FISHERIES RESEARCH BOARD OF CANADA

MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No.

498

Title

FISH (SALMON) MANAGEMENT

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FISH (SALMON) MANAGEMENT

VOLUME XLVI

CONTENTS

FISH (SALMON) MANAGEMENT

1951

REPORT NO. I. Report by V. M. Davidson.

1. Salmon Angling in Shubenacadie Lake in 1951.

Collection of Results

On April 10, I arrived at Wellington and commenced preparing the laboratory for the work of the summer and collection of data from the anglers as soon as the season opened on April 15. There was keen anticipation on the part of the anglers since Shubenacadie Lake and its tributaries were entirely free from ice as the result of a mild winter and early spring. I visited Mr. Andrew King who resides near the mouth of the lake and Mr. Aaron Morash at Grand Lake Station, both of whom have assisted us in previous years and arranged to pay each of them a reward of 5 cents per fish for examining all untagged fish for our marking and 25 cents per scar for the marked fish. This was an innovation and to be in addition to the usual payments for handling the rewards for tagged fish. To these gentlemen and to Mr. W. H. Cameron, Superintendent of the Rearing Ponds at Wellington, and his staff who cooperated so willingly during the summer I extend my thanks.

Sunday, April 15, was a pleasant spring day and anglers were busy at all the favourite fishing grounds in the lake

as well as in the head waters. At Wellington I could scarcely handle all the data from the recaptures of salmon tagged in 1950. Fish were brought in so rapidly that the little laboratory was crowded with anglers and some of the fish became dry on the exterior before they could be weighed, measured and have a sample of scales removed. Fish were brought in from more distant parts of the lake for examination and payment of rewards long after dark. It was impossible to find time to open all the fish to ascertain what they were feeding upon and a selection had to be made to cover the various sizes and the different fishing grounds. The fact that so many anglers came directly to the laboratory from as far as Kinsac Lake is evidence that they were well informed by our form letter which had been sent out previously as to the data required before rewards would be paid in full for tags submitted. Then too, I had an opportunity of inspecting the rest of the creel for marked fish and naturally produced salmon. It was interesting to hear the comments of the anglers, they were delighted with the condition of the fish, with their activity when hooked but disappointed in the size of the tagged fish and returned some of the latter to the lake as too small to keep unless badly injured in capture. The angler with the worm for bait who was content to fish from the river bank got his fish as readily as the one with expensive lure and the motorboat. In fact, a large part of the catch made on the opening day came from the head waters of Shubenacadie Lake and from the mouths

of the Fletcher and Rawdon Rivers at Wellington. The numbers of pond fish and naturally produced fish as taken on April 15 from the chief regions for angling are shown in Table No. 1.

Table No. 1. The numbers of salmon reported caught by angling on April 15, 1951, in the head waters and the chief regions of Shubenacadie Lake.

Beaver-Rawdon head waters		Head of Shubenacadie Lake		Grand Lake		Region of the mouth		Little Lake
Tagged and marked	Untagged and unmarked	Tagged and marked	Untagged and unmarked	Tagged and marked	Untagged and unmarked	Tagged and marked	Untagged and unmarked	
20	3[x]	75	0	10	12	4	3[x]	0

[x]Report incomplete.

The following week and weekly thereafter as long as it seemed advisable, I visited King Station and Grand Lake Station to collect information and pay rewards. I discovered that during the first two weeks of the season illness and bereavement had prevented Mr. King from collecting as comprehensive data as usual and that during the season the work of Mr. Morash, who was in failing health and passed away in August, was done very efficiently by his daughter, Mrs. Beanlands, and her husband.

During the season 61 names and addresses were added to our already large list of anglers in Shubenacadie Lake.

Conditions for angling

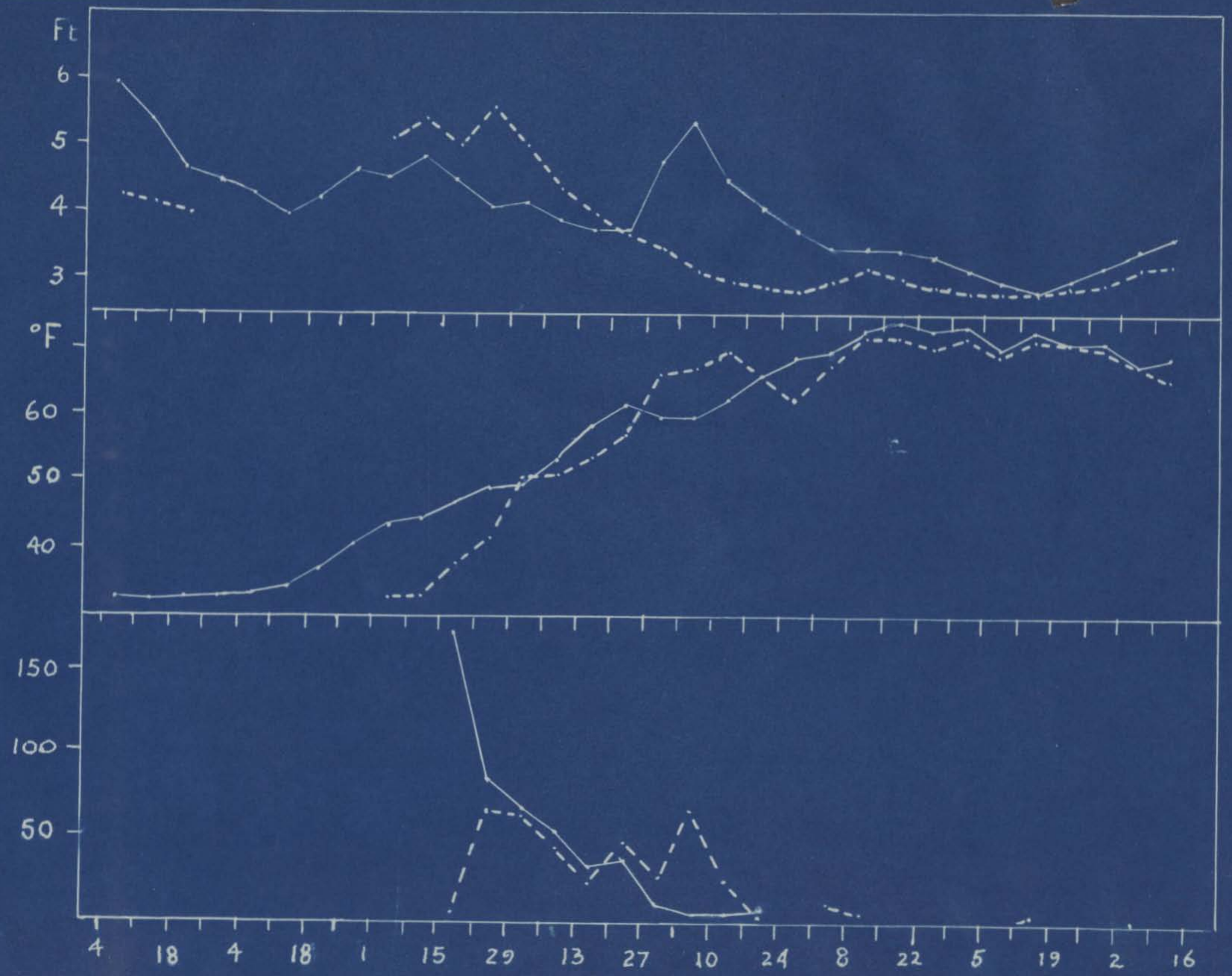
The scarcity of boats for hire when the angling season opened so favourably led to more than usual angling from the shores of Shubenacadie Lake at Grand Lake Station, the

broad part and from the banks of the Fletcher River near its mouth. The weather was less windy on weekends than in 1950 and as far as could be determined, the angling effort was as great as in previous years in spite of the early promise of good angling not being maintained as the season advanced.

Height of the water

Precipitation in the Shubenacadie Lake region according to the report from the Meteorological Station was near normal during the spring months of 1951, except for heavy rain at the end of May, which produced a freshet of major proportions. Mild weather with little snow during the winter allowed the water from the heavy autumn rains to drain gradually off and the height of the water at the mouth of the lock between the Fletcher River and the lake had decreased to 4 feet by the middle of March. Figure No. 1 and Table No. 2 show that between April 15 and May 31, while the height of the water was decreasing after early spring rains, most of the salmon were caught (97%), and, although the angling levelled off during the May freshet, there was no increase in the catch after the freshet. In contrast to 1951, the precipitation in 1950 was sub-normal during the winter and spring and the level of the lake remained below 5 feet except during the rapid melting of an unusually late fall of snow in April. Afterwards the height of the water decreased until it reached less than

Figure No. 1. The average weekly height (feet, the average weekly temperature (degrees Fahrenheit) of the water of the Fletcher river near its mouth and the total numbers of salmon reported caught in Shubenacadie lake and its head waters from February 4 to September 15 of 1950 (broken line) and of 1951 (continuous line).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three feet in June, a level not reached in 1951 until August. The numbers of naturally produced salmon reported caught in the two years differed little (284 in 1951 and 297 in 1950), and, although the low water was suggested by the local anglers to be responsible for the small total catch in 1950, the angling continued during the low water into June and July and the higher water in the lake in 1951 did not result in more fish for the anglers or an angling season as long as in 1950.

Table No. 2. The average weekly height of the water at the head of Shubenacadie Lake, the average weekly temperature of the water and the total number of salmon reported caught by angling in Shubenacadie Lake from February 4 to September 15 in 1950 and 1951.

Week beginning	Aver. Ht. (feet) 1950	1951	Aver. Temp. (°F.) 1950	1951	Total number salmon caught 1950	1951
Feb. 4	4.3	5.9		32.5		
11	4.2	5.4		32.5		
18	4.0	4.6		33		
25	ice	4.5		33.5		
Mar. 4	in	4.3		34		
11	the	4.0		34.5		
18	lock	4.2		37		
25		4.6		41		
Apr. 1	5.1	4.5	33.5	44		
8	5.4	4.8	33.5	44.5		
15	5.0	4.5	38.5	47.5	8	217
22	5.6	4.1	43	49.5	67	96

Table No. 2 (continued)

Week beginning	Aver. Ht. (feet) 1950	1951	Aver. Temp. (°F.) 1950	1951	Total number salmon caught 1950	1951
Apr. 29	5.0	4.2	50.5	50	63	72
May 6	4.4	3.9	51.5	54	42	58
13	4.0	3.8	54.5	59	24	39
20	3.7	3.8	57.5	62	51	40
27	3.5	4.7	66.5	60	28	13
June 3	3.2	5.4	67.5	60	67	3
10	3.0	4.5	70	62.5	28	4
17	2.9	4.1	66	67	1	5
24	2.8	3.7	63	69	0	0
July 1	3.0	3.5	67.5	70	9	0
8	3.2	3.5	72	73	3	0
15	3.1	3.5	72	74	0	0
22	2.9	3.4	70	73	0	0
29	2.8	3.2	72	73.5	0	0
Aug. 5	2.8	3.0	70	70	0	0
12	2.8	2.9	71	72.5	1	0
19	2.9	3.0	70.5	70.5	0	0
26	3.0	3.3	70	71	0	0
Sept. 2	3.3	3.5	67	67.5	0	1
9	3.3	3.6	65.5	69	0	0
					392	548

Temperature of the Water

April, 1951, was the sixth successive month in which the temperature of the air was reported by the Meteorological Office to be above normal. Consequently little ice formed on the lake and when the angling season opened, the average weekly temperature of the water calculated from the records of a thermograph at Wellington was 9°F. higher than in the corresponding week in 1950 and continued to be higher until the latter part of May. Study of the graphs in Figure No. 1 shows that the rapid warming up of the water to an average of 50°F. started the angling in both years, and, when the temperature became too high (an average of 70°F.), the angling fell off. The fact that the temperature of the water remained between these two extremes in June, 1951, would lead one to expect that the catch of the latter part of May would be maintained. It is possible that the excessive freshet had a harmful effect on the angling.

Angling results

The salmon caught by angling in 1951 may be classified under three headings: tagged fish, marked fish and untagged and unmarked fish. The tagged fish were all lake salmon and with the exception of 7 were of pond origin and all had been tagged at spawning time in 1949 and 1950; the marked fish were also of pond origin and had been planted in the lake as yearlings or smolts and the untagged and unmarked fish were all reported as naturally produced lake salmon, ex-

cept one which was identified by its appearance and scales as a pond escapee. Some of the tagged and marked fish were caught in the head waters of Shubenacadie Lake into which they had migrated, but all of the unmarked and untagged fish included in this report were caught in Shubenacadie Lake.

Samples of scales accompanied 95% of the reports of the tagged fish recaptured (237 fish) and for which rewards are paid as compared with 25% of the reports of the untagged salmon captured (13 marked and 61 unmarked) for which no reward is paid to the anglers.

The small number of marked fish four years old in 1951 which were recaptured is poor reward for the effort and expense involved in raising them.

Tagged fish

In November, 1950, a total of 885 pond fish of which 857 were three-year-olds and 28 were four-year-olds and 38 trapped lake fish were tagged and released at the head of Shubenacadie Lake. Of the trapped lake salmon 13 had been marked previously and released from the ponds at Wellington into the lake, 3 as yearlings and the rest as smolts. No sea salmon from the Sackville River were tagged in 1950. During the angling season the following were recaptured: 234 pond fish of which 220 were three-year-olds, 13 were four-year-olds and 11 trapped lake fish tagged in 1950/in addition xx 5 lake salmon that had been tagged and released in Grand Lake in 1949. The number of the tag, the age and

length at tagging, and the place and date of recapture for each fish is tabulated in Appendix No. 1.

Movement of the fish out of the lake after tagging was more extensive than in 1949-50. In contrast to two fish reported last year 62 pond fish and three trapped lake fish were recaptured by angling in the waters of the Beaver-Rawdon system emptying into Shubenacadie Lake; none was reported taken from the Fletcher River system or from the Shubenacadie River that drains the lake. In comparison with 1950, a much larger proportion of the tagged fish were recaptured in the first season after tagging. In the case of the pond fish the percentage was increased from 8.8% in 1950 to 26% in 1951, and of the trapped fish from 24% in 1950 to 29% in 1951.

Marked fish

Small rewards of 5 cents per fish that was untagged and unmarked and 25 cents per scar for marked fish were paid to Mr. Andrew King at Sandy Cove and Mr. Morash at Grand Lake Station, where catches are landed out of reach of examination at Wellington, to ensure careful reporting on the capture of marked salmon. With this added inducement only 14 marked fish were reliably reported as captured in 1951, and all lacked the left ventral fin. Samples of scales were received from 13 of them and showed that 7 were four-year-olds (the age most likely to be taken by the anglers), and 6 were three-year-olds, and the last, only 10 inches long and probably a three-year-old, was returned to the lake as too small to keep. The mark-

ing, the reported length and weight, the age as determined by scale examination, the place and date of recapture and the name of the examiner are indicated for each fish in Appendix No. 2.

To arrive at a fair estimate of the total number of four-year-old marked salmon recaptured, the proportion of those marked fish among the 27 salmon examined by me personally, namely 3 in 27, that is, 11%, was applied to the total catch of 298 untagged salmon. On this basis, 32 might be presumed to have been four-year-old marked fish. The few examined belonged only to the 9,189 lake salmon smolts released in the lake in 1949. Whether or not a larger number of the marked four-year-olds that were presumably taken by anglers would have shown any from the lot of 9,948 yearling lake salmon with left ventral and anal fins removed that were planted in the lake in 1948, or from the lot of 3,982 sea salmon smolts with the right ventral fin removed that were planted in 1949, is problematical. As they stand, the facts indicate recapture of 0.3% of the first lot mentioned and of none from either of the other two lots.

