Salmon Restoration in Maine

— BY —

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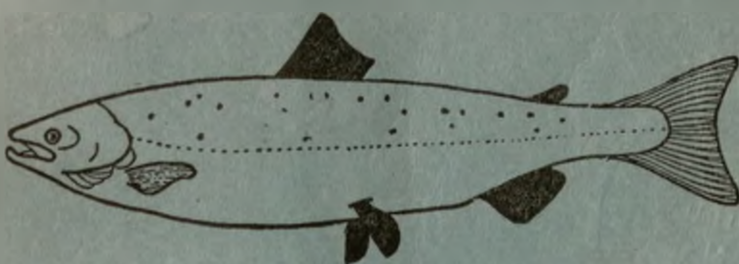

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ATLANTIC SEA-RUN SALMON COMMISSION

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Commissioner, Department of Sea and Shore Fisheries
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RESEARCH AND MANAGEMENT PROGRAM

Participating Organizations:
- Atlantic Sea-Run Salmon Commission
- Fish and Wildlife Service, U.S. Dept. of the Interior
- Department of Inland Fisheries and Game
- Department of Sea and Shore Fisheries
- University of Maine

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Fish Cultural Stations:
- U. S. Fishery Station, Craig Brook, East Orland
- Inland Fisheries Station: Tunk Lake, Cherryfield

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SALMON RESTORATION IN MAINE

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(The salmon on the cover shows in black the five fins which are removed in combinations of two in marking fish to study their migrations.)

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PRESENT EXTENT OF THE RESOURCE

The first question that arises in considering the program for restoring the abundance of salmon concerns the possibilities for restoring salmon to a fair proportion of their former numbers. From the published reports of Atkins (1887) and Bigelow and Welsh (1924), as well as from numerous unpublished field notes taken by Charles G. Atkins in the period 1867 to 1900, and other sources, we have ascertained that regular runs of salmon were once found in at least 33 rivers. There are regular salmon runs in only 8 today. Stray salmon are occasionally reported from 10 streams that do not contain regular runs. Some of these occasional salmon may be strays from other streams or they may be adults resulting from young landlocked salmon going to sea.

Penobscot River Salmon angling has been a well-recognized sport on the Penobscot River for nearly a century, with records extending back 56 years from 1893 to date as shown in Table 1. It will be noted that there has been a great falling off of the rod catch in recent years. This is due to a great scarcity of salmon. During the earlier years of the fishery the Penobscot River produced a commercial catch of over 10,000 fish a year. For instance, in the five years for which statistics are available, during the period from 1873 to 1890, the catch averaged 11,955 salmon. The abundance has dwindled so drastically that during 1947—the last year that salmon weirs were legally operated in the Penobscot—the weir catch was estimated at 40 fish.

There are many miles of excellent spawning beds and nursery areas for young salmon in the upper reaches of the Penobscot River that should be producing as large quantities of salmon as formerly. Now that the commercial fishing has been restricted, a vigorous campaign of stocking, fishway improvement and pollution abatement should bring results. In 1947 a number of adult salmon were captured at the Bangor Pool that had been released as fingerlings in the Sebois and Mattawamkeag tributaries of the Penobscot; had descended to the sea, made a tremendous growth, and were reascending their native river to spawn. This proves that the headwaters are still suitable for salmon.

Except for the small run remaining in the Penobscot, natural runs of salmon had become almost extinct by 1920. Only continuous stocking efforts kept small runs alive in the badly obstructed rivers of eastern Maine.

Table 1.—Salmon caught by rod at Bangor Pool, 1893 to 1948.

Year	Number of salmon	Year	Number of salmon
1893	81	1921	134
1894	51	1922	60
1895	61	1923	90
1896	112	1924	111
1897	125	1925	72
1898	51	1926	354
1899	53	1927	112
1900	57	1928	170
1901	112	1929	119
1902	120	1930	111
1903	39	1931	248
1904	51	1932	82
1905	115	1933	36
1906	111	1934	41
1907	117	1935	52
1908	39	1936	203
1909	37	1937	110
1910	103	1938	20
1911	64	1939	8
1912	153	1940	23
1913	111	1941	5
1914	50	1942	23
1915	72	1943	5
1916	120	1944	12
1917	121	1945	42
1918	52	1946	13
1919	57	1947	48
1920	76	1948	16

Dennys River

As long ago as 1882 the report of the Commissioner of Inland Fisheries and Game states: "On the Dennys River the run of salmon has been unusually good and many fish were taken on the fly by anglers . . . The great drought of the season impeded the transit of the salmon to their spawning grounds on the upper sources of the river, and many fish were dipped in nets by public-spirited citizens below the dams and transported to the water above where they had a free course." Atkins (1886) states that during the early 1880's the Dennys yielded from 200 to 1000 salmon annually. The run in the Dennys was always in peril from dams. Stocking kept the runs alive. The number stocked are as follows:

Atlantic salmon stocked in the Dennys River.

Year released	Number	Year released	Number	Year released	Number
1875	20,000	1918	21,000	1936	490,000
...		1919	627,000	1937	30,000
1881	3,900	1920	437,500	...	
...		1921	?	1940	25,500
1883	20,000	1922	?	...	
1884	39,500	1923	?	1942	21,000
1885	40,000	1924	40,000	1943	11,159
...		1925	?	1944	9,000
1888	40,000	1926	75,000		
1889	40,000	1927	100,500		
...		1928	100,500		
...		1929	88,725		
Subtotals	203,400		1,490,225		586,659
Grand total					2,280,284+

After the 1880's no stocking was carried on for nearly 30 years and the runs were almost exterminated. In 1918 a new fishway was built and restocking of the river commenced. In the 1922 report of the Inland Fisheries Commissioner it is stated that:

> "A new fishway at Dennysville built . . . three years ago was flooded with sea salmon last fall. The warden who had charge of the fishway counted 500 passing through in twenty-four hours . . . ".

In spite of this auspicious beginning and continued stocking, the runs were unable to withstand both commercial fishing and obstructions. However, in 1930 the last obstruction to salmon migration was removed from the Dennys River.

The Dennys River Sportsman's Club, formed in 1936, bought up commercial fishing rights on the river and has since been active in salmon angling. In 1947 this club had 190 active members, including 83 from 12 other states, the District of Columbia, and two foreign countries. The records of rod and reel catches on the Dennys River since the revival of sport fishing are as follows:

Salmon caught by rod from the Dennys River, 1936-1948.

Year	Number	Year	Number	Year	Number	Year	Number	Year	Number
1936	47	1939	35	1942	75	1945	80	1948	78
1937	84	1940	82	1943	130	1946	90		
1938	66	1941	12	1944	62	1947	58		

The low catches in some years, especially in 1941, were caused by drought conditions, and the club is now interested in providing means for storing sufficient water to furnish a more adequate flow during the summer months.

Narraguagus River

The Narraguagus River was obstructed near its mouth for many years by several small wooden dams with inadequate fishways. Notes by Charles G. Atkins as early as 1874 show rough sketches of existing and proposed fishways for five dams near Cherryfield. In 1886 Atkins (1887) states that the dams at Cherryfield long ago destroyed the salmon runs. That the proposed fishways were not built until much later is also indicated by the 1917 report of the Commissioner of Inland Fisheries and Game which states:

> "After more than half a century of agitation on the part of the citizens of Cherryfield and vicinity, the Narraguagus River has been opened to the passage of salmon and other anadromous fishes by the construction of fishways over the five dams at Cherryfield."

Only a few salmon managed to pass these dams, and without stocking the runs might have disappeared entirely. A record of the stocking in recent years is as follows:

Atlantic salmon stocked in the Narraguagus River, 1918 –

Year released	Number	Year released	Number	Year released	Number
1918	225,000	1927	100,500	1940	5,500
1919	437,500	1928	100,500	1941	20,000
....		1929	88,725	1942	10,000
1924	?	....		1943	17,000
1925	?	1936	85,000	1944	9,000
1926	50,000	....			

