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**Biology and management of river herring and shad in Virginia :
Annual report, Anadromous Fish Project 1975**

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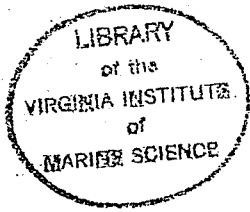


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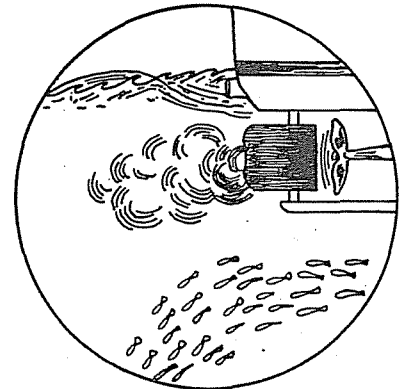
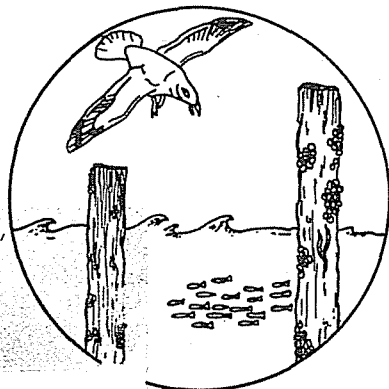
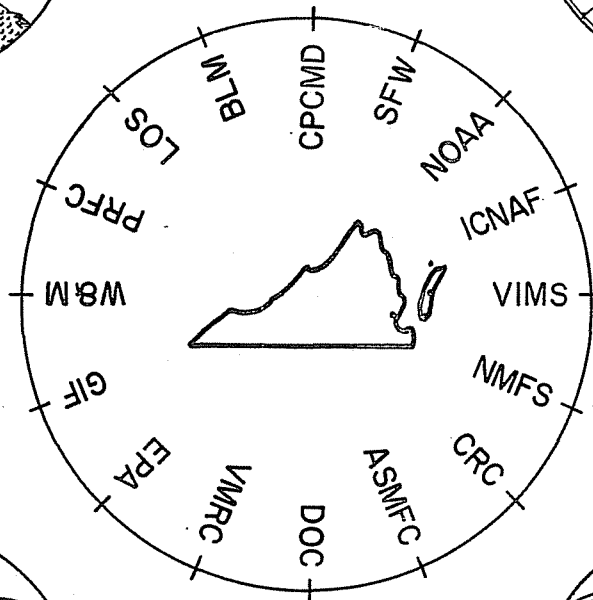
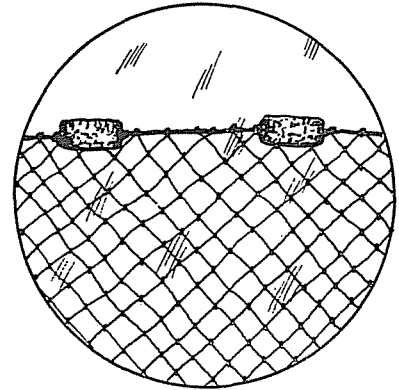
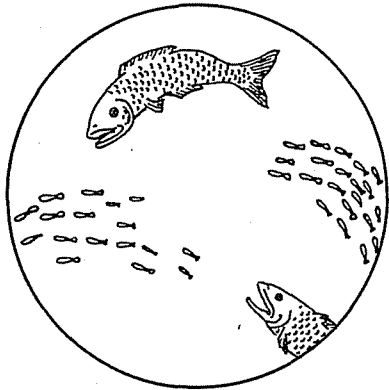
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Biology and Management of River Herring and Shad in Virginia



Annual Report, Anadromous Fish Project, 1975

Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

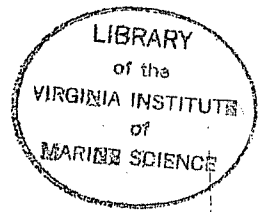
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Annual Report 1975

Project Title: Biology and Management of River Herring and Shad
Project Number: Virginia AFC 8-2
Project Period: 1 October 1974 to 30 September 1975

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Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

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Abstract

The number of pound nets and the catch of alosines per net continued to decline in 1975. Effort by stake gill nets increased but catch estimates declined. The James River yielded an estimated 853,847 pounds of American shad (down 47% from 1974) with the peak of the run at the end of March. Stake gill nets landed 246,036 pounds of American shad in the York River, a decrease from 1974. Estimates of Hickory shad landings declined 83% in the York River. Pound nets in the Rappahannock River had a 75% reduction in American shad catch and stake gill net catch was down 13% from 1974. River herring catch estimates were down 13% in the Rappahannock River. Pound net catches of American shad declined 47% while landings from stake gill nets increased by 44% from 1974 in the Potomac River. River herring landings increased 34% in the Potomac River.

Seven thousand specimens of alosines from the Virginia commercial fishery were obtained during the spawning season. Age four dominated the river herring run, with percentages ranging from 68 to 83%, up considerably over the last few years and nearly double the age four contribution of ten years ago. Age four American shad made up from 24 to 39% of the shad run. Weights of river herring remained below the long term average while shad have not changed. The foreign fleets took 20% of the reported river herring catch in 1974 from ICNAF area 6.

Blueback herring had a strong yearclass in every Virginia nursery zone sampled in 1975. Alewife and American shad had small yearclasses, which continued the long term decline. The 1970 and 1971 estimates of yearclass strength predicted the 1975 run of American shad quite well, whereas river herring landings and age composition in 1975 did not follow changes in yearclass strength between 1970 and 1971.

Juvenile alewife feeding energetics are presented in abstract form from a Ph.D. thesis supported by the project. Juvenile alewife had a positive electivity index for the larger zooplankton and a negative index for copepod nauplii. Mean maintenance efficiency was 52% in 1972 and 63% in 1973, while the remainder in each year was the net growth efficiency.

Winter survey data for the York, Rappahannock and Potomac rivers is presented for 1975, and 1972-75 for the James. Densities of white perch, channel catfish, spottail shiner and other river residents are compared between rivers. All rivers sampled differ substantially in density and relative rank of the principal species. Distribution of types and numbers within a river is presented based on catch per unit of effort.

Preface

This annual report covers the period October 1974 through September, 1975. It is the eighth report generated by the project, with 3-year completion reports prepared in 1970 and 1973. The project is continuing at VIMS and each year allows stronger conclusions to be made concerning trends in the basic population parameters studied.

The 1970-1973 completion report was widely distributed in Virginia, libraries at fishery science institutes, and throughout the National Marine Fisheries Service. The completion report analyzed data from the entire history of the project. In many cases the entire summarized data core for a particular segment were presented e.g. mortality rates and age composition of the run since 1966. Some jobs were presented in final analysis form, because they were made inactive after 1973. The history of the foreign fleet activities was presented with an analysis of their effect on the anadromous alosines.

This annual report has the specific purpose of reporting progress on the jobs and objectives of one additional year. Thus, many of the tables, figures, and conclusions are not repeated here. It is difficult to make conclusions or propose directions of effort without such background, however, so where necessary, some past data are presented. Overall, the 212-page completion report is the main reference document, and this annual report has been designed and written for brevity.

In 1976 we will draw together the last 3 years of data, combine them with the 1970 and 1973 documents, and again present full analysis and the summarized data bank.

The following jobs and objectives were proposed for our 1974-1975 contract period.

Job 1. Catch-Per-Unit-of-Effort

- Objective 1. To measure fishing effort and estimate landings of adult Alosa spp.
2. To detect changes in the stock, and economics of the river fishery by comparison with former years.

Job 2. Population Dynamics of Adults

- Objective. To determine mortality rates, age specific sizes, times of spawning, and ratios of abundance for adult alewife, blueback herring, and American shad.

Job 3. Annual Index of Juvenile Abundance

Objective. To determine annually an index of abundance for each species of juvenile Alosa spp. in the four major spawning areas (James, York, Rappahannock and Potomac rivers) in Virginia.

Job 4. Feeding Energetics of Juvenile Alewife

Objective 1. To determine food selectivity and feeding periodicity of juvenile alewife in the nursery zone of the James River.
2. To derive a seasonal energy budget by integration of ingestion, egestion, respiration, and growth rates.

Job 5. Culture, Rearing and Experimental Study of River Herring

This job was not contracted for by NMFS for the 1974-75 contract year.

Job 6. River Herring Population Estimates, Movements, and Resource Utilization Through a Tagging Program

This job was not contracted for by NMFS for the 1974-75 contract year.

Job 7. Resident Fishes of the Nursery Zone

Objective 1. To determine biomass indices of the nonmigratory fish component of the freshwater nursery zones of the major rivers during midwinter.
2. To derive quantitative estimates of overwintering populations of juvenile alosids.

Job 8. Shallow Water Population Indices (Pilot Program)

This job was not contracted for by NMFS for the 1974-75 contract year.

Job 1 was written by W. Kriete; Jobs 2 and 3 by W. Hoagman; Job 4 by J. Weaver; and Job 7 by W. Hoagman and W. Kriete. Cover design by W. Hoagman. A full list of project personnel follows. The report was critically reviewed by Drs. W. J. Davis and J. V. Merriner.

The National Marine Fisheries Service (NMFS) and the Commonwealth of Virginia through the Virginia Institute of Marine Science (VIMS) sponsor this project. Many other agencies and commissions receive and utilize the results. Our cover indicates some of these users. The abbreviations used on the cover are as follows:

- CRC - Chesapeake Research Consortium
- ASMFC - Atlantic States Marine Fisheries Commission
- DOC - Department of Commerce
- VMRC - Virginia Marine Resources Commission
- EPA - Environmental Protection Agency
- GIF - Game and Inland Fisheries - Virginia
- W&M - College of William and Mary
- PRFC - Potomac River Fishery Commission
- LOS - Law of the Sea, Conference of
- BLM - Bureau of Land Management
- CPCMD - Coastal Plains Center for Marine Development
- SFW - Bureau of Sport Fisheries and Wildlife
- NOAA - National Oceanic and Atmospheric Administration
- ICNAF - International Commission for Northwest Atlantic Fisheries

Project Personnel
October 1, 1974 - September 30, 1975

<u>Name</u>	<u>Position</u>	<u>Percent Assignment</u>	<u>Service</u>
Hoagman, W. J., Ph.D.	Prin. Invest.	75%	Four Years (a)
Merriner, J. V., Ph.D.	Co-Invest.	25%	Five Years
Davis, W. J., Ph.D.	Asst. Dir.	5%	Eight Years (b)
Kriete, W. H., Jr., B.S.	Research Asst.	50%	Two Years
Wilson, W. L.	Lab. Spec.	100%	Eight Years- (Resigned 8/15/75)
Bristow, J. A.	Lab. Tech.	100%	Eight Years
Estes, A. D.	Lab. Tech.	100%	Three Years- (Resigned 3/30/75)
Davis, J. S.	Lab. Tech.	100%	Two Years
Owens, J. C.	Lab. Tech.	100%	Two Years
DeBolt, L. L.	Clk-Typ. B	25%	14 Months- (Resigned 11/30/74)
Emerson, V. S.	Clk-Typ. B	25%	Three Months- (Resigned 4/30/75)
Sprinkle, D. B.	Clk-Typ. B	25%	Five Months
Weaver, J. E.	Grad. Student	50%	Five Years
Cooke, A. C.	"	50%	Two Years
Byrne, D. M.	"	50%	One Year
Colvocoresses, J. A.	"	50%	Five Months
Ross, J.	"	50%	One Month
Foell, E. J.	"	50%	One Month
Hedgepeth, M. Y.	Tech. (Temp.)	100%	Two Months
Tinsley, M.	"	100%	Two Months
Weishar	"	100%	Two Months
Martin, J.	Summer Aide	100%	(Approx.) 10 Weeks
Heil, N. P.	"	100%	"
Tinsley, M.	"	100%	"
Reidyk, R.	"	100%	"
Watkins, D.	"	100%	"
Zeigler, M.	"	100%	"

(a) On leave of absence with United Nations, December 17, 1974 to August 18, 1975

(b) Principal Investigator until 1972

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Job 1. Catch-per-unit-of-effort

Summary for Job 1

1. American shad, alewife, blueback herring, and hickory shad landings in the James, York, and Rappahannock rivers were determined by expansion of records from cooperating fishermen and total counts of pound nets and stake gill nets. For all rivers except the Potomac, miles 0-10 were excluded.
2. Fishing effort by stake gill nets was redefined as catch per linear foot of net, rather than catch per stand as in former years.
3. Pound net fishing effort in Virginia fell slightly in 1975, whereas stake gill net effort increased 12% over 1974.
4. American shad landings were lower in 1975 than 1974 for the James, York and Rappahannock rivers. Potomac landings increased by 49%.
5. Alewife landings decreased by 75% in the Rappahannock and increased by 29% in the Potomac River from 1974 to 1975.
6. Blueback herring landings increased by 36% in the Rappahannock and 62% in the Potomac from 1974 to 1975.
7. The peak of the American shad spawning run was the second half of March through 15 April for the James, York, and Rappahannock rivers. Peak landings for Potomac River American shad occurred late April through 15 May.
8. From April 8 to June 24, 1975, the number of active pound nets counted by overflights ranged from 167 to 218.
9. The James River had 148 active stake gill net stands in 1975, followed by 146 in the York River and 121 in the Rappahannock.
10. Total landings of alewife, blueback, and American shad combined, from the James, York, Rappahannock and Potomac were 7.1 million lb. in 1975 compared to 6.4 million lb. in 1974. All rivers decreased in total combined landings except the Potomac which had high blueback catches.

Methods

Adult alosine fishes enter the Chesapeake Bay and tributaries in the spring of each year on their annual spawning run. This migration begins in winter (February or even as early as January) and continues until late spring (May or early June). During the spawning migration they encounter a gamut of commercial and sport fishing gear. Pound nets, stake gill nets, fyke nets, and haul seines represent the major gears used in the commercial fishery, but are not the only gears that take spawning adults. Dip nets and even sport fishermen take quantities of spawning adults in medium to small fresh-water streams, but we have not assessed the landings by these fishing methods.

Job 1 contains results of catch estimates for the three major rivers in Virginia by stake gill nets and pound nets (the latter limited to the Rappahannock River). Estimates apply only to landings above mile 10 in each river.

The Potomac River figures were supplied by the Potomac River Fisheries Commission and reflect actual catch.

The method for determining catch-per-unit-of-effort (c/f) was changed slightly from previous years. Pound net and gill net data for 1975 are presented both ways for comparison.

Pound nets - The method for determining the estimated catch of pound nets in 1975 divides the Rappahannock River into two sections; lower river (miles 10-30) containing pound nets with approximately 600 ft. leads (hedging) and upper river (miles 31-55) containing pound nets with 200-250 ft. leads.

The number of active pound nets is determined by aerial counts. Log books are placed with cooperating commercial fishermen to obtain daily catch records. The number of pounds of any given species, and/or sex caught by cooperating fishermen in a half month period divided by the number of pound nets operated by that fisherman yields the index catch figure for a pound net. This index is then multiplied by the number of active nets in that section of the river. The formula is:

$$\frac{\text{Number of pounds caught by index nets for half month}}{\text{Number of index nets}} \times \text{Number of nets in section of river} = \text{Total estimated pounds in section of river.}$$

This procedure, summed across sections, gives the total estimated pounds of male and female American shad, hickory shad and river herring (alewife and blueback) landed by pound nets.

Stake gill nets - The 1975 stake gill net catch estimates were based on index lbs./linear ft. rather than lbs./stand. The procedure begins by counting the number of stands and the number of sections per stand per five mile block of river during the peak of the spawning run (15 Mar.-15 Apr.) (Table 1.2).

From these counts the average number of sections was established by dividing the number of sections by the number of stands in a 5-mile block of the river.

Log books collected from cooperating fishermen were used to establish an index value (pounds per linear foot of gill net). The index was determined by dividing the total pounds caught by the index fisherman, by the number of feet of gill net fished. The method to obtain the total pounds of male and female American shad (or hickory shad) for each 5-mile block per half month period was:

$$\frac{\text{Pounds caught by index nets for half month period}}{\text{Linear feet of gill net operated by index fisherman}} = \text{index pounds per linear ft.}$$

Number of stands X average sections per stand X average length per section X index pounds per linear foot = estimated total pounds. The total pounds for the river is obtained by adding the totals for all five mile blocks.

General Results

Pound nets continued to decline in 1975 although the decline was very slight (1.3%). Many areas did show an increase even though overall effort was down. Aerial counts of pound nets taken semi-monthly (Table 1.1), showed an increase in the Potomac River and from Windmill Point to Smith Point.

Pound net catch estimates in the Rappahannock River exhibited a decrease of American shad (75%) and river herring (13%) relative to 1974. The Potomac River had a 47% decrease in American shad landings but an increase of 34% in the yield of river herring from pound nets.

Stake gill net stands increased 12% from the 1974 season with the greatest increase appearing in the Rappahannock (30%) (Table 1.2). Catch estimates reflect a sharp decrease in weight of American shad landed in the James and York rivers and a sharp increase in the Potomac River. The Rappahannock River had only a slight rise in weight of American shad caught, based on figures computed using the 1974 method (see below).

James River

Pound nets were absent from the James River fishery in 1975, thus indices are not available.

Stake gill nets yielded an estimated 653,847 lb. of American shad from 16 February through 15 May (catch estimates compiled the "old way" equalled 728,833 lb).

The peak of the spawning run was the latter half of March through the first half of April. This period yielded 77% of the American shad of the James River (Table 1.3). Males represented only 23% of the landings of shad, which may reflect the practice of discarding the males at the net. This practice is due to the low market value after the first few weeks of the shad fishing season. The quantity of males discarded is unknown.

The greatest concentration of gill net stands was between river miles 15-20, containing an estimated 35,640 linear feet of gill net or 42% of all nets above mile 10. Effort was up 16% from 1974 yet catch was down 47%.

Included in this year's estimates are the catches by 6000 feet of anchor gill net. The catch of these nets was recorded by index fishermen in addition to their stake gill net catches. The anchor gill net catches were used in Table 1.4 by converting to equivalent stake gill net stands.

York River

Pound nets were not fished above mile 10 in 1975 thus catch indices could not be computed for the York River.

Stake gill nets in the York River exhibited a decrease in estimated pounds landed although the decrease was not as pronounced as in the James River. The estimated landings of 246,036 lb. of American shad and 3243 lb. of hickory shad (Table 1.5) were harvested in a 10 week period beginning the second half of February. Females represented 89% of the American shad landed during the fishing season, with 71% of this total being taken from 15 March to 15 April. As in the James, the male American shad estimate may reflect the practice of discarding males at the net. Landings in the second half of March represented 55% of the total landing of males and only 8% of the male shad landings were taken in the first half of April. This indicates males were not landed in proportion to the actual weight caught.

There seems to be a growing practice by York River gill netters, of selling the roe locally and either discarding the remains at the net or selling it as scrap to dealers. At present it is estimated that 50% of the fishermen engage in this practice intermittently (Table 1.5).

Hickory shad estimates exhibited an 83% decrease from the 1974 catch and 56% of the landings were taken between 1 April - 15 April. Hickory shad are not separated by sex when they are sold by fishermen or dealers.

Stake gill net stands were evenly distributed over a 19 mile section of the river (miles 10-29) for an average of 7.7 stands per mile. This was the highest average density in all the rivers and is a 5% increase over 1974.

The 1975 data from the York River were also analyzed by the 1974 method for comparison (Table 1.6).

Rappahannock River

The number of active pound nets in the Rappahannock remained unchanged from 1974. These nets yielded an estimated 9,222 lb. of American shad, 159,263 lb. of alewife and 379,078 lb. of blueback. This represents a 75% reduction in yield for American shad from 1974 and a 6% reduction from 1973 (see revised data, Table 1.7). The 1975 yield of river herring declined 13% from 1974 and 38% from 1973 (Table 1.7). The yield of alewife was down 40% from 1974 and 52% from 1973. Blueback were up 7% from 1974 and down 29% from 1973 (Table 1.7). Although there were fewer nets in the lower river, 86% of the river herring harvested in the Rappahannock were from mile 10-30.

Stake gill nets harvested an estimated 61,832 lb. of American shad and 3,052 lb. of hickory shad in 1975, a decrease from 1974 for both species (Table 1.8). If the 1975 data are computed by the 1974 method, there was an increase of 8% for American shad and a decrease of 84% for hickory shad from 1974 (Table 1.9).

The low total estimated poundage for American shad is also reflected in the c/f for the 1975 season (catch as pounds per linear feet) of only 0.65 compared to 7.72 in 1974 for the James River and 3.40 for the York River.

The peak of the spawning run of American shad was 15 March to 15 April. This period yielded 73% of the female and 78% of the male poundage based on gill net data.

Potomac River

Data supplied by the Potomac River Fisheries Commission are the total reported yield of the river. However, data from nets between river mile 00 and 10 are included; thus the data include some fish that might not have spawned in the Potomac River (percentage unknown).

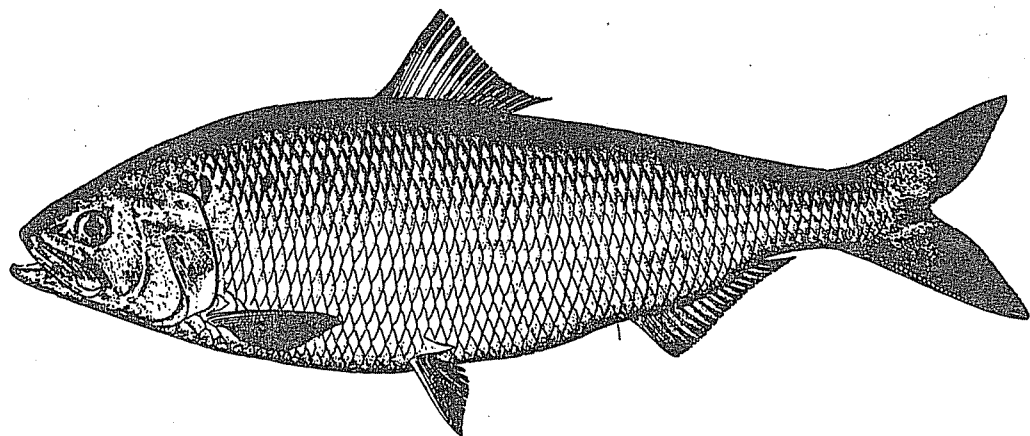
Pound nets harvested 9,762 lb. of American shad and 5,359,495 lb. of river herring. American shad landings declined 47% while the yield of river herring increased 34% with a 20% increase in effort over that of 1974. River

herring gains came mainly from increased yield of blueback (36%). The peak of the female American shad spawning run did not occur until May, much later than in other rivers studied. The males peaked in April, not much later than the Rappahannock peak. Alewife and blueback catches peaked in May but did not represent peak spawning because the Potomac River fishery for river herring is not active until late April and through May.

Stake gill nets yielded 108,483 lb. of American shad and 254 lb. of hickory shad. This was a 44% increase over 1974 yield for American shad and represents females entirely (Table 1.10).

The spawning run peak (from gill net data) was in April for both male and female American shad. Pound net landings were highest in May for males but female landings peaked in April. This difference of apparent peaks is due to putting pound nets in operation later than gill nets. Gill nets were all operational by the first of March but pound net effort did not peak until late May.

Although the yield of hickory shad increased 77% in 1975, the 254 pounds landed can only be considered as incidental to the American shad catch (Table 1.10).



American shad, Alosa sapidissima, adult

Table 1.1 Number of active pound net stands in Chesapeake Bay and its Virginia tributaries during Spring 1975

Area	February		March		April		May		June	
	21	5	21	8	23	9	21	3	24	
James River	0	0	0	0	0	0	0	0	0	0
York River	4	4	4	7	8	7	7	7	7	7
York Spit	0	0	0	0	1	1	1	2	2	2
Rappahannock	7	34	48	55	60	62	47	40	25	25
Potomac R.	1	3	9	24	30	41	45	43	30	30
Cape Henry- Willoughby Pt.	2	2	2	4	4	4	5	4	4	4
Old Point- Tue Marsh Pt.	1	7	8	10	8	9	10	9	3	3
Back River	1	3	3	7	4	5	5	5	5	5
Poquoson R.	1	1	1	1	1	1	1	0	0	0
Mobjack Bay	1	2	2	5	8	11	9	8	11	11
New Point- Stingray Pt.	1	6	4	11	14	16	19	20	17	17
Piankatank R.	0	0	0	-	-	4	4	4	4	4
Windmill Point- Smith Point	2	5	23	24	29	30	35	44	38	38
Great Wicomico R.	0	0	3	3	4	7	3	3	3	3
Eastern Shore-N.- Hungar Creek	0	0	0	0	0	0	0	0	0	0
Eastern Shore-S.- Hungar Creek	<u>7</u>	<u>7</u>	<u>7</u>	<u>11</u>	<u>19</u>	<u>25</u>	<u>27</u>	<u>27</u>	<u>18</u>	<u>18</u>
Total	28	74	114	162	190	223	218	216	167	167

Table 1.2 Number of stake gill net stands fished in Virginia rivers 1973-1975. (A) and average number of linear feet per five mile block (B) in 1975.