The three-year-old marked salmon recaptured are presumed to belong to 20,564 lake salmon smolts released at Grand Lake Station in 1950. They ranged in length from 8 to 12 inches when recaptured and 50% of them were caught in the headwaters of the lake. Fish of this year-class should be large enough to appear in greater numbers in the

catch of 1952.

In November, 1950, 38 lake salmon were trapped in rivers emptying into Shubenacadie Lake to be stripped, tagged and released in the lake. Examinations revealed that 13 of them had been marked and released from the ponds at Wellington, 3 as yearlings in 1947 and 10 as smolts in 1949. Scale study showed that the naturally produced salmon trapped were about equally divided into two age groups, 12 being of year-class 1947 and 13 of year-class 1946. In contrast to this, the younger fish were predominant in the group that had been marked, 10 being of year-class 1947 and only 3 of year-class 1946. The total number, therefore, of lake salmon of year-class 1947 trapped was 22, and of them 10 or 45% were marked. This is a much higher percentage of marked fish taken in the traps than caught by the anglers, as determined from the number of marked fish examined by me in the total number caught in 1951 (11%). Why a larger percentage returned to the traps is not clear. It is possible that the fall movement may be towards the waters of the Fletcher River in which the fish were reared. No record was kept of the number of fish trapped in the Fletcher as compared with the Rawdon, nor was the trapping in the latter river complete.

It is interesting to note that all the marked fish of year-class 1947 that were trapped and those examined by me were from a lot of 9,189 lake salmon planted as smolts and none from a lot of 9,948 of the same year-class planted

as yearlings or from 3,982 fish of Atlantic salmon origin planted as smolts. In the case of the year-class 1946, the 3 marked fish belonged to 36,173 lake salmon planted as yearlings. These results point to better survival among fish planted as smolts than as yearlings.

Untagged and unmarked fish

During the 1951 angling season, 284 untagged and unmarked fish were reported by the anglers. One caught in the Fletcher River near its mouth on September 4 was identified by its appearance and scales as a pond escapee. The total number of naturally produced salmon caught by angling was slightly less than in 1950 (283 to 297). Approximately 20% of them had been reliably meased and weighed when reported, and the results showed that 85% of them varied in length from the legal minimum of 15 inches to 20 inches and that 85% varied in weight from 1 lb. to 2½ lb. Samples of scales received from 60 fish revealed that 8% were three-year-olds, 75% were four-year-olds and 17% were five-year-olds. (Table No. 8).

The question arises as to the explanation of the small proportion of five-year-olds in the 1951 catch when it is remembered that 85% of the catch in 1950 were four-year-olds (estimated 252 fish). On the basis of 24% of the trapped lake fish, most nearly comparable in size to the "wild" fish being captured in 1950, it may be calculated that 76% of the population or 750 of the fish being then four-year-olds remained uncaught. Since only 17% of the 1951 catch were five-year-

olds it may be presumed that only 48 of them were caught by the angler in 1951. It seems that there must be a high mortality of the older fish or an extensive exodus of them from the lake since both ages, due to their length, were equally exposed to capture by the anglers.

Location of the fishing grounds

Regions

The catch was classified according to the same regions of the lake described in the report last year, namely: (a) Head, which is comperatively shallow and receives drainage from the Fletcher and Rawdon Rivers, (b) Grand Lake, the broad and deep part, (c) the region about the mouth and the immediate upper part of the Shubenacadie River, and (d) Little Lake, a shallow part at the north end beyond the Narrows.

Distribution of the catch

In table No. 3 is shown, for comparison, the numbers of salmon caught in each of the four regions during the angling seasons of 1950 and 1951, and the percentage that each part is of the whole catch. It is apparent that the greatest difference between the angling in the two years is in the numbers taken at the head of the lake. In 1950, the movement of the tagged fish into the head waters after tagging was much more pronounced than in 1949, and seems to have been maintained into the early spring of 1951. An additional 65 tagged fish and 3 marked fish were caught by anglers in

1951 in the Beaver-Hawdon system above the lake.

Table No. 3. Numbers of salmon and the percentages of the total taken in the 4 main regions of Shubenacadie Lake in 1950 and 1951.

Kind of fish	Head		Grand Lake		Region of the mouth		Little Lake		Total	
	1950	1951	1950	1951	1950	1951	1950	1951	1950	1951
Tagged		94		50		40		1		185
Marked		1		10		0		0		11
Untagged and Unmarked		5		146		133		0		284
Total	29	100	189	206	170	173	4	1	392	480
Percentages of total catch	8%	21%	47%	43%	43%	36%	1%	.2%		

Sizes of the salmon caught

In Table No. 4, the tagged fish have been classified according to length at the time of tagging and the numbers of the various lengths tagged and the numbers and percentages recaptured are shown. The fish were not weighed at tagging, but the weights of a small proportion caught and believed to be reliably weighed are indicated in Table No. 5, and used for calculation of the condition of the fish at the time of capture. In Table No. 5 the lengths and weights believed to be reliably reported for the marked and for approximately 20% of the untagged and unmarked fish are summarized for comparison with the tagged fish. As was observed for the catch in 1950, it is apparent that the anglers are equipped to catch salmon of all the sizes

tagged, but most of them use bait for the larger fish, the smaller fish often being returned to the lake unless injured in capture. In the case of the marked fish and the naturally produced fish, the minimum legal length is 15 inches and few below that length are reported. 85% of the latter fish caught weighed from 1 lb. to 2 lb. Two fish over 4 lb. in weight were reported taken on April 15 in the region of the mouth of the lake, but neither a sample of scales nor verified measurements were obtained and they have been omitted from the tables. It is possible from the descriptions given by the anglers that they were sea salmon which had entered the lake.

Condition of the salmon

The condition of the salmon in the catch seemed to make a bigger impression on the anglers than the number caught. Comment on the good colour, fatness and fighting qualities of both tagged and naturally produced fish was made at all landings in 1951 as compared with complaints about lean fish and small catches in 1950. The fact that most of the fish were caught early in the season while enthusiasm was at its height was another factor, no doubt, which pleased the anglers.

The well-known formula $\frac{100 \times W}{L3}$ for calculating the condition factor of a fish where W is the weight in ounces and L is the length in inches is used in this report, and the lengths and weights are those reliably reported when the fish

was captured except for the lengths of the pond and trapped lake fish, which were considered to be more accurately measured at tagging than at capture. The average monthly condition factors for the fish of the various kinds in the catch in both 1950 and 1951 are summarized in Table No. 6, and the details upon which the averages for 1951 are based are shown for convenience in a series of Tables Nos. 9 to 13, in which time of capture, the age and current growth of each fish are also given.

Table No. 4. The numbers of salmon of various lengths tagged and the numbers and percentages recaptured by angling in Shubenacadie Lake and its head waters in 1951.

Kind	Length at tagging in inches	Number tagged	Number recaptured	Percentage recaptured
Pond fish tagged in 1950	5½ to 10	314	66	21%
	11 to 14	571	168	29%
Trapped lake fish tagged in 1950	under 14	4	2	50%
	14 to 20	31	9	29%
	over 20	3	0	0
		Length at recapture		
Pond fish tagged in 1949	11 to 12	14 to 18	3	
Trapped lake fish tagged in 1949	19½ and 20½	22 and ?	2	

Table No. 5. The numbers of marked and unmarked and untagged salmon of various lengths and weights as reported when caught by angling in 1951.

Kind	Length at recapture (inches)	Number caught	%	Weight at recapture (ounces)	Number caught	%
Marked pond fish	8 to 10	3	21	3 to 10	5	41
	11 to 14	4	28	11 to 16	4	33
	15 to 16½	7	50	17 to 24	3	25
Unmarked and untagged	8 to 10	3	5	4 to 16	6	13
	11 to 14	4	7	17 to 24	14	30
	15 to 20	47	85	25 to 32	20	42
	20½	1	2	33 to 40	6	13
				41 to 44	1	2

Table No. 6. Average monthly condition factors of various kinds of salmon caught in Shubenacadie Lake region in 1950 and 1951.

Time of capture	Pond fish tagged 1st previous autumn (½ yr. in lake)	Trapped lake fish tagged 1st previous autumn	Pond and trapped lake fish tagged 2nd previous autumn (1½ yrs.)	Pond fish marked as yearlings or smolts	Naturally produced lake fi
1950					
Apr.	.24	.42	.56 (1 fish)	.39	.43
May	.36	.44	.47 (1 fish)	.47 (1 fish)	.55
June	-	-	-	-	.53
1951					
Apr.	.46	.53	.42 (2 fish)	.45	.53
May	.55	-	.51 (2 fish)	-	.55
June	.53	-	-	-	-

The table shows that in both 1950 and 1951 the condition of the fish tended to be better in May and June than in April, and on the whole the catch was in better condition in 1951 than in 1950. The naturally produced fish were in as good condition in April of 1951 as they were in May of 1950, which may be accounted for by the early spring of 1951. The remarkable improvement in the condition of the pond fish may be due in part to better condition at the time of tagging and release, since it was observed that they were more active in ascending the rivers at the head of the lake after tagging in 1950 than in 1949. The condition of the pond fish recaptured in April in three different regions for angling was very similar and points to similar condition at tagging since no evidence of current growth was observed in scales that were examined from fish caught in April. The average condition factors for the month of April for the three regions were as follows:

Head of the lake	-	52 fish	Av. 0.45
Grand Lake	-	8 "	Av. 0.45
Kinsac Lake	-	22 "	Av. 0.46

The salmon which had lived in the lake for sometime and were trapped, tagged and released more nearly resembled the naturally produced fish in condition the following spring than the pond fish tagged at the same time. The few marked fish recaptured were not in as good condition as the naturally produced fish and more like the pond fish. The number

of tagged fish more than one winter in the lake before being recaptured were so few that little can be deduced from the data.

Food and bait

The rush of the early angling in 1951 made it difficult to handle more than a small number of fish for stomach examination. Of 35 stomachs examined, 5 or 15% were empty, a small percentage as compared with the catch of 1950 when 56 stomachs were examined and 23% found empty. That the fish were feeding earlier in 1951 is shown by the fact that the fish examined in 1951, with one exception, were caught in April, and those examined in 1950 mostly in May and June. A condensed report on the contents of the stomachs is given in Table No. 7.

Minnows were the favourite bait of the anglers. Contrary to custom, considerable angling was done early in the season from the banks of the rivers at the head of the lake and from the shores of the lake at Grand Lake Station, and the success from these positions amazed the residents. Worms were also used and some anglers combined minnows and worms. Artificial bait was used by many angling from boats. The short season was a great disappointment to the anglers who occupied camps in May and June or were unprepared when the season opened.

Table No. 7. The stomach contents of selected fish from the salmon caught in the Shubenacadie region in 1951.

Date of capture	Kind of fish and length (in.)	Region of capture	Stomach contents
Apr. 15	Tagged Pond	Fletcher Run	Insect larvae - probably crane flies and diving beetles Winged diptera (combined report of 10-15 small tagged fish)
Apr. 18	Lake (15½")	Rawdon R. (pool)	Insect larvae as above
Apr. 22	Tagged Pond ?	Rawdon R.	Insect larvae and wings, legs of diptera
Apr. 22	Marked L. V. 15½"	Grand Lake	Insect larvae as above
Apr. 22	Lake - 17"	" "	3 partly digested fishes; 1 smelt (8-10 cm.), 1 perch, 1 ?
	" - 18"	" "	2 fish nearly digested
	" - 19"	" "	4 fish; 2 smelts (10 cm.) 2 smelts nearly digested 1 perch, probably bait
	" - 17") " - 18") " - 18")	" "	one empty; 2 contained only 3 small snails approximately ½ in. long
Apr. 29	Tagged pond - 13½"	" "	Insect larvae
	Tagged pond - 10½"	Fletcher	Mucous; tough plant fibres; gaspereaux scales
June 23	Lake - 17½"	Grand Lake	3 small smelts; 3 skeletal remains of small fish

Age and current growth as shown by the scales

All the samples of scales received from the anglers taken from marked pond fish, trapped lake fish and naturally produced salmon (75 samples) were examined to determine age and current growth, and 25 samples from tagged pond fish recaptured in April, May and June, of which the age was known at tagging, were selected as typical and studied to determine growth in the current year. Study was also made of scales from 38 fish trapped in rivers in November of 1950 and the scales from the same fish turned in by anglers when they were recaptured in 1951. The results are shown in a series of tables Nos. 9 to 13, in which the date of capture, the length, weight and condition also are given.

Ages of the salmon

Four-year-olds formed the largest part of the salmon catch in 1951, being 94% of the pond fish, 82% of the trapped lake fish and 75% of the naturally produced fish. The numbers of each kind and age tagged, the numbers and percentages recaptured and the ranges in lengths at tagging and recapture are shown in Table No. 8. For comparison, the corresponding data for 60 naturally produced fish for which samples of scales were received have been inserted in the table.

It is apparent that pond fish of the same age run smaller than either the trapped fish or the naturally produced fish. It appears that 16 inches might be considered to be the lower limit of length for a five-year-old natur-

elly produced salmon taken from the lake in the spring months. It is not surprising that a larger percentage of the five-year-olds were recaptured than the four-year-olds in the case of the pond fish since they tended to be the larger fish, but the smaller percentage of five-year-olds than four-year-olds among the trapped fish needs some explanation. Data secured for this group of fish show that the reverse was the case a year ago. Since the ages were not known, the lengths at tagging are used as a basis of separation into two age groups in Table No. 8. It is clear that the large fish formed the higher percentage in the catch in 1950, and one is led to conclude that the large ones had left the lake in 1951. It was reported at Wellington, and is borne out in the data supplied for the outflow of the Rawdon River, that unusually heavy autumn rains occurred after tagging in 1950 and may account for the large exodus of the bigger fish from Shubenacadie Lake.

Current growth of the salmon

Current growth was determined by counting the numbers of new circuli added since the winter ring at the margin of the scales, and the results are shown in Tables Nos. 9 to 13. The only tagged fish which had begun to grow before recapture were the four-year-old pond fish. In a group of 25 selected as typical over the angling season no growth was apparent in April, 2 to 4 circuli were added in May and 3 to 6 in June. Study of 60 samples of scales from lake salmon showed that current growth began as early as April 22, as compared with

April 27 in 1950 and the numbers of circuli had increased from 1 to 3 by the end of May.

Table No. 8. Ages and length of salmon caught by engling in the Shubenacadie Lake region.

Kind	Age (yr.) 1951	Number tagged 1950	Number recaptured in 1951	Percent total catch	Percent number tagged	Range - length (in.) at tagging	at recapture
Pond	4	857	200	94	26	5⅝ - 14	6 - 14
	5	28	13	6	46	10⅝ - 14	10⅝ - 14
Trapped lake	4	22	9	82	41	12½ - 16½	12⅝ - 16½
	5	16	2	18	12½	16 - 21½	18 - 19
		1949	1950				
Trapped lake	?	16	3	7	19	11 - 16	
	?	26	7	17	27	17 - 25½	
			1951				
	5		1			20½	?
	6		1			19½	22
Untrapped untagged lake (60 fish)	3		5	8 1/3			10 - 14½
	4		45	75			13½ - 20½
	5		10	16 2/3			16 - 20

Table No. 9. Condition and age of 25 typical pond fish tagged in November, 1950 and recaptured in 1951.

