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Index of juvenile striped bass, white perch, and alosine fishes in the Rappahannock River following the March 1980 oil spill

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INTRODUCTION

A ruptured pipeline caused a large spill of petroleum products above Fredericksburg, VA on March 6, 1980. Much of the oil was recovered; however, a portion of the contaminant eventually reached the Rappahannock River. The significance of the spill was magnified because it occurred during spawning of anadromous and other commerically important fishes.

A study following the spill was conducted by the Virginia Institute of Marine Science (VIMS) in the summer of 1980 in the upper Rappahannock River. The objectives as stated in the proposal were to (1) determine an index of abundance for juvenile striped bass (Morone saxatilis), alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), white perch (Morone americana) and American shad (Alosa sapidissima) in the Rappahannock River, (2) estimate relative abundance of juveniles over time during the period of high mortality, and (3) establish a data base of relative abundance of juvenile striped bass, white perch and alosine fishes in a portion of the Rappahannock River.

MATERIALS AND METHODS

Sampling was conducted in the Rappahannock River between Piscataway Creek (Mile 35) and Hayfield Bar (Mile 85)(Fig. 1).

All sampling was conducted at night to minimize the effect of varying light intensities (Loesch, Kriete, and Foell MS in review).

A 5.8 m outboard vessel equipped with a pushnet, and a 5.9 m outboard vessel towing a 4.9 m two-panel trawl were used to collect standard 5 min samples. Flowmeters were secured to the pushnet and the volume of water strained and distance covered in relation to the water column were recorded for each sample. Flowmeters were attached in the two-panel trawl as bottom conditions permitted (e.g., if no obstructions were anticipated). From these readings, average volume strained (872 m^3), and average distance covered in relation to the water column (241 m) were determined.

The pushnet is constructed of 1.9 cm stretched mesh nylon netting in the body and 1.27 cm stretched mesh nylon netting in the codend. The net is lashed to a 1.5 m X 1.5 m rigid frame which is pushed ahead of the vessel (Kriete and Loesch 1980). The two-panel trawl is constructed of 3.81 cm stretched mesh nylon netting with a 1.27 cm stretched mesh nylon netting liner in the codend.

The alosine nursery area (approximately Mile 50-85) was divided into 5-nautical mile strata. Each stratum was further divided into five 1-mile substrata. Perpendicular to this stratification, the 5-mile strata were divided into three nearly equal parts, a center section and two shoreward sections bounded by the 1.8 m depth contour lines (MLW) indicated on a navigation chart. Thus, each 5-mile stratum was partitioned into 15 "cells" (Loesch et al. 1979). Four randomly selected stations at each alternating

five-mile strata beginning at Mile 50 and terminating at Mile 85 were sampled during July, August and September.

On each side of the river, shoreward of the 1.8 m depth contour, the definition of stratum resulted in 10 cells, five for each shore (Loesch et al. 1979), in the striped bass-white perch nursery area. These sites were sampled with the 4.9 m trawl which swept virtually the entire water column. Randomly selected stations, 3 to 4 per stratum from Mile 35 to Mile 60, were sampled on dates coinciding with the juvenile alosine sampling. During the September sampling, the Mile 35-40 stratum was deleted and Mile 60-65 stratum was added because of the salt wedge encroachment upon the freshwater and oligohaline nursery areas due to drought conditions.

Tow direction in relation to current direction was randomized within each stratum for both pushnet and trawl collections. Hydrological data were collected during each of the three sampling periods (Table 1).

All samples collected were preserved in 10% formalin and returned to VIMS for processing. Fifty specimens (when available) of each of the species of concern were measured to the nearest millimeter (fork length), aggregate weights and total number in the sample were recorded. All remaining species were enumerated and aggregate weights taken. Large catches were sub-sampled, and sub-samples were expanded to reflect total catch.

Catch-per-unit-of-effort (CPUE) for juvenile alewife, blueback herring and American shad from pushnet catches was determined by

dividing species catch by volume strained per stratum for each sampling period. Trawl CPUE for juvenile white perch and striped bass was determined by dividing species catch per stratum by the number of trawls in that stratum for each sampling period. Adults were excluded from all calculations.

RESULTS AND DISCUSSION

A total of 31,614 finfish representing 28 species, and 912 blue crabs (Callinectes sapidus) were collected in 94 pushnet and trawl samples in July, August and September 1980 (Table 2). Blueback herring dominated the pushnet catches while spot (Leiostomus xanthurus) and white perch were the dominant species in the trawl samples.