A. River System		Number of Gill Net Stands		
		1973	1974	1975
James		115	128	148
York		130	139	146
Rappahannock		100	85	121

B. River	Mile	Number of Stands	Average Sections/ Stand	Average Length/ Section	Total Feet
James	10-15	24 ^(a)	27		
	15-20	66	18	30	19,440
	20-25	30	17	30	35,640
	25-30	3	25	30	15,300
	30-35	19	18	30	2,250
	35-40	5	11	30	10,260
				30	1,650
	50-55	1	7		
Totals		<u>148</u>		30	<u>210</u> 84,750
York	10-15	39	20		
	15-20	41	18	30	23,400
	20-25	32	16	30	22,140
	25-39	34	18	30	15,360
	Totals		<u>146</u>		19
Rappahan- nock	20-25	6	19		
	25-30	28	19	50	5,700
	30-35	23	18	50	26,600
	35-40	21	25	50	20,700
	40-45	15	21	38	19,950
	45-50	14	12	38	11,970
	50-55	7	7	38	6,384
	55-60	6	10	38	1,862
	60-65	1	3	30	1,800
	Totals		<u>121</u>		30

(a) Includes 6000 feet of anchor gill net converted to equivalent gill net stands.

Table 1.3 Estimated catch of American shad by stake gill nets above mile 10 for 5 mile section in the James River 1975 in lbs., by half-month intervals and by sex. Effort from Table 1.2 (linear ft) X index = lbs/ft of net.

Half Month Period	River Mile	Male Index (lbs/Ft. of Net)	Male Estimated Catch	Female Index Lbs/Ft. of Net)	Female Estimated Catch	Total Estimated Catch
Feb. 2nd	10-15	.029	564	.016	311	875
	15-20		1034		470	1504
	20-25		444		245	689
	25-30		62		36	98
	30-35		298		164	462
	35-40		48		26	74
	50-55		6		3	9
Total			2456		1255	3711
Mar. 1st	10-15	.257	4996	.129	2508	7504
	15-20		9159		4598	13757
	20-25		3932		1974	5906
	25-30		578		290	868
	30-35		2637		1324	3961
	35-40		424		213	637
	50-55		54		27	81
Total			21780		10934	32714
Mar. 2nd	10-15	.950	18468	2.46	47822	66290
	15-20		33858		87674	121,532
	20-25		14535		37638	52173
	25-30		2138		5535	7673
	30-35		9747		25240	34987
	35-40		1568		4059	5627
	50-55		200		517	717
Total			80514		208,485	288,999

Table 1.3 (continued)

Half Month Period	River Mile	Male Index (Lbs/Ft. of Net)	Male Estimated Catch	Female Index (Lbs/Ft. of Net)	Female Estimated Catch	Total Estimated Catch
Apr. 1st	10-15	[.409]	7951	[2.11]	41018	48969
	15-20		14577		75200	89777
	20-25		6258		32283	38541
	25-30		920		4748	5668
	30-35		4196		21649	25845
	35-40		675		3482	4157
	50-55		86		443	529
Total		34663	178,823	213,486		
Apr. 2nd	10-15	[.146]	2838	[1.20]	23328	26166
	15-20		5203		42768	47971
	20-25		2234		18360	20594
	25-30		329		2700	3029
	30-35		1498		12312	13810
	35-40		241		1980	2221
	50-55		31		252	283
Total		12374	101,700	114,074		
May 1st	10-15	[.009]		[]	175	175
	15-20				321	321
	20-25				138	138
	25-30				20	20
	30-35				92	92
	35-40				15	15
50-55		2	2			
Total			763	763		
Total by Sex			151,787	501,960		
Grand Total					653,747	

(a) Includes 6000 feet of anchor gill net

Table 1.4 Estimated catch of American shad by stake gill nets above mile 10 in the James River 1975 using the 1974 method, by half-month intervals (in lb.).

Half Month Period	Number Stands	Index	Male		Female		Total Stands	Total Pounds	
			Total Pounds Index Nets	Pounds/ Index Net	Total Pounds Index Nets	Pounds/ Index Net		Male	Female
Feb. 2nd	43 ^(a)		800	18.6	450	10.5	148	2753	1554
Mar. 1st			7050	163.9	3550	82.6		24257	12225
Mar. 2nd			26076	606.4	67550	1570.9		89747	232493
Apr. 1st			11211	260.7	57965	1348.0		38584	199504
Apr. 2nd			4000	93.0	32850	763.9		13764	113057
May 1st			-	-	260	6.05			
							Total by Sex	169105	559728
							Grand Total	728,833	

(a) Includes 6000 feet of anchor gill nets converted to equivalent stake gill net stands

Table 1.5. Estimated catch of American and hickory shad by stake gill nets above mile 10 in the York River, in lb., by half-month intervals. Effort from Table 1.2 (linear ft) X index = lbs/ft of net.

Half Month Period	River Mile	Male Index (Lbs/Ft. of Net)	Male Estimated Catch	Female Index (Lbs/Ft. of Net)	Female Estimated Catch	Total Estimated Catch
<u>American Shad -</u>						
Feb. 2nd	10-15	.0280	644	.0405	948	1592
	15-20		620		897	1517
	20-25		430		622	1052
	25-29		326		471	797
Total		2020		2938	4958	
Mar. 1st	10-15	.0976	2284	.2560	5990	8274
	15-20		2161		5668	7829
	20-25		1499		3932	5431
	25-29		1135		2977	4112
Total		7079		18567	25646	
Mar. 2nd	10-15	.2024	4736	1.006	23540	28276
	15-20		4481		22273	26754
	20-25		3109		15452	18561
	25-29		2354		11698	14052
Total		14680		72963	87643	
Apr. 1st	10-15	.0292	683	1.151	26933	27616
	15-20		646		25483	26129
	20-25		449		17679	18128
	25-29		340		13384	13724
Total		2118		83479	85597	

Table 1.5. (continued)

Half Month Period	River Mile	Male Index (Lbs/Ft. of Net)	Male Estimated Catch	Female Index (Lbs/Ft. of Net)	Female Estimated Catch	Total Estimated Catch
Apr. 2nd	10-15	.0089	208	.2875	6728	6936
	15-20		197		6365	6562
	20-25		137		4416	4553
	25-29		103		3343	3446
Total			<u>645</u>		<u>20852</u>	<u>21497</u>
Seasonal Total			<u>26542</u>		<u>198,799</u>	

Fish cut - Roe saved, fish discarded at net
 $\frac{72528 \text{ total ft. of net}}{2} \times .5952 \text{ index lbs.} =$

21584

26542

220,383

246,936

Table 1.5. (continued)

Hickory Shad -

	River Mile	Number Feet	Index Lb./Ft Male & Female Combined	Total
Mar. 1st	10-15	23,400	[.0018]	42
	15-20	22,140		40
	20-25	15,360		28
	25-29	11,628		21
				<u>131</u>
Mar. 2nd	10-15	23,400	[.0137]	321
	15-20	22,140		303
	20-25	15,360		210
	25-29	11,628		159
				<u>993</u>
Apr. 1st	10-15	23,400	[.025]	585
	15-20	22,140		554
	20-25	15,360		384
	25-29	11,628		291
				<u>1814</u>
Apr. 2nd	10-15	23,400	[.0042]	98
	15-20	22,140		93
	20-25	15,360		65
	25-29	11,628		49
				<u>305</u>
Total				3243

Table 1.6 Estimated catch of American and hickory shad by half-month intervals in lb. by stake gill nets in the York River 1975 using the 1974 method. Nets above mile 10 not included.

York	Number of Index Stands	Total Pounds Index Stands		Pounds/Index Stand		Total Stands For River	Total Pounds For River	
		Male	Total	Female	Total		Male	Female
<u>A. American shad</u>								
Feb. 2nd	[6]	47	7.83	68	11.33	[146]	1143	1654
Mar. 1st		164	27.33	430	71.67		3990	10464
Mar. 2nd		340	56.67	1690	281.67		8274	41124
Apr. 1st		49	8.17	1934	322.33		1193	47061
Apr. 2nd		15	2.5	483	80.5		365	11753
Total by Sex							14965	112056
Total							127,021	
Grand Total = 127,021+12,169 = 139,190 ^a								
<u>B. Hickory Shad</u>								
Mar. 1st	[6]		3		.5	[146]		73
Mar. 2nd			23		3.833			560
Apr. 1st			42		7.0			1022
Apr. 2nd			7		1.167			170
Total								1825

^aIncludes Cut Fish - Roe saved, fish discarded at net

<u>Number of Index Stands</u>	<u>Pounds/ Index Stand</u>	<u>Total</u>	<u>Total Stands For River</u>	<u>Total Pounds For River</u>
6	1000	166.7	73	12169
Grand Totals by Sex			Male - 14,965	Female - 124,225

Table 1.7 Estimated catch of American shad and river herring by pound nets in the Rappahannock River 1975 in lb., by half-month intervals. Nets below mile 10 not included.

Half Month Period	Mile	Number Nets	American Shad				River Herring				Total Number Days Index Nets Hauled	Number of Index Nets		
			Female		Male		Alewife		Blueback					
			Index	Estimated Total	Index	Estimated Total	Index	Estimated Total Percent ^a	Estimated Total Percent	Estimated Total				
Feb. 2nd	10-30	4	-	-	-	-	-	-	-	-	-	0		
	31-55	3	53.3	160	1.67	5	93.33	280	100.0 ^c	280	-	-	3	3
Mar. 1st	10-30	10	-	-	-	-	600.0	6000	99.5	5970	.5	30	2	4
	31-55	15	14.75	221	10.0	150	136.25	2044	99.5 ^c	2034	.5 ^c	10	5	4
Mar. 2nd	10-30	16	25.0	400	25.0	400	2665.5	42648	73.2	31218	26.8	11430	7	4
	31-55	19	8.5	162	18.0	342	75.0	1425	97.0	1382	3.0	43	5	4
Apr. 1st	10-30	17	93.0	1581	6.25	106	4873.75	82854	26.2	21708	73.8	61146	6	4
	31-55	20	31.0	620	22.75	455	663.75	13275	50.5	6704	49.5	6571	8	4
Apr. 2nd	10-30	18	12.5	225	-	-	14506.25	261,113	19.0	49611	81.0	211,501	11	4
	31-66	20	12.75	255	19.2	385	1471.25	29425	38.4	11299	61.6	18126	10	4
May 1st	10-30	18	2.25	41	2.25	221	3918.75	70538	29.5	20809	70.5	49729	9	4
	31-55	20	12.5	250	34.25	685	1437.5	28750	28.7	8251	71.3	20499	10	4
May 2nd	10-30	15	2.25	34									12	4
	31-55	12			2.0	24							1	4
Total				3949		2773		538,342		159,266		379,085		

Shad retailed at dock during March, April and May

Mile	Number Nets	Index	Total
10-30 ^b	10	250.0	2500
			6722
Grand Total			9222

Table 1.7. (continued)

1974 Rappahannock Pound Net													
Date	Number Nets	American Shad				River Herring				Total Number			
		Females		Male		Catch Index Nets	Estimated Catch	Alewife		Blueback		Days Nets Hauled	Index Number of Nets
		Catch Index Nets	Estimated Catch	Catch Index Nets	Estimated Catch			Percent Estimated	Total	Percent Estimated	Total		
Feb. 2nd	11	8.3	91	4.8	52	95.3	1049	100.0 ^C	1049	-	-	6	6
Mar. 1st	23	66.8	1537	239.5	5509	741.7	17059	94.6 ^C	16138	5.4 ^C	921	17	6
Mar. 2nd	37	73.3	2713	163.8	6062	3950.0	146,150	94.6	138,258	5.4 ^C	7892	8	6
Apr. 1st	40	48.8	1953	131.7	5268	1300.0	52000	69.4 ^C	36088	30.6 ^C	15912	11	6
Apr. 2nd	40	53.3	2133	213.7	8547	691.7	27667	42.3	11703	57.7	15964	10	6
May 1st	36	35.3	1272	45.5	1638	852.5	306,900	16.7	51252	83.3	255,648	11	6
May 2nd	16	22.2	355	-	-	4166.7	66667	18.2	12133	81.8	54534	12	6
		10054		27309		617,492		266,721		350,781			
37363													

Table 1.7. (continued)

1973 Rappahannock Pound Net		American Shad				River Herring						Total Days Index Not Hauled	Number of Index Nets
		Female		Male		Alewife		Blueback					
Half Month Period	Number Nets	Catch Index Nets	Estimated Catch	Index Nets	Estimated Catch	Catch Index Nets	Estimated Catch	Percent	Estimated Total Catch	Percent	Estimated Total Catch		
Feb. 2nd	5	-	-	-	-	12.3	62	100	62	-	-	2	6
Mar. 1st	21	7.8	164	40.7	855	6824.2	143,308	100	143,308	-	-	13	6
Mar. 2nd	34	15.8	437	66.8	2271	1195.3	40,641	92.5	37,593	7.5	3,048	14	6
Apr. 1st	36	75.5	2,718	30.5	1098	4324.7	155,688	52.2	81,269	47.8	74,419	16	6
Apr. 2nd	37	27.3	1,010	23.7	877	11317.8	418,759	7.8	32,663	92.2	386,096	16	6
May 1st	36	-	-	-	-	1974.2	71,071	34.1	24,235	65.9	46,835	4	6
May 2nd	27	6.5	175	5.3	143	1197.5	32,332	34.1	11,025	65.9	21,307	10	7
		4604		5244		861,861		330,155		531,706			
		9848											

- (a) Percentage figures derived from commercial samples.
- (b) Figures are unavailable for fish retained at the dock between miles 31-55.
- (c) Estimated percent

Table 1.8 Estimated catch of American and hickory shad by stake gill nets above mile 10 in the Rappahannock River 1975, in lb., by half-month intervals. Effort from Table 1.2 (linear ft) X index = lbs/ft. of net.

Rappahannock American Shad	Mile	Index Pounds/Feet Male	Total	Female	Total	Combined Total		
Feb. 2nd	20-25	[]	27	[]	47	74		
	25-30		128		218	346		
	30-35		99		170	269		
	35-40		96		164	260		
	40-45		.0048		57	.0082	98	155
	45-50		31		52	83		
	50-55		9		15	24		
	55-60		9		15	24		
	60-65		43		74	117		
Total			<u>499</u>		<u>853</u>	<u>1352</u>		
Mar. 1st	20-25	[]	55	[]	74	129		
	25-30		258		343	601		
	30-35		201		267	468		
	35-40		193		257	450		
	40-45		.0097		116	.0129	154	270
	45-50		62		82	144		
	50-55		18		24	42		
	55-60		17		23	40		
	60-65		87		1	88		
Total			<u>1007</u>		<u>1225</u>	<u>2232</u>		
Mar. 2nd	20-25	[]	296	[]	1371	1667		
	25-30		1381		6397	7778		
	30-35		1074		4978	6052		
	35-40		1035		4798	5833		
	40-45		.0519		621	.2405	2879	3500
	45-50		331		1535	1866		
	50-55		97		448	545		
	55-60		93		433	526		
	60-65		5		22	27		
Total			<u>4933</u>		<u>22861</u>	<u>27794</u>		

Table 1.8. (continued)

American Shad

Rappahannock American Shad	Mile	Index Male	Pounds/Feet Total	Female	Total	Combined Total
Apr. 1st	20-25	.0176	100	.1711	975	1075
	25-30		468		4551	5019
	30-35		364		3542	3906
	35-40		351		3413	3764
	40-45		211		2048	2259
	45-50		112		1092	1204
	50-55		33		319	352
	55-60		32		308	340
	60-65		2		15	17
Total			1673		16263	16936
Apr. 2nd	20-25	.0046	26	.1292	736	762
	25-30		122		3437	3559
	30-35		95		2675	2770
	35-40		92		2578	2670
	40-45		55		1547	1602
	45-50		29		825	854
	50-55		9		241	250
	55-60		8		233	241
	60-65		41		12	53
Total			477		12284	12761
Sub Total			8589		53486	
Grand Total				62075		

Table 1.8. (continued)

Hickory Shad

Mile	Index 2nd Mar.	Total 2nd Mar.	Index 1st Apr.	Total 1st Apr.	Index 2nd Apr.	Total 2nd Apr.
20-25	[]	23	[]	105	[]	54
25-30	[]	109	[]	489	[]	253
30-35	[]	85	[]	381	[]	197
35-40	[]	82	[]	367	[]	190
40-45	.0041	49	.0184	220	.0095	114
45-50	[]	26	[]	117	[]	61
50-55	[]	8	[]	34	[]	18
55-60	[]	7	[]	33	[]	17
60-65	[]	37	[]	2	[]	86
		<u>389</u>		<u>1748</u>		<u>905</u>

Grand Total 3052

Table 1.9 Estimated catch of American and hickory shad by stake nets above mile 10 in the Rappahannock River 1975, in lb., by half-month intervals. Computed with the 1974 method.

American Shad	Number Index Stands	Total Pounds		Pounds/Index Stand		Total Stands For River	Total Pounds For River	
		Index Male	Stand Total	Female	Total		Male	Female
Feb. 2nd	[14]	60	4.29	104	7.43	[121]	519	899
Mar. 1st		122	8.71	162	11.57		1054	1400
Mar. 2nd		654	46.71	3030	216.43		5652	26188
Apr. 1st		222	15.86	2156	154		1919	18684
Apr. 2nd		58	4.14	1628	116.28		501	14071
Total							9645	61192
70837								
Hickory Shad	Index Stands	Total Pounds/ Index Stand		Average Pounds/ Index Stand		Total Stands	Total Pounds For River	
Mar. 2nd	[14]	52		3.71		[121]	449	
Apr. 1st		232		16.57			2005	
Apr. 2nd		120		8.57			1037	
Total							3491	

Table 1.10 Total catch of American shad, hickory shad, and river herring by stake gill nets and pound nets in the Potomac River 1975 in **lb.**

A. Stake Gill Nets

<u>Months</u>	<u>American Shad</u>		<u>Hickory Shad</u>
	<u>Female</u>	<u>Male</u>	
January	0	230	0
February	275	135	0
March	6,061	3,425	13
April	77,058	14,255	211
May	6,787	257	30
Total	<u>90,181</u>	<u>18,302</u>	<u>254</u>
Grand Total	<u>108,483</u>		<u>254</u>

B. Pound Nets

<u>Months</u>	<u>American Shad</u>		<u>River Herring</u>	
	<u>Female</u>	<u>Male</u>	<u>Alewife</u>	<u>Blueback</u>
January	0	0	10	0
February	0	0	111	0
March	89	161	18,421	688
April	1,174	438	182,588	408,311
May	936	6,374	579,436	3,389,306
June	4	586	62,450	718,174
Total	<u>2,203</u>	<u>7,559</u>	<u>843,016</u>	<u>4,516,479</u>
Grand Total	<u>9,762</u>		<u>5,359,495</u>	

Job 2. Population Dynamics of Adults

Summary for Job 2.

1. Samples of the commercial catch of alosines in Virginia were taken by project personnel during the spring spawning run. Scales and basic measurements were taken from over 7 thousand fish.
2. Age four alewife and blueback (virgin adults) made up 68.2 to 82.6% of the ages in the spawning run.
3. A ten year summary of river herring age composition data has shown a dramatic change to extreme dominance by four and five year olds over the period 1966 to 1975.
4. Age four American shad made up 24.3 to 39.1% of the spawning run of shad in various rivers.
5. Alewife and blueback had a stronger yearclass in 1970 than 1971, yet the age four fish in 1974 and 1975 did not indicate there was any difference between the yearclasses. The expected recruitment pulse was not evident in 1974 and could not be followed with age composition data in 1975.
6. American shad also had a stronger yearclass in 1970 than 1971, and this produced age four fish in 1974 which continued through the fishery and depressed the relative contribution of age fours in 1975.
7. River herring samples from the Potomac had nearly the same average lengths in 1975 as 1974, but their weight has not recovered to 1966-68 or 1971-73 levels.
8. The foreign fleets took 20% of the 1974 river herring catch in ICNAF area 6, down 4% from 1973.
9. The strong 1975 blueback yearclass may or may not be recruited in 1979 proportional to original numbers due to offshore fishing mortality between 1977 and 1979.
10. The domestic fishery for alewife and blueback has been declining since 1968 with little reduction in domestic fishing effort. The offshore fleets have expanded and taken a sizeable percentage of total landings. The population attributes we have been able to measure indicate the total impact of the combined inshore and offshore fishery has caused dramatic changes in age composition, reduction in landings, decreases in average fish weight and length, and interruption of recruitment of strong yearclasses.

1975 Spawning Run.

Adult alewife, blueback and American shad were sampled semi-monthly from February to June 1975. If available, at least 50 specimens from each species were selected for scale samples, length, and weight within each two week period. The specimens were sexed, blueback gonads saved for fecundity analysis, and the scales made into plastic impressions. Over the entire spawning season, 2,315 alewife, 4,268 blueback, and 918 shad were sampled.

Alewife began entering the major tributaries to Chesapeake Bay during the latter half of February. Blueback and American shad usually enter later, although some shad specimens were gathered in February. The timing and species sequence of the spawning migration in 1975 (Table 2.1) appeared normal but the run was longer than usual after April. Large numbers of all three species were available for sampling from the second half of March to late April. American shad adults were not available at the Potomac River sampling sites in 1975, despite 15 contacts with pound net fishermen at two sites where the river herring samples were collected.

The sex ratio of alewife approximated 1:1 in the Potomac, York, and Rappahannock but was 3:1 (males to females) in samples from the James River. The sex ratio of blueback was 1:1 from the Potomac but 1.8:1 in the James, 1.6:1 in the York, and 1.2:1 in the Rappahannock. The sex ratio cannot be computed for shad because the fishermen often discard males at the net. The sex ratio for alewife and blueback did not show any pronounced seasonal changes during the spawning season (Table 2.1) although males tended to dominate the earliest samples in some rivers.

Age Composition

Comparison of age composition between years can give information useful to understanding the population biology of fish that are available for sampling at limited periods. Under conditions of stable yearclass strength and recruitment, the percentage age composition of spawners in the domestic fishery will be stable if fishing effort remains stable. If any of the influences on age composition are measured, then reasons can be advanced for instability of other parameters. Also, if age composition remains stable but other data indicate it should not be, then unusual events may have altered the expected pattern.

The 1971 yearclass of alewife which returned as age fours in 1975, was much smaller (1/3) than the 1970 yearclass (see Job 3). One would expect the age four contribution to

the 1975 catch to be less than in 1974, as the stronger 1970 yearclass continues through the fishery. Age four alewife made up 69.7% of the 1975 York catch, 76.1% of the James, 80.7% of the Potomac, and 82.6% of the Rappahannock (Table 2.2). The same rivers had 71.2, 57.5, 86.5, and 60.9% as age four alewife in 1974. For all rivers combined, age four alewife made up 77.3% in 1975 and 69.0% in 1974 of fish samples from the Virginia fishery. The 1971 yearclass was only 37% the size of the 1970 yearclass, which should have produced age four percentages much lower than typical in 1975.

The 1975 blueback catch was composed of 81.4% age fours in the James, 68.2% from the York, 85.4% from the Rappahannock, and 85.4% from the Potomac (Table 2.2). The blueback age composition in 1974 had a lower percentage of age fours than in 1975 except in the Rappahannock. For all rivers combined, age four blueback made up 80.1% in 1975 and 66.6% in 1974 of fish taken in the domestic fishery. As with alewife, the 1970 yearclass of blueback was stronger (1.6 times) than 1971, but did not provide a pulse that could be followed beyond 1974. Alewife and blueback appear to have been subjected to unusual fishing pressures before recruitment to the domestic fishery.

The age composition of river herring in the domestic fishery has changed to a greater reliance on younger fish and fewer age groups over the period 1966 through 1975 (Table 2.3). From 1966 to 1968 age five and older alewife averaged 48.8% of the river landings, but only 28.0% were five or more from 1973-75. Blueback older than four averaged 59.4% of the catch 1966 to 1968 but only 38.6% from 1973-75 inclusive. This dramatic change in age composition seems to be a direct result of oceanic fishing mortality increasing steadily after 1968. In 1967 the foreign fleets took 4% of reported landings, 5% in 1968, and it increased to 44% by 1971 (Table 2.4).

American shad usually enter the river fishery at age four and survivors return in subsequent years. The James in 1974 had 56.9% age four shad and 17.3% age five. In 1975 age fours made up 24.3% and age fives 44.9%. The 1970 yearclass of shad in the James was larger (3.4 times) than the 1971 yearclass. The York River spawning run of shad contained 67.2% age fours in 1974 and 39.1% age fours in 1975. The 1970 yearclass was 1.5 times the size of the 1971 yearclass.

The 1975 shad run confirmed our expectations that the 1971 yearclass would yield fewer age four fish than the 1970 yearclass yielded in 1974. Yearclass strength fell 71% between 1970 and 1971 in the James and four years later landings fell 52% from 1974 to 1975. Yearclass strength fell

47% between 1970 and 1971 in the York and four years later landings fell 38% from 1974 to 1975. The relative change was not perfect (1:1) but factors such as abundance of other age groups in the landings, variations in the estimated landings, and variation of yearclass strength measurements all contribute to uncertainty. Each percentage change of one in yearclass strength produced a percentage change of 0.81 in landings four years later in the James, and 0.73 in the York; a remarkable similarity which, if quantified over more years, could have great usefulness to management.

After leaving the freshwater nursery in early fall the juveniles migrate to sea. Here river herring (alewife and blueback) are taken by the foreign fleets but shad are seldom taken. It is possible that because of this uneven fishing pressure, successful yearclasses of alewife and blueback would be taken at sea in numbers sufficient to upset the normal expectation that stronger yearclasses will provide more recruits to the domestic fishery than weaker yearclasses. Our analysis, though limited, indicates shad have followed theoretical population responses while river herring have not.

