</u>	<u>Type of tag applied</u>	<u>Survival Time (days)</u>
230	Dacron streamer	6
238	Dacron streamer	71
213	Dacron streamer	66
258	Floy Dart 6-B	71
176	Nylon streamer	17
219	Nylon streamer	27
168	Nylon streamer	38
143	Control	31
?	Control	39

Mortality appeared to be tank-produced rather than tag-produced. Final survivors were blind and covered with a whitish layer of fungus and bacteria. Mortality was most rapid during abrupt rises in water temperature. Such changes could, of course, be avoided by fish in their normal environment, so that such mortality has little relation to expected occurrences in wild populations. Further holding experiments were not attempted.

Winter releases and preliminary return data are summarized in Table 4. All of these fish were obtained by trawling with the Institute's R/V PATHFINDER. Length and age was obtained for each fish tagged, scale samples being removed from the point of tag insertion. Data for each release have been punched on IBM cards, to which return information is added as it occurs.

Table 4. Winter releases of streamer and dart tags in the York, James, and Rappahannock rivers. Returns are those recorded as of September 15, 1968.

<u>River of Release</u>	<u>Date Tagged (1968)</u>	<u>Total Number Tagged</u>	<u>Number of Returns</u>	<u>Percent Returns</u>
York River	Jan 29-Feb 7	1468	160	10.9%
	Mar 5-6	464	36	7.8%
		<u>1932</u>	<u>196</u>	<u>10.1%</u>
James River	Feb 27-28	85	2	2.4%
<u>Rappahannock River</u>	Feb 13-20	<u>1178</u>	<u>198</u>	<u>16.8%</u>
<u>Total all rivers</u>		<u>3195</u>	<u>396</u>	<u>12.4%</u>

It became evident shortly after tagging was completed that streamer tags were being tangled in gill nets. Commercial fishermen have reported finding, in some cases, only the tag in the netting and, in other instances, tagged fish too small to be caught under normal circumstances. These latter were snagged by entanglement of tag and netting (Fig. 2). This selectivity by gill nets,

unsuspected from published literature, is undesirable in attainment of our objectives. Since an important assumption in analysis of tag returns is that a tagged fish has a chance of escapement equal to that of an untagged fish, a new type of tag was desirable. The relatively new Floy Tag No. FD-67, a cartridge-fed anchor tag, was chosen for subsequent tagging. This tag was field-tested in the summer of 1968 and found to be a fast, sure means of marking fish, although not without problems of its own (Fig. 3). A list of locations and dates of tagging with this type of tag is given in Table 5.

Table 5. Summer releases of anchor tags in the York, James, and Rappahannock rivers.

<u>River of Release</u>	<u>Date (1968)</u>	<u>Total Number Tagged</u>	<u>Method of Capture</u>
York River	June 17- Sept 6	283	Hook and line
Rappahannock River	July 3, 8	1493	Pound net
James River	July 29 - Aug 2	553	Pound net

Returns from summer tagging are too incomplete to warrant mention in the present report. The method of tagging, however, is judged superior to the streamer tags and will be utilized in subsequent tagging efforts.

Progress toward Objective 4, i.e. the estimation of mortality rates, has been made, in addition to a start of tagging, through the writing of analog computer analysis programs. These have been devised for growth in length and weight using the von Bertalanffy-type equations.

$$W_t = W_{\infty} (1 - e^{-k(t-t_0)})^3$$

and 
$$L_t = L_{\infty} (1 - e^{-k(t-t_0)}).$$

Estimates of mortality will be made with either an analog program or through use of the Institute's IBM 1130 digital computer. These studies will begin when tabulation of length, weight, and age data are more complete.

The accumulation of data for the estimation of abundance of individual year classes (Objective 5) has been continued through this contract period. Although the minnow seine survey for the current year (July-October 1968) is not yet complete and a full treatment will be reserved for the next report, it can be now stated that the 1968 year class appears to be much less successful in the James and York rivers than in the Rappahannock, and will probably be of overall smaller magnitude than the similarly estimated 1967 year class.

Young-fish trawl surveys were conducted on a monthly basis in the three rivers, interrupted only when and where icing conditions prevented safe passage of the vessel. Data on the age composition and abundance of striped bass caught by use of a 30' semi-balloon trawl is now available beginning in January 1967. Our previous annual report included the first eight months of this data, and pointed out an apparent deficiency of the 1966 year class in the James River. Table 6 includes a full year of data up to and including June 1968.



Table 6. Results of young-fish trawl surveys for striped bass, expressed as catch per unit effort within year classes, and total catch per total effort, by river system. The unit of effort is defined as one hour of trawling time, using a 30' semi-balloon trawl.

<u>July-Sept 1967</u>		Catch per unit effort in year class					Total catch	Total effort (hours)	Total catch per total effort
River System	1967	1966	1965						
James	0.6	1.1	0			6	3.61	1.66	
York	1.8	3.6	1.5			31	4.50	6.89	
Rappahannock	0	1.9	0			9	4.85	1.86	

<u>Oct-Dec 1967</u>		Catch per unit effort in year class					Total Catch	Total effort (hours)	Total catch per total effort
River System	1967	1966	1965	1964	1963				
James	3.5	0.9	0	0	0	15	3.38	4.44	
York	10.8	2.2	0.2	0	0.2	67	5.02	13.35	
Rappahannock	30.5	18.2	0	0.2	0	226	4.62	48.92	

<u>Jan-Mar 1968</u>		Catch per unit effort in year class					Total Catch	Total effort (hours)	Total catch per total effort
River System	1967	1966	1965	1964	1963				
James	10.0	2.3	1.0	1.0	0	43	3.00	14.33	
York	70.0	20.1	2.0	0	0	362	3.93	92.11	
Rappahannock	30.0	10.0	1.0	1.0	1.0	43	1.00	43.00	

<u>Apr-June 1968</u>		Catch per unit effort in year class					Total Catch	Total effort (hours)	Total catch per total effort
River System	1968	1967	1966	1965	1964				
James	0	1.2	1.2	0.6	0.3	11	3.38	3.25	
York	0.2	7.4	1.7	0	0	43	4.62	9.31	
Rappahannock	0	3.8	6.9	0	0	51	4.79	10.65	

Success in catches of striped bass continued to be lowest in the James River. Seasonal catches in the James River, adjusted for effort, were from 9 to 89 percent of those in the Rappahannock, and from 15 to 35 percent of those in the York River. Differences were due to lower catches of both the more abundant year classes (1967 and 1966). It is not clear from these data alone whether river differences are real numerical differences or a function of

station locations within the river systems. Tag return analysis should aid in this interpretation.

The 1967 year class became dominant in trawl catches during the fourth quarter of 1967, when it contributed 80 percent of the total catch in the James and York rivers and 62 percent in the Rappahannock. During the first three months of 1968 the 1967 year class continued to contribute from 70-76 percent of total striped bass catches in the three rivers. The latter figures may be compared with trawl data obtained in the first quarter of 1967, when the 1966 year class constituted about 80 percent of catches in the York and Rappahannock rivers, but only 26 percent of James River catches. Therefore, the percent age composition, at least, of catches during the winter months of 1968 was similar in all three rivers, with the 1967 year class showing equal relative importance. The deficiency of one-year-olds noted in the James River in the previous year is not evident in 1968. This fact corresponds well with results of the 1967 minnow seine survey, which showed abundance of the 1967 year class to be of the same order of magnitude in the three rivers.