Drought conditions prevailed as evidenced by the occurrence of marine fishes, e.g., summer flounder (Paralichthys dentatus), spot, Atlantic croaker (Micropogonias undulatus), weakfish (Cynoscion regalis) and Atlantic menhaden (Brevoortia tyrannus) and blue crabs in areas that are freshwater under normal conditions. Blue crabs were collected above Mile 60 in both pushnet and trawl samples, with one blue crab captured by the pushnet at Mile 80. The salinity in the sampling areas increased steadily from July to September ultimately relocating the salt-freshwater interface above Leedstown (Mile 52)(Table 1).

Alosine Fishes

Blueback herring was the dominant alosine in virtually all of the pushnet collections (Table 3A). Dominance of this species

is borne out in recent past commercial landings of adult alosines in the Rappahannock River (Loesch and Kriete 1976, Loesch et al. 1979).

Peak abundance of blueback herring, as indicated in pushnet collections, was during July. Catch-per-unit-of-effort (CPUE) declined in August compared to July due to natural mortality; however, CPUE increased in September compared to August. This increase may be attributed to either recruitment to the mainstream river population or sampling error in August, with recruitment being the more plausible explanation.

Alewife peak abundance, as opposed to blueback herring, occurred during September (Table 3A). However, only a slight increase in CPUE was noted from July to September. As with blueback, this phenomenon may be due to recruitment. Alewife spawn earlier than blueback herring (Hildebrand and Schroeder 1928); therefore, it is reasonable to assume that peak abundance of juvenile alewife would occur earlier than that of juvenile blueback herring.

Too few American shad were collected during the three sampling periods to draw any definitive conclusions concerning abundance or mortality for this species.

Peak abundance in July as indicated by CPUE for both alewife and blueback herring occurred in the stratum 70-75. In August the highest CPUE was recorded in stratum 60-65. This movement although still in freshwater is probably the beginning of the seaward migration (Loesch et al. 1979). However, the effects of

the drought experienced during the 1980 summer months are apparent in the CPUE of alewife and blueback in September. The highest CPUE for blueback herring occurred in stratum 70-75, and in stratum 80-85 for alewife. The lack of rainfall and the resulting encroachment of saline waters in the nursery area served to reduce the size of the alosine nursery. Further evidence of the encroachment may be found in the CPUE of alewife and blueback herring in Table 3B. (These results are used only as an illustration and should not be directly compared to those in Table 3A). Although much of the increase in CPUE in the upper strata in September relative to August is upstream movement, the possibility of recruitment must not be discounted.

White Perch and Striped Bass

Trawl collections in July resulted in the highest CPUE for white perch and the only striped bass for the three sampling periods (Table 3B). The decline in CPUE for white perch from July to September is indicative of natural mortality; however, movement to avoid areas of higher salinity is a probable contributing factor.

The highest CPUE for white perch in July through September occurred in stratum 55-60 and similarly the next highest CPUE for white perch was recorded at stratum 45-50 for all months. As noted in the sampling for alosine fishes, the effects of drought conditions are evident in the CPUE for white perch from the September sampling.

Only one striped bass was collected in 46 trawls during the three sampling periods.

CONCLUSIONS AND RECOMMENDATIONS

The lack of rainfall during the summer of 1980 produced severe drought conditions throughout Virginia.. Freshwater nursery areas utilized by anadromous fishes were greatly reduced, thus creating greater feeding competition. This, coupled with high water temperatures, may have increased mortality rates within these areas. The high mortality rate of 45% for blueback herring from July to August may not be excessive when these factors are considered. Alewife CPUE, although much lower than blueback herring, is representative of the population sampled. The precipitous decline in white perch CPUE from July to September would mean an extremely high mortality rate under normal conditions. However, given the sampling and environmental conditions, this may or may not be true. With increasing water temperature and salinity, the juvenile white perch may have either moved upstream or to deeper water and thus would be unavailable to the trawl.

Only three American shad and one striped bass were captured during the three sampling periods. Speculation would lead to endless possibilities with few of sound basis. It is reasonable to assume that the number of surviving juveniles of each of the species is low. However, without background data on the adult spawning population and some measure of immediate spawning success (eggs and/or larvae), coupled with an estimate of gear efficiency, it is difficult to attribute success or failure of a year class to a single source.

In light of the unusual environmental conditions encountered in 1980, several recommendations should be taken into consideration. First, the survey should be repeated to allow comparison with data that more closely fits the norm. However, minor modifications and/or improvements are advised. The number of repetitions in each stratum should be increased in the trawl collections to reduce sampling error. Secondly, given environmental conditions at the time of sampling, comparison trawls must be conducted to determine gear efficiency. Lastly, the trawling should be initiated at an earlier date with increased number of sampling periods to insure coverage of juvenile mortality.

