CIRC 1948

SEA-RUN SALMON INVESTIGATIONS CONDUCTED BY THE FISH AND WILDLIFE SERVICE, 1941-1947

By LOUIS D. STRINGER

Aquatic Biologist, Branch of Fishery Biology

Fish and Wildlife Service

United States Department of the Interior

Woods Hole Laboratory
Manuscript Report Number
Undated - 12

48-12

SOME TABLES AND FIGURES ARE MISSING

SEA-RUN SALMON INVESTIGATIONS CONDUCTED BY THE FISH AND WILDLIFE SERVICE, 1941-1947

By LOUIS D. STRINGER

Aquatic Biologist, Branch of Fishery Biology

Fish and Wildlife Service

United States Department of the Interior

INTRODUCTION

Atlantic salmon (Salmo salar) were once one of the most abundant of the anadromous fish in New England. They are said to have inhabited every stream of sufficient size in New England from the Hudson River north to the Canadian border. Their complete range continued into Canada and as far north as the southern coast of Labrador. Their abundance and stream migration during summer made them of inestimable value to the early settlers. Even until comparatively recent times they were the object of an intensive fishery and of great economic value.

Unfortunately, the quantity of this species in the United States has declined to such a marked degree in late years that only small remnants of runs now exist in a few rivers in Maine. This decline in number of runs and quantity of fish has been due, in large measure, to three reasons: (1) the building of impassable dams across spawning streams; (2) the heavy pollution deposited in these same streams by increased industrialization; and (3) the extensive overfishing placed on the runs by their economic value.

The catastrophe which was to overtake the Atlantic salmon was realized over 70 years ago. In 1871, the U. S. Fish Commission established at East Orland, Me., a hatchery under the supervision of Dr. Charles G. Atkins to take spawn from salmon, hatch, and plant the resulting fish. This work has been carried on without interruption to the present day. Large numbers of eggs, fry, and small fingerlings have been planted from this station in all major salmon streams throughout New England.

DEVELOPMENT OF THE PROGRAM

As the number of salmon continued to decline, various sportsmen's and conservation groups throughout the region became increasingly interested in the salmon. As a result of this growing interest, Mr. David Aylward, President of the National Wildlife Federation requested the United States Fish and Wildlife Service to report on the causes for the decline and the possibilities for restoration. Dr. George A. Rounsefell and Mr. William C. Herrington of the Fish and Wildlife Service, working in cooperation with the commissioners of fisheries of the various New England States made a study of the information available and recommended a program for restoration work. This program was presented and discussed at a meeting of all interested parties held in Boston in 1940. As a result of these discussions, the program was adopted tentatively and the Fish and Wildlife Service set up a project under Dr. Rounsefell to carry out experiments in the methods of restoration.

As the only runs of salmon remaining in the United States were located in Maine and as the hatchery was located there, Dr. Rounsefell made preliminary surveys of the streams in the State to determine if any were suitable for salmon restoration experiments. It was decided as the result of these surveys that the work should be confined to Maine.

COOPERATIVE AGREEMENT

In 1940, there was established at the University of Maine a fellowship in honor of Dr. William C. Kendall, for the study of Atlantic salmon. Because of the work of this fellowship and the various activities of the departments of Inland Fisheries and Game and Sea and Shore Fisheries on salmon, it was felt that some sort of coordinating agency was necessary to correlate the work and avoid duplication of problems. In October 1941, a cooperative agreement was drawn up and signed by the two Maine departments and the Fish and Wildlife Service. The agreement established as the functioning body, a Salmon Research Committee, composed of one member from each cooperating agency.

SALMON RESEARCH COMMITTEE

The function of the Salmon Research Committee as defined by the agreement is to serve as a coordinating agency for all sea-run salmon restoration and management work. The following duties were also assigned to the Committee by the agreement: ". . . to develop and recommend a general policy with respect to artificial propagation and stocking of sea-run salmon, and to develop plans and make specific recommendations concerning fishways, dams, stocking, fishing regulations, pollution abatement, and other needed measures." The Committee has no power to carry out any of its recommendations. These recommendations are only proposed to the three cooperating agencies as needed measures for them to put into practice.

The original membership of the Committee was Dr. George A. Rounsefell, for the Fish and Wildlife Service; Dr. Gerald P. Cooper, for the Maine Department of Inland Fisheries and Game; and Mr. Lester A. Stubbs, for the Maine Department of Sea and Shore Fisheries. In 1944, Mr. Louis D. Stringer replaced Dr. Rounsefell and Mr. Gerry Wade replaced Dr. Cooper. Upon his return from wartime duties, Dr. Rounsefell again returned to membership on the Committee, replacing Mr. Stringer.

The Committee has held seven formal meetings to date. A preliminary meeting and the first business session were held in 1942. Two meetings, at Augusta and Hampden Highlands, Me., respectively, were held in 1943. Due to the pressure of other work related to the war, only one meeting was held each year in 1944 and 1945. No meeting was called in 1946, and the seventh meeting took place on May 2, 1947. These meetings are usually quite informal, with the various members proposing for discussion any problem that has come to his attention during the intervening time. Two mimeographed reports of the meetings, reports, and recommendations of the Committee have been put out for general distribution.

The Committee has proposed and sent to the cooperating agencies 29 recommendations, covering many phases of the restoration work. The following is a list of these recommendations. The recommendations concerning the planting schedules have been abbreviated to save space, and the stocking, to be discussed later, follows these very closely.

1. In determining the present suitability for stocking of rivers now containing salmon runs, the Penobscot must be considered separately. The other five rivers in eastern Maine were classified from the standpoint of the chances for salmon to pass obstructions such as dams and nets, as follows:

    a. The Dennys and Narraguagus Rivers are open and were classified as being the most suitable.

    b. The Machias River was classified as being less suitable on account of having three fishways and three unscreened water diversions.

    c. The Pleasant and East Machias Rivers were classified as unsuitable.

2. Recommendation for the disposal of the Atlantic salmon remaining at Tunk Lake and Craig Brook Hatcheries from eggs taken in 1940.

3. Recommendation concerning the disposal of the sea-run salmon from 1941 eggs now hatching at Craig Brook.

4. Recommendations concerning the obtaining of Atlantic salmon eggs during 1942.

    a. Attempt to obtain 180 to 200 adult salmon.

    b. Hold the adults at Craig Brook and mark fish from each river by clipping part of one fin.

    c. Strip the fish at Craig Brook keeping the eggs from each river separately.

    d. Attempt to trap fish at Bangor Dam on the Penobscot, on the Machias River and at least one other river.

e. Attempt to maintain traps all season in any river from which adults are taken to count the entire run.

f. Maintain traps at both Bangor and Veazie Dams. Mark fish taken at Bangor in excess of those removed for stripping and release them above the dam in order to determine the percentage using the Bangor fishway, and to determine whether all fish passing the Bangor Dam reach the Veazie fishway.

g. At any trap, take the first ten fish and only every second fish thereafter until enough have been captured.

h. Attempt to rear all sea salmon at not more than two hatcheries.

5. Recommendations concerning pollution are as follows:

a. That the laws concerning the dumping of sawdust, shavings, and other wood waste into the Narraguagus and St. Georges Rivers be enforced.

b. That an adequate study be made of the pollution on the Penobscot River from East Millinocket to Sandy Point to determine whether present pollution is detrimental to salmon.

6. Recommendations for legislation are that the laws be amended to define an adequate fishway for salmon as having as a minimum requirement, pools 6 feet by 8 feet, or at least 48 square feet with a water depth of at least 4 feet, and having not over 18 inches difference in water level between pools.

7. About 100,000 Atlantic salmon eggs from the 1942 egg-take be transferred from Craig Brook Station to Tunk Lake Station.

8. Insofar as possible all of the young salmon be carried at the Tunk Lake Station until September 1, 1943.

9. Insofar as possible, 50 percent of the young salmon be carried until the spring of 1944.

10. Recommendation concerning the planting of the young salmon from the 1940, 1941, and 1942 egg-takes on hand at Craig Brook and Tunk Lake Stations.

11. That no bass of any species be introduced into the Pemaquid or Sheepscot River systems until the Committee has decided whether or not these rivers are suitable for the restoration of sea-run salmon. Dr. Cooper (see Fish Survey Report No. 5, Maine Department of Inland Fisheries and Game, 1942) found that some of the lakes in these river systems were suitable for bass, but concurs in the opinion of the Committee that they should not be introduced into these river systems unless, at a future date, experiments should prove these rivers to be unsuitable for salmon.

12. That an attempt be made to obtain about 180 to 200 adult salmon to hold at Craig Brook for spawning.

13. That the salmon-counting trap in the fishway at Veazie Dam, which was successfully operated by the Department of Inland Fisheries and Game during 1943, be operated annually as a permanent feature of the Penobscot River management program.

14. That a concrete wall be constructed below the foot of the fishway on the east bank of the Penobscot River at Bangor Dam to facilitate the passage of fish up through the fishway during summer low-water periods.

15. That the Rules and Regulations of the Department of Sea and Shore Fisheries 130, Resolves, 1941, c. 84, and the Commissioner's Ruling of March 26, 1942, amending it, be further amended. The present Ruling reads:

"No fish shall be taken, except by hook and line, from the waters of Pemaquid River, above a line drawn from the most southerly end of Cardy's Point to the most southwesterly end of Old Fort Point, EXCEPT, that during the months of May and June fishermen shall be permitted to seine ALEWIVES from the waters of Pemaquid River with seine of not less than two inch mesh and Alewife nets of not more than three inch mesh. March 26, 1942."

The Committee feels that the present restriction will not provide the necessary protection either for the young silver salmon migrating downstream in April and May or for the adult salmon migrating upstream in the autumn. Therefore, the Committee recommends that the last Ruling be amended to read:

"No fish shall be taken from the waters of Pemaquid River, above a line drawn from the most southerly tip of Thurston Point to the most southwesterly tip of Fish Point, EXCEPT, that during the months of May and June, ALEWIVES may be dipped at Pemaquid Falls in the manner determined by the fish committee of the Town of Bristol, with due regard for the downstream passage of young salmon."

16. That the Ducktrap River be henceforth considered suitable for salmon.

17. That the law prohibiting the taking of salmon after July 15 each year be more strictly enforced for the commercial gear in Penobscot Bay.