Length and Weight of Spawning Adults

Alewife and blueback samples from the Potomac and Rappahannock rivers did not change in average length throughout the spawning season (Table 2.5). Males and females of both species had near identical average lengths. Potomac alewife averaged 241.5 mm (sexes combined) and Rappahannock alewife 242.1 mm fork length. Potomac River blueback averaged 237.8 mm and Rappahannock River blueback 240.4 mm fork length. Female American shad were longer than males in the Rappahannock, usually by 30 to 50 mm.

Alewife and blueback from the Potomac averaged nearly the same length in 1975 as in 1974. In 1969 the average length of both species in the domestic fishery fell sharply (Figure 2.1). This was concurrent to the large landings taken by the foreign fleets in early 1969 in ICNAF area 6. Since 1969 the average length of both species has recovered to normal levels. This could indicate that the offshore fishery has reduced its take of these species relative to the domestic fishery and/or that the offshore fishery is now working on a thinned population which has the same basic population attributes (except fishing mortality) as prior to foreign fishing.

The average weight of alewife and blueback has not recovered to 1970-73 levels in the Potomac River (Fig. 2.2). Blueback in 1974 were the lightest ever sampled. Alewife were somewhat heavier than in 1974 but still near the 1969 low. Smaller river herring in the run indicates continuation

of heavy adult fishing pressure. The current domestic yield is made up of more fish per ton than several years ago, and this fact alone has greater stock consequences than previously. If the 1975 fish were "normal" in weight, the Virginia landings would have been approximately 10% higher with no increase in numbers.

If offshore fishing pressure on river herring were to decrease, we should witness an increase in length and weight because older members would make up a greater proportion of the available stock. Fishing mortality data are not available for the domestic or foreign fishery at this time; thus stock changes based on yield per recruit calculations must be postponed.

Landings of the Foreign Fleet in Area 6 of ICNAF

The foreign fleet began fishing off the shore of Virginia, Delaware, and North Carolina in 1967; but only the USSR, East Germany, Bulgaria, and Poland have taken appreciable quantities of river herring. These countries take other species far in excess of the river herring, but their take of river herring has been substantial compared to the river herring landings of the domestic fishery (Fig. 2.3).

Alewife and blueback herring are not separated in the catch of the foreign fleet or the domestic fishery. Thus all ICNAF landing statistics and all NMFS statistics report the two species under the general category of alewife.

Statistical area 6 of ICNAF includes all continental shelf waters from eastern Long Island, south to Cape Hatteras⁽¹⁾. Section B of area 6 (Cape May, New Jersey south to Cape Henry, Virginia and east to 70°W. longitude)⁽¹⁾ includes the primary zone of river herring landings. From January to May the offshore fleets take river herring east of the Virginia Capes and the Delmarva Peninsula. These fish would normally return to spawn in the tidal freshwaters of Virginia and other middle Atlantic states.

In 1968 the foreign fleet took 5% of the total reported river herring landings in area 6. By 1971 the foreign landings had increased to 44% of the total (Table 2.4). After 1971 the percentage taken by non-US fishermen began a downward trend, and was 20% in 1974.

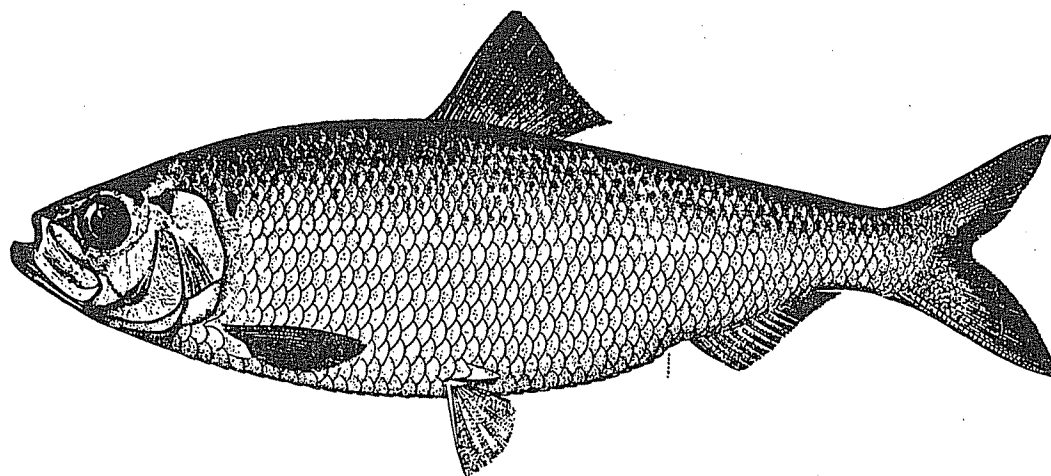
The USSR took 22 million lb. of river herring in 1969 and 13 million in 1970. After 1970 the Soviet Union took far less but East Germany (then not a member of ICNAF) entered the offshore fishery, taking 13 million lb. of river herring in 1971. East Germany then became the dominant foreign nation fishing for river herring.

⁽¹⁾ Approximate boundaries.

Determination of the impact of the foreign fleet on the population size and fluctuations of the anadromous clupeids in Virginia waters is a goal of our program. Without scientific data from the fish captured at sea we are forced to draw conclusions only from commercial statistics and our research program in Virginia waters. These data sets have shown substantial foreign impact on the total resource.

The recent history of landings, changes in basic vital statistics, decline in yearclass strength, and failure of moderately successful yearclasses to enter the domestic fishery in amounts anticipated, indicates the river herring have been overexploited. The exploitation has been on adults as well as immature fish. The catch of the foreign fleets has lowered domestic landings and altered age composition of the spawning run.

The river herring fishery in Virginia has not recovered from the impact of high combined domestic and foreign landings in 1969 and 1970 (Fig. 2.3). The fishing pressure by the offshore fleets may currently be low enough to allow recovery to previous population levels. Several years are required before the benefits of reduced effort will accrue to the fishery. If the strong 1975 yearclass of blueback (see Job 3) is not fished heavily at sea before spawning, the next good river herring year will be 1979.



Alewife, Alosa pseudoharengus, adult

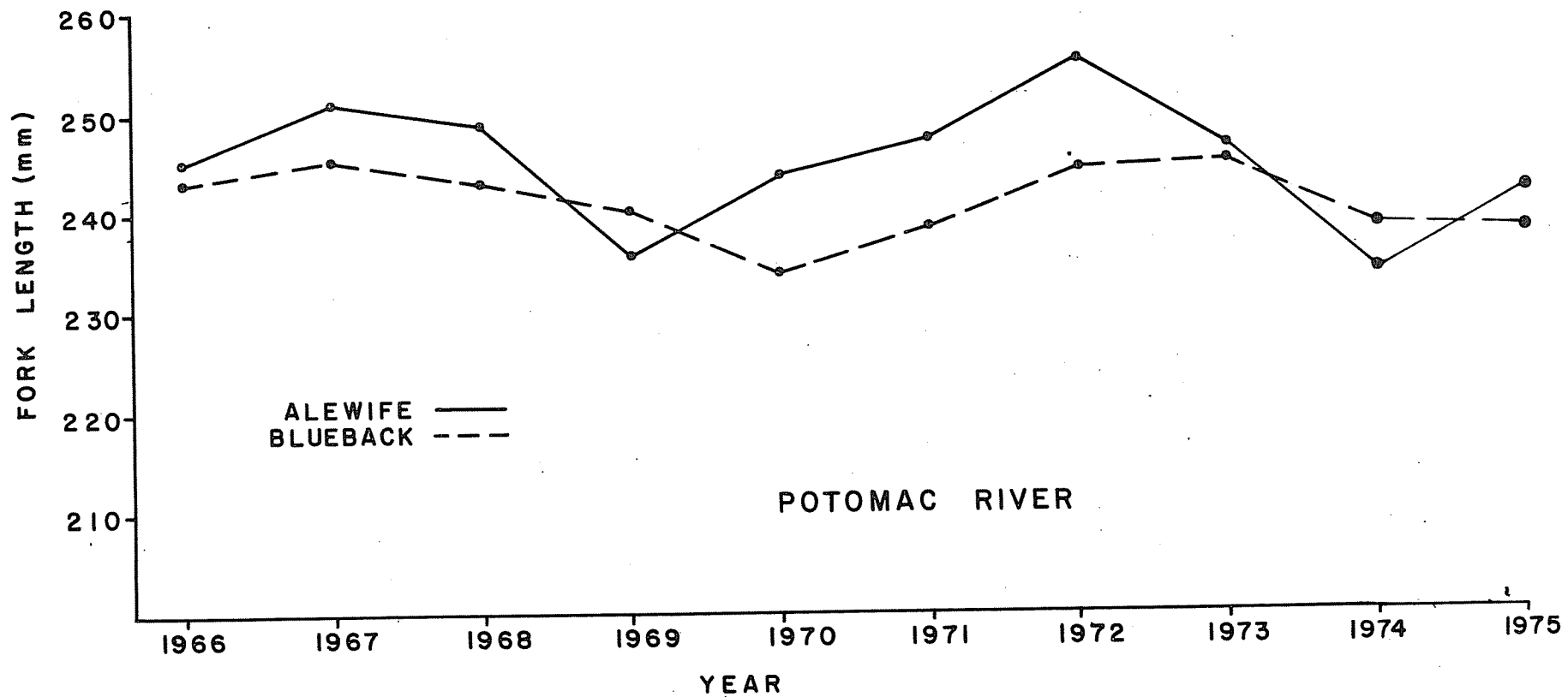


Fig. 2.1. Average fork length of sexes combined for alewife and blueback in landings from the Potomac River, 1966 to 1975.

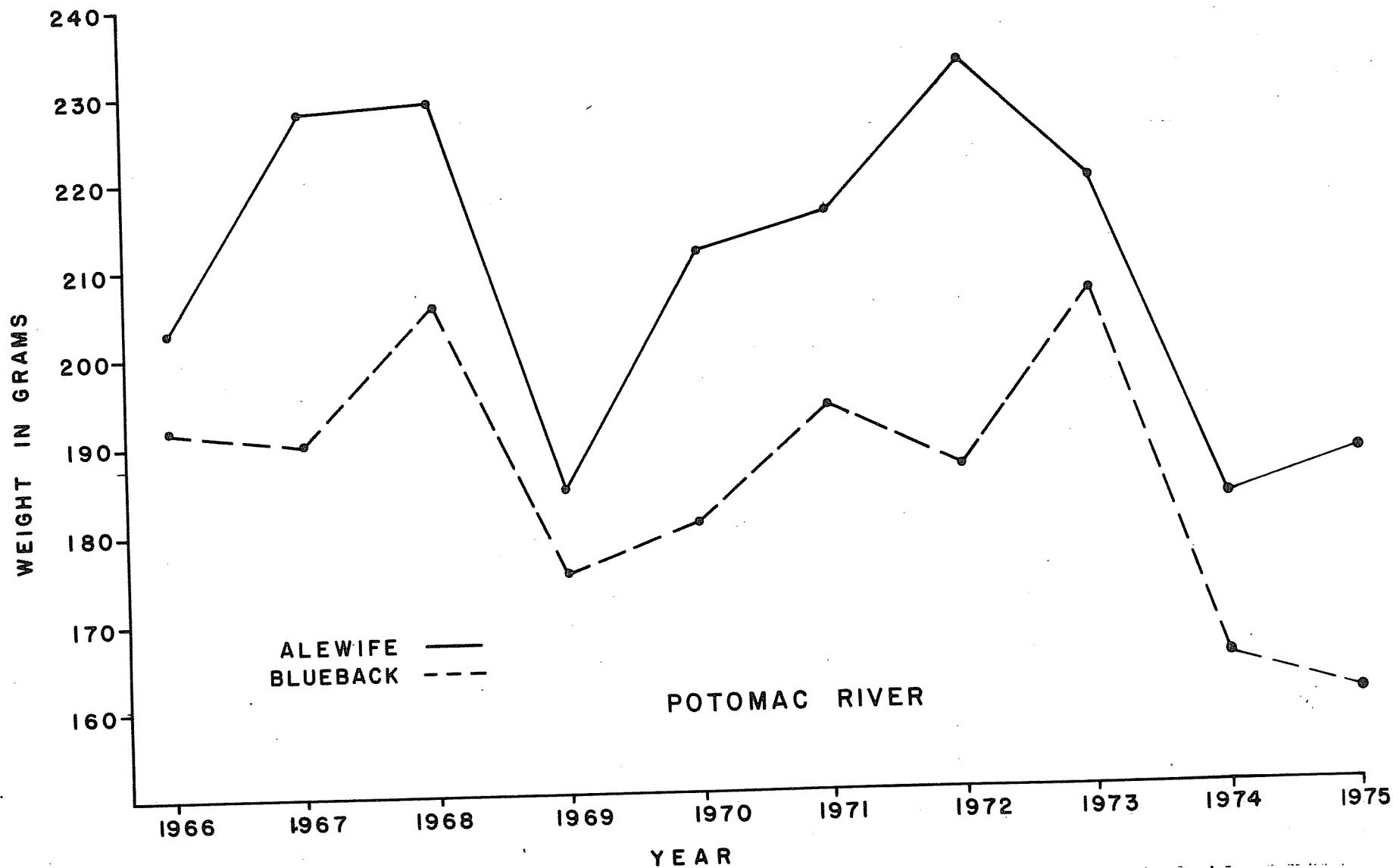


Fig. 2.2. Average weight, using combined data for season and sex, for alewife and blueback in landings from the Potomac River, 1966 to 1975.

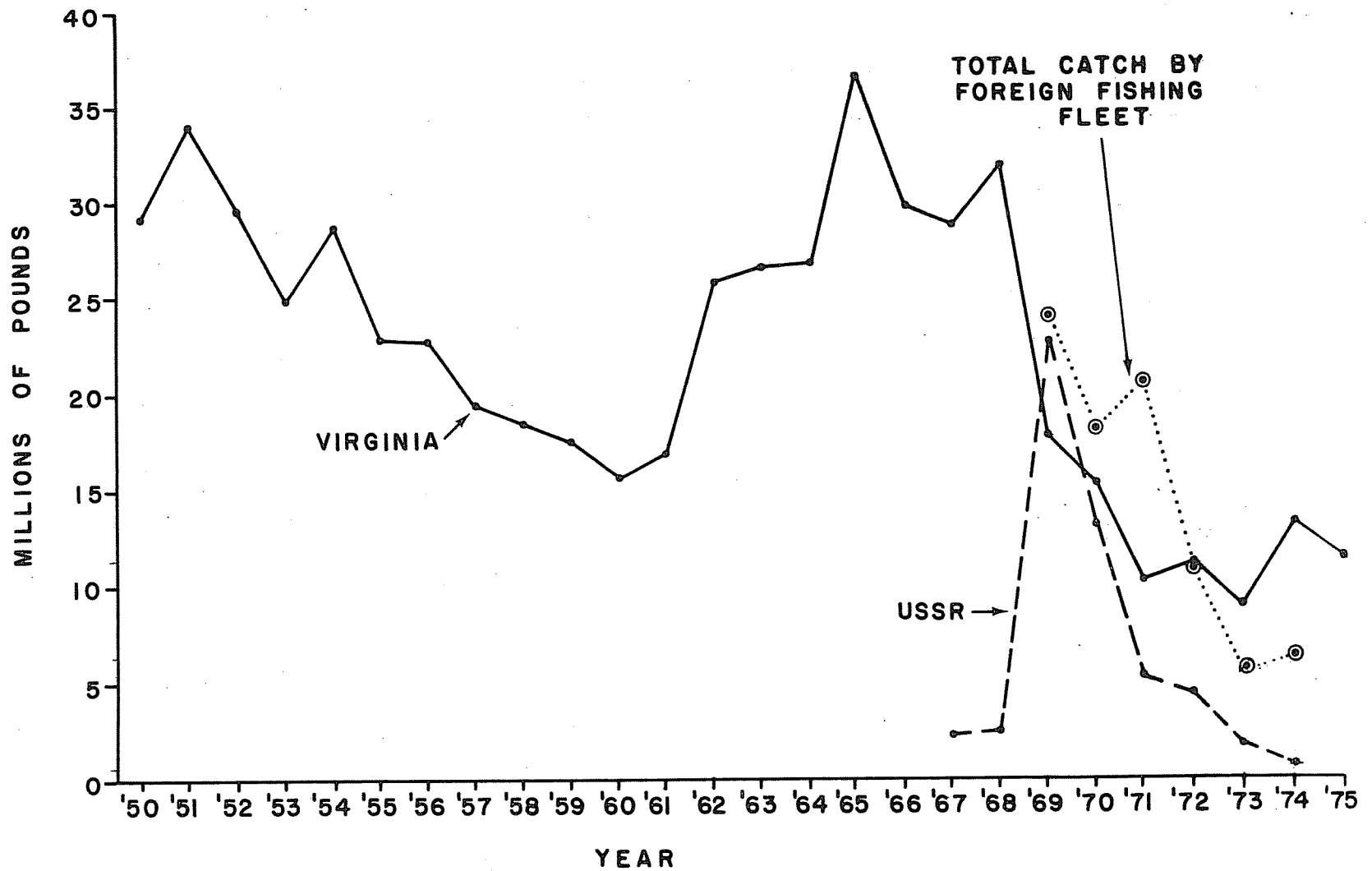


Fig. 2.3. Landings of river herring (alewife and blueback combined) in Virginia from lower Chesapeake Bay and tributaries, total foreign fleet catch and USSR catch in the Middle Atlantic Bight.

Table 2.1. Summary of alosine collections¹ gathered by project personnel during the 1975 spawning run in major Virginia tributaries to Chesapeake Bay.

River and half month	Alewife		Blueback		American Shad	
	Males	Females	Males	Females	Males	Females
<u>James</u>						
February						
2nd	22	3	1		4	5
March						
1st	75	16	6		25	35
2nd	84	29	64	20	66	34
April						
1st	40	21	107	40	50	72
2nd	78	25	78	53	20	88
May						
1st	42	17	114	84	2	17
2nd	6	1	74	41	2	1
<u>Chickahominy</u>						
April						
2nd			69	74		
May						
1st			200	99		
<u>Rappahannock</u>						
February						
1st	15	3				
2nd					28	22
March						
1st	108	80			17	6
2nd	111	96	43	11	58	41
April						
1st	56	52	123	89	18	54
2nd	100	53	244	179	26	43
May						
1st	69	68	126	174		
2nd	61	128	51	49		
June						
1st	41	66	112	67		
2nd	43	57	17	14		

Table 2.1. (continued)

River and half month	Alewife		Blueback		American Shad	
	Males	Females	Males	Females	Males	Females
<u>York</u>						
February						
2nd	14	3			19	17
March						
1st	13	12			1	2
2nd	70	55	40	6	26	24
April						
1st	17	26	64	50	1	55
2nd		1	178	108		37
May						
1st			54	46		
<u>Potomac</u>						
March						
1st	75	31	2	2		
2nd						
April						
1st						
2nd	46	58	108	125		
May						
1st	18	24	78	111		
2nd	16	26	95	105	1	
June						
1st	14	25	152	148		
2nd	2	8	102	68	1	
July						
1st	42	53	92	108		
Grand Totals	<u>1,278</u>	<u>1,037</u>	<u>2,395</u>	<u>1,873</u>	<u>365</u>	<u>553</u>

(1) Includes only fish from which biological data were taken.

Table 2.2. (continued).

River	Alewife							Total	Blueback							Total	American Shad							Total
	3	4	5	6	7	8	9		3	4	5	6	7	8	9		3	4	5	6	7	8	9	
Rappahannock																								
2a-M ⁽¹⁾		13	2																					
2a-F		3																						
2b-M															1	21	5		1					
2b-F																20	2							
3a-M	10	34	7					1							1	15	1							
3a-F		38	7	2												4	2							
3b-M		46	25	3					35	6						22	23	9	2					
3b-F	1	41	18	5	4				10	1						17	14	8	2					
4a-M		48	7						67	8	3				1	15	1	1						
4a-F		38	6						56	5	1				1	38	10	1	1					
4b-M		87	6	1		1		1	116	18	1	1			4	16	5							
4b-F		49	2						84	10						31	7	2						
5a-M	1	57	8	1	1			3	59	8	1													
5a-F	1	49	11					1	65	11														
5b-M		28	1						42	2	1													
5b-F	2	53	9	2					35	4	2													
6a-M		36	1						52	14	5													
6a-F		60	1						17	4	2	1												
6b-M		18	1						16															
6b-F		18	4						13															
Total	15	716	116	14	5	1		867	5	668	91	16	2		782	8	199	70	22	5		304		
%	1.7	82.6	13.4	1.6	0.6	0.1			0.6	85.4	11.6	2.0	0.3			2.6	65.5	23.0	7.2	1.6				
Potomac																								
3a-M	2	25	6						2															
3a-F	3	8	5							2														
4b-M	2	33	9						55	14														
4b-F		45	7						60	10	3	2	1											
5a-M		12	2	1					31	7	1	2												
5a-F		13	5	1	3				43	5	2													
5b-M		12	4						48	5		1												
5b-F		21	2						39	3														
6a-M		13							65	2														
6a-F		17	3						67	5		1												
6b-M		2							62	2														
6b-F		4							29	3														
7a-M	1	28	2						32	10														
7a-F	1	35	5						39	15	1	1												
Total	9	268	50	2	3			332	572	83	7	7	1		670	1						1		
%	2.7	80.7	15.1	0.6	0.9				85.4	12.4	1.0	1.0	0.1											
Species Grand Total																								
								1,778							2,422							896		

(1) Numbers indicate month of sample, letters (a & b) indicate first or second half of month;

M = male fish and F = female.

Table 2.2. Age composition of alosine fishes sampled from the commercial fishery of Virginia in spring 1975

River	Alewife								Total	Blueback								Total	American Shad								Total																
	Number at Age									Number at Age									Number at Age																								
	3	4	5	6	7	8	9			3	4	5	6	7	8	9			3	4	5	6	7	8	9																		
James	2b-M ⁽¹⁾	20	1	1						1																2	1	1											412				
	2b-F	3																								1	3	1	1														
	3a-M	33	20	12			2	1		5	1															17	7			1													
	3a-F	9	3	1		1																				29	2	1	3														
	3b-M	59	12	2	2	2				56	5	1	1													10	35	9	6	1	2							2					
	3b-F	25	2	1						17	2															15	14	1	2	2													
	4a-M	32	5	1						69	7				1											5	6	3															
	4a-F	16	4				1			17	3	1														1	1	53	41	7	1												
	4b-M	1	46	4						41	4															16	4																
	4b-F	15	4	1						29	4															4	55	22	5														
	5a-M	31	6	1		1				41	7	2														1	1																
	5a-F	13	3							38	9			1												5	3	4	2	2								1					
	5b-M	1	4							30	16	3	3	1												1	1																
	5b-F	1								17	6	1	3																									1					
	Total	1	305	68	20	3	3	1	401	361	64	8	8	2												443	1	100	185	85	31	6	4	412	0.2	24.3	44.9	20.6	7.5	1.4	1.0		
	%	0.2	76.1	17.0	4.9	0.7	0.7	0.2	81.4	14.4	1.8	1.8	0.5																														
Chickahominy	4b-M									23	2	1																															
	4b-F									17	6	1																															
	5a-M									79	10	14	5	2																													
	5a-F									22	8	4	2	1																													
	Total									141	26	20	7	3																							197						
	%									71.6	13.2	10.2	3.6	1.5																													
York	2b-M		6	5	3																				16	3																	
	2b-F		1	2																					2	4	10										1						
	3a-M	1	6	5	1																				1	1																	
	3a-F		6	5	1																					2																	
	3b-M	1	43	4	4					27	7	2													1	17	6	2															
	3b-F	1	23	13	4		1			4	2														2	12	4	5	1														
	4a-M		16		1					40	14	1													1																		
	4a-F		22	1	1					21	12	3		1											16	31	7																
	4b-M		1							83	13	3																															
	4b-F									44	3														32	2	1																
	5a-M									6	24	3																															
	5a-F										14	3																															
	Total	3	124	35	15	0	1		178	225	89	15	1												330	70	72	28	7	2			179	39.1	40.2	15.6	3.9	1.1					
	%	1.7	69.7	19.7	8.4		0.5	68.2	27.0	4.5	0.3																																

Table 2.3. Summary of age frequency data for alewife and blueback herring from the Potomac and Rappahannock commercial fishery.

