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ATLANTIC SALMON AND TROUT INVESTIGATIONS, 1936

Authors

Huntsman, A. G.

Logie, R. R.

Porter, J. B.

Richardson, L. R.

Rogers, H. M.

ATLANTIC SALMON AND TROUT INVESTIGATION

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ATLANTIC SALMON INVESTIGATIONS

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Report No. IX. The Influence of Salinity on the Distribution of Salmon in the Saint John Region.

By A. G. Huntsman and R. R. Logie

The study during the season of 1938 of the movements of the Saint John salmon as shown by tagging provided an opportunity of obtaining information on any relation there might be between the distribution of the salmon and the salinity of the water. It was already known that the salmon drift nets are operated from Saint John harbour well towards Grand Manan at the mouth of the bay over an area roughly corresponding with that occupied by the outflow of the water of the Saint John river from the harbour.

The early part of the season was rather fully occupied with the tagging operations so that study of the surface salinity was not begun until nearly the end of June. Since there was no boat at command, the observations were quite limited. Mr. Hoar obtained several series of temperatures and water samples when going with salmon fishermen out to set the drift nets from Dipper Harbour. Mr. Logie did likewise from Lorneville. Dr. Leim made the vessel "Zoarces" available for a quick survey of the whole area on July 19 and for similar work late in the fall. The material from the latter has not yet been worked up. A boat was hired for a survey of the waters outside Saint John harbour on August 4 by Mr. Logie.

The drift nets used for taking the salmon extend down from the surface to a maximum depth of fifteen feet and most of the fish are meshed within a few inches of the surface. According to Watson (1936) the Saint John water flows out to sea as a strongly stratified layer about ten metres thick, retaining its lower boundary as far as Grand Manan and becoming progressively more salt, the greater volume being accommodated by increase in horizontal extent rather than by any increase in thickness of the layer. It is clear that the distribution of the salmon at night when they are taken, is in the superficial water of low salinity with the greatest proportion of river water.

The fishing boats operate from Saint John, Lorneville, Irishtown or Seaview, Chance Harbour and Dipper Harbour, these being progressively farther at sea. The boats from these ports have no distinct fishing grounds, but tend to cover the whole area arranged on the whole in the order of the ports. Each boat will be carried many miles by the tide.

Small motor-boats are used. In Saint John harbour drifting is done only during the day, but outside the harbour there is at first both day and night fishing, changing to purely night fishing in the greater outer part of the area. It is in the clearer water that night fishing is more productive or essential. Also the fishermen prefer a dark, slightly windy night to a calm, moonlit one.

The drift-net is a simple wall of net with wooden floats at the top and lead sinkers at the bottom. Off Lorneville it is set across the flow of tide, since it has been observed that, when in

the surface water, the salmon move and "strike" with the flow of the tide, that is, on a strong ebb tide they will strike approximately westward and, on a strong flood tide generally eastward. At slack tide they are caught striking either way. The mesh of the nets measure six and one-half to seven inches, stretched. By regulation, the length of each net is limited to 700 fathoms. Actually they vary from 500 to 700 fathoms in length. The shortest ones are used out from Lorneville and the maximum length out from Dipper Harbour. This corresponds with a greater concentration of the Lorneville nets.

Methods.

At each station the temperature of the surface water was taken directly for a sample dipped up in a bucket. In part specific gravity determinations were made of the samples at the time, as a basis for planning the course. In all cases samples of the surface water were obtained and held in magnesium citrate bottles for chlorinity determinations in the laboratory. A 10 ml. portion of each sample was titrated with silver nitrate against a potassium chromate indicator and the salinity calculated in parts per thousand.

While on the whole the salter water was colder, the relation between temperature and salinity was not regular enough for any reliance to be placed upon the temperature as an indication of the salinity.

Conditions in Saint John Harbour

There is very intensive fishing for salmon in the harbour, both with weirs and with drift nets. This is outside the reversing falls, which form the inner limit. It is remarkable that drifting, and with so many nets, should be carried on in the confined waters of the harbour, where there is very considerable traffic. This testifies to the abundance of the salmon, and provides a marked contrast with the paucity of salmon above the falls.

Hachey (1934, p. 173) has shown what very steep salinity gradients occur in the harbour. On June 12 and 13, 1930, the surface salinity ranged from 3 to 21‰ and the salinity of the deeper water from 3 to 31 ‰. He considers that the water resulting from mixing in the reversing falls flows outward in the upper 5 metres. The salmon are taken in the drift nets within about a foot of the surface.

Conditions off Lorneville

Hachey (1934, p. 176) for April 25, 1930 failed to get any water lower in salinity than 27 ‰ coming from offshore to Split Rock during the first two hours of the ebb tide. The lowest salinity was about seven miles off, which must have represented a body of low salinity water separated from the harbour mouth. Near Split Rock the tide was apparently not sufficiently low for the harbour outflow to appear.

Watson (1936, pp. 164 and 198) found along a line straight out from Tiner Point on April 30, 1932, from half-ebb through low water, salinities at the surface generally under 18 ‰, the lowest

(16.91 ‰) close to shore and the highest the farthest out (about 10 miles) and scarcely above 21 ‰. The spring freshet had been running at full strength for over three weeks, so that this may be considered the extreme condition.

Hachey (1934, p. 173) found water even below 12 ‰ issuing past Partridge Id. early in June of 1930 with ebbing tide but with flooding tide, the salinity just outside rose quickly to around 18 ‰. It is clear that for some distance outside Partridge Id., the surface salinities will be highly variable and rapidly changing, with much mixing.

On August 4, 1938, surface surveys were made across the area outside the harbour between Lorneville and Cape Spencer, both during the latter half of the ebb and during the latter half of the flood (table 1). With ebb tide, water as low as 17 ‰ issues from the harbour (figure 1). The salinity gradient is steep on the eastern side, fully salt bay water being reached off Mispeck Point, as a result of the current flowing westward past Cape Spencer. To the west the water from the harbour extends in a mass about three miles broad almost as far as Lorneville with little increase in salinity. From Negro Head west there is quite a gradient from shore water of more then 23 ‰ to the lightest water several miles out. West of Musquash there was a band of low salinity water near the shore, quite evidently the out flow from the Musquash river.

With flood tide water of high salinity advances from the west along shore and tends to cut off the outside mass of low salinity water from that at the harbour mouth. While salinities have

Figure 1. Surface salinities in Saint John outflow on August 4, 1938. Upper, as determined from 9.15 a.m. to 2.20 p.m. at Stations 98 to 123, in order from near Lorneville eastward nearly to cape Spencer (Station 107), thence westward nearly to Negro head (Station 113), thence southward to Station 115 and northwest to vicinity of Tiner point (Station 117) thence southwestward to Station 120 and westward to offing of Little Chance Harbour (Station 123); lower, as determined from 3.40 to 6.25 p.m. at Stations 141 to 152, in order from near Lorneville northeastward and eastward to vicinity of Black rock (Station 146), thence westward to offing of Negro head (Station 152).

Table 1. Surface temperatures and salinities outside Saint John harbour, August 4, 1938.

Sta. No.	Time	Tide	Temp. (°C.)	Salinity (‰)
Lorneville				
98		3°5' ebb	15.5	23.1
99		3°15' "	16.5	18.8
100		3°25' "	16.5	19.0
101		3°35' "	17.0	19.0
102		3°50' "	17.5	16.9
103		4° "	17.5	18.1
104		4° 5' "	12.5	30.8
105		4°10' "	11.5	31.5
106		4°20' "	11.5	31.5
107		4°30' "	11.5	31.5
Near Cape Spencer				
108		4°45' "	12.0	31.3
109		4°55' "	12.5	31.2
110		5°5' "	17.5	19.0
111		5°15' "	18.0	17.3
112		5°25' "	17.5	19.7
113		5°35' "	15.5	23.2
Near Negro Head				
114		5°45' "	16.0	21.8
115		5°55' "	17.0	19.3
116		40' flood	15.0	23.5
117		50' "	16.0	23.1
Near Tiner Point				
118		1°5' "	16.5	23.6
119		1°15' "	16.0	23.5
120		1°25' "	15.5	25.1
121		1°40' "	15.5	24.0
122		1°50' "	15.5	20.9
123		2° "	16.0	26.5

Table 1 (continued)

Sta. No.	Time	Tide	Temp. (°C.)	Salinity (‰)
141	3.40 p.m.	3°20' flood	15.0	24.9
142	3.55 "	3°35' "	17.5	23.8
143	4.15 "	3°55' "	18.0	16.8
144	4.30 "	4°10' "	17.5	16.9
145	4.45 "	4°25' "	12.5	29.3
146	4.55 "	4°35' "	12.5	30.6
147	5.10 "	4°50' "	15.5	26.0
148	5.25 "	5°05' "	16.0	23.6
149	5.40 "	5°20' "	17.0	19.6
150	5.55 "	5°35' "	16.5	25.0
151	6.10 "	5°50' "	13.5	28.4
152	6.25 "	6° 5' "	12.5	30.0

Table 2. Surface temperatures and salinities in Lorneville Salmon-drifting area, 1938.

Sta. No.	Date	Time	Tide	Temp. (°C.)	Salinity (‰)
155	July 6	9.15 a.m.	2°31' ebb	10.5	25.50
156	" 6	10.10 a.m.	3°26' "	14	18.55
157	" 6	12.55 p.m.	1' flood	16	18.00
158	July 6	6.25 p.m.	5°31' flood	13.5	23.45
154	July 7	5.00 a.m.	3°30' "	11.5	25.50
159	July 8	3.10 p.m.	20' "	12.5	25.20
160	July 8			11.5	25.9
161	July 8	9.45 p.m.	45' ebb	12.0	26.05
162	July 13	12.55 p.m.	35' "	15.0	13.1
138	" 13	2.25 p.m.	2°5' "	13.5	17.75
163	" 13	3.30 p.m.	3°10' "	14.5	15.25
164	" 13	4.30 p.m.	4°10' "	14.5	14.8
139	" 13	5.40 p.m.	5°20' "	13.5	17.15
140	" 13	7.25 p.m.	1° flood	13.0	19.65

markedly increased on the west near Lorneville, they have decreased from Mispeck Point east, but the gradient here is still quite steep so that the water near Cape Spencer is more than 30‰. There is, therefore, no evidence that the flood tide carries much of the Saint John water even as far as Cape Spencer. The Saint John water may be considered to be from 16 to 23 ‰ as it passes out through this area, at least for the conditions of river discharge existing on August 4, which was fairly representative of the 1938 summer season.

That it varies with the river discharge is evidenced by the salinities of samples obtained from one of the salmon fishing boats during its operations (table 2). Since these samples were not taken when the boat was running definite courses, the localization of the places where the samples were taken is less definite. The observations plotted in figure 2 were during a freshet. The estuary (at Oak point 26½ miles above the reversing falls) rose rapidly on July 5, reached its highest level on July 11, after which it subsided steadily. The data for July 6 show the presence a short distance off the Lorneville coast of water of low salinity, as low as 18 ‰ off Tiner point at low tide. There was no wind or only a slight southwest wind. On July 8 at low tide, the water a couple of miles off Musquash Light was over 25‰, and with rising tide and movement eastward, water of slightly increasing salinity was encountered. This shows that the effect of the freshet did not extend so far westward. On July 13, which might be expected to show the maximum effect of the freshet, data were obtained going from not far outside the harbour mouth pretty much along the course of the issuing water. These show water

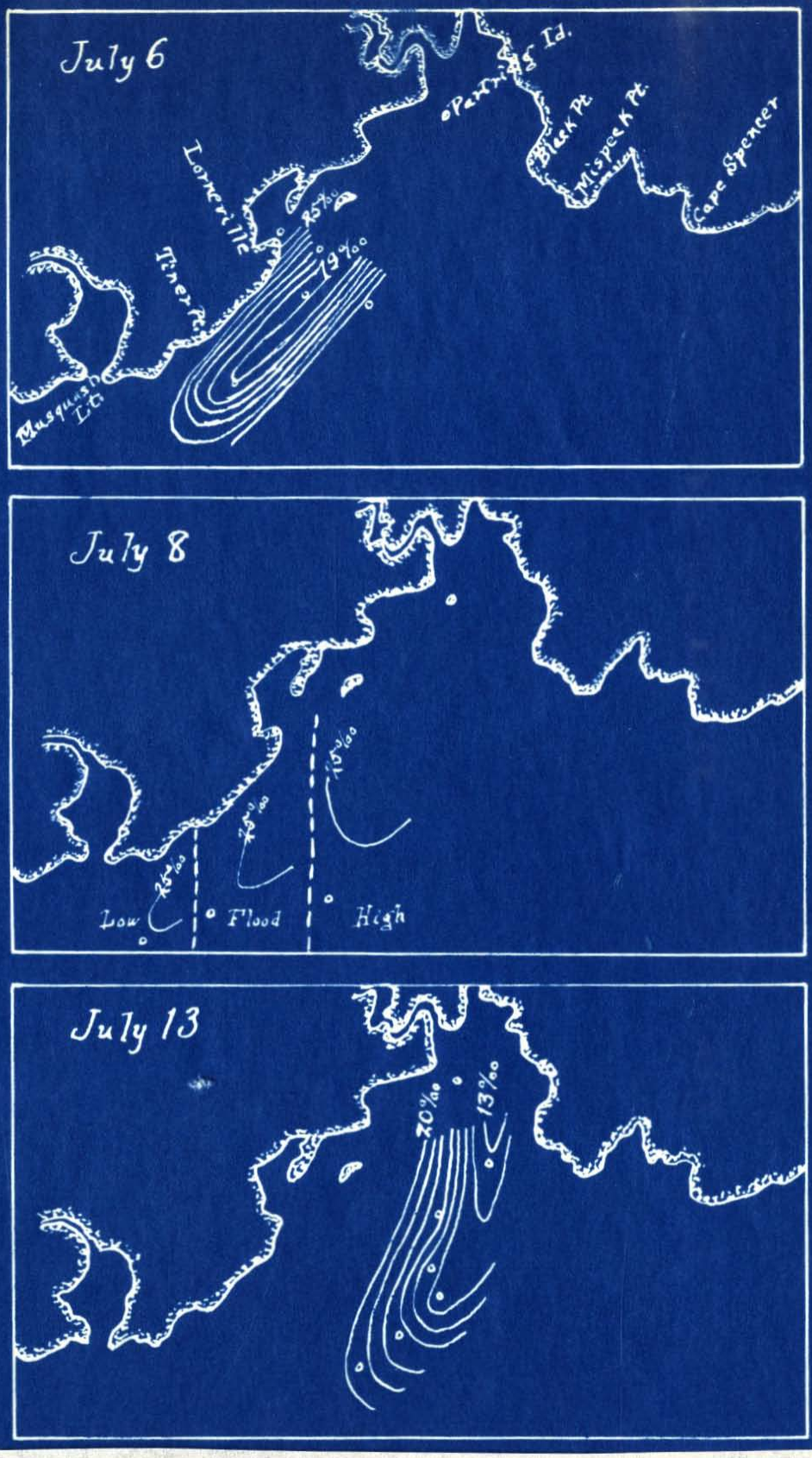


Figure 2. Surface salinities in Saint John outflow. On July 6, 1938, as determined at Stations 155 to 158, 157 being off Tiner point and 155 to 158 in order from Lorneville off shore; on July 8, as determined near low tide, about half flood and near high tide at Stations 159, 160 and 161 respectively; on July 13, as determined at Stations 162 to 167 in order from north to south.

nearly as low in salinity as 13 ‰ near the harbour and increasing not quite to 20 ‰ three miles off Tiner point. This indicates that with the level at Oak point about two feet higher (perhaps 4.3 vs. 2.3 ft.) the issuing Saint John water was from 13 to 20 ‰ as compared with 16 to 23 ‰.