Procedures for sampling juvenile alosine fishes appear to be adequate in their present form.

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Table 1. Temperature and salinity data collected in the Rappahannock River in July, August, and September, 1980.

A. Alosine sampling

	July		August		September	
River Mile	Temp. (C)	Sal. (‰)	Temp. (C)	Sal. (‰)	Temp. (C)	Sal. (‰)
80-85	30.6	(a)	30.0	0.0	28.2	0.0
64-75	31.0	0.0	30.0	0.0	29.0	0.0
50-55	30.0	0.1	30.0	0.5	27.8	1.0

B. White perch and Striped bass sampling

	July		August		September	
River Mile	Temp. (C)	Sal. (‰)	Temp. (C)	Sal. (‰)	Temp. (C)	Sal. (‰)
60-65					(b)	0.0
55-60	30.5	(a)	30.5	0.0	(b)	0.0
50-55			29.9	0.5	(b)	1.0
45-50	29.6	0.5	29.3	2.0	(b)	2.0
40-45			28.6	4.0	(b)	5.0
35-40	28.2	5.5	27.9	7.0		

(a) no readings, assumed to be 0.0‰
(b) no readings, equipment failure

Table 2. Number of fishes and crabs collected by pushnet and trawl in the Rappahannock River in summer of 1980, by species and month.

Species	Pushnet				4.9 m Semi-balloon Trawl			
	July	August	September	Total	July	August	September	Total
Alosa aestivalis (Blueback herring)	10,063	5,948	7,067	23,078	64	122	125	311
A. pseudoharengus (Alewife)	179	205	229	613	39	96	54	189
A. sapidissima (American shad)		3		3				
Anchoa mitchilli (Bay anchovy)	6	11	258	275	12	83	154	249
Anguilla rostrata (American eel)					3	2	1	6
Brevoortia tyrannus (Atlantic menhaden)	461	631	107	1,199	17	11	7	35
Cynoscion regalis (Weakfish)						2	7	9
Cyprinus carpio (Carp)					1		3	4
Etheostoma olmstedi (Tessellated darter)					80	58	47	185
Fundulus diaphanus (Banded killifish)							1	1
F. heteroclitus (Mummichog)	1			1				
Hybognathus regius (Eastern silvery minnow)	2	1		3	55	6	11	72
Ictalurus catus (White catfish)	1			1	11	5	13	29
I. nebulosus (Brown bullhead)						2		2
I. punctatus (Channel catfish)			1	1	70	56	69	195
Leiostomus xanthurus (Spot)					650	794	285	1,729
Membras martinica (Rough silverside)	18	4	9	31				
Menidia beryllina (Tidewater silverside)	38	63	50	151		1		1
Micropogonias undulatus (Atlantic croaker)					11	10		21
Morone americana (White perch)	8	12	4	24	698	306	239	1,243
Morone saxatilis (Striped bass)					1			1
Notropis hudsonius amarus (Spottail shiner)	12	8	3	23	162	27	33	222
Paralichthys dentatus (Summer flounder)					4	6	7	17
Perca flavescens (Yellow perch)					3			3
Pomoxis annularis (White crappie)		1		1				
P. nigromaculatus (Black crappie)	1			1				
Strongylura marina (Atlantic needlefish)	1			1				
Trinectes maculatus (Hogchoker)		4		4	653	461	566	1,680
	10,791	6,891	7,728	25,410	2,534	2,048	1,622	6,204
Callinectes sapidus (Blue crab)		3	5	8	437	294	173	904

Table 3. Monthly catch-per-unit-of-effort (CPUE) of blueback herring, alewife, American shad, white perch and striped bass by stratum by pushnet (A), and 4.9 m semi-balloon trawl (B). Pushnet CPUE expressed in catch per 1000 m^3. Trawl CPUE expressed in catch per standard trawl.

A. Pushnet

River Mile	Blueback herring			Alewife			American shad		
	Jul	Aug	Sep	Jul	Aug	Sep	Jul	Aug	Sep
80-85	597.3	221.2	340.4	14.5	17.1	40.7		1.0	
70-75	2214.5	348.3	1416.7	26.0	6.3	23.7			
60-65	830.0	1219.2	495.8	24.9	37.2	7.1			
50-55	132.4	271.8	35.0	1.5	9.8	2.0			
Grand CPUE	937.1	512.3	578.1	16.7	17.6	18.7		0.2	

