bottom organisms. The assistance of the late Roland Morris, Oscar M. Dennis and Edward Wrenn in the field work was invaluable. The secretarial help of Mabel Thomas is gratefully acknowledged.

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THE STATUS OF STRIPED BASS (Roccus saxatilis) (Walbaum) IN NORTH CAROLINA WATERS

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Unlike the striped bass of most of the northern Atlantic coast, the fish of the North Carolina waters seem to maintain a separate and distinct population which tend to remain in more or less inland waters. According to Raney (private correspondence) there are no morphological characteristics which would indicate a separate race of fish. All of the tagging studies carried out thus far indicate that there is very little migration of fish into and out of the brackish water sounds and rivers into the Atlantic. Observations show that the largest concentrations of striped bass are located in the Albemarle Sound area in the northeast portion of the state. Fish in these waters normally spend the summer months in the open water of the larger sounds and move into the estuarine rivers and streams during the late fall. Wintering usually takes place in the deeper holes in the rivers.

Both commercial and sports fishermen take advantage of this wintering concentration. Netters take large numbers of fish during the fall months when the fish are moving into the rivers. The fish are very susceptible to angling when they are concentrated in the rivers. There seem to be selected areas where the fish prefer to winter. Experienced fishermen know where these holes are located and annually remove large numbers of fish from the same areas. Trolling spoons and similar lures usually produce the best catches. Low temperatures seem to have little effect on the catchability of the fish with catches being recorded throughout the winter months.

In the spring the striped bass move out of the rivers into the sounds. In the Albemarle Sound area, most of the fish move toward the Roanoke River which flows into the western section of the sound. Some ten rivers empty into the sound but the Roanoke is the only one that carries a perceptible current. It is most probable that this current provides an attraction for the fish that are preparing to spawn. After ascending the river for a distance of about 135 miles

the fish arrive at the major spawning area near Weldon, North Carolina. The river current below Weldon is about 1.1 miles per hour but is increased by a steeper gradient and narrowing of the river channel above Weldon. This section is characterized by numerous rapids and small cascades. The river bed is strewn with rocks and boulders in this section. The physical features of the river changes from the tranquil, lowland stream below Weldon to a rolling, boiling stream from there to the Roanoke Rapids Dam (River mile 137). This impoundment constructed by Virginia Electric and Power Company (closed in 1955) prevents further upstream movement of the fish.

In the spawning migration, the male fish usually arrive in the Weldon area ahead of the females with the first fish being taken early in March. The commercial fishing line extends from Albemarle Sound to Highway 301 bridge at Weldon. Above this line only hook and line fishing is permitted.

The fish population is exploited by haul seines, gill nets and pound nets in the sounds, haul seines and trotlines are used in the lower section of the Roanoke and at Weldon large dip nets are used to catch the striped bass. This latter type fishing gear is unique and merits description. The bow nets, as they are called locally, consist of a long handle or staff about 16 feet long with a hoop made of hickory. The hoop is flattened on the bottom and has a width of about six feet. The net portion is constructed from fine linen to form a bag about 8 to 10 feet deep. In use, the net is held vertically from a drifting boat so that the bag portion remains as close as possible to the bottom. When fish enter the net, the staff is lifted to bag or trap the fish in the net. This device is fairly effective in taking fish in the Weldon area where the fish are concentrated. Most of the net fishing occurs during late evening and at night. It should be stated that only a small number of the bow netters operate on a commercial basis. It is considered to be a type of sport by many of the local people.

Sport fishermen operate in both the commercial and inland section of the river. Bottom fishing with cut bait is the most popular method of taking fish. During recent years there has been a trend to casting lures for the fish. Male fish seem to be more susceptible to bottom fishing than are the females. The larger females are taken by trolling spoons. Observations indicate that spawned out or spent females will take a bait more readily than the ripe fish.

Spawning activity usually occurs after the water temperature has reached 60° F. as indicated by the take of spent or spawning fish. It is suspected that most of the spawning takes place at or near the bottom but at times spawning fish rise to the surface in an activity that is locally called a "fish fight." These are marked by a fish partially emerged from the water with a number of smaller fish splashing near by. Fishermen are constantly alert for such action as it is an easy matter to scoop up such fish with the large dip nets. Up to 20 fish have been dipped up at one time from such a "fish fight." In most cases, one spawning female and a number of smaller males are taken from such a "fight."

Much consternation has arisen regarding the success and continuation of successful spawning of the striped bass in the Roanoke River. First of all, a large pulp mill is located at Plymouth near the mouth of the river. This plant discharges its waste products into the river. Another such plant is located at Roanoke Rapids a short distance above the major spawning area. The cities of Roanoke Rapids and Weldon discharge raw sewage in the river. A large number of textile mills are located at Roanoke Rapids which dump their effluent in the river. The Roanoke Rapids impoundment stratifies frequently and oxygen-free water has been discharged from the lake at intervals. All of these man-made, artificial conditions, certainly produce changes in the ecology of the river which may or may not have detrimental effects on the continuation and success of the striped bass spawning in the Roanoke River. A comprehensive joint study by State, Federal and private agencies is now in progress to determine what effects all water uses have on the eggs, fry, and adult striped bass and resident fish populations.