As has been shown, the Saint John out-flow reaches the Lorneville coast during ebb tide, and its advancing edge is known in this vicinity as the Mahogany (Manawagonish) Island ebb streak, since it comes from the direction of that island. Its onset was followed by observations made at half-hourly intervals on the shore west of Negro head (table 3).

Table 3. Temperatures and salinities at Cunningham's cove, 3 cables west of Negro Head on July 28, 1938.

Time	Tide	Temp. (°C.)	Salinity (‰)
2.30 p.m.	2° 6' ebb	10.5	31.2
3.00 p.m.	2°36' ebb	15.3	31.4
3.30 p.m.	3° 6' ebb	11.5	30.2
4.00 p.m.	3°36' "	11.5	29.3
4.30 p.m.	4° 6' "	12.0	28.2

A streak separating green water (outside) from brown water (inside) reached the shore from the east or north-east between 3.30 and 4.00 p.m. The surface of the brown water is tossed in wavelets near the streak, diminishing rapidly. It is known as the ebb streak and is said to make off the shore after setting on the

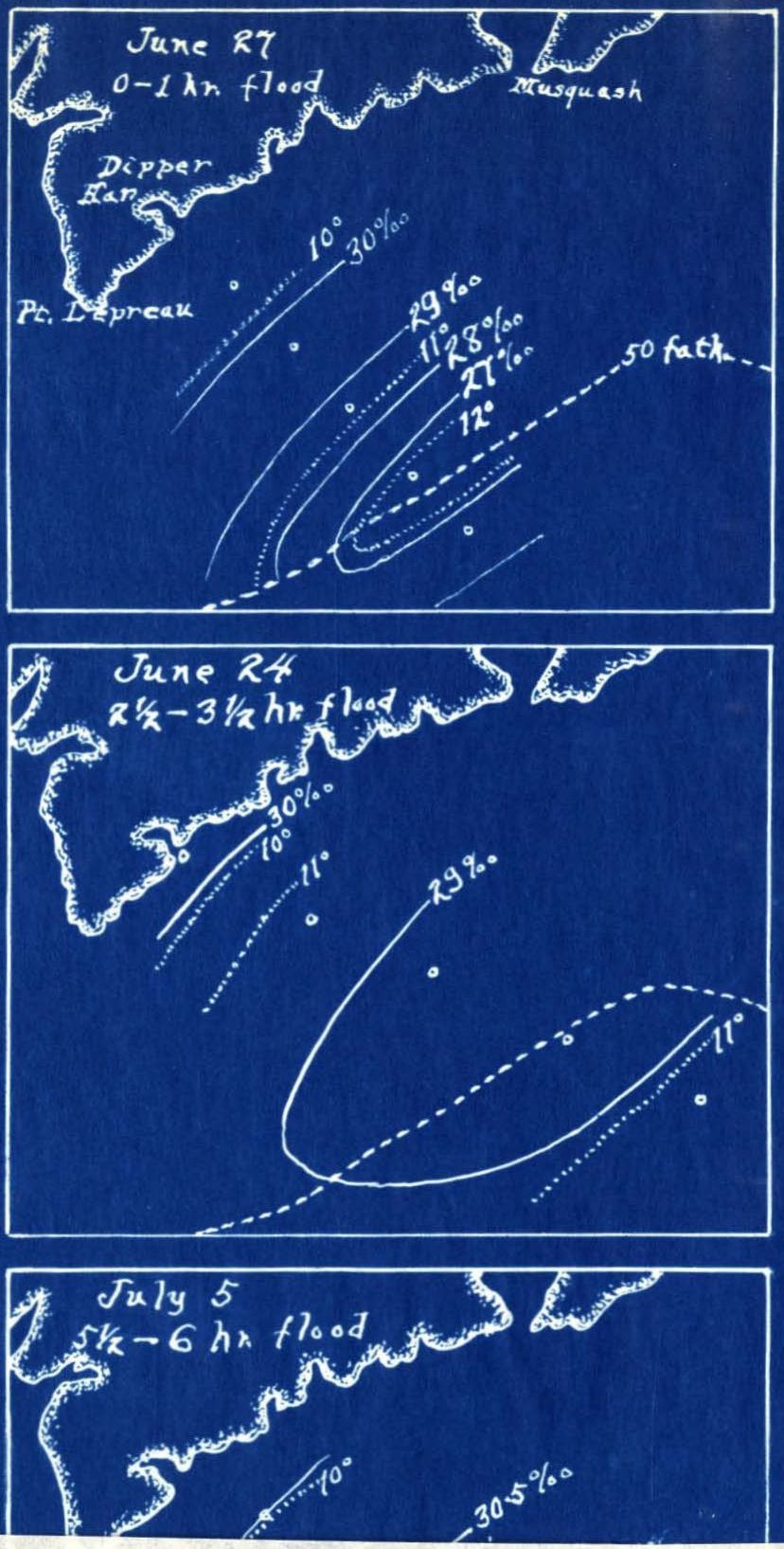


Figure 3. Surface salinities in Saint John outflow, off Dipper Harbour. On June 27, 1938, at Stations 133 to 137 in order going offshore; on June 24, at Stations 124, 126, 128, 131 and 132 in order going offshore; and on July 5 at Stations 125, 127, 129 and 130 in order going offshore.

shore at Negro Head, and dies out. The fishermen prefer to set their nets parallel with the advancing front so that the troubled surface passes over the nets. It is observed that most of the fish mesh more or less in front of the advancing front and few are taken when the brown water is universal. But after an hour or so the fish are apt to gradually increase (in the opinion of the fishermen).

It is quite evident from the facts that the streak is the edge of an advancing mass of fairly concentrated Saint John water, shown not only by its brown colour, but also by its lower salinity. The salinities observed on July 28th have a similar range to those found on the outer side of the Saint John outflow, e.g. about ten miles offshore. The streak reached this point shortly after half ebb.

With the exception of the observations at 3.00 p.m. a simple change is shown from cold, salt water at 2.30 to warm, less salt water at 4.30 p.m. It seems probable that the water passing the cove around 3.00 p.m. was from the Lorneville flats, and owes its high salinity to its origin from the last of the flood and its high temperature to exposure to the sun on the flats during high tide at midday with a clear sky.

Conditions off Dipper Harbour

On July 19 (figure 4), with a fairly heavy head of water in the estuary, water with a salinity as low as 26 ‰ was only two miles off from point Lepreau and there was probably off Dipper Harbour a few miles a salinity as low as 25 ‰ . This was at 1½ hr. flood and doubtless represents the extreme extension of such water in the tidal cycle.

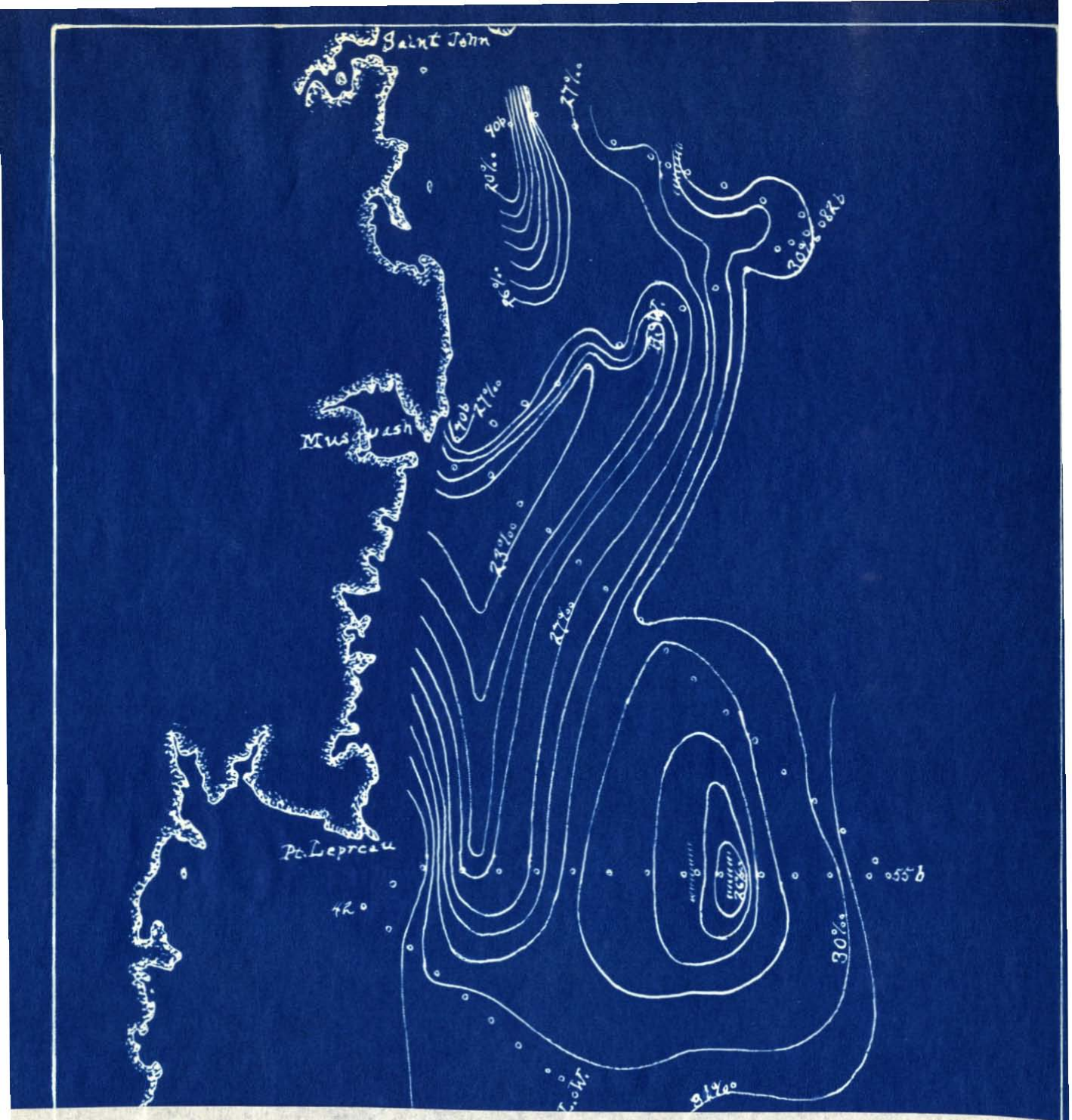


Figure 4. Surface salinities in Saint John outflow on July 19, 1938, as determined at Stations 1 to 90b, in order going from Letite passage at 5.37 a.m. to the offing of North Head, Grand Manan (Station 21), thence to the vicinity of point Lepreau (Station 42), thence offshore to Station 55b, thence to Station 70b, half-a-mile off Musquash light, thence offshore to Station 82b, and thence toward the Saint John whistling buoy, turning northwestward from Station 90 to Station 90b, by 6.07 p.m.

The samples obtained by Mr. Hoar along lines out from Dipper Harbour earlier in the season, when the head of water in the estuary was somewhat less, fail to show any water with as low salinity (table 4). The three series (figure 3) were made on different days, but, as it happened, at different times during the flooding tide. That on June 27 was taken during the first of the flood and shows water as low as 27 ‰ about five miles off. That on June 24, taken about half-flood, shows nothing as low as 28 ‰, and the least saline water again over five miles off. Finally, that on July 5, taken about high tide, shows nothing as low as 30 ‰, but the least saline water is only about 3 miles off.

Quite clearly a body of water of somewhat low salinity reaches this area with the ebbing tide and retreats with the flood. It varies in salinity and in distance from the shore, but there seems to be regularly a fair body of water of high salinity (30 - 31.5 ‰) near the shore.

Table 4. Surface temperatures and salinities in Dipper Harbour salmon-drifting area. 1938.

Sta. No.	Date	Time	Tide	Temp. (°C.)	Salinity (‰)
124	June 24		2°37' flood	9.7	30.1
126	" "		2°52' "	11.4	29.5
128	" "		3° 7' "	11.4	28.7
131	" "		3°22' "	11.5	28.2
132	" "		3°37' "	10.6	29.5
133	June 27		9' "	9.1	30.6
134	" "		19' "	10.4	29.6
135	" "		29' "	10.4	28.8
136	" "		39' "	12.3	26.2
137	" "		49' "	11.4	27.3
125	July 5		5°36' "	10.0	30.5
127	" "		5°46' "	10.5	30.4
129	" "		5°56' "	11.0	30.6
130	" "		6° 6' "	10.3	31.0

The Salmon-Drifting Area as a Whole

The area extends from Saint John harbour nearly to Grand Manan. The inner margin is at times quite close to the shore, but to the westward not inside the line from point Lepreau to the Wolves Islands. The outer margin is from Mispeck point east of the harbour entrance to a position about 8 miles off Lorneville, thence to a position 10 or 15 miles off Dipper Harbour.

On July 19, 1938 the vessel "Zoarces" of the Atlantic Biological Station was placed at our disposal, which permitted a survey of the surface water from the entrance of Letite passage to the 100 fathom water outside Grand Manan, and thence in a zig-zag course over the area to the offing of Saint John harbour. The observations are given in table 5, and the salinities are plotted in figure 4.

Table 5. Surface temperatures and salinities over the salmon-drifting area on July 19, 1938.