Subsequent to 1917 a total of 1,148,725 young salmon were planted. In the spring of 1942 heavy ice jams swept away the wooden dams near the river mouth. The salmon runs commenced to improve rapidly, and today the river furnishes as good salmon fishing as any other stream in Maine.

About 25 miles above the river mouth an impassable dam still exists at Beddington Pool. Because of the limited quantities of coarse rubble available for spawning purposes in the lower river, and because of the need for greater nursery area for young salmon, it is highly desirable that this obstruction be made passable to salmon.

Machias River The Machias River, with a drainage area of 450 square miles at Whitneyville, offers one of the most promising chances to develop a large run of Atlantic salmon. The river flows through wild forested country, largely inaccessible by car. However, the salmon runs have been kept to a minimum on account of three dams at Machias and Whitneyville.

East Machias River Records as early as 1870 mention a few salmon being taken in this river every season. A few salmon are still taken below the dam at East Machias every spring by fishermen with alewife dipnets This river should support a large salmon run but the combination of easy poaching and an inadequate fishway has kept the run from increasing. Another contributing hazard is the large unscreened power diversion that takes practically all of the stream flow during periods of low or average discharge.

Pleasant River The salmon run of the Pleasant River has always been in jeopardy on account of a 10-foot millpond dam at the mouth of the river in Columbia Falls. This dam has no fishway and forms a barrier except when the mill stops sawing and the dam is opened at the discretion of the owner,

usually in late fall. Between this obstruction and commercial netting just below it, which has only recently been stopped, it is a minor miracle that a few salmon have managed to survive. A proper fishway and control of poaching would make it possible to develop the Pleasant into one of our better salmon streams.

Ducktrap River This river is unobstructed and the gradient is steep in places with rubble bottom, providing good spawning and nursery areas. Around 1880 some of the most successful salmon weirs in Penobscot Bay were close to the mouth of the Ducktrap in Lincolnville. The stream still contains a small natural run, but the summer flow is too low. In September, 1948 there were dry stretches between pools; however, there was sufficient seepage between them to maintain a few young salmon. If a sufficient amount of water could be impounded during the spring freshets to provide several cubic feet per second of stream flow throughout the summer months the salmon run could be greatly increased. This would come about through the increase in available feeding and shelter area for young salmon, entailing better growth and survival.

Tunk Stream This stream has a drainage area of approximately forty square miles. In its headwaters there are over 3000 acres of lakes and ponds which have a stabilizing influence on the water run-off. Consequently Tunk Stream maintains a good flow even in years of drought. For many years a dam at Unionville with no fishway has limited the suitable salmon water to the small section found immediately below this dam and to a short area at Smithville, about 4 miles below Unionville. In addition to the obstruction of the river sawmill waste was allowed to pollute the river below Unionville, having an injurious effect upon the spawning areas and the food supply for young salmon. During the forest fires of 1947 the sawmill and dam at Unionville were destroyed and it is unlikely that they will be rebuilt. With a small expenditure the remaining debris could be removed and nearly a mile of good riffle area above Unionville would be available to salmon. It is reported that a small run of Atlantic salmon ascend this stream every fall.

Other Rivers In addition to the eight rivers that still contain runs or remnants of runs of Atlantic salmon, there are several other rivers that appear to be in favorable condition for salmon restoration. These will be discussed in detail below.

ORGANIZATION FOR SALMON RESTORATION WORK

The Fish and Wildlife Service and its predecessors have maintained a salmon hatchery on the lower Penobscot River at Craig Brook since 1870. For a number of years New Hampshire, Massachusetts and in some years Connecticut and even Rhode Island as well as the state of Maine, aided by furnishing funds for operation of this hatchery. However, as dams and pollution exterminated the last of the salmon runs in the states to the south they gradually lost interest in what seemed a forlorn hope.

After 1922 the Service discontinued the purchase of adult salmon for the hatchery, but obtained eggs from Canada until 1936 when all salmon work ceased.

In 1939 interest in the restoration of Atlantic salmon was revived. The state of Maine and the Penobscot Salmon Club cooperated with the Fish and Wildlife Service in capturing adult salmon for hatchery purposes. At the request of Mr. David Aylward, president of the National Wildlife Federation, the Service called a meeting of the conservation commissioners of all of the New England states to discuss the problem.

The group asked for a report on the subject, which has been published (Herrington and Rounsefell, 1940). It stressed the lack of sufficient knowledge to draw up a logical management program. Partly as a result of this report an agreement was signed on October 10, 1941 between the U. S. Fish and Wildlife Service, and the Maine Commissioners of Inland Fisheries and Game and of Sea and Shore Fisheries. This agreement established certain principles relating to salmon propagation and stocking procedures, and set up a research committee to coordinate the salmon work of the three agencies.

The University of Maine was also becoming interested in salmon restoration, and through the establishment of the William Converse Kendall Fellowship, graduate students studied salmon on the Dennys and Penobscot Rivers from 1940 to 1942.

The program had hardly begun when it was curtailed by the war. The U. S. Fish and Wildlife Service made preliminary surveys of a few streams and experimental plantings of Atlantic and silver salmon.

The Atlantic States Marine Fisheries Commission, representing all of the states of the Atlantic Seaboard (except North Carolina) became actively interested in salmon restoration and urged the creation in Maine of a special commission to end the overlapping jurisdiction of the two state fishery departments. In 1945, pursuant to a legislative act the Governor of Maine appointed a special three man commission to report on the situation. Their report (Baker et al, 1947) stressed the need of a permanent salmon commission.

In 1947 the Maine Legislature created a permanent salmon commission to be known as The Atlantic Sea-Run Salmon Commission. It consists of three men—the Commissioner of Inland Fisheries and Game, the Commissioner of Sea and Shore Fisheries and a third man appointed by the Governor. This Commission is vested with the power of promulgating rules and regulations providing for the times, number and manner in which Atlantic sea-run salmon may be taken in all waters of the state and to designate waters, frequented by this species, where special Atlantic salmon fishing licenses shall be required.

The agreement of October 10, 1941 between the U. S. Fish and Wildlife Service and the Departments of Inland Fisheries and Game and of Sea and Shore Fisheries was redrawn and extended to include the Salmon Commission and the University of Maine. The text of this agreement under which the research and management program is now being conducted is as follows:

MEMORANDUM OF AGREEMENT

THIS AGREEMENT by and between the Atlantic Sea-Run Salmon Commission of the State of Maine, hereinafter referred to as the Salmon Commission; the Department of Inland Fisheries and Game of the State of Maine, hereinafter referred to as the Inland Department; the Department of Sea and Shore Fisheries of the State of Maine, hereinafter referred to as the Sea and Shore Department; the Fish and Wildlife Service of the United States Department of the Interior, hereinafter referred to as the Service; and the University of Maine, hereinafter referred to as the University,

WITNESSETH, That

WHEREAS, the formerly abundant sea-run salmon in New England rivers has become seriously depleted through a variety of adverse circumstances, with a consequent loss of valuable recreational and commercial fishing assets, and

WHEREAS, the adverse circumstances that caused the severe depletion of salmon have become mitigated to the extent in many areas that restoration of the runs is practicable in certain rivers in the State of Maine, and

WHEREAS, the Salmon Commission, the Inland Department, the Sea and Shore Department, the Service, and the University, are individually and collectively interested and concerned, through the exercise of their legally prescribed and respective functions, in a restoration program for sea-run salmon to be conducted through scientific research and fishery management, and

WHEREAS, the cooperation and collaboration herein provided will result in more efficient utilization of funds, facilities, and personnel available for furthering restoration of sea-run salmon,

NOW, THEREFORE, IT IS MUTUALLY AGREED, as follows:

1. This agreement will supersede the agreement of October 10, 1941 between the Inland Department, the Sea and Shore Department and the Service.

2. A research committee shall be established through the appointment by responsible officials of one biologist to represent the Inland Department, one biologist to represent the Sea and Shore Department and one biologist to represent the Service, whose function shall be to serve as a coordinating agency for all sea-run salmon restoration and management work. The duties of the committee shall be to advise concerning the research program and to develop and recommend to the Salmon Commission a general policy with respect to artificial propagation and stocking of sea-run salmon, and plans and specific recommendations covering fishways, dams, stocking, fishing regulations, pollution abatement, and other needed measures.

