SPAWNING GROUNDS OF THE STRIPED BASS OR ROCK, *Roccus saxatilis* (WALBAUM), IN VIRGINIA

By

Ernest Frederick Tresselt

A THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE
DEGREE OF MASTER OF ARTS
FROM THE
COLLEGE OF WILLIAM AND MARY

1950

Acknowledgments

The writer wishes to express his appreciation to Dr. Nelson Marshall and Mr. Willard Van Engel of the Virginia Fisheries Laboratory, and Dr. Alfred R. Armstrong of the College of William and Mary, for their help in the preparation of the manuscript, and to others of the Virginia Fisheries Laboratory staff for their unfailing cooperation. Special thanks are due Dr. Edward C. Raney, Cornell University, for the loan of his excellent manuscript.

To William H. Massmann, of the Virginia Fisheries Laboratory, and James B. Sykes, of the U. S. Fish and Wildlife Service, co-workers in the field, are due much of the credit for the successful prosecution of the field work and the clarification of many of the problems involved in the study.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

SPAWNING GROUNDS OF THE STRIPED BASS OR ROCK,

Roccus saxatilis (WALBAUM) IN VIRGINIA

Since the early settlement of the country the spring migration of striped bass up rivers along the Atlantic Coast has been assumed to be a spawning movement. Pearson (1938) has reviewed these early observations. Though such a general assumption prevails, only one spawning ground is well known, that at Weldon, North Carolina, on the Roanoke River, where a hatchery for the artificial propagation of striped bass eggs has been operated at irregular intervals since 1874. The Roanoke River at this point is about 100 miles from tidewater and is about 100 yards wide, with a swift, erratic current of about 4 mph. Both Pearson (1938) and Merriman (1941) have described the river at Weldon and have presented illustrations of various developmental stages of eggs and larvae from material observed there.

In the Chesapeake Bay region there have been few studies which give direct evidence of striped bass spawning activities. Pearson (1938) collected eggs in the Susquehanna River at Garrett Island, about 12 miles below the Conowingo Dam during May and June, 1932, in a swift section of the stream. Vladykov and Wallace (Ms 1938), on the basis of collections of ripe females, stated that spawning grounds are located in the upper tidal reaches of rivers in water which is almost fresh, where the current is 2-1/2 to 3 mph. and the bottom usually mud or sand. Raney (Ms 1949) stated that striped bass spawn in the Chickahominy River, in Virginia, where there is no pronounced current. The source of the information was not given.

From other areas along the Atlantic Coast the data are equally fragmentary. Leim (1924) found larvae near the head of the tidal zone in the Shubenacadie River, Nova Scotia. Merriman (1941) found no evidence of spawning in Connecticut during 1936-37, though he found three juvenile bass in the Parker River, Massachusetts, in 1937. Curran and Reis (1937, in Merriman, 1941) reported juvenile bass from the Hudson River in water of low salinity in 1936 and 1937.

After a survey of most of the Atlantic Coast to determine the presence of ripe striped bass in spring catches and the presence of young in the summer, Wallace and Neville (Ms 1942, as reported in Raney 1949) concluded that the principle spawning and nursery areas of striped bass are found in the Hudson River around Newburgh, and in Delaware Bay, Chesapeake Bay, Pamlico Sound, and their tributaries.

Records of juvenile bass from many coastwise rivers led Merriman (1941) to suggest that in early times bass probably entered and spawned in every river of any size, where suitable conditions existed, along the greater part of the Atlantic Coast.

In California, where the striped bass was successfully introduced in 1879, spawning grounds were first accurately described by Woodhull (1947), who observed spawning in the San Joaquin River, about 60 miles above the Golden Gate. The river there is tidal, swift, and fresh. Calhoun and Woodhull (1949) and Calhoun, Woodhull, and Johnson (1950) collected eggs and larvae from various rivers of the Sacramento-San Joaquin River system.

Though many of the above studies lack specific information on spawning habitats, even omitting at times comments as to whether the water is fresh or brackish, it is evident that there is a wide variation in type of spawning environment. Thus Merriman (1941) concluded that, in addition to spawning in fresh water, bass at times may spawn in brackish or even saline waters.

The present study may be described briefly as a survey to determine where, and under what conditions striped bass spawn in Virginia rivers, by sampling for the presence of eggs. Sampling was started at the upper brackish region of each stream, where the salinity was about 5 ‰ or less, and continued upstream until navigational difficulties or schedule demands made it necessary to discontinue operations. The sampling schedule was set up to correspond to the spawning season, which in this area extends from April through June (Merriman 1941).

The Rivers Studied

The following rivers were sampled (Fig. 1):

The Pamunkey, a branch of the York River
The Mattaponi, a branch of the York River
The Chickahominy, a branch of the James River
The James River
The Rappahannock River

These rivers all have a number of characteristics in common. They are all tributaries of Chesapeake Bay or of rivers entering the Bay. They are all under tidal influence in the areas considered in this study. In the lower portions they are brackish. There is no fixed point at which a river becomes fresh, but rather an area

Fig. 1 - Darkened areas show the portion of each river where samples were taken.

over which salinity varies daily with the tide and with the total down-river flow. All these rivers have a high turbidity due to silt, particularly in the spring. The highest turbidity is found in the region where brackish water is first encountered. At this point a salting out process evidently takes place, with the result that turbidity decreases at successive points downstream. Other factors such as dilution of river water also tend to decrease the turbidity. Channels and flats are fairly well defined. Bottom conditions vary considerably over all the rivers, ranging from sand to mud.