Number of tag	Date of recapture	Length at tagging (inches)	Weight at recapture (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (yrs.)	Circuli in 1951
8,976	Apr. 15	9¼	3½	.45	4	0
10,651	" 15	10	4½	.45	4	0
10,583	" 16	8⅝	3	.45	4	0
11,484	" 16	13½	11	.47	5	0
8,844	" 17	10	?	-	4	0
8,848	" 18	11⅛	6⅞	.42	4	0
9,926	" 22	12½	7	.36	4	0
9,957	" 22	11⅛	8	.52	4	0
9,966	" 22	13	10	.45	4	0
11,222	" 22	11⅛	7	.46	4	0
11,239	" 22	12	8	.46	4	0
11,483	" 22	11⅝	7	.43	5	0
10,556	" 24	9½	5	.58	4	0
9,979	" 25	12¼	8	.44	4	0
11,258	" 29	13⅝[x]	11	.47	4	0
		[x]At recapture	Average	.46		
10,648	May 6	9⅝	5	.53	4	0
11,469	" 11	12⅝	14	.68	5	0
10,407	" 19	10	5	.41	4	3
11,394	" 20	11	8	.58	4	2
11,337	" 24	12	9	.52	4	0
8,865	" 27	11	7	.57	4	4
			Average	.55		

Table No. 9 (cont'd)

Number of tag	Date of recapture	Length at tagging (inches)	Weight at recapture (ounces)	Condition 100 x W / L3	Age (yrs.)	Circuli in 1951
10,374	June 1	11	8	.58	4	3
8,993	" 15	10	5	.50	4	5
9,990	" 17	13	12	.54	4	5
11,423	" 20	10½	6	.52	4	6
			Average	.53		

Table No. 10. Condition and age of trapped lake fish tagged in November, 1950 and recaptured in 1951.

Number of tag	Date	Mark	Sex	Length at tagging (inches)	Weight (ounces) reported	Condition 100 x W / L3	Age (yrs.)	Circuli
9,870	Apr. 15		M	15	?	-	4	0
9,876	" 15	L.V.	M	12⅝	11	.57	4	0
9,883	" 15		F	18	32?	.55	5	0
11,096	" 15		M	19	40?	.50	5	0
9,881	" 19	L.V.	F	16½	?	-	(no scales received)	
9,869	" 23	L.V.	F	14⅛	16	.47	4	0
9,872	" 27		M	14½	?	-	4	0
9,863	" 29		M	15	19	.56	4	0
9,868	May 12		M	15½	24?	-	4	0
9,867	" 19	L.V.	F	13	12?	-	4	0
9,889	" 19		M	15⅝	?	-	4	0
					Average April	.53		

Table No. 11. Condition and age of pond fish/trapped lake and fish tagged in November, 1949, and recaptured in 1951.

Number of tag	Date of recapture	Length in inches Tagging 1949	Length in inches Recapture 1951	Weight at recapture (ounces)	Condition $\frac{100 \times W}{L^3}$	Age	Circuli in 1951
9474#	Apr. 15	11	18	32	.54	5	0
9219#	" 25	12	14	8½	.30	5	0
					Av. .42		
9838	May 7	20½	?	?	-	5	0
9137#	" 9	11	17½	24	.44	5	0
9802	" 28	19½	22	64	.58	6	0
					Av. .51		

Pond fish, 3-year-olds at tagging

Table No. 12. Condition and age of pond fish marked and released as smolts and recaptured in 1951

Marking	Date of recapture	Length at recapture (inches)	Weight at recapture (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (Yrs.)	Circuli in 1951
L.V.	Apr. 15	8	3	.58	3	0
L.V.	" 15	10	5	.50	3	0
L.V.	" 15	11½	7	.44	3	0
L.V.	" 15	12	7	.40	3	0
L.V.	" 15	15	14	.41	4	0
L.V.	" 15	16½	21	.46	4	0
L.V.	" 15	16	24	.58	4	0
L.V.	" 15	10½	?	-	3	0
L.V.	" 22	15½	19	.51	4	0

Table No. 12 cont'd

Marking	Date of recapture	Length at recapture (inches)	Weight at recapture (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (Yrs.)	Circuli in 1951
L.V.	Apr. 22	15½	13	.35	4	0
L.V.	" 29	12	6?	-	3	4
L.V.	May 2	15	12½	.37	4	0
L.V.	" 2	15	13	.38	4	0
			Av.	.45		

Table No. 13. Condition and age of naturally produced salmon caught in Shubenacadie Lake in 1951.

Date	Length (inches)	Weight (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (yrs.)	Circuli in 1951
Apr. 15	15½	16?	.43	4	0
" 15	16	20	.48	4	0
" 15	19½	40	.53	4	0
" 15	20	44	.55	4	0
" 15	20	40	.50	5	0
" 15	20½	40?	.46	4	0
" 18	15½	18	.48	4	0
" 20	?	24?	-	4	0
" 20	?	24?	-	3	0
" 21	10	8	.80	3	0
" 21	13½	12	.48	4	0
" 21	19	28	.40	4	0
" 22	10	4	.40	3	0

Table No. 13 continued

Date	Length (inches)	Weight (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (yrs.)	Circuli in 1951
Apr. 22	14	20	.72	4	0
" 22	14½	20	.65	4	0
" 22	15	22	.65	4	0
" 22	15	14	.41	4	1
" 22	16	26	.63	4	0
" 22	16½	26	.57	4	0
" 22	17	24	.48	4	0
" 22	18	30	.51	5	0
" 22	18	28	.48	4	0
" 22	18	32	.54	4	0
" 22	18	28	.48	4	0
" 22	19	32	.46	4	0
" 22	19	36	.52	5	0
" 28	15	24	.71	4	0
" 28	19	32	.46	4	0
" 28	17½	28	.52	4	0
" 29	14½	23	.75	3	0
" 29	18	?	-	4	1
" 29	18½	30	.47	5	3
May 2	16	20	.48	4	0
" 2	17½	29	.52	4	0
" 5	14½	16	.51	4	0
" 5	16½	22	.49	4	0

Table No. 13 continued

Date	Length (inches)	Weight (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (yrs.)	Circuli in 1951
May 5	16⅛	30	.66	4	0
" 6	19⅛	36	.48	5	0
" 6	18⅛	32	.50	5	0
" 6	16	25	.61	4	0
" 6	16	21	.51	4	0
" 6	8	3	.58	2	5
" 8	15	24?	-	4	0
" 11	15	20	.59	4	2
" 12	14	21	.76	4	1
" 12	18	32	.54	4	0
" 13	14	8?	-	4	1
" 16	?	?	-	4	2
" 17	16	20?	-	5	0
" 19	19	36	.52	5	0
" 19	17	28	.57	4	1
" 19	16	21	.51	4	1
" 20	?	?	-	5	0
" 20	?	?	-	4	1
" 20	?	?	-	3	2
" 21	16	20	.48	4	0
" 24	16⅛	29	.64	4	0
" 28	18	32	.54	4	0
			Av. .55		

Table No. 13 continued

Date	Length (inches)	Weight (ounces)	Condition $\frac{100 \times W}{L^3}$	Age (yrs.)	Circuli in 1951
June 1	16?	40?	-	5	0
" 4	16½?	44?	-	4	0
" 23	17½	38	.70	4	1

Spawning marks on the scales of captured salmon

Mention was made in 1950 of the difficulty of recognizing spawning marks on the scales of pond fish of all ages and that naturally produced lake salmon generally showed some erosion along the margin of the scale at the end of the third and each succeeding year. Of 63 samples of scales from untagged and unmarked salmon 18 failed to show sign of spawning and 7 were marked as doubtful - in all nearly 40%; all the five-year-olds had spawned once or more and three of the three-year-olds appeared to have spawned. The difficulty of discerning spawning marks was confirmed by the examination of the scales of a four-year-old unmarked and untagged female fish 19 inches long and weighing 2 lb., caught in Grand Lake on April 22. The fish still contained several unextruded eggs from a previous spawning, and the only evidence of spawning discernible on the scales was a very slight thinning at the edge which would have been overlooked but for the conclusive proof when the fish was opened.

Rate of growth in the lake as shown by the scales of pond fish recaptured in the second year after tagging.

The information supplied by the anglers of the lengths

and weights of three pond fish tagged in 1949 and recaptured in 1951 showed that two of them had increased considerably in length during 1950 and were in good condition when recaptured, but the third had grown proportionately less in length and was a thin fish, although it was an inch longer than either of the others when tagged and released. To find out how the rate of growth of pond fish living in the lake compared with that of naturally produced fish in the lake the percentage increase in the length of the scales in 1950 was taken as a basis of comparison, three or more good scales being measured for each fish. Naturally produced fish both tagged and untagged of similar length and date of capture were selected for comparison. The ages and rates of growth of the various fish of which the scales were studied are shown in table no. 14.

The scales of the pond fish recaptured on April 15, 1951, grew in 1950 at approximately the average rate of those of the "wild" fish of similar length and time of capture; the fish recaptured on May 9 had the highest rate of growth for the pond fish and almost reached the maximum rate of any fish selected for comparison. For the thin fish captured on April 25, the percentage of the total length of the scale acquired in 1950 was about the same as that of the pond fish recaptured on April 15 but was the only one of the three cases in which the percentage increase in the length of the scales was similar to the percentage increase in the length of the body (13.5% and 14.2%) as reported at tagging and at recapture. The average increase in

the length of the scales of the five-year-old pond fish (13.9%) was slightly greater than for the five-year-old "wild" fish (13.1%) but considerably less than for the four-year-olds (14.6%).

Table No. 14. Condition, age and rate of growth in 1950 as shown by the scales of tagged pond fish recaptured and naturally produced fish of similar length and date of capture in 1951.

Kind	Date of capture 1951	Length (inches) 1949	Length (inches) 1951	Weight (ounces) 1951	Condition $\frac{100 \times W}{L^3}$	Age (yrs.)	Av. percentage increase in length of scale
Pond:							
9474 - '49	Apr. 15	11	18	32	.54	5	13.3
"Wild"	Apr. 15		20	40	.50	5	12.5
"	" 22		19	32	.46	4	13
"	" 22		19	36	.52	5	13
"	" 22		17	24	.48	4	16
"	" 22		18	28	.48	4	13
"	" 22		18	32	.54	4	15
"	" 22		18	30	.51	5	13
"	" 22		18	28	.48	4	13.5
Trapped Lake							
9883 - '50	" 15		18	?	-	5	14
11096 - '50	" 15		19	?	-	5	13
						Av.	13.6

Table No. 14 continued

Kind	Date of Capture 1951	Length (inches) 1949	Length (inches) 1951	Weight (ounces) 1951	Condition 100 X W / L³	Age (yrs.)	Av. percentage increase in length of scale in 1950
Pond							
9219 - '49	Apr. 25	12	14	8½	.30	5	13.5
"Wild"	Apr. 21		13⅜	12	.48	4	15
"	" 22		14	20	.72	4	15
"	" 22		14½	20	.65	4	15.5
"	" 28		15	24	.71	4	15.5
Trapped Lake							
9870 - '50	" 15		15	-	-	4	12
9872 - '50	" 27		14½	18	.59	4	16
9863 - '50	" 29		15	19	.56	4	15
						Av.	14.8
Pond							
9137 - '49	May 9	11	17⅛	24	.44	5	15.1
"Wild"	" 2		17⅝	29	.52	4	15
"	" 5		16½	22	.49	4	15.5
"	" 6		18⅛	32	.50	5	13
"	" 12		18	32	.54	4	13
						Av.	14.1
				Av. Pond fish 5-year-olds			13.9
				" "Wild" " 5-year-olds			13.1
				" " " 4-year-olds			14.6

Appendix No. 1

Salmon tagged at Shubenacadie Lake in 1950 and recaptured in 1951 by angling

Three-year-old salmon tagged from ponds at Wellington

No.	Tagging length (in.)	Where recaptured	Date
8828	10½	Sandy Cove	May 24
8829	11½	Mouth Lower Rawdon	Apr. 15
8836	10	Lower Rawdon pool	" 17
8844	10	Fletcher run	" 17
8847	10½	Sandy Cove	May 13
8848	11½	Fletcher run	Apr. 18
8850	11	" "	" 15
8851	10	" "	" 15
8852	12½	Sandy Cove	" 21
8859	11	Lower Rawdon (Railway Bridge)	" 29
8861	11	Below Cook's	" 20
8863	10	Lower Rawdon pool	" 17
8864	10½	Sandy Cove	May 9
8865	11	Off Big Head	" 27
8866	11½	Kinsac Lake	Apr. 15
8867	11	" "	May 19
8869	10	Fletcher Lock	Apr. 15
8881	11½	" run	" 15
8882	10	" "	" 19
8884	9½	Off Adam's Island	May 25

No.	Tagging length (in.)	Where recaptured	Date
8890	9⅝	Kinsac Lake	Apr. 15
8894	10⅜	" "	" 21
8897	12⅝	Off Big Head	May 17
8900	11	Mouth Lower Rawdon River	Apr. 15
8901	10⅜	Sandy Cove	" 22
8902	12	Mouth Upper Rawdon	" 29
8915	11⅞	Tingley's Point	May 20
8917	10	Fletcher run	Apr. 15
8922	11	Kinsac Lake	" 15
8924	11½	" "	" 15
8953	11⅜	Upper Rawdon River	" 15
8956	12	Fletcher run	" 15
8957	11	Kinsac Lake	" 21
8958	13⅝	Off Mt. Rascal	May 2
8959	10½	Sandy Cove	Apr. 29
8960	10⅜	Off Tingley's	May 27
8963	10	Fletcher Lock	Apr. 15
8966	12	Grand Lake	" 15
8967	9⅝	Kinsac Lake	" 24
8968	10	Fletcher Run	" 15
8972	10⅜	Kinsac Lake	" 15
8976	9½	Fletcher Run	" 15
8978	10⅝	Lower Rawdon pool	" 17
8979	13	Sandy Cove	May 20

No.	Tagging length (in.)	Where Recaptured	Date
8987	9½	Mouth Lower Rawdon	Apr. 15
8988	12½	Kinsac Lake	" 15
8993	10	Sandy Cove	June 15
8995	12	Fletcher Run	Apr. 17
8997	10½	Off Mt. Rascal	May 6
9752	14	Sandy Cove	Apr. 20
9755	11	Fletcher Lock	" 15
9756	11½	Off Adam's Island	" 22
9763	11½	Off Rocky Br.	May 20
9764	9	Kinsac Lake	" 19
9766	12½	Tingley's Pt.	" 6
9772	10	Fletcher Lock	Apr. 15
9773	9½	Fletcher Run	" 15
9780	9	Mouth Lower Rawdon	" 15
9784	10	Fletcher Run	" 29
9785	10½	Kinsac Lake	" 25
9791	10	Fletcher Run	" 15
9792	10½	Tingley's Point	May 20
9794	11	Fletcher Lock	Apr. 15
9797	11	Off Tingley's	" 28
9799	11½	Sandy Cove	May 12
9915	11	Kinsac Lake	Apr. 15
9916	10½	Fletcher Run	" 15
9922	11½	Blueberry Pt. (Adams)	May 28

No.	Tagging length (in.)	Where recaptured	Date
9926	12½	Big Island	Apr. 22
9927	9½	Mouth Lower Rawdon	" 15
9930	13½	Off Tingley's	May 7
9932	11½	Lower Rawdon pool	Apr. 17
9935	10	Fletcher Run	" 15
9937	11	" "	" 15
9940	10½	Kinsac Lake	" 15
9945	12½	Off Tingley's	May 20
9946	12	Kinsac Lake	Apr. 21
9951	9½	Fletcher Run	" 19
9955	9½	Near Boat Landing	" 17
9957	11½	Off Tingley's	" 22
9959	13	Sandy Cove	" 15
9962	11	Lower Rawdon Pool	" 17
9966	13	Off Laurie's	" 15
9970	10½	Kinsac Lake	" 15
9973	8½	Fletcher Run	" 15
9975	9½	Lower Rawdon	" 22
9979	12½	Off Oakfield	" 25
9984	12	Fletcher Run	" 15
9985	10½	Off Mt. Rascal	May 6
9989	9	Mouth Lower Rawdon	Apr. 15
9990	13	" " "	June 17
9991	11½	Lower Rawdon	Apr. 22
9992	12½	Sandy Cove	" 24