Alewife-Potomac	Percent at age, seasonal average							Percent age V and older
	III	IV	V	VI	VII	VIII	IX	
1966	18.6	42.2	17.6	19.6	2.0	--	--	39.2
1967	9.3	26.2	30.0	21.5	7.5	4.7	1.0	63.7
1968	2.2	41.3	31.5	26.1	1.0	--	--	57.6
1969	26.6	48.8	11.1	13.3	--	--	2.4	24.4
1970	7.3	66.0	16.7	4.2	2.1	2.1	2.1	41.5
1971	2.6	32.4	53.0	10.0	2.0	--	--	65.0
1972	12.4	30.2	22.1	24.2	6.8	3.9	0.4	57.4
1973	2.4	59.4	22.7	8.2	5.3	1.9	--	38.1
1974	--	86.5	9.0	2.7	1.8	--	--	13.5
1975	2.7	80.7	15.1	0.6	0.9	--	--	16.6
Average	9.3	51.4	22.9	13.0	3.3	3.2	1.5	
<u>Alewife-Rappahannock</u>								
1966	25.2	36.1	17.4	15.6	4.3	1.3	--	38.6
1967	14.8	52.0	19.4	6.6	6.1	1.0	--	33.1
1968	8.8	33.2	39.3	12.6	5.2	--	0.8	57.9
1969	10.2	41.6	23.5	18.4	4.0	0.8	1.6	48.3
1970	4.8	40.5	31.2	13.2	8.5	1.8	--	54.7
1971	2.6	29.5	49.3	15.5	2.4	0.7	--	67.9
1972	4.4	27.3	30.3	25.6	9.0	3.0	0.4	68.3
1973	0.6	53.8	26.4	12.6	5.2	1.2	0.2	45.6
1974	0.2	60.9	27.1	8.6	0.5	2.4	--	38.6
1975	1.7	82.6	13.4	1.6	0.6	0.1	--	15.7
Average	7.3	45.8	27.7	13.0	4.6	1.4	0.8	
Average of both rivers	9.6	47.8	25.0	12.7	4.0	1.9	1.1	
<u>Blueback-Potomac</u>								
1966	4.0	34.6	30.5	23.0	6.0	1.7	--	61.2
1967	1.6	45.1	28.0	17.4	6.9	1.0	--	53.3
1968	1.0	29.1	39.5	21.5	7.2	1.3	0.4	69.9
1969	8.6	50.5	27.9	8.2	4.8	--	--	40.9
1970	1.2	66.0	18.2	11.0	2.1	1.5	--	32.8
1971	0.6	43.4	45.4	9.7	0.6	0.3	--	56.0
1972	0.3	40.0	31.0	22.2	5.1	1.5	--	59.8
1973	1.5	38.9	32.5	15.5	3.1	1.5	--	52.6
1974	0.2	60.9	27.1	8.6	0.5	2.4	--	38.6
1975		85.4	12.4	1.0	1.0	0.2	--	14.5
Average	2.2	52.7	32.0	15.1	4.0	1.4	0.4	

Table 2.3 (continued).

Blueback-Rappahannock	Percent at age, seasonal average							Percent age V and older
	III	IV	V	VI	VII	VIII	IX	
1966	11.8	28.2	36.5	17.6	3.5	2.4	--	60.0
1967	4.0	29.1	38.0	19.4	7.7	1.6	--	66.7
1968	5.8	49.4	26.2	10.0	6.9	1.2	0.4	44.7
1969	6.7	52.5	25.4	9.2	3.5	2.5	0.4	41.0
1970	2.1	54.5	32.0	8.3	1.7	1.4	--	43.4
1971	0.5	35.7	53.0	9.0	1.6	0.1	0.1	63.8
1972		30.1	42.4	19.5	6.8	1.2	--	69.9
1973	0.4	48.9	30.9	15.4	3.7	0.6	--	50.6
1974	0.2	43.1	34.9	15.7	4.6	1.3	--	56.5
1975	0.6	85.4	11.6	2.0	0.2	--	--	13.8
Average	3.6	45.7	33.1	12.6	4.0	1.4	0.3	
Average of both rivers	2.9	49.2	32.5	13.9	4.0	1.4	0.3	
<hr/>								
Alewife, both rivers,								
average for 1966-68	13.1	38.5	25.9	17.0	4.4	1.2	0.3	48.8
average for 1973-75	1.3	70.7	18.9	5.7	2.4	0.9	0.1	28.0
Blueback, both rivers,								
average for 1966-68	4.7	35.9	33.1	18.2	6.4	1.6	0.1	59.4
average for 1973-75	0.6	60.7	25.2	9.9	2.4	1.1	--	38.6

Table 2.4. Catch of river herring (alewife and blueback) in the inshore fishery and in ICNAF area 6 by various countries. Catch is in thousands of pounds, round weight.

	INSHORE			OFFSHORE					Total All Countries	Foreign Catch As Percent of Total Catch
	Virginia	North Carolina	Total U.S.A.	U.S.S.R.	East Germany	Bulgaria	Poland	Total Foreign		
1966 ¹	29,061	12,522	46,689						46,689	
1967	28,166	18,489	48,944	2,163				2,163	51,107	4
1968	32,326	15,529	52,137	2,370	278			2,648	54,785	5
1969	30,454	19,766	53,686	22,884		1,257		24,141	77,827	31
1970	15,051	11,523	32,822	13,126		1,645		14,771	47,593	31
1971	10,287	12,665	26,012	5,015	12,773	1,160	1,806	20,765	46,777	44
1972	11,175	11,197	23,389	4,515	5,227	322	897	10,961	34,350	32
1973	8,942	7,901	16,843	1,764	2,284	615	745	5,408	22,251	24
1974	13,342	6,210	19,552	525	3,514	1,265	908	6,464	32,450	20
1975	11,357	5,952	17,309							
1966-1969 Average	30,002	16,576	50,364							
1971-1975 Average	11,021	8,785	20,623							
1966-1971 Average									54,130	

¹ First year of area 6 ICNAF statistics

Table 2.5. Basic population attributes of the anadromous alosids in the major tributaries from the 1975 spawning run. Fork length in millimeters and weight in grams; SD = standard deviation.

River	Month	Alewife										Blueback										
		Male					Female					Male					Female					
		Number Sampled	Mean Weight	SD	Mean Length	SD	Number Sampled	Mean Weight	SD	Mean Length	SD	Number Sampled	Mean Weight	SD	Mean Length	SD	Number Sampled	Mean Weight	SD	Mean Length	SD	
<u>James</u>	2b ⁽¹⁾	22	251.5	25.92	249.7	7.19	3	268.3	11.01	257.0	7.54	1	148.0		250							
	3a	75	232.9	37.02	244.2	12.24	16	290.4	46.69	259.3	10.52	6	177.2	19.43	232.2	5.08						
	3b	84	224.7	36.05	244.5	10.97	29	273.1	57.34	256.4	14.05	64	178.8	29.42	235.8	10.63	20	214.2	33.90	248.1	13.51	
	4a	40	217.4	24.63	239.8	8.75	21	282.8	57.15	254.6	14.50	107	194.3	29.32	236.7	9.69	40	213.1	28.47	244.1	9.04	
	4b	78	215.4	32.62	239.8	10.20	25	247.4	42.37	250.0	11.80	78	181.9	30.02	237.4	10.32	53	218.0	38.37	248.7	10.38	
	5a	42	199.4	28.57	239.7	11.82	17	230.6	28.31	250.8	8.93	114	166.8	21.52	232.3	9.46	84	206.7	36.67	244.2	11.46	
	5b	6	202.3	28.44	240.2	10.17	1	229.0		245.0		72	165.8	26.52	241.0	10.50	41	181.4	28.79	252.4	11.39	
Total		325					107					463					241					
M&F Combined		460	232.2	43.55	254.3	12.33						682	187.7	34.67	240.0	11.71						
<u>York</u>	2b	14	246.7	28.86	254.6	13.17	3	273.0	21.17	255.7	2.89											
	3a	13	223.5	38.38	242.6	13.30	12	270.4	32.36	253.7	11.67											
	3b	70	207.1	36.22	236.4	10.67	55	277.6	40.11	256.3	11.09	40	190.1	23.91	236.7	8.55	6	206.7	45.20	243.2	15.87	
	4a	17	205.8	34.79	240.5	13.97	26	263.9	31.10	257.8	8.33	64	190.8	23.48	237.8	8.46	50	226.6	39.86	249.7	12.19	
	4b	1	176.0		247.0							178	206.9	139.88	238.3	8.54	108	229.5	28.08	249.1	8.32	
	5a	-										54	187.6	18.82	241.0	6.71	46	220.7	25.36	249.8	8.07	
Total		115					96					336					210					
M&F Combined		212	240.3	47.24	247.4	14.28						547	206.0	31.64	242.6	10.08						
<u>Rappahannock</u>	2a	15	218.7	24.63	238.4	14.74	3	235	26.63	242.8	7.02											
	2b																					
	3a	107	212.8	37.58	238.8	12.23	81	267.1	50.58	253.7	13.78	1	169.0		239.0							
	3b	111	213.8	35.21	239.8	11.13	96	268.8	48.47	254.1	13.85	43	184.6	22.90	235.1	10.01	11	198.3	19.24	242.7	7.75	
	4a	55	207.0	34.98	238.2	12.08	52	249.9	33.98	252.3	9.77	121	186.9	28.02	237.4	11.58	87	217.8	37.51	247.4	11.08	
	4b	99	184.5	35.15	236.9	11.22	52	213.4	39.05	245.7	11.58	244	179.4	30.21	234.3	10.84	177	213.1	33.98	245.8	10.29	
	5a	69	166.0	27.78	234.9	13.07	68	186.2	37.93	244.1	11.94	126	162.3	30.73	233.3	11.44	174	179.0	36.94	244.6	12.10	
	5b	61	149.6	23.91	231.8	10.99	128	169.0	27.41	241.4	12.75	50	146.3	22.12	235.6	9.72	49	174.0	45.97	248.4	13.53	
	6a	41	154.9	16.70	235.8	9.43	66	170.9	21.23	246.1	9.50	112	153.1	26.76	239.4	12.01	67	173.0	26.99	249.1	11.01	
	6b	43	140.1	19.57	233.4	13.12	57	159.8	22.54	246.4	14.43	17	135.9	18.29	237.2	8.96	14	150.5	18.42	249.6	9.73	
Total		586					600					714					579					
M&F Combined		1,185	198.5	51.70	242.1	14.72						1,294	180.9	37.70	240.4	12.34						
<u>Potomac</u>	3a	75	201.8	33.48	236.7	11.12	31	235.9	43.32	244.1	13.09	2	160.0		246.5		2	195.0		245.0		
	4b	46	200.6	33.44	235.2	10.86	58	250.0	40.51	250.1	8.94	107	189.4	25.11	237.1	8.51	126	226.0	33.66	249.6	10.42	
	5a	18	172.0	25.44	242.9	12.68	24	199.8	40.63	250.3	13.47	78	166.9	23.76	238.4	10.18	111	186.8	35.34	245.9	9.71	
	5b	16	155.2	15.42	237.2	7.47	26	171.6	17.81	247.2	8.86	95	136.9	17.44	236.7	9.39	105	153.5	22.13	246.2	9.36	
	6a	14	152.4	21.96	236.2	9.18	25	159.9	17.74	243.9	7.70	152	137.9	19.40	234.1	9.45	148	160.5	21.72	246.7	16.58	
	6b	2	143.5		238.0		8	158.8	14.67	253.0	8.81	102	133.2	22.02	235.5	18.42	68	151.0	23.49	250.3	15.43	
	7a	42	133.1	19.67	232.0	21.00	53	147.3	17.36	243.0	9.43	92	121.9	17.84	205.7	44.01	108	141.9	21.90	223.6	42.15	
Total		213					225					536					560					
M&F Combined		438	187.5	47.79	241.5	13.10						1,296	160.0	37.92	237.8	23.17						
<u>Chickahominy</u>	4b	-	-	-	-	-	-	-	-	-	-	69	188.7	28.37	233.4	10.24	74	247.1	52.74	250.0	15.08	
	5a	-	-	-	-	-	-	-	-	-	-	200	182.0	30.30	237.6	12.21	99	205.5	35.54	246.8	17.89	
Total												269					173					
M&F Combined												442	199.2	42.64	241.1	15.00						

Table 2.5 (continued).

American Shad											
River	Month	Male					Female				
		Number Sampled	Mean Weight	SD	Mean Length	SD	Number Sampled	Mean Weight	SD	Mean Length	SD
<u>James</u>	2b ⁽¹⁾	4	1367.5	153.07	417.7	14.49	5	1576.0	254.8	434.4	21.18
	3a	25	1053.0	221.26	399.6	32.67	35	1539.7	297.06	438.7	25.61
	3b	65	1355.9	270.58	423.7	25.59	33	1887.3	515.73	467.6	36.27
	4a	14	1312.0	327.87	421.9	35.86	108	1679.2	395.31	448.9	34.69
	4b	20	854.75	127.88	385.7	15.56	88	1514.7	341.78	434.9	29.88
	5a	2	615.0		355.0		17	1590.3	459.27	444.0	39.50
	5b	2	772.5		332.5		1	1497.0		495.0	
Total		132					287				
M&F Combined		419	1492.6	426.26	434.2	37.26					
<u>York</u>	2b	19	585.3	283.98	324.8	43.31	17	1710.0	321.50	451.0	25.35
	3a	1	950.0		375.0		2	1775.0		459.5	
	3b	26	1217.3	246.7	408.4	27.06	24	1861.7	324.38	465.2	24.99
	4a	1	1100.0		390.0		55	1587.5	452.64	434.7	31.55
	4b						37	1584.6	300.98	436.3	28.69
	5a										
Total		47					135				
M&F Combined		181	1475.9	488.74	424.1	49.24					
<u>Rappahannock</u>	2a										
	2b	28	1224.3	200.68	413.4	27.19	22	1775.0	271.39	454.3	21.09
	3a	17	1070.6	170.44	394.0	20.99	6	1868.3	209.79	457.8	24.55
	3b	57	1259.7	187.63	417.2	18.76	41	1785.8	287.79	454.7	22.58
	4a	18	1250.3	221.66	417.9	21.88	54	1772.5	270.50	455.6	22.33
	4b	26	962.9	170.57	396.9	23.68	42	1625.9	355.2	448.5	26.06
Total		146					165				
M&F Combined		311	1476.9	387.55	433.2	31.85					
<u>Potomac</u>	5b	1	763.0		407.0						
	6b	1	312.0		312.0						
Total		2									
M&F Combined		2	537.5		359.5	47.49					

(1) Numbers indicate month of sample, letters indicate first half of month (a) or second half (b).

Job 3. Annual Index of Juvenile Abundance

Summary of 1975 Results

1. In every river blueback herring had a strong yearclass compared to 1974. Their annual index for 1975 was the highest ever recorded in the James, Rappahannock and Potomac rivers.
2. Alewife yearclass strength showed moderate improvement in the James, York, and Rappahannock rivers, but substantial gains were apparent only in the Pamunkey branch of the York River.
3. American shad yearclass strength fell in every river. The extremely low numbers of juvenile shad caught during recent years in all nursery zones is a disturbing trend.
4. Yearclass strength of all species in 1975 was independent of the size of the adult spawning stock.
5. The James, York, Rappahannock and Potomac rivers (mainstem only) contained an estimated 2.3 billion blueback, 13 million alewife and 1.5 million American shad juveniles on September 1, 1975.
6. The James River had the greatest density of juvenile blueback and American shad, but alewife were most dense in the York River system. The Potomac River had the lowest density of alewife and shad.
7. Juvenile blueback were numerically the most dominant, making up over 90% of the juvenile alosines in 4 of 5 rivers sampled.
8. The yearclass strength estimates were used for the first time to determine whether adult recruitment to the domestic fishery four years later can be predicted. (Discussion in Job 2.)

Yearclass Strength in 1975

Project personnel performed the sixth annual assessment of yearclass strength of the alosids during August and September. Two vessels were used to cover mainstream and shoal areas of the major Virginia rivers, using a 5 x 5 ft cobb trawl in the freshwater nursery zones (Fig. 3.1). Surface and midwater samples were taken with 5 min tows, whereas 10 min tows were taken in 1973 and 1974. All catch-per-unit-of-effort (c/f) values are expressed as 10 min tows for direct comparison with former years. Details of sampling, handling, and data manipulation have been described in Hoagman et al.

(1973), and Hoagman et al. (1974). Total towing effort in 1975 was reduced to 39% of 1974 effort in the same area, or 42.8% if the effort devoted to small tributaries in 1975 is considered (Table 3.1).

The 1975 data verified the need to sample surface and midwater in every river. Alewife were caught 5 to 100 times more frequently at midwater than at the surface but blueback vertical distribution varied according to river (Table 3.2). American shad juveniles were more abundant at midwater but the low numbers captured in 1975 showed no strong trend in vertical distribution. In the Potomac, blueback were 10 times more abundant at midwater than at the surface, but in the James the densities were equal at the two depths.

Seven tributaries to the James River were sampled in 1975. Few alewife or shad were captured but blueback were present in large numbers. Vertical distribution of blueback in the Chickahominy River and Turkey Island Oxbow was opposite from mainstream. In no tributary did the c/f average for blueback (Table 3.3) resemble the c/f average for the James mainstream. The average surface c/f for blueback in the mainstream was 2,768 compared to 234 in the tributaries and the average midwater c/f for mainstream was 2,388 compared to 1,063 in the tributaries. Alewife and American shad were captured in several tributaries but the few numbers taken in 35 tows cannot be used for comparison with the mainstream average. With greater towing effort the tributary estimates may converge toward the mainstream estimates or assume some fractional relationship which could be used for population estimation.

James River

The James has been the most productive for juvenile alosids of any of the Virginia rivers sampled. Sampling for juveniles began there in 1969 and in every year it has led in density of juveniles, and total contribution to the Virginia stocks of all three primary species of alosids.

Since 1970 there has been a steady decline in yearclass strength of all alosids in the James. In 1975, however, blueback yearclass strength was the highest we have recorded (Table 3.4) with an index of 2656 juveniles per tow. This reverses the decline for blueback and appears to be a record yearclass.

Alewife recovered from a 1974 index of 1.6 to 5.2 juveniles/tow in 1975 but this remains far below levels measured in 1970 and 1971 (164 and 63). American shad continued their downward trend in the James and in 1975 had the lowest yearclass strength we have recorded.

York River

Blueback showed moderate recovery over 1974 but were still far below several previous years. Alewife had a dramatic recovery in the Pamunkey branch, exceeding all other years; but in the Mattaponi branch the yearclass was a failure. American shad fell to the lowest levels ever recorded in either branch. Shad production (juveniles) had previously been fairly steady in the York but the low juvenile abundance levels in 1975 will probably affect adult availability in 3 to 4 years as they return to spawn for the first time.

Rappahannock River

Blueback yearclass strength broke all previous records with an index of 763. The previous high was 558 in 1973 (Table 3.4). Alewife also increased over 1974 but not as much as did blueback. The two best years for young alewife were 1972 and 1973. American shad in the Rappahannock had an index of only 0.3, but this has been typical since 1970. If adult production holds steady, the low indices of 1970-75 may not indicate low yearclasses for the Rappahannock.

Potomac River

Blueback had the largest yearclass we have measured, i.e. the 1975 index of 350 per tow was double the previous high year (1970). Alewife and American shad, however, did not show recovery in the Potomac. Very few were captured at any depth from mile 65 to 95.

Parent-Progeny Relationship

The 1974 annual report for this project included a detailed examination of the parent-progeny relationship of Virginia alosines. We concluded that yearclass strength for blueback, alewife, and American shad was independent of the size of the spawning stock, except for several years when shad yield fell below 150 thousand lb. of females per river, and very small yearclasses were produced. The 1975 data continued to show independence between spawning stock size and yearclass strength.

The percentage of blueback juveniles compared to alewife and shad in 1975 was not different from previous years (Table 3.5). Blueback dominated in every river except the Pamunkey. In the James, Rappahannock, and Potomac, 99% of the juveniles captured were blueback.

The yield of spawning adults has resembled the percentage distribution of juveniles only in the Potomac (Table 3.6).

Our data from the Rappahannock, where blueback and alewife adults have each yielded 20 to 50% of alosid landings, shows extreme blueback dominance.

In recent years the catch of spawning shad has been falling in the James, Rappahannock, and Potomac. The 1974 and 1975 average (all rivers) of 1.6 million lb represents only 48% of the 3.3 million lb per year taken in 1971 and 1972. All rivers have experienced nearly the same drop in landings (Table 3.6). Details of alosid landings are given in Job 1 this report.

The spawning stock size does not seem low enough at this time to preclude successful yearclasses. In several recent years, good yearclasses have been produced from spawning stocks considered low in the 1970-75 perspective, e.g. Rappahannock blueback in 1973 and 1975, York River shad between 1972-74, and James River shad in 1973.

For the Virginia situation in general, factors other than size of spawning stock seem to determine the size of a yearclass. At lower stock sizes we can probably expect an intensification of the cause and effect relationship. The offshore fishery overexploited the river herring stocks after 1968. The reduced number of alewife and blueback spawners decreased yield to Virginia fishermen but yearclasses produced from the depressed stocks continued to be highly variable.

The sequence of spawning is alewife and American shad, then blueback from March through May in every year. The later spawning blueback may benefit from warmer water temperatures, less temperature variability, and increased food supply.

The production of young may not be proportional to size of spawning stock, but size of adult stock usually is proportional to the size of the yearclass which produced it. Factors causing yearclass fluctuations are extremely difficult to identify, yet once identified can be used to implement management strategies. Some things, even if influential, may never be managed (e.g. weather) but steps can be taken if the environment has degraded or adult stocks simply cannot produce sufficient eggs to continue the stock.

The juvenile alosids do not live alone in the nursery zones. As eggs, larvae, and juveniles they are preyed upon by a large variety of other fishes (see Job 7) and are in direct competition among themselves and with other pelagic fishes of the freshwater nursery zone. Fluctuations among

these other populations may significantly affect alosid mortality between spawning and our late summer survey.

With increased monitoring activity of the chemical, physical, and biological variables in Virginia rivers we hope to formulate general principles of interaction as our data series continues.

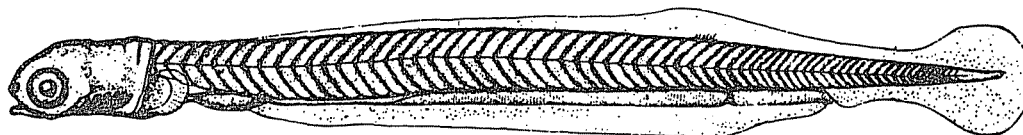
Estimate of Juvenile Alosid Production

From the annual grand average c/f estimates by river, the total number of juvenile alosids is computed based on methods and assumptions as detailed in Hoagman et al. (1974).

The James River, because of high juvenile density and large volume, contained an estimated 1.9 billion blueback, 3.7 million alewife, and 1.1 million juvenile shad on September 1, 1975 (Table 3.7). No other river had more than 272 million juvenile blueback.

Total blueback standing crop for all rivers sampled was estimated at 2.3 billion individuals. Alewife was second with 13.6 million and there were an estimated 1.5 million juvenile shad. The trend since 1970 has been disturbing, but blueback in 1975 had their best yearclass since 1970 and alewife showed some improvement over 1974 (Figure 3.2). American shad seem headed for commercial extinction if a good yearclass is not produced soon.

The estimated number of young alosids present in early fall does not include areas of creeks, or larger tributaries. We know juveniles inhabit these zones but their numbers are few in the several areas we have sampled. We cannot estimate juvenile density in these areas yet, therefore our general estimates are conservative. In 1976 we hope to better define vertical and lateral distribution of the juveniles. With this information, better estimates should follow and previous years may be adjusted in the next completion report.



Alewife, Alosa pseudoharengus, larva

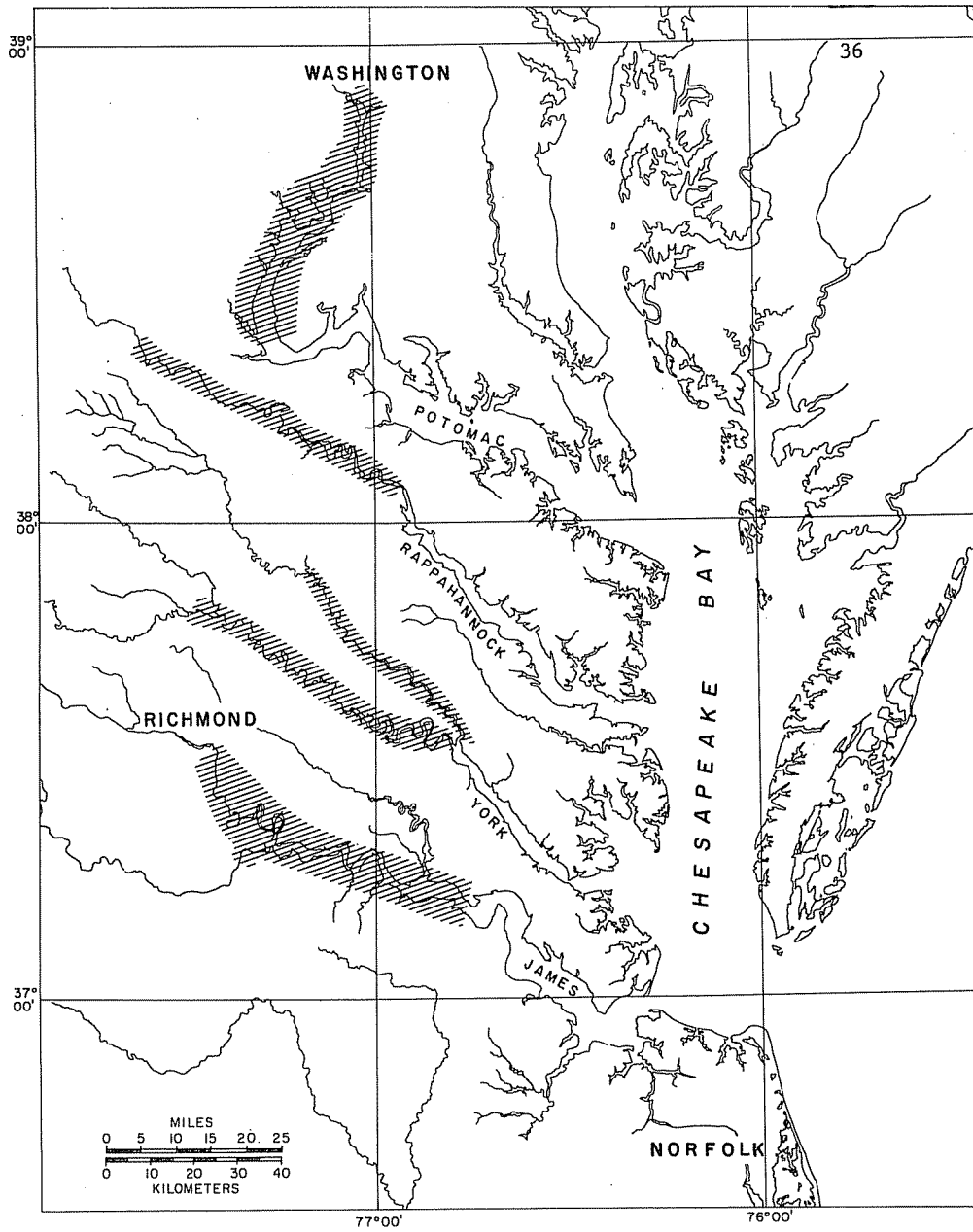


Figure 3.1 Chart of lower Chesapeake Bay and tributaries with major freshwater nursery zones shaded.

