ATLANTIC SALMON (*Salmo salar*)

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The Atlantic salmon is an anadromous fish which inhabits the coastal waters on both sides of the North Atlantic to the Arctic Circle. The adults are brownish above with silvery sides and covered with numerous black spots or crosses, and in the males, with red patches. The salmon are closely related to the sea trout (*Salmo trutta*), rainbow trout (*Salmo irideus*), and steelhead trout (*Salmo gairdnerii*).

In Europe, salmon are caught extensively in Scotland and the countries bordering the Baltic Sea. In North America, the principal fisheries are in the Gulf of St. Lawrence, in Newfoundland, and in southern Labrador. They were formerly abundant in all large rivers in New England as far south as the Hudson River. At present only small sport fisheries exist in six rivers in eastern Maine. In 1941 the report on the Fishery Statistics of the United States indicates only 2,100 pounds of salmon caught in New England. In the same year approximately 3,700,000 pounds were landed in the Canadian provinces of Nova Scotia, New Brunswick, and Quebec.

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The salmon spends the early part of its life in fresh water, then migrates to sea where it puts on the major part of its growth, matures, and then returns to fresh water to spawn. From scale studies made in Newfoundland and Labrador, A.A. Blair concluded that nearly 40 percent of the fish spend 4 years in the river, while about 25 percent spend 3 years and an equal proportion 5 years. He also observed that nearly 80 percent spend 2 years in the sea with the remainder varying from 1 year to 4 years. From scale examination of 172 salmon taken in the Penobscot River in 1936, R.W. Dow determined that 85 percent of the fish had spent 2½ to 3 years in the river and 2 years at sea. From these figures we may tentatively conclude that most Maine salmon return to spawn when 5 years old, with the remainder returning at 4, 6, and 7 years.

The salmon of various rivers differ in average size and the difference is always maintained under natural conditions. Some rivers are noted for high average size of salmon and others for their low average. The largest Atlantic salmon on record is a Scottish fish that weighed 84 pounds. The average size of salmon taken by anglers at the Bangor Pool in Maine over a period of 17 years (1927 - 43) was 10.5 pounds for 1,363 fish. The largest weighed 22.75 pounds and the smallest 3.25 pounds.

The adult Atlantic salmon enters the rivers on its spawning migration between April and September. The peak of the season for the sport catch on the Penobscot River at Bangor occurs on June 2. After entering the river the adults proceed upstream toward the spawning grounds. At this time the sexes are indistinguishable by external characteristics, and it is not until September and October that the hooked jaw and bright coloring, secondary sex characteristics of the male, develop. The females also are not ripe, for specimens examined in May and June, just out of salt water, showed very small ovaries and eggs. The fish spend the summer moving upstream or resting in deep pools near the spawning grounds. Usually during the last week in October or the first in November the fish are ripe and spawning begins. The first spawn-taking at the U.S. Fisheries Station, Craig Brook, Me., for the last five years has occurred on October 31 when 1/4 to 1/3 of the females were ripe. The spawning grounds are in the riffle areas with a coarse gravel or stone bottom. The digging of the nest or redd is done only by the female. When digging, the female turns on her side and with the tail drives a current of water against the bottom. This washes out sand and gravel and forms a U-shaped pit from one to two feet in diameter and eight to twelve inches deep. When about to spawn, the female swims close to the bottom of the redd and the male swims close along her side. The eggs and milt are deposited at the same time, the eggs fertilize instantly, and drift to the bottom of the pit. The female then covers the eggs with gravel piled at the sides of the nest. When extruding eggs the female may be attended by one or more males. All the eggs are not deposited at one operation and the female may dig several redds and spawn several times. When spawning has been completed the fish drop back into deep pools to rest. Some of these spent fish migrate immediately downstream to sea, while others spend the winter in the river. The spent fish, known as kelts, are sometimes caught in the lower part of the river the next spring.

