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REPORT OF THE SALMON RESEARCH COMMITTEE, MARCH 23, 1943

Salmon Research Committee

Gerald P. Cooper
Lester A. Stubbs
George A. Rounsefell

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I. Introductory statement.

In order to establish certain principles of operation and to effect economy and efficiency in the restoration and management of sea-run salmon through mutual collaboration and cooperation, an agreement was signed at Augusta, Maine on October 10, 1941 by Mr. George Stobie for the Maine Department of Inland Fisheries and Game; Mr. Arthur Greenleaf for the Maine Department of Sea and Shore Fisheries; and Mr. Charles Jackson for the United States Fish and Wildlife Service. The text of the cooperative agreement is appended to this report.

To implement this agreement the three parties appointed a Salmon Research Committee consisting of Mr. Lester A. Stubbs for Sea and Shore Fisheries, Dr. Gerald P. Cooper for Inland Fisheries and Dr. George A. Rounsefell for the Fish and Wildlife Service. After a preliminary meeting at Boothbay Harbor to exchange information and draw up a general plan of collaboration the Committee met on April 30, 1942 and drew up its first recommendations. This report summarizes the progress made up to date.

II. Recommendations of previous meetings.

A. Recommendations of second meeting at Tunk Lake, April 30, 1942.

The Salmon Research Committee held its second meeting on April 30, 1942 at Tunk Lake Hatchery, Cherryfield, Maine.

After exchange of information and discussion the Committee unanimously adopted the following recommendations to be presented to the three cooperating agencies.

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. The Pleasant River dam is leaky and presents a difficult fishway problem; also netting is permitted just below the dam on Tuesdays, Wednesdays and Thursdays of each week. The East Machias River has a bad obstruction due to the large water diversion of the Bangor Hydro-Electric Company which discharges about 800 feet below the dam. The salmon are attracted into the tailrace and remain there during all low water periods. At such times the main river is almost non-existent from the dam to the tailrace.

2. The recommendations for disposal of the Atlantic salmon remaining at Tunk Lake and Craig Brook hatcheries from eggs taken in 1940 are as follows:

Hatchery	Derivation of eggs	Approximate number	Disposal
Tunk Lake	Dennys River	15,000	Dennys River
Do.	Penobscot River	10,000	East branch of Penobscot
Do.	Miramichi River	17,500	St. Georges River
Craig Brook	Penobscot River	15,000	East branch of Penobscot
Do.	Miramichi River	15,000	St. Georges River

The Dennys River and St. Georges River plantings are to be made at localities designated by Dr. Cooper and Dr. Rounsefell, respectively.

3. Recommendations concerning the disposal of the sea-run salmon from 1941 eggs now hatching at Craig Brook are as follows:

The Miramichi salmon and the silver salmon from the Pacific coast will be planted respectively in the St. Georges and Pemaquid rivers at the times and places determined by Dr. Rounsefell.

Of the 247,000 Atlantic salmon fry from eggs collected from adults taken in the Machias and Penobscot rivers, 120,000 should be planted during 1942 after the first of September, the remainder should be held until 1943.

The 120,000 should be allocated as follows:

Machias River	55,000
Penobscot River	40,000
Narraguagus River	15,000
Dennys River	10,000

If for any reason it becomes necessary to plant over 120,000 during 1942, they should be allocated in the same proportions.

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 separate.

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 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 six feet by eight feet or at least 48 square feet with a water depth of at least four feet and having not over 18 inches difference in water level between pools.

Salmon Research Committee

Lester A. Stubbs
Gerald P. Cooper
George A. Rounsefell

B. Interim recommendations, February 17, 1943.

The Salmon Research Committee has not yet held its 1943 meeting. However, owing to the necessity for early notification of the cooperating agencies concerning any recommendations that require immediate action if they are to be carried out, the Committee has discussed certain matters by correspondence.

The Committee has unanimously agreed on the following recommendations that:

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

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

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

Salmon Research Committee

Lester A. Stubbs
Gerald P. Cooper
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III. Review of Action on Recommendations of Committee Made on April 30, 1943.

George A. Rounsefell, Ph.D., Aquatic Biologist
Fish and Wildlife Service
United States Department of the Interior
(January 27, 1943)

In reporting to the Salmon Research Committee on the progress of the investigations on salmon restoration and management, we wish to review in order the progress made toward fulfilling each of the recommendations made by the Salmon Research Committee at its last meeting on April 30, 1942.