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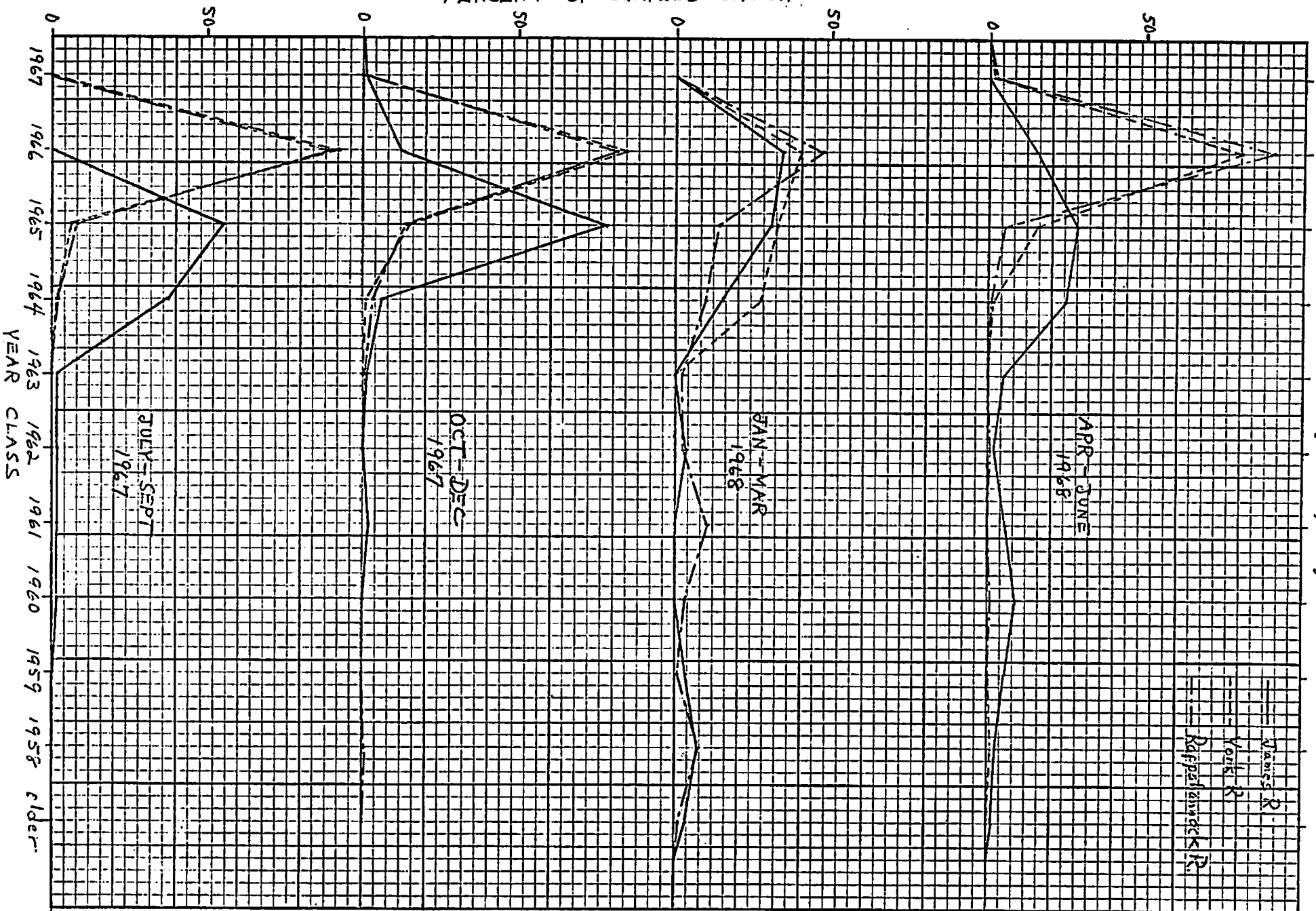
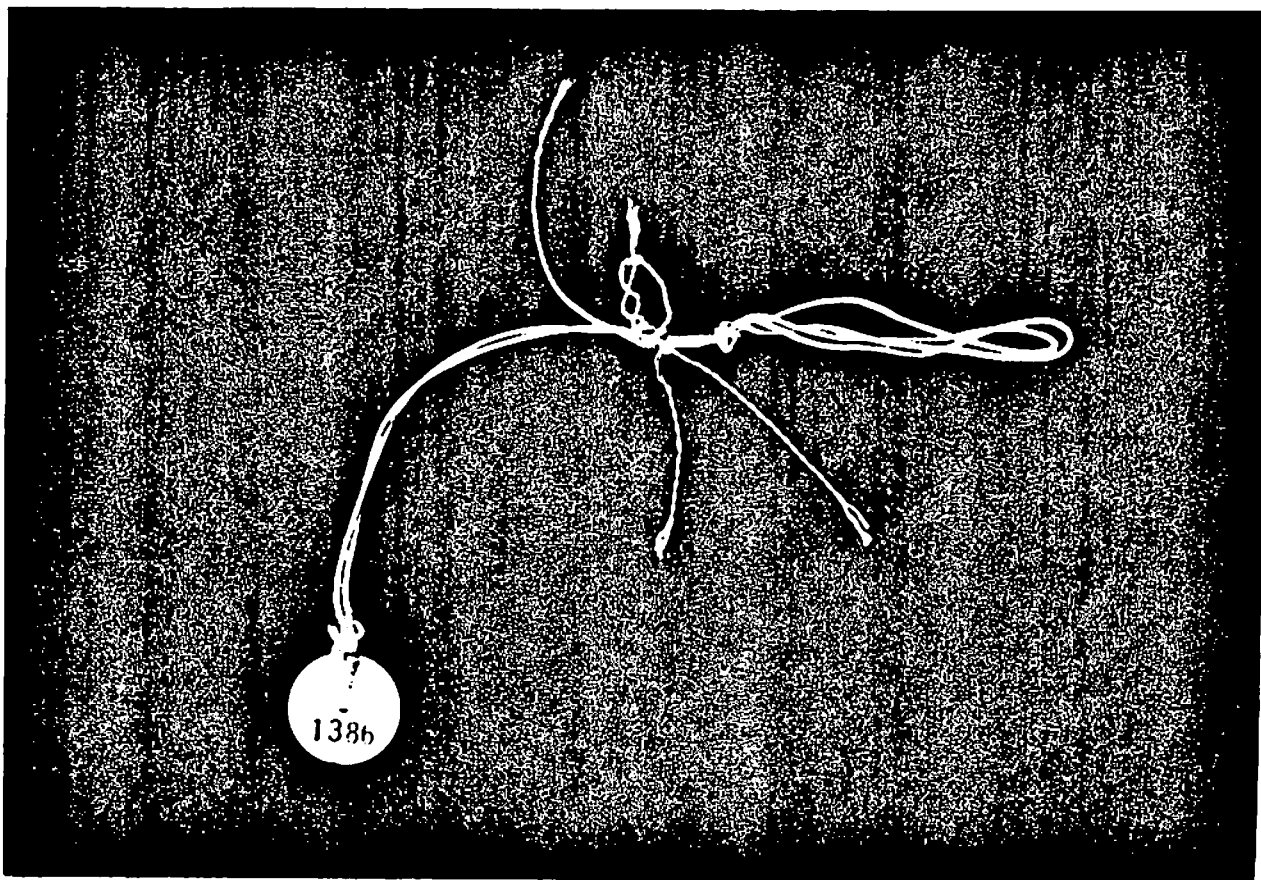


Fig. 1. Age composition of striped bass sampled from pound net and fyke nets within seasonal periods, July 1967 - June 1968.

Fig. 3. A returned FD-67 anchor tag with heavy attached growth. This condition of summer-applied tags was common in the Rappahannock River.



Fig. 2. A returned streamer tag with pieces of snagged gill netting still attached.



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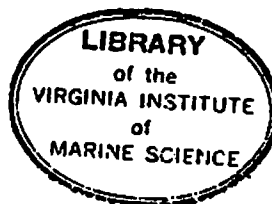
ANNUAL PROGRESS REPORT  
ANADROMOUS FISH PROJECT

PROJECT TITLE: ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATIONS  
AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE  
BAY  
PROJECT NO: FA-VIRGINIA-AFS-4-2

SEP 5 1969

PROJECT PERIOD: May 1, 1967 - June 30, 1970

This covers Sept 68 - June 69



NOT FOR PUBLICATION

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INTRODUCTION

This project, initiated in May 1967, was designed with five principal objectives: 1) to obtain an estimate of seasonal age composition of striped bass stocks in lower Chesapeake Bay, 2) to determine the age selectivity of fishing-gear types, 3) to measure the proportion of total catch taken by each type of fishing gear, including the sport catch, 4) to estimate mortality rates for striped bass during the resident phase, and 5) to estimate abundance of individual year classes.

Two previous annual reports have contributed to attainment of Objectives 1, 2, and 5. Age composition of river stocks was found to be closely similar in the York and Rappahannock rivers. However, the neighboring James River stocks were distinctly different, because of relatively poor production or survival of the 1966 year class (Grant and Joseph, in press). During the period September 1967-June 1968, approximately 80% of the pound and fyke net catches in the York and Rappahannock rivers consisted of 1966 year class striped bass; the comparable estimate from James River samples was 15%. These river differences in age composition have underlined the importance of sampling in more than one river.

Comparisons with non-selective pound and fyke net catches indicated that commercial haul seines are seasonally selective- for younger fish in warm months and somewhat older fish in cold months. Gill nets capture a distinctly stratified segment of the population, dependent on the mesh



size of nets and the girth of the fish. The two principal mesh sizes employed in Virginia are 3 1/2 and 5 inches ("spot" and "shad" nets, respectively). The latter are particularly selective for older striped bass. Publication of a detailed study on selection by gill nets of various sizes of North Carolina striped bass (Trent and Hassler, 1968) has obviated the need expressed in our previous report for a similar study. Sport catches were noted as only slightly selective for older striped bass.

Catch-per-unit-effort data from annual July-October seining and from January-March trawl surveys were selected to provide early estimates of incoming year-class strength. A promising correspondence between the 1967 minnow seine survey and winter 1968 trawl survey in estimates of relative abundance of the 1967 year class was shown.

Objectives 3 and 4 depend on tag-and-recapture methods. Tagging was initiated in January 1968 and is being continued. A description of tags, tagging methods, and early results was included in our second annual report (Grant, 1968). The present report includes a summary of preliminary tag return results through July 1, 1969, followed by a discussion of progress within each objective.

## PRELIMINARY RESULTS FROM STRIPED BASS TAGGING

Tagged striped bass have been released in Virginia waters, to date, within three distinct seasonal periods. For convenience in analysis, these will be treated separately in following tabulations. The initial period, January-March 1968, will be referred to as winter 1968 (Table 1). Remaining tagging periods were summer-fall 1968 and winter 1969.

A change in the tag type applied (Grant 1968) has been justified. The principal disadvantages of streamer disc tags- slow application in cold weather and snagging by gill nets- have been eliminated by use of internal anchor tags<sup>1/</sup>, first described by Dell (1968). Application of these tags has been as rapid as length measurements and removal of scales for age analysis have allowed. Tags should be inspected carefully before use for excess bits of plastic that can cause jamming of tagging guns and for duplication or omission of serial numbers. There has been no evidence of tagged fish becoming entangled in nets by the projecting nylon tube.

Growth of algae, bryozoans, and barnacles on the tags has been excessive at times. In numerous instances, such growth has abraded the side of the tagged fish, causing severe injury and subsequent infection. Reduction in the length of the trailing portion of tag is not considered advisable as a correction of the problem, however, because of a significant number of tag returns coming from the retail market or fish processing firms. Any further lessening of visibility of tags would increase this type of return.

<sup>1/</sup>Floy Tag & Manufacturing, Inc. Catalog No. FD-67

Table 1. Releases of tagged striped bass in Virginia rivers, 1968-1969.