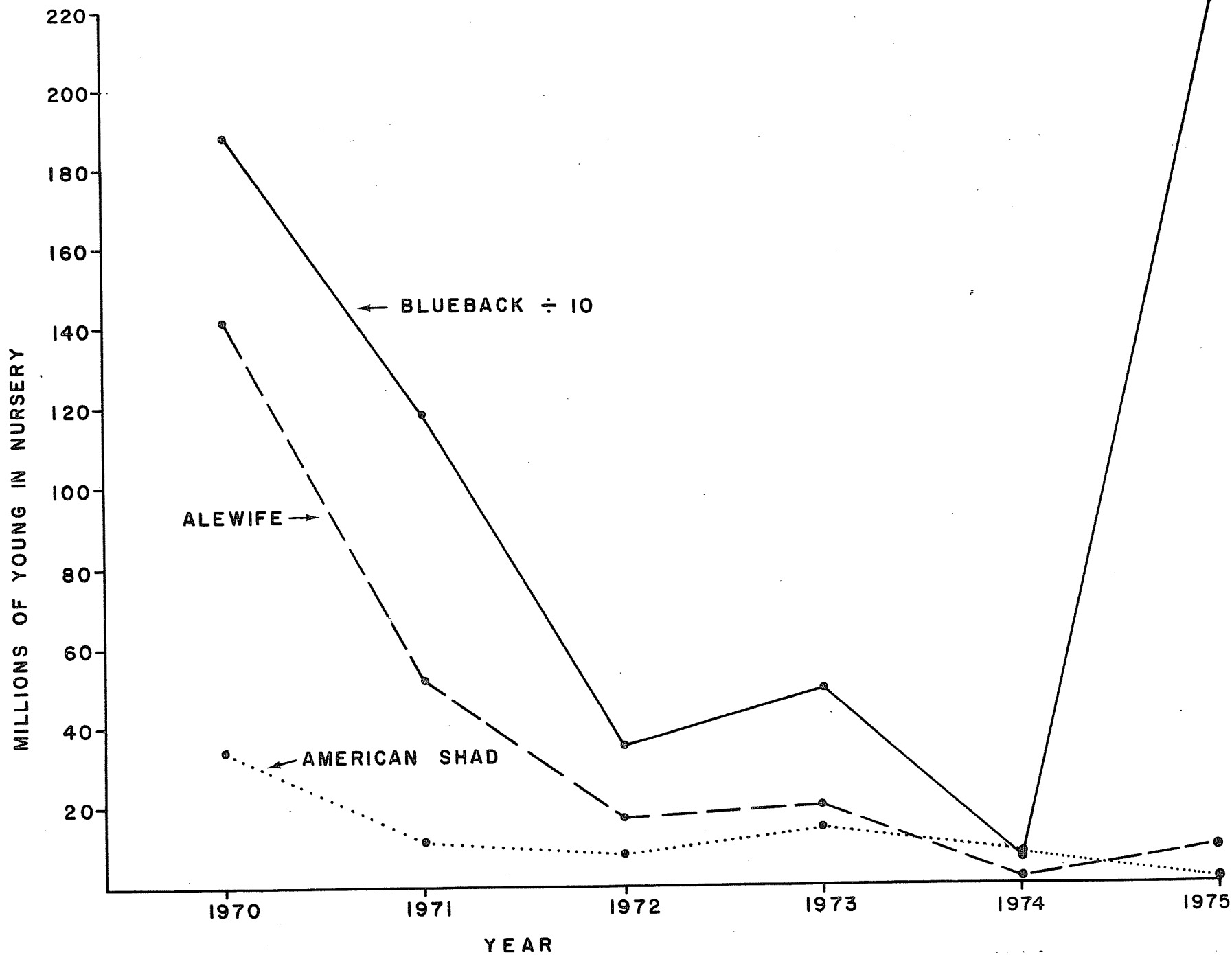


Fig. 3.2. Yearclass strength of alewife, blueback herring, and American shad expressed as total estimated number of young (Aug.-Sept.) in all nursery zones. Data from Table 3.7.

Table 3.1. Trawling effort with pelagic trawls for juvenile alosids in Virginia rivers. (Five-min tows in 1969-1972 and 1975, and 10-min tows in 1973 and 1974.)

	R/V Langley				R/V Brooks		Total Towing Time Surface & Midwater
	Surface		Midwater		Surface		
	Tows	Min	Tows	Min	Tows	Min	
James							
1969	20	100	10	50			150
1970	46	230	10	50	38	190	470
1971	46	230	10	50	40	200	480
1972	92	460			73	365	825
1973	33	339	16	160	66	660	1,150
1974	60	600	32	320	74	740	1,660
1975	24	120	45	225	64	320	665
James Tributaries							
1975	11	55	5	25	22	110	190
York- Pamunkey							
1970	30	150	3	15	35	175	340
1971	21	105	5	25	30	150	280
1972	42	210			66	330	540
1973	14	140	14	140	52	520	800
1974	60	600	20	200			800
1975	21	105	22	110	13	65	280
York- Mattaponi							
1970	25	125	4	20	25	125	270
1971	21	105	3	15	21	105	225
1972	44	220			50	250	470
1973	10	100	10	100	42	420	620
1974	60	600	20	200			800
1975	17	85	20	100			185
Rappahannock							
1970	31	155	5	25	26	130	310
1971	31	155	7	35	31	155	345
1972	62	310			62	310	620
1973	19	190	25	250	36	360	800
1974	66	660	40	400			1,060
1975	16	80	31	155	52	260	495
Potomac							
1970	31	155	7	35			190
1971	31	155	7	35	30	150	340
1972	62	310			62	310	620
1973	22	220	21	210	62	620	1,050
1974	70	700	35	350			1,059
1975	15	75	30	150	52	260	485

Table 3.2. Average c/f estimates in surface and midwater tows for juvenile alosids in major Virginia rivers during 1975. All vessels combined, estimates adjusted to 10-min tow equivalents.

River and Miles Used	Blueback	Alewife	American Shad	Total Tows Within Miles (a)
James, 35-80				
Surface c/f	2768.0	0.1	1.0	44.0
Midwater c/f	2544.6	10.1	2.0	22.5
York-Pamunkey, 30-55				
Surface c/f	51.6	0.2	0.9	17.0
Midwater c/f	7.4	169.8	1.6	11.0
York-Mattaponi, 30-50				
Surface c/f	0.4	0.0	0.5	8.5
Midwater c/f	28.4	0.8	1.2	10.0
Rappahannock, 50-80				
Surface c/f	406.2	0.9	0.0	35.5
Midwater c/f	1120.8	16.5	0.5	15.5
Potomac, 65-95				
Surface c/f	44.9	0.1	0.1	35.0
Midwater, c/f	655.2	1.3	0.0	15.0

(a) Expressed as 10 min. tows

Table 3.3. Catch of juvenile alosids in tributaries to the James River between miles 35 to 80. (All tows 5 min each; c/f expressed as catch for 10 min towing equivalent.)

Name of Tributary	Mile on James	Alewife c/f	Blueback c/f	American Shad c/f	Tows and Strata ^(a)
Grays Creek	35	0	75.8	0	2-S
Chickahominy River	40	0	410.8	0.5	9-S
"		1.7	131.8	0.7	3-M
Herring Creek	58	1.0	774.3	0	2-S
Powell Creek	59	0.5	61.7	0.2	2-S
Appomattox River	66	0	239.5	0.2	4-S
Turkey Island Oxbow	67	0	76.0	0	4-S
" " "		0	1994.5	0	2-M
Jones Neck Oxbow	70	0	1.9	0.2	7-S
Surface Average		-	234	-	
Midwater Average		-	1063	-	

(a) S - Surface Tow, M - Midwater Tow

Total Blueback Taken - 235,192

Table 3.4. Annual index of yearclass strength for all species in all rivers using the combined data of two vessels and the midwater and surface samples. Figures are average c/f defined as a 10-min tow with the 5 x 5 Cobb trawl.

River and Year	Total Tows	Blueback	Alewife	American Shad	Average Blueback and Alewife ^(a)	Average of all Species ^(a)
<u>James</u>						
1969	30	263.0	39.0	25.0	101.3	63.5
1970	94	2,273.0	164.0	41.0	610.6	248.2
1971	96	1,491.0	63.0	12.0	316.6	106.3
1972	165	368.0	4.6	4.9	41.1	20.2
1973	115	560.0	7.3	11.0	63.9	35.6
1974	166	86.7	1.6	4.9	11.8	8.8
1975	67	2,656.2	5.2	1.5	115.8	27.2
<u>York-Pamunkey</u>						
1970	68	128.0	12.0	3.6	39.2	17.7
1971	56	251.0	52.0	2.3	114.2	31.1
1972	108	15.0	5.5	4.2	9.1	7.0
1973	80	164.0	8.5	6.0	37.3	20.3
1974	80	3.7	1.4	3.2	2.3	2.6
1975	28	29.5	85.0	1.3	50.1	14.8
<u>York-Mattaponi</u>						
1970	54	89.0	7.1	5.8	25.1	15.4
1971	45	11.0	23.0	6.6	15.9	11.9
1972	94	17.3	8.3	5.7	12.0	9.4
1973	62	15.0	27.0	24.0	20.1	21.3
1974	80	4.8	0.0	3.7	2.0	1.2
1975	19	14.4	0.4	0.9	2.4	1.7
<u>Rappa-hannock</u>						
1970	62	108.0	10.0	0.6	32.9	8.7
1971	69	44.0	1.9	0.2	9.1	2.5
1972	124	234.0	38.1	0.2	94.4	12.1
1973	80	558.0	36.0	0.8	141.7	25.2
1974	106	3.8	1.2	2.1	2.1	2.1
1975	49	763.5	8.7	0.3	81.5	12.6
<u>Potomac</u>						
1970	38	169.0	27.0	0.5	67.5	13.2
1971	68	8.9	0.4	0.2	1.9	0.9
1972	124	54.0	5.5	1.0	17.2	6.7
1973	105	4.5	0.8	0.1	1.9	0.7
1974	105	1.4	0.4	0.0	0.6	0.4
1975	50	350.1	0.7	0.1	15.7	2.9

(a) Geometric mean.

Table 3.5. Percent **composition** of the juvenile alosids from the combined c/f of the R/V Langley and R/V Brooks, surface and midwater.

River and Year	Blueback	Alewife	American Shad
James			
1969	80.4	11.9	7.7
1970	91.7	6.6	1.7
1971	95.5	3.8	0.7
1972	97.5	1.2	1.3
1973	96.8	1.3	1.9
1974	93.0	1.7	5.2
1975	99.7	0.2	0.1
York-Pamunkey			
1970	89.1	8.4	2.5
1971	82.2	17.0	0.8
1972	60.7	22.3	17.0
1973	91.9	4.8	3.3
1974	44.6	16.9	38.6
1975	25.5	73.4	1.1
York-Mattaponi			
1970	87.3	7.0	5.7
1971	27.1	56.7	16.2
1972	55.3	26.5	18.2
1973	22.7	40.9	36.4
1974	56.5	0.0	43.5
1975	91.7	2.6	5.7
Rappahannock			
1970	91.1	8.4	0.5
1971	95.4	4.1	0.4
1972	85.9	14.0	0.1
1973	93.8	6.1	0.1
1974	53.5	16.9	26.6
1975	98.8	1.1	0.1
Potomac			
1970	86.0	13.7	0.3
1971	93.7	4.2	2.1
1972	89.3	9.1	1.6
1973	83.3	14.8	1.9
1974	77.8	22.2	0.0
1975	99.8	0.1	0.1

Table 3.6. Estimated yield of adult clupeids by pound nets and stake gill nets in Virginia rivers 1967-1975 and their percentage contribution to the catch. Yield is in thousands of pounds.

River and Year	Species							All Species, Yield ^(b)
	Blueback		Alewife		Yield of both Sexes	Yield of Females	Percent of Total	
	Yield	Percent of Total	Yield	Percent of Total				
James Mile 10+	1969	-	-	-	1569	1435	100	1569
	1970	-	-	-	1962	1619	100	1962
	1971	-	-	-	1961	1718	100	1961
	1972	-	-	-	2514	1409	100	3003
	1973	-	-	-	1901	1075		1901
	1974	-	-	-	1232	601		1511
	1975	-	-	-	654	502	100	734
York Mile 10+	1967	76	14	184	35	274	51	534
	1968	340	37	217	24	351	39	908
	1969	-	-	-	-	174	100	174
	1970	-	-	-	-	159	100	159
	1971	-	-	-	-	435	100	435
	1972	-	-	-	-	355	100	355
	1973	-	-	-	-	490		490
	1974	-	-	-	-	396		396
	1975	-	-	-	-	247	220(c)	247
Rappahannock Mile 10+	1965			995				
	1966			632				
	1967	2833	57	1932	39	204	4	4969
	1968	406	19	1248	59	469	22	2123
	1969	374	23	842	50	454	27	1671
	1970	103	14	363	49	268	37	734
	1971	445	32	430	31	518	37	1393
	1972	295	33	441	49	147	16	778
	1973	532	46	332	35	80	8	944
	1974	287	33	475	56	95	11	857
	1975	379	62	159	26	71	12	609

Table 3.6. (continued).

River and Year	Species							All Species, Yield ^(b)	
	Blueback		Alewife		American Shad				
	Yield	Percent of Total	Yield	Percent of Total	Yield of both Sexes	Yield of Females	Percent of Total		
Potomac ^(a)	1965	6723	65	4169	31	346	-	4	13328
Whole River	1966	9166	81	1943	17	177	-	2	11268
	1967	7043	80	1617	18	212	130	2	8772
	1968	6048	75	1629	20	393	249	5	8070
	1969	2838	75	637	17	298	204	8	3773
	1970	5676	90	473	7	170	111	3	6319
	1971	5065	82	790	13	354	300	5	6209
	1972	3105	60	1618	31	421	360	9	5144
	1973	834	53	550	35	194	157	12	1578
	1974	2873	80	648	18	79	49	2	3600
	1975	4516	83	834	15	118	92	2	5478

(a) Potomac figures are actual landings as reported to Potomac River Fish Commission.

(b) Does not include unreported clupeids used as bait fish or taken by sport fishermen.

(c) Includes 22 thousand lb. used for roe only, see Table 1.5.

Table 3.7. General estimates of yearclass strength and estimates of numbers of young alosids in Virginia rivers in August and September.

River and Miles Included	Area in Nursery Zone, 10 ⁶ m ²	Volume in Nursery Zone, 10 ⁶ m ³	Volumes Equated to Smallest Zone	Species	Estimated Number Present in Early Fall, in Millions.					
					1970	1971	1972	1973	1974	1975
James 37-80	190.8	763.2	15.97	Blueback	1633.2	1143.3	264.5	402.4	62.3	1908.9
				Alewife	117.8	45.3	3.3	5.2	1.2	3.7
				American Shad	29.5	8.6	3.3	7.9	3.5	1.1
York-Pamunkey 30-60	25.6	102.4	2.15	Blueback	12.3	24.2	14.4	15.8	0.4	6.2
				Alewife	1.2	5.0	4.3	8.1	0.1	8.2
				American Shad	3.5	2.2	4.0	5.7	0.3	0.1
York-Mattaponi 30-50	11.9	47.8	1.00	Blueback	4.0	0.5	0.8	0.7	0.2	0.6
				Alewife	0.3	1.1	0.4	1.2	0.0	0.1
				American Shad	0.5	0.5	0.5	1.1	0.2	0.1
Rappahannock 50-80	32.4	129.4	2.71	Blueback	13.2	5.4	28.5	68.0	0.5	93.0
				Alewife	1.2	0.2	4.6	4.4	0.1	1.1
				American Shad	0.07	0.02	0.02	0.09	1.5	0.1
Potomac 37-95	206.2	824.8	17.26	Blueback	131.3	6.9	42.0	3.5	1.1	271.9
				Alewife	21.0	0.3	4.3	0.6	0.3	0.5
				American Shad	0.4	0.2	0.6	0.07	0.0	0.1
Yearclass strength comparison, all rivers combined.				Blueback	1794.0	1180.3	350.2	490.4	64.5	2277.2
				Alewife	141.5	51.9	17.9	19.5	1.7	13.6
				American Shad	33.8	11.3	8.4	14.9	7.2	1.5

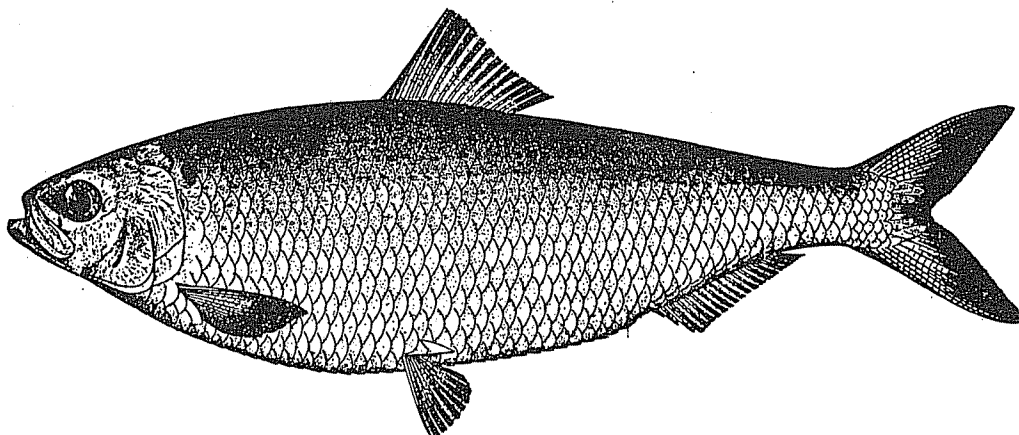
Job 4. Feeding Energetics of Juvenile Alewife

The Ph.D. dissertation of James E. Weaver was the contracted work in Job 4 during 1974-75. His study of the feeding energetics of juvenile alewife has increased our understanding of resource interactions in the freshwater nursery zone.

The full dissertation is not included in this report because of its length and detail. Complete copies on microfiche are available from:

University Microfilms
Ann Arbor, Michigan 48104

To indicate the scope and major findings of the study, the following is provided. Full publication of findings will be made through scientific journals. A brief review of methods and preliminary results was presented in the 1974 annual report for this project.



Blueback herring, Alosa aestivalis, adult

FOOD SELECTIVITY, FEEDING CHRONOLOGY, AND ENERGY
TRANSFORMATIONS OF JUVENILE ALEWIFE (ALOSA PSEUDOHARENGUS)
IN THE JAMES RIVER NEAR HOPEWELL, VIRGINIA

James Edwin Weaver
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B.S., Louisiana State University, 1968
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A Dissertation Presented to the Graduate
Faculty of the University of Virginia
in Candidacy for the Degree of
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1975

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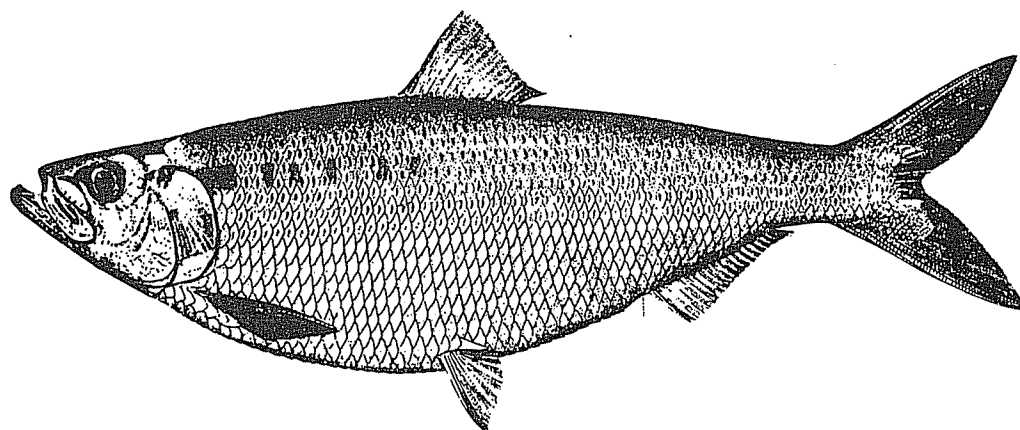
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Hickory shad, Alosa mediocris, adult

GENERAL ABSTRACT

Juvenile alewife, Alosa pseudoharengus (Wilson), in the nursery area of the James River, Virginia usually exhibited a bimodal diurnal feeding periodicity. Mature calanoid and cyclopoid copepods, copepodite stages of copepods, and cladocerans were predominant prey during the day. Nocturnal feeding on ostracods, oligochates, and immature and mature insects was occasionally noted. In general, electivity (E) was strongly positive for the large adult copepods Eurytemora affinis, Cyclops vernalis, and the cladoceran Leptodora kindtii, moderately positive for the cladocerans Bosmina spp., neutral for copepodites, moderately negative for the cladoceran Diaphanosoma brachyurum, and strongly negative for copepod nauplii. The effects of selective predation on the zooplankton community were not as pronounced as those found in lake environments, although the relatively small Bosmina spp. increased in abundance during the period of maximum utilization of the nursery area by alosine fishes in both years.

Energy transformations by juvenile alewife in the nursery area of the James River were estimated in 1972 and 1973 by field and laboratory methods. Preliminary estimations of daily rations were determined directly by ash-free caloric value of stomach contents in alewife collected every three hours during 27-hour stations, with laboratory-derived corrections applied for caloric value remaining from prior meals at mean environmental temperature. Percent egested of the caloric content of ingesta was estimated in the laboratory. Mean wet weight of all fish collected each month was converted to dry weight and caloric equivalent based on caloric analysis of ten fish each month, and the differences in caloric value between time intervals were calculated for estimation of growth rates. The caloric value of the remainder, after growth was subtracted from assimilation, was assigned to maintenance, since laboratory estimates of respiration rates were consistently high possibly due to handling of the excitable fish.

Ash-free caloric value of fish biocontent, daily ration, egesta, assimilation, and respiration for an average fish increased from early summer through September in each year. Growth, as percent of assimilated energy, was 48% in 1972 and 37% in 1973, respectively. Mean maintenance efficiency was 52% in 1972 and 63% in 1973. Lower water temperatures in 1972 may partially account for these differences.

Job 7. Fishes of the Nursery Zone

Summary

1. Fishes which live in association with the alosines were surveyed during the winter months to determine their densities and distribution from the mouth of each river to the head of navigation. Bottom trawls were towed for 1/4 mile at stations 1-1/4 miles apart in mainstream.
2. The James River contained the greatest variety of euryhaline species compared to the York, Rappahannock and Potomac. The variety of freshwater species was similar in all rivers.
3. The most numerous species captured in the lower saline zones of the rivers were juvenile blueback herring, bay anchovy, young-of-the-year croaker, and juvenile alewife and menhaden.
4. The most numerous species captured in the freshwater zones were channel catfish, white catfish, spottail shiner, brown bullhead, hogchoker, tessellated darter, and white perch; but the numerical rank was different in every river.
5. The James River ictalurids are most numerous approximately 10-20 miles below Hopewell, Virginia. Near Hopewell their numbers decrease, rise again upriver from Hopewell, then decrease again near Richmond.
6. Of the James River resident fishes sampled 1972-76, channel catfish had the highest average cn/f, followed by white catfish, spottail shiner, hogchoker, brown bullhead, and tessellated darter.
7. Of the York River resident fishes, hogchoker had the highest cn/f, followed by white perch, white catfish, spottail shiner, and channel catfish in 1975.
8. Of the Rappahannock resident fishes, white perch had the highest cn/f, followed by white catfish, spottail shiner, hogchoker, gizzard shad, and channel catfish in 1975.
9. Of the Potomac resident fishes, white perch had the highest cn/f, followed by brown bullhead, hogchoker, channel catfish, spottail shiner, and striped bass in 1975.
10. Young of the year croaker were most numerous in the James in 1974, and all rivers in 1975 indicate a successful yearclass was produced.

11. Average weight per tow (by species), average length, average weight, and the variation of cn/f, are presented by river zone for all rivers for 1975 and the James for 1972-75.