Point 1: No further work has been done on the classification of rivers now containing salmon as to their suitability for stocking. Work at present is being concentrated on a few rivers, selected by a preliminary survey as fulfilling the requirements of the program.

Points 2 and 3: The following table shows the estimated numbers of sea salmon on hand at the Craig Brook and Tunk Lake fisheries stations at the last meeting of the Research Committee, the recommended disposal of each lot, and their actual disposition.

SEA SALMON STOCKING IN MAINE DURING 1942

Salmon on hand April 30, 1942					Disposal recommended by Research Committee		Actual Planting		Number on hand Jan. 15, 1943
Fishery Station	Egg Source	Year	Species	Number	Locality	Number	Locality	Number	
Tunk Lake	Dennys R.	1940	Atlantic	15,000	Dennys R.	all	Dennys R.	15,000	0
" "	Penobscot R.	1940	"	10,000	E. Branch Penobscot	all	E. Branch Penobscot	10,000	0
" "	Miramichi R.	1940	"	17,600	St. Georges R.	all	St. Georges R.	17,600*	0
Craig Brook	Penobscot R.	1940	Atlantic	15,000	E. Branch Penobscot	all	Hd. of E. Branch	15,000	0
" "	Miramichi R.	1940	"	15,000	St. Georges R.	all	St. Georges R.	3,703*	5,872
" "	Machias R.	1941	"	247,000	Machias R.	55,000	Machias R.	34,000	
					Penobscot R.	40,000	Penobscot R.	25,032*	
					Narraguagus R.	15,000	Narraguagus R.	10,000	
					Dennys R.	10,000	Dennys R.	6,000	
					Remainder held				67,326
" "	Miramichi R.	1941	"	50,315	St. Georges R.			0	12,566
" "	Oregon	1941	Silver	47,300	Pemaquid R.		Pemaquid R.	18,246*	21,839

*These 4 lots, totaling 64,581 salmon were fin clipped and planted by the Fish and Wildlife Service as part of the cooperative salmon research program. Of the salmon planted in the Dennys River, 3,200 were marked by the Kendall Fellowship of the University of Maine.

Reckoning the age from the time of stripping the eggs (about November first), a total of 75,549,10- and 11-month-old Atlantic salmon, 32,329 18-month-old Atlantic salmon, 18,703 22-month-old Atlantic salmon, and 18,246 11-month-old silver salmon, or a grand total of 144,581 sea salmon were planted during 1942. The fish marked in the experiments were actually counted and other figures were supplied by the hatchery personnel. From the Tunk Lake hatchery of the Department of Inland Fisheries and Game 42,600 were planted, and from the Craig Brook hatchery of the Fish and Wildlife Service, 101,981 were planted.

In accordance with the Committee's recommendations, the Atlantic salmon from the 1941 egg take were held until after September 1, 1942, before being released.

Point 4: In line with the recommended collection during 1942 of 180 to 200 Atlantic salmon adults for spawning, 171 adults were collected under the direction of Mr. George Montgomery, Superintendent of Craig Brook Station, from a trap in the fishway at the Bangor dam on the Penobscot, through the cooperation of the parties to the Salmon Agreement, and transported by the Service to the Craig Brook retaining pool. Due to war-time transportation difficulties no attempt was made to obtain adults from any other river. Out of 121 females stripped 682,513 eggs are estimated to be on hand January 15, 1943.

No trap for counting salmon was maintained at the Veazie fish ladder, but according to present plans the Department of Inland Fisheries and Game will install a trap at Veazie or Great Works dam on the Penobscot so that a count may be made of all ascending salmon during the 1943 season.

Point 5: In line with the recommendations on pollution, Dr. Rounsefell prepared a report on wood waste pollution on the St. Georges River, which is appended to this report for inclusion in the minutes. This report has been referred to Mr. Stobie.

IV. Recommendations of the Salmon Research Committee at the Third Meeting, in Augusta, Maine, March 23, 1943.

The Committee, after considering reports of work accomplished by the various cooperating agencies during 1942, unanimously passed the following recommendations:

A. That the young salmon from the 1940, 1941 and 1942 egg takes now on hand at the Tunk Lake and Craig Brook Fishery Stations be released, insofar as practicable, in accordance with the following tables:

Recommendations for allocation and stocking of sea-salmon during 1943.