Date	River	Number of Fish Tagged	Tag Types	Fishing Gear Employed
<b>Winter 1968</b>				
Jan. 29-Feb. 7	York	1468	Streamer disc, dart	30' trawl
Feb. 13-20	Rappahannock	1178	"	"
Feb. 27-28	James	85	"	"
Mar. 5-6	York	464	"	"
	Total	3195		
<b>Summer-Fall 1968</b>				
June 17-Nov. 26	York	392	Internal anchor	Hook and Line
July 3, 8	Rappahannock	1494	"	Pound Net
July 29-Aug. 2	James	553	"	"
	Total	2439		
<b>Winter 1969</b>				
Jan. 8-Feb. 25	York	114	Internal anchor	30' trawl
Jan. 15-Feb. 19	Rappahannock	1161	"	"
Mar. 12-18	James	301	"	"
Mar. 25	York	771	"	Haul Seine
Apr. 1	James	544	"	"

Total 2891

Table 2. Age distribution of striped bass tagged in Virginia rivers, winter 1968.

River System	Unknown	Year Class							Total
		1967	1966	1965	1964	1963	1962	1961	
James	0	35	39	8	3	0	0	0	85
York	1	588	1301	37	3	1	0	1	1932
Rappahannock	0	134	1005	38	0	1	0	0	1178

Some anchor tags have been returned with the trailing end missing. Tag serial numbers have been moved toward the anchor end to counter such loss of information.

#### Winter 1968 Tagging

Large numbers of young striped bass from the 1966 and 1967 year class were present in the channels of the York and Rappahannock rivers during winter months of 1968, and readily obtainable with the use of a 30-foot semi-balloon trawl. All tagging during this period was conducted on the Virginia Institute of Marine Science R/V Pathfinder. Similar attempts in the James River failed because of the scarcity of the 1966 year class.

The age distribution of tagged striped bass released during this period is given in Table 2, and age distribution of returns from these 3195 tags in Table 3. Although overall return rates for the James, York, and Rappahannock rivers are 2.4%, 12.6%, and 20.5%, respectively, analysis within year classes is of particular interest in that a decided increase in return rates among older year classes is evident (Figure 1).

Proportions of returns within the various fishing-gear types will be used to satisfy Objective 3. An underlying assumption in this method is that tagged fish are neither more nor less likely to be caught than the untagged fish in any of the various gear types employed. This assumption was not satisfied in winter 1968 tagging, necessitating a

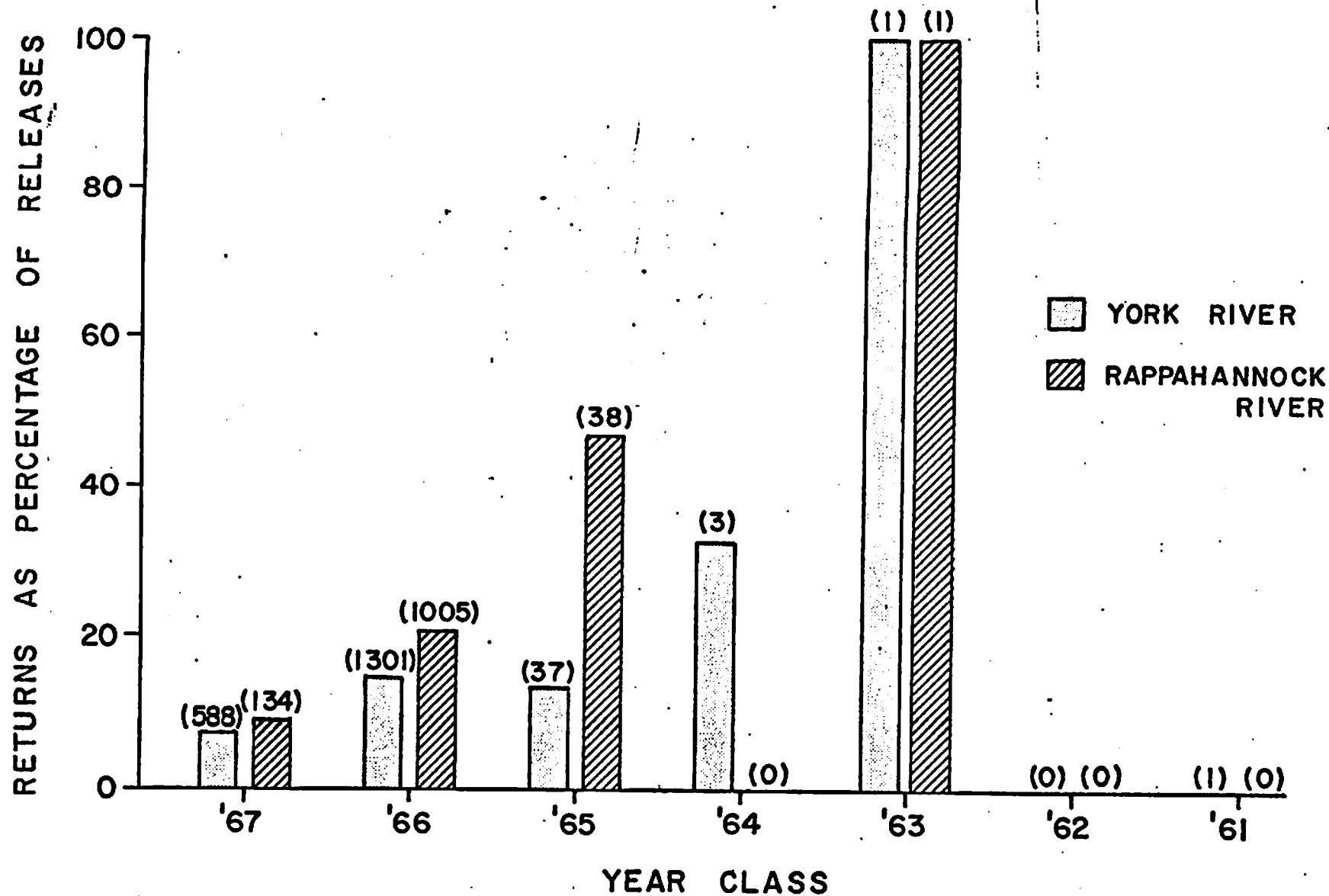


Figure 1. Percentage of returns within year classes of striped bass tagged in the York and Rappahannock rivers during winter 1968. Numbers in parentheses indicate total number of releases within each year class.

correction factor to modify gill net returns of small tagged striped bass. Length-frequency sample data from an extensive winter and spring gill-net fishery in the Rappahannock River were used to determine the length of the smallest striped bass likely to be taken in gill nets. Those returns from tagged striped bass below this minimum size (270 mm fork length for 3 1/2 inch nets, 298 mm for 5 inch nets) are considered invalid for gear analysis. The corrected number of returns is included with raw data in Table 4.

The number of recaptures within 30-day intervals from date of release is shown in Figure 2. Two returns from James River tagging, at large for 24 and 54 days, are excluded from this figure, as are two returns lacking such information from York River tagging. Secondary peaks in Figure 2 at approximately 225 and 360 days are seasonal effects of fall sport catches in the York River, fall pound net catches in the Rappahannock, and winter gill net catches in both rivers.

Only 3.7% of returns from York River tagging, and 0.8% of those from Rappahannock tagging, were recaptured outside the river system of release (Table 5). Two- and three-year-old striped bass appeared to move into the Bay in warmer months, and mixing between river stocks apparently occurred when this population returned to river channels in cooler months. The single return from New England waters was a five-year old tagged prior to the 1968 spawning run, after which it joined the migrating Atlantic Coast population. Both James River returns were recaptured within that river system.

Table 3. Age distribution of returns through July 1, 1969, from striped bass tagged during winter 1968.

River System	Year Class							Total
	1967	1966	1965	1964	1963	1962	1961	
James	0	1	0	1	-	-	-	2
York	44	192	5	1	1	-	0	243
Rappahannock	13	210	18	-	1	-	-	242

Table 4. Returns from winter 1968 striped bass tagging, within categories of fishing gear. Numbers in parentheses have been corrected for gill-net snagging of small fish.

River System	Commercial Gear					Sport Catch	Unknown	Total
	pound nets	haul seines	gill nets	fyke nets	other			
James	0	0	2	0	0	0	0	2
York	13	0	164 (72)	12	0	43	11*	243 (151)
Rappahannock	33	2	156 (47)	0	3	36	12	242 (133)