3. The Salmon Commission agrees to base the regulation of salmon fishing on the recommendations of the research committee established by Section 2 of this agreement.

4. The Service agrees, within the limitations of appropriations, to furnish a senior biologist to plan and to supervise the execution of a research program, for which all parties agree to furnish such facilities in the way of personnel, equipment or other services as they individually deem advisable. The equipment so furnished shall remain the property of the party purchasing or contributing it and shall be subject to that party's disposition.

5. The headquarters for the personnel conducting this abovementioned joint program of research shall be at the University of Maine. The University agrees to furnish suitable office and laboratory quarters including usual services and utilities.

6. The University further agrees to appoint as collaborators and extend the same privileges and courtesies accorded the staff of the University to those staff members of the cooperating agencies as may be mutually agreed upon.

7. The Service agrees, within the limitations of appropriations, to continue to propagate and rear sea-run salmon at the Craig Brook fishery station. The Inland Department also agrees to propagate and rear sea-run salmon within the limit of its appropriations, whenever the program calls for a larger output than can be handled at Craig Brook.

8. The Inland Department, the Sea and Shore Department and the Salmon Commission further agree within the limit of their appropriations, to furnish personnel and facilities for marking and stocking young salmon, catching and transporting adult spawning salmon, attending weirs and traps and such other field tasks as may be required.

9. The recommendations of the research committee will be followed in determining the numbers of spawning fish to be taken from any stream by duly authorized representatives or employees of the parties to this agreement.

10. Not less than 50 percent of the salmon hatched from eggs collected in any stream will be returned to that stream unless the stream is specifically declared by the research committee to be in unsuitable condition to afford a favorable habitat for sea-run salmon.

11. Stocking in other suitable waters of the balance of the young salmon not returned to their parent stream as specified in Section 10 of this agreement shall be based on recommendations of the research committee.

12. Data and results acquired independently or in collaboration, related to problems of mutual interest and concerning restoration of sea-run salmon shall be exchanged freely between the cooperating agencies, and each shall be free to publish reports and scientific papers resulting from the cooperative investigations. All such reports and publications shall give due credit to each of the cooperating parties.

13. No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this contract or agreement or to any benefit to arise thereupon; provided that this shall not be construed to extend to any incorporated company where such contract or agreement is made for the general benefit of such incorporation or company (Sec. 3741 Revised Statutes).

14. This agreement dated April 15, 1948, and executed in quintuple, shall become effective on the date of final signature and shall remain in force until cancelled. Any one of the parties to this agreement may effect its termination by giving six months' advance notice of its intention to withdraw.

IN WITNESS WHEREOF the authorized officers of the parties hereto have executed this agreement on the dates opposite their respective signatures.

June 14, 1948	George J. Stobie	Commissioner of Inland Fisheries and Game and of Atlantic Sea-Run Salmon Commission
June 11, 1948	Richard E. Reed	Commissioner of Sea and Shore Fisheries and of Atlantic Sea-Run Salmon Commission
June 2, 1948	Horace P. Bond	Commissioner Atlantic Sea-Run Salmon Commission
June 1, 1948	Arthur A. Hauck	President, University of Maine
June 25, 1948	Albert M. Day	Director, Fish and Wildlife Service United States Department of the Interior

SUITABILITY OF STREAMS FOR SALMON RUNS

The success or failure of any salmon restoration program lies in the condition of the streams. The salmon must be able to migrate up and down stream without undue harm from dams, water diversions, or pollution. A stream must contain spawning areas of suitable large gravel or rubble in riffles where the current through the stones will aerate the eggs during their long incubation period. Young Atlantic salmon live principally in shallow riffles where aquatic insects are most numerous and where they are safest from their enemies. Such nursery areas are imperative.

If a stream is to provide satisfactory Atlantic salmon angling then it must also have sufficient flow to permit the adults to ascend during the early summer; and it must contain deep, cool pools in which these early-running fish may spend the summer maturing their eggs and milt while awaiting the autumn spawning season.

The majority of Maine streams once satisfied all of these requirements, but many of them are now either temporarily or permanently unsuitable for salmon restoration. In Table 2 we have assembled information that we have on hand concerning all of the Maine streams with 15 or more square miles of drainage area (except the St. John River above the mouth of the Aroostook). For some streams the present information is reliable, for others it is vague and sketchy. It does suffice, in spite of its lack of detail, to give an overall picture of conditions.

Out of the 56 streams listed at least 33 once contained runs of salmon. It is probable that several of the remainder also contained salmon, but we have only listed those for which we have authentic records. Many of these records are from hitherto unpublished field notes made between 1867 and 1900 by Charles G. Atkins.

From Table 2 and from other sources we have prepared Table 3 which lists these same streams roughly in the order of their present suitability for salmon restoration, and also rates their former condition. It is striking that with very few exceptions it has been the better salmon streams that have suffered most from civilization. The streams with the steepest gradient, the largest volume, and the most constant summer flow were best both for salmon and for industry.

Table 2.—Characteristics of 56 Maine streams.

Stream	Mouth	Drainage area	Lake area	Stream discharge: Station	Stream discharge: Average daily	Stream discharge: Minimum daily	Pollution
		square miles	acres		second feet	second feet	
Penobscot R.	Bangor	7 760	248 428	West Enfield	11 600	**1 470	Heavy
West Branch	Medway	2 100	107 130	Medway		1 750	Heavy
East Branch	Medway	1 100	39 955	Grindstone	1 854	77	None
Piscataquis	Howland	1 500	38 541	Medford	2 219	120	Heavy
Mattawamkeag	Mattawamkeag	1 520	25 638	Mattawamkeag	2 749	110	None
Passadumkeag	Passadumkeag	394	20 134	Lowell	490	5	None
Main River	Bangor	1 146	17 030				
Kennebec R.	Richmond	5 900	171 123	Waterville	6 739	** 200	Heavy
Androscoggin R.	Topsham-Brunswick	3 430	90 784	Auburn	5 593	** 340	Extreme
Aroostook R.	Fort Fairfield	2 290	22 355			**	Light
Saco R.	Saco-Biddeford	1 680	4 204	Cornish	2 605	** 90	Heavy
St. Croix R.	Calais	1 470	87 123	Baileyville	2 120	** 100	Heavy
Presumpscot R.	Falmouth	615	28 787	Sebago Lake	639	*	......
Union R.	Ellsworth	496	31 751			*	None
Machias R.	Machias	450	9 576	Whitneyville	964	** 30	Very Light
Salmon Falls R.	South Berwick	340	1 965	S. Lebanon	220	* 6	......
East Machias R.	East Machias	286	15 408	East Machias	495	* 13	None
Sheepscot R.	Alna-Newcastle	228	2 839	N. Whitefield	171	** 5	None
St. George R.	Warren	225	5 745	Union	145	*** 5	Light
Cobboseecontee Str	Gardiner	221	11 546	Gardiner	322	* 0	
Narraguagus R.	Cherryfield	214	2 167				None

Table 2.—Characteristics of 56 streams. (Continued)

Kenduskeag Str.	Bangor	214	166	Kenduskeag	454	**	7	Extreme
Souadabscook Str.	Hampden	203	456			**		None
Marsh Stream	Frankfort	130	156					None
Mousam R.	Kennebunk	125	1 842	W. Kennebunk	114	*	5	.....
Orland R.	Orland	113	3 915			**		None
Royal R.	Yarmouth	97	250			**		.....
Dennys R.	Edmunds-Dennysville	94	10 740			**		None
Pleasant R.	Columbia Falls	85	860					Very Light
Medomak R.	Waldoboro	74	809			***	2	Very Light
Damariscotta R.	Newcastle-Nobleboro	57	4 463					None
Eastern R.	Dresden	44	73					.....
Orange R.	Whiting	43	1 868			*		None
Passagassawaukeag R.	Belfast	43	567					None
Pennamaquan R.	Pembroke	42	1 904			**		None
Chandler R.	Jonesboro	42	0					None
Tunk Str.	Steuben	40	3 237					None
Cathance R.	Bowdoinham	40	16					.....
Kennebunk R.	Kennebunk	38	244			*		.....
Pemaquid R.	Bristol	36	2 803			***	3	None
Ducktrap R.	Lincolnville	35	1 040			***	0.1	None
York R.	York	32	46					None
Dyer R.	Alna	30	576					None
Colson Str.	Prospect	29	155					None
Stroudwater R.	Portland	29	0					.....
Card Mill Str.	Franklin	27	715					None
Indian R.	Addison-Jonesport	25	0					None
Megunticook R.	Camden	25	1 332			**		Light