Stock	Number	Year spawned	Source of eggs	Where to plant	Number to plant	Percent of plant	Month to plant	Number to hold	Biologist to mark and/or designate exact place of release
Carried over from 1942									
Silver salmon	21,339	1941	Oregon	Pemaquid R.	21,839	100.0	April		Yes
Atlantic salmon	5,872	1940	Miramichi R.	St. Georges R.	5,872	100.0	May		Yes
	12,566	1941	Miramichi R.	St. Georges R.	12,566	100.0	May		Yes
	67,326	1941	Machias R.	Machias R.	30,900	46.0	May		No
				Penobscot R.	22,200	33.3	May		Yes
				Narraguagus R.	8,400	12.5	May		No
				Dennys R.	5,500	8.3	May		Yes
From 1942 eggs[1]									
Silver salmon	44,764	1942	Oregon	Pemaquid R.	Ca. 25,000		Sept.	15,000	Yes
Atlantic salmon Tunk Lake[2]	100,000	1942	Penobscot R.	Three Rivers:	Ca. 40,000		Sept.	50,000	
				Narraguagus R.		50.0			No
				Dennys R.		30.0			Yes
				Machias R.		[3]/20.0			No
Craig Brook	582,513	1942	Penobscot R.		Ca.125,000			400,000	
				St. Georges R.	20,000		May		Yes
				St. Georges R.	20,000		Sept.		Yes
				Penobscot R.	Ca. 85,000		Sept.		Yes

1/ This is the number of eggs on hand January 15, 1943, so allowance for hatching loss must be made.

2/ Eggs to be transferred from Craig Brook to Tunk Lake Hatchery.

3/ Machias River has a low allotment because the Committee considers its suitability somewhat in doubt due to the presence of three fishways and some question as to their efficiency.

Recommendations, subject to revision at a future meeting, for allocation and stocking during 1944 of sea salmon held over from the 1942 spawning.

Stock	Number held over	Source of eggs	Where to plant	Number	Percent to plant	Month to plant	Number to hold	Biologist to mark and/or designate exact place of release
Tunk Lake Hatchery								
Atlantic salmon	50,000	Penobscot R.	Narraguagus R.		50.0	May		No
			Dennys R.		30.0	May		Yes
			Machias R.		20.0	May		No
Craig Brook Hatchery								
Silver salmon	15,000	Oregon	Pemaquid R.		100.0	April		Yes
Atlantic salmon	400,000	Penobscot R.	St. Georges R.	20,000		May		Yes
			Penobscot R.	Ca.200,000		May		Yes
			St. Georges R.	20,000		Sept.		Yes
			Penobscot R.	Ca.100,000		Sept.		Yes
							50,000	

B. 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.

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

V. Information and reports submitted to the Committee at the third meeting in Augusta, March 23, 1943.

A. Report on 1942 field work on the Penobscot River by the Kendall Fellow

Gerald P. Cooper, Ph.D., Assistant Professor of Zoology
University of Maine
(March 19, 1943)

A Kendall fellowship in salmon research at the University of Maine was awarded to Mr. Virgil S. Pratt beginning October 15, 1941. Mr. Pratt had just completed his undergraduate course in Wildlife Conservation at this University, and had had one summer's experience on the Maine lake survey program. It was intended that Pratt would continue on the fellowship for two years -- through the summer of 1943 -- having two summers for field work, and two academic years to complete his course requirements for the Master's degree and compile his field data on salmon. However, Pratt resigned from the fellowship on September 30, 1942, and was drafted into the United States Armed Forces. Due to the manpower shortage, it has been, thus far, impossible to find a suitable candidate to continue where Pratt left off.

Pratt's project was a study of the Sea Salmon in the Penobscot. He carried on field observations during the spring and early summer of 1942: observations on the passage of salmon over the Bangor and Veazie dams during the spring run; and observations on the fish populations, bottom food, temperatures, etc. of the East Branch and some of its tributaries during early summer.

Pratt's sudden and somewhat unexpected call by the Army resulted in the fact that most of his bottom fauna and fish collections were not (and have not yet been) analyzed. However, the collections are preserved in good shape at the University at Orono. Pratt prepared a detailed report (still in rough form -- not typed) of his observations, from which a few of his more important conclusions have been abstracted, as follows:

Regarding the new and old fishways at the Bangor dam located at the east end, and in the middle, of the dam, respectively, Pratt observed that salmon could use the new fishway only during high water (June 16 to 25, 1942). During low water (July 11 to 19, 1942), he found salmon congregated on the west side of the dam and some salmon were using the old fishway. He concluded that the old fishway was more usable to the fish during low water.

Attempts by salmon to surmount the dam directly, when water in the river was low (about 1 foot of water flowing over the western, and lowest, side of the dam), were unsuccessful.

