GROWTH OF YOUNG ATLANTIC SALMON, *SALMO SALA*R, IN THE GANDER RIVER SYSTEM, NEWFOUNDLAND

C. W. Andrews
Department of Biology, Memorial University of Newfoundland, St. John's Nfld.

Introduction

During June, July and August of 1951 most of the major tributaries of the Gander River (Figure 1), both above and below Gander Lake, were visited with a view, primarily, to reporting obstructions natural or otherwise, to ascending adult salmon. At the same time, limited opportunity was afforded to make small sample collections of young salmon from which scales and length measurements were taken. This paper is concerned with growth rates and is a result of a study of the field data thus obtained. No previous work on growth rates of the young of Atlantic salmon in the Gander River appears in the literature.

Materials and Methods

Each tributary, with the exception of tributaries on the South West Gander River, was visited by canoe. The South West Gander tributaries were reached by access roads through the courtesy of the Bowater's Pulp and Paper Company, Corner Brook, Newfoundland. A small handseine measuring about 3 ft. by 3 ft., leaded at the bottom and equipped with two wooden handles, was used for collection in all tributaries. The meshes of the seine measured 20 mm in length (stretched), thus underyearlings could pass through the seine, and only a few were taken.

Most of the seining was done at night between the hours of 10:30 p.m. and 2:00 a.m., when it seemed that better results could be obtained than in daylight when young salmon tended to seek cover and were therefore more difficult to locate. At night it seemed that the young salmon were not under cover but lay motionless in the open and in contact with the river bottom. Seining was done with the help of a Coleman gas lamp which was held by one fieldman while the other operated the handseine.

Usually, the area to be seined, varying from one quarter to one half mile of stream bed, was selected on the afternoon preceeding the night of seining. Stretches of the river regarded as favourable for parr were selected and in general such areas had many similar physical characteristics especially with respect to bottom, width of stream, slope and depth of water.

Small samples of fish were taken at each of several points on the upper and lower parts of the Gander River (Figure 1). On the upper Gander these points were: South West Gander River at Camp 2, Camp 11, and Camp 13, and its tributary streams of Big Dead Wolf Brook at Camp 6 and Camp 11, and Little Dead Wolf Brook; on the North West Gander River at two miles