18. That accurate statistics of both sport and commercial catches of salmon be obtained for each river in the following manner:

    a. Statistics will be compiled of individual rivers and shall show number of fish (also weight when obtainable), type of gear used in making the catch, whether sport or commercial, and dates fish were taken as accurately as possible.

    b. All statistics will be compiled by the fishery statistician of the Department of Sea and Shore Fisheries.

    c. Reports will be collected each year immediately after the close of the salmon fishing season in each locality.

    d. The statistics shall not include kelts (spawned-out salmon, thin and emaciated, sometimes taken by so-called sport fishermen).

    e. The Department of Inland Fisheries and Game wardens will gather all records of salmon caught in fresh water by sport gear or other means (including known cases of fish taken illegally), and of salmon taken while dipping alewives.

    f. The Sea and Shore Fisheries wardens will gather the statistics on the remainder of the catch, including the commercial.

g. The Sea and Shore Fisheries statistician will make the detailed arrangements with the wardens of both fisheries departments in order to avoid duplication and to insure final centralized compilation.

19. That the collection of adult salmon for spawning purposes be carried out in conformity with the Committee's previous recommendation (4g) made on April 30, 1942.

20. That in carrying out the recommendations of the Committee in collecting adult salmon for hatchery use, the personnel do not select the fish, but take every second fish regardless of injuries, or other factors.

21. That certain vital statistics of hatchery operations, which are essential to the success of the salmon restoration program, be kept as follows:

    a. Methods of enumeration or estimation of the numbers of eggs or fish will be approved and the counting or estimating supervised by the biologists conducting the salmon research program.

    b. The number of adults taken by the hatcheries.

    c. The number of adults of each sex spawned.

    d. The number of eggs stripped.

    e. The number of fry hatched.

    f. The number of feeding fry placed in each pond and the date.

    g. Records of mortality by individual ponds.

h. Records of disease or preventative treatment by pond, showing diagnosis, who made the diagnosis, treatment recommended, date and type of treatments actually used, including exact name of chemical, concentration, and time of exposure, and date and results of reinspection.

i. Weight and either an actual count or approved estimate of each planting.

j. An approved enumeration or accurate estimation of the total numbers of each lot of salmon held in the hatcheries at the time any stocking is done. This approved estimate to be obtained for all lots, regardless of whether any are planted, at least twice annually, preferably in May and October.

22. That controlled experiments to determine the effects on mortality and growth of crowding, cannibalism resulting when fish are not sorted into size categories, and of differences in the composition, amount and frequency of feeding, be carried out in an attempt to bolster the survival of young salmon in artificial propagation.

23. Recommendation revising the planting of salmon of the 1942 brood year held at Craig Brook and Tunk Lake hatcheries.

24. That no weirs, pound nets, traps, or other fixed gear be permitted within a radius of three-quarters of a mile from the point where U. S. Highway 1 crosses the Ducktrap River.

25. Recommendation concerning the planting of the salmon of the 1943 brood year held at Craig Brook Station.

26. Recommendation concerning the planting of the salmon of the 1944 brood year held at Craig Brook Station.

27. Of the approximately 181,000 Atlantic salmon now on hand at Craig Brook derived from 1945 Penobscot River eggs, 50 percent shall be planted in the East Branch of the Penobscot River above Medway; 25 percent shall be planted in Little Falls Stream; and the remainder shall be planted in the Machias River. All will be planted in May 1947.

28. Of the 4,000 Atlantic salmon now on hand derived from 1946 Penobscot River eggs, all will be planted in the Penobscot River in May 1948.

29. Of the approximately 231,000 Atlantic salmon now on hand at Craig Brook derived from Machias River eggs, 50 percent shall be planted in the Machias River in May 1948; the remaining 50 percent will be allotted at a later meeting, after determining the success of this year's planting in Little Falls Stream.

Due to the shortages incident to the war and for other reasons, not all of the recommendations proposed by the Committee have been put into effect. The following comments, listed by number of the recommendation, briefly summarize the status of the recommendations to date.

1. As the rivers classified in this recommendation are the only ones now containing salmon, no further work has been done to classify other rivers.

4. The policy proposed in this recommendation has been carried out insofar as possible.

5. No further work has been carried out on pollution abatement.

6. No law has been passed defining an adequate salmon fishway.

11. As far as is known this recommendation has been carried out.

14. Due to the shortage of materials and labor during the war this proposal has been put off.

15. This recommendation was proposed when it appeared that adult silver salmon might return to the Pemaquid for spawning but as no fish have returned to date, the introduction of this recommendation has not been pressed.

16. The Ducktrap River has been stocked with silver salmon.

17. This recommendation has been enforced as far as known.

18. No system of catch statistics has been set up.

19. This recommendation has now been put into practice.

20. The selection of fish for injuries has been discontinued.

21. The Fish and Wildlife Service has installed a system in all its hatcheries which tabulates most of these data by months. The missing data have been obtained by the biologists.

22. Experiments were planned in 1946 to test the various causes of mortality in the hatchery and are now underway.

24. No law has been passed prohibiting the use of fishing gear within the mouth of the Ducktrap River.

All recommendations regarding the planting of the various year classes of salmon have been carried out essentially as recommended.

FISH AND WILDLIFE SERVICE PROGRAM

The Fish and Wildlife Service's part in the overall program for salmon was to develop a series of experiments to test various management methods which could be used. As the development of new runs of sea-run salmon would depend in large measure on hatchery-reared fish and their ability to survive in the stream after planting, the program concentrated on this phase of management. It was felt that only during the salmon's stream life and spawning migration could unfavorable conditions be controlled enough to increase survival. The following is the outline of the general program under which the work of the Fish and Wildlife Service was carried out.

I. Restoration of runs in streams now devoid of salmon.

A. Evaluation of factors affecting the stream survival of young salmon.

This is to guide in the selection of streams for restoration by indicating the effect of certain natural factors on the survival of planted stock, and by showing what factors may need correction in any particular stream.

1. Type of stream.

Only quantitative experiments can provide an accurate measure of differences in survival in gravel riffles, among boulders, or on muddy bottom, or the part played by shelter. This knowledge is of special value in deciding on the suitability of a stream for restoration work and in determining where to plant young salmon.

2. Water temperature.

The effect on survival of maximum summer temperatures is especially valuable as a guide in evaluating streams for restoration work.

3. Predators

To indicate the difference in mortality with and without the presence of predators. The effect of abundance and species of predator to be determined.

4. Food and space.

To indicate the effect of density of planting or survival and growth, correlated with the supply of food.

Remarks

This portion of the program will be carried out through an experimental design in which varying numbers of young salmon will be held in equal-sized fenced portions of a natural stream. Some of these sections will contain no predators, other will contain predators in varying numbers and species. An attempt will be made to include a few sections of each general type of stream bottom. Because of the variety of factors to be tested, the physical limitations will necessitate that this be continued for several years.

B. Selection of streams for salmon restoration.

1. Evaluation of obstructions to migration.

This is placed first, because in cases where a stream is badly blocked there is no need to make extended studies to determine if it is otherwise suitable.

a. Height, construction materials, and plans of dams and fishways.

This information is very important in planning a long-term program for salmon study, as the durability of the fishway and the non-leaking construction of the dams are big factors in maintaining clear passage of fish.

b. Number and size of water diversions.

Location and feasibility of screening to prevent loss of downstream migrants.

c. Location and description of natural barriers.

d. General extent and intensity of pollution.

Where a stream is not otherwise blocked to migration, it is suggested that a study of the suitability of the stream be made and if found satisfactory, then the pollution situation be carefully studied with a view to remedial measures.

e. Cost

Cost estimates should be made of all needed improvements, and then the improvements either should be made or definitely assured before the stream is listed for restoration attempts.

2. Suitability of the stream for adult salmon and for natural reproduction.

This point is listed second as it takes less investigation than the next, and is absolutely essential if the stream is to maintain a self-perpetuating run of salmon.

a. Sufficient flow in summer and fall to permit the ascent of adults, and to provide resting pools in which they can mature.

b. A sufficient quantity of gravel and small rubble bottom in moving water to provide spawning beds.

3. Suitability of the stream for survival of young salmon.

This point must be studied and steps taken to correct or avoid conflict with any factors found to be adverse to survival.

a. Amount and variation of water flow.

Tributaries need to be visited in midsummer to be certain of sufficient flow to support the young at minimum water levels. In cases where the flow is subject to considerable change, especially during low-water periods, due to the holding back of water for power requirements, it may be necessary to specify a minimum water flow to be maintained at all times before the stream is considered desirable for restoration.

b. Maximum summer water temperatures.

These need to be obtained and the degree and duration of high temperatures checked with the survival experiments (see section I-A-4) before stocking. In cases of doubt, holding experiments are indicated.

c. Predators.

Some method of evaluating the abundance and species of predators may have to be worked out if they prove to be a severe limiting factor (see section I-A-3). In some streams it may be necessary to undertake predator control in order to effect restoration of salmon.

d. Pollution.

Where pollution appears to be a factor, it may be necessary to study its extent and institute corrective measures before the stream is deemed suitable for restoration.

C. Determination of survival from different stocking procedures

In order to obtain a sufficient survival of young salmon to ensure a run of adults, and in order to obtain the highest returns from a given number of young salmon, it is essential to determine the best season, etc., for planting.

1. Season of liberation.

   Young salmon to be marked and liberated at different times of the year. The returning adults to be enumerated and examined for marks to determine the survival from each experiment.

2. Size and age when planted (marking and recovery as above).

3. Tributaries or localities in which liberated (marking and recovery as above).

Remarks

With the present limited egg supply it is absolutely essential that the maximum survival be attained whenever possible, or whenever cost is not out of proportion. These experiments will be carried out on the St. George and Pemaquid Rivers. The results can be checked by comparison with similar experiments on survival rates in streams now containing natural runs. These latter experiments will need to be run as part of the management program.

II. Development of management methods.

This includes streams in the progress of restoration as well as streams now having limited natural runs.

A. Annual census of the spawning escapement in all rivers being studied.

A knowledge of the number of adults in each year's run is necessary in evaluating increases or decreases in the size of the run, in judging the effect of fishing on the size of the spawning escapement, and in discovering the effect on the run of any conservation or management measures employed. The census of the spawning escapement coupled with the amount caught from each river will give the total number of adults returning to the river.

1. Rivers in which a census is necessary for experimental work.

a. Penobscot at Veazie Dam fishway in 1943 and annually.

b. Pemaquid at Pemaquid Falls fishway in 1943 and annually.

c. St. George at Warren Dam fishway in 1945 and annually (a few grilse may ascend in 1944).