Nine marked salmon were put above the Bangor dam, after being trapped above the old fishway. In addition, at least 35 unmarked fish went through the new fishway, escaping above the dam. Since none were seen jumping at the Veazie dam, it was concluded that the salmon found this fishway directly, and were not long delayed. That they went through the Veazie dam was evident by their presence at the Great Works dam where, on July 13, 23 "jumps" were counted in 25 minutes. Observations at Great Works dam indicated that manipulation of splash-boards can favor or greatly hinder the passage of salmon through this fishway. At least a few salmon were known to get above Great Works, but none were known to have reached the West Enfield dam.

A map showing the most suitable salmon spawning grounds on the East Branch and its tributaries was prepared.

In fish collecting by seining and fly rod, no young salmon were seen on the Sebois; a few were seen, but none collected, on the East Branch itself; and observations on the Wassataquoik were too limited for conclusions.

Pratt's data on temperature, pH, bottom fauna, etc. for the East Branch and its tributaries are not here summarized.

B. Inspection of salmon redds on the Dennys River.

Gerald P. Cooper, Ph.D., Assistant Professor of Zoology
University of Maine
(March 19, 1943)

Information on the number of spawning redds resulting from the 1942 spawning run of Atlantic Salmon in the Dennys River was obtained by Mr. Bertram Smith (Moosehorn National Wildlife Refuge, Milltown, Maine) assisted by Mr. Earle H. Dudley and Patrolman Stanhope. The services of Mr. Smith and his assistants for this work were authorized by Mr. S. B. Locke. Inspection trips on the river were made in part according to plans suggested by G. P. Cooper. The purpose of the inspection was to determine the total number of salmon spawning redds in the 1942 run, for comparison with similar data obtained by Mr. Goodwin for the runs of 1940 and 1941. Smith and his assistants made three inspection trips down the river. His results are given in a letter dated November 13, 1942 to Mr. Locke, as follows:

> In compliance with instructions contained in your letter of October 14th and those in Dr. Gerald P. Cooper's under date of October 20th, copy of which was enclosed with your letter, I made three trips by canoe down the Dennys River to obtain information regarding spawning salmon. The first trip was made from Meddybemps Village on the morning of October 26th accompanied by Patrolman Dudley. We had planned to make this trip on the 24th but a hard rain made it impractical to start out. The next was made from Gilman's Dam on November 2nd accompanied by Patrolman Stanhope. The third from Meddybemps Village on November 9th accompanied by Patrolman Stanhope. While the weather on the 26th was fine, the water in the river was high owing to previous rains thus making visibility not too good, as both the river bottom and the water are dark in color at best. The weather on November 2nd was very bad. It not only had rained the two days before, but it rained very hard all that day. The trip on the 9th was very successful, all conditions were at their best, and no incomplete redds were observed.

	Length	Spawning Redds Oct. 26	Spawning Redds not completed Nov. 2
Gilman Rips	400	8	2
Gardners	920	12	1
Bright Island	2,640	38	1
Ayers	450	5	0
Clark	880	28	1
Stoddard	1,760	169	10
Little Falls	264	0	0
Camp	1,841	211	5
Town	1,760	0	0

Signed: Bertrand E. Smith
Refuge Manager
Moosehorn National
Wildlife Refuge
Calais, Maine

For comparison, a summary of Goodwin's counts (from his thesis) for the 1940 and 1941 runs is as follows:

Name of Rips	Length in yards	Redds, 1940	Redds, 1941
Gilman	400)	12	0
Gardiner's	920)		0
Bright Island	2,640)		13
Ayer's	450)	37	5
Clark's	880)		15
Stoddard's	1,760)		185
Little Falls	264)	200	3
Camp	1,841)		50
Town	1,760	0	0

A considerable increase in the 1942 run over the two previous years is indicated.

C. Salmon fishing at Bangor Pool, on the Penobscot River, during recent years.

Lester A. Stubbs
Department of Sea and Shore Fisheries
(March 23, 1943)

The rod catch at Bangor Pool, recorded by the Penobscot Salmon Club.

Year	Date first salmon caught	Weight of smallest salmon (pounds	Weight of largest salmon (pounds)	Date last salmon caught	Total number caught	Remarks
1937	April 1	7	21	June 26	110	5 caught on April 1, 7 to 21 lbs.
1938	April 5	7 1/4	16 1/4	June 16	20	First salmon weighed 7 1/4 lbs.
1939	April 1	8	15 1/4	June 6	8	First salmon weighed 13 1/4 lbs.
1940	May 22	7	15	July 6	23	First salmon weighed 10 3/4 lbs.
1941	May 24	8	12 1/2	June 13	5	First salmon weighed 9 lbs.
1942	May 11	8	16 1/2	June 28	23	First salmon weighed 8 lbs.