The North Carolina Wildlife Resources Commission operates a hatchery at Weldon for the purpose of salvaging eggs which would normally be taken from the river. In the course of their netting activities, fishermen often catch female fish that are near or in the process of spawning. If these fish are brought to the hatchery, the eggs are purchased by the commission for hatching.

After it has been ascertained if the fish is ready to spawn, the ripe female is cut open and the ovaries are excised. The eggs are poured into a plastic pan and then sperm from a ripe male is stripped onto the eggs. A small quantity of water is then added to provide a media for travel of the sperm. The fertilized eggs are then transferred to MacDonald hatching jars at a rate of about 100,000 eggs per jar. The jars are placed on a rack where water flows down a central tube to the bottom of the jar. This flow serves to keep the eggs in constant agitation. All of the water used in hatching operations is Weldon City water which has been dechlorinated by aeration. After a 12-hour incubation period, the eggs are counted volumetrically, and the jars are capped and placed on racks where the overflow water spills into large glass aquaria. Hatching usually occurs in from 36 to 72 hours depending on temperature. Live eggs are various shades of green in color. Dead eggs turn white and float higher in the jars. The dead eggs are removed by siphoning. Mortality varies with all fish but at least 10% dead eggs can be expected.

After hatching, the fry tend to swim vertically in the jars. Movement is in short upward spurts with fry dropping downward between each swimming attempt. After a short time, the fry reach the surface of the water where they are carried over into the aquarium by the water current. The fry are stocked as soon as hatching is complete. While artificial feeding is possible it is not feasible when such large numbers of fish are involved. In the hatchery, where food is not available, the fry can survive for some time on the food supply in the egg sac but mortality begins as soon as this is depleted.

The fry are normally stocked in coastal rivers where the habitat is considered to be similar to that where the fry would be if hatched naturally. This is done on the theory that a scattering out of fish provides a better chance for survival of the young. In view of the pollution in the Roanoke River it has been deemed advisable to stock a good proportion of the fry in other waters. This has caused much consternation among the local fishermen who believe that the fish have a homing instinct similar to the salmonid fishes and will return to spawn in the area where they are stocked. An intensive education program has been under way to discount this idea.

The Weldon Hatchery was established by the U. S. Bureau of Fisheries. The first efforts consisted of a barge that was floated on the river where the eggs were taken and fertilized. The fertile eggs were stocked in the river to hatch naturally. After techniques of artificial hatching were developed, a small hatchery was put into operation at the Weldon community center. The present hatchery was built by the Fish and Wildlife Service. The North Carolina Wildlife Resources Commission took over its operation in 1951.

Most of the earlier egg take and hatch data is not available but the records from 1937 through 1957 are fairly complete (Table I). As can be seen, there has been considerable fluctuations in the annual take of eggs. No attempt should be made to correlate the egg take data with the relative spawning population of the striped bass. Public relations and fishermen-hatchery relations control to a great degree the number of ripe fish brought into the hatchery.

While the number of eggs involved in hatchery procedures throughout the years is considerable, this represents only a very small proportion of the eggs that are naturally spawned in the river. As has been stated the hatchery operation at Weldon serves mainly in the capacity of a saying of the eggs that would normally be lost to the natural production in the river.

In an effort to establish a landlocked population of striped bass, three million fry have been stocked from the Weldon Hatchery in Kerr Reservoir (one million each in the years, 1953, 1954 and 1955). This lake is located on the Roanoke River 44 miles above Weldon. The Roanoke Rapids lake has been stocked with two million fry (1956 and 1957) with plans made to add another million in 1958. Adult striped bass have been taken from both of these lakes since the time of stocking. It is suspected that these fish had been trapped back of the dam at the time of impoundment. One young-of-the-year fish was captured in Kerr Lake during the summer of 1956. The presence of this one fish cannot be taken as positive proof of natural reproduction but opens possibilities. Continued observations will be made in this lake to ascertain if there are any other such fish present.

The Roanoke Rapids Lake stockings are too recent to obtain any indications of natural reproduction.

Both lakes have areas where the fish could possibly spawn. The primary question which remains to be solved: Is it possible for a fish that normally spends the greater portion of its life in a saline environment, to physiologically adapt itself to a life in fresh water. It seems that if such an adaption is possible, the striped bass in North Carolina waters should more readily consummate the change. Unlike the northern population, the salinity variations normally encountered by these fish is not very great.