B. Statistics on numbers caught before ascending the rivers.

This information is very important in order to obtain the total run to a river.

1. Careful canvassing of weirs by Department of Sea & Shore Fisheries.
2. Collection of anglers' catch in each river with aid of salmon clubs.
3. Estimates of illegal catches where evidence is sufficient.

C. Comparison of survival from natural spawning and from artificial propagation.

This needs to be tested adequately on one river. From the standpoint of importance and favorable conditions for testing, the Penobscot River would be the best stream on which to run this test.

1. Relation between the number of natural spawners and the number of adults returning to the river from such spawning. In order to obtain these figures it will be necessary to count the number of ascending fish each year. To know the numbers of adult fish returning as a result of any one year's spawning it will also be necessary to collect sufficient scale samples from each year's run to give a good estimate of the age composition of the run.

2. Relation between the number of fish removed from the river for artificial propagation and the number of adult salmon returning from the resulting plants of young fish. It is to be noted that in order to put the two methods on an equitable basis it is the number of adults taken for spawning (in other words, the amount of natural spawning interfered with) that is compared to the number of returning adults.

   This will necessitate the marking of the young fish before planting and the examination of all adults passing up the river in a search for the marked adults. In order to make a fair test of the two methods it is desirable that the plants be made in waters as favorable as those utilized by the "wild" young salmon, and that the density of planting be no greater than will give fair survival rates (see section I-A).

D. Development of the most efficient stocking policy as a part of the management program.

   This is essential in order to obtain the best yield from the limited egg supply.

   1. Experiments on the best season, age, and location to plant similar to those carried out on the experimental streams (see I-C), except that this will be carried on in streams already possessing natural runs.

2. Holding of samples of young salmon in livecars in streams where planted for limited periods to check on the loss of planting resulting from:

   a. Temperature differences between water in the hatchery and in the stream.

   b. Effect of different methods of carrying the fish.

   c. Effect of distance fish are carried, or time in transit.

E. Evaluation of the effect of factors limiting the size of the runs and development of measures for their improvement or control.

1. Loss of young salmon occasioned by man.

   a. Loss of downstream migrants in power or other water diversions.

      Loss from this source needs to be estimated carefully. It may be high on small streams where most of the water is diverted for power. It may necessitate the screening of water diversions as a conservation measure.

   b. Loss of young salmon by angling.

      It is known that quantities are often caught and kept by trout fishermen, often with the knowledge that they are young salmon. This may be a severe limiting factor particularly when the runs are small, but there is no accurate data on its extent or on the quantities taken. Many of the streams fished for trout are said to contain few trout.

2. Inefficient use of river systems by natural runs through lack of runs in suitable tributaries.

Because of the remarkable homing instinct of salmon, some tributaries of a river system may be overcrowded while others that are equally desirable have meager runs. This necessitates working out a method of determining the relative use of each tributary, either by counting the run at points far upstream, or by developing a method of estimating the abundance of young salmon in each tributary. Where suitable tributaries are not as fully utilized as others, stocking of these tributaries on an experimental basis is indicated.

3. Predators.

From the study of predators in the holding experiments (see section I-A-3), the possible effect of predators can be estimated. If a method of sampling can be developed to indicate their abundance in a stream, then the cost of control and the estimated increase in survival of young salmon can be calculated.

4. Obstructions to migrations.

A dam or succession of dams, by slowing migration, especially if some of the fishways are passable at only certain stages of water, may so delay fish in their passage upstream as to reduce their stored-up energies to such a point that they cannot perform their journey to the headwaters. This wastes a great deal of potential nursery grounds for young salmon. Time of upstream migration needs to be checked, especially on the Penobscot, by marking experiments on the adult fish while passing upstream, in order to test the readiness with which they pass the dams. These data will indicate the efficiency of the present fishways, so that correction may be made if necessary.

The program given above represents the long-term proposals for the work. Not all the phases of this program have been started and only a few have received concentrated attention. Most of the work to date has centered on two points of the outline: (1) Survival from different stocking procedures, and (2) Development of the most efficient stocking policy. As stated above, the small number of fish available made the dependence on hatchery fish extremely important. The hatchery has, since its foundation, been stocking numbers of eggs, fry, and small fingerlings. Dr. Rounsefell has found on analysis of catch data of stocked streams, that there is little or no correlation between the plantings and the returns to the river for these past plantings. It was felt that this could be due to two factors: (1) the condition of the fish planted from the hatchery, and (2) the survival in the streams. The planted fish were so young that the hatchery probably had little effect on them, but conditions in the stream may have been such that few, if any, survived to migrate to sea. It should be borne in mind at this point that when a stream is dammed, as most salmon rivers in Maine have been at one time or another, the conditions which once made it suitable for salmon may have been changed. These changes may even carry over to the time when the stream is no longer made impassable by dams. Warm-water species which are predacious or competitive with young salmon, may have become established. The character of the stream may have changed through cutting over of the forested land and the subsequent erosion. The spawning beds may have been silted over from this erosion or from mill wastes dumped into the stream. The food available to young salmon may have decreased through pollution, erosion, or the presence of other fish. Taking the above factors into account and the apparent lack of success from previous hatchery plantings, it was decided to run a series of experiments, using marked fish, to test the planting of older and larger hatchery-reared salmon. The theory being that these fish, protected longer by the hatchery, might be better able to withstand the adverse conditions in the streams.

In order to select the most advantageous streams to be stocked with salmon, preliminary knowledge of the stream characters was essential. Some data have, therefore, been collected on the "Selection of streams for salmon restoration." Two streams were at first selected for stocking experiments. The St. George River, which enters salt-water at Warren, Me., and the Pemaquid River, which enters at Pemaquid Harbor, Me., were chosen. It was realized that these were not the most ideal, but they had certain other advantages. Their proximity to the Federal hatcheries at Boothbay Harbor and East Orland, Me., each with its facilities of manpower and material, made them especially desirable to the salmon investigation in the early years. In 1943 the Ducktrap River in Lincolnville, Me., was added to the list of experimental rivers.

A small amount of data, collected incidently to the other work, is available on the "Evaluation of factors affecting the stream survival of young salmon" and "Annual census of the spawning escapement in all rivers being studied."

HATCHERY METHODS

In order to be able to determine the condition of the fish planted by the hatchery, the techniques and methods used by them in obtaining and rearing the salmon were studied. Atlantic salmon have been obtained in two ways, by transfer of eggs from Canada and by trapping spawning adults on one of the Maine rivers and stripping their eggs. Three lots in 1940, 1941, and 1943 respectively, of approximately 50,000 eyed-eggs have been obtained from the Miramichi River in New Brunswick, by transfer from the Canadian government. Spawning fish for stripping have been trapped on the Dennys, Machias, and Penobscot Rivers.

On the Penobscot River a trap is installed in the upstream end of the fishway through the Bangor Dam, usually around the latter part of May and operated until the end of September. This trap is tended by a warden of the Department of Inland Fisheries and Game. Records are kept daily of the number of salmon taken, the water height, and the water temperature. The warden informs the hatchery when salmon are caught and the fish are transported to the hatchery via tank truck. The number of fish taken from any trap to the hatchery has been in accordance with recommendation 4-g of the Salmon Research Committee. This allows some fish to proceed upstream from the trap to spawn naturally. The fish are held at the hatchery in a large pool until they are ripe, usually around November 1, when the eggs are stripped. After spawning, the spent adults are returned to the salt water estuary of the Penobscot at Orland, Me. The procedure has been similar on other rivers, except the fish have been obtained by seining and dipping in addition to trapping.

Table 1 shows the number of fish taken by seven-day-periods in 1941-1945 at the trap at Bangor. No figures for 1946 are included as only one fish was taken.

The eggs taken by the hatchery since the start of the program are summarized by year classes in table 2. The numbers of both sexes spawned, where available, and the average number of eggs per female are also tabulated.

In addition to the Atlantic salmon, received from Canada or obtained by stripping, the hatchery has also received by transfer two lots of approximately 50,000 and two lots of approximately 100,000 eyed-eggs of the silver salmon (Oncorhynchus kisutch) from the Pacific Coast in 1941, 1942, 1943, and 1944, respectively. The first two and last shipments were transferred through the courtesy of the State of Oregon and the 1943 lot from the State of Washington. The transfer of 1944 eggs was completed by an exchange of adult lobsters for salmon eggs. The basis of exchange was one lobster for 1,000 eggs.

In table 3 is presented the percent of fish which survived from the original egg-take to the time of planting. As all individuals of a year class are not planted at one time, these survival figures do not represent the survival to any given age, but the number of fish of various ages which were planted. This means that the mortality on some of the fish of each group which was recorded is heavier than for those individuals that were planted early in their life cycle. The low percent of survival on the 1941 Miramichi and 1942 Penobscot was due to the outbreak of severe epidemics of disease during both summers that these young salmon were in the hatchery. The starred figures on the table show the number of fish held at Craig Brook of these brood years, not the total egg-take, and from which the plants of marked fish were made. Some of the fish from each of these year classes were transferred to the State of Maine hatchery at Dunk Lake for planting in the eastern rivers and for which no accurate survival figures are available.