B. 4.9 m Trawl

River Mile	White perch			Striped bass			Blueback herring			Alewife		
	Jul	Aug	Sep	Jul	Aug	Sep	Jul	Aug	Sep	Jul	Aug	Sep
60-65	(a)	(a)	4.3	(a)	(a)		(a)	(a)	16.0	(a)	(a)	2.7
55-60	57.6	23.0	9.0				13.3	0.6	25.0	2.0	7.3	13.3
50-55	14.2	9.6	4.0				6.7	15.3		6.0	9.0	2.0
45-50	54.0	15.3	4.7				1.3	24.6		3.3	14.6	0.7
40-45	4.6	6.0	1.7	0.3				0.3				
35-40	0.5		(a)			(a)		0.5	(a)			(a)
Grand CPUE	28.1	10.1	4.6	0.1			4.6	7.6	7.7	2.4	6.0	3.5

(a) not sampled

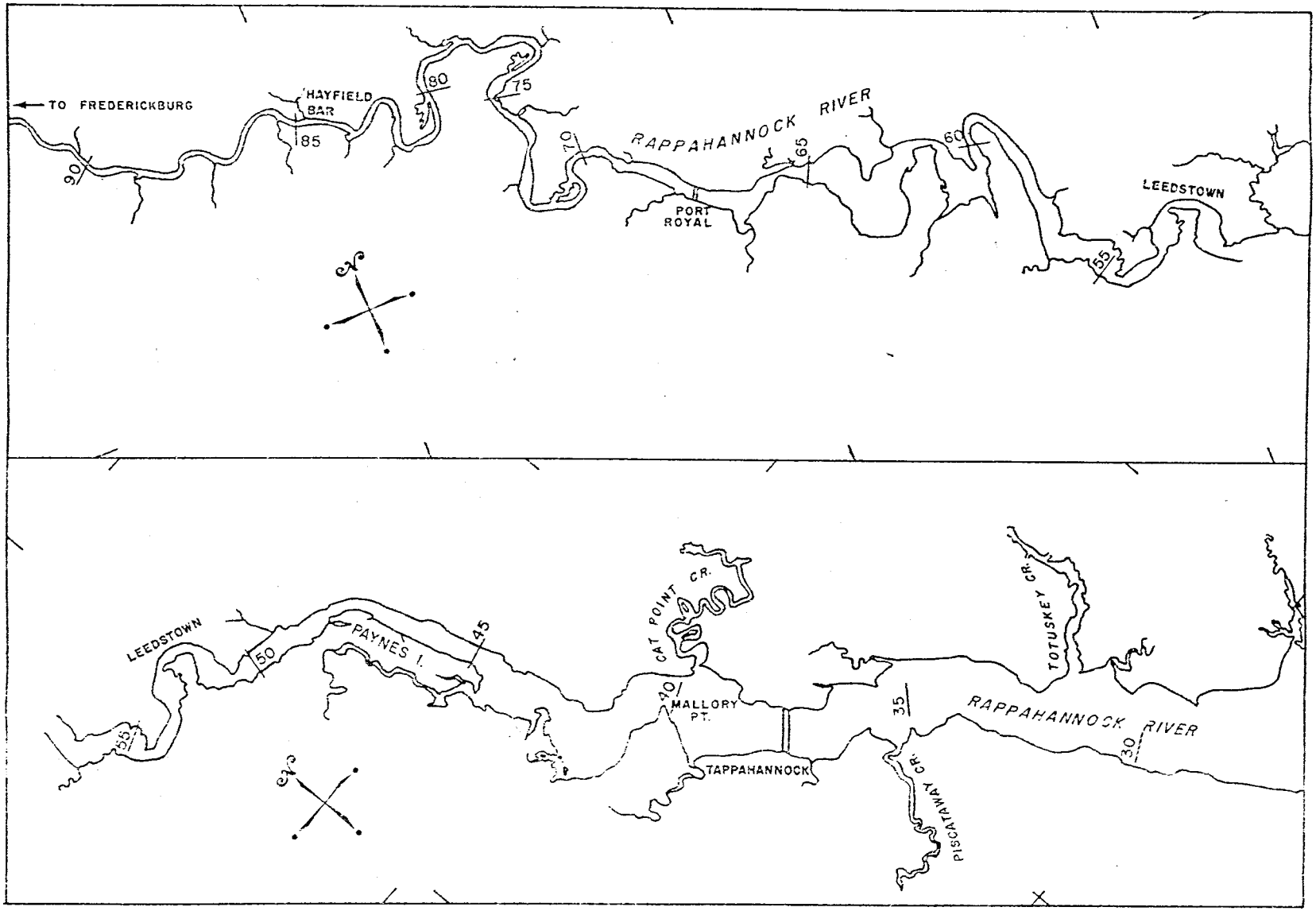

Figure 1. Nursery area in the Rappahannock River sampled in July, August and September 1980 for juvenile striped bass, white perch, and alosine fishes.