Table 2.—Characteristics of 56 Maine Streams (Continued)

Stream	Mouth	Drainage area	Lake area	Stream discharge: Station	Stream discharge: Average daily	Stream discharge: Minimum daily	Pollution
		square miles	acres		second feet	second feet	
Oyster R.	Thomaston-Warren	25	110				None
Nequasset Brook	Woolwich	25	430			**	None
Nonesuch R.	Scarboro	25	0				......
Patten Str.	Surry	23	1 102				None
Wescot Str.	Belfast	23	50				None
Sedgeunkedunk Str.	Brewer	20	1 195			*	None
Merriland R.	Wells	19	12				......
Little Falls Str.	Edmunds	18	300			*** 0.5	None
Goose R.	Belfast	18	1 370			*	......
Abagadasset R.	Bowdoinham	18	0				......
Ogunquit R.	Wells	18	3				......
East Str.	Trescott	17	0				None
Little R.	Northport-Belfast	16	0			*	None
Boyden Str.	Perry	15	2 016			*	None
Totals for 56 streams		27 677	778 622				

*Flow regulated

**Flow partly regulated

***Authors' rough estimates of minimum flow

Not all of these streams are permanently lost. Pollution abatement fishway construction and the screening of water diversions may eventually restore many of them. Of the really large streams only the Aroostook and the Penobscot offer any immediate hope. More fishway construction is necessary on the Aroostook before it is ready for stocking.

Even on the Penobscot River the salmon must pass over six dams—at Bangor, Veazie, Great Works, Oldtown, Howland and Mattaceunk—in order to gain access to the great spawning and nursery areas of the East Branch and the Sebois and Wassataquoik tributaries The present fishways, built after the dams were already constructed, were necessarily a compromise and it is doubtful whether a permanent salmon run of any magnitude could be maintained until they are improved.

Table 2a.—Characteristics of 56 Maine streams.

Stream	Dammed at or close to mouth	Fishway in dam near mouth	Salmon formerly present	Salmon present	Remarks
Penobscot R.	Yes	Yes	Yes	Yes	Salmon must pass four dams to first spawning grounds, six dams to best spawning grounds
West Branch	Yes	No	Yes	No	Closed by dams without fishways
East Branch	Yes	Yes	Yes		
Piscataquis	Yes	No	Yes	No	Closed by dams without fishways
Mattawamkeag			Yes		
Passadumkeag			Yes		
Main River	Yes	Yes	Yes	Yes	
Kennebec R.	Yes	No	Yes	No	
Androscoggin R.	Yes	No	Yes	No	Useless because of pollution
Aroostook R	Yes	Yes	Yes	No	Needs additional fishways
Saco R.	Yes	Yes	Yes	No	
St. Croix R.	Yes	No	Yes	No	
Presumpscot R.	Yes	No	Yes	No	About 50 second feet diverted for domestic use
Union R.	Yes	No	Yes	No	Very high dam at mouth
Machias R.	Yes	Yes	Yes	Yes	Fishways need improvement
Salmon Falls R.	Yes	No	Yes	No	
East Machias R.	Yes	Yes	Yes	Yes	Fishway needs improvement
Sheepscot R.			Yes	No	Dam at mouth opened up in 1948
St George R.	Yes	Yes	Yes	No	Second dam is bad obstruction
Cobboseecontee Str.	Yes	No	Yes	No	Stream too short
Narraguagus R.			Yes	Yes	Needs fishway at Beddington Dam
Kenduskeag Str.	Yes	No	Yes	No	Useless because of pollution
Souadabscook Str.	Yes	No	Yes	No	
Marsh Str.	Yes	No	Yes	No	
Mousam R.	Yes	No	Yes	No	
Orland R	Yes	Yes	Yes	No	Gradient poor, fishways need improvement
Royal R.	Yes	No	Yes	No	
Dennys R.			Yes	Yes	

Table 2a (Continued)

Pleasant R.	Yes	No	Yes	Yes	Few pass dam when millpond is lowered
Medomak R.	Yes	No	Yes	No	
Damariscotta R	Yes	Yes	No?	No	Stream too short
Eastern R.			Yes	No	
Orange R	Yes	No	Yes	No	
Passagassawaukeag R	Yes	No	?	No	
Pennamaquan R.	Yes	No	Yes	No	
Chandler R.			Yes	No	
Tunk Str			Yes	Yes	
Cathance R.			Yes	No	
Kennebunk R.	Yes	No	?	No	
Pemaquid R.	Yes	Yes	Yes	No	Good flow of water but low gradient
Ducktrap R.			Yes	Yes	Needs water storage for summer flow
York R.			?	No	Too small
Dyer R.			?	No	
Colson Str.			?	No	
Stroudwater R.			?	No	
Card Mill Str.			?	No	Stream too short
Indian R.			?	No	
Megunticook R.	Yes	No	?	No	Stream too short
Oyster R.			?	No	
Nequasset Brook	Yes	Yes	?	No	About 3 second feet diverted for domestic use
Nonesuch R.			?	No	
Patten Str.			?	No	
Wescot Str.			?	No	
Sedgeunkedunk Str.	Yes	No	?	No	Most of water diverted
Merriland R.			?	No	
Little Falls Str.			Yes	No	Experimental restoration stream
Goose R.	Yes	No	?	No	
Abagadasset R.			?	No	
Ogunquit R.			?	No	
East R.			?	No	
Little R.	Yes	No	?	No	About 1 second foot diverted for domestic use
Boyden Str.	Yes	No	?	No	

Table 3.—Streams classified according to their potential value for salmon restoration.

Stream	Drainage area	Natural suitability	Present potential	Remarks
	square miles			
Dennys R.*	94	Excellent	Excellent	Needs better summer flow
Aroostook R.	2,290	Excellent	Very good	Need additional fishway
Machias R.*	450	"	"	Fishways need improvement
East Machias R.*	286	"	"	Needs salmon fishway
Sheepscot R.	228	Very good	"	
Narraguagus R.*	214	"	"	Needs fishway at Beddington Dam
Tunk Str.*	40	"	"	
Penobscot R.*	7,760	Excellent	Good	Needs fishway improvement pollution abatement
Marsh Str.	130	Very good	Good	
Royal R.	97	"	"	Needs several low fishways
Pleasant R.*	85	"	"	Needs fishway at mouth
Chandler R.	42	Good	"	
Pemaquid R.	36	"	"	
Ducktrap R.*	35	"	"	Needs better summer flow
Little Falls Str.	18	"	"	Experimental stream
Saco R.	1,680	Excellent	Fair	Needs fishway improvement pollution abatement
St. Croix R.	1,470	Excellent	Fair	Needs fishways
St. George R.	225	Good	"	Needs additional fishways
Souadabscook Str.	203	Fair	"	Needs fishway
Medomak R.	74	"	"	Needs fishways
Passagassawaukeag R.	43	"	"	Needs fishways

Table 3 (Continued)

