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A FIVE-YEAR STUDY OF THE STRIPED BASS FISHERY OF MARYLAND, BASED ON ANALYSES OF THE SCALES

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A FIVE-YEAR STUDY OF THE STRIPED BASS FISHERY OF MARYLAND, BASED ON ANALYSES OF THE SCALES *

RICHARD E. TILLER **

INTRODUCTION

The striped bass, or rock as the species is called in the Chesapeake area, ranks high in value and volume among the commercially important fish taken in Maryland waters and, in addition, is highly prized as a game fish by sportsmen. Interest in the marked fluctuations characteristic of the species stimulated this investigation begun in October, 1941 under the joint sponsorship of the University of Maryland Graduate School and the Fish and Wildlife Service. The study was continued on that basis until 1943 when I joined the staff of the Maryland Department of Research and Education. From 1943 until 1947 the investigation was conducted under the auspices of that organization.

My investigation was designed as a general study, presenting simply a description of the fishery, an outline of techniques of investigation, and a recommendation of further study required. I collected and analyzed scales from fish of the 1940, 1941, 1942, 1943, and 1944 broods of striped bass to determine the rate of growth, contribution to the commercial catches, the rate of utilization of successive year classes of striped bass and the possibility of using the scales as an index of origin for the Atlantic stocks of striped bass.

* The data used in this paper were presented in thesis form at the University of Maryland in partial fulfillment of the requirements for the degree of Doctor of Philosophy in 1947.

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THE MARYLAND STRIPED BASS FISHERY

Striped bass are taken during the entire year in Maryland waters, with seasonal peaks of abundance in the late fall and spring months. The gear used in this fishery varies with the season, and to a lesser extent with the area fished. Pound nets which operate in the Bay and larger rivers during the spring, summer, and fall account for the greater portion of the catch. Gill nets, drifted or anchored in the Bay and larger rivers during the winter and early spring or fished as stake nets on or near the spawning grounds in the spring, are next in production. Lowest in value of the larger commercial gears are the haul seines, fished principally during the spring and summer. Fyke nets, typically used in the upper regions of rivers for perch and catfish, make only a relatively small seasonal contribution to the total catch of rock. The table following (Table I) was obtained from records compiled by the Maryland Department of Research and Education, and presents the most recent available data on the catch by gear of this species.

TABLE I

MARYLAND STRIPED BASS CATCH BY GEAR FOR 1944 AND 1945. CHESAPEAKE BAY AND TRIBUTARIES ONLY, ATLANTIC OCEAN CATCH NOT INCLUDED

		GILL NETS			HAUL	FYKE	
	POUND NETS	Drift	Anchor	Stake	SEINES	NETS	TOTAL
YEAR	(Lbs)	(Lbs)	(Lbs)	(Lbs)	(Lbs)	(Lbs)	(Lbs)
1944	768.595	522,115	86,622	689,583	502,888	6,315	2,576,118
1945	565,538	196,521	42,460	483,303	186,324	5,709	1,479,855

Records compiled by the U. S. Bureau of Fisheries covering the period from 1887 to 1942 (Table II) show marked variations in the abundance of striped bass taken in Maryland. A complete series for every year during that time is not available, but the following table presents the total catch for all years in which statistics were collected.

TABLE II

TOTAL CATCH OF STRIPED BASS IN MARYLAND FOR VARIOUS YEARS FROM 1887 TO 1942

YEAR	POUNDS	YEAR	POUNDS	YEAR	POUNDS
1887	1,140,000	1920	1,040,000	1935	927,700
1888	1,123,000	1925	1,414,000	1936	1,864,100
1890	1,366,000	1929	1,291,695	1937	2,011,300
1891	1,265,000	1930	1,227,990	1938	1,714,400
1897	935,000	1931	634,909	1939	1,728,500
1901	824,000	1932	433,811	1940	1,180,100
1904	721,000	1933	313,795	1941	1,223,300
1908	640,000	1934	332,700	1942	2,507,800

According to these statistics, Maryland produced in 1940 approximately 40% of the total catch of rock in the United States. Although conclusive proof from tagging is still lacking, there is strong evidence that the Chesapeake Bay is the point of origin for most of the striped bass found along the Middle and North Atlantic Coast. On the basis of tagging experiments during 1936, Vladykov and Wallace (1937) state that only a very small number of the Chesapeake rock leave the Bay or about 2.5% of the total recaptures from over 1,500 tagged fish. It is, however, interesting to note that in 1934 and in 1940 dominant broods of rock were produced and these "bumper crops" were easily traced up the coast during the early spring months following their first appearance in the Chesapeake catches. Merriman's work on the 1934 brood revealed that scales from northern catches had about the same values for the width of the first and second growth zones as scales from that same year class taken in the Chesapeake area.