No.	Tagging length (in.)	Where recaptured	Date
9996	10⅜	Mouth Lower Rawdon	Apr. 15
10280	11	Fletcher Run	" 15
10291	12	Kinsac Lake	May 19
10297	11⅝	Mouth Lower Rawdon	Apr. 15
10299	8⅜	Fletcher Run	" 15
10300	12¼	" "	" 15
10327	10⅛	Kinsac Lake	" 21
9968	12⅛	Sandy Cove	May 6
10328	10½	Off Tingley's	Apr. 22
10335	12	" "	May 19
10338	9⅛	Kinsac Lake	Apr. 15
10348	11⅛	Lower Rawdon	" 22
10351	10	Fletcher Lock	" 15
10355	12	" Run	" 15
10359	10⅝	Kinsac Lake	May 21
10360	9¾	Sandy Cove	Apr. 20
10361	9½	Lower Rawdon Pool	" 17
10362	11½	Fletcher Run	" 15
10367	10⅛	Kinsac Lake	May 19
10368	10⅛	" "	Apr. 21
10370	10½	Sandy Cove	" 20
10372	12	Off Tingley's	" 22
10373	11½	Kinsac Lake	" 24
10374	11	Off Cook's Camp	June 1

No.	Tagging length (in.)	Where recaptured	Date
10379	8	Fletcher Run	Apr. 15
10382	10½	Little Lake	June 15
10387	8½	Lower Rawdon	Apr. 22
10393	11	Fletcher Run	" 19
10403	9½	Off Big Head	May 28
10407	10	" Laurie's	" 29
10414	9½	Fletcher Lock	Apr. 15
10418	10½	Mouth Lower Rawdon	" 15
10432	10½	Lower Rawdon Pool	" 17
10463	10	Fletcher Run	" 15
10443	10	Lower Rawdon	" 22
10474	9	Mouth Lower Rawdon	" 15
10479	10½	Kinsac Lake	" 15
10483	10	Fletcher Run	" 15
10485	9	Mouth Lower Rawdon	" 15
10490	10	Off Mt. Rascal	" 28
10492	9½	Fletcher Run	" 15
10507	10	Near Boat Landing	" 22
10513	8½	Fletcher Run	" 15
10522	9½	Mouth Lower Rawdon	" 15
10530	10½	" " "	" 15
10540	10	Kinsac Lake	" 15
10541	9½	Sandy Cove	May 26
10543	9½	Lower Rawdon	Apr. 22

No.	Tagging length (in.)	Where recaptured	Date
10549	8½	Mouth Lower Rawdon	Apr. 15
10555	9	Fletcher Run	" 15
10556	9½	" "	" 24
10570	10½	Off Adam's Island	May 26
10577	9½	Kinsac Lake	Apr. 26
10583	8½	Fletcher Run	" 15
10590	9½	" "	" 15
10593	10	" "	May 5
10605	10½	Lower Rawdon Pool	Apr. 17
10622	10½	Off Cook's Camp	" 15
10645	8½	Fletcher Run	" 15
10648	9½	Off Tingley's	May 6
10651	10	Fletcher Run	Apr. 15
10654	9	Fletcher Look	" 15
10665	8	" "	" 15
11189	6½	" Run	" 15
11195	6	" "	" 19
Three-year-olds (half tags "Biological")			
11203	?	Sandy Cove	May 24
11204	12½	" "	" 12
11207	12½	Fletcher Run	Apr. 15
11213	10½	Lower Rawdon Pool	" 17
11222	11½	West shore, Big Island	" 22
11223	10½	Kinsac Lake	" 15

No.	Tagging length (in.)	Where recaptured	Date
11224	12½	Sandy Cove	May 6
11228	13¼	Off Cook's	Apr. 29
11230	12⅝	Fletcher Run	" 21
11235	10⅝	Sandy Cove	" 21
11239	12	Off Tingley's	" 22
11246	10	Sandy Cove	" 26
11251	10⅝	Fletcher Lock	" 15
11253	11	Below Cook's	" 20
11254	10½	Fletcher Run	" 15
11256	10⅝	Lower Rawdon Pool	" 17
11258	12½	Off Adam's Is.	" 29
11262	11⅝	Fletcher Lock	" 15
11263	13¼	Off Big Head	May 9
11264	11½	Fletcher Run	Apr. 15
11269	10½	Kinsac Lake	" 15
11278	10½	Fletcher Run	" 15
11279	11	Kinsac Lake	" 21
11290	10½	Fletcher Run	" 15
11291	12⅝	Sandy Cove	May 6
11299	11½	Kinsac Lake	Apr. 29
11307	10½	Off Big Head	May 15
11309	11⅝	Fletcher Run	Apr. 17
11327	11	Fletcher Lock	" 15
11330	12⅝	Mouth Lower Rawdon	" 15

No.	Tagging Length (in.)	Where recaptured	Date
11332	11½	Off Cook's Camp	Apr. 22
11337	12	Sandy Cove	May 24
11340	10½	Kinsac Lake	Apr. 24
11345	11½	Fletcher Run	" 15
11346	10½	Kinsac Lake	May 19
11348	11	Fletcher Run	Apr. 15
11351	10½	Lower Rawdon Pool	" 17
11360	11	Fletcher Run	" 15
11373	11½	Off Big. Is.	May 27
11374	11½	Off Big Hd.	Apr. 15
11377	10½	Mouth Lower Rawdon	" 15
11379	11	Fletcher Run	" 15
11384	12	Kinsac Lake	" 15
11386	10½	Lower Rawdon Pool	" 17
11394	11	Off Tingley's	May 20
11397	14	Off Mt. Rascal	" 2
11400	12½	Fletcher run	Apr. 15
11405	11½	Kinsac Lake	" 23
11410	11½	Fletcher Run	" 15
11412	11½	" "	" 15
11420	11½	Lower Rawdon Pool	" 17
11423	10½	Fletcher Run	June 20
11425	11½	Below Cook's	Apr. 22
11427	11	Fletcher Run	" 15

No.	Tagging Length (in.)	Where Recaptured	Date
11437	12½	Sandy Cove	May 26
11450	12	Off Tingley's	Apr. 22
11451	12½	Below Big Is.	May 27
11453	10½	Fletcher Run	Apr. 15
11454	11⅛	Kinsac Lake	" 15
11459	10½	Fletcher Run	" 19
11460	10⅝	Sandy Cove	May 26
11463	11	Kinsac Lake	Apr. 21
Four-year-old Salmon (Half Tags "Biological)			
11466	12⅝	Kinsac Lake	" 21
11467	13⅛	Square Lake	" 20
11468	12½	Lower Rawdon Pool	" 17
11469	12⅝	Off Tingley's Point	May 11
11473	12⅝	Fletcher Run	Apr. 15
11476	10⅝	Fletcher Run	" 18
11477	12	Kinsac Lake	" 24
11482	11½	Fletcher Run	" 15
11483	11⅝	Off Big Is.	" 22
11484	13½	Fletcher Run	" 15
11485	14	Grand Lake	" 22
11486	12⅝	Fletcher Run	" 15
11490	11	" "	" 15
Trapped salmon from rivers at Wellington - (Half Tag "Reward")			
9863	15	Off Big Head	Apr. 29

No.	Tagging Length (in.)	Where Recaptured	Date
9867 L.V.	13	Kinsac Lake	May 19
9868	15½	" "	" 12
9869 L.V.	14½	Mouth Upper Rawdon	Apr. 23
9870	15	Sandy Cove	" 15
9872	14½	" "	" 27
9876 L.V.	12⅝	Off Adam's Is.	" 15
9881 L.V.	16½	" " " to Tingley's	" 19
9883	18	" Mt. Rascal	" 15
9889	15⅝	" Tingley's	May 19
11096	19	Below Cook's	Apr. 15

Salmon Tagged and Released in Grand Lake in 1949 and recaptured by angling in 1951

No.	Kind	Length in inches Tagging	Caught	Weight caught (ounces)	Where captured	Date 1951
x9137	3-yr.-old	11	17½	24	Fletcher Run	May 9
9219	" "	12	14	8½	Tingley's	Apr. 25
+9474	" "	11	18	32	Off Adam's Is.	" 15
+ 9802	Trapped Lake Fish	19½	22	4 lb.	Sandy Cove	May 28
9839	" "	20½	13?	⅝ ?	" "	" 7

x length and weight checked

+ " " " believed to be correct.

Appendix No. 2

Marked salmon caught by angling in 1951

Date 1951	Mark	Length (in.)	Wt. (oz.)	Where taken	Examined by	Angler	Address
Apr. 15	L.V.	12	7	Off Adam's Is.	V.M.B.	S.Roberts	121 Will Halifax
" 15	L.V.	16½	21	" "	"	" "	"
" 15	L.V.	11½	7	Fletcher Run	"	F.Hayter	Wellingt
" 15	L.V.	10	5	No. Upper Rawdon	"	K.Mitchell	245 Port-land, Dartmouth
" 15	L.V.	8	3	" "	"	" "	"
" 15	L.V.	10½	?	Lr.Rawdon	"	C.West-haver	37 Summit Halifax
" 15	L.V.	15	14	Off Laurie's	Scar received	F.Connors	41 Union Halifax
" 15	L.V.	16	24	Off Tingley's	" "	C.Beanlands	Gr.Lake
" 22	L.V.	15½	19	Off Big IS.	V.M.B.	J.Bateman	Fletcher Lake
" 22	L.V.	15½	13	" " "	"	E.Hartlen	Bedford
" 22	L.V.	10	?	Off Tingley's (returned to lake)	Beanlands	C.Beanlands	Gr. Lak
" 29	L.V.	12	6?	Off Tingley's	V.M.B.	H.Palmer	" "
May 2	L.V.	15	13	Off Mt. Rascal	Scar received	F.Connors	41 Union Halifax
" 2	L.V.	15	12½	" "	" "	" "	"

Marked and tagged salmon caught in 1951

Date 1951	Mark	Length (in.)	Wt. (oz.)	Where taken	Examined by	Angler	Address
Apr.15	L.V. 9876	12⅝	11	Off Adam's Is.	At tagging	C.Ferguson	Enfield
" 19	L.V. 9881	16½	?	" "	" "	J.Donaldson	Wellington
" 23	L.V. 9869	14½	16	Long L.	" "	W.Burgess	Fall Riv
May 19	L.V. 9867	13	12	Kinsac (Long) L.	" "	D.Payzant	71 Yale Halifax

2. Current growth of young salmon trapped in 1951

Age and current growth of young salmon trapped in 1951 in the Nawdon river

A smolt trap was put in operation in the Nawdon River on May 7 and descending fish were trapped from that date until May 29, when unusually heavy rain caused a freshet of sufficient force to carry away the trap and part of the fence. The numbers of fish trapped had been decreasing for several days and in all probability the peak of descent had passed, but it is doubtful if the early migrants were trapped, as many small fish were reported to have been seen in Kinsac Lake in April and the earliest fish trapped had already begun adding new circuli to the scales. A total of 43 marked smolts and 112 "wild" young salmon were captured. Samples of scales were received from all but one fish of each kind and the date of capture, the length of the fish, the age and current growth as deter-

mined from the scales are shown for the marked smolts in table No. 1 and for the "wild" fish in table No. 2. All the marked smolts were 2 years old and of the naturally produced fish 14 were 3-yr.-olds, 83 were 2-yr.-olds and 14 were yearlings. Evidence of growth in the current year was shown by 66 2/3% of the marked fish as compared with 100% of the "wild" fish, indicating that 1/3 of the pond fish that had been marked and released in the rivers above the lake in December, 1950, had not yet become adapted for growth under the new conditions. The numbers of circuli of current growth varied from 2 to 4 for the 3-yr.-olds, from 2 to 7 for the 2-yr.-olds, both marked and unmarked, and from 5 to 9 for the yearlings. The youngest fish were growing most rapidly and the number of circuli tended to increase with the lateness of the trapping.

The fact that a smaller percentage of the marked smolts than of the "wild" smolt showed current growth led to a comparison being made in the rate of growth of fish of similar lengths trapped in the same river in May of 1950 and 1951. A summary of the results is shown in table No. 3.

Table No. 1. The time of capture, size and age of young marked salmon taken in a trap for descending fish in the Rowdon River in 1951.

Date	Mark	Length (cm.)	Age Yrs. + Circuli in 1951
May 9	R.V.	19	2+6
13	"	17½	2+0
13	"	17½	2+0

Table No. 1 (cont'd)

Date	Mark	Length (cm.)	Age Yrs. + Circuli in 1951
May 13	R.V.	20	2+0
13	"	23	2+0
14	"	18½	2+3
15	"	22	2+0
18	"	22	2+0
20	"	17½	2+4
21	"	16½	2+0
21	"	20	2+4
22	"	16½	2+6
22	"	17	2+3
22	"	18	2+4
23	"	20	2+4
23	"	20½	2+4
24	"	18½	2+4
24	"	19½	2+5
25	"	21½	2+6
27	"	20	2+7
29	R.V.+ Adp.	17½	2+0
29	" "	20	2+0
May 7	L.V.	23½	2+2
8	"	18	2+2
9	"	17	2+2
10	"	19	2+0
11	"	17	2+0
13	"	16	2+0

Table No. 1 (cont'd)

Date	Mark	Length (cm.)	Age Yrs. + Circuli in 1951
May 14	L.V.	18	2+4
15	"	16	2+0
18	"	17	2+5
18	"	18½	2+4
19	"	18	2+4
19	"	18½	2+4
20	"	17	2+0
20	"	18	2+4
21	"	17	2+0
21	"	22	2+3
22	"	16½	2+6
23	"	18	2+6
24	"	19½	2+5
24	"	20	2+6

Table No. 2. Time of capture, size and age of young naturally produced salmon taken in a trap for descending fish in the Rawdon River in 1951.

Date	Length (cm.)	Age in yrs. + No. of circuli in 1951	Date	Length (cm.)	Age in yrs. + No. of circuli in 1951
May 6	16	2+5	May 6	18½	2+6
6	17	2+6	6	18½	2+6
6	17½	2+6	6	20	2+6
6	17½	2+6	6	24½	2+4

Table No. 2 (cont'd)

Date	Length (cm.)	Age in yrs. + No. of circuli in 1951	Date	Length (cm.)	Age in yrs. + No. of circuli in 1951
May 7	17⅝	2+5	May 10	27	3+4
7	19½	2+5	10	29	3+3
8	17	2+6	10	29	3+4
8	17⅝	2+6	11	18½	2+2
8	18½	2+5	11	18½	2+5
8	19	2+6	11	29	3+4
8	19½	2+6	12	15	1+9
8	20	2+4	12	18	2+4
9	16½	2+5	12	18½	2+5
9	17½	2+5	13	18	2+3
9	17⅝	2+6	13	20⅝	2+5
9	17⅝	2+6	13	25	3+4
9	18½	2+6	14	19	2+5
9	19	2+5	14	20½	2+3
9	19⅝	2+4	15	11½	1+5
9	20½	2+6	15	20	2+3
10	20	2+6	16	8	1+5
10	21	1+5	16	17	2+7
10	19	2+4	16	19	2+5
10	19½	2+4	16	22	2+5
10	21½	2+4	16	30	3+6
10	23	2+5	17	19	2+5
10	23	2+4	18	20	2+5
10	23½	3+2	18	20	2+6

Table No. 2 (cont'd)

Date	Length (cm.)	Age in yrs. + No. of circuli in 1951	Date	Length (cm.)	Age in yrs. + No. of circuli in 1951
May 18	21½	2+5	May 22	9	1+7
18	25	3+4	22	14	1+8
18	27	3+3	22	15	1+8
18	28	3+4	22	19½	2+6
18	28	3+4	22	21	2+7
18	19¼	2+6	23	22	2+5
18	19	2+5	23	19	2+4
18	19	2+6	23	19	2+6
18	18½	2+6	24	17	2+6
18	9½	1+6	24	19	2+6
19	16	1+9	24	19	2+7
19	17½	2+6	24	19½	2+6
20	27	3+3	24	20	2+7
21	15	1+8	24	20	2+8
21	18	2+5	24	20	2+7
21	18½	2+6	24	20½	2+5
21	19	2+6	24	20½	2+7
21	19½	2+6	24	21	2+6
21	19½	2+7	24	21	2+6
21	20	2+7	24	22	2+5
21	26½	2+7	25	17½	2+5
21	27	3+6	25	18	2+5-6
21	28	3+3	26	19	2+7
22	8½	1+7	26	20	2+7

Table No. 2 (cont'd)

Date	Length (cm.)	Age in yrs. + No. of circuli in 1951	Date	Length (cm.)	Age in yrs. + No. of circuli in 1951
May 26	9½	1+5	May 28	15	1+8
26	19⅝	2+7	28	18	2+7
27	18	2+6	29	10½	1+6
28	12	1+7			

Table No. 3. Current growth in marked and "wild" smolts of similar lengths trapped in the Rawdon River in May of 1950 and of 1951.