Program

Juveniles of the Alosa spp. compete with and are preyed on by other species of estuarine fishes. Yearclass strength may have some direct relationship to these interactions. We have made intensive winter surveys of the James, York, Rappahannock, and Potomac rivers to determine what the resident population pressures (predation and competition) might be. Resident fishes spend the entire year in the estuary-river, whereas migrants influence the interactions for only a part of the year. Most of the migratory fishes have left the river in the winter, but we do catch a few individuals of most species that are more common in summer. Resident species seem to seek deeper water as water temperatures fall below 6C. Cold water lowers the fish's metabolic rate, making the species less mobile and more susceptible to our trawl gear.

The winter survey of 1975 was conducted during January and February by making four tows with a 30 ft semiballoon otter trawl within each five mile block of river from the mouth to the head of navigation for our vessel. Each 5 mile block was divided into 1.25 mile sections and the tow location was selected randomly within each 1.25 mile section. Each tow was .25 mile (nautical) long, measured by radar; and made independent of tidal flow. The net had a cod end of 1/2 inch stretched mesh. Tow stations were selected along the main navigation channel. Hydrological data were gathered. From each tow, fish were counted and measured and total weight by species by tow determined. River miles are shown in Figure 7.1.

Data presentation and analysis for this progress report include trawl surveys made in 1972, 73, 74, and 75 on the James River, and 1975 data from the other rivers. The parameters derived are very basic ones and narrative or conclusions are minimal. The James River has been emphasized because of recent attention concerning fish kills and contamination by kepone⁽¹⁾. The 1976 completion report will include all years of data for every river.

The following definitions apply to the parameters calculated or usage of terms.

cn/f = Catch as numbers per unit of effort. The number of specimens of each species captured per tow. Average cn/f for each section is presented.

cw/f = The catch as weight per unit of effort. The total weight of all specimens of each species captured per tow. Average cw/f for each section is presented.

⁽¹⁾ Chlorinated hydrocarbon used as insecticide.

\bar{L} = Average fork length of each species for all tows within the five mile block.

\bar{W} = Average weight (individual weight) of each species from all tows within the five mile block.

Biomass⁽²⁾ = the amount by weight of each species equated to unit area or unit volume. Since tow length and net type have been identical for the winter surveys, biomass can = cw/f . Biomass is not additive between blocks nor additive across rivers. Biomass can be averaged for any combination of river blocks.

Standing crop = the total weight or number of species or combined, from a particular defined area. Comes from expansion of cn/f or cw/f estimates. Cannot be computed from winter survey data because only mainstream stations made for biomass.

Each tow sweeps 1,727 m² with the 30 ft tow bridles we have used. The 30 ft (footrope) otter trawl opens to 12.25 ft. (3.73 m) when used with a 30 ft. (each leg) bridle. This small opening increases dramatically when bridle length is increased, e.g., with bridle legs of 50 ft the opening becomes 16.75 ft and with bridle legs of 100 ft the opening becomes 22.3 ft. Biomass can be computed with a unit swept area of 1,727 m², making it equivalent to average cw/f . Within each five mile block the cn/f 's estimated only apply to water deeper than 18 ft. Thus we cannot use these data to calculate total numbers or weight by zone in the river. Shallow water (less than 18 ft) stations were made in 1975 in the lower third of the rivers but these data are too incomplete for use in expansion estimates. The upper stations in the York and Rappahannock rivers and the oxbows of the James River are typically less than 18 ft deep and are considered mainstream stations.

The proportion of the fishes which migrate from shoal to mainstream with falling water temperatures is not known, but in colder winters we suspect the movement is more complete. Yearly comparisons of cn/f by zone, or calculation of average river cn/f , therefore, contain the assumption of similar distribution between years. Measures of variance have been computed by zone as an aid to determining significance between comparisons.

- (2) The 1974 progress report for this project defines biomass as mean total weight of specimens captured. This is incorrect and users of the 1974 document are advised to change every occurrence of the term biomass in Job 7 to read total weight captured.

A wide variety of euryhaline species occur between the mouth of each river and freshwater. Many are part of the summer migrant populations. The severity of the winter may determine the extent to which these fishes remain in the estuary rather than going to sea. We may never know the actual relationship between temperature and overwintering estuarine fishes and presently have no sound basis for adjusting catches in any year. With continuance of our winter Chesapeake Bay survey we may be able to (after several more years) compare relative population size between rivers and the Bay for warm and cold winters. If the migrant fishes in the lower rivers and Bay leave each area proportional to water temperature, then population comparisons between years and between rivers become more tenuous.

The winter survey provides a description of the winter fish community, and some general population estimation statements can be made with cognizance of the sampling assumptions and factors of movement by zone and group of fishes.

James River Winter Fish Populations

The James River flows through Virginia's main industrial and population zones from above Richmond to its mouth at Chesapeake Bay. It is the most southerly of the main tributary rivers, and is nearest to the Chesapeake Bay mouth. Bottom salinity at mile zero (JA-00 = Old Point Comfort) averages near 20‰, decreases to 5‰ between JA-20 and JA-25, and falls to near zero between JA-28 and JA-37. The freshwater zone (less than 0.5‰) fluctuates in extent, depending on freshwater runoff within the drainage basin.

Freshwater species occur in low salinity zones but mainly are confined above mile 25 (JA-25). Euryhaline species are found in Chesapeake Bay and between the river mouth and the edge of their salinity tolerance upriver. Thus, the lower third of the James can contain summer holdovers, winter migrants, and young-of-the-year that previously lived in freshwater. The distribution and density of these latter groups in the lower James in winter cannot be considered a constant proportion of stock size, thus comparisons between years are meaningless for these groups.

The freshwater species can be considered unit stocks because they have tangible limits to their distribution. Our sampling program assesses those fish present in main-stream, where species such as carp, the sunfishes, chain pickerel, yellow perch, suckers, several forage species, are not normally taken. Species such as the American eel, hogchoker, and sheepshead minnow burrow in the bottom mud during the cold months, preventing assessment of their

true abundance. Species such as silversides, bay anchovy, blueback, alewife, menhaden, gizzard shad, spottail shiner, threadfin shad, and several others are typically pelagic species that seem to live closer to the bottom in winter. Bottom trawls cannot be used for population assessment of these normally pelagic species.

The river residents such as white perch, striped bass, hogchoker, tessellated darter, channel catfish, white catfish, and brown bullhead are commonly taken in the survey. These, plus young-of-the-year croaker, are the only species for which comparisons between rivers and years can be attempted. Even for these species, only the smaller members (below 25 cm) are regularly captured because of the small operational width of the trawl.

Each of the rivers sampled can differ in proportion of pelagic species or incidentals to residents. The fishes that are not sampled proportional to real abundance should not be compared to species that are better sampled. Comparisons between rivers of total number or total weight per species, expressed as a percentage of either total specimens or total weight of all species captured, cannot be used as a guide to relative differences between rivers⁽³⁾ or between years within a river. River comparisons of cn/f are valid if the same species are chosen in all rivers and distribution limits defined.

The James River from the mouth to freshwater contains the greatest variety of fishes of any river sampled. In a typical year 12 to 19 species have been taken per five mile zone. Over the four previous winter surveys, 35 species have been taken between the mouth and mile 20. Above mile 20 the species number drops to 6-10 per zone and declines even more between Hopewell and Richmond. From all trawl surveys, 55 species have been captured in the James from the mouth to Richmond (Table 7.1).

The most numerous species captured in the lower James (JA-00 to JA-30) were bay anchovy, followed by young-of-the-year croaker, blueback, alewife, and menhaden. The most numerous species captured from freshwater were channel catfish, white catfish, spottail shiner, brown bullhead, and tessellated darter. White perch and striped bass were taken in small quantities between 1972 and 1975. Prior to 1972 white perch were common in midwinter trawl catches in the James.

Young-of-the-year croaker enter the lower James from the ocean in late summer and throughout the fall. They are abundant bottom fish in mainstream in winter up to mile 25. By assuming that an equal fraction (per year) of all young croakers enter the James (and other rivers), our

⁽³⁾ Figure 7.1, Job 7, 1974 progress report for this project.

measurements can be used to estimate yearclass strength. From mile JA-00 to JA-24.9 the average cn/f of young croaker was 26 in 1972, 6 in 1973, 348 in 1974, and 63 in 1975, and 217 in 1976 (Table 7.10).

Channel catfish, white catfish, and brown bullhead represent species for which the best quantitative data exist from the winter surveys of the James. Channel catfish are distributed from JA-20 to JA-79.9 with the main population between JA-30 to JA-75. Average cn/f estimates computed from zone cn/f data by year show a channel catfish river index of 55 in 1972, 52 in 1973, 57 in 1974 and 69 in 1975, for miles JA-30 to JA-75.

White catfish are also distributed throughout the freshwater zone but the main population occurs between JA-30 and JA-64.9. For this zone the indices per year were 36 in 1972, 5 in 1973, 8 in 1975, and 15 in 1975.

Brown bullhead are found in mainstream but not to the extent of channel and white catfish. Their preferred habitat seems to be shallower water, oxbows, and small coves. They are more restricted along the river with the majority of specimens taken between JA-45 and JA-59.9. Within this zone their river index was 18 in 1972, 7 in 1973, 9 in 1974, and 6 in 1975.

Spottail shiner were captured in every year from mile JA-30 to JA-85 with the zone of main abundance between JA-45 to JA-84.9. By assuming similar vertical distribution in all years the average cn/f can be used as the river index between JA-45 and JA-84.9. The average cn/f was 38 in 1972, 21 in 1973, 12 in 1974, and 26 in 1975.

The ten mile section from JA-50 to JA-60 contained the greatest numbers of catfishes, bullheads and spottail shiners in every year. From mile 60 to 68 (Hopewell area) the numbers of these species fell in every year, recovered somewhat between mile 70 to 79, then fell again in proximity to Richmond (mile 85). White catfish were scarce in every year above mile 60.

York River Fish Populations

During the winter of 1975 the York River was sampled from the mouth through the Pamunkey and Mattaponi branches. The same program was used as on the James River. The greatest variety of fishes was found near the mouth (16 species at mile 05) with the species number falling to 3-10 in the freshwater zones of both branches.

The most numerous species were Atlantic croaker followed by hogchoker. Bay anchovies and menhaden were numerous near the river mouth. White catfish were far more numerous than channel catfish (Table 7.3), the reverse of the

James. White perch were abundant throughout the river except at the mouth. Sea lamprey and American eel were found in the Pamunkey branch but not the Mattaponi. Small numbers of alewife, blueback, and American shad were found from mile 00 to 29.9.

Rather than attempt to present detailed narrative of 1975 distribution, average length and weight and weight per tow; full 1975 data are presented in Table 7.3.

A comparison of catch rates of principal species for all rivers is presented as the last section of Job 7.

Rappahannock River Fish Populations

White perch were the most abundant river species captured, followed by white catfish, spottail shiner and hogchoker. Croaker were abundant from mile 00 to 40. The Rappahannock average cn/f for croaker was 15.3 from mile 00 to 39.9, compared to 400 for the York and 63 for the James River (Table 7.5).

Total number of species captured was 31 in 1975 with 7 to 12 species typically encountered within any five mile section. The number of species did not decline progressively in the upriver sections as was found for the James and York. Of special interest may be the occurrence of several blue catfish between mile 55 and 75. This species is apparently becoming established in the Rappahannock system, but has not been taken by our surveys from other rivers during 1972-75.

The distribution of fishes during the winter of 1975 is best determined by inspection of Table 7.5. Other data are presented for the contract year in Table 7.9.

Potomac River Fish Populations

The Potomac River is dominated by white perch, with all other common species having far lower cn/f (Table 7.7). White perch occur from the mouth to Washington D. C., with the bulk of the population (in winter) between mile 10 to 65.⁽⁴⁾ The average cn/f for white perch was 328 in 1975, compared to 108 for the Rappahannock, 21 for the York, and less than one for the James (Table 7.9).

Brown bullhead are the second most abundant species encountered in our survey and the average river cn/f of 30.7 in 1975 was much higher than the bullhead index from the James River. Numbers of channel catfish were similar to other rivers but white catfish were less numerous in the

⁽⁴⁾ We do not sample mile 20 to 40 because of the Dahlgren firing range.

Potomac than in any other river sampled. Overall, fewer species were found in the Potomac than in other rivers but the typical number per zone was similar to other rivers.

River Comparisons for 1975

The cn/f values of Tables 7.1 to 7.8 can be used to derive a river index of abundance for species available to the gear. Within a river, zones for computation of average cn/f (river index) were selected by inspection of distribution and abundance. For most species selected, their occurrence is sporadic within the blocks of first appearance, then stabilizes over some distance, then declines again to sporadic captures. The tail ends of each distribution curve were eliminated from data for average cn/f calculation. With four years of James River data, the zones could be determined well, but for the other rivers only the 1975 distribution was considered.

The zonation and summation method has several drawbacks but represents the best alternative to delineation of stock size. Complications such as shifts in distribution one year to the next, catch rate within a block outside of the inclusive zone being dependent of yearly stock size, and segments of river known to contain the species but not within our ability to sample, must be considered limitations to the precision of the estimate. With long term measures of prime abundance areas and variance of the estimates the numerical differences between rivers will become more meaningful.

Average cn/f values for Atlantic croaker, hogchoker, white perch, spottail shiner, channel catfish, white catfish, brown bullhead, striped bass, gizzard shad, and tessellated darter are given in Table 7.9. The values are density measurements only for the trawl paths and within the river zones indicated. The zone of principal abundance for each species is different in each river and between each species within a river, however the values can be compared directly for any combination. Direct comparison of average cn/f values for different species assumes equal vulnerability to the trawl.

A five year summary of average cn/f estimates for the James River principal species is presented in Table 7.10. Hogchoker, white perch, and brown bullhead have been declining since 1972. Spottail shiner and channel catfish were fairly stable 1972-1974, but both showed a 50% decline from 1975 to 1976. Atlantic croaker young-of-the-year have increased since 1972, which parallels the general increase in croaker stocks throughout the Chesapeake Bay system.

Literature Cited

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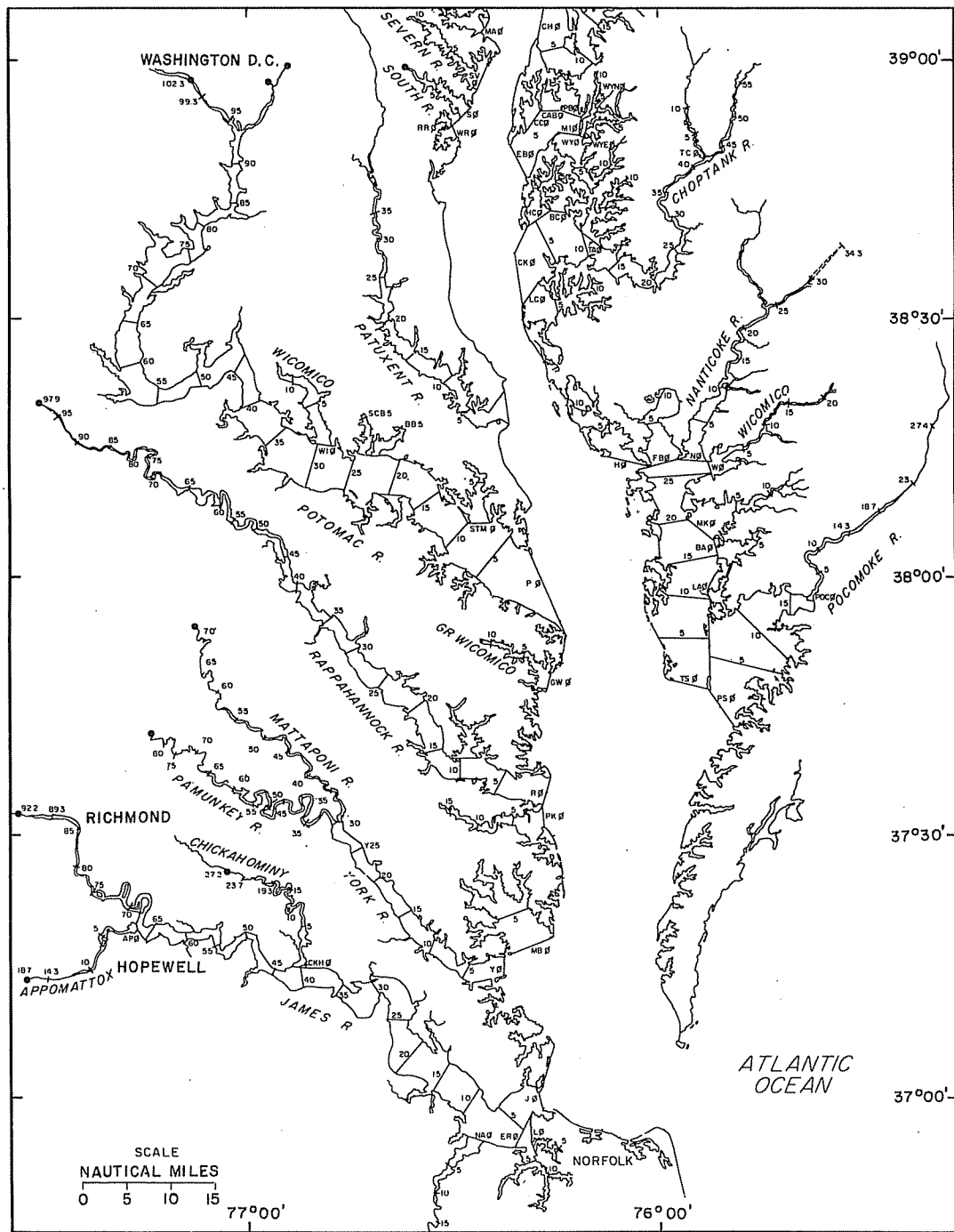


Fig. 7.1 Locator map of study area with river miles indicated.

Table 7.1 James River winter survey data 1972-75 expressed as average catch in numbers per tow (cn/f), average catch in weight per tow (cw/f), average fork length (\bar{L}) in millimeters, and average weight (\bar{W}) in grams. All tows within the five-mile section listed below the first mile of that section.

Species	Year	JA-00				JA-05				JA-10				JA-15				JA-20				
		cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	
Bav Anchovy	1972	393	511	53	1	2140	2568	56	1	161	194	60	1	390	468	58	1	5263	5263	52	1	
	1973	29	30	47	1	101	51	42	1	270	203	49	1	130	117	43	1					
	1974	366	563	59	2	145	185	57	1	69	113	64	2	74	105	62	1	144	121	51	1	
	1975	90	135	61	2	213	358	55	2	403	658	52	2	31	41	54	1	4	5	47	1	
Blueback Herring	1972	12	14	77	5	50	160	76	3	112	236	66	2	19	38	65	2	32	116	83	4	
	1973	21	108	77	5	144	609	75	4	304	1430	73	5	19	72	70	4	8	19	69	3	
	1974					1	25	138	33	<1		96	10	1	23	104	18	1			96	5
	1975	<1		72	5	<1		131	15	<1		83	10	1	41	149	29	1			158	68
Alewife	1972	61	906	108	15	54	631	99	12	5	56	95	13	30	304	96	10	62	722	99	12	
	1973	4	47	104	11	37	53	105	14	54	54	100	10	28	255	95	9	7	81	96	12	
	1974	23	273	99	12	20	170	89	9	18	210	98	12	14	183	99	14	4	50	95	12	
	1975									2	56	113	28	1	38	138	38					
American Shad	1972	8	115	111	15	13	227	114	17	<1		96		<1		111	17	9	105	104	12	
	1973	<1		116	10	1	15	104	12	1	26	115	20									
	1974	1	30	139	24	3	68	119	21	1	35	128	28	3	78	130	28					
	1975	1		118	15	1	14	110	14	1	32	113	26	<1		110	20					
Atlantic Croaker	1972	<1		83	10	8	50	74	7	84	209	66	3	19	42	65	2	17	69	77	4	
	1973	8	37	91	5	6	23	73	4	6	71	77	12	9	57	59	7	<1		87	10	
	1974	102	338	73	3	166	543	70	3	405	1265	66	3	1198	4190	64	4	231	913	62	4	
	1975	28	98	69	3	36	98	67	3	36	126	56	3	132	248	61	2	42	55	55	1	
Spot	1972	<1		112		<1		118	20									<1		112	20	
	1973	<1		119	13	<1		134	20	<1		130	50									
	1974	62	1045	104	17	18	223	98	13	33	400	98	12	36	450	98	13	3	31	98	13	
	1975	3	60	115	20	1	22	107	22	13	312	107	24	1	36	116	30					
Atlantic Menhaden	1972	9	88	87	10	5	42	95	9	<1		83		6	47	80	9	5	55	98	12	
	1973	3	29	82	9	9	85	82	10	28	146	71	5	7	46	75	7					
	1974	3	50	107	18	9	160	102	18	5	80	99	15	30	404	95	14	103	1765	101	17	
	1975	56	678	92	12	10	140	89	13	52	690	92	13	119	52	92	13	3	33	85	11	
Silverside	1972	13	48	95	4	6	38	96	7	3	10	92	3	<1		100		4	25	94	7	
	1973	1		74	3	<1		71		5	23	78	5	1		88	5					
	1974	1	10	91	10	1		104	10	<1		105	5	<1		105	20					
	1975	18	110	99	7	8	70	101	9	108	1860	108	10	15	118	106	8					
Hogchoker	1972	<1		100	10	2	75	128	50	<1		145	50	3	90	108	32	2	40	103	20	
	1973	4	162	125	38	2	113	125	75	2	128	128	56	22	677	108	32	33	1095	111	34	
	1974					2		131	53	2	105	131	53	5	663	126	126	62	2063	132	33	
	1975	1		88	35	<1		138	65	<1		120	45					5	210	118	43	
Water Toad	1972	2		68		4		149	117	6	555	141	101	1		147	130	<1		191		
	1973					2	450	203	225	3	233	129	78	<1		172	155					
	1974					1	71	130	71													
	1975	2	335	143	168	<1		175	160													

Table 7.1 (Continued). James River winter survey data.

Species	Year	JA-00				JA-05				JA-10				JA-15				JA-20				
		cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	
Northern Pipefish	1972	3		144		1		131		<1		115		<1		136						
	1973	3	11	133	3	2	7	132	3	<1		142										
	1974					<1		113	5													
	1975					1		151	8													
White Perch	1972													3		198	190		3	420	183	140
	1973													<1		188	177		<1		71	10
	1974																		1		140	50
	1975																		<1		92	20
American Eel	1972					<1		400	230					<1		505	120					
	1973													<1		526	240		5	233	247	50
	1974									<1		265	30	2	45	243	30		9	238	224	26
	1975					<1		96	5					2	206	387	114		1	43	246	35
Black-heck Tonguefish	1972	<1		75		<1		93	20	<1		58		<1		147						
	1973	3	14	84	4	<1		73		<1				<1		78	5					
	1974					2	3	59	1					1		61	3					
	1975	1	3	60	2																	
Spotted Hake	1972	<1		43		<1		73	20													
	1973					<1		96														
	1974	3	30	98	10	25	200	88	8	8	66	92	8	10	80	89	8					
	1975	6	43	81	7	8	68	89	8	6	62	94	11	1		103	18			<1	95	5
Summer Flounder	1972																					
	1973	1	23	176	23	3	135	171	49													
	1974	5	90	118	19	15	260	121	18	21	303	112	15	36	513	112	14		2	23	129	15
	1975	17	535	143	31	4	124	134	28	10	198	118	21	2	34	122	21		<1		98	10
Threadfin Shad	1972																					
	1973	<1		89																		
	1974	1		94	10	1		109	20	2	33	104	19	1		85	8					
	1975	<1		65	5	<1		73	5	1	18	86	15	11	100	85	9		9	48	76	5
Gizzard Shad	1972																					
	1973																					
	1974									2	58	143	38	2	190	153	106		2	93	153	51
	1975													<1		95	20		1	45	150	45
Atlantic Herring	1972	11	3190	299	285	4		300	321	7	1885	306	277	<1		306	300					
Mokory Shad	1974					<1		112	30	<1		116	20									
Striped Blenny	1974					<1		58	5													
Spotted Sea Trout	1974									<1		122	20									
Sea Lamprey	1974																		<1		174	10
Northern Seabrobin	1975	<1		45	5																	
Spotted Bullhead	1975	<1		27	5																	

Table 7.1. (Continued). James River winter survey data.

