

Keyed to ocean temperature regimes,
Pacific salmon may replace
the seriously depleted Atlantic
salmon in New England.

Salmon for New England Fisheries

Part I: Historical Background

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INTRODUCTION

The shallow ocean waters over the broad northeastern shelf and slope of the North American continent support an abundance of marine life — an important source of food for human populations bordering the North Atlantic Ocean. The richness of the salmon resources were appreciated by the first Europeans likely to have set foot on North America.

The American historian, Samuel Eliot Morison (1971), drawing from information in the *Groenlendina thattr* (Tale of the Greenlanders) in the *Flateyar-bok* (Flat Island Book) compiled by Jon Thórhásson in 1387, gives an account of the Norseman Leif Ericson's short-lived settlement in 999 or 1,000 A.D. The location of this settlement has recently been placed at l'Anse aux Meadows near Cape Bauld at the northern tip of Newfoundland (Ingestad, 1964). The saga tells how the Norsemen were impressed by the abundance and size of the salmon in the river and lake at the site. They

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were, in Morison's words, "... bigger salmon than they had ever seen."

By the beginning of the 16th century, John Cabot, after his first voyage to North America, reported a great abundance of cod in the waters he had explored. This report did much to stimulate the interest of northern Europeans in later explorations and colonization (de Loture, 1949). A few decades after Cabot, Jacques Cartier, a master mariner from Brittany, conducted extensive explorations of the northeastern coast of North America for France. He corroborated Cabot's observation about the cod and, having a Frenchman's high regard for gastronomic delights, he also carefully noted that the waters of Chaleur Bay teemed with salmon as he explored the western part of the Gulf of St. Lawrence in the summer of 1534 (Morison, 1971).

Although its commercial value has been minor relative to cod, flatfish and herring, the Atlantic salmon, *Salmo salar*, has been held in high esteem by people on lands bordering the North Atlantic Ocean. From the middle ages, and indeed into modern times, fishing for salmon in Europe had been largely the special preserve of royalty and of a privileged aristocracy. The rapid decline in the abundance of salmon along the coast of France at the end of the 18th century has been attributed

to overfishing by an eager public when restrictions on the taking of the king's fish were abolished in the wake of the Revolution of 1789 (Centre Nation pour l'Exploitation des Océans, 1972).

In the countries bordering the North Sea, industrialization has taken a heavy toll of salmon, even at considerable distances from industrial centers. Atmospheric pollution emanating from the industrial valleys of northern Europe and the British Midlands is carried by winds to generate acid rains over Norway. In the south of that country, where the bed rock is

EDITORIAL NOTE

During the past year the staff of the National Marine Fisheries Service's Division of Coastal Zone and Estuarine Studies at the Northwest Fisheries Center, Seattle, has considered the problem of increasing the yield of salmon from New England waters. This is the first of a series of three papers on the subject. Parts II and III, which follow, deal with the Effect of the Ocean Environment on the High Seas Distribution of Salmon, and Developing a Coastal Fishery for Pacific Salmon.

granitic and has little buffering capacity, surface waters become too acid for the successful incubation of salmon eggs (Berg, 1972).

Throughout colonial times in New England, salmon—which had for thousands of years provided seasonal food for Indians—remained abundant. During the 19th century, however, industrial development of the region brought about the damming and pollution of many of the rivers and streams that served as spawning grounds. This, coupled with overfishing, probably led to the depleted state of salmon stocks in New England today.

Now there are only small remnants of the stocks of Atlantic salmon which once spawned in streams around the entire rim of the North Atlantic Ocean — from the Arctic southward to the Connecticut shore and to the Iberian Peninsula on the other side. Of these remnants, most are found in the sparsely populated, northern parts of the region. As these remaining stocks are highly prized, the recent development of commercial fishing for Atlantic salmon on the high seas off southwest Greenland and in the Norwegian Sea has become a highly controversial issue in international fisheries management.

IMPROVING SALMON FISHERIES IN THE ATLANTIC

There are two possible approaches to the problem of increasing the salmon stocks of the North Atlantic: (a) the development of systems for improvement of freshwater habitats and for increasing the survival and geographic range of native stocks of Atlantic salmon, and (b) the transplanting of stocks of Pacific salmon, *Oncorhynchus* spp. to the Atlantic region. In a 1954 paper, Ricker discussed their relative merits. He argued with respect to the first that such measures as bird control, opening up of new nursery grounds by fishways, continuous arti-

ficial propagation, better spawning escapements, etc., were worthy and should be intensified but that even the most optimistic could not expect that they could “. . . do more than double or triple the supply of salmon on the Atlantic coast as a whole in any foreseeable future.” He reserved his most favorable arguments for the second approach. He pointed out the far greater abundance of salmon in the North Pacific Ocean than in the North Atlantic Ocean as reflected in the comparative Canadian catch statistics for 1948 (roughly 150 million pounds from the Pacific vs. 5 million from the Atlantic). He ascribed the difference to the fact that “. . . the two most numerous Pacific salmon live in rivers only during spawning and incubation periods and do not require the freshwater food or living space which appears to limit the supply of Atlantic salmon.” Addressing himself to a Canadian readership, he suggested that it would be in the national interest to develop an inshore anadromous fishery in which Canada would have a proprietary interest to insure it against the day when its “. . . eastern offshore banks will be so continuously scoured by the trawls of competing nations that good quality bottom fish can no longer be taken in paying quantities.” He went on to suggest that transplants of pink, *O. gorbuscha*, and chum salmon, *O. keta*, from the west coast would be the best approach to generating such an inshore fishery.