Colson Str.	29	"	"	
East Str.	17	"	"	
Orland R.	113	Poor	Poor	Limited riffle area
Orange R.	43	"	"	Limited riffle area
York R.	32	"	"	Stream too small
Dyer R.	30	"	"	Low summer flow
Card Mill Str.	27	"	"	Limited riffle area
Patten Str.	23	"	"	Limited riffle area
Wescot Str.	23	"	"	Limited riffle area
Kennebec R.	5,900	Excellent	Unsuitable	Needs fishways, abate pollution
Androscoggin R.	3,430	"	"	Needs fishways, abate pollution
Union R.	496	"	"	High dam at mouth
Salmon Falls R.	340	"	"	Needs fishways, abate pollution
*Kenduskeag Str.	214	Very Good	"	Needs fishways, abate pollution
Presumpscot R.	615	Good	"	Excessive number of dams
Cobboseecontee Str	221	Poor	"	
Damariscotta R.	57	Unsuitable	"	No riffle area
Megunticook R.	25	"	"	
Nequasset Brook	25	"	"	
Sedgeunkedunk Str.	20	"	"	
15 streams	497	Unclassified	Unknown	Need reconnaissance

*Contain runs of Atlantic salmon

The problem of fishways is too lengthy to be discussed in detail in this report. The state is attempting to have fishways constructed and maintained wherever their need is indicated, but the present legislation has not proven satisfactory. The state needs adequate provision for patrol, inspection and maintenance of fishways. The present law which places the entire cost of building and maintaining a fishway on the dam owner does not make for good fishways. A provision in the present law permitting a sharing of the cost of fishway construction between the state and the dam owner in the older structures would make it possible to build adequate fishways The state should also be given funds for a special fishway maintenance crew. In no other way will it ever be possible to expect all six fishways on the Penobscot, for example, to all be in proper repair and functioning simultaneously. If one of the six is out then the others are more than worthless, and one cannot rely on six dam owners all repairing their fishways at the same time.

An analysis of Table 3 reveals that out of the 56 streams listed in Table 2, those not naturally unsuitable for salmon (ignoring the unclassified) comprise 37 streams with a drainage area of 27,053 square miles, or 98 percent of the total area listed. The changes in suitability in that area are strikingly shown by the following:

Time	Stream suitability	Number of streams	Drainage area in square miles	
			Actual	Percent
Past	Excellent or very good	18	25,204	93.2
	Good or fair	11	1,337	4.9
	Poor	8	512	1.9
		37	27,053	100.0
Present	Excellent or very good	7	3,602	13.3
	Good or fair	16	11,944	44.1
	Poor or unsuitable	14	11,507	42 6
		37	27,053	100.0

SALMON PROPAGATION

Artificial propagation is necessary to provide young salmon with which to restock streams for the reestablishment of former runs. The successful maintenance of a run depends on increasing the numbers of young surviving from a given number of adults, or decreasing the mortality of adult salmon, so that the annual death rate for adults is less than the number of salmon that become adult each season.

In spite of many years of artificial propagation the runs on the Penobscot River continued to dwindle. Overfishing and obstructions alone could easily account for this decline. For instance, in 1900 (Repts. U. S. Fish Commission) it was estimated that only 200 salmon passed the dams and spawned in the upper Penobscot. Again in 1902 an attempt was made to catch wild adult salmon for the hatchery by placing a weir across the East Branch of the Penobscot, but on account of low water they almost wholly failed to surmount the dams in the lower Penobscot.

River conditions are better now than in former years. It is therefore hoped that the runs can be restored in a large share of the salmon's former territory.

As explained above the propagation of Atlantic salmon came to a complete standstill when shipments of Canadian eggs ceased in 1936. In 1939 operations were resumed, dependence being placed chiefly on obtaining adult salmon for spawning purposes from Maine streams. The numbers and source of adult salmon captured, the numbers of eggs stripped and the numbers of eggs received from other sources since propagation was resumed are shown in Table 4.

Table 4.—Source of salmon reared at Craig Brook Fishery Station, 1939 to 1947.

Year eggs taken	Number adult salmon captured: Penob-scot	Machias	East Machias	Dennys	Total adult survival	Females stripped	Number of eggs taken[1]	Eggs from Canada[2] [1]	Total Atlantic salmon eggs[1]	Silver salmon eggs[3] received[1]	Total of all salmon eggs stripped or received[1]
1939			2	23	18	(12)	113		113		113
1940	104				84	43	250	51	301		301
1941	7	63	2		57	41	268	51	319	53	372
1942	171				162	121	709		709	45	754
1943	54				53	23	157	50	207	101	308
1944	38				38	26	150		150	113	263
1945	108				98	62	307		307		307
1946	1	100			69	36	267		267		267
1947	120				116	60	324		324	8[4]	330
Total	603	163	4	23	695	424	2,545	152	2,697	320	3,015

[1]In thousands
[2]From Miramichi River, New Brunswick, courtesy of Dept. of Fisheries, Canada
[3]Courtesy Washington Dept. of Fisheries and Oregon Game Commission
[4]Second generation from the Ducktrap River.

A total of 3,015,000 salmon eggs from all sources was handled over a 9-year period, or an average of 333,000 eggs per year. Some idea of the size of this operation may be had by comparing it with Atlantic salmon propagation in the Canadian Maritime Provinces. The comparison for the 5-year period from 1941 to 1945 is as follows:

	Average number of Atlantic salmon taken for spawning	Average number of Atlantic salmon eggs obtained	Average number of Atlantic salmon stocked in the streams
Canada	4,539	21,412,000	14,957,000
Maine	89	318,000	121,000

The facilities now available for the hatching and rearing of sea-run salmon are insufficient both in quality and quantity. In order to restore salmon runs within a reasonable number of years the goal should certainly be to rear not less than one million salmon annually.

The federal fishery station at Craig Brook, the oldest fish-cultural station in the United States, dating back 78 years to 1870, is not adequate for this program. It was established in the days when fish were planted very soon after hatching. The present pond system was built piecemeal as demand for rearing space increased. The water supply is distributed through various sizes of makeshift conduits, wooden flumes, pipes, troughs, etc , without proper valves.

Because it requires a great deal more water to rear salmon than it does to hatch them, the water supply has been woefully inadequate during such dry summers as 1947 and 1948. This can be traced to two causes:

1) The water supply line is not submerged deeply enough in Craig Pond to permit more than a few feet of drawdown. By drawing the lake down farther during the summer, it should be possible to increase the safe yield of water during years of normal precipitation, as there is normally a spill during the wet months, although none occurred in 1947 and 1948.

2) The entire pond system should be rebuilt so that the ponds can obtain a much better water flow. At present each pond has an independent water supply; the water is used only once and then flows

into the waste line. As a consequence, each pond receives so little water that there is no current. The temperatures rise and waste accumulates. The present ponds are of three different designs, scattered about over a wide area, and some are in poor condition. It would be cheapest to build a new and modern pond system.

With the present layout the Craig Brook Station cannot be expected to rear over 250,000 sea salmon annually.

STOCKING

When natural conditions are suitable and salmon runs are not overfished, they can maintain themselves by natural propagation. However, in the present situation where runs have been completely exterminated, artificial propagation is necessary to reestablish them, and also to increase the survival of young while the spawning stock of adult fish is so limited.

The numbers of Atlantic salmon stocked in various rivers since propagation was resumed in 1939 are shown in Table 5. The coded stocking number shows (first two digits) the year the eggs were taken, followed by a letter (in this case A) for the species and a number (in chronological order) for the lot. After a hyphen is given the month and year of liberation. Thus 41A10-543 indicates the tenth lot of Atlantics to be planted from eggs stripped in 1941 and that the fish were liberated in May 1943.

The letters in Table 5 under "Mark Used" refer to fins removed from the fish before liberation in order that they may be recognized if they are recaptured. The letters refer to the following fins:

A—Adipose, the small fleshy fin without rays on the back just ahead of the tail.

D—Dorsal, the large fin on the middle of the back.

L—Left ventral, the left one of the two paired belly fins.

R—Right ventral.

N—Anal, the fin on the under side just ahead of the tail.

Table 5.—Atlantic salmon stocking 1939 to 1948.