Apparatus and Methods

The equipment used in this survey is being described by Massmann (1950, in prep.). It was developed for the collection of planktonic eggs and larvae of anadramous fishes in rivers with tidal currents.

Large nets similar in design to simple plankton nets were used. These were made of nylon marquisetts, a fine material having about 25 meshes per inch. Six nets were used: four of these had a diameter of 1 meter at the mouth, one was 1/2 meter in diameter, and the other was a sled-type net in the shape of a semicircle which had a radius of 1/4 meter. Each net was fitted with a brass sleeve which held a quart mason jar.

These nets were set in the current, not towed. They could be placed on the surface or bottom in most any part of the stream where there was sufficient current. Stations for sampling with these nets were planned at approximately 3 mile (1) intervals on the short

---

(1) All mileage distances used in this manuscript are nautical miles.

rivers and approximately 5 mile intervals on the longer rivers in order that sampling could be completed in the time available. Samples were generally taken at these stations, though various conditions encountered at the time of sampling made some variation necessary.

The exploratory nature of the survey and the fact that shad and herring spawning grounds were being surveyed concurrently necessitated some variation in the number of surface and bottom samples taken at each station. Previous experience in collecting shad eggs by the method mentioned here showed that most eggs were collected on the bottom. Since both shad and striped bass eggs are described in the literature as semi-buoyant, it was believed at first that bottom samples should be stressed; however, one surface net was set at each station from the start. Experience soon indicated that most bass eggs were taken in surface samples, henceforth more surface nets were set at each station. Nets were set for approximately one hour.

Samples were preserved in formalin and stored in quart jars until sorted. Eggs were separated from the organisms and debris in the sample as soon as possible. In some instances this was carried out soon enough to enable taking additional samples on the return trip downstream in areas where large numbers of eggs had been collected.

Location of Striped Bass Spawning Grounds in Virginia Rivers. (2)

A summary of egg collection data for each of the rivers described below is given in Table I. Hydrographic data and detailed egg collection data for each river are given in the Appendix. Salinity and turbidity data are presented graphically in Figure 2.

Pamunkey River. Samples were taken at approximately 5 mile intervals from West Point to Bassett's Bar, a distance of about 45 miles upstream from the mouth. Above this point navigation became difficult and sampling was stopped. Eggs were collected only in the vicinity of Morgan's Landing, which is located about 17 miles above West Point, on April 6 and April 13. Fishermen questioned during the survey indicated that the largest catches of bass are made in this area from year to year. Indications are that a spawning ground is located in the vicinity of Morgan's Landing. Salinity and turbidity records show that the water here is fresh and relatively turbid.

Mattaponi River. Sampling was started at West Point and continued at approximately 3 mile intervals upstream to Pointer's Landing, about 25 miles from West Point. Navigation became difficult beyond this point and sampling was stopped. On April 26 and 27 eggs were collected from all but one of the stations from Boardley

---

(2) For locations and details of river topography refer to the following U. S. Coast and Geodetic Survey Charts: Pamunkey and Mattaponi Rivers - No. 504, April 17, 1950; Chickahominy River - No. 530, July 3, 1950; James River - No. 530, July 3, 1950; No. 531, February 6, 1950; Rappahannock River - No. 535, April 24, 1950; No. 536, June 12, 1950.

TABLE I

A SUMMARY OF STRIPED BASS EGG COLLECTIONS FROM VIRGINIA RIVERS - 1950

River	Date		Number of Hour Samples		Number Eggs			Eggs per
			Surface	Bottom	Surface	Bottom	Total	Net Hour
Pamunkey	April	4-13	10	82	71	1	72	0.8
Mattaponi	"	25-30	35	68	12500*	2000*	14500*	140.8
Chickahominy	May	5-8	23	20	2	1	3	0.1
James	"	9-10	22	16	45	12	57	1.5
Rappahannock	"	17-21	18	34	32**	8**	40**	0.8
Total			108	220	12650	2022	14672	

* Calculated from a count of a portion of the total sample.

** Rough estimate. Eggs were obtained but sampling technique was encumbered by an abundance of algae clogging nets.

to Rickahock. Boardley is about 8 miles from West Point and Rickahock about 19 miles. On April 30 on the downstream trip, many eggs were collected between Mattaponi and Muddy Point, where the last sample was taken.

The largest numbers of eggs on both trips were taken in the vicinity of Foxes, which is about 9 miles above West Point. Although spawning was probably taking place over a fairly wide section of the stream the peak activity was in the vicinity of Foxes. The river at this point was fresh and relatively turbid. Fishermen over the river indicated that from year to year the largest spring catches of bass are made in the region around Foxes.

Large number of eggs were also taken in the Muddy Point samples, about 3 miles above West Point, where the salinity was about 1 $^{0}/oo$. These were collected toward the end of an ebb tide, indicating that they could have been carried to this point by the current. Since no eggs were collected here on the upstream trip it seems evident that spawning was not being carried on this far downstream.