Kind	Time of trapping	Number examined	(cm.) Length	Percentage showing growth	Number of Circuli	Average number of circuli
	1950					
Marked	May 5-29	18	16-20	100	2-5	2.5
"Wild"	" 5-31	11	16-20	100	2-6	4.4
	1951					
Marked	May 7-29	33	16-20	70	2-7	3.09
"Wild"	" 6-29	65	16-20	100	4-8	5.6

The average rate of growth was greater in both years for the "wild" smolts than for the marked smolts and the fact that the average rate for both groups was greater in 1951 than in 1950 is evidence of the earlier spring in 1951.

Parr and current growth as shown by the scales of marked post-smolts recaptured in Mines channel in 1951.

Samples of scales from a single post-smolt recaptured on July 19 and from 3 post-smolts recaptured on August 4 and having the same markings used at Wellington for fish released

in the head waters of Shubenacadie lake as yearlings in December, 1950, and as smolts at Grand Lake Station in June, 1951, were received from fishermen operating weirs in Minas Channel. The first fish had the left ventral fin missing and each of the rest a right ventral and on one of the latter the left half of the anal fin was missing. Enquiry revealed that the Atlantic Sea Run Commission had been planting marked salmon (fingerlings and older fish) in various Maine rivers, always with two fins removed. The Minas Channel weirs had been taking quite a number of smolts with their markings, but the particular combination for this fish did not correspond with any of their marks having been used only for Penobscot fish, which would be much older in 1951. It is possible that the anal fin had been damaged either at marking or following the planting of the fish. The scales were examined carefully and the parr growth was compared with that of scales from fish of the same age and marking that had descended into Shubenacadie Lake in May, with those from fish of the same lot unmarked and remaining in the ponds and with those of "wild" fish of the same age which had passed through the smolt trap in May. The details of the procedure and the tabulated results are given in a separate section of this report under the heading: "A comparison between the scales of post-smolts trapped in Minas Channel and those of smolts of Shubenacadie Lake and the Beaver-Dawson River system". It was found that the parr growth of the fish taken in Minas Channel much more nearly resembled that of pond fish than of

"wild" fish which had descended in May. Even less did the parr growth resemble that of post-smolts from the rivers of Maine, which tended to have fewer circuli than those from the Shubenacadie Lake region.

A missing left ventral fin was the mark used for fish of lake salmon (Sebago) origin of which 200 were planted as yearling parr in the Upper Rawdon River in December of 1950 and 13,347 as smolts at Grand Lake Station in June of 1951; a missing right ventral fin indicated one of Atlantic salmon origin of which 200 yearling parr were planted similarly in December and 3,079 smolts in June. A much smaller percentage of the planting of lake salmon was recaptured in Minas Channel (0.007%) than of the planting of Atlantic salmon (0.09%). This is the first evidence received of marked smolts passing from Shubenacadie Lake and the river that drains it far out into the Bay of Fundy.

All the fish had grown rapidly in the current year, the scales of two of them having more than doubled in length before recapture. The circuli of current growth were composed of several narrow bands similar in width and thickness of scale to growth in the head waters of the lake and the rest were wider and thicker bands, characteristic of sea salmon. The numbers of circuli of each kind in the current growth of the various fish are shown in Table No. 4. The numbers of circuli of the narrow type are similar for the four fish and the greater number of the wide type for the fish captured in Aug-

ust is to be expected. In the scales of the fish planted in the short Machias and Hobart rivers from which the migrants would soon reach the sea, there was little if any difference in the width and thickness of the current circuli, but of the fish planted in the Penobscot, a longer river, 3 to 4 narrow bands were counted. This indicates that the amount of slow growth is related to the length of the journey to the sea, the Shubenacadie fish showing the greatest amount.

Table No. 4. Date of recapture, length, marking and current growth of post-smolts trapped in Minas Channel in 1951.

Date of recapture 1951	Length (in.)	Marking	Av. number of circuli in 1951 Narrow	Wide	Total
July 19	12	L.V.	4	9.5	13.5
Aug. 4	11	R.V.	5	12	17
Aug. 4	12	R.V.	4	14	18
Aug. 4	13	R.V.	5	11.5	16.5

A comparison between the scales of post-smolts trapped in Minas Channel and those of smolts of Shubenacadie Lake and the Meaver-Newdon system

Post-smolt from Hall's Harbour

Description of the fish

When caught by Mr. James Houghton on July 19, 1951, the salmon was 12 inches long and weighed ½ lb. The left ventral fin had been removed.

Description of the scales

Examination of the scales showed that the fish belonged

to year-class 1949 and had spent two years in the parr stage. In the current year the scales had doubled in length and had increased by 13-14 circuli of which the inner four were narrower bands than the rest with finer ridges between them. Since the narrower circuli resemble normal smolt growth in the Beaver-Rawdon system or in the rearing ponds at Wellington it may be assumed that the first part of the migration occurred in fresh water. If the body length increased at the same rate as the scales the parr was 6 inches long when it descended.

Of 100 scales examined, 30% might be described as good scales, that is, having the origin clearly present. The rest showed regeneration in varying degrees and were separated as nearly as possible into two groups: 15% regenerated in the first and 55% in the second and current year combined.

Five of the best scales were examined in detail and measured on a ruled slide. In the first year, the number of circuli varied from 17-20 and averaged 19; in the second from 15-19 and averaged 17. All the scales were 1 mm. in length from the centre of the origin to the outer margin of the winter band of the second year.

Sebago smolt, L. V. marking

Description of the fish

The smolt descended through the trap on the large Rawdon River on May 15, 1951. It was 6.4 inches long and 2 years old. The scales had not yet begun to show growth in

the current year. The marking indicated that it belonged to a lot of 200 yearlings raised in the rearing-ponds at Wellington and released on December 2, 1950, below the cascades of the Upper Rawdon River.

Description of the scales

The examination of 100 scales revealed that 24% might be considered good, 35% regenerated in the first year and 41% in the second year.

On five good scales studied, the number of circuli indicating the first year varied from 19-22 with an average of 21 and in the second year from 13-17 with an average of 15 circuli, the total being 36, the same as that for the parr growth in the marked fish from Hall's Harbour. The average length of the scales was .9 mm., slightly less than that of the scales of the fish from Hall's Harbour.

Smolts from the rearing-ponds at Wellington

Description of the fish

a. On August 11, a fish which had recently assumed the silver phase, was selected. The parr bars could be discerned faintly and there were still many red spots on the sides. It was approximately 7 inches long and of the year class 1949.

b. On August 13, a larger fish (8 inches) and completely in the silver phase, was selected from the ponds. It also belonged to the 1949 year class.

Both fish were similar in life history to the marked

smolt taken in the Rawdon trap except that they had remained in the ponds.

Description of the scales

a. Examination of 150 scales showed only 10% in good condition; 37% regenerated in the first year and 53% in the second and current year together. The circuli for 5 good scales varied from 18-21 for the first year with an average of 20 circuli. On the second year the number varied from 15-21 and averaged 18 while in the current year 13 circuli had been added. The average over-all length of the scales was 1.28 mm. of which .38 had been acquired in 1951. The average length of the scales at the end of the second year was the same as that of the smolt from the ponds that had been released in December, namely .9 mm.

b. Only 6.5% of 200 scales examined were good; 15% were regenerated in the first year and 79% in the second and current year combined. An average of 20 circuli were added each year to the scales and the variation was 19-21 in each year of the parr growth with 10 circuli in 1951. The length of the scales averaged 1.4 mm. with 30% belonging to the current year.

Smolts from the Beaver-Rawdon River system

Description of the fish

The scales of three smolts that descended from the head waters through the trap on the Rawdon River into Shubenacadie Lake were selected for special study on the basis of

the size of the fish being comparable with that of the post-smolt from Hall's Harbour at the end of the parr growth.

a. 18.5 cm. (7.4 in.) captured May 9, 1951

b. 20 cm. (8 in.) " " 15, 1951

c. 18 cm. (7.2 in.) " " 25, 1951.

Description of the scales

a. Eighty-five scales of the first fish were examined of which 30% were good, 36% regenerated in the first and 34% in the second year. The numbers of circuli on five good scales selected varied from 13-18 and averaged 15 in the first year and from 17-20 and averaged 19 for the second year. Growth in the current year made 6 new bands. The total length of the scales averaged 1.1 mm. with 25% of this length added in 1951. At this rate the parr would be approximately 5.6 inches long at 2 years.

b. From the second fish 80 scales were examined; 16% were good, 60% regenerated in the first and 25% in the second year. The numbers of circuli varied from 18-21 with an average of 19 for the first and from 26-32 with an average of 29 for the second year. 3-4 new bands were grown in the current year. The average total length was 1.4 mm., of which 14% belonged to 1951, making the estimated length of this smolt as 6.8 inches at the end of parr growth.

c. 100 scales of the third fish were examined. 50% were good and 25% regenerated in each of the first and second years. For the first year the numbers of circuli varied

from 10-14 and averaged 13 and for the second from 15-19 with an average of 16. Five circuli were added to the scales in 1951. The average over-all length of the scales was 1.1 mm., 22% representing 1951. Both a and c were probably a little smaller than the post-smolt from Hall's Harbour, being estimated as 5.6 inches at end of the parr growth.

The principal differences between the scales of the naturally produced smolts and those of pond-reared smolts both marked and unmarked were two: greater contrast in width of the bands denoting winter and spring seasons in the parr and greater rate of growth in the second as compared with the first year in the case of the naturally produced fish.

The numbers of scales of each fish examined, the numbers of circuli and the lengths of the scales per year based on an average of 5 good scales are shown in table No. 5.

Summary of comparison

Post-smolt from Hall's Harbour vs. pond-reared salmon

Resemblances

a. Circuli similar in number for corresponding lengths during a parr growth.

b. Width of circuli during different seasons in the parr growth were similar.

Differences

1. The smolt from Hall's Harbour had a slightly higher percentage of unregenerated scales (30%-24%) than the marked smolt which was liberated in the autumn of 1950. It also

had a much higher percentage of good scales than either of the smolts which had remained over winter and during the current year in close proximity in the ponds. In view of the difficulty of classifying the scales as to the time at which regeneration took place especially for the post-smolt which had grown so rapidly in the current year, this difference is considered less important than the resemblances already cited.

Post-smolt from Hall's Harbour vs. naturally produced smolts

Differences

a. Sharper contrast between the width of the circuli of the winter of the first year and the spring of the second year in the case of the "wild" fish.

b. Greater variation in the rate of growth in the first and second years in the "wild" than in the marked fish.

On August 4, three post-smolts with the right ventral fin removed, the marking used at Wellington for fish of Atlantic salmon origin, were trapped in Minas Channel, one at Hall's Harbour and two at Black Rock Point. Samples of the scales, fin scars and records of the lengths and weights were received and the procedure used for studying the scales of the first fish from Hall's Harbour was followed, scales from recaptured smolts with right ventral marking being selected for comparison. The results are shown in part 2 of table No. 5.

The resemblances and differences cited on page 60 of the comparison are also applicable to the scales of the three additional post-smolts taken on August 4. This is the first evidence received of marked smolts from the rearing ponds at Wellington having been recaptured far out in the Bay of Fundy.

Table No. 5. Body lengths, average numbers of circuli and lengths of the scales in the parr and current growth of post-smolts from Mines Channel, the Rawdon River and the rearing-ponds at Wellington, showing the condition and the numbers of scales examined.

Kind and mark	Body length 1951 (inches)	parr (est.)	Av. No. circuli for 5 scales '49	'50	'51	Av. length (mm.) (5 scales) '49	'50	'51	No. scales examined	Condition of scales good	- regenerated '49	'50-'51
Hall's Hbr. L. V.	12	6 50%	19	17	13.5	.4	.6	1.0	100	30%	15%	55%
Rawdon trap L. V.	6.4		21	15	0	.54	.36	0	100	24%	35%	41%
Pond A	6.8	4.8 70%	20	18	13	.44	.46	.38	150	10%	37%	53%
Pond B	8.2	5.7 70%	20	20	10	.48	.52	.42	200	6.5%	15%	79%
"Wild" A	7.4	5.6 75%	15	19	6	.3	.5	.14	85	26%	30%	29%
"Wild" B	8	6.8 86%	19	29	3.5	.4	.8	.2	80	16%	60%	25%
"Wild" C	7.2	5.6 78%	13	16	5	.36	.54	.26	100	50%	25%	25%

Table No. 5 (cont'd)

Kind and mark	Body length 1951 (inches)	parr (est.)	Av. no. circuli for 5 scales '49	'50	'51	Av. Length (mm.) (5 scales) '49	'50	'51	No. scales examined	Condition of scales good - regenerated '49	'50-'51
Hall's Hbr. R. V.	11	6.6 60%	25	12	17	.8	.4	.8	100	12%	43% 45%
Black Rock Pt. R. V.	12	5.1 43%	19	14	18	.4	.34	1.0	100	23%	38% 36%
Black Rock Pt. R. V.	13	6.2 48%	19	15	17	.4	.38	.8	100	21%	44% 35%
Pond Atlantic Salmon	8#	6.5 75%	21	24	10	.48	.7	.4	100	21%	11% 68%
Rawdon trap R. V.	6.6		21	21	0	.5	.5	0	100	14%	52% 34%
Rawdon trap R. V.	6.4	5.3 82%	23	16	6	.5	.4	.2	100	8%	47% 45%

3. Operation of the Smolt Trap in the Rawdon River in 1951

Under the direction of Dr. Huntsman, the triangles of the fence leading to the Rawdon smolt trap which had been weakened during the winter were replaced, the racks attached and the trap reassembled to function for descending fish only. It was operated from May 6 to May 9 by Dr. Huntsman and then by Miss Lillian King until May 29 when excessive rain resulting in a freshet carried the trap and part of the fence away. It was considered unwise to rebuild for the remainder of the season.

Descent of salmon

On the first day of operation 9 smolts entered the trap and in view of the early migration of smelts and gaspereaux in 1951 as compared with 1950, it is doubtful whether trapping began early enough to take the first migrants. By the end of May, the numbers were declining and in all probability most of the fish had descended. A total of 155 young salmon were trapped, 43 being marked fish and the rest naturally produced salmon. In addition, 7 pond fish tagged in November, 1950, and released at the head of Shubenacadie Lake were recaptured and a single untagged and unmarked lake salmon 18 inches long and having a hook and 30 inches of cast attached was found dead in the trap. The following summary shows the marking used for each kind of fish, the number marked, where released and number of each kind recaptured.