METHODS

Collection of Samples

To minimize variations due to environmental or physiological peculiarities which might alter the scale pattern of populations from different areas uniform procedures were used in every collection. All specimens for a single sample were taken from the same area on the same day, and successive samples were made from the same nets whenever possible.

The areas selected for collection of the samples for this study were two representative centers of pound net operations, one at Galesville, Maryland, and the other at Flag Pond, near Lusby, Maryland. All samples were taken at random from the catches, usually during the return trip from the nets, although some collections were made as the fish were landed, before they were sorted according to size.

The scales were removed from the fish with forceps, and placed in small envelopes on which the length of the fish, the body area from which the scales were taken, and any other necessary data were recorded. All specimens were measured from the snout to the fork of the tail, using a measuring board equipped with an offset scale divided into half-centimeter units.

Two problems became evident in the early phases of the study; first, the selection of a fishing gear which would be least selective in the size of fish taken, and which would therefore present a more uniform cross-section of the total population; and second, the selection of the most reliable body area for the collection of scale samples.

Selection of Gear for Sampling

A brief discussion of the four major types of commercial gear used in Maryland was included in the introductory section, together with a table (Table I) indicating the contribution of each to the total catch of striped bass in the state. In addition to exceeding all other individual types of gear in total production, pound nets have certain other advantages which make them a desirable source from which to obtain the most typical samples of a fish population. The regularity characteristic of pound net operations is a highly important factor in their favor. Lifted daily, except in exceptionally bad weather, pounds fish the same waters in the same way throughout the entire fishing season. Under favorable conditions the pound net season may run from March through November, with only a short midsummer break in operations. The previously-mentioned table shows stake gill nets to be second in total production of striped bass, but this gear, and also drift and anchor gill nets, exerts very definite size selectivity, for the mesh size captures only fish falling within a relatively narrow size range. Stake nets, and all other types of gill netting, are fished only during the winter and spring, and their operations are necessarily irregular. Drift nets are the most irregular of this class of gear, since they characteristically work from one area to another, following the movements of the fish.

The last of the commercial gears to be considered is the haul seine. This type of net might well be termed a gear of "feast or famine." Seine operations are usually limited to the late spring, summer, and fall months, and like drift nets, characteristically follow the fish. Days or weeks may pass without a catch, or several tons may be landed in a single haul. Although less selective in operation than gill nets, haul seines occasionally make almost pure catches from a single year class, particularly when fished in rivers. Table III presents an age composition analysis of samples made from various types of commercial gear outside of the Galesville and Flag Pond areas on which this study is based.

Selection of Reliable Body Area for Sampling

To determine the comparative reliability of scales from different body areas, preliminary studies were conducted which indicated that scales from the region used by Merriman and by Scofield in their studies gave values for calculated length which approached very closely the average of the values from extreme body areas.

The original formula is given as:

$$\frac{s_x}{S} = \frac{l_x}{L} \quad \text{.....} \quad (1)$$

Where s_x = length of scale to annulus year$_x$,
S = total scale length,
l_x = body length at end of year$_x$, and
L = body length when captured.

This formula was used in a somewhat more convenient form of:

$$\frac{L}{S} \cdot s_x = lx. \quad \text{.....} \quad (2)$$

These calculations showed that the short, broad scales of the anterio-dorsal region gave consistently lower values than the regular, symmetrical scales of the middle body area, and the large, long scales of the ventral region yielded values which were consistently higher. The variation in calculated length was therefore determined to be a function of scale size. Table IV, prepared from calculations made on the 89 fish used in the preliminary study, indicates this fact. Three body areas were selected and designated as areas A, B, and C. Area A was located very high on the body, between the bases of the spiny and soft dorsal fins, at the extreme point where reasonably symmetrical scales can be found. Area B (used by Merriman and by Scofield), was located on the second and third row above the lateral line, between the dorsal fins, and yielded the most symmetrical scales. Area C was located very low on the body, one row below the lateral line. The scales were very large and noticeably longer than those of the mid-body region.