Sta. No.	Time	Tide	Temp. (°C.)	Salinity (‰)
1	5.37 a.m.	1°47' ebb	10.4	31.6
2	5.44	1°54' "	11.5	31.1
3	5.51	2° "	11.6	31.2
4	5.59	2°8' "	10.9	31.1
5	6.08	2°17' "	11.2	31.3
6	6.15	2°24' "	10.5	31.6
7	6.23	2°32' "	10.2	31.5
8	6.31	2°40' "	10.3	31.6
9	6.39	2°48' "	10.4	31.5
10	6.47	2°56' "	11.1	31.0
11	6.55	3° 4' "	11.2	31.1
12	7.03	3°12' "	11.5	31.0
13	7.13	3°21' "	11.1	31.0
14	7.20	3°29' "	11.5	31.0
15	7.28	3°37' "	11.5	31.0
16	7.36	3°45' "	11.3	30.9
17	7.44	3°53' "	11.1	31.1
18	7.52	4° 1' "	11.8	31.1
19	8.01	4°10' "	12.5	31.2
20	8.08	4°17' "	12.6	31.4
21	8.17	4°26' "	12.7	31.6
22	8.25	4°34' "	12.7	31.7
23	8.33	4°42' "	12.8	31.5
24	8.42	4°51' "	13.0	31.5
25	8.50	4°59' "	13.3	31.7
26	8.58	5° 7' "	12.5	31.4
27	9.06	5°15' "	12.3	31.4
28	9.14	5°23' "	12.6	31.3
29	9.23	5°32' "	12.7	31.3
30	9.31	5°40' "	12.5	31.5
31	9.39	5°48' "	12.2	30.5
32	9.47	5°56' "	12.5	30.4
33	9.55	6° 4' "	12.7	30.5
34	10.04	Low water	12.2	30.4
35	10.13	0° 9' flood	12.4	30.4
36	10.22	0°18' "	12.3	30.4
37	10.30	0°26' "	12.5	30.5
38	10.40	0°36' "	12.7	30.4
39	10.48	0°44' "	12.5	29.95
40	10.58	0°54' "	12.7	30.6
41	11.06	1° 2' "	11.5	31.1
42	11.15	1°11' "	11.0	31.1
43	11.29	1°25' "	10.5	31.4
44	11.39	1°35' "	14.0	26.0
45	11.48	1°44' "	14.0	26.2
46	11.57	1°53' "	13.1	27.1
47	12.05 p.m.	2° 1' "	12.1	29.6

Table 5, continued:

Stat. No.	Time	Tide	Temp. (°C.)	Salinity (‰)
48	12.14 p.m.	2°10' flood	13.3	28.1
49	12.24	2°20 "	13.7	28.1
50	12.32	2°28' "	14.3	27.1
50b	12.36	2°32' "	15.6	27.2
51	12.41	2°37' "	15.0	25.7
52	12.51	2°47' "	13.0	28.6
53	12.59	2°55' "	13.4	29.6
54	1.08	3° 4' "	14.1	29.6
55	1.18	3°14' "	13.2	31.2
55b	1.23	3°19' "	13.9	31.3
56	1.26	3°22' "	13.8	31.1
57	1.36	3°32' "	14.9	31.1
58	1.44	3°40' "	15.1	30.1
59	1.52	3°48' "	15.0	29.6
60	2.00	3°56' "	13.5	29.8
61	2.07	4° 3' "	15.8	28.7
62	2.15	4°11' "	14.0	28.9
63	2.24	4°20 "	13.8	28.6
64	2.32	4°28' "	12.3	30.0
65	2.42	4°38' "	14.6	27.1
66	2.49	4°45' "	14.5	26.8
67	2.55	4°51' "	15.0	23.9
68	3.04	5° "	15.5	22.4
69	3.13	5° 9' "	15.3	23.1
70	3.20	5°16' "	14.8	24.2
70b	3.24	5°20' "	15.0	24.5
71	3.29	5°25' "	12.4	27.0
72	3.37	5°33' "	13.3	26.5
73	3.44	5°40' "	13.3	26.4
74	3.52	5°48' "	14.2	25.0
75	4.00	5°56' "	15.6	23.0
76	4.08	6°04' "	14.6	26.0
77	4.17	High water	15.2	24.0
78	4.24	7' Ebb	15.1	25.3
79	4.32	15' "	13.8	28.9
80	4.39	22' "	13.7	30.0
81	4.47	30' "	13.9	29.4
81b	4.52	35' "	13.6	29.5
82	4.56	39' "	13.3	30.0
82b	5.00	43' "	13.9	30.1
83	5.04	47' "	14.2	30.0
84	5.14	57' "	15.0	29.1
85	5.20	1° 3' "	12.9	30.1
86	5.28	1°11' "	12.3	30.9
86b	5.32	1°15' "	13.0	28.5
87	5.36	1°19' "	12.8	29.65
88	5.43	1°26' "	12.6	28.1
89	5.52	1°35' "	13.0	27.0
90	6.00	1°43' "	12.4	26.9
90b	6.07	1°50' "	15.0	19.5

It is quite clear that the drifting area corresponds with the Saint John outflow. The 31‰ isohaline at the surface enclosed on July 19 an area closely approximating that in which drifting is rather regularly carried on. The tidal currents cause constant changes in the distribution of the less salt water, and figure 4 does not represent the condition at any one time, since it took a complete tidal cycle, from about 2 hrs. ebb in the morning until 2 hrs. ebb in the evening to cover the area. For this very reason the picture in figure 4 may be considered as fairly representative, keeping in mind the changes that occur.

There seem to be three masses of water of lower salinity within the common mass that covers the area. Water issuing from the harbour has a salinity as low as 20‰. A mass, centred about 3 miles off Musquash, is as low as 23‰. A third mass, centred about 9 miles off Point Lepreau, is as low as 26‰. These evidently represent stages in the progress seaward of successive parts of the harbour outflow.

when separated by tidal action off Lorneville, as illustrated in figure 1. It may well be that the mass off Musquash issued from the harbour with the evening ebb tide, and that off Point Lepreau with the morning ebb tide of July 18. With such a rate of progress, the water from the harbour would reach Grand Manan in about a day.

Salmon occur not only in the drifting area, but all around it. They are taken in weirs practically everywhere along the shore and at Grand Manan. They have been seen jumping out in the middle of the bay. The drifting area is, therefore, merely a place of greater concentration, where fishing is better. While weirs in Saint John harbour and on the south shore of Minas channel at the head of the bay are successful mainly for the salmon they take, the weirs along the coast outside Saint John harbour take only an occasional salmon. There seems to be a sharp change in this respect on leaving the harbour.

Owing to the risk in drifting near shore, it is not readily established that the salmon are less numerous near shore than farther off. It is true that at times the drifters come so close inshore as to be said to be drifting "on the rocks". With a steep gradient near shore, the salmon would be expected to be concentrated there, even if not actually in the shore water. On the whole, however, it seems that drifting is not so successful close to shore as some distance off, and this distance seems definitely greater near Dipper Harbour than near Lorneville. It is stated that they are off shore at the beginning of the season, but come in, even within a mile of the shore later on.

The outer limit is also somewhat indefinite. It may be claimed that the fishermen go no farther than 10 miles or so because of the time involved, but some state that they believe they get beyond the fish if they go farther. It may be taken as certain that, if the fishing was as good farther out, some would go there to avoid being "blanketed" by the other fishermen.

Near Mispeck, where the margin of the outflow is so definite, there is no question that the nets are run in the outflow rather than outside it. As observed on July 19, all were inside the margin, none outside. It is difficult, however, to get a categorical statement from the drifters that they don't drift outside because there are no salmon there, as they will advance other reasons, - that they wish to avoid the Cape "streak". Nevertheless one pair of fishermen living near Mispeck gave the information in 1931 that years before they had tried drifting down from five miles outside Cape Spencer. They ran 8 nets with new tops and old bottoms. When down opposite Black rock near Mispeck point, they had not got one salmon, but from there to Negro head, Lorneville, they got 12, which averaged 12 lb. The had never heard of anyone else fishing above the cape. This experiment shows a definite relation of the salmon to the outflow.

Watson (1936, p. 170) has shown that the Saint John outflow reaches the east side of Grand Manan, where a gradient from 30 to 31 ‰ may occur (May 18, 1932). While there is no regular fishery here, two men from Grand Manan did drift for salmon in 1931 and 1932. At first they drifted out from Dipper Harbour an hour's run down to the offing of the Wolves. They did not do very well, but paid expenses. They were in amongst the Dipper Harbour boats, and decided to drift

nearer home. They went from 4 to 8 miles off from North Head village in a direction ranging from ENE to E x S and were always carried during the night irrespective of the tide, toward the island or down to the Bulkhead rip off White Head island, which is the direction the Saint John water takes in approaching Grand Manan to be mixed as shown by Watson's figure 12 (1936, p. 170). The records show that 20 cwt. of salmon were landed at Grand Manan in 1931 and 12 cwt. in 1932. The men did not continue this fishing because they did not get fish enough. Salmon are occasionally taken in the weirs along the northeast part of the island, but not as far along as Whitehead island. They are, however, reported as having been taken there in fishing for pollock. Their distribution in this locality seems definitely to end with the dissipation of the Saint John water.

ATLANTIC SALMON AND TROUT INVESTIGATIONS

1938

Report No. X. The distribution of young salmon in the Salmon river watershed.

By L. R. Richardson.

The past ten years have seen, from all accounts, a rapid and steady decline in the numbers of salmon taken by anglers and fishermen from the waters of Guysborough County.

In undertaking a preliminary study of this problem it was felt that the first step to be taken was the determination of the population of a single salmon system in this area with the point in view of determining the extent to which the salmon are utilizing this system as a hatchery water. For this purpose the Salmon River watershed was selected and an intensive study of the system made during the past summer. This system was chosen since it is intermediate in character between the watersheds of the more fertile northern districts and the more barren southern areas in the county.

The present report is restricted to field observations. Time has not yet been available for consideration and study of collections made during the summer.

The Salmon river watershed is divisible into two sections, a highland section in the form of a wide, shallow bowl drained by four major tributaries (the Salmon River Lakes, the Porter River, the North West Branch, and the North Branch Lake system) and a lower section in which the main stream travels in a long narrow valley with highland plateaus on either side drained by many small tributary

streams which enter abruptly into the main river. Cultivation and the clearing of land has been confined chiefly to the broad, head bowl. Only a small portion of this area has come under cultivation and obvious extensive modification is restricted almost entirely to the areas drained by the Porter River and the headwaters of the North Branch Lake system. These systems represent only a small portion of the entire watershed. A total of sixty-five seining and observation stations has been established on the Salmon river watershed. These stations are marked on the map with indication as to the presence or absence of young salmon, parr and fry and demonstrate the extent of penetration of the system by the salmon.

The method of investigation employed was simple and direct. The system has been visited at as many points as possible. Many stations were accessible only through the woods. At each station careful seining was undertaken to demonstrate the fish population present. This seining was checked by visual examination of the water. A record was taken of the temperature and of the characteristics of the water. Wherever salmon parr or fry were present, the stream was examined both upstream and downstream from the station and the range of the young salmon carefully determined. It was very early found that parr and fry alike, if present were to be found at or close to the mouths of the lesser tributary brooks and that the range in the streams was limited. In the case of fry, the range was seldom more than a hundred yards and more generally only fifty to one hundred feet from the mouth of the tributary, parr on the other hand would frequently range upstream for a quarter of a mile but seldom more than half a mile.

Of the sixty-five stations indicated on the map, sixteen are marked as barren and placed on the map to indicate the range of salmon parr or fry in the lesser tributary waters. The remaining forty-nine stations are distributed to cover the system as uniformly as possible and so to establish the extent of penetration of salmon in the system. Fry were found present at only eleven of these stations, in each case being found in the vicinity of gravel bars such as are characteristically situated at or close to the mouths of the tributary waters. In view of the persistence of this correlation it is felt that these bars are utilised as spawning beds by the adult fish. Parr were taken at fifteen stations, and were not generally correlatable with the presence of gravel bars. The presence of parr at fifteen of forty-nine stations is not to be interpreted as indicating that nearly thirty percent of the watershed is inhabited by parr. In the case of the lesser tributary brooks, it was quite common to find parr in only a quarter mile portion of a brook system with more than two miles of water. The purpose of these records is to establish the extent of penetration, that is the longitudinal distribution of the salmon in the watershed.

Throughout the lower section of the watershed, the salmon parr and fry are restricted to the lowest sections of the tributary waters. They were not found in the main stream except at one point (shortly below the entry of the North Branch Lake system). Progress upstream is frequently prevented by natural physical barriers (e.g. R 9, R 10, L 5) while in other cases (R 7, R 5) the range upstream is limited by natural barriers other than physical ones. As a result only a very small portion of the waters in the

lower section of the watershed is utilised as rearing grounds for young salmon.

With the exception of the Porter River (L3L4) which is occupied by young salmon throughout the greater part of its length, the waters of the upper section are little utilised, and penetration into the three other large systems (Salmon River Lakes, North West Branch, and North Branch Lake) is limited. Salmon enter the Salmon River Lake but do not penetrate further to the chain of lakes higher up on the main branch. This is not difficult to understand, since these lakes and their tributary brooks drain a comparatively flat, low-lying country and so far as I was able to determine are generally pond-formations with only marshy lowland brooks entering. Spawning gravels were not present in the three mile section which I investigated most carefully and in this section, as is indicated, no salmon were seen and in simple fact only one speckled trout was seen. This main stream contrasted completely and in all respects with the Porter River. The latter is a generally fast-flowing brook with many small gravel beds suitable for spawning. Salmon enter the lower end of the North West branch but do not penetrate beyond the first lake. Young salmon were much commoner at Sta. B than at Sta. D. Penetration into the North Branch Lake system was limited. Physical barriers were not located, but it was found that while the salmon passed into the North Branch Lake and spawned in this lake, they did not penetrate into the higher streams, nor even pass up in to Round Lake. The connecting brook between Round and North Branch Lakes is devoid of any physical barrier. Round Lake possesses many excellent gravel

bars at the mouths of ~~XXX~~ streams and also along the shore line, but I was unable to find any trace of salmon in this water.