<u>Chickahominy River</u>. Samples were taken at 3 mile intervals from Barret's Point, at the mouth of the river, to Walker's Dam, which is about 19 miles upstream. A few eggs were collected on May 5 at Nettles Creek, Watt's Point, and below Big Marsh Point. The latter two stations are in the region where fishermen make the best catches of bass. Nettles Creek is about 8 miles above Jamestown Island and Big Marsh Point is about 16 miles above. The whole river was fresh and appeared to be less turbid than the other streams studied.

Brackish water was encountered in the James River below Jamestown Island, about 10 miles downstream from the mouth of the Chickahominy River.

The few eggs collected in the river makes the location of any peak effort impossible; however, on the basis of catches reported by fishermen a spawning ground is probably located between Watt's Point and Big Marsh Point.

James River. Samples were taken at approximately 5 mile intervals from Jamestown Island to the west side of Turkey Island Cutoff, above Hopewell, Virginia. Sampling was stopped there in order that schedule demands could be met. Eggs were collected on May 9 and May 11 at almost every station from Jamestown Island to the last upstream sample. Evidently eggs were being spawned over a relatively wide area, possibly extending upstream from our last sampling station. The eggs from the Jamestown sample and the next one above were almost to the larval stage, indicating that they may have been spawned further upstream. The largest numbers of eggs were taken between Dunmore and Jordan Point, which are 16 and 27 miles, respectively, above Jamestown Island and brackish water. Turkey Island Cutoff is about 32 miles above Jamestown Island. The whole river appeared turbid during the sampling period. A few fishermen were questioned but no indication of where the most fish were caught was obtained.

Rappahannock River. Samples were taken from Tappahannock to Port Royal at approximately 3 mile intervals, from May 17 to May 21. Sampling was discontinued there in order that schedule demands could be met. Sampling conditions were very poor because of a heavy load of fine filamentous algae in the water which clogged nets and made sorting of samples difficult. A few eggs were collected from Layton, Ketch Point, Wilmot, and Portobago Bay. Layton is about 13 miles from Tappahannock and Portobago Bay about 28 miles. The river was fresh in the vicinity of Tappahannock and the whole area studied was very turbid. No clear picture of where the best commercial catches of bass were made could be obtained from the fishermen questioned.

In the above descriptions of spawning grounds no attempt has been made to interpret the significance of the number of eggs collected per sample because of limitations in herent in the type of survey undertaken. The appartus is at best semi-quantitative due to the inability to measure currents accurately, to compensate for variable clogging of nets, and similar factors. The short time spent on each river allows no comparison of the importance of spawning grounds because spawning is not carried on throughout the season with equal intensity.

Discussion

Spawning grounds in all the rivers described here are similar in that they are located in fresh, turbid water not far above brackish water. In all the rivers some spawning takes place over a relatively wide area. Nothing distinctive in river topography was observed in the various areas where eggs were collected.

Though eggs were collected in every river surveyed, only in the Mattaponi River were they collected in appreciable numbers. On the

Pamunkey, Mattaponi, and Chickahominy Rivers there is a high correlation between where the largest commercial catches are reported to be made from year to year and where eggs were collected in greatest abundance. This indicates that the peak activity on these rivers probably takes place in the same limited area from year to year. This area is usually located within about the first 25 miles of fresh water.

In the James and Rappahannock Rivers no good indication of where the best commercial catches of fish were made was obtained. Only a few eggs were collected over a wide section of these rivers, thus no region where a peak spawning activity took place could be located. This greater distance over which eggs were collected may be an indication of a wider range of spawning activities.

No eggs were collected in the last upstream samples except in the James River. Fishermen on the various rivers reported that few bass were taken at and above the location where the last samples were taken. These two observations seem to indicate that spawning does not take place at the fall line in Virginia rivers.

Spawning grounds described by Vladykov and Wallace (1938) and Pearson (1938) in the Chesapeake Bay region, and by Woodhull (1947) in California, appear to be similar in most respects to those described here. By contrast the spawning ground at Weldon, North Carolina, is distinctly different. It is much farther from brackish water and is located at the fall line, some distance above tidal influence. The bottom is rocky and the current more swift and erratic.

The contrast between the Weldon spawning ground and those in Virginia raises many questions regarding the nature of this difference. Possibly it is an indication of a physiologically different race of fish, on the other hand it may simply indicate an adaptation to existing river conditions. Further study on striped bass spawning activities on the Roanoke and other rivers should help clarify some of these problems.

SUMMARY

1. During April and May 1950, the Pamunkey, Mattaponi, Chickahominy, James and Rappahannock Rivers were studied to determine the location of striped bass spawning grounds by sampling for planktonic eggs and larvae.

2. Samples were taken from brackish water (about 5 $^{o}/_{oo}$ or less) and continued upstream until navigation became difficult or schedule demands required that sampling be stopped.

3. Large nets similar in design to simple plankton nets were anchored in the current both on the bottom or at the surface.

4. Eggs were collected in all the rivers over a fairly wide portion of the stream just above brackish water. The greatest numbers of eggs were usually within the first 25 miles of fresh water, indicating that the peak spawning activity occurs within this region. No eggs were collected at the last upstream samples except in the James River, indicating that the major spawning effort is well below the fall line.

5. On the Pamunkey, Mattaponi, and Chickahominy there was a high correlation between where fishermen made the best spring catches of bass from year to year and where eggs were collected.

6. On the James and Rappahannock eggs were collected over a wide section of the stream, but no correlation between commercial catches of fish and egg collections could be determined.