TABLE 1--Trap Catch of Atlantic Salmon Caught at Bangor Fishway by 7-day Periods in Numbers and Percent

Period ending	Numbers						Percent					
	1941	1942	1943	1944	1945	Total	1941	1942	1943	1944	1945	Total
May 26	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	00.0
June 2	0	1	0	0	0	1	0.0	0.5	0.0	0.0	0.0	00.1
June 9	0	0	4	0	2	6	0.0	0.0	8.5	0.0	1.2	1.9
June 16	0	9	6	0	0	15	0.0	4.8	12.8	0.0	0.0	3.5
June 23	0	69	10	0	1	80	0.0	36.9	21.3	0.0	0.6	11.8
June 30	0	103	0	27	132	262	0.0	55.1	0.0	38.5	78.6	34.4
July 7	0	2	11	1	16	30	0.0	1.1	23.4	1.4	9.5	7.1
July 14	1	3	5	0	0	9	16.7	1.6	10.6	0.0	0.0	5.8
July 21	1	0	0	0	17	18	16.7	0.0	0.0	0.0	10.1	5.4
July 28	1	0	0	26	0	27	16.7	0.0	0.0	37.2	0.0	10.8
Aug. 4	0	0	0	7	0	7	0.0	0.0	0.0	10.0	0.0	2.0
Aug. 11	0	0	0	1	0	1	0.0	0.0	0:0	1.4	0.0	0.3
Aug. 18	2	0	0	0	0	2	33.2	0.0	0.0	0.0	0.0	6.6
Aug. 25	0	0	6	0	0	6	0.0	0.0	12.8	0.0	0.0	2.6
Sept. 1	1	0	0	0	0	1	16.7	0.0	0.0	0.0	0.0	3.3
Sept. 8	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Sept. 15	0	0	5	0	0	0	0.0	0.0	10.6	0.0	0.0	2.1
Sept. 22	0	0	0	8	0	8	0.0	0.0	0.0	11.5	0.0	2.3
Sept. 29	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	6	187	47	70	168	478	100	100	100	100	100	100

TABLE 2:--Egg Take from Atlantic Salmon at Craig Brook Station

Year	River	Number males Spawned	Number females spawned	Total eggs taken	No. of eggs per female
1940	Dennys	-	-	113,000	-
1941	Machias	-	-	68,080	-
1942	Penobscot	40	121	708,945	5,859
1943	Penobscot	28	23	157,240	6,837
1944	Penobscot	12	26	144,949	5,575
1945	Penobscot	35	63	307,400	4,879
1946	Machias	20	49	266,523	5,439
Total	. . . . .	135	282	1,585,057	5,621

Page 30 is

Table 3 which has yet

to be typed.

Although Atlantic salmon have been hatched and reared at Craig Brook Hatchery since 1871, it has only been since the start of the program that young salmon have been held in the hatchery to such ages. The rearing of fish over winter and to as old as 2-1/2 years, presented many problems which heretofore had not been encountered. Diet, disease, and differential growth rates were the most troublesome of these problems. It has been found that the standard trout diets used by the Fish and Wildlife Service do not produce healthy salmon. Up until the fall of 1946, when Dr. Arthur Phillips was called in, almost all the fish showed definite signs of anaemia and on some lots this was so prevalent that all fish had almost white gills. The introduction of more meat, principally liver, to the diet in late 1946 and the resultant improvement in this anaemic condition over the winter seems to point a way to clearing up this difficulty. More complete experiments, however, are still necessary to solve the problem.

Disease epidemics have always occurred on salmon early each spring and quite often re-occurred during the following summer and fall. The poor condition of the fish, due to improper diet, was probably the largest contributor to these epidemics, but a number of other factors all added their weight. The lack of a pathologist, who could be called in at any time to assist with the diagnosis and treatment, was very inconvenient. Dr. Clifford Nelson, pathologist of the State of Maine, rendered invaluable assistance at various times, but his State duties prohibited his spending enough time to make a thorough study of the trouble. The lack of prophylactic measures by the hatchery and the fact that only total losses were kept contributed to these epidemics. If losses were kept by individual ponds and if periodic treatments were given even with no sign of disease, these epidemics could have been kept to a minimum. Quite frequently the presence of disease was not recognized and the subsequent treatment was not started until the disease had reached full epidemic proportion. Treatments were, in large measure, sporadic and there was almost never any follow-up with a second treatment. The chemicals were often applied with little attention to dosage or duration of exposure.

The lack of sorting of fish into different size categories during the time they were in the hatchery also contributed to their poor condition. The fact that large fish were allowed to stay mixed with medium and small sizes, caused increased cannibalism and made the food fed unequally available to the various sizes. This in turn increased the differential rates of growth and mortality, and a spiral started which pushed the larger and smaller members of the group farther and farther away from each other. We have observed members of a group of 1-1/2 year-old fingerlings which had grown little, if at all, since they hatched from the egg.

The arithmetic mean length in millimeters of hatchery fish for various ages, obtained from samples of fish taken at time of planting, is as follows: 1/2-year-old, 38.6; 1-year-old, 61.7; 1-1/2-years-old, 79.5; 2-years-old, 103.1; and 2-1/2-years-old, 153.0.

Hatchery methods and techniques, however, have improved since 1946 and during the winter of 1946-47 gain in weight was obtained on all fish for the first time. This is an encouraging sign and may mean that we are finally learning something about the raising of young salmon.

STOCKING EXPERIMENTS

As mentioned above, the stocking experiments were designed to test the survival of larger and older hatchery-reared fish and have been the basis of the major part of the work of the program to date. The method, as first outlined, was to plant marked fish at different times of the year in different parts of the river system, to install downstream traps near the mouth and count the marked smolts going to sea, and to trap and enumerate the marked adults returning to spawn. This would give three points on a mortality curve and from these the place of greatest loss, either river or sea, could be determined. If in the river, stream improvements, predator control, and increased protection might improve the survival to a point where enough adults would return from the sea to spawn and establish a run. If the highest mortality occurred at sea, then much greater numbers of fish would have to be planted from the hatchery or the restoration of salmon from hatchery stocking abandoned as impractical. Unfortunately, due to the lack of sufficient personnel and funds all of the original points of the experimental design could not be obtained.

In order that the individual plants made from year-to-year could be distinguished from one another, some sort of tagging or marking system had to be used. As it is impractical to use tags, because they must be on 5 to 6 years and the increase in size of the fish causes them to pull out, the fin-clipping technique seemed to be the most satisfactory. It is by no means a perfect method, but no better one for the purpose has yet been developed. The technique consists of cutting off two fins close to their junction with the body. The wounds heal over with the fins permanently missing. By using various combinations of the dorsal, adipose, anal, and left and right ventrals, any lot of fish could be distinguished from any of the others. In all cases different marks were used for each planting, but due to the fact that only 10 combinations, using whole fins, are possible, some combinations had to be repeated. When it was necessary to repeat a space of at least two years in time of expected return was left between the lots having the same mark.

That the fin-clipping method is a valid technique has been tested by workers on the Pacific Coast and at Craig Brook. If the fins are removed close to the body and if all rays are completely severed, there is little or no tendency for regeneration. Two lots of Atlantic salmon marked dorsal and left ventral and dorsal and right ventral, respectively, examined after one year showed 98.2 percent of the dorsals and 92.4 percent of the ventrals to be recognizable as having been removed. These were selected from lots of fish marked for planting and received no special care in marking. Combinations of two fins were used, rather than only one, because single fins may be missing naturally for various reasons. The probability of a given combination being missing naturally is very much less.

In order to test the mortality, if any, caused by marking, a careful record of all losses from time of marking to time of planting was kept on all fish marked. These data show that this loss only averaged approximately 2 percent; and as this figure includes all deaths during this period, some of which would probably have occurred even if the fish had not been marked, it can be seen readily that the loss from marking is very small.

All plants of marked fish were first counted, then marked, weighed, the losses tallied, and finally planted. The fish were subjected to no treatment to facilitate marking, except exposure to low oxygen conditions, which decreased their activity and made them more easily handled.

The following is an explanation of the abbreviations used throughout the tables covering the planting experiments. Each marked plant was called one experiment and given an experiment number. These numbers were formulated to combine some of the data, so that certain facts would be contained in the number and could, therefore, be left out of many of the tables. The first two figures of the experiment number are the year the eggs were deposited. The letter, A, S or K signifies Atlantic, silver or king; in other words, the species. The figure after the letter is the number of the plant made from that brood year and the three or four figures after the dash are the month and year in which the plant was made. For example: 42A1-444 is the first experiment of 1942 Atlantic Salmon planted in April 1944.

The source river is the river which provided the adults from which the eggs were taken to start the brood year.

The abbreviations used for the marks are as follows: D - dorsal; A - adipose; N - anal; L - left ventral; and R - right ventral. Therefore, D & A means the dorsal and adipose fins were removed from all fish of this planting to mark them.

An outline map of the State of Maine, showing the major rivers, the more important salmon rivers, the rivers in which stocking experiments were carried out, and the localities which were planted in each river, is presented in figure 1. The locality called for in the stocking tables

FIGURE 1.--Outline Map of Maine showing major rivers, important salmon rivers, and planting localities.

will in all cases be in the vicinity of the planting locality as given on the map.

Table 4 summarizes all sea-run salmon planting in Maine since 1941 by age of fish when planted. This age is figured from the time the eggs were deposited in every case.

FIGURE 1.--Outline Map of Maine showing major rivers, important salmon rivers, and planting localities.

TABLE 4.--Age at Planting of all sea-run salmon planted since 1941

River planted	Species	Year spawned	Source river	Years of age					Total planted
				1/2	1	1-1/2	2	2-1/2	
Dennys	Atlantic	1940	Dennys	-	-	15,000	-	-	15,000
Dennys	Atlantic	1941	Machias	-	6,000	4,150	-	-	10,150
Dennys	Atlantic	1942	Penobscot	-	-	7,500	-	-	7,500
Machias	Atlantic	1941	Machias	-	34,000	16,000	-	-	50,000
Machias	Atlantic	1942	Penobscot	-	-	5,000	-	-	5,000
Narraguagus	Atlantic	1941	Machias	-	10,000	5,000	-	-	15,000
Narraguagus	Atlantic	1942	Penobscot	-	-	12,500	-	-	12,500
Penobscot	Atlantic	1941	Machias	-	25,032	9,166	-	-	34,198
Penobscot	Atlantic	1942	Penobscot	-	-	29,091	17,350	12,561	59,002
Penobscot	Atlantic	1943	Penobscot	-	-	34,140	17,635	13,979	65,754
Penobscot	Atlantic	1944	Penobscot	-	-	18,306	7,051	-	25,357
St. George	Atlantic	1940	Miramichi	-	-	17,645	3,703	6,728	28,076
St. George	Atlantic	1941	Miramichi	-	-	3,648	-	-	3,648
St. George	Atlantic	1942	Penobscot	-	-	15,880	14,990	-	30,870
St. George	Atlantic	1943	Miramichi	-	-	14,975	10,206	-	25,181
Pemaquid	King	1940	Pemaquid	4,983	-	-	-	-	4,983
Pemaquid	Silver	1941	Oregon	-	15,046	19,922	-	-	34,968
Pemaquid	Silver	1942	Oregon	-	10,220	10,070	-	-	20,290
Pemaquid	Silver	1943	Washington	-	14,966	5,209	-	-	20,175
Pemaquid	Silver	1944	Oregon	-	19,976	19,766	-	-	39,742
Ducktrap	Silver	1943	Washington	9,084	-	11,924	-	-	21,008
Ducktrap	Silver	1944	Oregon	-	19,995	16,133	-	-	36,128
Total	. . .	. . .	. . .	14,067	155,235	291,025	70,935	33,268	564,530

The king salmon (Oncorhynchus tschawytscha) experiment listed in table 4 was the result of the return of at least 20 adult salmon of this species which ascended the fishway at Poole's Mill on the Pemaquid River in September 1940. These fish were presumed to be the result of a plant of young king salmon in Biscay Pond by the State of Maine. The screens that were placed in the outlet of the pond to prevent their escape were washed out by floods in 1936. Of the fish that returned in 1941 two females were stripped of approximately 14,000 eggs and these hatched and reared at the State of Maine hatchery at Auburn. The plant was made from these fish. A downstream screen, maintained in the river in 1941, failed to show any downstream run of young kings. However, as the return of these fish caused considerable interest among local sportsmen and the State authorities, it was decided to continue investigations into the possibility of developing a run of Pacific salmon. The silver salmon (Oncorhynchus kisutch) was deemed a more desirable species for conditions in Maine than the king. It is somewhat smaller in size and inhabits smaller streams than the king. It matures in 3 rather than 4 years, and is, therefore, more desirable for experimental purposes. It is an excellent sport fish in salt water. It was with these factors in mind that the planting of silver salmon was undertaken. It was hoped that the planting might result in the development of runs of this species in some of the smaller streams which would not be practical for Atlantic salmon, and also that the sports fishery in salt water could be developed. This fishery would offer employment to many people in the small coastal towns.