The 1942 rod catch of fish was small due to the lack of fishermen. There were plenty of salmon in the pool. They could be seen jumping every day. I helped take 56 salmon out of the trap at the fishway in one day. They were all very nice fish.

D. Report of the Salmon Research Committee on Sea Salmon Restoration and Management Experiments in Maine in 1942 by the Fish and Wildlife Service, Including Cooperation Extended by the Maine Departments of Inland Fisheries and Game and of Sea and Shore Fisheries.

George A. Rounsefell, Ph.D., Aquatic Biologist
Fish and Wildlife Service
United States Department of the Interior
(January 27, 1943)

1. Progress in Biological Investigations

During 1942 a general program for salmon restoration and management was drawn up by Dr. Rounsefell. This program was approved by the parties to the Salmon Agreement as the general basis for both present and future work. Certain parts of this program are already under way. Therefore, a copy of the program is appended to this report for the convenience of the Committee.

One of the most pressing problems at the moment, due to the small runs of Atlantic salmon remaining, is to determine how to obtain maximum efficiency from the limited egg supply. To shed light on this point, a series of marking experiments has been started to show at what age and season the young salmon should be released in order to obtain maximum survival. This requires a careful count and examination of all ascending adults in order to determine the numbers surviving from each planting, and, in streams with a natural run, the number resulting from natural spawning. Mr. Stobie's plan to have the Department of Inland Fisheries and Game install a trap in the fish ladder of either the Great Works or Veazie dam during 1943 and future years, to count all of the ascending adults, has made it possible to go ahead with controlled experiments on restoration and management work on the Penobscot. Accordingly, in October 1942, 25,000 marked Atlantic salmon were planted in the upper Penobscot, half of them in the Mattawamkeag River near Kingman, and the other half in Shin and Sawtell Brooks, tributaries to Sebois River. These fish, spawned in the fall of 1941, were eleven months old from the time the eggs were taken. More of this same lot of fish will be marked and planted in the spring of 1943 to determine the relative results attained from planting fish at these two different ages.

In a practical demonstration to discover whether or not it is possible through hatchery plants to restore salmon runs to a river apparently in fair condition, from which dams exterminated all salmon many years ago, 17,600 salmon from the 1940 spawning were planted in the St. Georges River in May 1942. The eggs from which these fish were hatched were collected on the Miramichi River in New Brunswick, by the Canadian Government, and kindly sent to the Service to aid in the research program. Although low water and high temperatures prevailed during a good share of the late summer, young parr from this plant were collected in the St. Georges River in September. These fish had made fine growth and were in excellent condition, indicating that present-day conditions in some Maine rivers now devoid of salmon runs may be favorable for young salmon.

A second lot of these Miramichi salmon were to be marked and released in the St. Georges River in September as part of the program to test the efficacy of stocking salmon at different ages, in terms of survival to the adult stage. Only 3,700 were marked and released and the remaining 5,800 were held at the hatchery on account of their physical condition. At our request Mr. George Stobie and Mr. Gerry Wade of the Inland Fisheries and Game Department provided assistance in this difficulty by sending Dr. Clifford E. Nelson to Craig Brook hatchery. He diagnosed the difficulties and prescribed treatments. Dr. Nelson makes periodic inspections of State hatcheries as well as prescribing routine preventative treatments according to the needs of each hatchery, to be carried out at certain seasons by the hatchery personnel. Arrangements have been made with Mr. Stobie and Mr. Locke to have Dr. Nelson in the future include Craig Brook hatchery in his itinerary.

On the Pemaquid River an attempt was made to obtain data on stream survival of silver salmon by holding young fish in a fenced section of the stream. Warden Fred Duplisey of the Sea and Shore Fisheries Department took daily temperatures at the fences and inspected them for debris, but unusually heavy early summer freshets brought down more debris than could be taken care of, so that the water overflowed the fences.

In September 1942, 15,000 one-year-old silver salmon were marked and planted in the Pemaquid River system, 5,000 in Biscay Pond, 5,000 at Bristol and 5,000 below Poole's Mill, about 100 yards above salt water. Older fish of this same lot will be planted in the spring of 1943.