ANALYSIS OF DATA

Rate of Growth

The growth of rock, as indicated from length frequencies of the age classes observed in this study, appears to be highly variable (Table V).

TABLE III

AGE COMPOSITION OF COLLECTIONS FROM MISCELLANEOUS GEARS AND AREAS

Date (Month)	Gear	Area	1940 Brood No.	1940 Brood %	1941 Brood No.	1941 Brood %	1942 Brood No.	1942 Brood %	1943 Brood No.	1943 Brood %	R. F., others No.	R. F., others %	Total No.
1942													
Mar.	Pounds	Potomac R.	58	72.5							22	27.5	80
July	Seine	Patuxent R.											
Oct.	Pounds	Ches. Beach	95	95.0							5	5.0	100
Oct.	Pounds	York R.	50	59.5	31	36.9					3	3.6	84
Oct.	Pounds	James R.	29	52.7	24	43.6					2	3.6	55
Oct.	Pounds	Rappahannock R.	69	72.6	23	24.2					3	3.2	95
1943													
Jan.	Dr. Gill	Rock Hall	45	90.0	1	2.0					4	8.0	50
Feb.	Dr. Gill	Kent Island	110	94.0	3	2.6					4	3.4	117
May	Pounds	Cedar Pt.	29	81.5	2	7.4					3	11.1	27
1944													
Jan.	Dr. Gill	Rock Hall	3	2.1	9	6.4	127	90.7			1	.7	140
Feb.	Dr. Gill	Kent Island	1	3.8			25	96.1					26
June	Seine	Flag Pond					1	3.3	29	96.7			30

Although samples were obtained from the least selective of fishing gears, and in every case were taken at random from unsorted catches, occasional values from mean length occurred which were quite different from the expected values. In some instances, the composition of the catch was such that only a very few samples from certain broods were obtained.

TABLE IV

Body Length (cm/2)	(mm./00) Total Scale Radius	Average Calc. Length
AREA "A"		
49-53	243	18
54-56	271	21
57-59	282	21
60-62	313	21
63-65	303	26
66-69	334	29
AREA "B"		
49-53	284	20
54-56	315	22
57-59	325	22
60-62	350	23
63-65	355	27
66-69	377	30
AREA "C"		
49-53	312	21
54-56	332	25
57-59	337	25
60-62	371	25
63-65	379	30
66-69	409	32

Average increase in calculated length
Between A & B — 1.14 cm/2
Between B & C — 2.01 cm/2

The occasional discrepancies in the length frequencies of samples from Galesville and Flag Pond area might at first be taken as evidence of sub-populations in the Chesapeake Bay, but statistical analysis of the data fails to substantiate such an interpretation. While bass from Flag Pond did grow significantly larger in 1940 than those from the Galesville area, in the 1941 and 1942 year class, the bass from Flag Pond were actually smaller, contradicting any indication of "sub-populations" based on growth analysis.

Several interesting facts are indicated in Table V and Figure 1. First, a close agreement is seen in the size of all year classes at the time of their entry into the commercial catches. The 1940 and 1941 broods tend to be slightly faster in their rate of growth, and show slightly higher values for corresponding intervals of time. This tendency is not, however, clearly defined in all instances. Trend lines were prepared showing the growth rate of the four year classess under observation, using the method of least squares. The slight variation in the slope (Figure 1) indicates the slight degree of variation in the growth rate of the four broods after their entrance into the commercial fishery.