Prior to the publication of Ricker's (1954) paper, there had been several attempts to introduce Pacific salmon to the Atlantic coast. Pink and coho salmon, *O. kisutch*, had been planted in Maine, and chinook salmon, *O. tshawytscha*, in Lake Ontario streams and in New Brunswick. Permanent runs from these plants did not become established, although in Maine, small returns did occur for several cycles. At that time, the only successful, self-perpetuating runs of Pacific salmon transplanted from their natural habitat were the chinook salmon which since 1905 have become established in the

Waitaki and other rivers of the South Island in New Zealand (Davidson and Hutchinson, 1938).

USSR TRANSPLANTS OF PACIFIC SALMON TO ARCTIC EUROPE

From 1956 to 1961, mass transplants (4 to 46 million) of the roe of pink and chum salmon were made from USSR fish culture stations on Sakhalin Island in the northwestern Pacific Ocean to stations in the Murmansk area on the Arctic coast of Europe. In 1960, 300,000 adult pink salmon returned to the rivers of that area. Smaller numbers appeared along the coast of Norway as far south as Bergen and along the coasts of Iceland and Great Britain. These runs subsequently dwindled. Rass (1965) suggests that roe from the spawning of transplanted adults had died from low temperatures in the rivers during the incubation period, the weather being colder at that time on the Murman Coast than on Sakhalin Island to which the fish were adapted.

U. S. TRANSPLANTS OF PACIFIC SALMON IN NEW ENGLAND

During the past 6 years, fishery management agencies in several of the New England states have made modest plants of coho salmon (Figure 1) in an attempt to generate runs of these fish into their rivers. The eggs were from Washington and Oregon and reared at trout hatcheries in New England. The efforts of Connecticut and Rhode Island agencies have proved futile; no returns to the home rivers from any of the plants by these two states have ever been achieved. New Hampshire, on the other hand, has had returns (estimated at 3 percent in 1972) to the Exeter and Lamprey Rivers, which flow into Great Bay, and is seeing the beginning of a small salt-water sport fishery in that bay. In New Hampshire in the fall of 1972,

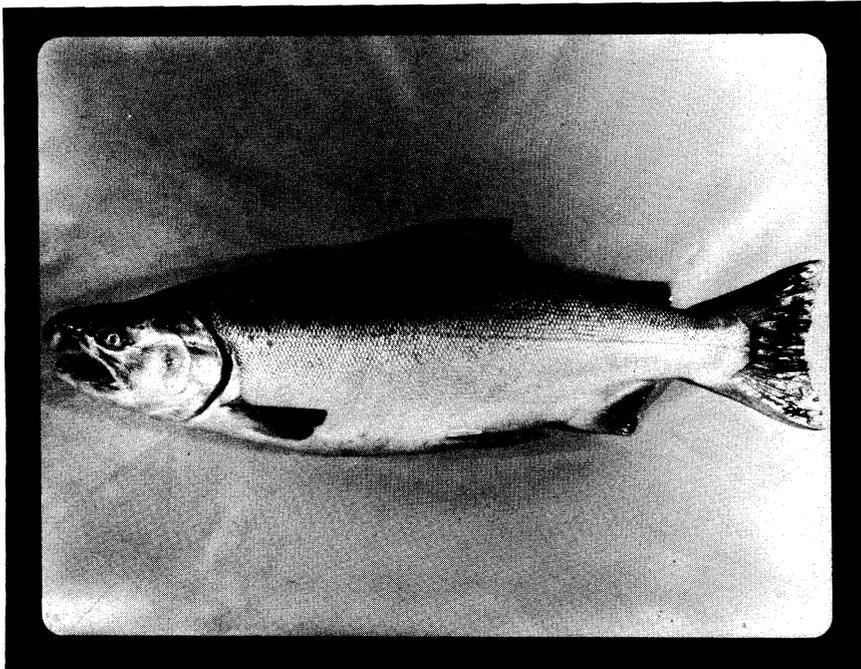


Figure 1.—The coho salmon is a possibility for the New England salmon sport fishery.

over 1,000 adult coho from a Columbia River stock planted in 1970 returned and 200,000 eggs were taken. These will be incubated in state hatcheries with 350,000 coho eggs from the Green River Hatchery in Washington. As development of self-sustaining, naturally-spawning runs of coho salmon into Great Bay is not considered feasible, New Hampshire biologists are focusing on hatchery production. A new state hatchery, primarily for the production of coho salmon, is being constructed at Milford, N.H., with funding assistance from the National Marine Fisheries Service.

New Hampshire coho salmon have been appearing in the estuary of the Merrimack River in Massachusetts, where a number have been caught by

sport fishermen. The Commonwealth of Massachusetts has also recently begun a modest effort of its own to establish coho salmon in the North River just to the south of Boston. Of 60,000 Green River (Washington) coho planted in the spring of 1971, personnel of the Division of Fish and Game of the Massachusetts Department of Natural Resources recovered 178 spawners returning to the North River in the fall of 1972. The weight ranged from 3 to 12 (avg. 7) pounds. Of the 130,000 eggs taken from these returning spawners, 90 percent hatched successfully and the fry are now being reared for future planting. During the summer before the spawning run, there were incidental catches of coho in the ocean off the North River by both

sport and commercial fishermen.

In these recent attempts to transplant Pacific salmon to New England, the success of the New Hampshire experiment and encouraging early returns from Massachusetts contrast with the stark failures experienced in Connecticut and Rhode Island.

The next article, Part II, will show how these results have reflected how well the timing of the homing migration of these fish was matched with the seasonal changes in the ocean environment off New England.

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