Mark	Kind (origin)	Number released	Where released	Number trapped	
L. V.	Lake	200	Upper Rawdon	20	10%
R. V.	Atlantic	200	" "	21	
L. V. + Adp.	Lake	200	Beaver River	0	.5%
R. V. + Adp.	Atlantic	200	" "	2	
		800		43	5.4%

The annual struggle with migrating gaspereaux pressing against the fence and the mouth of the trap was so successfully handled that only four young salmon were presumed killed by the overcrowding.

Results of the trapping in the last three years show considerable diversity. The trap was in operation much longer in 1949 and 1950, which would have some effect upon the number trapped, although the month of May is usually the time of maximum smolt migration. The numbers of fish trapped in each year are shown below:

Year	Time of trapping	Number of unmarked salmon	Marked smolts Released	Caught	% of number released
1951	May 6-May 29	112	800	43	5.4
1950	May 2-Aug. 25	28	200	84	42
1949	May 2-Aug. 29	334	9,948	2	.02

The total number of naturally produced smolts which descended in 1951 would be higher probably than indicated in the table and compare even more nearly with the number descending in 1949 than in 1950. This is probably due to the

fact that the rivers were higher during the spring in 1949 and 1951 than in 1950.

The diversity in the proportion of marked smolts recaptured presents an interesting comparison. The yearlings were released in Grand Lake during the spring of 1948 and only 2 appeared in the trap the following spring; in 1949, the planting was done in the autumn in the Lower Rawdon about halfway between Kinsac and Shubenacadie Lakes, and not far above the trap and in 1950, 50% of the yearlings were released in the autumn above Kinsac Lake and the rest above Beaverbank Lake. The conclusion to be drawn is that fall planting produces more descending smolts than spring planting and that yearlings released far above Shubenacadie Lake may remain in the lakes of the Beaver-Rawdon system or fall a prey to enemies there.

Descent of other fish

As in previous years, suckers and gaspereaux were trapped more abundantly than other fish. The numbers of them taken were comparable when the shorter time that the trap was in operation is considered. The increase in the number of trout over 1950 (15-2) may be due to higher water affecting their migration as well as that of the salmon. Eels were fewer than in 1950 (8-60) which may be due in part to the early trapping and in part to the large numbers taken in eel traps in 1950. Lampreys and catfish which usually appear in June were not taken in 1951.

4. Smelt Fishing in Shubenacadie Lake and Its Tributaries in 1951

Angling

Angling for smelts during the winter in Shubenacadie Lake was almost nil since ice covered the lake for only three days. No report was available for small numbers known to have been caught at the mouths of brooks where the ice remained a little longer.

Spring fishing

Migration for spawning into the Fletcher and Rawdon rivers occurred ten days earlier in 1951 than in 1950, and lasted approximately the same length of time. The earlier movement was the result, no doubt, of the temperature of the water being warmer in March of 1951 than in the same month in 1950 (ref. fig. no. 1 and table no. 2, report on salmon angling in Shubenacadie Lake in 1951). It was reported by the local residents that smelts first appeared in the Large Rawdon River on March 22 and in the Small Rawdon on the following day. The runs were just over when I arrived at Wellington on April 10. The run was described as fair in the Rawdon but the numbers caught were small since high water made dipping difficult. According to reports received from the staff at the rearing ponds at Wellington, smelts entered the Fletcher River in March and were last seen on April 9. The run was very small and the water too high for dipping.

Mr. Hamilton Lee who resides on the shore of Kinsac Lake at Fall River hoped to secure enough smelts from that

lake to preserve some for study, but succeeded in getting only two or three for his own use.

Distance of ascent

Miss Lillian King reported that smelt spawn was found scattered on rocks and vegetation in deep water as far up the Large Rawdon River as the trap for spawning salmon and in the Small Rawdon River spawn was abundant 300 yards above the road-bridge over that river. No spawn was seen along the west bank of the Fletcher River where it was found in 1950.

Trout angling in Shubenacadie Lake in 1951

Five trout were reported from Shubenacadie Lake as compared with fifteen in 1950. None of the fish was caught at the head of the lake or brought to the labratory at Bellington. The details of the report are shown below:

Date	Place of capture	Size	Name of angler
Apr. 15	Off Cook's Camp	1 lb.	Clyde Swicker
May 6	Sandy Cove	2½ lb.	Wm. Mould
		? (small)	" "
" 24	Mouth of lake	½ lb.	A. Kieley
" 26	Little Lake	8-10 in.	Wm. Poske

5. Eel Trapping in the Rawdon River in 1951

The procedure for trapping eels in the Rawdon River tried out in August of 1950 was used again in 1951 with certain modifications, which were suggested by Dr. Huntsman by the results as the summer advanced. Mr. Stewart Stevens operat-

ed the traps daily, visiting them fairly regularly each morning from May 10 to July 27, and then during the late afternoon or early evening until September 22, when his services were no longer available and the traps were taken up. During May, June and July, 6 traps were used, one in each of the sections A to F, the whole length of the river being worked by moving each trap to a new station 81 feet away every 2 days. Then, on July 21, 6 stations were selected as the best positions for steady trapping. On August 1, the number was reduced to 4, one in each of the sections A, B, C, and F, it being considered that immigrant eels were mostly coming from the lake below. The time of operation was changed from morning to evening so that the bait would be fresh at the time that the eels were most active. The eels were counted, weighed and disposed of at first by letting them die in wire baskets suspended from trees near the traps and later by killing them as soon as captured. The dead eels were returned to the river as fertilizer.

The numbers of eels, the total weight and the average weight per month for each section and the number of times the traps were lifted in each section of the river are shown in Table No. 1.

Nearly 40% of the total number of eels was taken in Section A, closest to the mouth of the river. On the whole, the eels were quite small, the average weight decreasing from 0.77 lb. in May to 0.45 lb. in July, and then increasing sl-

most to the average of June in August and September (Table No. 1). Anglers reported capturing large eels in Shubenacadie Lake near the mouth of the Rawdon River in the latter part of the summer, but they either were not entering the river or were not being taken in these traps. In 1950, Mr. Chisholm reported only small eels being captured in the traps at the same time that large eels were descending the Rawdon River and entering the smolt trap. In August of 1950, 54 traps were visited and yielded 325 eels weighing 93 lb., or an average of 0.29 lb. in weight. In the same month of 1951, the weight of 348 eels captured in 108 trappings average 0.53 lb. It may be assumed that the number of eels was less in 1951, but the size nearly twice as great. The conclusion reached in August of 1950 that the small numbers of eels taken in Section C of the river was due to faulty trapping is borne out in the results of 1951 since this section of the river yielded the second largest number (217) of eels trapped. It is possible that the small catch made in Section B in 1951 may be due to faulty trapping at first.

On October 26th, 1951, trapping of eels in the Rawdon River was resumed under the operation of Miss Lillian King. Trap A1 was placed below the road-bridge and trap B1 just above the first island, both in position to take eels ascending the river. Beside B1 a smaller trap, B2, was placed in the reverse direction to take descending eels. The traps were baited in the evening and lifted in the morn-

ing. The temperature of the water, the numbers, the lengths and weights of the eels were recorded, and the results are shown in Table No. 2.

It is apparent that in the same number of trappings a greater number of eels was ascending the river than descending (27 to 7) and that some of those ascending were larger than any that descended (23 in. to 15½ in.). The average weight of the eels in the autumn catch was half that of the average weight of the eels taken in the spring and summer (0.28 lb. to 0.55 lb.) and similar to that of the eels captured in August of 1950 (0.28 lb. to 0.29 lb.).

It was clear that ascent was associated with the higher temperatures, especially since none were taken from November 10 to November 17, nor until the temperature rose again to 10°C. While the few eels were descending in October, the temperature was falling.

Table No. 1. Numbers and weight of eels trapped in the Rawdon River from May 10 to September 22, 1951.

Section	No. of lifts	May		June		July		August		September		Total	
		No.	Wt. (lb.)	No.	Wt. (lb.)	No.	Wt. (lb.)	No.	Wt. (lb.)	No.	Wt. (lb.)	No.	Wt. (lb.)
A	114	15	14½	179	94⅝	102	42½	152	82⅝	48	26⅞	496	251¼
B	111	2	1½	35	26	27	11⅝	81	44	36	17	181	100¼
C	111	23	18	49	30¼	48	24	77	40¼	20	11½	217	124
D	69	30	23	33	21	25	11½					88	55½
E	70	25	17½	29	20⅝	54	24 3/8					108	62 5/8
F	108	34	25¼	59	42⅝	23	12¼	38	18¼	7	3⅝	161	102¼
	583	129	99⅝	384	225½	279	126 1/8	348	185¼	111	58⅝	1251	695 5/8
		Av. 0.77		Av. 0.58		Av. 0.45		Av. 0.53		Av. 0.52		Av. 0.55	

Table No. 2. Numbers and weights of eels trapped in the Rawdon River from October 26 to November 17, 1951.

Date 1951	Temp. of water degrees C. A.M.	P.M.	Av.	Trap A1 Ascending eels	Trap B1 eels	Trap B2 Descending eels	Total Wt. lb.	Length inches.
Oct.26				16	1	0	5	12½-19½
" 27	10	12	11	0	1	0	1/8	13½
" 28	8.5	11.5	10	2	1	1 (12 in.)	1½	10 -16
" 29	11	10	10.5	0	0	0	0	
" 30	8	10	9	0	0	2	1	12 -15½
" 31	9	10.5	9.75	0	0	3	½	11½-14½
Nov. 1	10	-	-	0	27	1 (12 in.)	7 1/8	12½-19½
" 4	-	11	-	0	0	0	0	
" 5	9.5	10	9.75	0	3	0	½	10 -11½
" 6	9	9	9	0	0	0	0	
" 7	9	8.5	8.75	0	0	0	0	
" 8	10	11	10.5	0	1	0	1/8	12
" 9	9.5	9	9.25	0	1	0	1/8	10
" 10	8.5	9	8.75	0	1	0	1/4	19
" 11	9	9	9	0	0	0	0	
" 12	9	8	8.5	0	0	0	0	
" 13	7	7.5	7.25	0	0	0	0	
" 14	8	8.75	8.3	0	0	0	0	
" 15	9.75	10	9.8	0	0	0	0	
" 16	10	10	10	0	0	0	0	
" 17	9.5	9.5	9.5	0	2	0	1½	19 - 23
				18	38	7	17⅞	

Average 0.28

6. Striped bass angling in Shubenacadie Lake in 1951

Collection of Results

In the region of the mouth of Shubenacadie Lake the anglers usually landed their bass in Sandy Cove and reported to Mr. Andrew King. The rest of the reports were secured by me either from the anglers who came to the laboratory at Wellington or when collecting reports on salmon angling at Grand Lake Station and at Horne Settlement on the shores of Little Lake.

Angling results

The decrease from 1950 in the numbers of striped bass taken in Shubenacadie Lake in 1951 was a great disappointment to the anglers. Bass up to 20 inches in length were reported being taken in May in the shad nets in the lower part of the Shubenacadie River, and, according to local anglers, they migrated up as far as Enfield, but in the lake itself the total number reported caught was little more than 50% of the number reported in 1950. The fish examined by me varied in length from 9½ in. to 22 in. and in weight from 4 oz. to 4½ lb. The rest of the fish that could be considered to be reliably reported weighed 5 lb. or less. The angling results in Shubenacadie Lake seem to fit into the picture of the general distribution of the striped bass in 1951 as reported by the fishery officer for the region, namely, that commercial bass fishing was good in the Stewiacke River

and along the adjacent shores of the upper part of the Bay of Fundy, but poor in the Shubenacadie River. It is probable, too, that the large fish remained farther out than in 1950.

The numbers of bass reported caught by anglers between April 15 and September 15 in the three main divisions of Shubenacadie Lake in 1950 and 1951 are listed in Table No. 1.

Table No. 1. The numbers of striped bass caught by angling in the three main parts of Shubenacadie Lake from April 15 to September 15 of 1950 and 1951.

Year	Month	Head of the lake	Grand Lake and region of the mouth	Little Lake	Total Catch
1950	May and June	60 116	47	119	
	July	29	1	0	
	Aug.	17	3	0	
	Sept. 1-15	26	0	0	
		248	51	119	418
1951	Apr. 15-30	0	4	25	
	May	46	14	75	
	June	17	10	0	
	July	0	9	0	
	Aug.	7	2	0	
	Sept. 1-15	3	0	0	
		73	39	100	212

The table shows that the greatest decrease in the num-

bers of bass was at the head of the lake, and this decrease was mainly responsible for the reduction of the total catch to almost 50% of that of 1950. Angling began earlier in 1951 in Little Lake than at the head of the lake, and the spring catch was made earlier in all parts of the lake in 1951 than in 1950. The position of the bass in the lake in the spring and the time at which they are available seems to be determined by the temperature of the water. In 1950, it was found that the temperature of the water in Little Lake in May was 3°C. warmer than that of Grand Lake near its mouth, and, in 1951, the temperature was 5°C. higher for the waters at the head of Shubenacadie Lake at the opening of the salmon angling season than in 1950. (Ref. fig. no. 1 and table no. 2 "Salmon angling in Shubenacadie Lake in 1951"). Summer and autumn angling for bass is most successful while young gaspereaux are descending from the head waters into the lake. The numbers caught in 1951 were less than in 1950 (table No. 1), and also less than in 1949 according to verbal reports, and although gaspereaux were observed to be descending until late in October, no improvement in the bass angling was reported at the head of the lake.

Although no large bass were caught by the anglers, one weighing 15-18 lb. was killed on May 8 with a stick when it became trapped in a pool in the Rawdon River when the dam was raised and another, a female, 41 inches long and weighing 17½ lb. was found dead in the Shubenacadie River just below the

mouth of the lake on August 2.

Age and condition of the bass

The ages as shown by the scales, the lengths, weights, calculated condition factors, and the dates and places of capture are shown in Table No. 2. The fish are arranged in order of length to show the relation between age and length.

With exception of the four-year old caught on June 4, the bass from the head of the lake were considered very small by the anglers. All were caught in the lower part of the Fletcher River or in the lake at its mouth. That the fish caught in 1951 were smaller than those of 1950 was indicated by the reports of the anglers and from the lengths of 53 bass taken in 1950 of which 20 were over 20 inches long. A variation of 3 inches in the lengths of the four-year-olds in 1951 (14 inches to 17 inches) corresponds closely with that found for fish of the same age in 1950 (15 inches to 18 inches). There was less variation in the lengths of the younger fish.

The bass caught at Wellington appeared to be in good condition. The average of the condition factors for 10 bass (0.57) caught in 1951 was slightly higher than that for 16 fish taken in 1950 (0.54) and also a little higher than that found for the naturally produced salmon caught in Shubenacadie Lake in May of 1951 (0.55).

Food for bait

The stomachs of three bass examined were empty; one caught on June 23 contained insects only and four contained

Table No. 2. Dates and places of capture, ages, lengths, weights and condition factors of striped bass caught by angling in Shubenacadie Lake in 1951.

Date of capture	Region of lake	Age (yrs.)	Length (inches)	Weight (ounces)	Condition $\frac{100 \times W}{L^3}$
June 2	Head	2	9½	4	.47
" 20	"	2	10	6	.60
May 24	"	2	10⅛	6	.51
Aug. 2	"	2	10⅛	?	-
" 2	"	2	10⅜	?	-
June 2	"	3	12	9	.52
Aug. 2	"	3	12	?	-
" 2	"	3	13⅛	?	-
Sept.2	"	3	13⅜	16	.60
June 23	Grand Lake	4	14	17	.62
June 4	Head	4	16⅛	24	.53
May 6	Grand Lake	4	17	?	-
" 11	" "	4	17	35	.71
Apr. 15	" "	6	20	45	.56
" 24	Little Lake	(No scales received)	22	68	.64
					Av. .57

partly digested fish, identified as perch, elvers and gaspereaux.