LITERATURE CITED

Calhoun, A. J. and Chester A. Woodhull. 1948. A progress report on studies of striped bass reproduction in relation to the Central Valley Project. Calif. Fish and Game., 34(4): 171-187.

Calhoun, A. J., C. A. Woodhull and W. C. Johnson. 1950. Striped bass reproduction in the Sacramento River system in 1948. Calif. Fish and Game., 36(2): 135-145.

Curran, H. W. and D. T. Ries. 1937. Fisheries investigations in the lower Hudson River. State of N.Y. Cons. Dept. Biological Survey (1936) No. 11: 124-128.

Leim, A. H. 1924. The life history of the shad (Alosa sapidissima (Wilson)) with special reference to the factors limiting its abundance. Contr. to Canadian Biol., 2 (11): 161-284.

Merriman, Daniel. 1941. Studies on the striped bass (Roccus saxatilis) of the Atlantic Coast. Fishery Bull. 35, from Fishery Bulletin of the U. S. Fish and Wildlife Service, 50: 1-77.

Pearson, J. C. 1938. The life history of the striped bass or rockfish, Roccus saxatilis (Walbaum). Bull. U. S. Bur. Fish., 49 (28): 825-851.

Raney, Edward C. 1949. The life history of the striped bass, Roccus saxatilis (Walbaum). Unpub. manuscript.

Vladykov, V. and David Wallace. 1938. Studies of the striped bass with special reference to the Chesapeake Bay region. Unpub. manuscript. Chesapeake Biol. Lab., Solomons, Md.

Wallace, David H. and W. C. Neville. 1942. The problem of conservation of striped bass on the Atlantic Coast. Unpub. manuscript.

Woodhull, Chester. 1947. Spawning habits of the striped bass (Roccus saxatilis) in California waters. Calif. Fish and Game., 33(2): 97-102.

APPENDIX

TABLE II

STRIPED BASS EGG COLLECTIONS - PAMUNKEY RIVER, 1950

Station	Date	Time	Temp.C.	Depth Range Ft.	No. Hour Samples Surface	No. Hour Samples Bottom	Number Eggs Surface	Number Eggs Bottom	Number Eggs Total	Number Eggs per Net & Hour
A-West Point	4/4	1120-1230	12.4	23-25	0	4	0	0	0	0.0
B-Lee Marsh	4/4	1550-1830	13.2	20-32	0	12	0	0	0	0.0
C-Devil's Reach	4/5	1200-1445	13.5	18-26	1	13	0	0	0	0.0
D-Island Reach	4/6	0630-0850	13.4	16-22	1	12	8	1	9	0.7
D-Island Reach	4/13	0915	13.0	25	3	2	63	0	63	12.6
E-Lestor Manor	4/6	1345-1445	14.1	20	0	8	0	0	0	0.0
E-Lestor Manor	4/11	1145	13.2	13-20	1	3	0	0	0	0.0
F-Rockahock	4/10	1715-2000	12.9	18-20	1	12	0	0	0	0.0
G-Gregory's Bar	4/11	1500-1600	14.0	5-6	1	8	0	0	0	0.0
H-Hogan Bar	4/12	1600	13.4	9	0	4	0	0	0	0.0
I-Bassett's Bar	4/12	1200	13.9	10	2	4	0	0	0	0.0
					10	82	71	1	72	

TABLE III

HYDROGRAPHIC DATA-PAMUNKEY RIVER, 1950

Station	Date	Time	Tide	Current ft/sec	Depth	Temp. C° Surface	Temp. C° Bottom	Hydrometer Salinity o/oo Surface	Hydrometer Salinity o/oo Bottom	Titrated Salinity o/oo Surf.	Titrated Salinity o/oo Bottom	Turbidity E at 400	Winkler O_2
York River-Claybank	4/4	0645	E	1.0	19	11.6	12.2	13.5	-	-	-	-	6.5
A-West Point	4/4	0905	LS	2.0	25	12.0	11.7	4.1	-	-	-	-	5.6
" " "	4/4	1130	F	2.9	25	12.2	12.0	7.5	9.2	-	-	-	-
" " "	4/4	1215	F	2.0	25	12.6	12.2	7.5	9.6	-	-	-	-
B-Lee Marsh	4/4	1540	E	1.5	30	13.3	13.1	3.3	5.1	-	-	-	5.6
" " "	4/4	1640	E	1.7	30	13.0	12.7	2.5	4.6	-	-	-	-
" " "	4/4	2000	-	-	30	13.2	13.8	1.7	2.4	-	-	-	-
C-Devil's Reach	4/5	1140	F	2.0	20	13.6	13.6	0.5	1.1	-	-	-	6.4
" " "	4/5	1250	F	2.0	20	13.6	13.6	0.9	0.7	-	-	-	-
" " "	4/5	1350	F	1.7	20	13.5	13.2	0.8	0.4	-	-	-	-
" " "	4/5	1450	-	1.3	20	13.5	13.2	0.5	0.7	-	-	-	-
D-Island Reach	4/6	0640	E	1.7	22	13.2	13.0	0.3	1.2	-	-	-	6.2
" " "	4/6	0740	F	2.9	22	13.4	12.8	0.3	0.3	-	-	-	-
" " "	4/6	0845	F	2.5	22	13.6	13.2	0.5	0.5	-	-	-	-
" " "	4/6	0945	F	1.7	13	13.5	13.0	0.3	0.5	-	-	-	-
E-Lestor Manor	4/6	1400	F	1.4	11	14.0	13.6	-	-	-	-	-	6.3
" " "	4/6	1500	F	1.3	11	14.3	13.7	-	-	-	-	-	-