Lake Hickory, near Hickory, North Carolina in the western part of the state was stocked with 20,000 striped bass fry from the Weldon Hatchery in 1953 and 1954. It was deemed that these stockings were not successful and 100 adult striped bass were added to the lake in March, 1956. These fish were obtained through the courtesy of South Carolina Fish and Game Commission and were brought from the Santee-Cooper system where a landlocked population of striped bass has been reported. It is hoped that these fish have become adapted to life in fresh water and will establish a population of fish that are not anadromous in nature. There was no indication of spawning during 1957.

Another question which remains to be answered in regards to the striped bass on the North Carolina coast is the possible location of other spawning areas. There are a number of coastal streams such as the Tar River and the Cape Fear River which superficially have the same characteristics as the Roanoke and it would be possible for the fish to spawn in these rivers. Striped bass occur in the streams in some numbers but it has not been ascertained whether or not the fish spawn there. Further studies are planned in these areas.

The North Carolina Wildlife Resources Commission realizes the value of the striped bass to the overall fisheries resources of the state and is taking all practical steps to preserve this species.

TABLE I

STRIPED BASS EGGS TAKEN AT THE WELDON HATCHERY, 1937-1957

Year	*No. of Fish*	*Egg Take*	*Hatch*	*% Hatch*
1937	..	1,160,000	641,000	55.25
1938	..	646,000	515,000	79.72
1939	..	3,413,000	1,798,000	52.68
1940	..	8,075,000	5,917,000	73.27
1941	..	635,000	469,000	73.85
1942	..	.....	.....	.....
1943	..	2,515,000	1,563,000	62.14
1944	..	11,168,000	7,618,000	68.21
1945	..	465,000	279,000	60.00
1946	..	6,392,000	3,517,000	55.02
1947	..	11,225,000	7,756,000	69.09
1948	..	2,990,000	1,681,000	56.22
1949	..	6,625,000	2,686,500	40.55
1950	..	2,532,000	1,668,000	65.87
1951	..	5,650,000	3,689,000	65.29
1952	40	10,255,000	7,016,000	68.41
1953	53	16,935,000	10,763,000	63.55
1954	68	33,187,000	22,113,000	66.63
1955	76	22,303,000	16,334,000	73.23
1956	21	4,005,000	2,300,000	57.42
1957	60	16,644,000	8,356,000	50.20

TABLE II

NUMBER OF EGGS TAKEN FROM FEMALE STRIPED BASS, WELDON HATCHERY APRIL–MAY, 1953

Date	Total Length (Inches)	Weight (Lbs.)	Number of Eggs Taken	Number of Fry Hatched	% Hatch
4–29	19.1	3.05	230,000	195,000	84.8
4–26	19.9	3.10	155,000	140,000	90.3
5– 3	20.4	4.11	295,000	265,000	89.8
5– 3	20.6	4.19	305,000	250,000	81.9
4–26	21.5	4.6	365,000	315,000	86.3
5– 2	22.0	5.03	115,000	68,000	59.1
4–24	22.8	5.24	440,000	225,000	51.1
5– 5	22.9	5.77	614,000	466,000	75.9
5– 1	22.9	5.08	15,000	10,000	66.7
4–28	23.0	5.63	195,000	160,000	82.1
4–28	23.1	5.43	305,000	245,000	80.3
4–24	23.2	5.71	395,000	302,000	76.5
5– 4	23.5	6.19	44,000	33,000	75.0
5– 2	23.9	6.32	270,000	215,000	79.6
5– 3	23.9	6.41	415,000	360,000	86.7
4–27	24.3	5.87	505,000	460,000	91.1
4–24	24.3	5.87	630,000	446,000	70.8
5– 5	25.2	7.22	171,000	150,000	87.8
5– 2	25.3	8.27	535,000	405,000	75.7
4–25	25.4	6.81	305,000	235,000	77.0
5– 3	27.6	9.60	385,000	190,000	49.3
5– 4	28.4	10.91	415,000	300,000	72.3
5– 5	28.6	10.91	439,000	315,000	71.8
4–28	29.5	13.61	1,425,000	765,000	53.7
AVERAGE	23.8	6.45	373,666	271,458	72.64

STRIPED BASS (Roccus saxatilis) (Walbaum) RESEARCH IN MARYLAND

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FOREWORD

The striped bass fishery of the Maryland Chesapeake Bay (1,500,000 acres) has been an important source of commercial income and recreation, to the people, for many generations. Early investigation work on this fish was started by the U. S. Bureau of Fisheries in 1886, when a hatchery was established and 20,000 fish were reared at Havre de Grace, Maryland. From 1921 to 1924 hatchery fry were reared at Lloyd's Creek, Still Pond, Charlestown and Principio Creek.

John Pearson* biologist of the U. S. Fish and Wildlife Service, initiated investigation work on the Upper Bay in 1931 and carried forward life history and tagging programs until 1938.

Vladykov and Wallace made a major study of striped bass, which included the economics of the fishery, migration, rate of growth, sexual maturity, races, and population structure. Truitt, Hammer and Tiller made studies during 1940 through 1950. During 1954 through 1957, R. Mansueti has studied the early life history of this species and has done some tagging.