Since the number of stations at which salmon were found compared with the number at which they were not present cannot be taken as an indication of the population of salmon in the system, attempts were made to estimate the population of salmon at some of the stations. In the case of R 5, as is indicated the brook was examined for a distance of more than a mile from its mouth. Salmon parr ranged from within fifty feet of the mouth of the stream for approximately four hundred yards upstream. In this distance there were only twenty-eight parr, less than one fish per pool. Fry were limited to a stretch reaching from the main stream only one hundred yards up on the tributary. In this distance eighteen fry were seen. These were generally distributed two or three to a pool, less often one per pool, and as a maximum one pool contained four fry. Three gravel beds of small size were present in the lowest hundred yards of the tributary. A recount was made, with twenty-seven parr and eighteen fry as the result. At R 4, in the one hundred yard stretch inhabited by young salmon, only two parr and three fry were counted as against fifteen speckled trout fry in the same distance. Similar counts with correspondingly low figures were made on the majority of the other brooks but the above two brooks are mentioned in detail since the counts there were made under favourable conditons. At L 6, twelve fry and eight parr were counted in the one hundred and fifty yard stretch inhabited by salmon, while at L 8 only three fry were found and no parr.

The most heavily stocked stream was L 5, parr were present from within fifty feet of the main stream up to the falls. While no count could be made owing to the repeated deep pools and large boulders, it was quite obvious that the population density was as high as could be desired. Fry were common and easily taken at only the one point, Sta. F. on the Porter River. The fry were taken from a small pool twenty feet from the main brook on a tributary of small size. From a single pool three feet wide and six feet long eight salmon fry and four speckled trout fry were taken. This represented the entire salmon population of the tributary, and was the only case where with salmon and trout fry associated the salmon fry outnumbered the trout fry, the general representation being more in the neighbourhood of two or three to one in favour of the trout.

In general it may be stated from the field observations that while the penetration of the system by spawning salmon is quite good, the degree to which the system acts as a hatchery for young salmon is very limited and the population of young salmon, extremely small. The spawning fish travel up the main stream to the Salmon River Lake and from there into the North West Branch and the Porter River. Other fish spawn in North Branch Lake and at suitable points, in the mouths of tributaries on the way up the main stream from the estuary. The survival of young fish must be extremely low if we judge by the populations observed in the brooks tributary to the lower section of the main river since the most careful study of the main stream in the regions of these tributaries and elsewhere has failed to

reveal young salmon. It is difficult to explain why small populations should exist in this fashion. The successful spawning of even one pair of fish on a bar in a tributary such as L 6, L 7, or R 5 should yield at least fifty or even one hundred young fish. The fry would naturally disperse, but their dispersal is not in the nature of a definite migration but favors rather an uncontrolled scattering. It would naturally be anticipated that fry would be found in the main stream, but this was not so and being such an obvious factor was a matter carefully enquired into.

The conclusion remains that the survival of young fish is very low. The population of the system does not appear to be maintaining itself at a point even approximating the optimum. This may be a result of the decrease in number of spawning adults, but this assumption will not serve to explain the paucity of young salmon at points where spawning must have taken place.

The virtual absence of young salmon from the main stream below the Salmon River Lake is I believe highly significant and indicative of the functioning of a factor destructive to the young fish, a factor more dominantly operative in the main stream and less so in the tributaries. The one obvious factor apparent as an agent in modification of the system is that of pulp-running but whether this is the causal agent in the reduction of the salmon population can not be stated on the basis of the past summer's work. However the practices of pulp-running offer possibilities in explanation of the problem. The retention of water by dams may lower the stream levels sufficiently to expose spawning beds and lead to egg-killing by frost or dessication.

Gravel beds in the vicinity of which fry were found, were generally exposed even during the high waters of the past July. Survival of a few fry from a spawning would be readily understandable on this basis, since lowering of the water level might expose only part of the bed. Secondly the sudden liberation of water for the run may well disturb beds or shelter for young fish and expose eggs or fry to predators or to injury; and thirdly the actual passage of logs during the high water may well disturb the bottom, destroyixg shelter and reduce the population of food animals.

An alternative possibility is that the present population has been developed by stocking, that the waters are for the greater part no longer suitable for young salmon and that the survival from the stockings has been very limited.

The above two suggestions are put forward as possibilities, others suggest themselves but the one factor apparent from the field studies made during the past summer is that a factor is present and operative in producing a reduction of the population of young salmon.

The work of the past summer has been preliminary in nature and merely introductory to the problem. It has however demonstrated that the problem is not entirely a matter of the fate of the salmon in the ocean. There may well be a second factor affecting the numbers of salmon in the ocean, but it is evident that much may be undertaken with a view to the determination and alleviation of a factor operating against the young fish in their freshwater environment.

It would be regrettable to have the present work cease at this point. Comparison of the distribution and population of salmon in adjoining and contrasting watersheds and further studies of the young salmon in the Salmon River watershed may well lead to the definition

of a factor which appears to be operative in the present system and adversely affecting the population of young salmon, a factor apparently as yet not definable.

Appendix 1. Records of Observations.

The following pages give the detailed observations made on the Stations established on the Salmon River system during the summer of 1938.

The figures for average size represent a cross-section of the brook at the station and taken at a point in between pools. The great fluctuation in speed and volume as the result of heavy rains throughout the greater part of the summer rendered useless the taking of measured observations on the speed and flow of the brooks. Accordingly comparative terms alone are used. Slow, the speed of a lowland brook; medium, of a mountainous brook; fast, that of an upper or lower transitional brook. Flow, indicating the volume, is given here as, poor - the stream bed not fully covered; fair, for a stream at moderately low water; good, when the bed is normally covered; flood, when the volume exceeds or almost exceeds the capacity of the stream. Temperature is given in degrees centigrade. The bottom is described as covered with silt; gravel, up to 3" pebbles; stony, up to 1' in diameter; boulders, stones more than 1' diameter. Generic names only are used for the fishes, these being sufficiently distinctive. Pools are described as small, when less than the width of the brook, or when exceeding this, the width, depth of average pools are given. The margin refers to the degree and kind of forestation.

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
Stations on the Main Stream A to E								
Aug.8	10'x1'	Slow	Fair	25.0	Stony	Salvelinus Semotilus Catostomus	10'x 20'x 3'	Dense mixed

Stations A to E embrace the section above Beaver Dam Lake to the top of the fourth stillwater. This section is virtually uniform and consists essentially of a slow-running highland river situated in a broad and shallow valley. The temperature of the water is maintained at a high point by the stillwaters. The latter are shallow, not over 3', and bordered by ericaceous-sphagnum marsh. At several points on the river there are short narrow intervales. More than three miles of brook were examined and only one trout seen in this distance. The water is generally unsuitable for trout, or salmon spawning or rearing grounds.

Station F.								
Aug.9	50'x1'	Slow	Good	23.0	Stony	Fundulus	Small	Dense mixed

Station F: Outlet of Salmon River Lake.

Station G.								
Aug.9	40'x1'	Fast	Fair	24.0	Stony	Catostomus Salmon parr	Small	Dense mixed
Station H.								
Jly.16	50x1'	Fast	Flood	20.0	Stony	Semotilus	Small	Dense mixed

Station H: intensively seined above entry of R7, but neither parr or fry taken.

Station I.								
Jly. 14	60'x1'	Very fast	Flood	21.0	Stony	Semotilus Catostomus Fundulus G. aculeatus	Small	Dense mixed
Station J.								
Jly. 8.	Same as Station I.							
Station K.								
July 5	60'x1'	Very fast	Flood	19.0	Stony	Semotilus Notropis Catastomus Anguilla Fundulus Pugnitius	Small	Grass

From Sta. F to tidal water the Salmon River is of a uniform nature with little change other than a gradual increase in size. The main river below F is essentially of a lower transitional type, having a broad shallow bed, a gravel bottom and a slightly meandering course. The gravel is generally large and ranges up to stones of a foot or

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
R1 Aug.8	40'x3'	Very slow	Good	24.0	Silt	Semotilus Fundulus	---	Dense mixed

R1 is a virtual stillwater connecting Beaver Dam and the lakes on this brook and partaking of the nature of a partially flooded backwater rich in submerged and emerged vegetation and with ericaceous-sphagnum banks.

R2 Aug. 8	Trickle	Medium	Poor	20.0	Silt and gravel	None observed	Small	Dense mixed

R2 a small insignificant brook partially destroyed by road construction.

R3 Aug 8	Trickle	Medium	Poor	18.0	Silt	None observed	Small	Dense mixed in part

R3 similar to R2 but of smaller size and running at lower temperature.

R4 Aug 8	5'x1'	Medium	Fair	18.0	Stony	Salvelinus Salmon parr and fry	5'x10' x3'	Dense mixed

R4 was examined from a point ½ mile above the road down to its mouth. A gravel bed at the latter point partially occludes the stream. Above the mouth the stream is silted for a short distance and overgrown by bush. Parr are found up to the road, fry only in lowest one hundred yards of the brook. In one hundred yards of brook 2 parr, 3 fry and 15 Salvelinus fry were counted. The trout were regularly spaced, parr and salmon fry scattered and at irregular intervals.

R5 Aug 9	3'x6"	Medium	Poor	18.0	Stony	Pfrille Salvelinus Salmon parr and fry	5'x10' x2'	Dense mixed open above

R5 examined from the mouth to a point nearly two miles upstream. Speckled trout abundant (maturing adults, yearlings and fry) throughout this distance with the exception of the lowest fifty feet where the brook was of a semi-highland nature. Salmon fry were present in the lowest one hundred yards while parr extended upstream for an additional three hundred yards. No salmon above level of the road. Three sea-run trout taken (8"-10") from several of the deepest pools. Small gravel beds scattered in the lowest section of the brook in association with salmon fry.

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
R5R1								
Aug 9	3'x3"	Slow	Good	22.0	Gravel	Semotilus Anguilla	Small	Dense brush

R5R1 is of a semi-highland nature markedly influenced by the large shallow lakes which it drains. Both lakes show considerable marginal encroachment and are reported to be excellent early trout waters.

R6								
Jly 15	4'x3"	Fast	Poor	17.0	Gravel	Salvelinus	Small	Dense alder brush with much open in back

R6 The uppermost portions of this brook are purely mountainous with stony and rocky bottom and very small pools. Speckled trout fry are abundant, averaging one or two per pool. The brook changes rapidly to a lower transitional type with long reaches of fast water over a gravel bottom. The book emerges sharply into the main river. There is no gravel at the mouth, and the absence of salmon fry or parr coincides in this case with the absence of an estuarial gravel bed.

R7								
Jly 16	12'x6"	Fast	Good	17.0	Gravel and Stony	Salvelinus Salmon fry and parr	Small 2' deep	Open with mixed forest.

R 7 The outlet of Lawlor's Lake is well-stocked with parr, almost as heavily as L5, but fry are few and restricted to the lower end of the brook, for a distance of two hundred yards from the mouth. One or two parr per pool on an average with five to ten more rarely. The mouth of the brook partly occluded by silting but cleared gravel present. Speckled trout fry common.

R8								
Jly 14	4'x3"	Fast	Good	16.0	Gravel and Stony	Salvelinus Salmon parr	3'x8'x 2'	Heavy mixed

R 8 Descends sharply into the main stream from the highland plateau to the south of the valley. Similar to R9

R9								
Jly 14	4'x3"	Fast	Good	16.0	Gravel and stony	Salvelinus Salmon parr Anguilla	5'x10'x 3'	Heavy mixed

R9 A mountainous stream throughout most of its course, descending abruptly into the main river by falls and chutes. Falls within 100 yards of the mouth 12' high and marked limit of parr upstream. About ½ mile upstream an impassible 30' fall. Speckled trout above this fall. This stream and the preceding empty into a backwater on the Salmon river.

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
R 10								
Aug. 22	10'x1'	Fast	Good	23.0	Stony	Salvelinus Salmon parr Anguilla	Small	Dense mixed

R 10 Cutler (Mill) Brook descends abruptly into the upper end of the Salmon estuary. There is a compact series of falls each about 8' high and each with a small pool at its foot. Three parr were taken between the estuary and the falls, but none above them. Trout of all sizes are common both above and below the falls. No gravel suitable for spawning was noted in this lower stretch and it would appear that the parr were spawned at some location in the estuary itself. No salmon fry were observed.

R 11								
Aug. 22	4'x6"	Fast	Good	21.0	Gravel	None observed	Very small	Dense brush

R 11 A small brook entering abruptly into the lower end of the estuary, suitable for trout or young salmon, but not occupied so far as could be determined.

Extra	Delaney Brook							
Aug 18	10'x6"	Fast	Poor	20.0	Boulders	None observed	Very small	Dense mixed

This brook was examined for a distance of more than two miles upstream, although it is outside of the Salmon watershed. Natural barriers are present close to the mouth of the stream. The complete absence of fish from this brook is nevertheless remarkable.