The anglers used minnows, worms and artificial bait as in salmon angling in the spring months/and young gaspereaux, if obtainable in August and September.

7. Gaspereaux migration and fishing in 1951

Ascent for spawning

Water free from ice during the early spring afforded better opportunity than usual for observation of fish movement in Shubenacadie Lake. Ascending gaspereaux were reported in the lake near its mouth in March, but were first observed at the head of the lake ascending the Fletcher River on April 23 and both branches of the Rawdon River on April 24. The interval of a single day in their appearance in the two rivers as observed in 1950 is added evidence of their route of migration being along the east shore of the lake. Scattered migrants were seen from day to day until the fish became numerous enough for dipping in the Fletcher on May 15 and in the Rawdon on May 16. The maximum amount was fished from both rivers on May 29 which proved to be the final day of good fishing for the season since rain began to fall heavily that afternoon and continued intermittently for four days producing a freshet of sufficient volume to carry the gaspereaux from both rivers back into the lake. At the same time that the fish were most abundant at the head of the lake, an angler who camps on the shore of Little Lake reported seeing the sandy bottom of that lake covered with gaspereaux on May 26, and was surprised to catch

two gaspereaux when fly-fishing for bass. Mr. Andrew King also reported that two gaspereaux took bait in Sandy Cove. From June 12 to 21 fish known locally as "Mulheden" or Bluebacks became sexually mature and ascended the rivers. Few were used since fishing was illegal after June 15.

The first migrants ascended ten days earlier in 1951 than in 1950 (April 23 versus May 2), and the big catches were made in the latter part of May in both years (May 23-25 in 1950 and May 27-28 in 1951). Small catches were made almost daily between these dates; in 1950, fish were plentiful on May 5, May 11 and May 19 in the Fletcher River, and in 1951 there was a fair run in both rivers from May 15 to May 17. The late run of Bluebacks took place about the same time in the two years. In 1950, they were reported first on June 9 and were most plentiful from June 12 to June 14, and the last stragglers were ascending the fishway on the Fletcher on July 3; in 1951, fish were numerous in the Fletcher lock on June 12 and were last reported there on June 21. In 1949, two runs occurred, the first and largest being between May 16 and May 21 and the second from June 1 to June 6. Whether the latter run included the Bluebacks is not known.

The catch

It is estimated that 30 tons of gaspereaux were dipped from the two rivers in 1951, the amount being made up of approximately 190 barrels of 300 lb. each from the Rawdon River to be sold as salted fish, and 3,500 lb. from the Fletcher River to

be frozen as food for salmon and trout in the rearing ponds at Wellington. In addition, local residents dipped an undetermined small amount from the Fletcher River for their own use. In 1950, the catch was estimated as about 30 tons, a decrease of 10 tons from that of 1949.

Physical conditions

a. Height of the water

Low water in the rivers in May and especially in June was considered to be responsible chiefly for the decrease from 1949 in the abundance of gaspereaux in 1950. When migration began in 1950, the water was actually higher than when the fish entered the Fletcher River in 1951 (5.0 ft. versus 4.1 ft. from measurements of lake level at the mouth of the lock in the Fletcher River). During the weeks of maxima in the two years the average heights were similar (3.7 ft. in 1950 and 3.8 ft. in 1951). However, in June of 1950, the water became so low (2.9) that parts of the rocky beds of the rivers had little water in them, whereas, in 1951 a flood carried the fish back into the lake. These diversely unfavourable conditions for migration probably resulted in the catches being the same estimated amount for each of the two years.

b. Temperature of the water

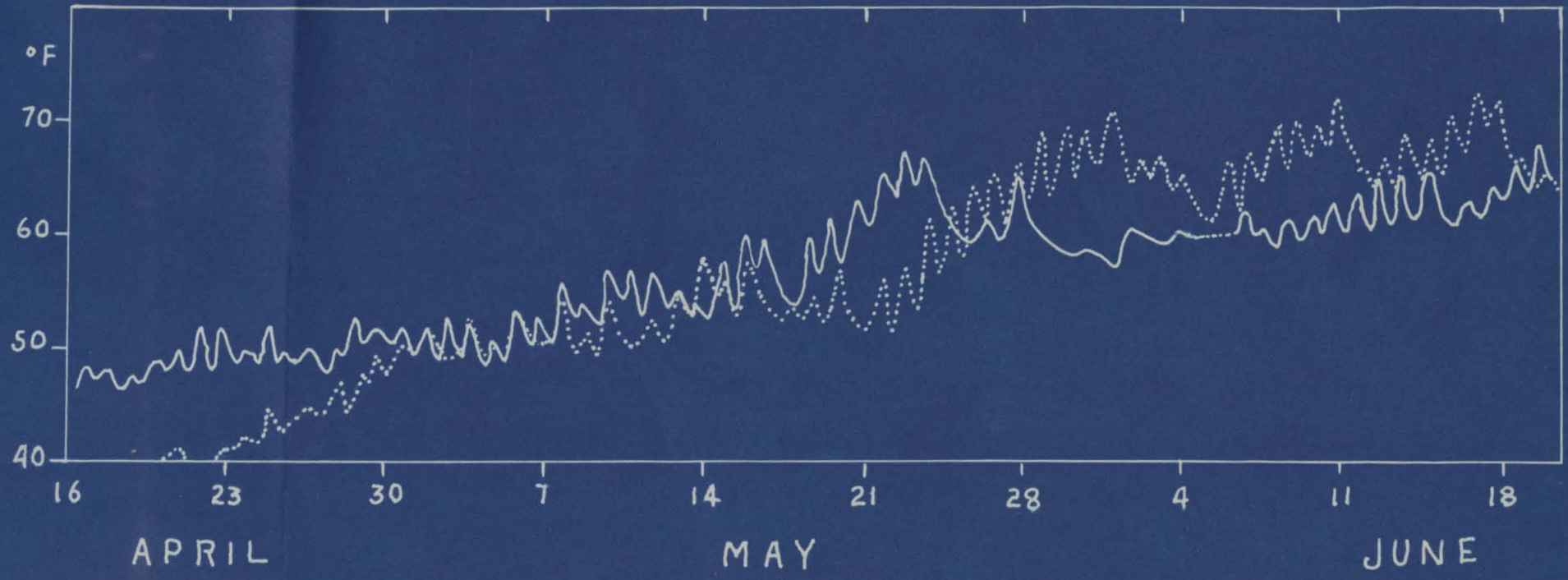
In 1950, an attempt was made to test a theory held by local fishermen that gaspereaux were more abundant on sunny days than on cloudy days by comparing the total number of hours of sunshine with the estimated amount fished daily from

the two rivers. It was concluded that the warming of the water resulting from sunny days had a greater effect of migration than the actual number of hours of sunshine and that good fishing could be done in cloudy weather. Observations made in 1951 strengthen this conclusion.

In figure No. 1, the continuous daily temperature of the water entering the rearing ponds from the Fletcher River, as recorded by a thermograph, are plotted for 1950 (broken line) and for 1951 from April 16 to June 21.

On May 2, 1950, when the initial ascent of gaspereaux into the Fletcher River took place, the water had been warmed to 50°F. for the first time during the spring, and, similarly in 1951, the same temperature was reached just prior to the first ascent. In 1950, the period of greatest abundance coincided with a temperature of 60°F. on May 23 and the fish ascended in such numbers that the run was soon over. In 1951, a small run took place on May 16 and May 17 when the temperature first became 60°F., but the best fishing was done on May 27 and May 28 after an interval of several days in which the fish must have been collecting at the head of the lake. In 1949, there was a similar correlation between migration and temperature of the water. The fact that the water was much warmer in June of 1950 when the Bluebacks were migrating than when they ascended in 1951 would point to some other stimulus influencing the time of their ascent.

Figure No. 1. The continuous temperature of the water from the Fletcher river entering the rearing ponds at Wellington, N. S., from the records of a thermograph from April 16 to September 21 of 1950 and 1951. The dotted line is used for 1950.


°F
70
60
50
40
16
23
30
7
14
21
28
4
11
18
APRIL
MAY
JUNE

Descent after spawning

Little information was available in 1951 concerning the time of descent of the gaspereaux after spawning. Partly-spent males taken in the smolt trap in the Rawdon River on May 25 and the loss of the trap soon after interfered with observing the movements of both adults and young for the rest of the summer. The occurrence of frequent rain and high water probably explains why descending gaspereaux were not reported to be passing over the dam in the Fletcher River before June 12 since in 1950, a later season, they were descending as early as June 5.

Size, sex and condition of the gonads

In a sample of a dozen fish from each of the rivers on the day of the initial ascent, the lengths varied from 27 cm. to 32 cm.; all were nearly sexually mature and the males outnumbered the females. Five days later, in a sample of 12 fish from the Fletcher River, 6 were males averaging 29 cm. in length and 6 females averaging 31.5 cm. The males were mature and the females nearly so. That spawning was soon under way was shown by the fact that a partly-spent male was taken in the smolt trap in the Rawdon River on May 9 and a partly-spent female on May 14. Three small (24 to 25 cm.) and partly-spent males were also trapped there on May 24. From the June run of bluebacks, 15 females averaged 29 cm. in length and 14 males averaged 27.5 cm. All were mature or partly-spent.

Descent of underyearling gaspereaux

Underyearlings in downstream migration were observed in Sandy Cove by Mr. Andrew King as early as June 19, and at the same time gaspereaux, intermediate in size between underyearlings and spawners, were seen in the cove.

Descent from the Fletcher River into the ponds at Wellington was described by the staff as less abundant than usual in 1951. They were first seen passing through the screens at the intake on July 21, five days earlier than in 1950. Descent continued spasmodically throughout the summer and autumn, but no correlation between freshet and time of descent was evident. The initial descent occurred when plankton near the surface of the Fletcher River was at a minimum as indicated by the samples taken weekly with a No. 5 plankton net. That the fish had migrated from locations at different distances from Wellington or belonged to spawnings of different periods was indicated by the variation in size of the lots dipped on consecutive dates. For example, in 61 fish dipped on July 21, the lengths varied from 3.5 cm. to 5.5 cm.; in 95 fish taken July 24, from 3.5 cm. to 6 cm.; on July 25, in 120 fish the variation was from 4.5 cm. to 6.5 cm. and on August 7 in a lot of 98, the lengths varied from 3.5 cm. to 6.0 cm. The fish in the last lot were no bigger than those that descended more than two weeks earlier. By September 17, the length of the migrants varied from 6.0 cm. to 8.5 cm. with an occasional individual 12.5 cm. long, and a month later the length had increased to a variation of 12 cm.

to 14 cm.

8. Salmon movement in still water and Gasterosteus movement in still water

Salmon movement in still water

In 1948, some observations were made on the movements of young salmon taken from the rearing ponds at Wellington and placed in an oval pond with a sloping clay bottom, which was 16 inches deep at the middle. It was found that fish 5.3 cm. and larger settled to the bottom and that the bigger the fish the more quietly it settled. Fish smaller than 5.3 cm. roamed at distances from the margin and below the surface that varied with the size of the fish and the brightness of the sun.

During 1950, a series of 5 circular concrete ponds designed by Dr. Huntsman for the extension of this work on biopoerisis were constructed at Wellington. All had straight sides, were connected by straight channels and had depth and diameter such that each was double the next in the series, the largest being 4 ft. deep and 20 ft. in diameter. Manipulation of rate of flow at the inlet, depth of pipe at the outlet of each pond and screens and dams in the channels made it possible to stock each pond separately and maintain the same depth of water or vary it as desired.

Blinds to permit the observer to approach the ponds without being seen or obstructing light from the sky and thus disturbing the fish were built in 1951 and by the end of August, when the season for salmon angling was drawing to

a close, opportunity was available for trying out the new "biopoc" ponds.

Summary of observations - Pond IV- August 30 to September 11

Depth of water - 16 in. for underyearlings 4.5 to 6 cm.
16 to 20 in. for yearlings 9 cm. and 14 cm.

Diameter - 10 ft.

Temperature of water - 19°C. a. m.; 22° to 24.8°C. p. m.
(partly cloudy to very bright).

1. In still water 16 inches deep the underyearlings released separately swam to the bottom and across the pond and settled near the margin (1 to 3 in.). After several hours, all but the smallest were quiet on the bottom near the margin and in the shadow of the wall; the smallest was swimming to hold position 12 in. from margin and 12 to 14 in. from the surface, the distance being less when the sky was partly cloudy.
2. In still water 20 inches deep, both yearlings settled near the margin or close to the screen about the outlet at the centre when the sky was bright or partly cloudy, but the smaller swam, holding position but not wandering at 17 to 18 inches from the surface when the sky was overcast during rain.
3. Salmon of all lengths took up "homing" positions which seemed to be associated with cover, the smaller in the niches at the ends or under the screens and the larger close to the screens or margin of the pond. After being

disturbed they returned quickly to their homes, the only exception being during bright sunlight when the yearlings sought the shade of a plank placed across the top of the pond.

4. Movement from pond to pond took place, the smaller fish, in spite of a screen, to a shallower pond above and nearer the inlet and the largest fish over a dam into deeper water below.

This preliminary work led to the conclusion that the depth of water that could be maintained in Pond IV was hardly great enough to study young salmon of the size then available in the rearing ponds while rearing.

Summary of observations - Pond V - September 11 to 16

Depth of water - 41 in. without appreciable current.

Diameter - 20 ft.

Temperature of water - 19°C. in morning to 21.5°C. in the afternoon.

Light - mornings till near noon, overcast except September 13, afternoons bright except September 16 when heavy rain occurred.

Fish - underyearlings from the circular ponds released separately. Lengths 4 to 8 cm.

1. The salmon did not school. Each adopted some position almost at once to which it returned when disturbed and which it attempted to defend from other fish. It tended to attack another and usually smaller fish when the

latter was in motion and not more than 3 to 4 ft. away and the victim of attack escaped by settling rather than by swimming rapidly for more than a short distance.

2. A limited number of measurements led to the following conclusions as to the distance from the margin and from the surface that fish of different lengths wandered when the sky was overcast:

   8 cm. - 3 ft. from the surface and 2 to 3 ft. from the margin.

   6 cm. - 1 to 1½ ft. from the surface and 6 in. from the margin.

   4 to 5 cm. - 6 in. from the surface and in middle distance between the screen at the centre and the margin.

3. During heavy rain the fish became very active, coming to the surface where the drops fell as though feeding.

4. When the sky was bright and the pond well illuminated, the fish swam closer to the bottom and it is doubtful whether the water was deep enough for the largest fish since it settled most of the time. The smaller fish were swimming approximately 1 ft. deeper in bright sunshine.

Summary of observations - Pond V - September 19 to 21

Depth of water - 41 in. without appreciable current.

Temperature of water - September 19 - 19°C. to 21°C.

" 20 - 19°C. to 20°C.

" 21 - 16.5°C to 19.5°C.

Light - Bright except during early morning fog on September 21.

Fish - 2-yr.old salmon from the same rearing pond. Lengths 11.5 cm.; 18 cm.; 21 cm.

- yearling salmon from a similar pond for the final afternoon. Lengths 8 cm. and 12 cm.