Table 5 presents a summary of the planting experiments to date. The column "number per pound" is included to give a rough idea of the size of the fish when planted. Table 6 presents the same data for the silver salmon experiments. Experiments 44A2-946, 43S1-1044, 44S1-1045, and 44S2-1045 were not marked because of the shortage of help. Experiment 43S3-644 was a plant of very small fingerlings which could not be marked.

In Table 7 the planting experiments are summarized by river planted. This shows the number of fish planted, the locality in which the plants were made, the number of experiments on the river, and the year each of the experiments was expected to have returning adults.

The summaries presented in the foregoing three tables are for the number of fish planted in each experiment. As the time and manpower available would not always permit the marking of all lots planted, only a certain percent of each experiment were marked. The Penobscot River, from the beginning of the program was not considered an experimental river. It was too large for the program to consider screening for downstream migrants, census of predators, etc. which were parts of the original design for the experiments. Large plants of fish were made in the Penobscot because of the Salmon Research Committee's interpretation of section 4 of the Co-operative Agreement that "The bulk of the salmon hatched from eggs collected in any stream will be returned to that stream . . .," would mean 50 percent of the eggs. Fish were marked for the Penobscot because it seemed wasteful to allow these plants to be made without gaining some information. When it became necessary to plant some of the fish without marking, efforts were made to mark all the St. George River plants and cut on those to the Penobscot. Table 8 shows the percent of the fish that were marked in each experimental plant.

TABLE 5.--Summary of Planting Experiments of Atlantic Salmon

Experiment number	Year Spawned	Source	Stocking					Number per pound
			Date	River	Locality	Number	Mark	
40A1-542	1940	Dennys	May 1942	Dennys	. . .	3,200	D & A	. . .
40A2-542	1940	Miramichi	May 1942	St. George	Heart Falls	17,645	A & L	. . .
40A3-1042	1940	Miramichi	Oct. 1942	St. George	Heart Falls	3,703	A & N	25.2
40A4-543	1940	Miramichi	May 1943	St. George	Sennebec Pond	6,728	D & N	14.7
41A1-1042	1941	Machias	Oct. 1942	Penobscot	Shin Brook	6,285	D & L	159.1
41A1-1042	1941	Machias	Oct. 1942	Penobscot	Sawtelle Brook	6,223	D & L	153.6
41A2-1042	1941	Machias	Oct. 1942	Penobscot	Kingman	12,524	D & R	155.6
41A3-543	1941	Miramichi	May 1943	St. George	Sennebec Pond	3,648	D & A	128.1
41A4-543	1941	Machias	May 1943	Penobscot	Sawtell Brook	2,524	N & R	25.0
41A5-743	1941	Machias	July 1943	Penobscot	Kingman	6,642	A & R	31.5
42A1-444	1942	Penobscot	Apr. 1944	St. George	Sennebec Pond	15,880	A & R	75.1
42A2-544	1942	Penobscot	May 1944	Penobscot	Kingman	16,789	A & L	78.9
42A3-544	1942	Penobscot	May 1944	Penobscot	Sawtelle Brook	12,302	L & R	85.7
42A4-1044	1942	Penobscot	Oct. 1944	Penobscot	Kingman	9,401	A & N	23.8
42A5-1044	1942	Penobscot	Oct. 1944	Penobscot	Sawtelle Brook	7,949	D & N	23.3
42A6-745	1942	Penobscot	July 1945	Penobscot	Winn	12,561	N & L	8.9
42A7-944	1942	Penobscot	Sept. 1944	St. George	Sennebec Pond	14,990	N & R	30.9
43A1-745	1943	Penobscot	July 1945	Penobscot	Kingman	34,140	D & A	44.9
43A2-945	1943	Penobscot	Sept. 1945	Penobscot	Medway	17,635	A & R	30.7
43A3-546	1943	Penobscot	May 1946	Penobscot	Kingman	13,979	N & R	12.8
43A4-645	1943	Miramichi	June 1945	St. George	Sennebec Pond	14,975	D & L	49.8
43A5-945	1943	Miramichi	Sept. 1945	St. George	Sennebec Pond	10,206	L & R	34.3
44A1-546	1944	Penobscot	May 1946	Penobscot	Medway	18,306	D & L	69.5
44A2-946	1944	Penobscot	Sept. 1946	Penobscot	Milford	7,051	none	13.6
Total	. . .	. . .	. . .	. . .	. . .	275,286	. . .	. . .

TABLE 6.--Summary of Planting Experiments of Silver Salmon

Experiment number	Year spawned	Source	Stocking					Number per pound
			Date	River	Locality	Number	Mark	
41S1-942	1941	Oregon	Sept 1942	Pemaquid	Biscay Pond	5,013	D & A	84.6
41S2-942	1941	Oregon	Sept 1942	Pemaquid	Bristol	5,015	D & L	77.2
41S3-942	1941	Oregon	Sept. 1942	Pemaquid	Poole's Mill	5,018	D & R	98.8
41S4-643	1941	Oregon	June 1943	Pemaquid	Bristol	9,033	A & N	24.8
41S5-643	1941	Oregon	June 1943	Pemaquid	Poole's Mill	10,889	D & N	27.6
42S1-1043	1942	Oregon	Oct. 1943	Pemaquid	Bristol	10,220	N & L	47.7
42S2-444	1942	Oregon	Apr 1944	Pemaquid	Bristol	10,070	N & R	30.1
43S1-1044	1943	Washington	Sept 1944	Pemaquid	Bristol	14,966	none	106.4
43S2-645	1943	Washington	June 1945	Pemaquid	Bristol	5,209	A & R	28.2
43S3-644	1943	Washington	June 1944	Ducktrap	Route 137	9,084	none	479.9
43S4-545	1943	Washington	May 1945	Ducktrap	Route 137	11,924	A & L	42.5
44S1-1045	1944	Oregon	Oct 1945	Ducktrap	Route 137	19,995	none	64.0
44S2-1045	1944	Oregon	Oct 1945	Pemaquid	Bristol	19,976	none	49.8
44S3-546	1944	Oregon	May 1946	Ducktrap	Route 137	16,133	A & N	25.7
44S4-646	1944	Oregon	June 1946	Pemaquid	Bristol	19,766	L & R	20.8
Total	. . .	. . .	. . .	. . .	. . .	172,311	. . .	. . .

TABLE 7.--Summary of Planting Experiments by Rivers

River planted	Locality	Experiment number	Year of return	Number planted	Total planted
Penobscot	Shin Brook	41A1-1042	1946	6,285	
Penobscot	Sawtelle Brook	41A1-1042	1946	6,223	
Penobscot	Kingman	41A2-1042	1946	12,524	
Penobscot	Sawtelle Brook	41A4-543	1946	2,524	
Penobscot	Kingman	41A5-743	1946	6,642	
Penobscot	Kingman	42A2-544	1947	16,789	
Penobscot	Sawtelle Brook	42A3-544	1947	12,302	
Penobscot	Kingman	42A4-1044	1947	9,401	
Penobscot	Sawtelle Brook	42A5-1044	1947	7,949	
Penobscot	Winn	42A6-745	1947	12,561	
Penobscot	Kingman	43A1-745	1948	34,140	
Penobscot	Medway	43A2-945	1948	17,635	
Penobscot	Kingman	43A3-546	1948	13,979	
Penobscot	Medway	44A1-546	1949	18,306	
Penobscot	Milford	44A2-946	1949	7,051	184,311
St. George	Heart Falls	40A2-542	1945	17,645	
St. George	Heart Falls	40A3-1042	1945	3,703	
St. George	Sennebec Pond	40A4-543	1945	6,728	
St. George	Sennebec Pond	41A3-543	1946	3,648	
St. George	Sennebec Pond	42A1-444	1947	15,880	
St. George	Sennebec Pond	42A7-944	1947	14,990	
St. George	Sennebec Pond	43A4-645	1948	14,975	
St. George	Sennebec Pond	43A5-945	1948	10,206	87,775
Pemaquid	Biscay Pond	41S1-942	1944	5,013	
Pemaquid	Bristol	41S2-942	1944	5,015	
Pemaquid	Poole's Mill	41S3-942	1944	5,018	
Pemaquid	Bristol	41S4-643	1944	9,033	
Pemaquid	Poole's Mill	41S5-643	1944	10,889	
Pemaquid	Bristol	42S1-1043	1945	10,220	
Pemaquid	Bristol	42S2-444	1945	10,070	
Pemaquid	Bristol	43S1-1044	1946	14,966	
Pemaquid	Bristol	43S2-645	1946	5,209	
Pemaquid	Bristol	44S2-1045	1947	19,976	
Pemaquid	Bristol	44S4-646	1947	19,766	115,175
Ducktrap	Route 137	43S3-644	1946	9,084	
Ducktrap	Route 137	43S4-545	1946	11,924	
Ducktrap	Route 137	44S1-1045	1947	19,995	
Ducktrap	Route 137	44S3-546	1947	16,133	57,136
Total	. . .	. . .	. . .	. . .	444,397