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
L 1 and L 2 --Relatively inaccessible.								
L3 A Aug 16	20'x1'	Fast	Fair	20.0	Stony	None observed	Small	Brush
L3 B Aug.11	10'x1'	"	Good	20.0	Gravel	Salmon fry	15'x20' x3'	Brush and Pasture
L3 C Aug.16	25'x1'	"	Flood	22.0	Stony	Anguilla	Small	Brush
L3 D Aug. 11	15'x1'	"	Good	20.0	Gravel	Salmon fry	20'x15' x3'	Scattere brush
L3 E Aug.11	50'x2'	Slow	Good	23.0	Stony	None observed	up to 70'long	Dense brush
L3L3 Aug.11	3'x6"	Medium	Good	22.0	Gravel	Salmon fry Catostomus Semotilus	5'x10' x 1'	Brush and Pasture
L3	The North West Branch of the Salmon was not examined above Sta. A. The area is relatively inaccessible, conforming in general contour to the main stream above the Salmon River lake. By local report, salmon have not been known to penetrate into the lakes above Sta. A. Time was not available for the examination of the water above the lakes.							
L3L4A Aug 18	5'x1'	Medium	Flood	26.0	Stony	None observed	Small	Brush
B and C -- Similar to Sta. A.								
L3L4D Aug 16	10x1'	Fast	Good	21.0	Stony	None observed	Small	Brush
L3L4E Aug 15	6'x2'	Fast	Flood	22.0	Gravel	Semotilus Catostomus G.aculeatus Salmon parr	10'x10' x 3'	Open, some brush
L3L4F Aug	20'x1'-3'	Fast	Good	21.0	Stony	Salmon parr	Very small	Dense brush
L3L4 R1 a Aug 18	Trickle	Fast	Good	18.0	Silt	None observed	Small	some open Dense brush
L3L4 R1 b Aug 18	5'x3"	Fast	Flood	23.0	Stony	None observed	Small	Dense brush
R2 Aug 15	3' x 3"	Medium	Flood	18.0	Gravel	Salvelinus Semotilus Catostomus	4'x5'x1'	Dense alder brush

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
L3L4 Aug 15	L2 3' x 3"	Medium	Flood	22.0	Gravel	Salvelinus	4'x 6' x 1'	Dense brush and pasture
L4L3 Aug.15	2' x 3"	Fast	Flood	18.0	Gravel	Semotilus Catostomus Salvelinus Salmon fry	5'x10' x 1'	Dense brush mixed
L3L4	The Porter River. A small generally rapid brook running through a wide and shallow valley much of which is under cultivation. Tributary brooks to this River small on the average with dense brush giving excellent shelter throughout their length. Salmon fry and parr generally scattered and not common. Although at the time visited the flow was generally good, the main brook showed every indication of excessive fluctuation in volume.							
L4A Aug. 16	3'x6"	Fast	Good	19.0	Gravel	Salvelinus	Small	Dense brush
L4B Aug. 16	3'x1'	Fast	Good	20.0	Gravel	Semotilus	4'x10' x 2'	Dense brush
L4C Aug. 16	5'x1'	Fast	Flood	23.0	Gravel	Semotilus Salvelinus	Small	Dense brush
L4D Aug. 17	40'x1'	Fast	Flood	20.0	Stony	Salmon parr	Small	Dense mixed
L4E Aug. 12	30'x1'	Fast	Good	23.0	Stony	Anguilla	Small	Dense mixed
L4F Aug.12	30'x1'	Fast	Good	22.0	Stony	Salmon parr	30'x60' x 5'	Dense mixed
	Station D -- situated at entry into North Branch lake; Sta. E at outlet of same; Sta. F at junction with main river.							
L4R1 Aug.16	15'x1'	Fast	Flood	18.0	Stony	Salvelinus	5'x10' x2'	Dense mixed
	L4R1 -- Examined between Round and North Branch lakes.							
L4L1a Aug.17	20'x1'	Fast	Good	23.0	Stony	None observed	Small	Open mixed
L1L3 Aug.17	3'x6"	Slow	Fair	18.0	Gravel	Salvelinus	Small	Open mixed
L1L4 Aug.17	4'x6"	Slow	Fair	18.0	Gravel	Salvelinus	5'x30' x3"	Open mixed
	So far as could be determined the waters above the North Branch Lake on the L4 system are purely speckled trout waters and in general extremely well stocked with trout. Salmon parr were found only in the main brook just above and below the North Branch Lake.							

Date	Average Size	Speed	Flow	Temp.	Bottom	Fish	Pools	Margin
L5 Aug. 4	10'x1'	Fast	Fair	20.0	Stony	Salvelinus Salmon parr and fry Anguilla Semotilus	Small	Dense mixed

L5 This stream has been examined from the mouth to a point about 1¼ miles upstream. At 1 mile, there are two falls, the first 8' high, the second a series of 3 falls with an impassable 20' fall as the lowest. Salmon fry found only in the lowest ½ mile, parr common up to the 20' fall; speckled trout only, above the upper falls. Elvers abundant and actively moving upstream.

L6 Jly. 15	10'x1'	Fast	Flood	17.0	Gravel	Salvelinus Salmon parr and fry Anguilla	3'x5' x1'	Brush and open mixed

L6 MacAllister Brook - a popular trout brook. Salmon fry taken only in the lowest 100 yards, parr extending upstream for 300 yards, above the latter point only speckled trout. Parr scattered. Intensive seining on two occasions in 150 yard stretch at lower end yielded only 12 salmon fry and in a 200 yard stretch above this, 8 parr. Bed of stream badly eroded in lower section. Much emerged gravel at mouth.

L7 Jly 14	3'x3"	Fast	Flood	17.0	Gravel	Salvelinus Salmon parr and fry	5'x8' x1'	Brush

L7 Kelly Brook - Examined for ½ mile. Salmon fry taken at mouth, parr for lowest 100 yards, trout only above this. Intensive seining over lowest 100 yards yielded 2 fry and 3 parr. Volume of stream subject to great variation.

L8 Jly 8	10'x1'	Fast	Flood	16.0	Stony	Salvelinus Salmon fry and parr	10'x20' x2'	Dense mixed

L8 Horton's (Mill) Brook - An excellent trout brook and well stocked. Salmon fry taken only at mouth where stream enters into main river over a partially emerged gravel fan. Bed eroded in lower section. Ratio of trout fry to salmon fry at mouth, 6:3.

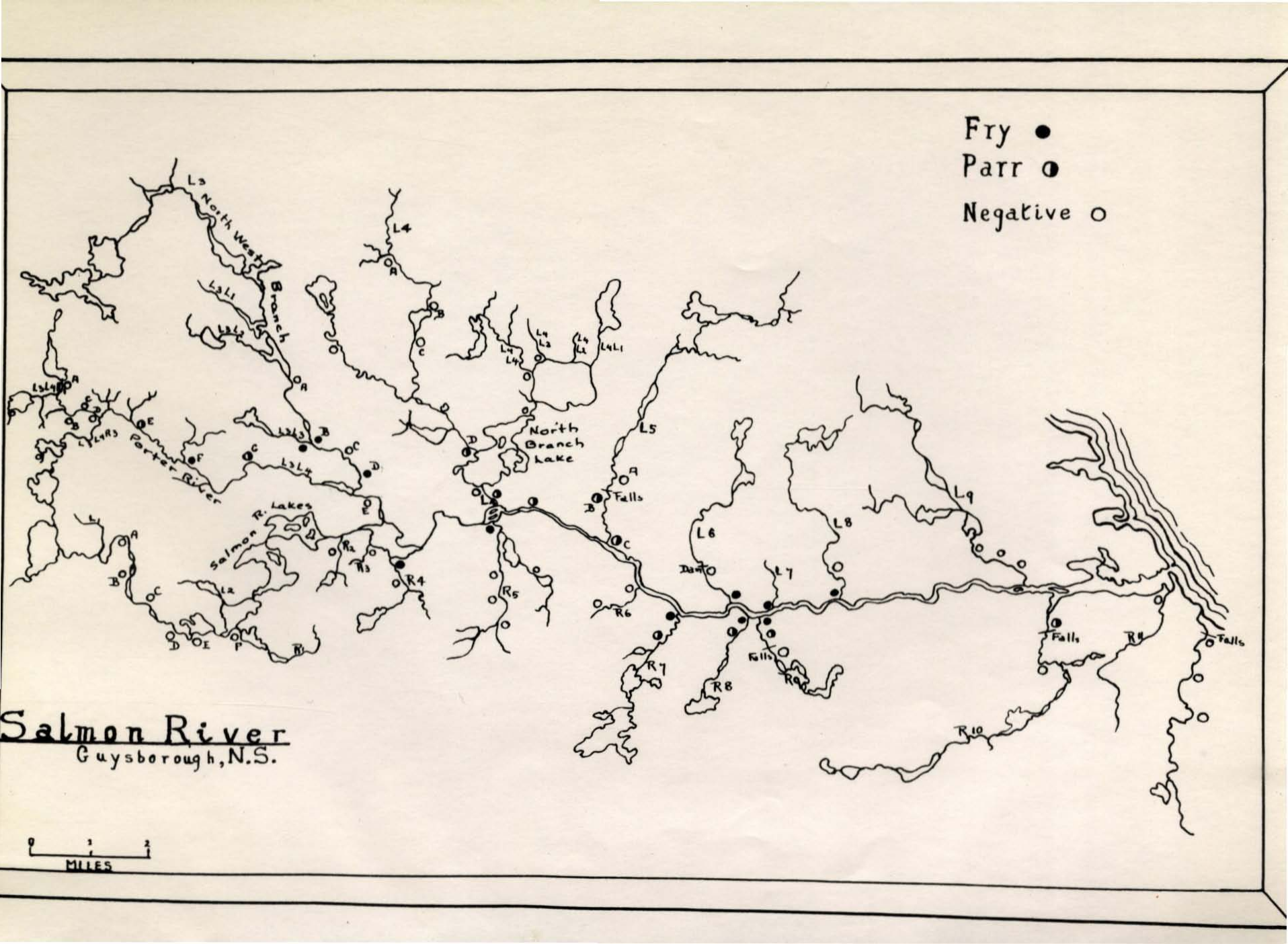
L9 Jly 7	12'x1'	Very	Flood	18.0	Stony	Salvelinus	Small	Dense mixed

L9 Tovy (Tory, Godfrey) Brook- Examined for 1 mile above Salmon River road and at entry into Salmon River. Two trout the only fish seen in this distance.

Appendix 2. Length-Weight Proportions of Parr and Fry.

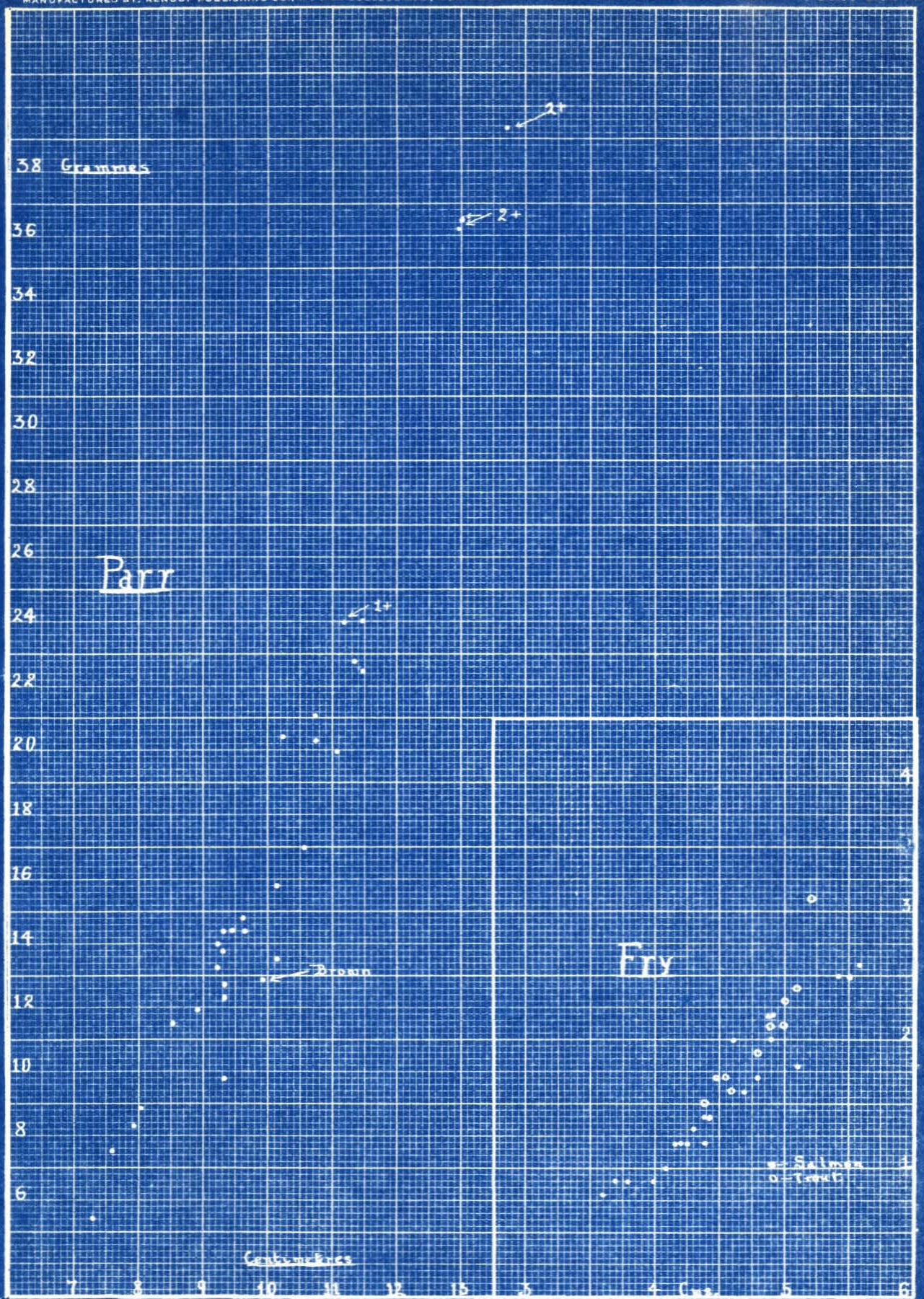
The following two figures give the length in centimetres and the weight in grams of salmon parr and fry, of speckled trout fry and of a single brown trout fingerling taken at various times during the summer of 1938. The measurements have all been taken from preserved material. The amounts of material was necessarily small and collections limited. In view of the exceedingly small salmon populations encountered, it was felt that no practical purpose would be achieved and probably much harm performed if all available specimens had been taken. Complete collections of all the salmon fry encountered during the summer would not have more than doubled the present figures.

A total of thirty-one parr, including five parr from the Guysborough River intervale and also one brown trout fingerling from the same location were preserved. Twenty-two salmon fry from the Salmon River and ten speckled trout fry from the same locations were also taken. Expressed graphically, there is no marked deviation or tendency to separate into two groups noticeable for the parr and such as would be expected if a second race were present. The speckled trout fry clearly run heavier per unit of length than do the salmon. Parr of 2 plus age were few. The largest specimen was taken from L5 on the Salmon, the other 2 plus fish were taken from the Guysborough intervale. The single brown trout was actually a yearling (1 plus) and small in comparison with the speckled trout of the same age. It was taken in association with the 2 plus salmon.



Salmon River

Guysborough, N.S.



Appendix 3. List of the Fishes Encountered:

Attention was directed to the non-game fishes with the particular point in view of determining their distribution throughout the system. Previous studies by the writer in other waters have shown a ready indication of modification in a system is given by the distribution (sic) of the minnows. The best trout waters contain only the speckled trout, the black-nosed dace (Rhinichthys atratulus) and occasionally the long-nosed dace (R. cataractae). The presence of other minnows in brooks is associated with and indicative of the operation of modifying factors. The above two minnows were not located in the waters studied during 1938. However, Semolitis stromaculatus, the chub is a common species. Elsewhere, the chub has been found to be the first invader of trout waters entering freely shortly after the effects of modification have become apparent. The distribution of this species is significant in this connection.

In the case of the Salmon watershed, the chub and other minnows are restricted to the main stream with very few exceptions and are common in lakes. Penetration up brooks is generally limited and evident only in the case of some of the short, small tributaries in the lower sections of the main river.

On this basis, the greater number of the tributaries are to be considered as natural and unmodified.