Stocking number	Total stocked	Number marked	Mark used	Fish per pound	Waters stocked	Year of majority return
39A1-940	5,500				Narraguagus River	1944
39A2-940	5,500				Pleasant River	1944
39A3-1240	7,000			160.0	East Machias River at Wesley	1944
39A4-1240	5,000			160.0	St. Croix River. Wastahgan Stream	1944
39A5-1240	10,000			160.6	St. John River, Aroostook River	1944
39A6-541	19,500			81.2	Penobscot River, Sebois River	1944
39A7-641	27,500			77.9	Penobscot River, Sebois River	1944
39A8-641	16,500			78.2	Penobscot River, East Branch	1944
40A1-741	75,200			611.4	Penobscot River, Grindstone	1945
40A2-841	37,300			595.6	Penobscot River. Sebois River	1945
40A3-941	20,000			533.3	Machias River	1945
40A4-941	20,000			533.3	Narraguagus River at De Blois	1945
40A5-542	15,000	3,200	D & A		Dennys River	1945
40A6-542	17,645	17,645	A & L		St. George River, Heart Falls	1945
40A7-942	15,000			30.9	Penobscot River. East Branch at Patten	1945
40A8-1042	3,703	3,703	A & N	25.2	St. George River. Heart Falls	1945
40A9-543	6,728	6,728	D & N	14.7	St. George River. at Union	1945
41A1-942	34,000			465.8	Machias River, Machias & Mopang tributaries	1946
41A2-942	10,000			465.1	Narraguagus River at De Blois	1946
41A3-942	6,000			461.5	Dennys River	1946
41A4-1042	12,508	12,508	D & L	156.4	Penobscot River, Shin & Sawtelle Brooks	1946
41A5-1042	12,524	12,524	D & R	155.6	Penobscot River. Mattawamkeag River (Kingman)	1946
41A6-543	3,448	3,448	D & A	128.1	St. George River at Union	1946

Table 5.—Atlantic salmon stocking 1939 to 1948 (continued).

Stocking number	Total stocked	Number marked	Mark used	Fish per pound	Waters stocked	Year of majority return
41A7-543	2,992			197.0	Orland River	1946
41A8-543	16,000			68.4	Machias River, Machias & Mopang tributaries	1946
41A9-543	5,000			67.9	Narraguagus River	1946
41A10-543	4,150			84.7	Dennys River	1946
41A11-543	2,524	2,524	N & R	25.0	Penobscot River, Sawtelle Brook	1946
41A12-743	6,642	6,642	A & R	31.5	Penobscot River, Mattawamkeag River (Kingman)	1946
42A1-1043	12,000				Narraguagus River	1947
42A2-1043	5,000				Machias River	1947
42A3-1043	7,000				Dennys River	1947
42A4-444	15,880	15,880	A & R	75.1	St. George River at Union	1947
42A5-544	16,789	16,789	A & L	78.9	Penobscot River, Mattawamkeag River (Kingman)	1947
42A6-544	12,302	12,302	L & R	85.7	Penobscot River, Sawtelle Brook	1947
42A7-844	4,498			62.5	Penobscot River Sawtelle Brook	1947
42A8-844	9,000				Dennys River	1947
42A9-844	9,000				Narraguagus River	1947
42A10-944	14,990	14,990	N & R	30.9	St. George River at Union	1947
42A11-1044	7,949	2,943	D & N	23.3	Penobscot River Sawtelle Brook	1947
42A12-1044	9,401	3,000	A & N	23.8	Penobscot River, Mattawamkeag River (Kingman)	1947
42A13-745	12,561	1,888	N & L	8.9	Penobscot River at Winn	1947
42A14-745	600			4.3	Orland River	1947
43A1-645	14,975	14,975	D & L	49.8	St. George River at Union	1948
43A2-745	34,140	10,602	D & A	35.5	Penobscot River Mattawamkeag River (Kingman)	1948
43A3-945	10,206	3,581	L & R	31.0	St. George River at Union	1948
43A4-945	17,635	5,526	A & R	30.7	Penobscot River at Medway	1948

Table 5.—Atlantic salmon stocking 1939 to 1948 (continued).

Stocking number	Total stocked	Number marked	Mark used	Fish per pound	Waters stocked	Year of majority return
43A5-546	13,979	3,180	N & R	12.8	Penobscot River, Mattawamkeag River (Kingman)	1948
44A1-546	18,306	2,301	D & L	69.6	Penobscot River at Medway	1949
44A2-946	1,269			18.9	Penobscot River at Winn	1949
44A3-946	5 782			13.6	Penobscot River at Milford	1949
44A4-547	5,640			6.0	Penobscot River at Milford	1949
45A1-547	41,146			44.2	Penobscot River at Medway	1950
45A2-547	18,000			45.0	Machias River & triubtaries	1950
45A3-547	10,989			55.0	Little Falls Stream	1950
45A4-647	14,280			37.1	Machias River & tributaries	1950
45A5-647	24,294			22.2	Penobscot River at Medway	1950
45A6-647	18,452			42.3	Little Falls Stream	1950
45A7-747	6.532			19.2	Machias River & tributaries	1950
45A8-747	5,025			15.8	Penobscot River, Sawtelle Brook	1950
45A9-747	5,923			13.5	Little Falls Stream	1950
46A1-548	43,102			92.3	Machias River & tributaries	1951
46A2-548	11,726	11,726	D & A	80.2	Little Falls Stream	1951
46A3-548	37,157	37,157	D & R	78.2	Penobscot River, Sebois, Sawtelle, & Mattawamkeag	1951
47A1-1048	7,036	7,036	L & R	70.2	Little Falls Stream	1952
47A2-1048	61,000			86.0	Penobscot River, Sebois, East Branch, Passadumkeag	1952
47A3-1048	12,000			168.2	Sheepscot River	1952

Table 6.—Recovery as adults of marked Atlantic salmon of the 1942 brood year, liberated in the Penobscot River in May and October of 1944.

Locality	Liberated May 1944		Liberated Oct. 1944		Total liberated		
	Number liberated	Number recovered	Number liberated	Number recovered	Number liberated	Number recovered	Expected recoveries
Sebois River	12,302	41	2,943	4	15.245	45	26.1
Mattawamkeag River	16.789	9	3,000	6	19,789	15	33.9
Total	29.091	50	5,943	10	35.034	60	
Expected		49.8		10.2			60.0

To date the numbers marked have been too small to obtain many returns. However, we obtained 60 authenticated recoveries of Atlantic salmon hatched from eggs taken in 1942 and liberated in the upper Penobscot during 1944. All but one were recaptured during 1947 in their fifth year. The other, a large fish weighing over 16 pounds, was taken in 1948 in its sixth year. All were taken in the Penobscot. The details are given in Table 6.

The numbers involved in the fall planting are too small to yield reliable results, but the data so far would indicate no difference between returns from spring and fall plants. However, because of the great difference in this regard between localities, no valid conclusion can be drawn.

Returns from the Sebois River planting were in the order of four times larger than those from the Mattawamkeag, but the meager data available suggest that the fall planting on the Mattawamkeag was very successful. Only further planting of larger numbers of marked fish can confirm or deny the present indications.

An attempt has been made to introduce silver or coho salmon (*Oncorhynchus kisutch*) from the Pacific Coast. The silver salmon weighs about the same as an Atlantic and provides the bulk of the salmon sport fishing on the Pacific Coast. As the adults ascend the rivers just prior to spawning, it is hoped that they may be adaptable to many streams unsuitable for Atlantics because of the lack of deep pools for the adults to spend the summers. The silver salmon when established will provide excellent salt water angling in the river estuaries. It is not the intention to replace Atlantic salmon with silver salmon, but to provide an additional fishery for the state. The silver salmon have been and will be stocked in rivers not providing suitable conditions for Atlantic salmon angling. The silver salmon stocked to date are shown in Table 7.

Table 7.—Silver salmon stocking 1943 to 1948.