Species	Year	JA-50				JA-55				JA-60				JA-65				JA-70				
		cn/f	cw/f	L	W	cn/f	cw/f	L	W	cn/f	cw/f	L	W	cn/f	cw/f	L	W	cn/f	cw/f	L	W	
Blueback Herring	1972	<1				<1		59														
	1974					1	3	70	5	2	10	72	4									
White Perch	1972	2	257	181	143	<1		193	200	<1		182	110	<1		176	120					
	1973					<1	2	92	20	<1		202	240									
	1974					<1		96	20													
	1975					<1																
Hogchoker	1972	<1		70										<1		105	40					
	1974	1		55	3	1		56	3													
American Eel	1972	15	692	258	46	4	89	200	22	<1		253	30	6	123	213	20	2	46	251	26	
	1973					4	93	204	23					<1		263	50					
	1974	9	51	263	448	4	240	256	69	2	63	243	28									
	1975	34	1385	279	40	<1		155	10													
Brown Bullhead	1972	22	2337	213	106	29	4707	229	162	3	403	230	146	<1		231	150	<1		170	270	
	1973	10	1395	219	135	11	1350	217	123									2	150	209	100	
	1974	2	300	219	150	20	3090	229	158	1		229	177					<1				
	1975	12	1540	207	134	3	583	227	179	<1		208	120					<1		165	60	
White Catfish	1972	69	1228	90	18	9	420	132	49	2	80	113	36	3	13	70	4	<1		80		
	1973	4	144	128	36	5	129	103	24	4	69	116	18	<1		139	5					
	1974	16	584	150	37	7	109	101	15	3	65	118	26					<1	1200	650	4800	
	1975	81	2003	124	25	3	43	88	17	1		98	17	<1		68	5					
Channel Catfish	1972	70	7089	173	102	67	4704	188	70	6	1791	190	289	120	5223	186	44	39	1824	168	47	
	1973	31	5191	208	167	72	4598	190	64	10	718	170	73	56	1729	164	31	46	1624	152	35	
	1974	118	11,510	219	98	64	3525	154	55	46	3363	157	73	133	1868	104	14	3	105	142	42	
	1975	46	6985	187	48	34	1140	115	34	13	1305	185	100	150	1583	106	11	144	3555	142	25	
Gizzard Shad	1972					<1		173	70					<1		158	50	<1		215	130	
	1974																					
Spottail Shiner	1972	17	96	82	6	12	70	81	6	6	37	80	6	20	95	81	5	38	183	79	5	
	1973	<1		77	5	55	308	81	6	5	24	78	5	34	218	86	6	25	125	78	5	
	1974	6	45	84	8	6	45	85	8	11	63	82	6	4	33	85	9	1	11	81	9	
	1975	15	120	87	8	19	143	84	8	4	30	88	8	2	9	74	6	8	40	76	5	
Threadfin Shad	1974	<1		71	5																	
	1975	1	2	60	2	<1		73	1					1	11	72	9	<1		91	10	
Tessellated Darter	1972	13	28	69	2	3	13	71	4	<1		79		2	7	78	4	<1		73		
	1973	28	65	69	2	15	61	69	4					1		76	5	<1	3	84	3	
	1974	10	36	72	4	2	11	82	6	6	20	78	4	2	14	78	9	<1		74	5	
	1975	<1		68	1					1		93	20	1		72	8	<1		70	4	
Shorthead Redhorse	1973					<1		144	35													
	1974	<1		147	60					<1		175	80	<1		168	90	<1		128	40	
	1975																					
Carp	1974								<1	1363	775	5450						3	115	140	46	
Northern Hogsucker	1975																	<1		221	150	

Table 7.1 (Continued). James River winter survey data.

Species	Year	JA-75				JA-80				JA-TIO (1)				JA-JNO (2)			
		cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Channel Catfish	1972	20	1055	150	54	3	345	202	138	643	13,632	120	21	209	5671	125	27
	1973	112	5242	160	47	3	533	244	211	26	293	109	23	519	679	171	26
	1974	120	3418	134	29					6	1560	270	275	62	1920	131	31
	1975	51	1825	157	36	10	380	134	40	19	233	157	97	18	577	131	32
White Catfish	1972	1		71						257	3007	88	12				
	1973	<1		213	5	<1		165	5	5	80	137	36				
	1974	2	118	168	59									<1		174	60
	1975	<1		145	40					<1		104	20	<1		205	160
Brown Bullhead	1972	8	1750	228	233					311	31,287	198	101	88	9187	200	104
	1973	<1		219	140	<1		212	160	194	8998	204	93	15	677	195	90
	1974	2	168	186	96					32	3400	213	106	48	5113	190	106
	1975	1	195	219	156					25	1867	190	94	8	600	176	72
Gizzard Shad	1972									<1		168	60	1	215	234	215
	1973									5	85	131	34	1		112	25
	1974									2	133	149	57	3	197	163	66
	1975	<1		120	20					1	347	214	260	2	560	204	280
Spottail Shiner	1972	92	525	79	6	109	760	88	7	46	173	81	4	51	318	83	6
	1973	25	63	87	8	15	66	90	9	369	1161	90	6	189	453	83	5
	1974	10	69	84	7	52	80	80	6	755	3417	76	5	309	1707	81	6
	1975	100	663	88	7	27	190	81	7	287	2027	91	7	48	293	81	6
Tessellated Darter	1972	<1		66						29	105	78	4	6	46	74	3
	1973	1	3	75	3					40	100	80	5	54	123	80	5
	1974	1		72	5	1		46	5	11	43	78	4	6	20	74	3
	1975	6	20	65	4	1		69	5	10	55	78	5	6	33	74	6
Shorthead Redhorse	1972									2	100	152	50				
	1973																
	1974	1	130	175	130												
1975	1		177	110					1	700	194	233	1	60	139	45	
Carp	1972									3	2155	426	1724	1	1928	467	1928
	1973									4	2325	405	1329	4	2668	425	1524
	1974	<1		463	1830					<1		348	920	2	3397	419	1456
	1975	<1	340	413	1360					1	1717	394	1288	15	22,817	411	1488
Threadfin Shad	1974									2	20	84	9	3	27	83	10
	1975									70	670	91	10	59	617	90	10
Northern Hogsucker	1974	<1		147	40												
	1975	1	8	207	165												
Tadpole Midtom	1974					1		66	5								

Table 7.1. (Continued) .James River winter survey data.

Species	Year	JA-75				JA-TIO (1)				JA-JNO (2)			
		cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Yellow Perch	1972					2	55	147	37				
	1973					<1		110	5				
	1974					1		170	85	1	57	145	57
	1975												
Pumpkinseed	1972					3		121		<1		117	30
	1973					5	110	103	24	1		115	35
	1974					<1		115	50	<1		90	25
	1975												
White Perch	1972					6	710	185	118	<1		172	130
	1973					3	28	110	22	2		111	30
	1974					5	140	103	26	6	130	100	22
	1975					7	133	104	19	7	147	97	17
Golden Shiner	1973					1		123	10				
	1974					74	1813	120	25	1		105	15
	1975	<1		128	40	12	440	139	37				
American Eel	1972	1	35	242	35	1	40	270	40				
Eastern Silvery Minnow	1972					<1		100					
	1974					1		100	10	3	53	106	18
	1975					4	87	114	22				
Hogchoker	1972					1		44		<1		84	
	1974									1		40	
Blueback Herring	1974					63	143	66	2	2	8	63	5
Black Crappie	1975					<1	10	104	15				
Quillback Carpsucker	1972					<1		210	180				
	1975									1	833	314	625
Bluegill	1972					1	90	160	90				
River Chub	1974					1		85	20				
Longnose Gar	1973									1		558	680
Creek Chubsucker	1975									1	67	235	200

(1) TIO = Turkey Island Oxbow on James River mile 67

(2) JNO = Jones Neck Oxbow on James River mile 70.5

Table 7.1. (Continued). Incidental catches from the James River winter survey.

Species	Year	Zone	cn/f	cw/f	\bar{L}	\bar{W}
Quillback Carpsucker	1974	JA-75	<1		141	40
	1975	JA-65	<1		103	20
Naked Goby	1973	JA-00	2		32	
	1974	JA-20	<1		31	5
	1975	JA-20	<1		29	5
Channel Bass	1973	JA-00	<1		66	
River Chub	1973	JA-40	<1		87	5
Silver Hake	1973	JA-00	<1		93	
Channel Catfish	1973	JA-20	<1	660	515	2000
	1974	JA-20	2	148	174	74
	1975	JA-20	1	265	280	353
White Catfish	1974	JA-20	1		197	110
	1975	JA-20	1	64	137	51
Brown Bullhead	1973	JA-20	<1		90	5
Green Goby	1973	JA-15	<1		40	5
Fantail Darter	1973	JA-80	<1		39	39
Creek Chubsucker	1975	JA-50	<1		90	10
Atlantic Sturgeon	1975	JA-70	<1		200	50
Winter Flounder	1972	JA-00	<1		160	80
		JA-05	<1		208	100
	1973	JA-00	<1		139	20
Tautog	1972	JA-05	<1		130	40
		JA-10	<1		85	
	1975	JA-00	<1		178	170
Feather Blenny	1972	JA-00	<1		62	20
		JA-05	<1		74	
	1973	JA-00	<1		46	
	1975	JA-00	1	18	74	18
		JA-05	<1		95	30
Striped Bass	1972	JA-10	<1		254	253
		JA-15	2	640	276	320
	1973	JA-00	<1		379	450
		JA-15	<1		346	595
Skillefish	1972	JA-00	<1		43	
	1973	JA-05	<1		51	
Smallmouth Flounder	1972	JA-05	<1		64	
	1974	JA-05	<1		71	5
Alewife	1972	JA-25	6	40	86	6
Atlantic Croaker	1972	JA-25	91	182	2	52
	1974	JA-25	1		37	3
Atlantic Menhaden	1972	JA-40	<1		71	
American Shad	1974	JA-45	21		121	20
	1975	JA-50	9	505	251	56
Tessellated Darter	1972	JA-20	<1		71	
		JA-25	<1		100	10
		JA-30	<1		76	
		JA-35	<1		71	
		JA-40	<1		62	
		JA-45	8	27	65	3
	1973	JA-30	<1		68	5
		JA-35	2		77	5
		JA-40	1	7	65	5
		JA-45	31	84	64	3
	1974	JA-30	<1		55	5
		JA-40	5	11	65	2

Table 7.2 Standard deviation (s) of cn/f and coefficient of variation (V) in percent for James River winter survey data listed in Table 7.1.

Species	Year	JA-00		JA-05		JA-10		JA-15		JA-20		JA-25		JA-30		JA-35		JA-40		JA-45		JA-50	
		s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Bay Anchovy	1972	564.4	144	3274.6	152	211.7	131	358.4	92	1745.5	33	2687.1	102										
	1973	20.9	72	53.2	53	240.7	89	161.4	124														
	1974	320.5	88	70.5	49	85.7	125	118.9	161	171.8	119	1.0	200										
	1975	68.8	76	371.6	175	729.7	181	53.7	172	5.2	148	1.0	200										
Blueback Herring	1972	11.1	97	46.8	94	54.4	48	25.6	136	27.2	84	25.4	77	9.0	80	3.3	87	1.3	87				
	1973	12.5	61	69.7	48	356.9	117	11.6	63	7.8	98	3.1	14	1.4	47	5.6	60	2.8	93	0.8	80		
	1974			1.5	200	0.5	200	1.9	151	1.0	200	1.0	200	1.5	85.7	1.5	119.9	0.5	200	1.4	141		
	1975	0.5	200	0.5	137	0.4	224	0.9	64	0.9	128	0.9	77	2.8	52	3.3	82	1.0	77	0.5	200		
Alewife	1972	65.3	107	25.0	48	7.7	171	26.2	89	29.1	47	2.5	40										
	1973	4.2	98	12.8	34	68.7	128	9.8	35	6.0	90												
	1974	19.7	86	25.8	129			15.7	93	3.4	25	7.2	170										
	1975					2.0	100	1.7	173														
American Shad	1972	5.4	72	19.3	146	0.6	115	1.0	128	6.2	69												
	1973	0.5	200	1.9	151	2.5	192																
	1974	1.0	77	1.5	46	1.9	151	3.8	137											0.5	200		
	1975	0.6	115	1.7	173	1.3	109	0.4	224													18.0	200
Atlantic Croaker	1972			5.9	79	99.7	119	26.1	137	13.7	83	37.6	41										
	1973	6.9	83	2.6	41	2.6	45	8.8	104	1.2	182												
	1974	115.5	113	134.8	81	549.7	136	1362.7	114	173.2	75	1.5	200										
	1975	18.6	65	65.0	181	63.2	175	170.7	130	64.2	152	4.4	174										
Spot	1972	0.6	115	0.5	200					0.5	200												
	1973	0.1	127	0.5	200	0.5	200																
	1974	66.6	108	19.4	110	22.8	70	19.5	55	2.4	05												
	1975	2.6	86	1.4	141	16.8	129	1.6	137														
Atlantic Menhaden	1972	8.3	94	1.9	42			6.4	116	3.7	82							0.5	200				
	1973	3.2	97	5.8	68	23.9	87	6.1	94														
	1974	3.4	124	8.7	96	4.0	78	25.1	85	196.7	191												
	1975	97.0	174	15.0	145	66.7	129	156.9	132	4.8	159												
Silversides	1972	11.9	95	4.6	79	3.9	122			2.5	71												
	1973	1.4	141	1.0	127	4.4	98	1.3	100														
	1974	1.4	141	1.0	200	0.5	200	0.5	200														
	1975	21.0	116	9.8	128	315.5	174	31.3	206														
Hogchoker	1972	0.5	200	1.7	113	0.5	200	2.8	100	0.8	40	15.7	79	37.5	52	22.1	92	5.2	69	1.2	115	0.5	200
	1973	2.5	58	0.6	38	2.9	126	8.7	40	15.9	49	9.4	113	24.3	75	1.3	24	1.2	120	0.6	114		
	1974			2.2	108	6.2	118			65.4	105	63.4	128	12.6	53	2.4	82	2.4	95	0.6	115	1.0	200
	1975	1.0	200	0.9	224	0.5	137			9.5	200	2.0	200	1.0	200					0.5	200		
Cunner Thad	1972	1.7	113	5.7	163	3.1	56	1.9	151	1.0	128												
	1973			1.8	91	2.9	98	1.0	200														
	1974			0.8	82			1.0	200														
	1975	2.2	108	0.5	137																		

Table 7.2 (Continued)

Species	Year	JA-00		JA-05		JA-10		JA-15		JA-20		JA-25		JA-30		JA-35		JA-40		JA-45		JA-50	
		s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Northern Pipefish	1972	3.6	120	1.4	141	0.6	115	0.5	200														
	1973	2.5	76	2.7	135	0.5	200																
	1974			0.5	200																		
	1975			0.9	149																		
White Perch	1972							2.6	104	4.7	157	0.1	15	1.0	82	0.5	200	0.6	115	1.7	113	1.5	83
	1973							1.0	127	1.2	171	0.5	200	0.6	114					0.6	38		
	1974									0.9	128	1.5	200			1.0	200	0.8	82				
	1975									0.5	200	1.0	200					0.5	200				
American Eel	1972			0.5	200			0.5	200			1.0	200	1.0	200					0.5	200	21.5	143
	1973							0.5	200	6.4	137									0.5	200		
	1974					0.5	200	1.7	115	10.1	113	0.8	27	1.7	98			1.0	200			5.9	68
	1975			0.4	224			3.5	194	2.5	200	4.0	200									59.4	173
Blackcheek Tonguefish	1972	1.0	128	1.0	128	0.6	115	0.5	200														
	1973	3.3	100	0.5	200			0.5	200														
	1974			2.9	164			1.0	200														
	1975	1.5	120																				
Spotted Hake	1972	0.5	115	0.5	200																		
	1973			0.5	200																		
	1974	3.5	116	16.9	67	9.0	110	5.0	49	0.5	200												
	1975	4.8	77	10.1	123	6.3	108	1.1	137														
Summer Flounder	1973	0	0	2.8	100																		
	1974	8.8	186	18.0	124	15.5	75	24.0	68	1.9	128												
	1975	2.7	16	5.5	125	16.8	175	1.1	71	0.5	200												
Threadfin Shad	1973	0.5	200																				
	1974	1.0	128	0.6	116	2.2	127	1.0	128									0.6	115			0.5	200
	1975	0.5	200	0.4	224	1.3	109	8.8	82	7.9	87	21.1	83	9.5	72	1.7	76	1.7	50	1.5	120	1.0	128
Gizzard Shad	1972									1.2	67	0.6	40	0.5	200			0.5	200	0.5	200		
	1973							2.4	133	1.0	100	9.6	80	0.5	200					0.5	200		
	1974					1.3	86	1.0	200	0.8	82	1.5	200			0.5	200			0.5	200		
	1975							0.9	224			0.5	200	0.5	200	0.5	200			0.5	200		
Atlantic Herring	1972	10.9	97	5.0	131	13.5	198	1.0	128														
Hickory Shad	1974			0.5	200	0.5	200																
Brown Bullhead	1972													0.6	115			1.0	115	3.0	107	28.1	128
	1973									0.6	173	0.5	200	0.6	114							19.2	186
	1974																			9.2	175	1.8	91
	1975																	0.5	200	5.4	178	12.4	108
White Catfish	1972													17.1	46	111.4	134	17.1	78	17.3	58	54.7	79
	1973													4.3	81	1.7	94	1.7	74	2.5	22	4.2	107
	1974							1.0	200	1.7	49	5.2	84	4.2	93	7.3	67	5.2	90	13.4	87		
	1975							0.9	77	3.3	88	2.6	117	1.0	128	2.1	22	7.2	50	66.8	87		

Table 7.2 (Continued).

Species	Year	JA-00		JA-05		JA-10		JA-15		JA-20		JA-25		JA-30		JA-35		JA-40		JA-45		JA-50	
		s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Channel Catfish	1972									0.6	115	17.9	37	52.7	182	52.7	55	22.7	43	43.0	62		
	1973									0.6	173	22.4	122	42.4	36	3.5	78	13.5	135	35.0	63	46.4	148
	1974									2.4	122	6.4	52	5.7	65	14.2	73	43.0	103	8.7	72	162.6	138
	1975									0.5	67	0.9	128	1.0	77	1.4	47	5.9	41	23.3	65	27.8	19
Spottail Shiner	1972													2.4	86	1.7	113	16.7	106	5.8	94	10.3	62
	1973													1.5	65	1.0	127	1.0	67	3.8	51	0.5	67
	1974									0.5	200	4.5	114	0.5	67	0.6	115	0.6	115	3.8	84	5.4	99
	1975																	10.8	86	6.3	88	4.2	29
Tessellated Darter	1972									0.5	200	0.5	200	0.5	200	1.5	200	0.5	200	8.3	106	5.0	39
	1973													0.5	67	1.0	56	1.0	77	17.6	57	16.4	59
	1974													0.5	200			5.0	99			12.0	117
	1975																					5.0	200
Striped Bass	1972					1.0	128	2.8	141														
	1973	0.5	200					0.6	114														
Feather Blenny	1972	0.5	200	1.0	200																		
	1973	0.5	200																				
	1975	1.4	141	0.4	224																		
Winter Flounder	1972	0.5	200	1.0	128																		
	1973	0.5	200																				
Naked Goby	1972									0.5	200												
	1973	0.7	47																				
	1974									65.4	105												
	1975									0.5	200												
Tautog	1972																	0.5	200				
	1974																					0.5	200
Smallmouth Flounder	1972			0.5	200																		
	1974			0.5	200																		
Skilletfish	1972	1.0	128																				
	1973			0.6	114																		
Shorthead Redhorse	1972																	0.5	200				
	1974																					0.5	200
Striped Blenny	1974			0.5	200																		
Northern Searobin	1975	0.5	200																				
Sea Lamprey	1974							0.5	200														
Carp	1975																			0.5	200		
Striped Mullet	1975	0.5	200																				
Creek hubsucker	1975																					0.5	200

Table 7.2 (Continued).

Species	Year	JA-55		JA-60		JA-65		JA-70		JA-75		JA-80		JA-TIO ⁽¹⁾		JA-JNO ⁽²⁾	
		s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Blueback Herring	1974	0.6	115.5	1.7	76									55.0	88	2.1	125
American Shad	1972													0.7	141	1.4	141
Hogchoker	1972															0.7	141
	1974	0.1	200			0.5	200							1.2	173	0.6	87
White Perch	1972	0.5	67	0.5	200									0	0	0.5	200
	1973			0.5	200	0.5	200							2.1	84	2.1	140
	1974	0.5	200											5.9	110	8.7	145
	1975	0.5	200											4.6	65	9.0	81
American Eel	1972	4.2	105	1.0	200	12.0	200	2.9	16	1.4	141			1.4	141		
	1973	4.5	113			0.5	200										
	1974	5.2	148	1.7	76												
	1975	0.5	200														
Threadfin Shad	1974													2.5	108	2.5	94
	1975	0.5	200			1.2	101	0.5	200					60.1	86	70.3	119
Gizzard Shad	1972					0.5	200							0.5	200	1.4	141
	1973													5.7	200	1.4	140
	1974	0.5	200					0.5	200					4.0	173	3.6	120
	1975									0.5	200			1.2	87	1.7	87
Brown Bullhead	1972	25.6	88	2.5	89	1.0	200	0.5	200	3.5	47			199.4	64	50.9	58
	1973	5.8	53					1.9	127	1.5	200	0.5	200	55.9	29	1.4	9
	1974	35.7	183	1.0	128					2.1	118			37.8	118	42.1	87
	1975	2.5	77	2.5	200			0.5	200	1.9	151			9.5	38	9.3	111
White Catfish	1972	30.6	46	1.0	45	4.6	144	0.5	200	0	0			335.2	130		
	1973	3.2	60	5.6	147	0.5	200			0.5	200	0.5	67	4.9	109		
	1974	12.5	173	1.7	69					3.4	168					0.6	173
	1975	31.7	148	1.5	200	0.5	200	0.5	200	0.5	200			0.6	173	0.6	173
Channel Catfish	1972	30.6	46	5.1	82	105.2	88	51.0	131	10.6	54	2.1	84	239.0	37	152.0	73
	1973	38.6	54	6.9	70	51.0	91	23.2	50	94.0	84	2.2	73	26.9	103	149.2	29
	1974	71.4	111	34.6	75	239.7	181	2.4	95	117.3	98			5.1	91	43.2	70
	1975	49.3	147	14.7	113	218.5	146	183.4	127	83.9	164	10.6	112	10.2	54	20.4	113
Spottail Shiner	1972	5.5	45	2.2	37	8.1	41	28.7	75	67.9	74	7.8	7	53.0	116	46.0	91
	1973	25.9	47	2.9	64	21.2	62	10.0	40	19.2	76	11.0	73	402.3	109	122.3	65
	1974	5.8	97	4.5	43	5.1	145	1.3	101	8.2	82			813.5	108	242.5	78
	1975	18.1	97	7.3	184	1.7	115	8.6	105	110.0	110	37.5	141	310.7	108	33.3	69
Tessellated Darter	1972	3.2	107	0.5	200	2.2	122	0.5	200	0.7	141			24.0	83	4.9	89
	1973	9.9	65			1.0	77	1.5	200	2.0	200			15.6	39	24.7	46
	1974	2.2	108	6.4	115	2.4	159	0.5	200	0.6	115			9.5	89	7.9	132
	1975			1.0	200	1.0	128	4.9	116	7.1	130	0.7	141	6.6	66	4.7	83

Table 7.2 (Continued).

Species	Year	JA-55		JA-60		JA-65		JA-70		JA-75		JA-80		JA-TIO ⁽¹⁾		JA-JNO ⁽²⁾	
		s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Shorthead Redhorse	1972							0.6	114	0.7	141			2.8	141		
	1973																
	1974	0.5	200	0.5	200	0.5	200			0.8	82			1.0	100	2.3	173
	1975							3.1	124	1.0	200						
Carp	1972													0.7	28	1.4	141
	1973													0.7	20	2.1	60
	1974			0.5	200					0.5	200			0.6	173	2.1	89
	1975									0.5	200			2.3	173	25.7	168
Northern Hogsucker	1974									0.5	200						
	1975							0.5	200	1.0	200						
Yellow Perch	1972													2.1	141		
	1973													0.7	140		
	1974													1.2	173		
	1975															00	00
Pumpkinseed	1972													2.8	94	0.7	141
	1974													4.7	101	1.2	173
	1975													0.6	173	1.2	173
Golden Shiner	1973													1.4	141		
	1974													62.6	85	1.2	173
	1975									0.5	200			19.9	166		
Eastern Silvery Minnow	1972													0.7	141		
	1974													1.2	173		
	1975													6.9	173	5.2	173
Quillback Carpsucker	1972													0.7	141		
	1974									0.5	200						
	1975					0.5	200									1.2	87
Black Crappie	1975															1.2	173
Bluegill	1972													1.4	141		
River Chub	1974													0.6	87		
Longnose Gar	1973															1.4	140
Creek Chubsucker	1975															0.6	173
Atlantic Sturgeon	1975							0.5	200								
Pantail Darter	1973											0.5	200				

(1) TIO = Turkey Island Oxbow on James River mile 67

(2) JNO = Jones Neck Oxbow on James River mile 70.5

Table 7.2 Continued: Incidental catches from the James River winter survey.

Species	Year	River Mile	s	V
River Chub	1973	JA-35	0.5	200
Green Goby	1973	JA-15	0.5	200
Silver Hake	1973	JA-00	0.5	200
Red Drum	1973	JA-00	0.5	200
Spotted Sea Trout	1974	JA-10	0.5	200

Table 7.3. York River winter survey data 1975 expressed as average catch in numbers per tow (cn/f), average catch in weight per tow (cw/f), average fork length (\bar{L}) in millimeters, and average weight (\bar{W}) in grams. All tows within the five-mile section listed below the first mile of that section.