\* includes 1 return from VIMS trawl

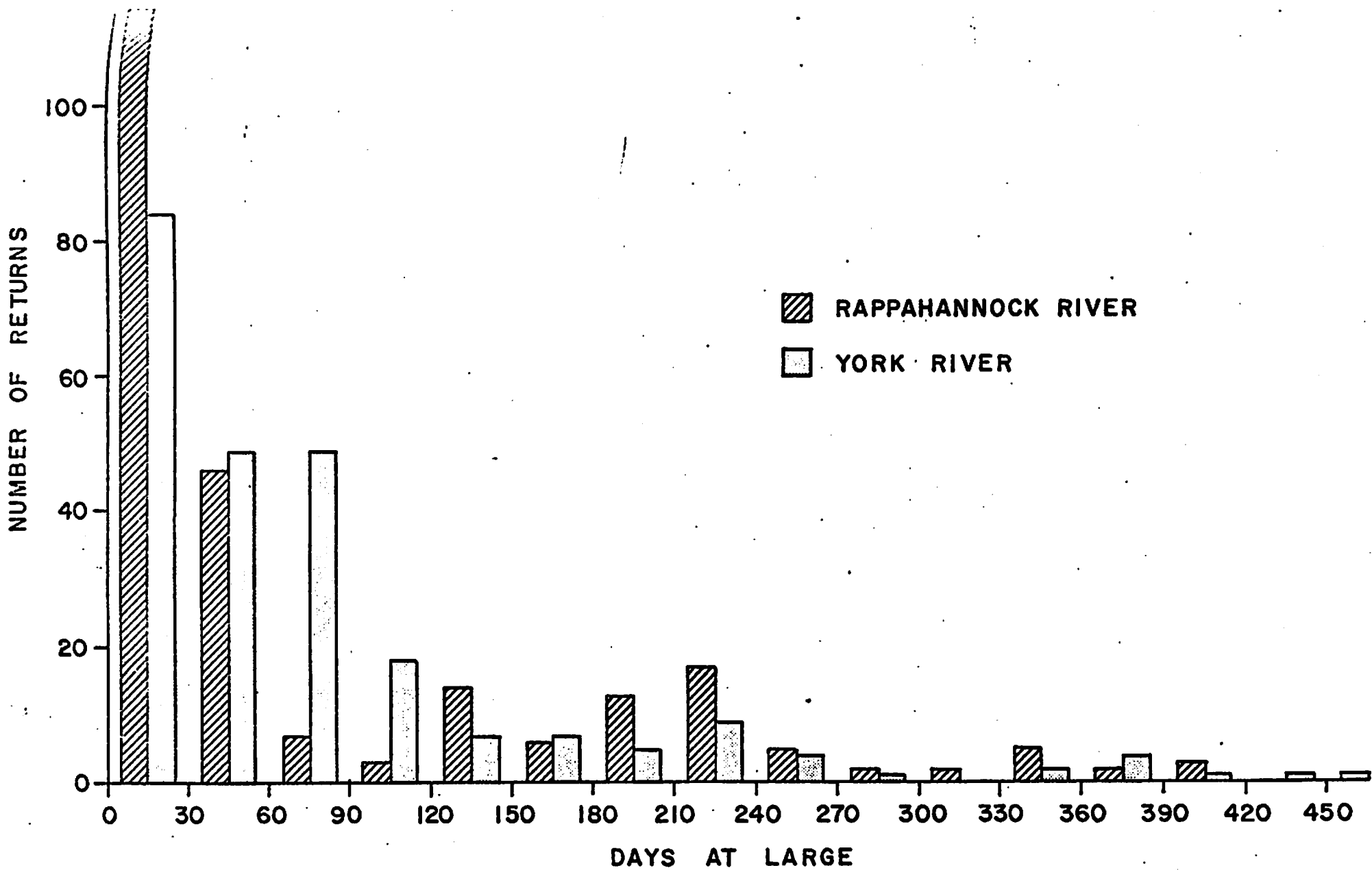


Figure 2. Number of returns within 30-day intervals from date of individual tag release. Winter 1968 tags.



Table 5. List of tag returns from areas outside river of tag release-winter 1968 tagging.

River of Release	Number of Days at Large	Year Class	Recapture Area	Minimum Distance (naut. miles)	Month of Recapture
York	72	1966	Mid-Chesapeake Bay	56	April 1968
"	77	"	"	59	"
"	78	"	Upper Chesapeake Bay	115	May 1968
"	155	1965	"	75	July 1968
"	187	1963	So. New England	385	August 1968
"	224	1966	Rappahannock River	82	October 1968
"	232	1966	Piankatank River	47	October 1968
"	380	1967	Rappahannock River	70	February 1969
"	432	1966	Upper Chesapeake Bay	115	April 1969
Rappahannock	124	1966	Upper Chesapeake Bay	75	June 1968
"	359	1966	James River	200	February 1969

Table 6. Chi-square analysis of returns from four different tag types employed in winter 1968 striped bass tagging.

	Tag Type				Total
	Streamer		Disc	Dart	
	Tied Dacron	Tied Nylon	Spliced Dacron (Floy FT-6B)		
Number Released	1491	1396	99	209	3195
Number of Returns	246	221	4	15	487
Expected Returns	227.26	212.78	15.09	31.86	-
Chi-square	1.23	0.32	8.15**	8.92**	18.62**
P	>0.25	>0.50	<0.005	<0.005	<0.005

A chi-square analysis of returns from the four types of tags used during winter 1968 (Table 6) demonstrates that both bowline-tied spliced streamer discs and dart tags were returned at a much lower rate than streamer disc tags tied with crossed running knots (U. S. Fish and Wildlife Service method used in 1958). Differences were highly significant ( $p = < 0.005$ ). There is no evidence of any difference in returns resulting from the use of different tying material in streamer disc tags.

#### Summer-Fall 1968 Tagging

River populations of striped bass move into shoaler waters in warmer months, so are unavailable to channel-bound trawling. Fish were purchased from pound net fishermen in the James and Rappahannock rivers during the summer of 1968, tagged with internal anchor tags, and released outside the channel ends of the nets. Although current wholesale prices were paid to these commercial fishermen, they contributed considerable time and care in supplying us with striped bass in good condition. Since no York River commercial gear was catching sufficient numbers of striped bass, we resorted to hook-and-line methods.

The age distribution of these 2438 tagged striped bass is given in Table 7, and that of the returns through July 1, 1969 in Table 8. Overall rates of return are 20.1%, 8.2% and 17.7% for the James, York, and Rappahannock rivers, respectively. The high rate of returns for the James River is deceptive, however, since these fish remained in the general vicinity of tagging for several weeks. Nearly 95% of these returns were recaptured within 6 weeks at the site of tagging. An increase

in return rates among older year classes, similar to that shown in Figure 1, was again evident. Percent returns within year classes for the combined rivers was as follows:

1967	12.4%
1966	17.5%
1965	26.3%
1964	37.5%
1961	0%

Recaptures by fishing-gear type are given in Table 9. James River returns from pound nets are heavily weighted because of the failure of marked fish to move from the tagging site for several weeks. It would therefore be unrealistic to use these figures in estimating proportionality of catch among gear types.

The number of recaptures within 30-day intervals from date of release is given in Table 10. Peaks in the Rappahannock tag return distribution at 75 and 225 days were caused by fall pound net fishing and winter gill-netting.

Returns from outside the river of tagging were limited to the 1966 year class. Although none of the James River returns were taken elsewhere, this may be more a reflection of the number left after the first six weeks than an indication of stock integrity. Migration was evidenced in 3.1% of York River returns and 2.6% of Rappahannock River returns. The recapture of one Rappahannock River striped bass on the coast south of Virginia Beach, Virginia, is considered unusual. Its importance will become evident in discussion of winter 1969 tagging. None of the summer-fall 1968 tag returns have yet been returned from more northerly waters (Table 11).

Table 7. Age distribution of striped bass tagged in Virginia rivers, summer-fall 1968.

River System	Year Class					Total
	1967	1966	1965	1964	1961	
James	404	118	23	6	2	553
York	212	162	17	1	0	392
Rappahannock	225	1251	17	1	0	1494

Table 8. Age distribution of returns, through July 1, 1969, from striped bass tagged during summer-fall 1968.

River System	Year Class						Total
	1967	1966	1965	1964	1961	unknown*	
James	66	34	9	2	0	0	111
York	17	12	0	1	-	2	32
Rappahannock	21	222	6	0	-	16	265

\* tags returned with severed numbers

Table 9. Returns from summer-fall 1968 striped bass tagging within categories of fishing gear.

River System	Commercial Gear					Sport Catch	Unknown	Total
	pound nets	haul seines	gill nets	fyke nets	other			
James	105	1	1	0	0	4	0	111
York	3	1	9	1	0	15	3	32
Rappahannock	171	8	24	0	6	45	11	265

Table 10. Numbers of returns within 30-day intervals from date of individual tag release—summer-fall 1968 tagging.

Days At Large	James River	York River	Rappahannock River
0 - 30	102	5	32
31 - 60	6	4	39
61 - 90	0	7	80
91 - 120	0	1	49
121 - 150	0	3	22
151 - 180	2	3	6
181 - 210	0	3	7
211 - 240	0	3	12
241 - 270	1	1	7
271 - 300	0	0	3
301 - 330	0	0	4
unknown	0	2	4
Total	111	32	265

Table 11. List of tag returns from areas outside river of tag release—summer-fall 1968 tagging.

River of Release	Number of Days at Large	Year Class	Recapture Area	Minimum Distance (naut. miles)	Month of Recapture
York	169	1966	Mid-Chesapeake Bay	68	April 1969
Rappahannock	77	1966	Potomac River	70	Sept. 1968
Rappahannock	85	1966	Potomac River	70	Oct. 1968
Rappahannock	89	1966	Upper Chesapeake Bay	127	Oct. 1968
Rappahannock	136	1966	James River	72	Nov. 1968
Rappahannock	252	1966	Atlantic Coast, south of Chesapeake Bay	75	Mar. 1969
Rappahannock	262	1966	York River	60	Mar. 1969
Rappahannock	279	1966	Mid-Chesapeake Bay	44	April 1969

Winter 1969 Tagging

The expected abundance of striped bass in river channels during the winter months of 1969 failed to materialize. The use of a trawl in the capture of taggable fish was effective only in the Rappahannock River, where 1161 striped bass were tagged by this means. Repeated efforts over a two-month period resulted in only 114 tagged fish in the York, and 301 in the James River. The success of a commercial trawl fishery operating during this period off the coast between Cape Henry and the False Cape suggested river populations had moved out of rivers en masse to congregate in these coastal waters. Reported trawler landings increased from 50,000 pounds in 1968 to over 800,000 pounds in 1969. Direct evidence of the identity of these stocks is lacking as no returns have come from this fishery. However, this stock was the object of tagging operations by the North Carolina Division of Commercial & Sport Fisheries during winter months. All of their early returns came from lower Chesapeake Bay rivers. Coincident with these returns was the reappearance of large numbers of striped bass in haul seine catches in the James, York, and lower Rappahannock rivers, in late March. Further tagging operations by VIMS in winter 1969 utilized such catches. The single tag return from Virginia coastal waters referred to in the last section was taken by a haul seiner, and is our clearest evidence that winter coastal stocks had a Chesapeake Bay origin. Lack of returns from the trawl fishery can only be considered "non-response".