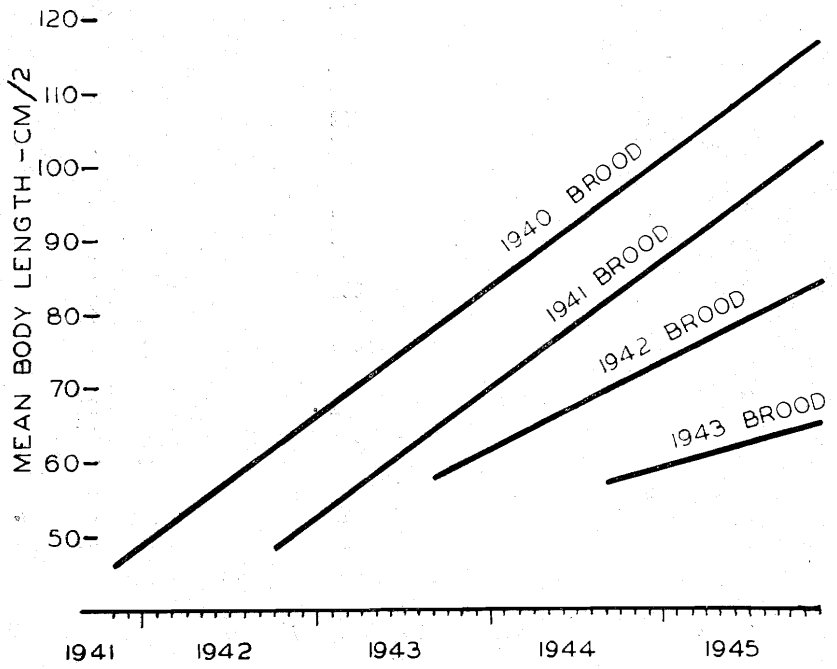

FIGURE 1. Rate of Growth of Striped Bass, Based on Length Frequencies of Four Successive Year Classes in the Chesapeake Bay.

EVIDENCE OF CHESAPEAKE ORIGIN OF ATLANTIC STOCKS OF STRIPED BASS

The possibility of using scale analyses as an index to origin of the stocks of striped bass of the Middle Atlantic Coast was stated as one of the objectives of this study. The introductory section summarized

to a greater or lesser degree. The variation in size between male and female striped bass might also cause a sex selectivity to result from sampling with these types of gear. Samples from other gears than pound nets afford valuable supplementary data, but cannot be regarded as representative in the composition of their catches.

In addition to this easily recognized gear selectivity there is indication of a seasonal selectivity which must be considered. During August and September, 1943, 560 samples were taken from the same nets, the collections in every case being made entirely at random. A marked decrease was observed in the percentage of 1940 fish. This brood, which during the preceding spring had comprised approximately 75% of the catch by numbers, dropped in one case to as little as 3% of the catch, averaging only about 19% of the catch for the period. In March, 1944, the percentage of 1940 fish rose again to 60%, then dropped during the summer months, and rose again during the following winter and spring. Each successive peak was lower than the preceding one, indicating a gradual utilization of the brood. The seasonal decreases during the summer months did not occur until the third year of life, when the fish had reached an average weight of approximately two pounds. It is common knowledge that striped bass simply do not trap as readily during the summer months as in the colder months of fall and winter. Commercial fishermen firmly maintain that "big rock won't trap," and as a seasonal phenomenon this is unquestionably true. The larger fish are undeniably later in making their appearance in the fall pound net catches.

Haul seines and hand lines took a somewhat greater percentage of the larger fish (1940 brood) than did the pound nets during the summer and fall months of 1943. A satisfactory explanation for this tendency is not available. If water temperature were considered the controlling factor, on the hypothesis that the fish sought deeper, cooler water during the summer, the haul seine and hand-line catches made inshore of pound nets, in even shallower water, would be contradictory. If food were advanced as an explanation, the catches of these two types of gear would again be difficult to explain.

The value of scale analyses in following the trends of fishing intensity in the striped bass fishery of Maryland can readily be seen. The State's rock fishery is prosecuted in what may well be termed a nursery area. Adult fish enter the rivers of Maryland to spawn, and the young remain in those rivers and in the waters of the Chesapeake

Bay for at least two years before even a portion of them begin seaward migrations. The fishery is therefore supported to a considerable extent by small fish. In some years, as indicated by the age-composition tables included in the preceding section, nearly all of the catch is composed of yearling rock, about eleven inches in length, and weighing approximately one-half pound. Those surviving the first year in the fishery reach the "medium" market classification the following year, and during the third or fourth year become "large" rock. Male fish may spawn at two year of age, but females are typically four or five years old when they first spawn. The value of scale analyses in determining the brood stock of a population, and the rate of utilization of successive year classes is obvious. Data of this type, supplemented by accurate statistical records of the catch, yields valuable information for the proper administration of conservation measures.