TABLE III (continued)

HYDROGRAPHIC DATA-PAMUNKEY RIVER, 1950

Station	Date	Time	Tide	Current ft/sec	Depth	Temp. C° Surface	Temp. C° Bottom	Hydrometer Salinity o/oo Surface	Hydrometer Salinity o/oo Bottom	Titrated Salinity o/00 Surf.	Titrated Salinity o/00 Bottom	Turbidity E at 400	Winkler O_2
F-Rockahock	4/10	1800	F	1.7	18	13.2	13.2	-	-	-	-	-	7.1
" "	4/10	1900	F	1.4	18	12.5	12.5	-	-	-	-	-	-
" "	4/10	2000	F	1.4	18	12.6	12.6	-	-	-	-	-	-
E-Lestor Manor	4/11	1150	E	2.2	20	13.2	13.2	-	-	-	-	-	6.3
G-Gregory's Bar	4/11	1520	E	1.8	6	13.4	-	-	-	-	-	-	-
" " "	4/11	1550	E	1.7	6	13.6	-	-	-	-	-	-	-
I-Bassett's Bar	4/12	1345	E	0.9	10	13.9	-	-	-	-	-	-	-
H-Hogan Bar	4/12	1600	E	1.7	9	13.4	-	-	-	0.07	-	0.320	7.0
Whitehouse	4/12	2010	F	-	30	14.8	14.8	-	-	0.12	0.09	0.460	-
E-Lestor Manor	4/13	0710	F	-	35	13.0	13.0	0	-	0.07	0.08	0.810	-
D-Morgan Ldg.	4/13	0900	F	-	58	13.0	12.7	-	-	0.08	0.05	1.26	6.6
C-Sweet Hall Ldg.	4/13	1130	E	-	60	12.6	12.4	-	-	0.34	0.45	1.62	-
B-Lee Marsh	4/13	1300	E	-	55	12.4	12.1	-	-	2.90	3.77	1.34	-
Port Richmond	4/13	1330	E	-	54	12.5	12.1	-	-	6.71	6.71	1.20	-
A-West Point-C25	4/13	1345	E	-	23	12.4	12.2	-	-	7.96	9.18	0.980	-

TABLE IV

STRIPED BASS EGG COLLECTIONS - MATTAPONI RIVER, 1950

Station	Date	Time	Temp.C°	Depth Range Feet	No. Hour Samples Surface	No. Hour Samples Bottom	No. Eggs Surface	No. Eggs Bottom	No. Eggs Total	No. Eggs per Net Hour
A-West Point	4/13	1420	12.6	30	0	4	0	0	0	0.0
B-Below Muddy Point	4/25	1200-1430	15.8	12-28	1	4	0	0	0	0.0
B2-Muddy Pt. Above 13	4/30	1530	16.6	25	3	0	1700	-	1700	566.7
C-Chelsea	4/25	1615	14.6	31-35	1	4	0	0	0	0.0
D-Boardley	4/25	1745	13.9	31	1	4	16	44	60	12.0
D2-Above Clifton Ldg.	4/30	1400	16.8	18-25	3	2	5100	236	5336	1067.2
E-Foxes	4/25	2115	14.0	25-30	2	4	30*	1	31	5.2
E2-Below Foxes	4/30	1215	16.8	21-30	3	2	5600	1700	7300	1460.0
F-Courthouse Ldg.	4/26	0900	14.9	29-30	1	4	5	2	7	1.4
F-Courthouse Ldg.	4/30	0915	17.7	10-29	2	3	40	90	130	26.0
G-Mattaponi	4/26	1100-1810	15.2	15-30	3	8	0	0	0	0.0
G-Mattaponi	4/30	0710	19.0	11-18	1	4	1	2	3	0.6
H-Sandy Point	4/26	1300	15.2	20-30	5	2	0	0	0	0.0
H-Sandy Point	4/27	0630	15.7	15-28	1	4	0	1	1	0.2
H-Sandy Point	4/29	1830	19.1	15-20	2	2	0	0	0	0.0

TABLE IV
(continued)

STRIPED BASS EGG COLLECTIONS - MATTAPONI RIVER, 1950

Station	Date	Time	Temp.C°	Depth Range Feet	No. Hour Samples Surface	No. Hour Samples Bottom	No. Eggs Surface	No. Eggs Bottom	No. Eggs Total	No. Eggs per Net Hour
I-Rickahock	4/27	0955	16.4	20	1	4	1	0	1	0.2
I-Rickahock	4/29	1715	20.5	15	1	1	Slack		Water	-
J-Peavine Island	4/27	1145	16.2	10	0	4	0	0	0	0.0
K-Line Tree Bar	4/28	0800	17.0	10-14	1	4	0	0	0	0.0
L-Pointer Ldg.	4/29	2000	17.4	9	0	4	0	0	0	0.0