It is planned to install a rotary screen near the mouth of the Pemaquid. This will take care of debris, making it practical to capture and count all downstream migrants. Blueprints have been obtained of successful rotary screen installations on the Pacific coast, and both the Sea and Shore Fisheries Department and the Fish Culture Division of the Service have agreed to aid in its construction and installation but, because of the existing emergency in materials, its construction will probably have to be held in abeyance.

The parties to the Salmon Agreement through discussion and correspondence have arrived at an understanding of the part each can play in the propagation and distribution part of the program. For the information and convenience of the Committee I have appended a copy of this memorandum to my report. (See 5e)

2. Hatchery Capacities.

For the use of the Committee we have obtained some data on the capacity of Craig Brook Station insofar as sea salmon are concerned. Mr. Markus, regional supervisor of Fish Culture for the Service has supplied the following data:

Total Capacity (All ponds except adult retaining pond and two dirt pools)

Atlantic Salmon

Size	Number
2-inch	4,000,000
3-inch	2,500,000
4-inch	1,250,000
5-inch	800,000
6-inch	500,000

The number for each size represents the total capacity, so that when different sizes are held at one time the numbers must be figured in proportion.

Since the total hatchery capacity at any time depends on the sizes reached at any given ages and the numbers of fish of each age, I have made tables to show the total capacity on different dates, of fish of two or more ages. In these tables I have used Mr. Markus' figures given above, except for interpolation between sizes, in computing the number at each size equal to the total capacity in 2-inch fish. The column on "Date attained" I have taken from some growth curves based on measurements of samples of young salmon collected on various dates at the Craig Brook hatchery.

Total rearing capacity of Atlantic salmon of any given age at Craig Brook Station, and factors to convert into terms of 2-inch Atlantic Salmon (See text)

Size of fish (inches)	Date attained (approximate)	Conversion factor to 2-inch fish	Total capacity	Age from date of spawning (Nov. 1)	
1	May 1			6	months
1 1/2	July 1			8	do.
2	August 20	1.0	4,000,000	9 2/3	do.
2 3/8	October 1	1.2	3,333,000	11	do.
3	May 1	1.6	2,500,000	18	do.
3 1/2	June 10	2.4	1,667,000	19 1/3	do.
4	July 20	3.2	1,250,000	20 2/3	do.
4 1/2	September 1	4.0	1,000,000	22	do.
5	October 15	5.0	800,000	23 1/2	do.
6		8.0	500,000		

From this table it can be seen that the Craig Brook hatchery can carry at total capacity 3 1/3 million salmon through the first summer and 2 1/2 million until the following spring, at which time they will average about three inches in length. One million or one-quarter of the original four million 2-inch fish can be carried until the fall of the second year. Of course this would not be done in practice as each year's fry would take up a portion of the capacity of the rearing pools.

In order to show the numbers of each age that could be carried in a continuous balanced program in which the same number of eggs were collected each year I have made up the following table:

Numbers of Atlantic salmon on hand at each age in a continuous schedule of production for Craig Brook hatchery if utilized to full capacity

Approximate Dates	Approximate Ages		Number on Hand	Number to Plant Minus Mortality
November 1	Eggs		2,000,000*	
	12	months	1,250,000	
	24	do.	250,000	
May 1	6	do.	2,000,000*	
	18	do.	1,250,000	750,000
	30	do.	250,000	250,000
August 20	9 2/3	do.	2,000,000*	
	21 2/3	do.	500,000	
September 1	10	do.	2,000,000	750,000
	22	do.	500,000	250,000
October 1	11	do.	1,250,000	
	23	do.	250,000	
November 1	Eggs		2,000,000*	
	12	do.	1,250,000	
	24	do.	250,000	

*The number of eggs necessary to produce 2,000,000 2-inch fingerlings on August 20 has not been shown but may be in the neighborhood of 2,500,000.

The above table is, of course, based on the assumption that the hatchery is operating at full capacity on Atlantic salmon. At present the hatchery has greatly decreased its output of brook trout in order to accomodate salmon but funds and personnel are insufficient to rear salmon to full capacity.

Mr. Markus states that the numbers of the fry from the 1942 egg take that Craig Brook can handle are:

Fry from the period of hatching to Sept. 1943 (Fry resulting from 682,513 eggs)	675,000
Of the same fish, Oct. 1943 to April 1944	500,000
Of the same fish, April 1944 to Oct. 1944	250,000
of the same fish, Oct. 1944 to April 1945	50,000

Mr. Markus also stated that silver salmon at the same age will, it is estimated, require three times the amount of space and three times the amount of food required for the same number of Atlantic salmon.