The age distribution of winter 1969 tagged striped bass is given in Table 12 and that of returns from these 2891 tags in Table 13.

Percent returns within year classes, all rivers combined, is as follows:

1968	2.1%
1967	7.1%
1966	11.7%
1965	13.0%
1964	12.5%
1963-1961	0 %

Overall return rates for the James, York, and Rappahannock rivers as of July 1, 1969, are 9.1%, 6.8%, and 8.1%, respectively. Considering that James River tags have been at large only three months, these return percentages are notably high.

Numbers of returns within categories of fishing gear are given in Table 14. Since a full year has not elapsed subsequent to tag releases, these figures are, at best, only a seasonal estimate of proportional catches. The high proportion of tags from haul seines in the James and Rappahannock rivers is a seasonal effect.

Recaptures within 30-day intervals from date of individual tag release are given in Table 15, and a list of recaptures outside the river of tagging in Table 16. The percentage of migrating fish from the James and York rivers in this short 3-month period is a distinct departure from previous observations, where approximately 3% of returns were recaptured outside the river of origin. It is possible that these fish, tagged in the lower regions of the James and York rivers immediately after their return from coastal waters, were in the process of distributing themselves among Chesapeake tributaries prior to the spawning season.

Table 12. Age distribution of striped bass tagged in Virginia rivers, winter 1969.

River System	Year Class									Total
	unknown	1968	1967	1966	1965	1964	1963	1962	1961	
James	0	6	528	298	7	5	1	0	0	845
York	0	9	594	259	15	3	3	1	1	885
Rappahannock	2	128	922	108	1	0	0	0	0	1161

Table 13. Age distribution of returns, through July 1, 1969, from striped bass tagged during winter 1969.

River System	Year Class									Total
	unknown	1968	1967	1966	1965	1964	1963	1962	1961	
James	0	0	45	29	2	1	0	-	-	77
York	0	0	41	19	0	0	0	0	0	60
Rappahannock	1*	3	59	30	1	-	-	-	-	94

\* returned tag with missing number

Table 14. Returns from winter 1969 striped bass tagging, within categories of fishing gear.

River System	Commercial Gear					Sport Catch	Unknown	Total
	pound nets	haul seines	gill nets	fyke nets	other			
James	6	35	11	0	0	15	10	77
York	7	5	23	1	0	17	7	60
Rappahannock	18	43	13	0	1	10	9	94



Table 15. Numbers of returns within 30-day intervals from date of individual tag release—winter 1969 tagging.

Days at Large	James River	York River	Rappahannock River
0 - 30	44	22	37
31 - 60	17	13	26
61 - 90	9	17	13
91 -120	1	4	6
121 -150	-	-	4
unknown	6	4	8
<b>Total</b>	<b>77</b>	<b>60</b>	<b>94</b>

Table 16. List of tag returns from areas outside river of tag release—winter 1969 tagging.

River of Release	Recapture Area	Number of Returns	Percent of Total Returns
James	Lower Chesapeake Bay	4	
"	York River	8	
"	Mid-Chesapeake Bay	2	
"	Rappahannock River	2	
"	Potomac River	3	
"	Upper Chesapeake Bay	3	
"	So. New England	1	
	<b>Total James River</b>	<b>23</b>	<b>29.9%</b>
York	Lower Chesapeake Bay	1	
"	Mid-Chesapeake Bay	2	
"	Upper Chesapeake Bay	6	
"	Gulf of Maine	1	
	<b>Total York River</b>	<b>10</b>	<b>16.7%</b>
Rappahannock	Lower Chesapeake Bay	1	
"	Mid-Chesapeake Bay	1	
"	Upper Chesapeake Bay	1	
	<b>Total Rappahannock R.</b>	<b>3</b>	<b>3.2%</b>

## PROGRESS WITHIN OBJECTIVES

Objective 1

The determination of age from scale samples obtained from pound net and fyke net catches is being employed in an estimation of the age composition of striped bass stocks in lower Chesapeake Bay. Catches in "non-selective" fishing gear such as pound and fyke nets would be expected to have a similar age composition from year to year, providing recruitment of incoming year classes was constant. Dissimilarities in age composition will result not only from strong or weak year classes but, as pointed out in previous annual reports, from spawning success differences among neighboring river systems. The age composition of striped bass stocks from the York and Rappahannock rivers was nearly identical during the period July 1967-June 1968. Both stocks were dominated by a strong 1966 year class. This year class was a relative failure in the James River (Grant and Joseph, in press), so that older fish dominated catches.

Results from age analysis during the period July 1968-June 1969 are summarized in Table 17. A belated appearance of the 1966 year class in James River catches is evident. What proportion of these are truly James River stock is unknown at present. Some mixing from other river systems is suspected, although close analysis of scale samples may show an extremely slow growth rate as a contributing factor to their late appearance. The persistence of the 1966 year class in Rappahannock

River catches has changed this stock's former agreement in age composition with that of the York River. The 1966 year class has dominated non-selective catches in the Rappahannock River throughout two full years of sampling (Figure 3), whereas the 1967 year class has assumed numerical dominance of York River catches in the past three quarters. Age composition in the James and York rivers has been similar during the past year.

#### Objective 2

Catches of striped bass by haul seines, gill nets, and the sport fishery have been considered in planning this project to be somewhat selective for certain ages, either younger or older in proportion to their availability. Haul seines were shown to be seasonally selective (Grant 1968), for younger fish in warm months and somewhat older fish in cold months. Selectivity for rather narrow ranges of size and age by gill nets is well recognized, and expressed in Virginia fisheries by a dominance of fish one year older, in general, than the dominant available year class. Sport catches have tended to be only slightly selective for older fish. A comparison of non-selective and selective catches during the period July 1968-June 1969 is given in Table 18.

Haul seine catches in the past year were not notably selective for certain ages. The dominant age group in gill net catches was usually one year older than that in non-selective catches, and sport catches generally selected somewhat younger fish than non-selective catches.

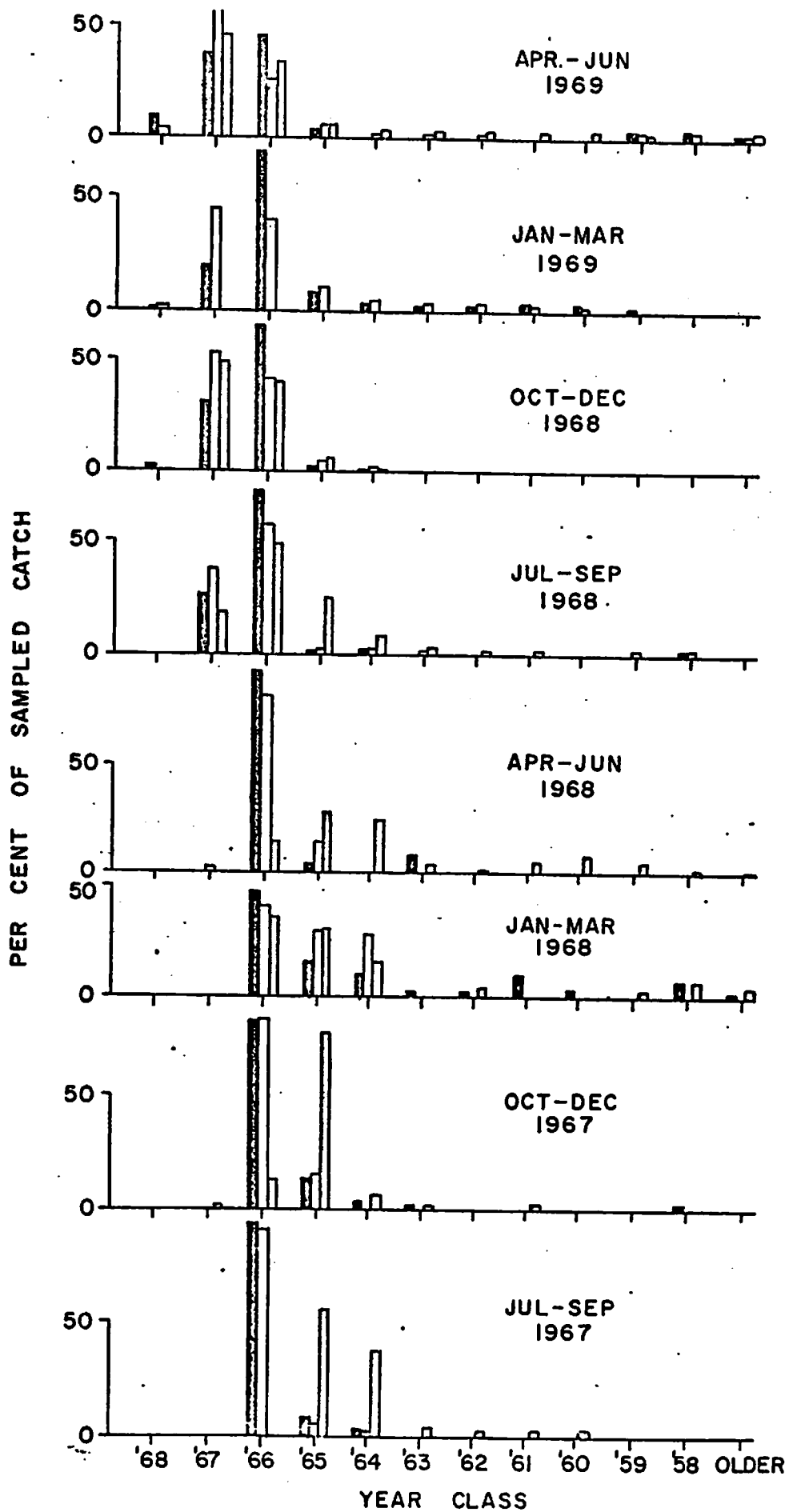


Figure 3. Percent age composition of striped bass sampled from pound and fyke nets within seasonal periods July 1967-June 1969. Rappahannock River (solid), York River (hollow), James River (shaded).