TABLE V

HYDROGRAPHIC DATA - MATTAPONI RIVER, 1950

Mattaponi Station	Date	Time	Tide	Current ft/sec	Depth	Temp.C° Surface	Temp.C° Bottom	Hydrometer S o/oo Surface	Hydrometer S o/oo Bottom	Titrated Salinity o/oo Surface	Tur-bidity E at 400	Winkler Oxygen
A-West Point	4/13	1410	E	1.0	6	12.6	-	6.6	7.2	-	-	5.9
B-Below Muddy Pt.	4/25	1445	F	1.0	15	15.8	15.6	3.9	7.2	-	-	5.2
C-Chelsea	4/25	1515	F	1.7	31	14.6	14.6	2.9	2.8	-	-	6.0
D-Beardley	4/25	1700	F	0.6	31	13.9	13.9	1.1	1.5	-	-	6.2
E-Foxes	4/25	2115	E	1.3	30	14.0	14.0	0.5	0.7	-	-	6.2
F-Courthouse Ldg.	4/26	0915	E	1.4	29	14.9	14.9	1.0	1.0	-	-	6.4
G-Mattaponi	4/26	1100	E	1.4	15	15.2	15.2	0.8	0.8	-	-	6.2
H-Sandy Point	4/26	1300	E	0.8	25	15.2	-	-	-	-	-	-
H-Sandy Point	4/27	0635	F	1.0	25	15.7	-	-	-	-	-	6.0
I-Rickahock	4/27	0955	E	1.3	15	16.4	-	-	-	-	-	5.5
J-Walkerton	4/27	1145	E	0.8	14	16.2	-	-	-	0.07	0.441	-
L-Pointer Ldg.	4/27	2000	F	0.3	7	17.4	-	-	-	-	-	-
K-Line Tree Bar	4/28	0815	F	0.8	10	17.0	-	-	-	-	-	-
I-Rickahock	4/29	1715	E	0.4	15	20.5	-	-	-	0.08	0.394	-
H-Sandy Point	4/29	1830	F	1.4	25	19.1	-	-	-	0.12	0.431	-
G-Mattaponi	4/30	0640	F	1.0	20	19.0	-	-	-	0.07	0.410	-

TABLE V
(continued)

HYDROGRAPHIC DATA - MATTAPONI RIVER, 1950

Mattaponi Station	Date	Time	Tide	Current ft/sec	Depth	Temp. C° Surface	Temp. C° Bottom	Hydrometer S0/oo Surface	Hydrometer S0/oo Bottom	Titrated Salinity o/oo Surface	Turbidity E at 400	Winkler Oxygen
F-Courthouse Ldg.	4/30	0905	F	1.1	29	17.7	-	1.2	1.3	0.10	0.472	-
E-Below Foxes	4/30	1210	E	1.1	30	16.8	-	1.3	0.9	0.20	1.49	-
C-Above Clifton	4/30	1400	E	2.0	24	16.8	-	1.2	1.2	-	-	-
B-Muddy Point	4/30	1530	E	-	25	16.6	-	2.0	2.2	0.93	1.45	-