TABLE 8.--Percent of Salmon Marked in Each Experiment

Experiment number	Mark	Number marked	Number planted	Percent Marked
40A1-542	D & A	3,200	3,200	100
40A2-542	A & L	17,645	17,645	100
40A3-1042	A & N	3,703	3,703	100
40A4-543	D & N	6,728	6,728	100
41A1-1042	D & L	6,285	6,285	100
41A1-1042	D & L	6,223	6,223	100
41A2-1042	D & R	12,524	12,524	100
41A3-543	D & A	3,648	3,648	100
41A4-543	N & R	2,524	2,524	100
41A5-743	A & R	6,642	6,642	100
42A1-444	A & R	15,880	15,880	100
42A2-544	A & L	16,789	16,789	100
42A3-544	L & R	12,302	12,302	100
42A4-1044	A & N	3,000	9,401	32
42A5-1044	D & N	2,943	7,949	37
42A6-745	N & L	12,561	12,561	100
42A7-944	N & R	14,990	14,990	100
43A1-745	D & A	10,985	34,140	32
43A2-945	A & R	5,526	17,635	31
43A3-546	N & R	3,180	13,979	23
43A4-645	D & L	14,975	14,975	100
43A5-945	L & R	3,581	10,206	35
44A1-546	D & L	2,301	18,306	13
44A2-946	none	0	7,051	0
41S1-942	D & A	5,013	5,013	100
41S2-942	D & L	5,015	5,015	100
41S3-942	D & R	5,018	5,018	100
41S4-643	A & N	9,033	9,033	100
41S5-643	D & N	10,889	10,889	100
42S1-1043	N & L	10,220	10,220	100
42S2-444	N & R	10,070	10,070	100
43S1-1044	none	0	14,966	0
43S2-645	A & R	5,209	5,209	100
43S3-644	none	0	9,084	0
43S4-545	A & L	11,924	11,924	100
44S1-1045	none	0	19,995	0
44S2-1045	none	0	19,976	0
44S3-546	A & N	5,499	16,133	34
44S4-646	L & R	4,806	19,766	24

Returns from the planting experiments were unsuccessful until the spring and summer of 1947. It should be noted, however, that fewer fish were planted which should have returned up to 1947, than make up the plantings from 1947 on. Only about one-third (36.5 percent) of all fish planted should have returned in 1944, 1945, and 1946. The remaining 63.5 percent are due to return in 1947, 1948, and 1949. Of this latter percentage 165,742 fish or 37.3 percent were due in 1947. It should also be pointed out that there has been a slight progressive improvement in the condition of planted fish each year since the program was started. This latter observation combined with the quantity of fish planted may account for the lack of returns in previous years.

Returns of marked Atlantic salmon adults have been obtained during 1947 on both the Penobscot and St. George Rivers. To date, one fish which was marked has been caught in an alewife weir on the St. George River. This fish weighed 13-3/4 pounds and was marked adipose and right ventral. It was one of a plant of 15,880 1942 fish made in April 1944 at Sennebec Pond. The returns of marked fish have been much more successful on the Penobscot. The sport fishery at Bangor Pool took 48 fish on rod and reel during the season, of which 19 were marked. As the salmon investigation was dropped officially in April 1947, no complete check was made of these fish, so that the exact marks on these salmon were not recorded. The hatchery at Craig Brook has also been trapping fish for spawning purposes at Bangor. To date they have taken fish of which were marked. Of these marked fish had the left and right ventrals missing, the adipose and left ventral, the adipose and anal, and the dorsal and anal. No fish marked anal and left ventral have been caught. Three fish have been taken with only one fin missing and final identification of these as marked fish must be left until fall, when they can be examined more closely. The results of these returns seem to indicate that the spring plantings of 1-1/2-year-old fish are the most satisfactory. The data also indicate that the planting site at Sawtelle Brook is better than that at Kingman. This latter observation is not surprising in view of the physical characters of the two locations. The lack of returns from the Winn plant, although of large fish, seems to indicate this area very unsatisfactory as a nursery ground.

It is unfortunate that the closing of the investigation stopped a more complete check on marked returns. Examination of fish at the next dam above Bangor would have been very desirable to check any fish jumping the Bangor Dam. Reports of observers at Bangor state that several fish were observed passing the dam by this method.

During the fall of 1946 four silver salmon grilse were caught in the salt water estuary of the Pemaquid River by smelt fisherman. These fish average approximately two pounds in weight. A number of fish were seen jumping at this time and were probably the result of the plant at Bristol in June 1946. Although no observations have been obtained on Atlantic salmon smolts migrating to sea from the Penobscot and St. George Rivers, silver salmon have been seen entering salt water at Poole's Mill every year. No counts have been obtained of these migrating smolts, but the number was estimated at several thousand. As they must pass through a small mill pond and down a fish ladder, they should be seen readily and the numbers estimated.

PORTABLE FISH FENCE

The most important problems which faced the salmon program during 1946, when plans were being formulated to expand the work, were the population evaluations necessary for accurate information on mortality of young fish in the stream, the escapement of smolts to the sea, and the number of mature salmon which return to the river. Until these population data were obtained, it was not possible to determine what conditions in the stream were limiting the restoration of salmon runs, nor what conditions regarding escapement of mature fish upstream to spawn are necessary to build up and maintain maximum runs. In order to evaluate these data, it is necessary that fish-tight barriers or fences be installed at selected points in the stream. The construction of these fences present difficult problems. They must be easily installed, strong enough to withstand high water, easily cleaned, fish-tight, and from the standpoint of this investigation relatively cheap to construct. Preliminary work with screens of hardware cloth and examination of reports of similar work elsewhere proved these to be unsatisfactory. Rotary screens of the type used on the West Coast and bar racks of metal or wood all required permanent construction or large outlays of money, neither of which was practical for our work. It was, therefore, necessary to study the possibilities of developing a new type of screen.

In late 1945, preliminary ideas, drawings, and a scale model were made for a portable fence. The fence consisted of flexible sections linked together through supporting posts and held in place in the stream by wire rope fastened to anchors on the stream bank. The sections consisted of three redwood beams, one close to the stream bottom, one about 4-1/2 feet above this and third between the two. To the forward edge of these beams were fastened brass rack plates or spacers, similar to the teeth of a comb. Into the slots formed by these teeth were placed bars of 1/8 by 1 inch steel. These formed the rack or screen. These bars slide free in the slots and could be driven into the bottom. The posts which support the weight of the fence pass through holes in each end of the beams, and the beams are held in position by brass pins on either side of them through the posts. The spacing between the bars was 1/4 inch, but can be varied to suit local conditions. The joints, where the spacing was greater than this, were covered with canvas or hardware cloth to make them fish-tight.

A full-size fence was constructed in 1946 and installed in the Pemaquid River for testing in August. It was in the form of a V pointing upstream, but could be used as readily in the form of a straight diagonal across the stream. The test model was allowed to plug with leaves and debris until there was a 23-inch difference in water level above and below. This pressure showed no tendency to blow-under or pull out of shape. The 35 feet of fence constructed in 1946 cost approximately $800.

It has the following advantages: it is easy to install; it can be made rugged enough to withstand almost any pressure; it can be installed at almost any location; it is easy to clean; it can be made to conform to the contour of the bottom; it is relatively cheap as it can be used over and over again; and it requires no permanent base or sides.

STREAM SURVEY

At the beginning of the program and throughout its existence, it has been necessary to conduct stream surveys on some of the streams, principally those that were used as experimental rivers. These surveys have not been complete, but only preliminary to gather the data needed at the time. The amount of effort which could be expended on these as compared with the other necessary work, was small. The Pemaquid, Ducktrap, and St. George Rivers received the greatest attention, with some work done on the Penobscot. The extent of spawning areas, the size of nursery grounds, water temperatures, height of water and stream flow, and dams and fishways were all observed from time to time on all these rivers. It has been the policy to obtain data on water temperatures and stream flow whenever biologists were on the stream. It was hoped that these data would eventually reach sufficient quantity to give complete seasonal pictures of stream characters. Preliminary investigations have been undertaken into the methods of tabulating and filing these data, so that if it were possible to conduct more complete surveys, the data could be put into usable form at the very beginning and so that the data collected would be relatively complete.

CATCH STATISTICS

The collection of catch statistics, although formulated in the program outline, has never received any appreciable attention. The Salmon Research Committee recommended (18) a method for the gathering and compiling of catch records, but this method has not been adopted. A few catch records have been collected and tabulated during the course of other work.

The commercial catch obtained from the Fish and Wildlife Service's annual canvass for certain years is shown in Table 9. In the years shown there has been no catch reported in New Hampshire, so this is left out of the table. It can be seen that the catch has declined rather steadily over these years. It has not been possible to obtain figures for the amount of gear necessary to catch these fish, making it impossible to calculate the effort.

Because of the activities of the Penobscot Salmon Club, it has been possible to obtain from their records the rod catch of Atlantic salmon at Bangor Pool on the Penobscot River from 1929-1943. These records show the date fish were caught, the weight of the fish taken, and the name of the person making the catch. In Figure 2 is depicted graphically

---

FIGURE 2.--Atlantic Salmon Rod Catch at Bangor Pool

---

the sport catch at Bangor Pool from 1900-1943. These figures are from the Salmon Club and other sources. In Table 10 are presented the rod catch at Bangor by seven-day-periods from April 1 to July 21. This period covers the legal season for sport fishing on the Penobscot. The peak catches for sport fishing occur between June 2 to 8. In Table 11 are tabulated the weight of the largest and smallest fish and the average weight of fish taken by sport fishermen from 1929-1943. It should be noted that, contrary to popular opinion, the average weight is only 10.4 pounds, which is quite close to the average reported weight in other rivers. It is perennially argued that the fish on the Penobscot are larger than those from other rivers, and that they have been decreasing in weight over the past years. The figures presented in this table do not seem to show that this is true. It will be extremely difficult to obtain estimates of the effort expended on the sport catch at Bangor Pool as no records have been kept of the number of persons fishing or the time that was spent.