Table 17. Age composition of non-selective commercial striped bass catches in the James, York, and Rappahannock rivers, July 1968-June 1969.

River System	Month	Number of Fish in Year Class												Total	
		1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	older		unknown
James	July	-	5	75	69	17	4	1	2	0	0	1	0	0	174
	Aug.	-	22	64	17	7	0	0	0	0	0	0	0	0	110
	Sept.	-	43	50	8	3	0	0	0	0	0	0	0	0	104
	Oct.	-	55	37	7	0	0	0	0	0	0	0	0	0	99
	Nov.	-	35	13	2	0	0	0	0	0	0	0	0	0	50
	Dec.	-	7	39	4	0	0	0	0	0	0	0	0	0	50
	Jan.-Mar.	(None)													
	Apr.	-	16	16	3	7	5	5	1	1	2	1	1	0	58
	May	-	25	31	9	6	5	3	2	4	0	0	0	0	85
June	-	113	61	4	6	0	0	0	0	0	0	0	0	184	
Percent Total		-	35.1	42.2	13.5	5.0	1.5	1.0	0.5	0.5	0.2	0.2	0.1	-	914
York	July	-	30	61	4	0	0	0	0	0	0	0	0	95	
	Aug.	-	17	31	0	0	1	0	0	0	1	1	0	0	51
	Sept.	-	37	34	1	0	0	0	0	0	0	0	0	0	72
	Oct.	-	86	60	6	0	0	0	0	0	0	0	0	0	152
	Nov.	-	98	71	5	0	0	0	0	0	0	0	0	1	175
	Dec.	1	90	79	16	4	0	0	0	0	0	0	0	0	190
	Jan.	0	25	43	17	10	2	1	0	0	0	0	0	0	98
	Feb.	1	48	43	15	2	2	0	1	0	0	0	0	0	112
	Mar.	0	105	65	8	2	0	0	0	0	0	0	0	0	180
	Apr.	1	89	37	5	2	0	1	0	1	0	3	0	0	139
	May	3	72	26	10	1	3	0	0	1	1	0	0	0	117
June	7	29	13	0	0	0	0	0	0	0	0	0	0	49	
Percent Total		0.9	50.8	39.4	6.1	1.5	0.6	0.1	0.1	0.1	0.1	0.3	0	0.1	1430

Table 17. (continued)

River System	Month	Number of Fish in Year Class												Total	
		1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	older		unknown
Rappahannock	July	-	14	138	1	2	0	0	0	0	0	0	0	0	155
	Aug.	-	13	37	0	0	0	0	0	0	0	0	0	0	50
	Sept.	-	54	45	0	0	0	0	0	0	0	0	0	0	99
	Oct.	-	27	70	3	0	0	0	0	0	0	0	0	0	100
	Nov.	-	54	90	5	0	0	0	0	0	0	0	0	0	149
	Dec.	4	43	96	0	1	0	0	0	0	0	0	0	0	144
	Jan.	0	24	82	4	1	1	0	0	0	0	0	0	0	112
	Feb.	0	2	16	7	1	0	0	0	0	0	0	0	0	26
	Mar.	0	10	41	3	2	0	0	2	1	0	0	0	0	59
	Apr.	1	31	61	1	0	0	0	1	1	1	3	0	0	100
	May	21	33	53	5	0	0	0	1	1	2	1	0	0	117
	June	8	58	31	2	0	1	0	0	0	0	0	0	0	100
Percent Total		2.8	30.0	62.8	2.6	0.6	0.2	-	0.3	0.2	0.2	0.3	-	-	1211

Table 18. Age distribution of striped bass sampled from "selective" catches in the James, York, and Rappahannock rivers, July 1968-June 1969. Non-selective catches are included for comparison.

July-Sept.	JAMES RIVER													Sample Size
	1968	1967	1966	Percent of Sample in Year Class							1959	1958	older	
				1965	1964	1963	1962	1961	1960					
Non-selective	-	18.0	48.7	24.2	7.0	1.0	0.3	0.5	-	-	0.3	-	-	388
Selective														
Haul Seine	-	30.9	40.0	8.2	7.3	3.6	1.8	3.6	3.6	-	0.9	-	-	110
Gill Net	-	-	35.7	64.3	-	-	-	-	-	-	-	-	-	14
Sport	-	34.9	49.6	8.5	2.3	0.8	0.8	1.6	1.6	-	-	-	-	129
<b>Oct.-Dec.</b>														
Non-selective	-	48.7	44.7	6.5	-	-	-	-	-	-	-	-	-	199
Selective														
Haul Seine	-	26.3	38.4	29.3	1.0	-	1.0	-	4.0	-	-	-	-	99
Gill Net	-	28.3	49.3	18.1	3.6	-	-	0.7	-	-	-	-	-	138
<b>Jan.-Mar.</b>														
Non-selective	(none)													
Selective														
Haul Seine	-	64.0	34.0	2.0	-	-	-	-	-	-	-	-	-	50
Gill Net	-	6.7	77.2	12.7	2.2	0.7	0.4	-	-	-	-	-	-	268
<b>Apr.-June</b>														
Non-selective	-	47.1	33.0	4.9	5.8	3.1	2.4	0.9	1.5	0.6	0.3	0.3	-	327
Selective														
Haul Seine*	-	51.2	45.2	1.2	1.4	0.3	-	0.6	-	-	-	-	-	648
Gill Net	-	8.3	34.7	18.1	20.8	6.9	1.4	5.6	2.8	-	1.4	-	-	72
Sport	-	78.1	13.5	3.1	2.1	1.0	-	2.1	-	-	-	-	-	96





Table 18. (Continued)

July-Sept.	RAPPAHANNOCK RIVER													Sample Size
	Percent of Sample in Year Class													
	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	older	unknown	
Non-selective	-	26.6	72.4	0.3	0.7	-	-	-	-	-	-	-	-	304
Selective														
Haul Seine	-	32.0	67.3	0.7	-	-	-	-	-	-	-	-	-	150
Gill net	-	9.5	89.1	1.4	-	-	-	-	-	-	-	-	-	211
Sport	-	60.0	36.3	3.7	-	-	-	-	-	-	-	-	-	135
Oct.-Dec.														
Non-selective	1.0	31.6	65.1	2.0	0.3	-	-	-	-	-	-	-	-	393
Selective														
Haul Seine	0.7	51.3	46.7	1.3	-	-	-	-	-	-	-	-	-	150
Gill Net	-	17.4	81.5	1.0	-	-	-	-	-	-	-	-	-	195
Sport	-	36.0	64.0	-	-	-	-	-	-	-	-	-	-	50
Jan.-Mar.														
Non-selective	-	18.3	70.6	7.1	2.0	0.5	-	1.0	0.5	-	-	-	-	197
Selective														
Haul Seine	-	14.0	82.0	4.0	-	-	-	-	-	-	-	-	-	50
Gill Net	-	20.8	72.8	5.4	1.0	-	-	-	-	-	-	-	-	298
Apr.-June														
Non-selective	9.4	38.5	45.7	2.5	-	0.3	-	0.6	0.6	0.9	1.3	-	-	317
Selective														
Gill Net	-	0.8	93.3	1.7	3.4	0.8	-	-	-	-	-	-	-	119

\* includes tagged fish

Table 18. (Continued)

July-Sept.	RAPPAHANNOCK RIVER													Sample Size
	Percent of Sample in Year Class													
	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	older	unknown	
Non-selective	-	26.6	72.4	0.3	0.7	-	-	-	-	-	-	-	-	304
Selective														
Haul Seine	-	32.0	67.3	0.7	-	-	-	-	-	-	-	-	-	150
Gill net	-	9.5	89.1	1.4	-	-	-	-	-	-	-	-	-	211
Sport	-	60.0	36.3	3.7	-	-	-	-	-	-	-	-	-	135
<b>Oct.-Dec.</b>														
Non-selective	1.0	31.6	65.1	2.0	0.3	-	-	-	-	-	-	-	-	393
Selective														
Haul Seine	0.7	51.3	46.7	1.3	-	-	-	-	-	-	-	-	-	150
Gill Net	-	17.4	81.5	1.0	-	-	-	-	-	-	-	-	-	195
Sport	-	36.0	64.0	-	-	-	-	-	-	-	-	-	-	50
<b>Jan.-Mar.</b>														
Non-selective	-	18.3	70.6	7.1	2.0	0.5	-	1.0	0.5	-	-	-	-	197
Selective														
Haul Seine	-	14.0	82.0	4.0	-	-	-	-	-	-	-	-	-	50
Gill Net	-	20.8	72.8	5.4	1.0	-	-	-	-	-	-	-	-	298
<b>Apr.-June</b>														
Non-selective	9.4	38.5	45.7	2.5	-	0.3	-	0.6	0.6	0.9	1.3	-	-	317
Selective														
Gill Net	-	0.8	93.3	1.7	3.4	0.8	-	-	-	-	1	-	-	119

\* includes tagged fish.

Table 19. Number of returns from winter 1968 tagging within categories of fishing gear, through July 1, 1969. Gill net returns are excluded.