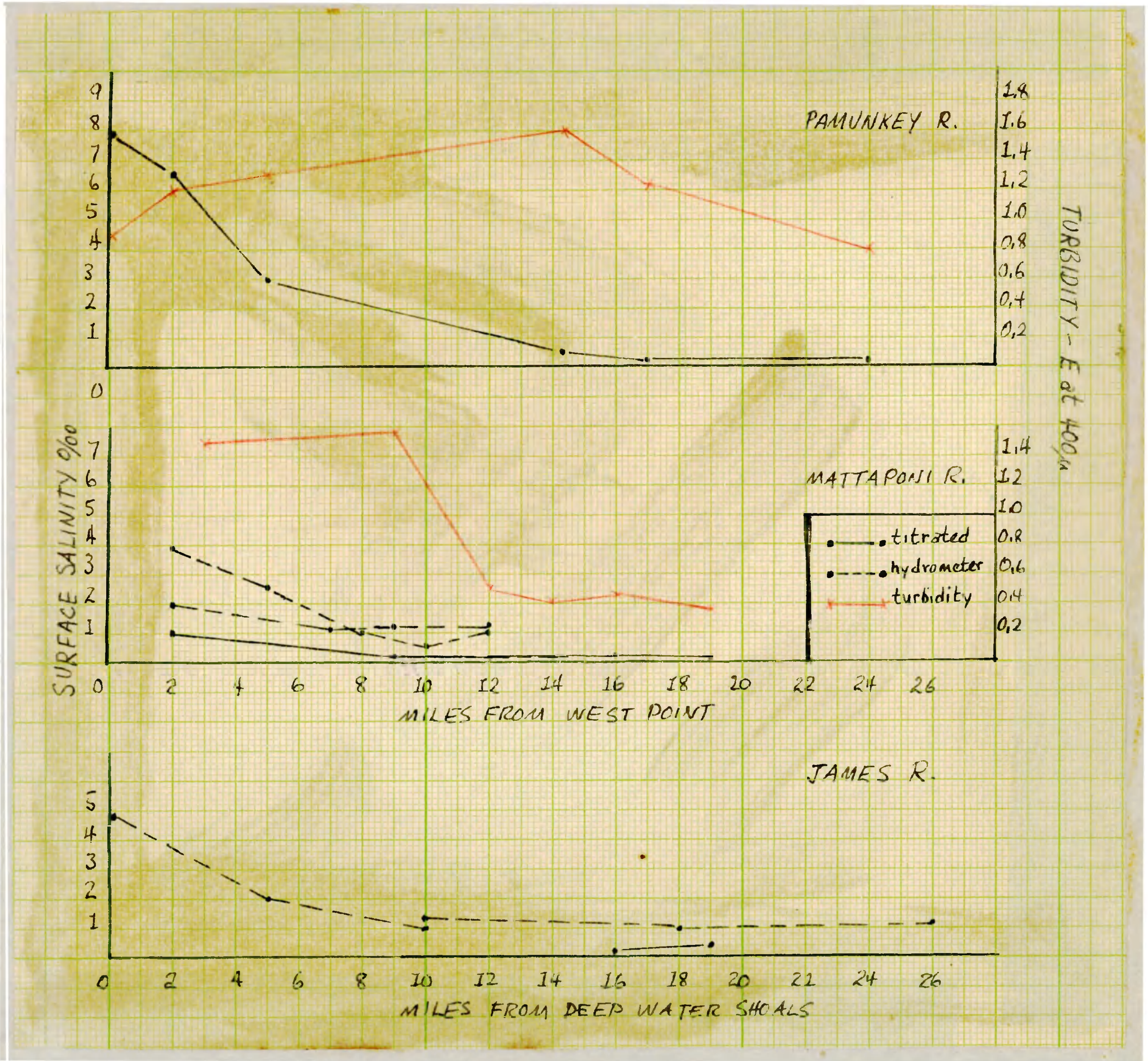

Fig. 2 - Salinity and Turbidity Relationships - Spring 1950.

Comparable hydrometer salinities (corrected for temp.) and titrated salinities from both the Mattaponi and James indicate that the former are about 1 $^{o}/oo$ higher than the titrated salinity due to the effect of silt as well as the errors inherent in using this type of instrument.

Turbidity measurements were madeagainst a distilled water standard and show extinction due to extraneous matter in the water.

TABLE VI

STRIPED BASS EGG COLLECTIONS - CHICKAHOMINY RIVER, 1950

Station	Date	Time	Temp.C°	Depth Range Feet	No. Hour Samples Surface	Bottom	No. Eggs Surface	Bottom	Total	No. Eggs per Net Hour
A-Barret's Point	5/5	0915	18.3	25-30	1	4	0	0	0	0.0
B-S_7 at Nettles Creek	5/5	1230	18.7	17-19	1	4	0	1	1	0.2
C-Shipyard Ldg.	5/5	1430	19.0	38	2	3	0	0	0	0.0
D-SE Watt's Point	5/5	1315	21.1	15-20	2	3	1	0	1	0.2
E-S11 at Big Marsh Pt.	5/6	1450	20.4	14-20	2	3	1	0	1	0.2
F-Lanexa	5/6	1745	20.4	10-15	4	0*	0	0	0	0.0
Walker's Dam	5/7	0915	-	Tow	-	0*	0	-	0	0.0
Above Walker's Dam	5/7	1800	-	Tow	-	0*	0	-	0	0.0
Walker's Dam	5/8	0640	20.2	13-20	2	3	0	0	0	0.0
					19	20	2	1	3	

* No currents strong enough to fill out nets.

TABLE VII

HYRDROGRAPHIC DATA - CHICKAHOMINY RIVER, 1950

Station	Date	Time	Tide	Ekman Current Meter*	Depth	Temp. C° Surface	Temp. C° Bottom	Hydrometer Salinity o/oo Surface	Hydrometer Salinity o/oo Bottom	Titrated Salinity o/oo Surface	Titrated Salinity o/oo Bottom
A-Barret's Point	5/5	0920	E	484	30	18.3	17.8	1.1	0.8	-	-
Nettles Creek	5/5	1110	-	-	60	18.8	18.8			0.17	0.07
B-Above Nettles Creek	5/5	1230	F	814	17	18.7	-			0.12	0.05
C-Shipyard Ldg.	5/5	1330	F	450	38	19.0	-			0.11	0.12
D-SE Watt's Point	5/6	1320	F	780	20	21.1	-			0.08	0.13
E-Below Big Marsh Pt.	5/6	1450	F	498	15	20.4	-			Broken	0.23
H-Walker's Dam	5/8	0640	-	-	14	20.2	-			0.11	-

* Revolutions per hour - not converted.

TABLE VIII

STRIPED BASS EGG COLLECTIONS - JAMES RIVER, 1950

Station	Date	Time	Temp.C°	Depth Range Feet	No. Hour Samples Surface	No. Hour Samples Bottom	No. Eggs Surface	No. Eggs Bottom	No. Eggs Total	No. Eggs per Net Hour
A-Deep Water Shoals	5/4	2000-0515	-	15	Net set overnight		0	0	0	0.0
B-Jamestown Island	5/9	0900	19.0	10-15	3	2	1	0	1	0.2
C-Dancing Point	5/9	1110	20.0	25-30	3	2	5	1	6	1.2
D-Dummore	5/9	1340	20.6	25-32	3	2	7	1	8	1.6
E-Windmill Pt.	5/9	1710	20.8	20-28	3	2	13	3	16	3.2
F-Jordan Pt.	5/10	0710	20.2	30	3	2	13	6	19	3.8
G-City Point	5/10	0905	20.4	15	1	2	0	0	0	0.0
I-Turkey I. Cutoff West	5/10	1145	21.1	10-35	3	2	6	1	7	1.4
H-Turkey I. Cutoff East	5/10	1400	20.8	12-15	3	2	0	0	0	0.0
					22	16	45	12	57	