1. None of the salmon took up homing positions to defend.
2. They did not school while wandering, but seemed to settle anywhere in the pond and often close together near the screen which surrounded the outlet at the centre of the pond.
3. They were more active at the higher temperatures, frequently darting to the surface as though feeding and roaming about the pond. The largest and the smallest of the fish were relatively the most active. This did not seem to be associated with hunger since the first lot had not been fed for two days before being put in the pond and the last had just been fed.
4. When wandering in the late afternoon and when the sky was less bright they swam a little closer to the surface.
5. When settled the fish seemed to face toward the sun more often than away from it.
6. A beam of light from a flash-light passing to the bottom of the pond after sunset while a glimmer of light was still visible in the west attracted the salmon. All rose

separately to within 1 to 2 ft. of the surface, but did not linger there, swimming to hold position.

7. Relation to other fish in the pond:

(a) 3 gaspereaux (7.5 to 8 cm.) translocating in mid-depth and mid-distance seemed to stimulate the salmon to join them in wandering for short distances only.

The salmon did not seem to attack them.

(b) 6 minnows (3 to 4 cm.) translocating near the surface and near the margin had no appreciable effect on the salmon.

Gaspereaux movement in still water

Migrating gaspereaux 4 cm. to 8 cm. long entered the "biapoe" ponds through the intake pipe from the Fletcher River during August and early September and unless they interfered with the study of other fishes or became too numerous, were left there until the ponds were cleaned. Other gaspereaux removed from the salmon-rearing ponds were placed from time to time in the biapoe ponds for study. They were exposed to temperatures ranging from 19°C. to 25°C., to a variety of light intensities and to the company of salmon, minnows, perch and suckers up to 8 inches long.

The observations recorded on their movement may be summarized as follows:

1. They were more active than salmon or minnows of the same size. They swam incessantly during the daylight and none was observed to settle. They seemed to dart forward from

side to side and could be distinguished from the other fish in the pond from this habit of swimming.

2. Gasperesux formed a school whether released separately or in a group into a pond. They translocated in a clockwise direction about a circular pond more often than counterclockwise and usually completed the circuit unless disturbed by othef fish or collecting food. The rate of translocation was observed to vary during the day but the factors responsible were not determined. The rate was found to be approximately 2 ft. per second for fish 7 to 8 cm. long at 10.20 a. m. when the sky was overcast and the temperature of the water 21°C. That the rate decreased after sunset was observed by watching a school pass through a beam of light passing from a flashlight to the bottom of a pond.

3. The distance from the margin that gasperesux swam varied from approximately 2 ft. to 5 ft. and no correlation between size and distance was observed. The depth, however, varied with the size of the fish and the intensity of the light. On a bright afternoon the approximate depths below the surface for various lengths of fish swimming in a school was estimated as follows:

4 cm.	8 to 10 inches
5.5 cm.	12 to 13 inches
6.5 cm.	14 inches
7.5 cm.	15 inches
8 cm.	18 to 20 inches

In cloudy weather they swam a little nearer to the surface.

4. When alarmed or attacked by other fish, the rate of swimming increased and the fish scattered, but soon reformed the school when the danger was past. It was concluded that the fish were more vulnerable at night since the number in a school decreased only at night when the fish lived for some days in the same pond with larger perch and suckers.

9. The plankton of the Fletcher River and The plankton of the Rawdon River

The plankton of the Fletcher River

Method of collection

A plankton net with No. 5 mesh was suspended from the bridge over the Fletcher River at Wellington weekly in the current and near the surface from April 17 to September 25, 1951. The collections were usually made before 10 a. m. and the length of time that the water passed through the net was determined by the rate of flow, the standard being 10 minutes for a rate of 1½ ft. per second, the standard used in 1950. Each collection was examined while fresh, the chief organisms were recorded and the collection was preserved for quantitative determination later.

Qualitative study

Copepods and Cladocera were the principal groups in all the collections, the former being the more abundant. Fil-

mentous algae and occasionally desmids, diatoms of the phytoplankton and infusoria, hydrozoa, rotatoria, hydracarina, larvae of aquatic insects and glochidia of the zooplankton appeared in the collections. The Copepoda belonged chiefly to two genera, Diaptomus and Cyclops and the Cladocera included Daphnia, Bosmina, Holopedium, Chydorus, Ceriodaphnia, Acroperus, Camptocercus and Polyphemus, the latter being a nocturnal form either brought to the surface by vertical circulation in that part of the river bed or caught before being driven down by the light. The character of the plankton as the season progressed is indicated in short summaries for the various months.

April

In the two collections made in April, Diaptomus and Cyclops were present and were reproducing. The chief Cladocera, Bosmina and Daphnia were carrying eggs and young. An occasional Glochidium was observed and although the temperature of the water had exceeded 50°F. by the end of the month this form did not appear in as great numbers in any collection in 1951 as it did in the first collection made in May of 1950 when the temperature of the water was similar. Both stalked and medusa forms of Hydra were present.

May

The number of young Copepoda increased during May and adults of both genera were present. The nocturnal Polyphemus was noticed for the first time and there were a few

hydracarina and larvae of aquatic insects which were not identified. Several species of rotatoria were represented by small numbers of individuals.

June

Of the Copepoda the numbers of Cyclops seemed to increase and many were reproducing. The collections were brownish in colour due to algal flowering and the presence of a colorial rotatoria believed to be Conochilus unicornis. Daphnia and Ceriodaphnia were more frequent than in previous samples. Polyphemus with eggs and young was seen.

July, August and September

The collections were very small and contained many dead plant cells and exo-skeletons and pupa cases of zooplankton. Two genera of Cladocera not noticed earlier appeared, namely, Acroperus and Camptocercus. An autumn flowering of phytoplankton imparted more colour to the collection made on September 18 than had been present since June.

Quantitative study

Variations in the amount of the principal food in the plankton was estimated by counting the numbers of Copepoda and Cladocera in several samples of 1 c.c. each, drawn quickly from the well-mixed total collection, averaging the results and multiplying by the total volume of the collection.

The date of collection and the numbers of Copepoda and Cladocera calculated to be in each collection are shown in Table No. 1.

Food was being produced in the head waters and carried down into Shubenacadie Lake by the Fletcher River in considerable quantity as early as the middle of April. During May the quantity increased as the water became warmer, but the largest collections were made in June following a strong freshet in the latter part of May. During the rest of the summer the collections were very small.

With the exception of September 18, when a very small collection was made, the Copepoda were more abundant than the Cladocera.

Plankton was much more abundant in the Fletcher River in the spring of 1951 than in the same period in 1950, as shown by the total numbers (thousands) of Copepoda and Cladocera collected in May, June and July in the two years listed below:

	May (14-31)	June	July
1950	55	24	24
1951	80	249	30

The greater quantity in May was probably due to the early spring of 1951 and the increase in June was associated with the freshet, the average heights of the water at the mouth of the Fletcher River being 2.9 ft. in June of 1950 as compared with 4.52 ft. in June of 1951.

Table No. 1. Estimated numbers of Copepods and Cladocera taken similarly with a No. 5 plankton net in the current of the Fletcher River in 1951.

Date	Copepods	Cladocera	Total
Apr. 17	12,500	5,500	18,000
" 24	11,500	6,750	18,250
May 2	54,000	14,000	68,000
" 8	6,500	3,500	10,000
" 15	27,500	10,000	37,500
" 23	5,500	1,500	7,000
" 28	28,750	6,250	35,000
June 6	93,750	18,750	112,500
" 12	48,000	24,000	72,000
" 19	21,250	7,500	28,750
" 26	24,000	12,000	36,000
July 4	10,800	4,200	15,000
" 11	2,400	2,100	4,500
" 17	1,250	750	2,000
" 24	5,000	3,400	8,400
" 31	250	250	500
Aug. 7	0	0	
" 14	0	0	
" 21	0	0	
" 29	250	250	500
Sept. 4	1,200	1,200	2,400

Table No. 1 (cont'd)

Date	Copepods	Cladocera	Total
Sept. 11	300	300	600
" 18	0	1,500	1,500
" 25	750	750	1,500

The Plankton of the Rawdon River

Preliminary work in 1950 showed that the swiftly-flowing Rawdon River with its rapids and rocky bed presented a contrast to the slowly-moving, broad Fletcher River in the amount of plankton that was carried into Shubenacadie Lake. In 1951, nine bi-monthly collections were made from the road-bridge over the Lower Rawdon River by suspending in the current, and near the surface, a No. 5 plankton net and two, similarly, at the dam near its origin from Kinsac Lake. The time allowed for each collection was estimated to correspond with that taken on the same day for collecting from the Fletcher River, the relative rates of flow being considered.

All the collections were exceedingly poor in plankton suitable for food for young fish and the numbers too few for quantitative determination by the method of counting used for the collections from the Fletcher River. The collections made on May 15 and July 11 near the origin of the river were a little richer than those on corresponding days near the mouth but much smaller than those from the Fletcher River. They contained adults and larvae of the Copepoda, Diaptomus,

and Cyclops and occasional Bosmina, Holopedium and Polyphemus of the Cladocera. Collections from the lower part of the river contained larvae and pupa cases of aquatic insects and much plant debris, indicating that plankton-straining insects were active in the rapids and that the swift current was detaching plants from the rocky bed.

10. The Effect of a Freshet on the Movement of Plankton from Shubenacadie Lake

At the end of May of 1951, heavy rain produced a freshet of unusual proportions in the tributaries of Shubenacadie Lake and the abundance of the plankton in the first collection from the Fletcher River made in June showed a sharp increase which was not maintained in subsequent collections. To follow up the effect upon the amount of plankton leaving the lake, collections were made on June 23 by towing from a row boat for 10 minutes, a No. 5 net (a) at the surface in shallow water at the outlet of the lake, (b) at the surface over deep water a short distance above the outlet and (c) over deep water in the same location with 60 feet of line out.

On June 26, towing at the surface at the shallow outlet of the lake was repeated and two collections were made from the Shubenacadie River below the outlet of the lake, the first from a bridge at Enfield and the second from a bridge at Elmsdale by suspending the same net in the current for 10 minutes.

On the evening of July 3, three collections were made

in similar fashion from bridges over the Shubenacadie River at Enfield, Elmsdale and Milford above that part of the river affected by tidal movement.

The collections were preserved and examined later for content and abundance.

Content

The surface tows taken on June 23 contained a rich collection of a colonial form of rotatoria believed to be Conochilus unicornis and many unicellular rotifers which were not identified. The Copepoda were chiefly Diaptomus and Cyclops and the Cladocera chiefly Holopedium, Daphnia, Ceriodaphnia, Bosmina and Polyphemus. The collection from deep water was composed largely of a mass of the diatom Asterionella and C. unicornis in which were caught the same forms of Copepoda and Cladocera as were found at the surface as well as an occasional Leptodora kindtii. The collection made at the outlet three days later was rich in the colonial rotatoria and diatoms present in the deep tow of June 23 and contained the same genera of Copepoda and Cladocera with the exception of Leptodora.

The collections from the Shubenacadie River contained the same kinds of planktonic forms encountered in the lake but had less variety. In addition there were insect larvae and pupa cases similar to those found in the Rawdon River and an occasional Hydra.

Quantitative study

The relative abundance of Copepoda and Cladocera considered to be the chief food for fish in the plankton was estimated by counting the numbers in two samples of 1 c.c. each, drawn quickly from the well-mixed total collection, averaging and multiplying by the total volume. The date, time and place of collection and the estimated numbers of Copepoda and Cladocera are shown in table No. 1

That flood waters carry off vast quantities of plankton from the lakes where it is most effective as food for fish is shown by the large numbers leaving the lake on June 23. In three days the effect had decreased to 50% at the outlet of the lake and there was little plankton in the river below the lake. The effect of the freshet on the plankton entering by the Fletcher River from Lake Fletcher in numbers (thousands) of Copepoda and Cladocera is indicated in the table of comparison below:

Date	Outflow from Lake Fletcher	Outflow from Shubenacadie Lake	Shubenacadie River at Enfield	Elmsdale	Milford
May 28	35				
June 6	113				
June 23		100			
June 26	36	47	7	5	
July 3-4	15		0	0.5	0.25

Table No. 1 shows that the plankton (Copepoda and Cladocera) was more than three times as abundant at the sur-

face as in the deep water on June 23 after the freshet. This result is a sharp contrast to that found in May of 1950 when vertical hauls taken in the same region brought more than 4 times as many of these planktonic forms from a depth of 38 feet as from a depth of 21 feet.

Table No. 1. Date, time and place of collection and the estimated numbers of Copepoda and Cladocera in plankton from Shubenacadie Lake near its outlet and the Shubenacadie River above tide-water.

Date	Time	Location	Copepoda	Cladocera	Total
1951					
June 23	2.35 p.m. to 2.45	Shub.L.outlet (surface tow)	46,000	54,500	100,500
" 23	3.43 to 3.53 p.m.	Over deep water (surface tow)	12,000	90,000	102,000
" 23	4.07 to 4.17 p.m.	Over deep water (60 ft.line out)	19,000	11,000	30,000
June 26	7.55 to 8.05 p.m.	Shub.L. outlet (surface tow)	21,000	26,000	47,000
" 26	8.45 to 8.55 p.m.	Enfield bridge (surf.in current)	5,400	1,800	7,200
" 26	9.27 to 9.37 p.m.	Elmsdale bridge (surf. in current)	2,700	2,100	4,800
July 3	12.05 to 12.15 p.m.	Enfield bridge (in current)	0	0	
" 3	11.30 to 11.40 a.m.	Elmsdale bridge (in current)	250	250	500
" 3	10.45 to 10.55 a.m.	Milford bridge (in current; water clear)	250	0	250

11. Effect of Sunset on Surface Plankton

The evening of July 26, 1951 with a long interval between sunset (8.49 p. m.) and moon-rise (12.18 a. m.) and a relatively clear sky was chosen for the experiment. Surface tows with No. 5 net, lasting 10 minutes and at intervals of 30 minutes, were taken from Shubenacadie Lake, where the depth was approximately 93 ft. and the surface temperature of the water 20.9°C. When the contents of the collections had settled in similar jars it was apparent that the quantity at the surface was practically nil at sunset, that it increased considerably during the waning light and most rapidly at the first darkness. Thereafter, there was little change in the quantity.

Quantitative determination was made by counting and averaging the numbers of Copepods and Cladocera, which formed the bulk of all the tows in several samples of 1 c.c. drawn quickly from the well-mixed total collection and multiplying by the volume of the whole collection. The numbers estimated to be in each collection and the time at which the work was done are shown in table No. 1.

The change from light to darkness seemed to be the stimulus to the upward movement of the Copepods in particular and also of the less numerous Cladocera. There were most at the surface two hours after sunset, with a decline in numbers thereafter.

In the first collection, no Copepods in good condition was found. There were hydracarina of 2 species, rotatoria of

several species and a few Cladocera of the genera Holopedium and Bosmina. In the rest, Copepoda were the most abundant forms. Both Diaptomus and Cyclops were present and reproducing, the former being much more abundant than the latter. Of the Cladocera, Ceriodaphnia and Daphnia were most abundant and Bosmina and Leptodora occurred in small numbers. At the first darkness and in subsequent tows, the planktonic and predacious Diptus larva, Corethra plumiformis appeared in limited numbers. This is the first time that this large form has been seen in the plankton from Shubenacadie Lake and I am grateful to Dr. E. M. Walker who identified it for me.

Table No. 1. Estimated numbers of Copepoda and Cladocera in surface tows with No. 5 plankton net over deep water in Shubenacadie Lake from sunset to moon rise on July 26, 1951.

Time (Atlantic daylight)	Copepoda	Cladocera
8.45-8.55 p. m.	250	250
9.15-9.25 p. m.	22,000	1,750
9.45-9.55 p. m.	117,500	6,250
10.15-10.25 p. m.	171,000	9,000
10.50-11.00 p. m.	175,000	19,250
11.15-11.25 p. m.	81,250	11,250