Experiment number	Total stocked	Number marked	Mark used	Fish per pound	Waters stocked	Year of majority return
41S1-942	5,007	5,007	D & A	84.6	Pemaquid River, Biscay Pond	1944
41S2-942	5,015	5,015	D & L	77.2	Pemaquid River, Bristol	1944
41S3-942	5,018	5,018	D & R	98.8	Pemaquid River, Poole's Mill	1944
41S4-643	8,984	8,984	A & N	24.8	Pemaquid River, Bristol	1944
41S5-643	10,889	10,889	D & N	27.6	Pemaquid River, Poole's Mill	1944
42S1-1043	10,220	10,220	N & L	47.7	Pemaquid River, Bristol	1945
42S2-444	10,070	10,070	N & R	30.1	Pemaquid River, Bristol	1945
43S1-644	9,084			479.9	Ducktrap River, Rt. 137	1946
43S2-1044	14,966			106.4	Pemaquid River, Bristol	1946
43S3-545	11,924	11,924	A & L	42.5	Ducktrap River, Rt. 137	1946
43S4-645	5,209	5,209	A & R	28.2	Pemaquid River, Bristol	1946
44S1-1045	19,995			64.0	Ducktrap River, Rt. 137	1947
44S2-1045	19,976			49.8	Pemaquid River, Bristol	1947
44S3-546	16,133	5,437	A & N	25.8	Ducktrap River, Rt. 137	1947
44S4-646	16,028	4,769	L & R		Pemaquid River, Bristol	1947
47S1-1048	5,653	5,653	A & R	53.4	Ducktrap River, Rt. 137, State Park	1950

From the plantings in the Pemaquid River large numbers of smolts were observed descending the fishway at Pemaquid Falls, and several half-grown salmon were reported captured in the vicinity of Pemaquid, but no adults returned to the river.

From the plantings in the Ducktrap River a number of adult silver salmon, estimated at from 100 to 150, returned in 1947 from the 1944 brood year. A few of these were captured by seining in the mouth of the river in November, 1947, and some ripe spawn obtained.

The silver salmon returns in the third year after spawning instead of in the fifth as in the Atlantics. However, the adults of both species spend two summer growing seasons at sea.

Of the 41 adult silvers seined in the mouth of the Ducktrap, all were in their third year (1944 eggs) and eight were marked fish. The details are as follows:

Date liberated	Marking	Fish per pound when planted	Number planted	Number seined	Expected number
May 1946	Marked	25.8	5,437	8	8
May 1946	Unmarked	25.8	10,696		16
				33	
October 1945	Unmarked	64.0	19,995		17

From the basis of the eight marked fish it can be estimated that 16 of the unmarked fish were from the 10,696 planted in May 1946, and the other 17 from the fall planting. Although the data are too meager to draw any final conclusions, they indicate that returns from the spring planting were about 75 percent higher for the numbers planted than from the fall planting.

HOW DOES THE PROGRAM FUNCTION?

All of the organizations involved in the salmon restoration program are contributing such facilities and personnel as are available.

The University of Maine is furnishing the research staff with office and laboratory facilities, and their professor of fishery biology is studying the food requirements of young salmon in fresh water.

The Sea and Shore Fisheries Department is aiding in the marking and distribution of young salmon. Their statistician is collecting statistical data on locality, weight, etc., of the salmon catch from the wardens of the Sea and Shore and the Inland Departments. The Sea and Shore biologists are conducting an expermient to determine the feasibility of holding a brood stock of Atlantic salmon in salt water, and are aiding by making field observations. The Sea and Shore wardens enforce salmon regulations promulgated by the Atlantic Sea-Run Salmon Commission.

The Inland Fisheries and Game Department is contributing the full-time services of a biologist to the program. The hatchery division of the Department aids in the marking and distribution of young salmon. During 1949 they will hatch and rear sea-run salmon at the Tunk Lake and De Blois fishery stations.

The engineer of the Inland Department designs and supervises construction of fishways needed for the program.

The warden service of the Inland Department maintains a special fishway patrol on the Penobscot River from Bangor dam to Mattagamon Lake. The local wardens also patrol fishways in their district, and cooperate directly with the Sea and Shore statistician in furnishing detailed information on salmon fishing. They aid in maintaining and watching weirs for trapping adult salmon for spawning and census purposes. They enforce salmon regulations promulgated by the Atlantic Sea-Run Salmon Commission.

The personnel of the Camden Hills Recreational Area of the State Park Commission are cooperating in the salmon census being carried on in the Ducktrap River.

The Fish and Wildlife Service of the United States Department of the Interior is furnishing the full-time services of a biologist to coordinate the salmon restoration program. The hatchery division of the Service is operating the Craig Brook Fishery Station to rear sea-run salmon for the program. The biologists are also carrying on biological experiments at this station.

The refuge division personnel of the Service are aiding in all phases of the experimental studies being conducted in Little Falls Stream on the Moosehorn Refuge.

All phases of the program are reviewed and coordinated by the Salmon Research Committee, composed of three biologists, one each from the Sea and Shore Department, the Inland Fisheries and Game Department, and the Fish and Wildlife Service. The Committee makes recommendations for action to the Atlantic Sea-Run Salmon Commission.

The Atlantic Sea-Run Salmon Commission is the agency responsible for all regulations concerning sea-run salmon in both river and coastal areas of Maine. They are empowered to consider all factors affecting the welfare of the salmon runs.

The tentative program for the salmon investigations giving the detailed outline of the work follows. This program has been reviewed by the Salmon Research Committee and approved by the Sea-Run Salmon Commission.

ATLANTIC SALMON RESEARCH AND MANAGEMENT PROGRAM SHOWING NEEDS AND PRESENT WORK PROGRAM

(November 1, 1948)

Program Outline	Need	Work Program
A. Environment		
1 Physical		
a. Obstructions and fishways	List of all obstructions and fishways in 56 larger streams.	Obtain from files in Augusta.
	Notes on each fishway and dam.	Inspect as many as other work permits. Trap some.
	Trial of fishway types.	Construct models at Craig Brook and test.
b. Diversions and screens	List of water diversions, purpose, size and type of wheels, mesh and size of screens, etc.	
c. Hydrology	Minimum stream flow.	Visit all chief Maine streams and gauge twice during summer.
	Maximum temperatures.	Buy and run recording thermographs in a few streams each year.
d. Stream bed	Need to know extent of spawning rubble, riffles, and cool pools for summering adults.	Make general observations on streams to be developed.
e. Pollution	Type, toxicity, dilution, fluctuations in volume, abatement methods.	
2. Biological		
a. Food in relation to parr survival	Food requirements of parr in streams to guide in stocking young.	Holding parr in stream sections at different density for growth, survival and effect on food volume.

Program Outline	Need	Work Program
b. Relation to other species	Effect of predator fish and other fish on survival.	
c. Effects of birds on survival	Effect of mergansers, etc.	
d. Effect of mammals on survival	Effect of beaver, otter, seal, etc.	Some observations on Little Falls Stream.
B. Habits and Life History		
1. Age and growth		
a. Age at maturity	Age of maturity for population studies and management.	Collecting scales for study.
b. Age and growth of young	To compare with hatchery stock and to determine stream carrying capacity.	Collecting samples of young.
c. Recovery of kelts.	What percent of kelts spawn again, and can a brood stock be held.	Hold kelts and feed in salt water. Boothbay harbor.
2. Migrations		
a. Smolt migration	Size, age and season of migration to to protect against eel weirs, water diversions, etc.	To build all-year smolt weir in Little Falls Stream.
b. Homing instinct	Degree to which adult salmon return to their native stream.	Marking and releasing young.
c. Season of adult migration	Season needed for management of fishways, fishing season, stream flow, etc.	Trapping of Penobscot River fishways and elsewhere.
3. Spawning		
a. Types of bottom most suitable	To decide stream suitability, need egg survival in redds under different conditions.	In 1949 put adults in Little Falls Stream to compare natural with artificial propagation.
b. Predators in redds	Effect of eels, lampreys, mammals, etc., on eggs in redds.	