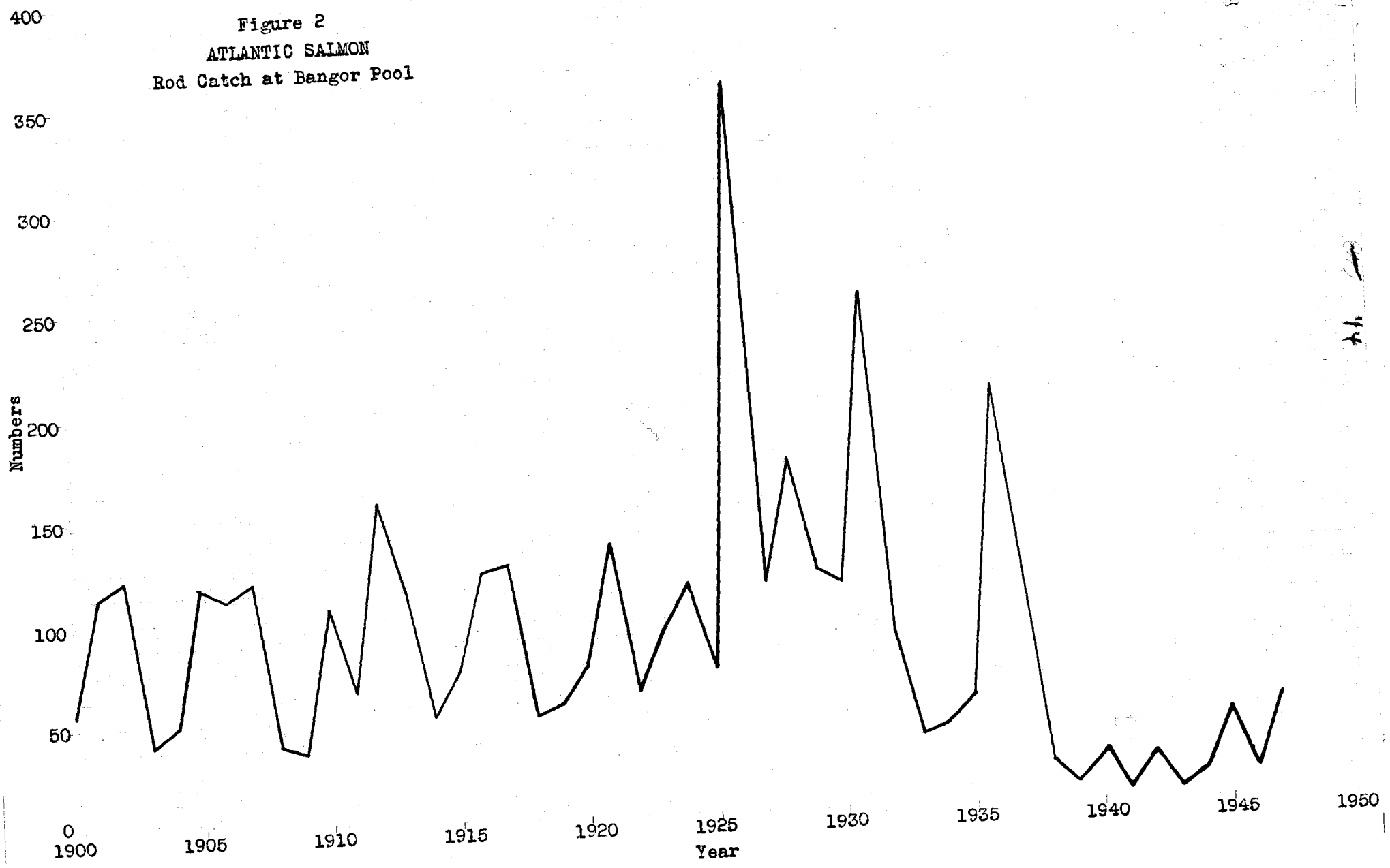


Figure 2
ATLANTIC SALMON
Rod Catch at Bangor Pool
Numbers
400
350
300
250
200
150
100
50
0
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
Year

TABLE 10.--Rod Catch at Bangor Pool by Seven-day Periods, 1929 - 1943

Period	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	Total
Apr. 1- 7	10	. .	1	5	5	. .	2	. .	12	1	2	. .	. .	. .	. .	38
Apr. 8-14	1	. .	1	. .	. .	. .	. .	1	2	3	. .	. .	. .	. .	. .	8
Apr. 15-21	4	. .	6	15	1	. .	. .	4	. .	. .	. .	. .	. .	. .	1	31
Apr. 22-28	2	. .	8	3	. .	1	. .	1	. .	. .	. .	. .	. .	. .	. .	15
Apr. 29-5/5	. . .	1	16	10	4	. .	. .	4	2	2	. .	. .	. .	. .	. .	39
May 6-12	4	. .	8	6	8	2	2	3	7	2	. .	. .	. .	1	. .	43
May 13-19	11	9	19	10	3	8	10	19	6	2	. .	. .	. .	9	. .	106
May 20-26	20	24	19	12	5	7	8	40	14	5	4	3	1	1	. .	163
May 27-6/2	21	37	31	7	5	2	14	47	19	2	1	4	2	3	. .	195
June 3- 9	32	20	32	7	3	5	8	31	26	1	1	5	. . .	1	. .	172
June 10-16	10	16	53	4	. .	8	5	6	13	2	. .	2	2	1	3	125
June 17-23	3	. .	22	3	2	4	8	12	7	. .	. .	3	. .	4	. .	68
June 24-30	1	2	25	. .	. .	4	. .	24	2	. .	. .	5	. .	3	. .	66
July 1- 7	. . .	. .	2	. . .	. .	. .	. .	9	. .	. .	. .	1	. .	. .	1	13
July 8-14	. . .	. .	4	. .	. .	. .	. .	2	. .	. .	. .	. .	. .	. .	. .	6
July 15-21	. . .	2	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	3
Total	119	111	248	82	36	41	57	203	110	20	8	23	5	23	5	1,091

TABLE 9.--Commercial Catch of Atlantic Salmon in Selected Years

Year	Maine		Massachusetts		Rhode Island		Connecticut		Total	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1887	185,637	36,398	. . .	. . .	. . .	. . .	430	338	186,067	36,736
1888	205,149	41,209	. . .	. . .	. . .	. . .	530	426	205,679	41,635
1889	152,740	34,118	139	66	. . .	. . .	280	222	153,159	34,406
1898	53,322	10,009	60	30	. . .	. . .	. . .	. . .	53,382	10,039
1902	60,768	13,394	18	9	. . .	. . .	. . .	. . .	60,786	13,403
1905	86,298	20,137	. . .	. . .	10	2	24	4	86,332	20,143
1908	19,000	3,700	. . .	. . .	. . .	. . .	. . .	. . .	19,000	3,700
1919	20,610	7,926	. . .	. . .	70	12	. . .	. . .	20,680	7,938
1924	12,348	3,994	117	25	90	18	. . .	. . .	12,555	4,037
1928	14,747	5,288	16,050	710	92	28	12	6	30,901	6,032
1929	43,554	14,634	100	4	. . .	. . .	. . .	. . .	43,654	14,638
1930	88,295	27,265	55	10	. . .	. . .	. . .	. . .	88,350	27,275
1931	70,190	18,824	38	8	. . .	. . .	. . .	. . .	70,228	18,832
1932	36,125	8,566	. . .	. . .	. . .	. . .	. . .	. . .	36,125	8,566
1933	24,644	6,269	45	9	. . .	. . .	. . .	. . .	24,689	6,278
1935	39,400	9,366	900	202	. . .	. . .	. . .	. . .	40,300	9,568
1938	15,700	4,720	500	92	. . .	. . .	. . .	. . .	16,200	4,812
1939	2,100	650	400	37	. . .	. . .	. . .	. . .	2,500	687
1940	2,000	593	100	25	. . .	. . .	. . .	. . .	2,100	618
1942	7,700	2,728	. . .	. . .	. . .	. . .	. . .	. . .	7,700	2,728
Total	1,140,327	269,788	18,522	1,227	262	60	1,276	996	1,160,387	272,071

TABLE 11.--Weight of Rod Catch at Bangor Pool

1929-1943

Year	Number caught	Weight (lbs)		
		largest	smallest	average
1929	119	20.0	7.5	12.2
1930	111	22.5	3.0	10.5
1931	248	18.5	6.5	9.8
1932	82	20.5	6.5	12.1
1933	36	17.5	6.5	11.2
1934	41	12.5	6.5	9.5
1935	57	12.5	7.5	9.9
1936	203	16.5	5.0	9.8
1937	110	21.0	2.5	10.3
1938	20	16.0	6.5	10.1
1939	8	15.5	8.0	11.3
1940	23	15.0	7.0	9.3
1941	5	12.5	8.0	9.7
1942	23	10.5	8.0	9.3
1943	5	20.0	9.5	11.9
Total	1,090	22.5	2.5	10.4

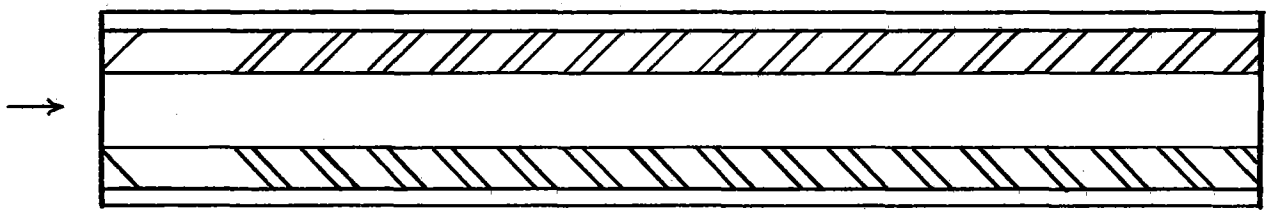
FISHWAY EXPERIMENTS

As most of the salmon rivers in New England are dammed at one or more places and as any run of salmon to these rivers must pass over these dams, a knowledge of fishways and their uses is essential. Throughout the existence of the program, the biologists have been called upon to advise on design and location of fishways. This was particularly true in regards to Federal Power Commission licenses. The information available on fishways and their design has been very meager and the various opinions on the best types are numerous. As it was impossible to obtain information from the investigators on the West Coast and as the problems in New England seemed somewhat different, it was decided to review some of the literature and try to find a design which would fit local conditions better than the present types. The most important feature to be considered was the quantity of water necessary for adequate operation. Almost all the other problems involved in fishway installation resolve back to this point. As most rivers have dams which are used for some type of industrial process, and as during the low-water periods the owners of the dams are interested in saving every drop of water, it is necessary that any fishway operate on as little water as possible.