Species	YO-00				YO-05				YO-10				YO-15				YO-20			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Bay Anchovy	1702	862	49	1	842	826	50	1	103	84	50	1	46	45	49	1	34	28	48	1
Blueback Herring	<1		75	10	1		80	3	1		75	5	1	5	75	4	<1		66	5
Alewife	1		100	13	<1		112	20	1	12	98	12	<1		95	10	1		94	10
Atlantic Croaker	632	688	54	1	456	303	46	1	102	78	43	1	45	43	47	1	636	205	33	<1
Spot	3	60	104	20	2	36	107	16	1	24	107	20	5	93	111	19	1		109	15
Atlantic Menhaden	983	13,942	92	14	2	20	86	13	<1		69	10	1	8	81	8	1		75	7
Atlantic Silverside	3	16	94	5	2	16	102	9												
Hogchoker	2	84	124	42	25	1182	127	47	41	1474	118	36	36	1083	105	30	14	355	98	25
White Perch					27	5122	215	193	12	1702	187	144	32	2838	158	88	37	948	104	26
American Eel	<1		489	200	<1		426	120					<1		420	50	1		200	10
Summer Flounder	2	84	170	53	1	48	178	60	1		184	60	1	78	178	62	5	243	173	54
Gizzard Shad													<1		206	140	1		170	80
White Catfish													<1		330	560	<1		238	670
Blackcheek Tonguefish	1	20	114	17	1	14	115	12	2	12	71	5	4	9	61	2	1		100	3
American Shad	2	28	107	13	<1		105	15												
Sea Lamprey	<1		141	10					<1		148	5					1		150	5
Striped Bass									<1		207	120	<1		100	10				
Oyster Toad					<1		77	10	<1		111	33								
Naked Goby					1		35	3	<1		40	3								
Northern Pipefish	<1		111	5																
Black Sea Bass									<1		180	90								
Spotted Hake													<1		95	10				
Threadfin Shad																	<1		71	5

Table 7.3 (Continued) York River winter survey data 1975.

Species	YO-25				YP-30 (1)				YP-35				YP-40				YP-45			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Bay Anchovy	5	6	45	1																
Blueback Herring	<1		69	5																
Alewife	<1		122	20																
Atlantic Croaker	527	83	25	<1																
Atlantic Menhaden	<1		136	40																
Hogchoker	1		100	20	2	100	123	44	9	80	66	7	72	465	68	7	757	8043	79	11
White Perch	27	1048	116	39	16	1333	155	85	9	233	87	20	7	368	108	53	19	323	88	17
American Eel	<1		148	10	1		257	57	<1		150	10	1	40	258	40	<1		340	80
Gizzard Shad	<1		105	10													<1		199	110
White Catfish	8	700	184	90	27	2800	180	105	11	790	139	54	11	763	121	71	20	353	89	18
American Shad	<1		80	10																
Sea Lamprey	1		145	5					1		138	5	<1		158	10	1		155	10
Longnose Gar	<1		368	100																
Channel Catfish									<1		97	10	6	730	207	133	10	400	129	42
Tessellated Darter													<1		60	5	3	6	62	2
Spottail Shiner																	1		91	7
Atlantic Sturgeon																	<1		129	10

Table 7.3, (Continued). York River winter survey data 1975.

Species	YM-30 ⁽²⁾				YM-35				YM-40			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Hogchoker	16	163	177	10	3	18	66	7	40	145	57	4
White Perch	8	436	125	53	9	228	107	33	15	588	116	39
Gizzard Shad									<1		155	60
White Catfish	15	1470	158	101	71	2438	102	46	17	1780	153	103
Channel Catfish					1	55	132	40	1		126	40
Tessellated Darter					3	11	71	5	13	253	64	19
Spottail Shiner					13	10	94	95	3	30	96	12
Shorthead Redhorse									1	70	162	70

(1) PM = Pamunkey branch of York River

(2) MP = Mattaponi branch of York River

Table 7.4. Standard deviation (s) of cn/f and coefficient of variation (V) in percent for York River winter survey data listed in Table 7.3.

Species	YO-00		YO-05		YO-10		YO-15		YO-20		YO-25		PM-30 ⁽¹⁾		PM-35	
	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Bay Anchovy	1563.5	92	1689.3	200	194.2	188	64.0	141	27.6	82	3.6	71				
Blueback Herring	0.4	224	1.3	224	1.1	137	1.2	101	0.5	200	0.5	200				
Alewife	0.9	149	0.5	137	1.0	100	0.5	200	0.5	67	0.5	200				
Atlantic Croaker	588.4	93	697.0	153	106.0	104	35.5	78	858.3	135	374.4	71				
Spot	6.2	205	1.9	87	1.6	137	1.9	40	0.6	115						
Atlantic Menhaden	2050.9	209	3.0	190	0.4	224	1.4	141	1.0	128	0.5	200				
Atlantic Silverside	3.6	114	2.7	149												
Hogchoker	1.4	71	37.2	146	42.3	103	17.9	49	15.4	108	0.6	115	2.6	117	20.8	173
White Perch			27.0	101	18.5	157	20.2	62	37.5	102	36.3	134	19.5	124	9.0	79
American Eel	0.4	224	0.4	224			0.5	200	1.0	128	0.5	200	1.0	128	0.6	173
Summer Flounder	3.0	191	0.8	105	0.5	91	1.0	77	8.3	185						
Gizzard Shad							0.5	200	0.6	115	0.5	200				
White Catfish							0.5	200	0.5	200	15.5	200	21.6	81	2.5	17
Blackcheek Tonguefish	1.6	137	1.3	109	3.3	152	1.8	46	1.0	200						
American Shad	4.9	274	0.9	224							0.5	200				
Sea Lamprey	0.4	224			0.5	137			1.0	200	1.0	200			1.2	173
Striped Bass					0.4	224	0.5	200								
Oyster Toad			0.9	224	0.5	137										
Naked Goby			0.9	149	0.9	224										
Northern Pipefish	0.4	224														
Black Sea Bass					0.4	224										
Spotted Hake							0.5	200								
Threadfin Shad									0.5	200						
Longnose Gar											0.5	200				
Channel Catfish															0.6	173

Table 7.4 (Continued).

Species	PM-40		PM-45		MP-30 ⁽²⁾		MP-35		MP-40	
	s	V	s	V	s	V	s	V	s	V
Hogchoker	65.4	91	716.0	94	25.6	162	3.3	133	40.3	100
White Perch	5.6	80	13.7	74	15.8	192	2.9	42	11.8	79
American Eel	1.4	141	0.5	200						
Gizzard Shad			0.5	200					0.5	200
White Catfish	4.3	40	23.4	120	16.1	111	26.4	50	15.7	91
Sea Lamprey	0.5	200	0.6	115						
Channel Catfish	3.8	69	5.7	60			2.0	200	0.6	115
Tessellated Darter	0.5	200	3.6	119			4.4	174	23.3	176
Spottail Shiner			1.0	128			16.9	174	2.4	95
Atlantic Sturgeon			0.5	200						
Shorthead Redhorse									2.0	200

(1) PM = Pamunkey branch of York River

(2) MP = Mattaponi branch of York River

Table 7.5 Rappahannock River winter survey data 1975 expressed as average catch in numbers per tow (cn/f), average catch in weight per tow (cw/f), average fork length (\bar{L}) in millimeters, and average weight (\bar{W}) in grams. All tows within the five-mile section listed below the first mile of that section.

Species	RA-00				RA-05				RA-10				RA-15				RA-20			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Bay Anchovy	33	71	56	2	28	47	60	2	11	11	47	1	3	10	51	4				
Blueback Herring	7	48	88	7	103	682	93	7	<1		105	20	36	218	81	6				
Alewife	47	920	118	19	5	94	110	18	60	1332	117	22	5	130	119	25	1		102	17
Atlantic Croaker	10	16	41	2	41	45	48	1	22	24	54	1	18	45	61	2	1	3	59	3
Spot	<1		111	20	24	385	105	16	14	192	98	14	6	90	97	14	5	89	105	18
Atlantic Menhaden	1425	20,970	100	15	21	329	86	16	10	162	90	17	14	136	105	9	4	58	94	16
Atlantic Silverside	10	164	101	16	15	474	97	32	4	34	104	9								
Hogchoker					1	66	138	66	4	210	133	53	2	64	119	40	<1		155	10
White Perch	4	940	224	216	12	1946	197	168	52	7160	188	138	28	3494	181	127	441	24,676	137	56
American Eel					<1		206	30					<1		178	20				
Summer Flounder					<1		133	40	<1		153	40	<1		161	40	<1		172	40
Gizzard Shad					<1		163	70	<1		141	50	<1		145	60	6	410	146	68
Blackcheek Tonguefish	<1		93	18																
American Shad					2	42	108	18												
Winter Flounder					<1		245	220												
Skilletfish					<1		52	5					<1		59	10				
Spotted Hake									<1		115	20								
Striped Bass																	<1		95	10
Striped Mullet																	<1		170	70

Table 7.5 (Continued). Rappahannock winter survey data 1975.

Species	RA-25				RA-30				RA-35				RA-40				RA-45			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Bay Anchovy	8	9	47	1	12	14	46	1	15	16	48	1	1		37	2				
Blueback Herring	1		78	10	1		79	3	<1		72	5								
Alewife	1		103	15	<1		122	30												
Atlantic Croaker	1	3	42	2	4	4	38	1	3	5	32	2	1	1	29	1				
Threadfin Shad					<1		91	20	1		81	18								
Atlantic Menhaden	6	35	88	6	5	54	85	11	3	41	89	14								
Atlantic Silverside									1		88	5								
Hogchoker					1	40	116	40	4	24	62	6	45	235	61	5	74	678	73	9
White Perch	12	923	151	76	53	1563	111	29	27	1330	113	50	383	5218	92	14	150	1928	93	13
Striped Bass													2	19	92	11				
Eastern Silvery Minnow																	1		103	25
Gizzard Shad	7	253	134	39	11	303	134	28	15	1210	147	81	57	1778	126	31	3	80	114	29
White Catfish					<1	225	340	900					1		126	30	128	7920	170	62
Channel Catfish																	4	285	161	76
Spottail Shiner									1		102	20	<1		75	5	3	28	96	11
Tessellated Darter													<1		67	5	2	16	72	7
Yellow Perch													<1		152	50	<1		191	120
Golden Shiner																	<1		118	20
Sea Lamprey																	<1		171	20

Table 7.5. (Continued). Rappahannock River winter survey data 1975.

Species	RA-50				RA-55				RA-60				RA-65				RA-70			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Hogchoker	16	108	65	7	1		86	18	3	35	88	14	<1		82	5				
White Perch	53	1053	102	20	100	2275	111	23	43	938	102	22	20	175	107	9	34	838	106	20
Pigfish					1		146	55												
Yellow Perch					<1		100	20												
Gizzard Shad	5	140	109	27	2	105	151	70	4	1000	218	235	1		199	150				
White Catfish	17	1308	143	78	5	420	150	95	1		82	15	2	125	146	56	3	233	155	62
Channel Catfish	4	235	119	55	8	325	124	43	8	370	152	49	18	1158	169	64	7	738	150	84
Spottail Shiner	2	20	97	10	1		99	28	2	20	91	11	9	91	43	10	50	574	94	9
Tessellated Darter	1	4	76	3	2	13	77	6	7	39	81	5	6	24	74	4	2	8	71	4
Yellow Perch					<1		100	20									1	128	170	85
Eastern Silvery Minnow	1		108	20					1	20	103	16	1	14	98	14	41	845	111	16
Golden Shiner													1		123	30	4	230	148	51
Blue Catfish	1		148	30					1		105	15	<1		81	5	2	45	106	18
Brown Bullhead					<1		198	110	<1		161	190	<1		171	80	1	205	206	164
Threadfin Shad																	<1		94	5

Table 7.5. (Continued). Rappahannock River winter survey data 1975.

Species	RA-75				RA-80				RA-85			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
White Perch	2	48	109	27	<1		96	5				
American Eel					<1		94	5	<1		117	5
Pumpkinseed	<1		100	20								
White Catfish	13	813	160	61	<1		200	120				
Channel Catfish	41	2098	160	51	5	403	170	81	1	56	125	45
Spottail Shiner	61	770	95	13	30	320	95	11	9	88	91	10
Tessellated Darter	4	18	77	5	24	95	72	4	4	24	78	6
Yellow Perch	<1		219	170								
Eastern Silvery Minnow	42	1073	111	25	2	10	115	6	<1		110	30
Golden Shiner	<1		138	50								
Blue Catfish	1		119	20								
Brown Bullhead	13	1763	213	141								

Table 7.6. Standard deviation (s) of cn/f and coefficient of variation (V) in percent for Rappahannock River winter survey data listed in Table 7.5.

Species	RA-00		RA-05		RA-10		RA-15		RA-20		RA-25		RA-30		RA-35		RA-40		RA-45	
	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
Bay Anchovy	55.2	167	53.2	188	17.1	161	2.4	93			10.8	140	8.1	69	18.0	122	1.5	200		
Blueback Herring	15.2	224	230.1	222	0.4	224	67.6	189			1.0	200	1.0	200	0.5	200				
Alewife	99.4	210	6.0	115	130.3	217	9.5	184	0.9	149	1.0	200	0.5	200						
Atlantic Croaker	3.8	86	68.7	167	41.2	184	34.8	191	1.7	173	1.5	120	3.6	89	1.7	52	2.5	200		
Spot	1.0	137	39.8	163	24.2	178	9.7	152	9.5	191										
Atlantic Menhaden	2028.4	142	24.5	115	20.8	212	25.3	176	2.3	64	3.3	60	3.2	63	4.1	136				
Atlantic Silverside	12.3	121	15.9	106	4.6	116			0.4	224					0.6	115				
Hogchoker			1.4	141	8.9	224	3.0	190					0.6	115	4.2	106	47.4	106	89.6	121
White Perch	5.0	138	15.8	136	70.7	136	40.9	148	721.2	163	18.2	148	53.2	100	18.8	70	357.3	93	90.6	61
American Eel			0.4	224			0.4	224												
Summer Flounder			0.4	224	0.4	224	0.4	224	0.4	224										
Gizzard Shad			0.4	224	0.5	137	0.4	224	7.2	120	9.7	150	14.8	135	17.3	116	78.6	139	2.8	100
Blackcheek Tonguefish	1.0	137																		
American Shad			2.5	104																
Winter Flounder			0.4	224																
Skilletfish			0.4	224			0.4	224												
Spotted Hake					0.4	224														
Striped Bass									0.9	224							2.9	164		
Striped Mullet									0.4	224										
White Catfish													0.5	200			1.0	200	187.0	146
Channel Catfish																			2.2	59
Threadfin Shad													0.5	200	0.9	128				
Snottail Shiner															1.0	200	0.5	200	3.1	124
Tessellated Darter																	0.5	200	2.6	117
Yellow Perch																	0.5	200	0.5	200

Table 7.6 (Continued).

Species	RA-50		RA-55		RA-60		RA-65		RA-70		RA-75		RA-80		RA-85	
	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V
White Perch	30.4	57	63.2	64	6.2	14	37.2	184	73.3	217	2.9	164	0.6	173		
American Eel													0.6	173	0.5	200
Hogchoker	26.0	160	0.6	115	5.0	200	0.5	200								
Gizzard Shad	4.5	86	1.7	115	6.0	140	1.0	128								
White Catfish	27.5	164	1.3	29	1.0	200	3.9	172	5.6	187	26.5	200	0.6	173		
Channel Catfish	6.0	140	5.4	73	11.0	147	35.3	196	13.5	193	81.3	198	1.7	35	1.0	77
Threadfin Shad									0.4	224						
Spottail Shiner	1.4	71	1.0	128	2.4	135	10.2	110	68.7	137	79.9	130	19.0	64	11.6	129
Tessellated Darter	1.2	101	2.6	117	9.5	131	8.3	152	2.5	157	4.4	124	37.3	155	3.9	103
Yellow Perch			0.5	200					2.7	224	0.5	200				
Eastern Silvery Minnow	1.0	200			1.9	151	1.4	141	87.3	213	83.2	197	2.1	125	0.5	200
Golden Shiner							1.0	200	5.1	142	0.5	200				
Blue Catfish	1.0	200			0.5	67	0.5	200	3.5	173	1.5	200				
Pigfish			1.0	200												
Brown Bullhead			0.5	200	0.5	200	0.5	200	1.7	173	22.4	179				
Pumpkinseed											0.5	200				

Table 7.7. Potomac River winter survey data 1975 expressed as average catch in numbers per tow (cn/f), average catch in weight per tow (cw/f), average fork length (\bar{L}) in millimeters, and average weight (\bar{W}) in grams. All tows within the five-mile section listed below the first mile of that section.

Species	PO-00				PO-05				PO-10				PO-15				PO-45			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Bay Anchovy	1	5	52	4	6	5	33	1	4	6	47	1	1	2	43	2	1		44	5
Blueback Herring	1		82	7	2	8	79	4	<1		79	5	<1		75	5				
Alewife	<1		117	20	<1		121	20	7	162	123	23	1	12	100	10	<1		92	10
Atlantic Croaker	<1		38	5	<1		36	5	18	17	49	1	47	59	52	1	17	24	51	1
Spot									48	1126	119	23	3	76	117	24				
Atlantic Menhaden	2	20	90	13	2	36	101	20	7	162	97	23	5	160	116	32	3	63	99	25
Atlantic Silverside	1		82	5					1		109	10	<1		110	5				
Hogchoker													<1		120	25	17	353	89	21
White Perch	1		174	97	4	528	185	139	141	13,826	176	98	98	8298	166	85	777	26,098	126	34
Summer Flounder													<1		176	50				
Gizzard Shad	<1		108	20									1	68	153	85	<1		242	250
Striped Bass	<1		315	520					2	326	209	181	10	2480	240	243	1		361	1523
Threadfin Shad									<1		102	10								
Channel Catfish																	<1		138	30
Winter Flounder									<1		321	500								
Skilletfish	<1		40	5	1		48	3	<1		57	5	2	5	54	3				

Table 7.7. (Continued). Potomac River winter survey data 1975.

Species	PO-50				PO-55				PO-60				PO-65				PO-70			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
Bay Anchovy	1		50	5																
Atlantic Croaker	20	31	48	2																
Atlantic Menhaden	2	45	118	26																
Hogchoker	6	98	76	16	23	155	58	7	1	20	68	16	11	19	44	2				
White Perch	1523	32,990	107	22	925	14,743	97	16	616	9475	94	15	106	2608	102	25	34	2499	102	18
Gizzard Shad	1	110	155	88	7	988	193	152	2	315	187	140	<1		100	10	<1		115	20
Striped Bass	1		118	30	1		106	17	<1		80	10								
Channel Catfish					<1		96	10	1	13	91	13	5	145	124	31	11	203	99	19
American Eel	3	133	241	41	1		284	40	1		329	117	12	160	406	13				
Brown Bullhead	1	265	237	212	<1		202	110	9	963	205	113	31	3493	200	114	49	5153	196	105
White Catfish									2	63	105	28	6	280	151	49	2	48	120	24
Tessellated Darter									1		82	8								
Spottail Shiner																	<1		92	10
Pumpkinseed	<1		126	40																
Yellow Perch	1		190	130																

Table 7.7 (Continued). Potomac River winter survey data 1975.

Species	PO-75				PO-80				PO-85				PO-90			
	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}	cn/f	cw/f	\bar{L}	\bar{W}
White Perch	18	368	102	20	18	463	110	26	6	148	109	26	5	115	110	23
Gizzard Shad	1	88	151	70	<1		216	150					<1		286	470
Channel Catfish	19	595	125	32	16	505	121	33	6	246	136	41	17	620	138	36
American Eel	<1		400	100	<1		186	40								
Brown Bullhead	56	5370	196	96	26	3060	198	118	20	2470	199	125	24	3418	208	141
White Catfish	1	85	159	68	1	75	156	75					<1		138	30
Tessellated Darter					1		81	5	2	8	75	4	1	5	75	4
Spottail Shiner	<1		109	20	1	18	113	18	5	90	108	17	11	185	112	17
Carp	<1		671	6500									1		624	4725

Table 7.8. Standard deviation (s) of cn/f and coefficient of variation (V) in percent for Potomac River winter survey data 1975 from Table 7.7.

Species	PO-00		PO-05		PO-10		PO-15		PO-45		PO-50		PO-55		PO-60		PO-65		PO-70		
	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	s	V	
Bay Anchovy	1.1	91	6.0	93	8.3	197	1.4	141	0.6	115	0.6	115									
Blueback Herring	1.3	224	4.5	224	1.0	224	0.4	224													
Alewife	0.4	224	1.0	224	16.1	224	1.0	70	0.5	200											
Atlantic Croaker	0.4	224	0.4	224	36.0	202	55.0	117	17.0	98	21.0	106									
Spot					87.4	180	7.2	224													
Atlantic Menhaden	1.5	95	2.4	133	9.7	134	4.8	97	3.1	124	2.9	164									
Atlantic Silverside	1.0	149			1.3	224	0.4	224													
Hogchoker							1.0	224	8.3	50	3.2	53	16.4	72	1.2	101	20.0	182			
White Perch	0.5	91	5.0	129	214.4	152	90.6	92	546.2	70	837.3	55	400.0	43	486.4	79	64.0	60	11.2	33	
Summer Flounder							1.0	224													
Gizzard Shad	0.4	224					1.3	163	0.5	200	1.2	101	5.7	87	2.1	92	0.5	200	0.5	200	
Striped Bass	0.4	224			3.0	164	11.0	107	1.0	128	0.5	67	1.5	200	0.5	200					
Threadfin Shad					0.4	224															
Channel Catfish									0.5	200	0.8	82	9.5	200	2.5	23	19.4	104	8.3	54	
Winter Flounder					0.4	224															
Skilletfish	0.4	224	1.0	149	0.6	137	4.0	197													
American Eel											3.3	102	0.6	115	0.5	67	19.6	163			
Brown Bullhead											2.5	200	0.5	200	3.9	46	23.7	77	26.5	54	
White Catfish														2.1	92	10.8	189	2.8	141		
Tessellated Darter													0.6	115							
Spottail Shiner																			0.5	200	
Pumpkinseed											0.5	200									
Yellow Perch											0.6	115									

Table 7.8. (Continued).

Species	PO-75		PO-80		PO-85		PO-90	
	s	V	s	V	s	V	s	V
White Perch	7.2	40	8.8	50	4.5	78	8.7	174
Gizzard Shad	1.5	120	0.5	200			0.5	200
Channel Catfish	19.4	104	8.3	54	6.0	99	26.5	154
American Eel	0.5	200	0.5	200				
Brown Bullhead	40.2	72	8.0	31	15.6	79	39.4	162
White Catfish	1.0	77	1.4	141			0.5	200
Tessellated Darter			1.0	200	1.4	71	1.2	101
Spottail Shiner	0.5	200	0.8	82	8.5	162	9.6	89
Carp	0.5	200					0.6	115

Table 7.9. Average cn/f for selected species and zones during winter of 1975. Zones used^(a) given in parentheses below average cn/f.

Species	James		York		Rappahannock		Potomac	
	Average cn/f	Rank	Average cn/f	Rank	Average cn/f	Rank	Average cn/f	Rank
Atlantic Croaker	62.8 (00-24.9)	2	400.2 (00-29.9)	1	15.3 (00-39.9)	4	17.3 (00-54.9)	3
Hogchoker	1.1 (05-49.9)	7	129.1 (05-49.9)	2	12.8 (10-64.9)	5	11.6 (45-69.9)	4
White Perch	<1 (20-59.9)	8	21.3 (05-49.9)	3	107.6 (00-74.9)	1	328.5 (05-94.9)	1
Spottail Shiner	25.8 (45-84.9)	3	8.3 (35-44.9)	5	18.6 (45-83.9)	3	6.0 (80-94.9)	6
Channel Catfish	69.2 (30-79.9)	1	6.0 (35-49.9)	6	9.1 (45-89.9)	7	10.7 (60-94.9)	5
White Catfish	15.1 (30-64.9)	4	15.2 (25-49.9)	4	24.1 (45-79.9)	2	2.0 (60-94.9)	8
Brown Bullhead	6.1 (45-59.9)	5	0.0 (35-49.9)	10	4.0 (60-79.9)	9	30.7 (60-94.9)	2
Striped Bass	0.0 (10-34.9)	10	<1 (05-29.9)	7	<1 (10-44.9)	10	2.5 (10-59.9)	7
Gizzard Shad	<1 (15-49.9)	9	<1 (15-29.9)	8	9.4 (10-69.9)	6	1.7 (15-75.9)	9
Tessellated Darter	1.2 (30-79.9)	6	<1 (30-49.9)	9	6.1 (45-89.9)	8	<1 (60-94.9)	10

- (a) Zones, such as 05-49.9, include all tows made from mile 05 to mile 44.9, e.g. 8 five-mile blocks with 32 tows total.
 (b) p = Pamunkey branch, m = Mattaponi branch.

Table 7.10. Average cn/f for selected species in the James River during winters of 1972-76. Rank given below cn/f.

Species	Average cn/f by year					Five Year Average	River Miles Included
	1972	1973	1974	1975	1976 ^(a)		
Atlantic Croaker	25.8 4	6.0 6	348.2 1	62.8 2	217.1	132.0	00-24.9
Hogchoker	14.8 6	12.2 3	16.7 3	1.1 7	1.6	9.3	05-49.9
White Perch	3.4 7	<1 9	<1 9	<1 8	1.0	0.8	20-59.9
Spottail Shiner	37.5 2	21.0 2	11.8 4	25.8 3	12.7	14.3	45-84.9
Channel Catfish	54.9 1	51.6 1	56.7 2	69.2 1	29.8	52.4	30-79.9
White Catfish	36.0 3	4.7 7	7.6 6	15.1 4	11.8	15.0	30-64.9
Brown Bullhead	18.1 5	7.2 5	9.0 5	6.1 5	1.4	8.4	45-59.9
Striped Bass	<1 10	<1 10	0 10	0 10	0		10-34.9
Gizzard Shad	<1 9	2.3 8	1.0 8	<1 9	<1	0.7	15-49.9
Tessellated Darter	3.2 8	8.1 4	2.7 7	1.2 6	3.7	3.8	30-79.9
Average catch without croaker	18.7	12.0	11.7	13.2	6.9		

(a) Preliminary estimates