River of Return	Commercial Gear					VIMS Trawl	Sport	Total Non-Gill Net
	Pound Nets	Haul Seines	Fyke Nets	Peeler Pots	Traps			
James	0	0	0	0	0	0	1	1
York	12	0	12	0	0	0	39	63
Rappahannock	34	2	0	1	2	1	35	75

Table 20. Number of returns from summer-fall 1968 tagging within categories of fishing gear, through July 1, 1969.

River of Return	Commercial Gear					Sport	Total
	Pound Nets	Haul Seines	Gill Nets	Fyke Nets	Peeler Traps		
James	106	1	1	0	0	4	112
York	3	2	7	1	0	15	28
Rappahannock	170	4	24	0	6	44	248

catch (68.5%), with a smaller proportional sport catch (17.7%). Estimates of proportions of catch by the various gear types in the latter two rivers are believed to be realistic.

A similar treatment of returns from winter 1969 tagging is omitted from this report because of the short period tags have been at large. Results would only provide a seasonal estimate of the proportions of total catch taken by gear types. A full year of return information from these tags will not be complete until April 1970.

#### Objective 4

One of the simplest methods available for estimating total mortality rates in fish populations is the Jackson indirect method. This estimate is obtainable from a single, large sample of the population and its age composition. Survival rate is then calculated as

$$s = \frac{II + III + IV + \dots + n}{I + II + III + \dots + n - 1}$$

where I, II, etc. are the numbers of fish from the sample of Age I, II, etc., and n is the oldest age considered. Total mortality rate may then be calculated as  $1 - s$ .

Although this indirect method assumes constant recruitment, an assumption not met in striped bass populations, we have used it as a first approximation to an estimate of total mortality. Trawl catches were summed for January-March in each river (James, York, and Rappahannock)

for three consecutive years. These were treated as our "single large" samples. Survival and mortality rates were calculated using numbers of striped bass within the first four age groups, e.g. for trawl catches in winter 1967,

$$s = \frac{1965 + 1964 + 1963}{1966 + 1965 + 1964}$$

Calculated total mortality rates for these nine samples are given in Table 21. The method is very sensitive to the strength of in-coming year classes. Strong in-coming year classes elevate total mortality rate estimates, as evidenced by 1967 estimates for the York and Rappahannock rivers, while weak in-coming year classes lower such estimates (James River estimates in 1967 and 1969). The first three examples were caused by relative strength of the 1966 year class (strong in the York and Rappahannock, weak in the James), and the last example was a result of a poor showing by the 1968 year class in the James.

The 1967 year class was of moderate strength in all three rivers, suggesting that 1968 estimates may more closely approximate true mortality rates. However, an additional factor that affects such estimates must be taken into account. The 30-foot semi-balloon trawls used in collecting samples are progressively more inefficient as size of the striped bass increases. This would tend to elevate all estimates of total mortality rates. The first order approximation for overall total mortality rates in Virginia striped bass populations is therefore estimated at approximately 0.5.

Table 21. Total mortality rates of Virginia striped bass populations, calculated by the Jackson indirect method and based on winter trawl catches. Sample size in parentheses.

River System	Year of Estimate		
	1967	1968	1969
James	0.258 (66)	0.675 (43)	0.247 (73)
York	0.828(606)	0.760(362)	0.590(195)
Rappahannock	0.787(494)	0.707 (43)	0.697(195)

Table 22. Currently available estimates of annual fishing mortality rates among Virginia resident populations of striped bass (1966 year class only). See text.

River System	Tagging Season	Total Number Tagged	Corrected Total (A)	Total Returns	Corrected Total (B)	Annual Fishing Mortality (B/A)
Rappahannock	Winter 1968	1006	905	205	225	0.249
Rappahannock	Summer 1968	1251	1126	222	244	0.217
York	Winter 1968	1302	1172	238	262	0.224

This preliminary estimate of total mortality will be refined by use of a direct method of estimation based on tag recaptures. The snagging of streamer tags by gill nets and resulting change in tag types have delayed such an estimate for one year. A second winter of tagging with anchor tags will be necessary, as this method is based on proportional returns of fish tagged in two consecutive years.

Estimates of annual fishing mortality rates are available for those tagging periods and rivers for which tags have been at large for one year. Fishing mortality rates based on the number of returns occurring within one year from date of release are given in Table 22. Estimates were restricted to a single year class and river, and were somewhat modified by two estimated correction factors: 1) the total number of tagged fish was reduced by 10% to account for tagging mortality, and 2) the total number of returns was increased by 10% to account for non-response. Similar estimates for summer-fall tagging in the York River, and winter 1969 tagging in the James, York, and Rappahannock rivers will be available during the next year. Based on analyses of return rates within year classes of tagged fish, which suggested a higher fishing mortality among older resident striped bass, fishing mortality rate estimates of a given year class are expected to increase from one tagging period to the next succeeding one, providing that emigration of tagged fish has not become a significant factor.

Length-weight data accumulating from our commercial and sport catch sampling will be used in further estimates of mortality rates and in

refining growth curves for local striped bass populations. An analog computer is being employed in plotting optimal age at harvest for various total mortality rates (Richards 1967, 1968). Length-weight relationships, along with our samples of commercial catches, will be used to convert reported landings (in pounds) to numbers of striped bass within year classes. Resulting data will allow a cumulative monthly estimate of mortality when used in conjunction with observed tag returns.

Length-weight relationships have been calculated for the 1966 year class in each of the months July-December 1967. Log-log equations for these relationships are listed in Table 23. Comparisons of males and females from the York River system Sept.-Nov. 1967 (not included in Table 23) detected no significant difference between sexes at this early age, so sexes were combined. Covariance analysis of paired samples revealed significant differences between months within quarterly periods, so that data, even within a river system, cannot be further combined. Data from the York and Rappahannock rivers can be combined in August, October, and December; but, a significant difference between rivers was evident in both September and November. The single sample from the James River was significantly different from comparable samples from both the York and Rappahannock rivers. A treatment of length-weight relationships within rivers and months is indicated.

#### Objective 5

Three separate sampling methods and periods are being examined for use in estimating the relative abundance of individual year classes in



Table 23. Length-weight equations for the 1966 year class of striped bass, July-December 1967 (Y = weight in grams, X = fork length in millimeters).

Month (1967)	River System	Sample Size	log Y
July	York	142	-5.161 + 3.1042 log X
August	York	237	-4.789 + 2.9468 log X
August	Rappahannock	59	-4.602 + 2.8693 log X
September	York	276	-5.281 + 3.1474 log X
September	Rappahannock	170	-4.798 + 2.9569 log X
October	James	52	-4.820 + 2.9752 log X
October	York	145	-4.869 + 2.9784 log X
October	Rappahannock	131	-5.097 + 3.0731 log X
November	York	151	-4.832 + 2.9752 log X
November	Rappahannock	138	-5.257 + 3.1601 log X
December	York	69	-5.029 + 3.0664 log X
December	Rappahannock	103	-5.057 + 3.0664 log X

Virginia rivers. These include 1) a minnow seine survey of young-of-the-year striped bass in the James, York, and Rappahannock rivers, conducted from July-October of each year since 1967, 2) young fish trawl surveys of these rivers during winter months, and 3) commercial sampling during the initial period of a year class entry into the fishery.

#### Minnow Seine Surveys

Results of the 1967 seining survey were included in our second annual report (Grant 1968). Indices of abundance based on catch-per-unit-effort data indicated the 1967 year class was one of moderate strength in all three rivers. Indices (total catch per total effort, with a single seine haul as the unit of effort) ranged from about 2.2-4.5, with the York River showing the highest index and the Rappahannock River the lowest.

The 1968 year class, in contrast, appeared to be of much lower overall magnitude in Virginia rivers, although the 1968 index in the Rappahannock River was higher than that of 1967 (Figure 4). The 1968 index of abundance in the James and York rivers indicated a four-fold difference in year-class strength between these two rivers and the Rappahannock River. Such river differences in relative success of year classes may be compared to previous observations regarding the 1966 year class in Virginia (Grant and Joseph, 1968).

#### Young-fish Trawl Surveys

A 30-foot semi-balloon trawl is most effective during winter months in the capture of young striped bass. Catch-per-unit-effort data from



Figure 4. Catch per minnow seine haul of 1967 and 1968 young-of-the-year striped bass in the James, York, and Rappahannock rivers. Based on semi-monthly surveys, July-October.

the three-month period January-March are therefore utilized for a second estimate of relative strength of in-coming year classes in Virginia rivers.

Estimates of year-class abundance from trawl surveys are available for the three year classes 1966-1968. An estimate for the 1966 year class was made possible by the freezing of catches made in winter 1967, before the initiation of this project. Again, total catch per total effort is used as an index to abundance, but with a unit of effort equivalent to one hour of trawling.

Results of trawl surveys for the period July 1968-June 1969, expressed as catch-per-unit-effort within quarterly periods, are given in Table 24. The gradual increase in York River catches of the 1968 year class until the first quarter of 1969 was surprising in view of that river's minnow seine survey results. Catch-per-unit-effort for the 1968 year class in the York River, however, is still well below that for the 1967 year class (Figure 5). A general decrease in the strength of year classes 1966-1968 is evident.