The problem of the factor, or factors influencing the salmon problem again appears thrown back onto the main stream and is probably to be correlated with the history of the spawning beds.

1. Petromyzon marinus Linnaeus:

Two post-larval specimens taken from the main stream of the Salmon River at the lowest station.

2. Pomolobus pseudoharengus (Wilson):

Post-larval specimens collected from the Salmon River Lake in August.

3. Salmo salar Linnaeus:

Previously discussed.

4. Salmo (Trutta) trutta (Linnaeus):

Specimens from the Guysborough intervale were examined. Of five specimens three were maturing males; two nearly gravid females. Specimens ranged from 9" to 11" in length. A single yearling taken from quiet water in the intervale. Of the fish examined, two had probably entered at least brackish water since the stomachs contained a small number of Littorina sp. Other food noted, caddis-larvae (very common), spiders, and a single elver (3").

Moderate infections with Echinorhynchus sp. in the rectum of two males and of one female. Eubothrium sp. in stomach of one male.

5. Salvelinus fontinalis (Mitchill):

The Salmon River system is well stocked with speckled trout; the Guysborough, less so. In both cases, with the exception of migrating fish, the trout is restricted to the tributaries and lacking from the main stream. Trout in the tributary brooks are generally small, but it is not difficult to locate fish of 11" in the moderate-sized streams. There is apparently little fishing for trout in the brooks and many of the brooks could well be studied with a view to determining the habits and behaviour of the speckled trout in well-established waters.

Sea-run fish were located as high up the system as R5. The distribution of trout in R5 is worthy of record. Sea-run trout had taken up their position in the lower ½ mile of the brook, and were restricted to the larger pools. There was only the one fish to each pool. These fish ranged in length from 8" to 11". Smaller trout were present between the pools and in lesser pools along this stretch, and were readily divisible into three age classes, fry, up to 2¼"; yearlings, 3"-4"; and adults, 5" to 7". Above the point of penetration of the sea-run fish the smaller fish were distributed normally in the stream and crowding was not evident. In the waters occupied by the sea-run fish, it appeared evident that the entry of these much larger fish had seriously upset the normal arrangement of the fish in the stream.

The heaviest natural stocking I have ever seen in a brook was found at L4R1 where 35 trout ranging from fry to adults of 6" occupied a single pool only 25' long by 5' wide and 2' to 4' in depth.

Sea-run speckled trout from the Guysborough intervale ranged from 8¼" to 11" in length, the latter fish approximating one pound in weight. Of six fish, four were males, three females. All were nearly fully ripe. Three of these fish had been feeding heavily on caddis-larvae. A specimen from the Sea-pool, Salmon estuary, held a single Menidia in its stomach. Parasitism was normal in the fish examined, there being moderate infections with Echinorhynchus sp., Eubothrium salvelini and Crepidostomum fausti. The absence of nematodes from the fish examined was remarkable. A single sea-run fish apparently freshly in from the sea was heavily infested with Lepeiophtherius sp. The stomach of this fish was empty.

6. Menidia notata (Mitchill):

Listed here since a single specimen was taken from the stomach of a sea-run speckled trout and since specimens were common in the estuary of the Salmon River even in distinctly brackish water.

7. Catostomus commersonii (Lacepede):

No adult fish were seen with the exception of a single dead specimen on the shore of the Salmon River Lake. Nevertheless, this is a common species with a wide distribution in the Salmon, Guysborough and Larry's River systems. Larval and post-larval stages were common in the main stream in each case and in nearly all the lakes visited on the Salmon River system. The sucker was commonly associated with Semotilus and Pungitius.

8. Notropis cornutus (Mitchill):

Larval and small adult specimens of this minnow were observed in the Salmon River Lake and in the main stream at the lowest station. It was relatively a rare species. Larval stages were present in the lower stillwaters on the Larry's river.

9. Semotilus atromaculatus (Mitchill):

The chub is common in the main stream and many of the lakes on the Salmon River system. As mentioned previously, penetration into tributary brooks is very limited.

Abandoned nests of this species were found on July 15th at the lowest station on the Salmon River.

10. Pfrille neogaeus Cope:

This species was only located in the Salmon River system where small collections were made at the lower end of several of the tributary waters. A small group of 8 Pfrille were taken in association with salmon fry at R5.

11. Fundulus diaphanus diaphanus (Le Sueur)

A common species in backwaters, pools and other small quiet water-bodies along the lower portion of the Salmon River. Common in the Salmon River Lake and observed in several other small lakes in the River valley. Gravid females were taken in mid-July. The species is also present in the Larry's river.

A light myxosporidian infection is present in some of the males.

12. Fundulus heteroclitus(Linnaeus):

In brackish and salt water pools in the Salmon River estuary. Gravid specimens taken July 5th.

13. Anguilla bostoniensis LeSueur:

Specimens from 3" to 2' observed at various points on the Salmon River. The species is common in all parts of this watershed. Migrating elvers observed from July through to the end of August. Elvers were frequently observed in brooks in association with speckled trout of all sizes, salmon fry and parr. Yearling and larger speckled trout would readily eat injured elvers. At Cutler Brook, three eels 12" to 15" in length were taken from a pool also containing salmon parr, while at the foot of the impassable falls on L5 parr were associated with large numbers of eels up to 9" in length.

Elvers also noted in the Guysborough and Larry's Rivers, and in tiny inlet brooks such as that at Cook's Cove.

14. Pungitius pungitius (Linnaeus):

Common in pools, backwaters and other quiet waters in the Salmon River valley down to the head of the estuary. Gravid females taken up to the end of July.

15. Apeltes quadracus (Mitchill):

A prominent species in Zostera associations in the estuary of the Salmon River. Ripe males and females taken during the middle of July.

16. Gasterosteus aculeatus Linnaeus:

In pools along the lower portion of the Salmon river. Uncommon in fresh water. Observed once in association with salmon fry.

17. Perca flavescans (Mitchill):

In the Larry's and Salmon Rivers. Common in some stillwaters and lakes.

Appendix 4. Dwarfism in the Salmon of Larry's River:

Collections of "dwarfed" salmon were made from the head of the Trout Pond, Larry's River, on August 20th and again nearly a week later. On the first occasion four fish were taken; on the second visit, six. Associated species were S. fontinalis and P. flavescens. On both visits to Trout Pond, fishing was also undertaken at the top and bottom of the first and second stillwaters on the same system, but without taking any of these dwarfed fish. An earlier visit to the first and second stillwaters and to a point below the Squaw Pond in July yielded only speckled trout and perch.

The ten salmon have been found to be all male fish. All had spent two years of normal parr life. Three of the ten showed a subsequent year of accelerated growth; the remainder, two years. Accelerated growth does not approach that of sea-run fish but is greatly in excess of normal parr growth, so much so that even the smallest of these fish is more than double the weight of a normal

parr of similar length from the Guysborough or Salmon Rivers. At the same time, in the remaining fish it is apparent that the weight increment accelerates above that of length. The largest of the dwarfed fish, a specimen 22 cm. in length and weighing 285 grams, is less than double the length of the largest normal parr in my collections (a fish of 13.6 cm. in length, and weighing 39.3 grams) while the weight of the dwarf exceeds that of the normal parr by 245.7 grams.

The specimens collected are quite definitely Atlantic salmon. The first collection was of very handsome fish, dark in hue and with a strong golden color obscuring other markings. The second lot were silvery with clear and heavy parr marks and differed little from normal parr except in their greater size and relatively deeper bodies. Parr marks, seven to ten in number on each side, were obvious in all specimens following preservation.

Unfortunately the number of dwarfed salmon in my collection is too small for reliable graphic analysis of growth. The length-weight ratio when plotted gives a curve of similar slope to that of normal parr. The age-weight ratio shows the greatly accelerated growth of the last one or two summers.

Trout Pond is a natural pond, longer than wide and partially reduced by ericaceous-sphagnum invasion. The head of the pond is narrow (50' - 60') and shallow, being not more than four or five feet in depth. The brook entering at this point is ten to fifteen feet in width, averages only a foot in depth, with a good flow and running rapidly over a bottom of small stones enters abruptly into the head of Trout Pond over a gravel fan which extends some thirty feet beyond the mouth of the brook.

The majority of the fish were taken from over the gravel fan, the remainder from shortly below the fan. All were in the current and apparently occupying this position for feeding purposes since the disturbance of the stream bed on our approach to the head of the pond and later during fishing improved the take.

Recent workers (Orton, Jones, King- Proc. Roy. Soc. B. 125 etc.) have demonstrated certain aspects of the life of male salmon which appear highly significant in the present instance of dwarfism. Recognition must be given now to a tendency in male parr to mature before running to the sea. Cases have been recorded of mature male parr tending the redd and it is suspected even mating and spawning before migration. Such instances as have been given show that normally the matured parr form only a small percentage of the population but in some cases as high as 40% of the two and three year parr have been found mature. These mature parr are known to perform migratory movements and run upstream at the time of the run of normal salmon.

Ward (Proc. Nat. Acad. Sci., 18: 569-580 and earlier) has considered at length many cases of land-locking in salmon under conditions where barriers are present and also where the waterway is clear of obstructions. Ward has concluded that barriers, unless dry during the time of migration are not to be considered as preventing downstream movement of young or adult fish and that the criterion for the establishment of a "land-locked" race is the presence of a sufficient variety of habitats to fulfill all the requirements of young and adult life.

The conclusions arrived at by Ward and the demonstration of maturity in male parr indicates clearly that the sea-run is imposed on the salmon in consequence of the great variation in the habitats required to satisfy the needs of the young and of the adult fish. The migrations observed in land-locked fish are the equivalent of the migration to and the return from the sea in the sea-run fish.

The establishment of a land-locked race is dependent on their being a sufficiency of suitable habitats to accommodate the salmon throughout its life. To judge on the basis of known naturally and artificially developed land-locked races, these factors are the presence of spawning bed sites associated with streams to serve as rearing-grounds for the young fish and a large body of water of considerable depth to satisfy the requirements of the adult fish. Under these conditions the tendency towards land-locking is evident in the absence of barriers and even in the presence of normally migrating fish which are running to the sea.

Under the above conditions it has been commonly found and in many countries, Japan, New Zealand, the Pacific and Atlantic waters of the North American continent, and in Norway, that the land-locked races run to smaller sizes than the sea-run fish. Otherwise, the land-locked fish are closely similar to their original species, so much so that attempted specific and even sub-specific distinctions are seldom to be made and if made are created more on the basis of behaviouristic than morphological differentiation.

The present case of "dwarfism" does not appear clearly as the establishment of a land-locked race but on the basis of our present knowledge is better referable to the known habit of male parr to mature in fresh water without migration to the sea. It is significant that no females the equivalent of the present males have been identified as yet. In cases of established land-locked races the sexes approximate one another numerically and although it has been demonstrated that in artificially induced land-locking males predominate at first, nevertheless the numerical discrepancy between the sexes is soon reduced to virtual parity. The present "dwarf" salmon have been recognised and recorded by Dr. Porter since 1914. If the present case is one of race-evolution, it would be reasonable to anticipate that by now the discrepancy in the sexes would have been appreciably reduced.

This does not appear to be the case. Prior to the last summer, specimens have been examined by Dr. Porter and others and where the sex has been determined, the fish have been found to be males. In some cases the sex could not be determined. It is more probable that such fish were males than females, since the detection of the female gonad is always simpler than for the male and the female gonad can be identified over a greater period of the year with certainty than in the case of the male. The situation stands that no female fish the equivalent of the present males have been identified.

The present collection is of interest in that it is composed of two catches of "dwarfs" taken at an interval of a week from one another. While sex segregation is a common phenomenon during

spawning migrations, it is unlikely that a run of pure males would last a week and it is surprising that if there are equivalent females, none were taken on either of the visits. The distribution and behaviour of the fish at the head of Trout pond gave no indication of their being a migration in progress, but pointed to the fact that this is a favored feeding ground. Again, in the absence of apparent migration, the chances of females being present would be greatly increased by the fact that this is a feeding ground and that the fish were not obviously migrating.

Until several females salmon, the equivalent of the present males have been taken, this "dwarfism" is referable only to the established habit of male parr to mature in and remain in freshwater. The occasional taking of similar fish from other waters in this vicinity favors this concept equally as much as does the fact that from all accounts there is no indication of a significant population of these fishes in any of the waters.

However, the present case is most valuable and significant in that the male fish are known to have spent up to five years in the freshwater over and above their normal parr life. It is apparent that the imposition of the sea-run habit is less marked in the case of the male than of the female fish. This has been evidenced previously in the maturation of male parr before running to the sea; in the early development of male preponderant populations in cases of artificially induced land-locking; and in the present case where it appears that the conditions of river-life are favorable to the requirements of the male fish throughout a normal span of life.

It would appear from all accounts that the male parr taken from the west branch of the Larry's river have been spawned in the east branch since normal runs of fish into the latter portion of the system are well known. The male fish while dropping down to the sea have matured and in consequence before reaching the sea have started upstream again. The females which do not mature in the freshwater have continued their normal descent into the sea. The ascent of the male parr leads them into the west branch where the salmon population is low and feeding and other conditions apparently sufficiently suitable for these fish to remain in these waters without further reference to the sea. Even if there is a spawning of normal salmon in the west branch the segregation of the sexes would be produced in the same fashion.

In view of the absence of equivalent female fish, the low density of "dwarf" fish in normal salmon populations, the discontinuous distribution of these "dwarfs" and their occurrence in several separate watersheds, and in view of our present knowledge of the habits of male parr, the present problem is one of unduly prolonged male parr life, and the possibility of race-evolution is scarcely tenable at all.

Supplement to Dr. Richardson's Report of November 25th, 1938.

By Dr. J. B. Porter.

Dr. Richardson's report on Salmon River is, in my opinion, an admirable piece of work and remarkably complete in view of the limited time and money available. It is to be regretted that these limitations prevented detailed study of any other of the rivers of the immediate neighborhood, and no examination at all of several of these streams, but I think he was wise to deal as adequately as possible with Salmon River, which is by far the largest and most important stream in the district, rather than to attempt what would, under the circumstances, have been of necessity a very hasty and inconclusive examination of the larger field.

It is to be hoped, however, that his work may be extended to the other waters in the early future, although probably none of these smaller streams will require anything like the detailed study given to Salmon River. It is also regrettable that it has not been possible to deal with the peculiar large non-sea-going parr found in certain of the smaller rivers. I understand, however, that Dr. Richardson is preparing another, but shorter paper on these special fish in so far as he was able to observe them during two or three brief visits.