The eggs remain in the gravel of the redd until the following spring. Because of the looseness of the gravel, water flows through it and around the eggs keeping them well aerated. During the latter part of March and in April (the time probably depending on the water temperature) the eggs hatch into fry. The fry spend the next two or three weeks in the nest, living on the food material in the yolk-sac, which remains attached to the young salmon. At the end of this time the yolk-sac has been absorbed and the young salmon become free-swimming, advanced fry. They live usually in the pool areas just below the riffles and hide among the rocks and over-hanging banks. As they grow, they take on characteristic red spots and black transverse bars. These bars are known as parr marks and the young salmon, at this stage, as parr. The rate of growth of parr, as found by Belding for Canadian fish, depends on temperature and food supply, and the time of seaward migration depends on the age and growth rate. Thus, fast-growing fish migrate to sea at an earlier age than the slower-growing ones. During their last summer and winter of stream life the parr begin to move downstream and gradually lose the parr marks and take on the silvery appearance of the smolt or migrating fish. The actual migration to sea usually takes place in the spring or early summer.

The movements of salmon at sea are not very well known but are probably influenced by food supply. Experiments with tagged Pacific salmon on the West Coast indicate that in many cases they migrate long distances and probably beyond the influence of their home rivers. As salmon approach maturity, the spawning urge develops and they return to fresh water, usually to the same river, tributary, and often to the same area in which they were hatched. The factors which guide their return are unknown. Huntsman advances one theory to explain how they return to a particular river. From work on Canadian salmon he concludes that warming of the water, along with wind and currents, bring the fish to the surface and shoreward. Here they are influenced by the water flowing from the rivers. Other workers have theorized that the chemical composition of the river water can be detected by returning salmon and this serves as a guide. None of these theories explains adequately all the features of the spawning migration. Fish which return to the river after passing one winter at sea are termed grilse and are usually adolescent salmon. A great majority of the grilse are males.

The number of times which Atlantic salmon spawns has been questioned frequently. From Scottish and Canadian investigations it seems well substantiated that the mortality after the first spawning is so heavy that only between five and ten percent of the mature fish survive to spawn more than once. The number of years between the first and second and subsequent spawnings varies over a considerable range.

By the late 1930's, the Atlantic salmon runs in New England as a whole had decreased almost to the point of extinction, but in the last few years available observational evidence indicates that the residual runs in a few of the rivers in eastern Maine have begun to increase. This has probably been due to the improved conditions in some of these rivers. At present, the Fish and Wildlife Service, in cooperation with the Maine conservation departments, is carrying on a program to study restoration possibilities and methods. The principal causes of the decline in the number of salmon appear to be the construction of impassable dams, thus blocking the adults from the spawning grounds, extensive pollution, which causes a high mortality of both adults and young, and overfishing.

At present, the U.S. Fisheries Station at Craig Brook, Me., is hatching and rearing sea-run salmon for stocking in Maine rivers. The methods and technique for the artificial propagation of Atlantic salmon are very similar to those employed in the propagation of the larger trouts and Pacific salmon. The same equipment is utilized, with necessary modifications in the mesh of hatching baskets and trays. The general practice is to incubate the eggs by the stacked tray system. The incubation period is approximately 150 days at a mean temperature of 37° or 38° F. The fry are handled in the same manner as trout fry and are reared in the same type of pools used for trout and Pacific salmon.

The main point of difference between trout and sea-run salmon hatching is the manner in which the eggs are secured. No domesticated breeders are maintained, but wild fish are trapped during the spring and summer, usually on the Penobscot River at the fishway in the Bangor dam, and taken to the hatchery, where they are held in a large pool until they are ripe. Adults for spawn-taking have also been obtained in the Dennys, Machias, and Narraguagus rivers. The egg-take from Maine salmon for the past six years (1940 - 1945) has averaged approximately 250,000 a year. The Canadian government contributed another 50,000 eggs in 1940, 1941, and 1943, for use in restoration experiments in a small Maine river from which the salmon run had been completely destroyed.

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