3. Sawmill pollution of the St. Georges River.

George A. Rounsefell,
Aquatic Biologist

The pollution of the St. Georges River by wood wastes in the form of sawdust, shavings, etc. can do much harm to the restoration of salmon runs in spite of the 35-mile length of river from Warren to St. George Lake. Thus, our observations indicate that only about 13,500 yards (less than 8 miles) of the river furnish riffles suitable as a habitat for young salmon. A smaller portion of these riffles have gravel or rubble suitable for the spawning of the adults.

Between Warren at the mouth of the river, and the low log dam at Union village there are only 1,500 yards of riffles. Obviously, in order to create a run of any size it will be necessary to utilize more of the stream. From Union village upstream to the abandoned concrete dam just below Sennebec Pond there is an additional 1,000 yards.

Above the abandoned concrete dam about 8,500 yards of riffles are available between Sennebec Pond and the sawmill dam on Ghent Road in Searsmont. It is the mill utilizing power from this damsite that is polluting the river with wood wastes.

This 8,500 yards of riffles immediately below the source of pollution constitutes the best portion of the St. Georges River for the spawning of adult and the growth of young salmon. The pollution by the above-mentioned sawmill was first observed on June 24, 1941, on which date Inland Fisheries Wardens Charles Head, Winifred Foster, and I observed fresh sawdust falling constantly into the river and being carried downstream.

On July 21, 1942 I again visited the locality and observed large quantities of sawdust and other mill waste falling from the mill into the river. The bottom of the river below the mill was littered with sawdust, shavings, slabs, bark, and edgings.

During the past year we have been able to demonstrate that salmon do survive and grow in the St. Georges River during the critical summer period of high temperatures. Obviously then it is only a question of time until most of the suitable portions of the river will be needed as nursery ground for the young salmon.

Sawdust pollution is particularly harmful in that the effects linger on long after the pollution has ceased. The sawdust does not readily decay, but forms a blanket over the bottom ruining it both for spawning and for the growth of food organisms. Since this pollution is immediately above the best portions of the stream it is highly desirable that it be stopped as quickly as is practical.

4. General Program for Salmon Restoration and Management

by

George A. Rounsefell
Aquatic Biologist

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 temperatures.

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 predators 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, others 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 dam are a big factor in maintaining clear passage of fish.

b. Number and size of water diversions.

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

c. Location and description of any 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 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 or small rubble bottom in moving water to provide spawning beds.

3. Suitability of the stream for the 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 or 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 costs are not out of proportion. These experiments will be carried out on the St. Georges and Pemaquid rivers. The results can be checked by comparison with similar experiments on survival rates in streams that now contain 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 process 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 1944 and annually.

c. St. Georges 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 and Shore Fisheries.

2. Collection of anglers' catch in each river. 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 the 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 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 and to cut the cost per returning adult.

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 in planting resulting from:

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

   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 carefully estimated. 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, particularily when the runs are small, but there is no accurate data on its extent or on the quantities taken. Many of the streams so 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 if any. 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 increases 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 the 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.

E. Allocation of Responsibility for the Hatching, Rearing, and Planting of Sea-Run Salmon for Maine Waters.

(Summary of conclusions arrived at by discussion and correspondence, October 30, 1942)

In order to establish a more definite understanding for handling and planting sea-run salmon in Maine to permit more effective preparation of budget estimates and planning of future operations, and to reduce the truck mileage required for planting, the following allocation of responsibility in respect to these operations has been agreed upon by the three parties to the Salmon Agreement, subject to changes made necessary by war-created limitations.

The Fish and Wildlife Service will be responsible for picking up the brood salmon from collecting gear on the Penobscot or other rivers (this will be handled by the Craig Brook Hatchery, but the actual trapping of the salmon will be carried out by whatever personnel is in the best position to do it), carrying them through to the spawning season in Craig Brook pools, and stripping and carrying all eggs until the eyed stage. Insofar as possible, all eggs not shipped to Tunk Pond Hatchery will be reared by the Craig Brook Hatchery to the stage recommended by the Salmon Research Committee. The Service also will take care of salmon planting operations for the Penobscot and any other rivers to the west which are used for restoration experiments.

The Maine Department of Inland Fisheries and Game will take about 100,000 eyed eggs each year from Craig Brook, hatch them at Tunk Pond, and, if possible, carry about 50 percent of them into the second year. The Department will take care of all salmon planting operations for rivers east of the Penobscot, including the fish reared at Tunk Pond and any fish raised at Craig Brook for these rivers.