#### Entry into Commercial Fishery

Although striped bass less than one year old appear in un-culled non-selective commercial catches as early as October, the first reliable indication of a year class' relative strength is not available until the following summer. Data from summer 1967 and 1968 sampling of non-selective commercial catches are incorporated into Figure 6 to show relative abundance of the 1966 and 1967 year classes. Comparison of Figures 4-6 shows a better agreement between independent estimates of year class strength

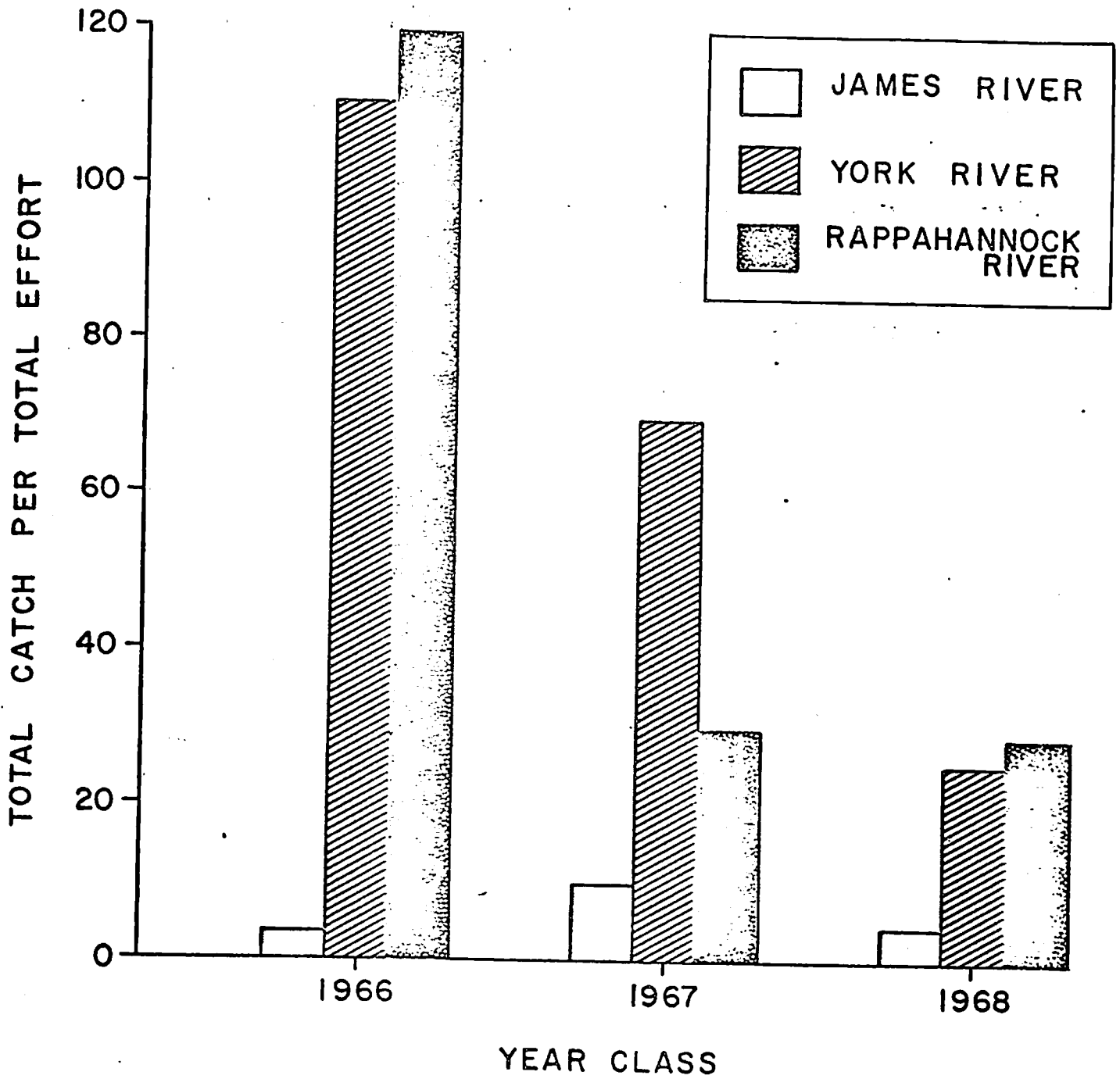


Figure 5. Catch per trawl hour of three striped bass year classes in the James, York, and Rappahannock rivers. Based on 30-foot semi-balloon trawl catches during winter months (January-March) of calendar year following hatch.

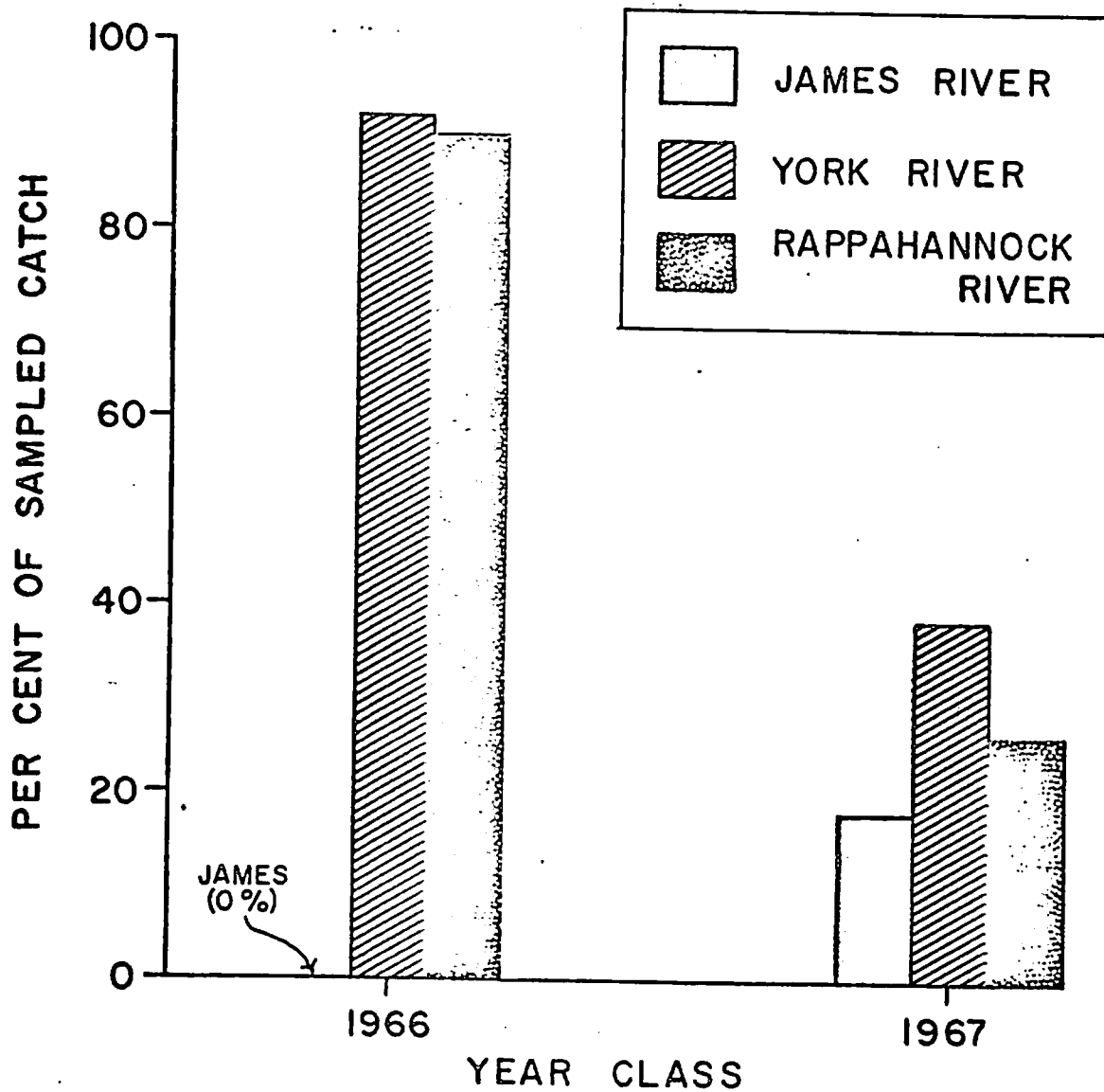


Figure 6. Relative abundance of the 1966 and 1967 year classes of striped bass in three Virginia rivers, expressed as percent of sampled non-selective catches during the summer months (July-September) following calendar year of hatching.

from trawl and commercial gear than between those from minnow seine surveys and either of the former. However, minnow seine and trawl surveys are still considered to be the best available estimates since they 1) are the earliest estimates of relative abundance available and 2) provide catch-per-unit-effort data, which are not readily obtained from the commercial fisheries.

All available estimates reveal a progressive decline in the abundance of year classes 1966 through 1968, considering all three rivers combined. Individual rivers demonstrated variation within this overall pattern. Thus, the James River produced a moderate-sized 1967 year class of striped bass and poor 1966 and 1968 year classes. The Rappahannock River produced a strong 1966 year class, followed by 1967 and 1968 year classes of moderate strength.

Table 24. Results of young-fish trawl surveys for striped bass, expressed as catch per unit effort (one hour trawling time) within year classes, by river system.

July-Sept. 1968

River System	1968	Catch per Unit Effort in Year Class			Total Catch per Total Effort
		1967	1966	1965	
James	0	10.67	0.30	0	10.96
York	0.67	8.44	1.33	0.22	10.67
Rappahannock	8.21	0.42	0.42	0	9.05

Oct.-Dec. 1968

River System	1968	1967	1966	unknown	Total
James	1.25	0.31	0.93	-	2.49
York	8.67	5.78	0	-	14.44
Rappahannock	19.06	7.99	0.41	1.02	28.48

Jan.-Mar. 1969

River System	1968	1967	1966	Total
James	4.41	12.75	0.74	17.89
York	25.81	16.63	1.35	43.82
Rappahannock	29.12	11.99	0.64	41.76

Apr.-June 1969

River System	1969	1968	1967	1966	Total
James	0	0.27	0.82	0.27	1.36
York	1.83	8.22	11.42	0	21.46
Rappahannock	0	0.20	0	0	0.20



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