Dr. Richardson's report necessarily deals with Salmon River as observed in only two months of the one summer of 1938, and attention should be called to the fact that it was once a notable salmon river, and even in the years before say 1930 it had quite a number of fish up from the sea each summer, and afforded from ten to thirty or more salmon and grilse each year to anglers. Also, contrary to Dr. Rich-

ardson's 1938 observations the main river and its lower tributaries at least had an ample stock of parr and smolts and a good run of sea trout. These fish have decreased and at last practically disappeared within the last few years, only two salmon having been observed in 1937 and 1938, and no parr in the main stream. Sea trout also have been so rare that the river has become useless for angling, except that the entrance to the sea at the break in Salmon River beach sometimes affords sea trout in May and early June.

The above changes are in spite of several plantings of young salmon and possibly of trout fry in the upper waters in recent years, and the present dearth cannot possibly be charged to over fishing. The river has, however, been largely used for pulp log driving for ten or more years. Also it had a dam without an effective fish ladder for many years below Salmon River Lakes and all migrant fish were completely barred from the extensive upper waters. This dam was destroyed several years ago and a very few fish ran up, but the damage had already been done and the river has never recovered.

As for other streams in the immediate district of northern and north-eastern Guysboro County and the adjacent parts of Antigonish County, I need only note that the conditions as re fish life reported in my little paper of last spring remained without change in 1939. There was ample rain during the early summer and sufficient showers all summer long to keep the streams at a decent level, but the exceptionally dry weather of the several preceding years had done their mischief all too well, and had so

reduced both catchable fish and also young of both salmon and trout, that none of the waters showed appreciable recovery and and the future, both as regards angling and the salmon stock for the shore nets, is as dark as before.

In addition to the above general notes, there are certain details of Dr. Richardson's report on which special comments may be illuminating.

Porter River, page 4 , is stated to be "exceptional " in that it has young salmon and more of them than any other branch of the river, many of which have none. This stream is really nothing but a fairly large brook, and it joins the main river above Salmon River Lakes, in other words at a point well above where any adult salmon have been observed for a great many years. This little stream is, however, exceptional in other respects as pointed out in one of my earlier reports. It is the only tributary of Salmon River which flows in the main part through a granite area and it provided me some years ago with several typical dwarf salmon like those of Larry's River and other granite area streams, but unlike anything found in other Salmon River waters. As these dwarf salmon, only 10-11 inches in length, have been taken in spawning maturity in Larry's river, is it not quite possible that the young fish taken by Dr. Richardson in Porter River are not the progeny of non-existent or at least not observed normal salmon from the sea, but are the young of local dwarf salmon which are already known as rare, but proven inhabitants of Porter River itself?

Dr. Richardson, on page 6 , refers to salmon from the sea spawning in Porter River, but unless I am greatly mistaken he bases this on the fact that he found many fry and parr in the water. He observed no large salmon, however, nor has any one else seen any for many years, and I venture to suggest that his Porter River fry are a purely local product of its dwarf salmon.

Finally, Dr. Richardson did not test his waters for acidity, nor did I find low pH. count even in the bog streams of the granite areas in 1938, as the heavy rains of last year overwhelmed stale bog water with fresh normal water. In the preceding years of abnormally dry summers, however, some of the streams in the granite areas did show slight acidity, although this was never observed in Porter River or any of the few Salmon River tributaries I tested, and in view of the opinions of certain observers that acidity not only prevents salmon from taking the fly, but probably prevents successful spawning, it is possible that this factor may have played a part in the disappearance of young salmon in several of the other streams of the district.

Montreal, January 1939

ATLANTIC SALMON INVESTIGATIONS

1938

Report No. XI. The marking of Smolts on the Margaree, 1938

By Harold M. Rogers.

During the spring and early summer of 1938, over 27,000 smolts were marked at the Etheridge Trap on the North East Margaree in Cape Breton, N. S., by shaving off the adipose fin with a razor blade. With the addition of those marked by H. C. White at Forest Glen brook, some fifteen miles farther up this stream, the total number approaches 32,000 fish. The objective of 100.000 was not reached due to the fact that the Etheridge Trap was not in operation until the smolt run was more than half over.

Prior to the establishment of the trap on June 6th on the North East branch, some 2½ miles above the Forks, a trap had been constructed from the property of Martin Chisholm on the west bank of the main river just below the head of tide. Work was begun on May 17th, and completed in ten days' time. With the funds available, the site chosen was the only place where the current would permit a trap to be constructed below the Forks at that time, but as construction neared completion, the river dropped to such an extent that the trap, which depended on the current for efficient operation, would not function satisfactorily. In addition, the number of gaspereaux which began to clog it made it imperative, that if a successful trap were to be operated, it must be located at some place where the gaspereaux would be but a minor nuisance.

The Chisholm trap consisted of an enclosure of which one side was formed by the west bank of the river, laths composing the remaining sides, and the whole anchored in place by triangles. On the up-stream side was a V-shaped opening. From one side of this opening ran the leader or wing which pointed upstream at an angle of 45°. (See Fig. 1) It had been proposed originally to form the wing from three-inch netting, but due to the current, gaspereau menace, and appreciable amounts of drift wood, it was finally constructed of sections of laths, 7 feet deep, and averaging 11 feet in length, the whole being slung by wires from a steel cable stretched across the river where the water averaged 8 feet in depth.

On June 1st, the trap was dismantled and trucked to the North East where William Etheridge gave permission for the trap to be set up from his property on the Long Reach just below the Wash Pool. A new trap proper (Fig. 2) was constructed, a description being contained in later pages. The river at this point was about 200 feet wide and quite shallow (between one and two feet) except for a narrow channel some four feet deep on the opposite shore. The ten seven-foot sections from the Chisholm Trap were sawn in two lengthwise, thus giving 20 sections 3½ feet deep, the total length being about 220 feet. With three additional sections, the wing stretching across the stream assumed a length of 260 feet. Each section was supported by a 9-foot spruce triangle, the whole approaching at an acute angle to within 15 feet of the farther side, where it terminated at the edge of the channel that was left open for ascending fish.

The first catch was made on June 2nd, with the run extending to July 3rd, the last week characterized by a considerable falling off in numbers taken.

During the course of the run, Mr. White put special marks on the fish which he liberated, each new mark replacing the one used previously, so that only one design was in use at a time. In the following table, the marks used are indicated under the letters A to I, the dotted horizontal line representing the lateral line of the fish. The figures indicate the number of fish taken in the Etheridge trap. The time of liberation of Mr. White's marked fish at Forest Glen brook is indicated.

By noting the time of liberation by Mr. White of certain of the marked fish, the speed of descent may be calculated. There is evident a wide variation in the time of descent, some individuals making the 16 mile trip from Forest Glen to the Etheridge trap within 12 hours, as occurred with those fish marked with design D on June 10th. A freshet on that date no doubt accentuated the speed of their descent. Other fish took weeks to negotiate the same distance. Indications are that the majority came down within two or three days. Of the fish marked with design B, about 65% had descended by the end of the second day. This percentage is approximately true for the other groups also, with a little more than 30% going down the first day.

Date	Time	No. of fish marked	Total	No. of Forest Glen fish captured. A	B	C	D	E	F	G	H	I
				Time Liberated Up to June 7	June 7 7-9 p.m.	June 8 8.30-10a.m.	June 10 9a.m.	June 9 2.30 p.m.	June 12 4.30 To June 15 9 a.m.	June 18 10a.m.	June 21 a.m.	June 29 4 p.m.
June												
3		97	97									
4		514	514	6								
5		439	439	4								
6		1597	1597	24								
7	a.m.	2183		51								
	p.m.	1813	3996	47								
8		1924		39								
		3327	5251	85								
9	noon	3413		105	8	9						
	3 p.m.	2289		90	14	13						
	5 p.m.	1939	7641	47	5	8						
10	a.m.	1047		20		10						
	p.m.	459	1506	13	1	1	10					
11	a.m.	744		20		5	22	4				
	p.m.	825	1569	42	3	3	25	11				
12	a.m.	402		5	1	1	3	3				
	p.m.	385	787	18		4	12	2				
13	a.m.	About 250	record lost									
	p.m.	299	549	13			5	9				
14	a.m.	258		8	1	1		3				
	p.m.	311	569	5		2	5	2				
15	a.m.	537		15	3		8	1				
	p.m.	300	837	17	2	1	5	5				
16	a.m.	520		15	1	2	1	1				
	p.m.		520									
17	a.m.		239	3			4		1			
18	a.m.		386	6		1	6		1			
19	a.m.		228	2			1					
20	a.m.		133				2	2	1	3		
21			122				2			3		
22			57	1			6		1			
23			20	2								
24			16									
25			7	1								
26			6						1			
27			6									
28			12									
29			15									
30			70	3	1		1	2	1	1	1	
July 1			32			2						
2			54	1		1	1				2	
3			7									
4			5				1					1
5			0									
			27,289	711	40	64	120	45	6	7	3	1

No. marked by White 2761 211 204 575 179 53 32 19

Total number of fish marked at Etheridge trap = 27,289

" " " " " Forest Glen = 4,034

" " Forest Glen fish captured = 997

The efficiency of the Etheridge trap which did not completely block off the Margaree may be calculated by comparing the number of marked fish taken with the total number of those which had been liberated previously by Mr. White. Mark A cannot be used in this computation since these fish were already going down before the Etheridge trap was in operation, but the total of all fish marked after A may be used for this purpose. 1273 such fish were liberated, 286 of them being taken in the Etheridge trap. The Forest Glen trap which completely closed off the brook was supposedly 100% efficient so that the efficiency of the Etheridge trap was then but $\frac{286 \times 100}{1063} = 27\%$.

The smolt population on the North East and its tributaries may be estimated in this fashion: by comparing the numbers of Mr. White's marked fish taken in the Etheridge trap with the unmarked ones captured there. This works out to be roughly 3%.

The total number marked by Mr. White was a little more than 4000. If this represents 3% of the number of smolts on the North East Margaree, then the total population is approximately 133,000 fish.

There is a considerable probable error in this calculation due to the fact that the Etheridge trap was set up late in the season, so that only figures for the last part of the run may be used. The figure of 3% is applicable more probably to the mountain brooks and upper reaches, most of the fish from the lower Margaree and its tributaries having presumably left the river at the first part of the season. The percentage of Forest Glen fish to these latter would undoubtedly be smaller than 3%, and hence the total population of smolts on the North East Margaree is undoubtedly considerably above 133,000 fish.

Other fish taken in the trap.

In addition to the smolts, a few other fish were taken in the trap. The most numerous of these were spent gaspereaux which at the height of their return run numbered a hundred or more per day. Gaspereaux began to enter the trap on June 4th, the run terminating with the end of the month. These fish on the whole seemed to be in very poor condition, many dying either within the trap or after having been placed outside.

During the course of the marking, two slink smelts were taken, a finding which surprised many of the local people who had never heard of smelts ascending farther than the Forks. They apparently penetrate occasionally for some distance above the Forks since two specimens were taken by P.F. Elson at the Trout River trap in Lake Ainslie.

A slink shad was also taken in the Etheridge trap on June 26th. Suckers were occasionally captured, there being two main sizes, 3 to 5 inches, and 2 to 3 pounds.

Trout of all sizes now and then found their way into the trap and were also marked and liberated.

Eels frequently entered, usually making a meal of smolts before being removed. The stomach contents of one 2½ foot specimen consisted of five freshly consumed smolts.

One specimen of Morone americana was taken, it apparently having been carried from its normal habitat by the high turbid water of the freshet of July 1st.

Several of the marked smolts were destroyed by large two to three pound trout which frequented the vicinity of the trap waiting to snap up the smolts as they were tossed into the water following the marking procedure.

Many fish were captured more than once, marked fish appearing in the trap from time to time. The marked individuals after being tossed from the trap below the lead frequently worked their way through the lath work of the wing or made their way around the up-river end of the lead and thus found their way again into the trap. On one occasion when an especially large number of repeaters was encountered, examination revealed a hole under one of the sections of the wing. Plugging of the aperture stopped this large influx of already marked fish.

Factors determining the movements of the smolts.

Evidence gathered this summer seems to corroborate the belief that there is more than one factor governing the descent of smolts from the upper reaches of the river. The very fact that smolts begin to move in the late spring at which time the river water is beginning to warm up suggests that temperature is of prime importance in initiating the run of fish, for it is a well known fact that up to a certain point, temperature increases the activity of many cold blooded animals.

The temperature curve as recorded by the thermograph at the Etheridge trap is seen in Fig. 5.

The accompanying graph, (Fig.6) shows the numbers of smolts marked per day. The greatest number were marked on the 9th of June after which time there was a falling off until the 28th of June which saw another rise in the curve. The scale of this latter part of the curve of marked fish (from June 20 on) has been increased to show detail more clearly. This last peak, June 28 to July 3, is very small compared with that of June 15 which in turn is almost insignificant when compared with the peak of June 9, but following as it does a steady decline in numbers, its presence seems significant.

Care must be taken in interpreting the main run of June 6th to 10th. It must be borne in mind, that, although the trap began fishing on the 3rd, it was not completed until the 6th, so that June 7th is the first catch that can be called a true indication of the state of affairs, catches previous to that time being but partial catches as compared with the succeeding ones.

Light intensity is another factor obviously affecting the movements of the fish. The greatest catches during any 24 hours were always made at night; at those times when only a few fish were running, there was only an occasional capture or perhaps none at all during the day, but as soon as darkness fell, they began entering the trap.

The opacity of the water may also be considered under the general topic of light intensity, since turbidity diminished appreciably the penetration of light into the water. On all occasions when the water was turbid, there was an increase in the catch of smolts. Such opacity of the water occurred at times of spate when heavy rains washed silt into the water. Not only was the water rendered dark on such occasions, but the level of the river rose, and the strength of the current increased, two factors which tend to bring in complications, and which must be considered in working out the factors determining the movements of smolts. Since high water was always accompanied by a certain degree of opacity, it is difficult to say to what extent high water along affected the fish. If we may compare the smolts with sticklebacks, then we may conclude that there would be a run of smolts during high water even if it was perfectly clear, the influencing factor being however, not height of water, but rather velocity, a factor which inevitably accompanies an increase in water level. With the sticklebacks at the mouth of the harbour, it was noted that unusually large numbers were carried out not only during times of spate when the water was rendered opaque, but also during spring tides when the out-

flowing current was stronger than usual, and when incidentaly, the water fell to a lower level than usual. If this comparison is valid, then it would seem that velocity of the current which increases with rise in water level is also a factor influencing the movements of the young salmon.