TABLE IX

HYDROGRAPHIC DATA - JAMES RIVER, 1950

Station	Date	Time	Tide	Ekman Current Meter*	Depth	Temp. C° Surface	Temp. C° Bottom	Hydrometer Salinity o/oo Surface	Hydrometer Salinity o/oo Bottom	Titrated Salinity o/oo Surface	Winkler Oxygen
Deep Water Shoals	5/5	0530	E	-	80	17.0	16.8	4.7	6.8	-	-
Hog Point	5/5	0625	E	-	45	17.6	17.4	2.1	4.1	-	-
Jamestown Island	5/5	0720	E	-	60	17.7	17.5	1.1	1.7	-	-
A- " "	5/9	0900	E	424	14	19.0	18.0	1.4	1.4	Broken	6.5
C-Dancing Point	5/9	1110	E	115	25	20.0	19.7	0.9	1.3	Broken	4.5
Sturgeon Point	5/9	1310	E	131	75	20.4	20.2	-	-	-	4.2
D-Dunmore	5/9	1340	E	519	33	20.6	20.6	1.4	-	0.10	4.5
Wayanoke Point	5/9	1530	E	-	80	20.7	20.6	-	1.2	0.41	4.8
E-Windmill Point	5/9	1710	F	256	20	20.8	20.7	-	-	-	5.0
F-Jordan Point	5/10	0710	F	676	30	20.2	20.2	-	-	-	4.7
G-City Point	5/10	0905	F	-	20	20.4	-	-	-	-	-
H-Turkey I. Cutoff East	5/10	1145	E	-	30	21.1	20.8	-	-	0.22	5.5
I-Turkey I. Cutoff West	5/10	1305	E	-	15	20.8	-	-	-	0.40	5.0

* Revolutions per hour - not converted.

TABLE X

STRIPED BASS EGG COLLECTIONS - RAPPAHANNOCK RIVER, 1950

Station	Date	Time	Temp.C°	Depth Range Feet	No. Hour Samples Surface	Bottom	No. Eggs Surface	Bottom	Total	No. Eggs per Net Hour*
A-1 Tappahannock	5/21	1500	20.4	12-16	2	2	0	0	0	0.0
A-Mallory's Pt.	5/17	1115	19.0	15-18	2	4	0	0	0	0.0
B-Island Pt.	5/17	1400	19.4	25	2	4	0	0	0	0.0
D-Layton**	5/17	1620	20.4	22-25	2	4	2	0	2	0.3
E-Ketch Pt.	5/18	0815	20.0	20-35	2	4	0	1	1	0.1
F-Owl Hollow	5/18	1130	20.3	15-22	2	4	0	0	0	0.0
G-Wilmot	5/21	0900	18.1	15-25	2	4	1	0	1	0.1
H-Portobago Bay	5/20	1800	17.9	11-16	2	4	1	0	1	0.1
I-Port Royal	5/20	1500	16.7	15-25	2	4	0	0	0	0.0
					18	34	4	1	5	

* Because of a heavy load of algae in the nets only an estimated 1/8 of each hour sample was taken. Therefore each figure should be multiplied by 8 to obtain the estimated number of eggs per net hour.

**Skipped Station "C" because it was too near the previous station.

TABLE XI

HYDROGRAPHIC DATA - RAPPAHANNOCK RIVER, 1950

Station	Date	Time	Tide	Current ft/sec	Depth	Temp.C° Surface	Temp.C° Bottom	Hydrometer So/oo Surface	Hydrometer So/oo Bottom	Titrated Salinity o/oo Surface	Titrated Salinity o/oo Bottom	Secchi Disc Reading	Winkler Oxygen
A-Mallory's Pt.	5/17	1000	E	0.8	15	19.0	-	1.3	1.3	0.17	-	12"	5.9
B-Island Pt.	5/17	1300	F	1.3	22	19.4	-	0.7	0.7	0.25	-	14	6.1
C-Fone's Cliffs	5/17	1545	F	-	50	20.6	20.0	-	-	0.21	-	-	6.1
D-Layton	5/17	1620	F	0.8	22	20.4	-	-	-	-	-	14	-
Saunder's Wharf	5/18	0745	E	-	60	20.0	19.9	-	-	0.49	0.22	-	5.7
E-Ketch Point	5/18	0815	E	1.3	35	20.0	-	-	-	-	-	16	-
F-Owl Hollow	5/18	1130	E	1.3	20	20.3	-	-	-	-	-	-	-
Horsehead	5/18	1310	E	-	60	20.0	19.8	-	-	0.10	0.45	-	5.0
Mud Folly Bend	5/18	1405	E	-	45	18.7	18.2	-	-	0.11	0.08	12	-
I-Port Royal	5/20	1500	E	0.5	20	16.7	-	-	-	-	-	5	4.5
H-Portobago Bay	5/20	1750	F	0.6	16	17.9	-	-	-	-	-	-	5.0
Green Bay	5/21	0830	E	-	19	18.0	-	-	-	-	-	12	-
G-Wilmot	5/21	0930	E	1.3	25	18.1	-	-	-	-	-	12	4.5
A-I Tappahannock	5/21	1500	F	1.3	12	20.4	-	1.4	1.4	-	-	12	-