Insofar as is possible, the Department of Sea and Shore Fisheries will assist in the planting operations on the Pemaquid involving silver salmon.

The number of salmon planted in each river will be based on the recommendations of the Salmon Research Committee after approval by the parties to the Salmon Agreement. The time of planting each batch of young fish for the Dennys, Penobscot, St. Georges, and Pemaquid, will be based on the recommendations of the biologist in charge of the experimental work on each river; the planting time for other rivers will be based on the recommendations of the Salmon Research Committee. These recommendations will take into consideration and be conditioned by the available hatchery capacities and services. Information concerning the latter will be obtained by the Committee from the respective fish culture departments. Recommendations for allocation and rearing of each season's eggs will be furnished the State and Service fish culture departments by the following February 1.

VI. Agreement Between the Department of Inland Fisheries and Game of the State of Maine, the Department of Sea and Shore Fisheries of the State of Maine, and the Fish and Wildlife Service of the United States Department of the Interior Concerning Cooperation in the Restoration of Sea-Run Salmon.

MEMORANDUM OF AGREEMENT by and between 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; and the Fish and Wildlife Service of the United States Department of the Interior, hereinafter referred to as the Service,

WITNESSETH THAT,

WHEREAS, the formerly abundant sea-run Atlantic salmon in New England rivers has become depleted through a variety of adverse circumstances, with a consequent loss of valuable recreational and commercial-fishing assets, although such adverse circumstances now have ameliorated in some areas to the extent that a program of salmon restoration is practicable in certain rivers of the State of Maine, and

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

WHEREAS, mutual and material advantages in the conduct of their respective functions and in the economy and effectiveness of the restoration program will result from cooperation and collaboration of said Inland Department, Sea and Shore Department, and Service:

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

A. A research committee shall be established through the appointment by responsible officials of one member to represent the Inland Department, one member to represent the Sea and Shore Department, and one member 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 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.

B. The responsible officials of the Inland Department and the Sea and Shore Department hereby agree to regulate salmon fishing and fisheries in waters under their separate or joint jurisdiction in accordance with the necessity for such regulation; said regulation to be based on the recommendations of the research committee established by Section 1 of this agreement.

C. 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.

D. The bulk of the salmon hatched from eggs collected in any stream will be returned to that stream provided said stream is in suitable condition to afford a favorable habitat for sea-run salmon, said suitability to be indicated by investigations and recommendations of the research committee.

E. The balance of the young salmon not returned to their parent stream as specified in Section 4 of this agreement, will be planted in other suitable waters in accordance with the recommendations of the research committee. In view of the poor results, evaluated from the standpoint of restoration, obtained from extensive and widespread stocking in past years when much greater numbers of fish hatched from eggs secured in Canada and elsewhere were distributed in Maine streams, the present policy will be to confine stocking to two or three of the streams most suitable for salmon. Concentration of the limited amount of stocking now possible will provide the best opportunity for the development of substantial natural runs which are needed to demonstrate the practical possibilities of restoration work, and to provide a source of eggs for later expansion of the work to include rehabilitation of salmon runs in other streams.

F. Participation of the Service and its employees in any work or activity incident to carrying out the purposes and terms of this agreement shall be conditioned by the availability of funds, personnel, equipment, and facilities, and shall also be subject to any laws of the United States or regulations of the Department of the Interior governing the activities of the Service, or to any limitations imposed by the Congress of the United States on the expenditure of appropriations for the work of said Service.

G. 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.

H. No member of or delegate to Congress or resident commissioner after his election or appointment, and either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of this Government shall be admitted to any share or part of this contract or agreement or to any benefit to arise thereupon; and no convict labor shall be employed in carrying out the terms of this agreement, in accordance with the Executive Order signed May 18, 1905. The provision herein with respect to the interests of members or of delegates to Congress and resident commissioners in this agreement 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, and Sections 114-116, Act of March 4, 1909).

I. This agreement, dated October 1, 1941, 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.

Date October 10, 1941 — (Sgd) George J. Stobie
Commissioner of Inland Fisheries and Game, State of Maine

Date October 10, 1941 — (Sgd) Arthur R. Greenleaf
Commissioner of Sea and Shore Fisheries, State of Maine

Date October 10, 1941 — (Sgd) Chas. E. Jackson
Acting Director, Fish and Wildlife Service, United States Department of the Interior