On the night of June 8th-9th, a precipitation of .835 inches occurred, and next day the level of the water had risen some eight inches; it was murky and swift. During the next day, the 9th, the largest catch of the season was made, 7641 fish being marked. Not only was the water dark and swift, but the mean temperature on the 9th, though differing little from that of the 8th, was considerably above that of the 7th, which day also experienced an appreciable run. During the 8th, an increased temperature may well have been the cause of the increase in numbers of fish over the 7th, while on the 9th, the freshet, in addition to this high temperature, may well have been the cause for the increase of the 9th over the 8th. On the 10th, though the water had fallen considerably, and the temperature had decreased markedly, the water still contained appreciable amounts of silt. The comparatively very small catch for this day however, seems to be related not so much to these above conditions, but to the fact that on the proceeding day, the great majority of the fish in the river had already gone down. No subsequent catch of any appreciable figure was handled.

On June 30th, another increase in the numbers taken occurred, and though small when compared with the other peaks, it had a significance in that it is a repetition of what occurred on June 9th. The numbers of fish descending at that time (last of June) were small, but the freshet of June 30th with its accompanying increase in temperature served to increase the run of 15 individuals on June 29th to 70 on June 30th. This last radical change in the condition of the river apparently brought down the last few fish remaining, since after July 4th, no further specimens were taken.

Description of the Trap.

Figures 2,3, and 4 show the construction of the trap which was designed by H. C. White. The purpose of the trap was the capture of as many smolts as possible, and the retaining of them until marked. Long wings on the up-river end guided the fish into the mouth of the trap. To function, a current of water of appreciable velocity must be constantly entering the trap, carrying the fish with it. In order to facilitate removal of the water which enters the trap, the walls, were made of upright laths of 1" x 1½" material, (one inch boards sawn in 1½ inch widths) placed ¼ inch apart. A four or five inch difference in water level was not uncommon between the mouth and the inside of the trap.

The overall length was 15 feet with a width of 7 feet and a depth of 3½ feet, and the floor was of 1" boards. The V-shaped opening extended half the way to the rear, where it was narrowed down to about 8 inches. The V was continued back for another 2½ feet by window screening supported on a frame, the opening at the end being but 4 inches in width, an addition which increased the efficiency of the trap considerably, passage of water through the screen further tending to distract the attention of the fish from the opening.

In future construction, it might be well to make the converging wings of the mouth (A in Fig. 2) solid. With the wings made of laths as at present, the 4 or 5 inch difference in water level on the two sides made a miniature fall between each lath at which the fish would often jump with danger of self injury. They also tended to wander along the wings in

these incoming jets of water, some finally coming back to the entrance and making their way out. It has been suggested that the leading faces of the trap (B in Fig. 2) be made of coarse wire netting to permit a greater flow of water in at this point, which, along with the solid walls at A would tend to keep the fish headed into the forward end of the trap away from the region of the entrance.

Weather, N. E. Margaree, June 1 to July 10, 1938.

	A. M.		Noon		P.M.	
	Sky	Rain	Sky	Rain	Sky	Rain
June						
1	Bright, fine	-	Bright, fine	-	Bright, fine	-
2	" "	slight rain last night	" "	-	" "	-
3	" "	-	" "	-	" "	-
4	" "	slight rain last night	" "	-	" "	-
5	Dull		Fine	-	10	-
6	9	.035 in.	Dull	-	10	Drizzly
7	Fine and warm all day					-
8	" " " " "					-
9	Drizzly	.835	Dull	-	Clear, fine	-
10	Dull	-		-	Fine	-
11	0	-	Fine	-	0	-
12	Dull	.156	Dull	-	Dull	-
13		-		-		-
14		-		-		
15		-		-		-
16		-		-		-
17	Dull	-	Raining			.225
18		-				-
19	Dull	.223	Dull		Dull	-
20	Dull	-	Dull		7	-
21	Fine	.08	Warm, fine	-	Fine	-
22	Warm, bright	-	Warm, bright	-	Warm, bright	-
23	" "	-	" "	-	" "	-
24	" "	-	" "	-	" "	-
25	" "	.018	" "	-	Warm, foggy	-
26	Wet	.170	Wet, drizzly	-	Wet	.248
27	Rainy, warm	.046	Rainy	-	Rainy	.33
28	Dull, rainy	.100	Drizzly most of day			-
29	Dull and rainy all day					
30	Dull	.63	Sunny		Fine	
July						
1	Fine all day though not sunny at all times					
2	Weather dull all day					
3		-		-		-
4	Rainy and dull all day					-
5		-		±		-
6	Dull	-	Rainy	-	Dull	-
7	Dull		Drizzly		Dull	-
8	Fine and warm all day					-
9	Cloudy and dull all day					-
10	Fine and warm all day					1

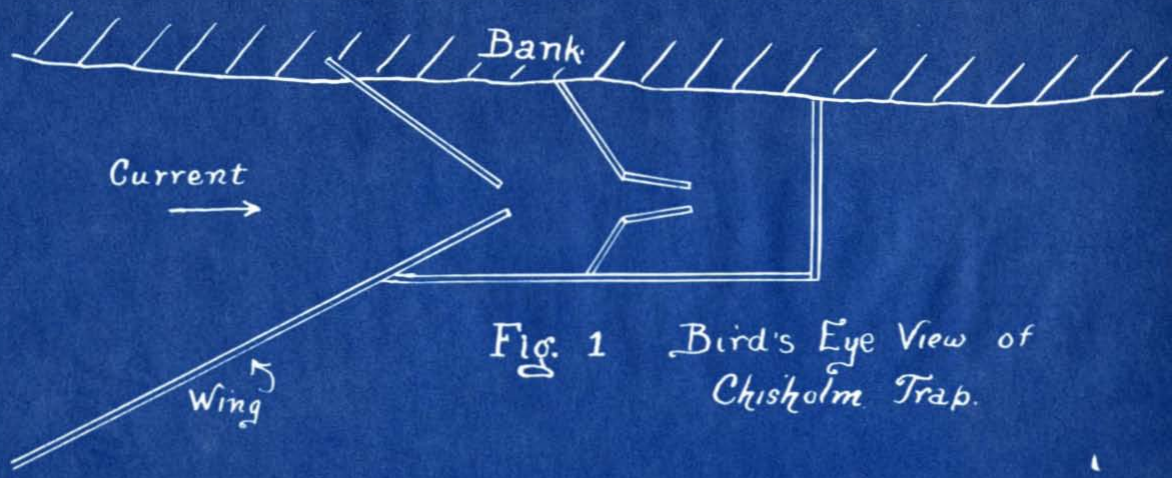


Fig. 1 Bird's Eye View of Chisholm Trap.

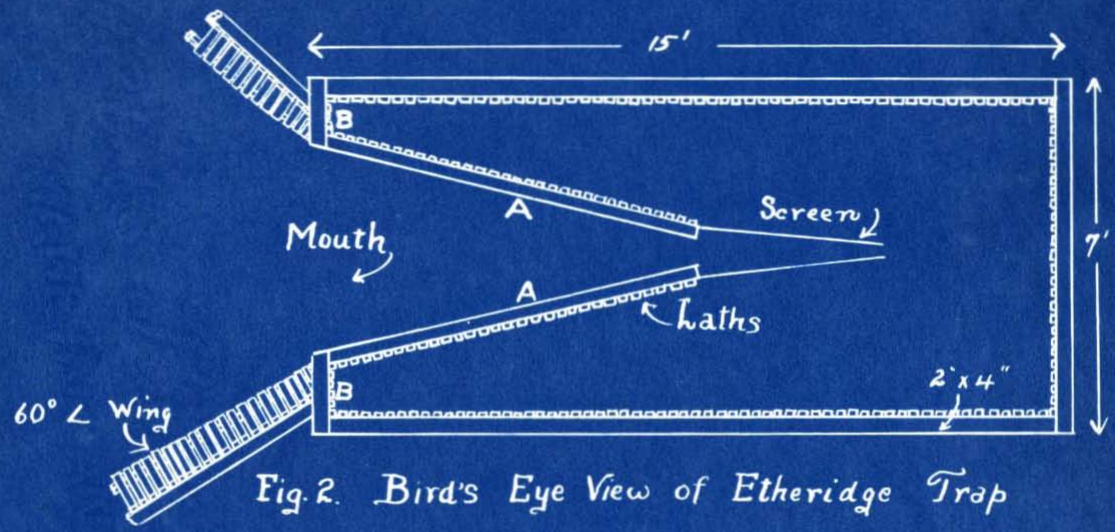


Fig. 2. Bird's Eye View of Etheridge Trap

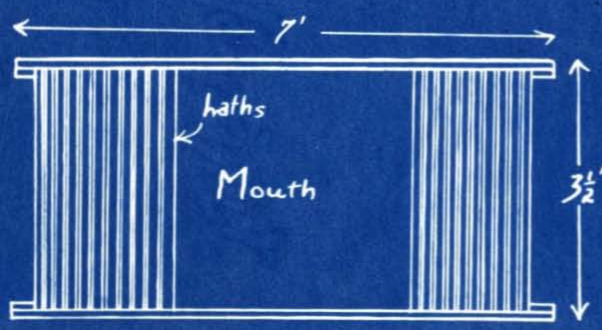


Fig. 3. Front View of Etheridge Trap.

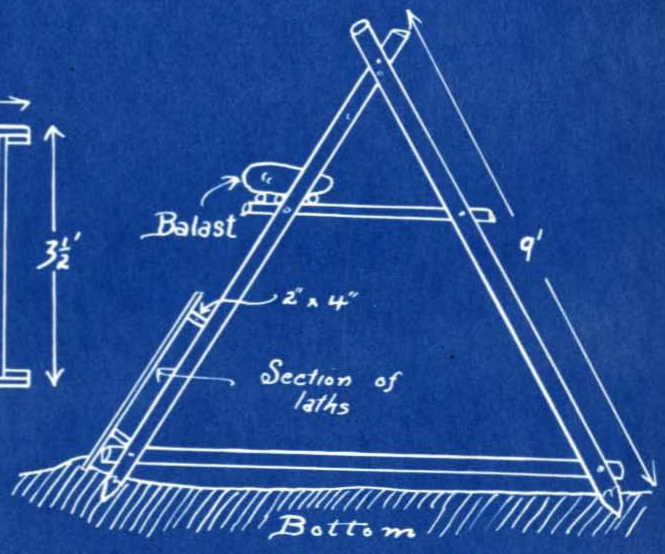


Fig. 4. Spruce triangle

Fig. 5 Temperature Record, Etheridge Trap.

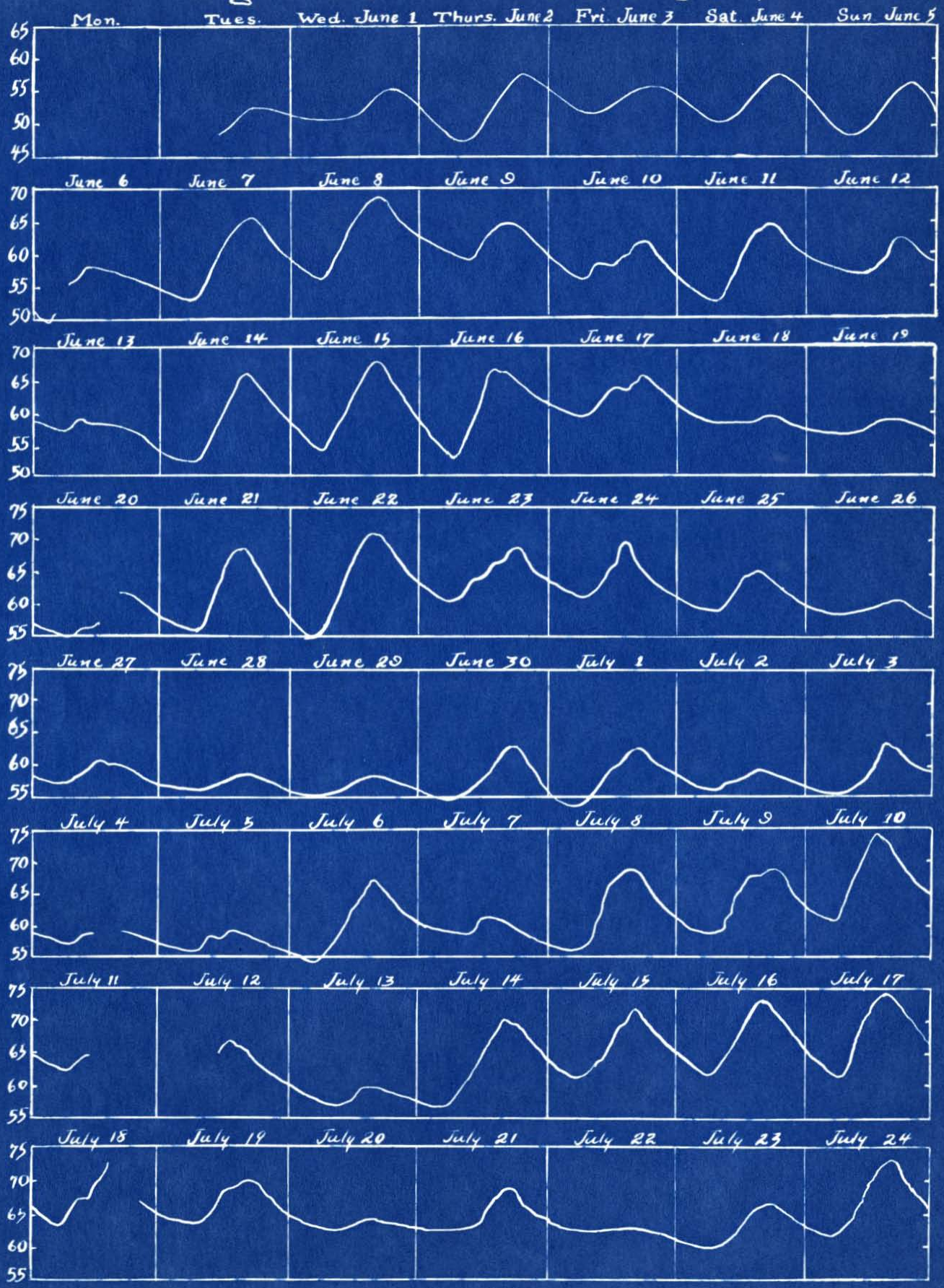


Fig. 6. Smolt Catch at Etheridge Trap.