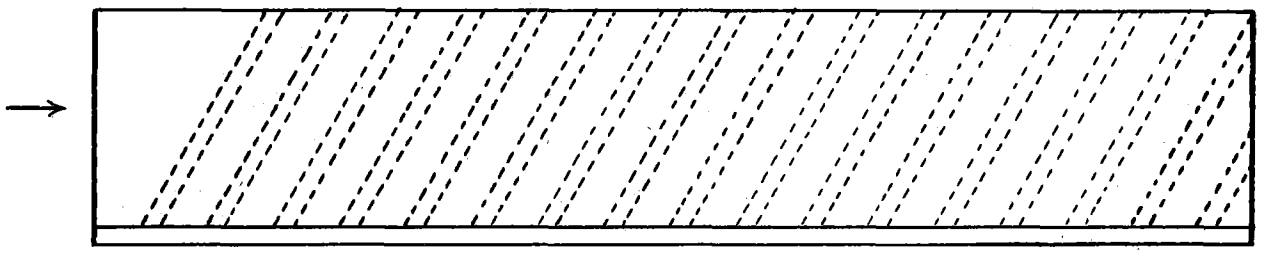
Investigation of the literature showed the Denil type fishway to be suitable for most of these conditions. Hydraulic tests conducted at the University of Iowa showed this type to be the best of all types tested under most circumstances. This design is characterized by a straight open channel through which the fish can swim, without any twisting or turning. The flow of water is retarded by a series of baffles projecting upstream into the current from the sides of the fishway. These cause back currents to be formed which slow down the water flow. The slope, shape, and position of these baffles have been changed and modified into many different designs. An outline drawing of the particular type tested is shown in Figure 3.

FIGURE 3.--Basic Design of One Type of Denil Fishway

The Denil design is probably best adapted for use between a series of large resting pools and at these resting pools any turns or changes in direction can be made.



Top View



Side View

Figure 3

BASIC DESIGN
of One Type of Denil Fishway

As the Denil type was decided on as a possible design, a series of tests was planned using scale models. These models were constructed of wood and installed in a small stream. Preliminary experiments were run to study the current flow and action of water. A Pitot tube was used to measure current flow at various parts of the fishway. It was found that a central channel composed of fairly slow-flowing water free from back eddies and cross currents existed close to the bottom. Small trout were then used to test the suitability of the fishway to fish. No concrete data could be gathered from these fish, as it was difficult to induce the fish to migrate up the ladder. However, those that could be started, in one way or another, made the ascent with little or no difficulty. One of the larger specimens made the trip with very little exertion, even though his tail hit the sides of the fishladder ateach motion. It was also found that the entrance offered little or no attraction to these fish and probably was one cause for their not making the climb. On the whole, however, the design was thought satisfactory and superior to most of the present designs used inthis area. Plans were made for the construction of full-size fishways of the Denil type to be installed at the Craig Brook Station. These were to be tested using adult salmon, which would be on their migratory spawning journey. It was hoped that more complete information would be obtained from these experiments.

It was also planned in connection with the above experiments to try different entrance designs. This is one bad feature of many of the existing fishladders. The internal construction is good and fish can use them with little difficulty, if they are attracted to the entrance. In many cases the fish are so worn out by their search for the fishway that they fail to complete their spawning migration. Little or no information seems to exist on methods required to attract fish and how these can be incorporated into fishway design. It was hoped that if an adequate internal design could be found, entrance designs could be tested on this model and some basic information gained. Unfortunately, these experiments planned for 1947 cannot be carried to completion.

MISCELLANEOUS ACTIVITIES

In addition to the activities definitely formulated in the program outline, many other functions directly or indirectly connected with salmon restoration, have been carried out by the investigation. These activities in many cases have been essential to efficient operation of the program, while others have been merely service functions that were necessary for proper public relations.

Among the more essential activities have been our contacts with the State governments, the Atlantic States Marine Fisheries Commission, and private organizations interested in conservation. Several meetings between the various New England States have been participated in to discuss problems related to salmon and to guide activities into coordinated work. The development of legislation in Maine for the formation of a salmon commission to coordinate the functions of the various state departments was largely the result of agitation by Fish and Wildlife Service biologists. The discussions of April 1947 regarding interstate cooperation on the Connecticut River participated in by all State agencies concerned, was the result of the need for an overall policy on this river as reported by our biologists for the past four years. Reports of the work of the program have been forwarded to the Atlantic States Marine Fisheries Commission from time to time for their information. This latter organization has been extremely interested in the salmon restoration work. Cooperation through conferences and field trips with the National Wildlife Institute has been an annual occurrence. This organization has interest in salmon through its connection with the Kendall Fellowship at the University of Maine.

Until the spring of 1947, all Federal Power Commission license applications were passed on by the salmon project. This function brought the program into contact with many of the most important rivers in New England and which might again be potential salmon rivers if restoration in Maine was successful. These licenses, which involved principally approval of fishway design and location, required the gathering of data on the dam for which the license was applied and the general conditions of the river above and below the dam. A rather complete survey of part of the Connecticut River was conducted in 1945. This survey was instigated as a result of several license applications and the lack of definite knowledge of dams, fishways, and other industrial conditions on the river. Data were collected on this survey on the first five dams on the main river relating to their physical plants, fishway conditions, and the migratory habits of any fish that were present. All major tributaries between these dams were also surveyed for number of dams, fishways present, and other information upon which an intelligent appraisal of anadromous fish restoration possibilities to that river could be made.

In addition to the above functions, which were more or less directly related to salmon, we were frequently consulted by various agencies regarding other anadromous fish. As a result of the alewife work carried on in 1943 and 1944, when several thousand adult fish were stocked in several ponds, frequent inquiries have been received for opinions on fishways and management measures for these fish. Questions, which quite often required field trips, have also been received regarding smelt runs. These activities were deemed essential to proper public relations and were carried out with that in mind. They brought the biologists of the program into contact with streams and situations which might eventually involve salmon, and for this reason alone were probably quite profitable.

FUTURE PLANS

Because of the lack of returns from the planting experiments on the experimental rivers, it was decided in the spring of 1947 to change the approach to the problem. The new plans call for the selection of a small stream which is suitable in most respects for salmon and upon which various biological problems could be investigated without interference with other interests. This stream would be cleaned, using retonone, of all predator and competitor fish. Various stream improvements would be introduced and a fish screen would be installed near the mouth. The stream would then be stocked as heavily as possible with hatchery reared fish. These fish would be sampled at various times, using the shocking method developed by the New York Conservation Department, during their life in the stream, to determine mortality. They would be counted through the screen when migrating to sea. All spawning adults would also be counted upon their return to the stream. This approach was decided upon to make the best effort possible to start a run of fish. All the original problems upon which experiments have been run would now be assumed to be detrimental to salmon and on the test stream either eliminated or controlled. With better fish from the hatchery, with predator control in the stream, with the elimination of obstructions, and with attempts to control mortality, it is hoped that the maximum number of healthy fish for any year class would go to sea, and, therefore, unless conditions in the ocean are extremely detrimental, a large number would return for spawning.

Little Falls Stream which borders the Fish and Wildlife Service's Moosehorn Wildlife Refuge was inspected and found to be suitable for the purpose. Unfortunately, at this time cuts in the appropriations caused the dropping of the salmon investigation by the Division of Fishery Biology. However, certain parts of this approach can be carried out. The hatchery at Craig Brook will continue to operate and raise young salmon. The portable fish screen has been installed at Little Falls Stream. Mr. Stobie has agreed to detail a biologist from his department to conduct experiments on the stream. The Fish and Wildlife Service has agreed to advise this biologist through periodic conferences with him and loan of certain pieces of equipment. This seems to be the best arrangement possible under the existing cimumstances.

Although it is unfortunate that the program on salmon has been dropped without concrete results, it should not be reopened again, unless funds and manpower are adequate for the work. In the five years of its existence it has been operating with insufficient manpower and funds. The average yearly expenditure including salaries of the salmon investigation for the years 1940-1946 was $3,041. A large part of the lack of concrete results has been due to the inability to put enough effort into the program. The determination of mortality in the stream could not be obtained because screens could not be operated. This is only one example of how the program was held back because of the lack of money. The salmon work requires considerable travel and equipment. Much of the work to be accomplished efficiently requires at least two men. These factors should all be outlined adequately and budgeted before the program is ever reopened. One life cycle of the Atlantic salmon requires at least five years and the program should be outlined for at least this length of time. It seems inefficient and a waste of money to ever attempt to study salmon again without adequate provisions for the continuance of the program long enough to accomplish some results.

Sea Run Salmon Program for Maine

1. In general limited salmon runs will be of most value to the people of coastal communities and the state as a whole, if used to supply sport rather than commercial fisheries. Consequently it will be basic policy to restrict salmon fishing in rivers and bays at the mouths of salmon rivers, to sport fishing, until the runs are large enough to supply more than the sports fishery.

2. To carry out this policy and to implement an effective program for the improvement of salmon runs, the following measures are necessary:

   a. No weir fishing will be allowed specifically for salmon or within designated areas near the mouths of salmon streams, except as is authorized under 2 e. below.
      Weir sites or other fishing rights within present or potential closed areas should be assessed as soon as possible by an impartial agency and bought up at that price as rapidly as funds permit.

   b. All sport salmon fishing will require a license, whether in fresh or salt water.

   c. A license will be required for the sale of all salmon taken by any form of gear.

   d. All fish dealers handling Atlantic salmon will be required to keep a record of their purchases and the party from whom purchased.

c. When a salmon run reaches a size where it is more than sufficient to supply the sports fishery, commercial fishing will be allowed to whatever extent the surplus will support. "Surplus" shall be defined as the number in excess of that required for maximum reproduction and sport fishing, and shall be based upon the results of an adequate research ~~and management~~ program.

3. To administer the above program and to carry out such other conservation and management measures as are required for the developement and maintenance of maximum salmon runs, a joint commission shall be set up consisting of the Comm of Inland Fish & Game, Comm of Sea and Shore Fisheries, and a third member to be appointed by the Governor from the legislature.

a. The Commission will implement management recommendations based on the results of biological research on salmon carried out by the State biologists, Fish and Wildlife Service, and cooperating organizations.

b. The proceeds of the sale of licenses for salmon fishing will go into a fund to be administered by the Comm. These funds will be used for buying up weir sites, and other purposes furthering the salmon program.

Questions:

1. Appointment of third member of Comm.
2. Status of Salmon Research Comm.
3. Licensing + enforcement.

1945 Program

1. Research Comm. representatives
2. Stocking program for 1945
3. Count at Veazie continued
4. Fishway and possible collection of spawner at Dam foot of Beddington Lake.
5. Concrete wall at foot of Bangor Dam fishway?