Program Outline	Need	Work Program
C. Population estimates		
1. Catch of adults	For all purposes.	Collected by wardens and compiled by Sea and Shore statistician.
2. Number of spawners	For management	Obtain counts at fishways, redd counts, etc.
3. Number of young	To estimate survival.	Weir in Little Falls Stream, samples in other streams, marking young.
D. Propagation		
1. Hatchery techniques	Effect of diets on growth, water flow and volume on growth and survival, etc.	Run tests as occasion permits.
2. Hatchery statistics	Seasons of highest mortality, best growth, etc. to determine survival and cost per fish at each size and or age.	Craig Brook Hatchery keeping records of losses and growth.
3. Success of stocking	Survival (fresh-water and marine) of salmon stocked at different ages and sizes, and in different streams.	Marking large experimental lots of different ages to determine survival to adult. Counting weir to determine fresh-water survival.
4. Survival of wild and hatchery stock	Does hatchery stock of same age survive as well as the "wild"?	Mark equal numbers of "wild" and hatchery stock in same stream to determine survival. Transfer of adults.
5. Sea-run and land-locked stocks	Determine possible source of unmarked fish and strays.	Stock land-locked and sea-run in the same stream.
E. Management		
1. Predator control	Reduce losses from all predators.	Warden control of mergansers on salmon streams. Trapping of eels in vicinity of redds.

Program Outline	Need	Work Program
2. Water control	Adequate summer flow in salmon streams	Encourage spring storage and summer release of water by clubs etc. Insist on minimum flow in all streams with dams in headwaters.
3. Fishways		
a. Fishway design	Minimum adequate standards to be defined.	Trap fishways wherever indicated to determine whether they actually function.
b Fishway construction	To make barriers passable on all suitable salmon streams.	Salmon Commission to insist on construction of adequate fishways wherever indicated
4. Screens	Protection of upstream and downstream migrants from water diversions.	Screening and by-pass construction at water diversions.
5. Commercial salmon fishing		
a. Definitions and standards		Salmon Commission.
b. Seasons, gear and areas		" "
c. Closing of new streams	Closure until runs are established.	" "
6. Salmon sport fishing		
a. Definitions and standards		" "
b. Seasons, gear and areas		" "
c. Closing of new streams	Closure until runs are established.	" "
d Protection of smolts	Regulate newly stocked areas.	Educate public.

ATLANTIC SALMON WORK PROGRAM—BY JOBS

Work to be done	Personnel	Agency
Collect statistics of salmon catches by gear and rivers.	Inland Wardens Sea and Shore Wardens	Inland Dept. Sea and Shore Dept.
Compile statistics of salmon catches	Statistician	Sea and Shore Dept.
Control of mergansers on salmon streams.	Wardens	Inland and Sea and Shore
Study of merganser damage.	Federal Aid Biologists	Inland Dept.
Trapping of fishways for counts and spawners:		
Penobscot River	Fishway patrol warden	Inland Dept.
Ducktrap River	State Park Ranger	Park Commission
Machias River	Temporary	Salmon Commission
Count of spawning redds on Dennys River.	Refuge personnel	Fish & Wildlife Service
Construct smolt weir in Little Falls Stream.	Refuge Branch Personnel and Biologists.	Fish & Wildlife Service Inland Dept. and Salmon Commission.
Observe all streams for minimum flow.	Biologists	FWS, Inland Dept.
Observe bottom, temperature, etc. on certain streams.	Biologists	FWS, Inland Dept.
Fishway design and construction.	Engineer	Inland Dept.
Fishway development and trial (model construction etc.)	Engineer, Biologists	Inland Dept. FWS.
Feeding kelts in salt water.	Bioolgists	Sea and Shore Dept.
Survival experiments in Little Falls Stream.	Biologists, Refuge pers.	Inland Dept. FWS.
Young salmon food requirements in the stream.	Biologist	University of Maine
Marking young salmon before release.	Biologists, Temporary	Inland, FWS, Sea & Shore, Salmon Commission.
Watching weir and pens in Little Falls Stream.	Refuge personnel & Biologists	FWS Inland Dept.
Collect scales, etc. on adult salmon, various rivers.	Wardens, Biologists	Inland Sea & Shore

Work to be done	Personnel	Agency
Propagation of salmon, Craig Brook, Tunk Lake & elsewhere.	Gamefish & Hatcheries Hatchery Division	FWS Inland Dept. Salmon Commission.
Distribution of young salmon.	Sea and Shore. Inland. FWS.	Sea and Shore. Inland. FWS.
Pollution	Chemists	State Sanitary Water Board

ATLANTIC SALMON WORK PROGRAM—BY AGENCIES

Agency	Personnel	Work
Inland Fisheries & Game Dept.	Biologist	Work with FWS biologist on all phases
" " " " "	Engineer	Design and supervise construction of all fish protective devices, also aid biologists with technical advice in developing and testing devices.
" " " " "	Hatchery Division	Aid in hauling salmon to stock. Rear salmon at Tunk Lake and if necessary at De Blois Hatcheries.
" " " " "	Federal Aid Div.	Study merganser control methods.
" " " " "	Warden Service	Patrol fishways, collect information on salmon catches· collect data on salmon caught, control mergansers, trap fishways.
Sea and Shore Fisheries Dept.	Biologist	Aid in marking salmon, conduct experiment on feeding kelts in salt water.
" " " " "	Statistician	Compile all data on salmon caught
" " " " "	Hatchery Div.	Aid biologists in kelt experiment Aid in hauling salmon to stock.
" " " " "	Warden Service	Patrol marine waters, cooperate with Inland wardens on tide-water fishways. Collect information and data on salmon caught, control mergansers, trap fishways.
University of Maine	Biologist	Study available food of young salmon and young salmon food requirements in streams.

Agency	Personnel	Work
Atlantic Sea-Run Salmon Comm.	Temporary	Trap fishways at Machias. Aid in marking young salmon.
" " " "	Hatchery	Raise salmon at Tunk Lake Hatchery.
" " " "	Commission	Make all regulations.
State Park Commission	Park Ranger (Camden)	Watch weir in Ducktrap River.
State Sanitary Water Board	Chemists	Study and recommend on pollution abatement.
U. S. Fish & Wildlife Service	Biologist	Coordinate work. Observe stream suitability, fishways, conduct experiments on stream survival, propagation, stocking, etc.
" " " " "	Gamefish & Hatcheries	Propagate salmon at Craig Brook. Aid in their distribution
" " " " "	Refuge Branch	Aid in watching weir and pens in Little Falls Stream, in constructing weir and dam at Hobart Lake, in redd census of the Dennys River.

ATLANTIC SALMON WORK PROGRAM—BY RIVERS

(Not including general features applicable to several rivers.)

River	Work	Program
Dennys River	Determine relative survival of "wild" and hatchery fish of the same age.	Mark equal numbers of "wild" and hatchery young salmon of same age.
	Continue former estimate of spawners.	Count redds in mid-November.
Little Falls Stream	Determine both fresh water and marine survival of salmon stocked at various ages	Build and maintain a permanent weir near mouth to count smolts and adults.
	Determine carrying capacity of stream.	Hold young salmon in pens at different densities.
	Determine best age and season to stock.	Mark and release lots at different ages and seasons of fish of same brood year.
	Determine survival from natural spawning.	In 1949 put adult salmon in stream. Do no other stocking of that brood year.
Machias River	Determine number of spawners and collect some for spawners.	Trap fishway and count all salmon. Obtain spawners
	Stock young salmon.	Stock Mopang, Machias and Old Stream Tributaries.
	Provide safer passage through gorge at Machias.	
Chandler River	Observe flow, gradient, etc.	List for silver salmon stocking.
Narraguagus River	Stock above Beddington Dam, and later observe if successful.	To determine suitability of this portion of the river and need for fishway at Beddington Dam.

River	**Work**	**Program**
Tunk Stream	Observe flow, gradient, etc.	List for silver salmon stocking and removal of debris of old dam at Unionville.
Penobscot River	Determine passability of obstructions, Bangor and Veazie in 1949, then working upstream, possibly Great Works in 1949 if enough salmon are present.	Trap both fishways at Bangor and fishway at Veazie to determine their efficiency. Keep water levels and temperatures.
	Determine where to stock, mark young salmon.	Stock in main East Branch at foot of Grand Lake, Sebois River and Passadumkeag River.
Marsh Stream	Observe flow, gradient, etc.	If suitable list for silver salmon and fishway.
Ducktrap River	Needs water storage to improve summer flow.	Induce local interests to provide necessary water control.
	Stock silver salmon.	
Sheepscot River	Stock Atlantic salmon.	

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