Possible inaccuracies characteristic of the scale method have already been indicated, in the discussion of the existence of sub-populations of striped bass in Maryland waters. The scales certainly do not provide an accurate index to origin of striped bass, although correlations of calculated length values indicate that a refinement of this method may offer possibilities. After five year of age, the scales become difficult to read. The first annulus is often hard to distinguish, and false annuli are more frequently found than in the scales of younger fish. Regenerated scales are much more numerous on older fish than on younger ones, and decrease the usable number of samples in the collections. Only rarely, however, does a brood survive the high fishing intensity in Maryland for more than four years, and significant numbers of larger fish are seldom found in commercial catches. As a means of studying the normal course of the Maryland striped bass fishery, the scale technique is unquestionably useful and valuable.

CONCLUSIONS

(1) Pound nets are the only type of gear employed in the Maryland fishery which combine regularity of operation, fixed location, long season, and minimum size selectivity, and therefore provide the most reliable source for obtaining representative samples of the striped bass population.

(2) Scales from extreme body areas, either high or low on the body, yield distorted values of calculated length. Scales from the middle region, on the second and third row above the lateral line at a

point between the spinous and soft dorsal fins, give calculated values which closely approximate the averaged values of the extreme areas. The variation is a function of scale size, smaller scales yielding lower values, and larger scales higher values for calculated length.

(3) The rate of growth, indicated by length frequencies of the age classes investigated, is variable. There is a close agreement in the size of the fish at the time of their entry into the fishery, and a degree of agreement is apparent among the rates of growth of successive year classes. Variations which occurred were independent of the size of the year class, since dominant and subnormal broods showed closely parallel rates of growth.

(4) Marked fluctuations in the size of year classes is characteristic of the striped bass, and occasionally dominant broods arise with no apparent relation to the extent of parental stock. There is a possible correlation between the production of dominant year classes and below-mean temperatures preceding and following the spawning season. A correlation between the production of the dominant brood of 1940 and low salinity during the spawning season is also apparent, but contradictory data in both cases renders these correlations questionable.

(5) Seasonal selectivity of age classes occurs in the pound net fishery. During the summer months the percentage of large striped bass taken in pound nets is not as high as in haul seine and hand-line catches. The fact that the catches of these latter types of gear are often made in pound net areas eliminates water temperature and food habits as possible causes for the selectivity.

(6) Thickening of the scales with increasing age tends to obscure the first annulus, and make age determination more difficult, but up to the fifth year the technique is accurate and reliable. The number of regenerated scales increases with age, but neither of these factors is of great consequence in the Maryland fishery since individual year classes, in significant numbers, rarely survive the high fishing intensity for more than four years.

SELECTED BIBLIOGRAPHY

CLARK, G. H., 1932. *The Striped Bass Supply Past and Present.* Calif. Fish and Game, Vol. 18, No. 4, pp. 297-298.

CLARK, G. H., 1933. *Fluctuations in the Abundance of Striped Bass (Roccus lineatus) in California.* Division of Fish and Game of California, Fish Bulletin No. 39, 20 pp., 7 figs.

CRAIG, J. A. *An Analysis of the Catch Statistics of the Striped Bass (Roccus lineatus) Fishery of California.* Division of Fish and Game of California, Fish Bulletin No. 24, 43 pp., 22 figs.

CREASER, Chas. W., 1926. *The Structure and Growth of Fishes in Relation to the Interpretations of their Life History, with Special Reference to Sunfish (Eupomotis gibbosus).* Univ. of Michigan, Ann Arbor, Mich.

FOERSTER, R. E., 1929. *An Investigation of the Life History and Propagation of the Sockeye Salmon (Oncorhyncus nerka) at Cultus Lake.* Contr. to Canadian Biology and Fisheries, No. 1, 1929, 35 pp.

GILBERT, Chas. H., 1913. *Contributions to the Life History of Sockeye Salmon, No. 1.* Report of the British Columbia Commissioner of Fisheries, pp. 53-77.

GILBERT, Chas. H. and Willis H. Rich, 1927. *Investigations Concerning the Red Salmon Runs to the Karluk River, Alaska.* Bulletin of the Bureau of Fisheries, Vol. 43, part 2, 69 pp., 34 figs.

HILDEBRAND, S. F. and W. C. Schroeder, 1927. *Fishes of Chesapeake Bay.* Bull. of the U. S. Bur. of Fisheries, Vol. 43, part 1, 388 pp.

HILE, R., 1940. *Age and Growth of the Cisco, Leucicthys artedi Le Sueur, in the Lakes of the Northeastern Highlands of Wisconsin.* Bull. of the U. S. Bur. of Fisheries, Vol. 48, pp. 211-317.

HUBBS, Carl L., 1921. *An Ecological Study of the Life History of the Fresh-Water Atherine Fish, Labisdesthes sicculus.* Ecology, Vol. 2, pp. 262-275.

HUBBS, C. L. and Gerald P. Cooper., 1934. *Age and Growth of the Long-Eared and Green Sunfishes in Michigan.* Mich. Acad. of Sci., Arts and Letters, Vol. 20, pp. 669-696.

JENSEN, A. J. C., 1932. *The Effect of the Plaice Fishery on the Stock of Undersized Plaice and Its Influence on the Yield of the Plaice Fishery in the North Sea.* Rapp. de Proc. Verb. les Reunions. (Counseil Perm. Internationale pour L'Exploration de la Mer), Vol. 80.

LEA, Einar, 1910. *On the Methods Used in the Herring Investigations.* Pub. de Circonstance, No. 53, pp. 8-23.

LEA, Einar, 1911. *A Study on the Growth of Herring.* Pub. de Circonstance, No. 53, pp. 35-48.

LEA, Einar, 1913. *Further Studies Concerning Methods of Calculating Growth of Herrings.* Pub. de Circonstance, No. 66, 36 pp.

LEE, Rosa M., 1912. *An Investigation into the Methods of Growth Determination in Fishes.* Pub. de Circonstance, No. 63, 34 pp.

McHUGH, J. L., 1942. *Growth of the Rocky Mountain Whitefish.* Journal of the Fisheries Research Board of Canada, Vol. 5, No. 4, pp. 334-343.

MERRIMAN, D., 1941. *Studies on the Striped Bass, Roccus saxatalis, of the Atlantic Coast.* U. S. Fish and Wildlife Service, Fishery Bulletin 35, 77 pp., 36 figs.

PEARSON, John C., 1939. *The Life History of the Striped Bass, or Rockfish, Roccus saxatalis (Walbaum).* Bull. of the U. S. Bur. of Fisheries, Vol. 69, pp. 825-851, 26 figs.

SCOFIELD, Eugene C., 1931. *The Striped Bass of California (Roccus lineatus).* Div. of Fish and Game of California, Fish Bulletin No. 29, 82 pp., 47 figs.

TILLER, R. E., 1943. *Indications of Compensatory Growth in the Striped Bass Roccus saxatalis Walbaum, as Revealed by a Study of the Scales.* Maryland Dept. of Research and Education, Pub. No. 57, 15 pp., 4 figs.

VAN OOSTEN, John, 1938. *The Age, Growth, Sexual Maturity, and Sex Ratio of the Common Whitefish, Coregonus clupeaformus, of Lake Huron.* Papers of the Mich. Acad. of Sci., Arts and Letters, Vol. 24.

VLADYKOV, V. D. and D. H. Wallace, 1937. *Migration in the Striped Bass of the Chesapeake Bay.* Trans. of the Amer. Fish. Sec., Vol. 67, pp. 67-86.

VAN OOSTEN, John, 1928. *Life History of the Lake Herring, Leucicthys artedi Le Sueur, of Lake Huron as Revealed by Its Scales, with a Critique of the Scale Method.* Bull. of the U. S. Bur. of Fisheries, Vol. 44, pp. 265-427.