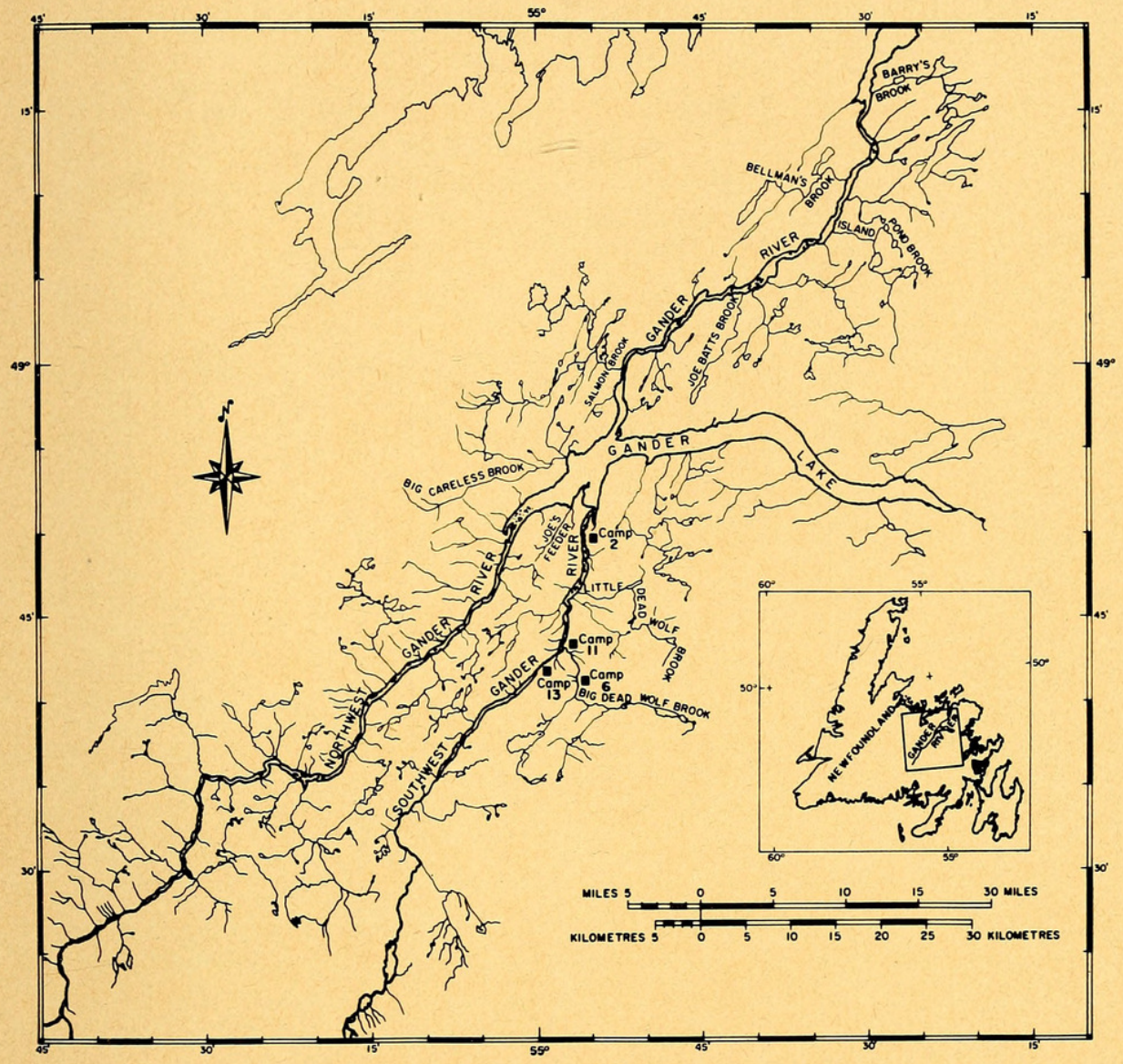

FIGURE 1. Locations on the Gander River system mentioned in the text.

above its mouth; small samples were also taken at Big Careless Brook and Joe's Feeder. On the lower Gander, samples were taken in the main river at First Pond and in the tributary streams of Barry's Brook, Bellman's Brook, Joe Batt's Brook, Island Pond Brook, and Salmon Brook. All fish from tributary streams were seined in the first mile or two and samples ranging from 15 to 54 in number were taken at the various points seined. A total of 218 young salmon were collected in the lower Gander and 342 in the upper Gander.

RESULTS

Availability of Parr

A crude measure of availability or density of parr may be obtained if the time spent in actual seining operation and the number of parr caught are known. This is tabulated for night seining in Table 1. The highest density occurred in the South West Gander River at Camp 11 where the average time

TABLE 1. — Availability of parr in various areas of the Gander River System

Location	Time	Minutes	No. parr taken	Average time to catch one parr	Date 1951
S.W. Gander at Camp 11	11:00 p.m. — 1:00 a.m.	120	50	2.4	July 18
Joe's Feeder	10:45 — 11:50 p.m.	65	24	2.7	Aug. 1
Big Careless Brook	9:50 — 11:20 p.m.	90	32	2.8	July 19
Big Dead Wolf Brook	10:30 p.m. — 1:00 a.m.	150	51	2.9	July 16
S.W. Gander River at Camp 2	11:00 p.m. — 12:10 a.m.	70	20	3.5	July 17
Salmon Brook	11:00 p.m. — 1:30 a.m.	150	36	4.2	July 27
Salmon Brook	10:30 p.m. — 2:00 a.m.	210	50	4.2	July 19
N.W. Gander River at 2 miles	10:50 p.m. — 11:55 p.m.	65	13	5.0	Aug. 2

spent to catch one parr was 2.3 minutes. Additional time indicating lower density was spent per parr caught at each of the other points listed in the table, with North West Gander at 2 miles having the lowest density — 5.0 minutes, to catch 1 parr.

Length Composition

A total of 218 young salmon were collected in the lower Gander, and 348 were taken in the upper Gander chiefly in the South West Gander River and its tributaries. In the upper Gander the mean fork length of fresh specimens was 91.9 mm (Table 2 and Figure 2) while for some other tributaries flowing into the western part of Gander Lake — North West River at 2 miles, Joe's Feeder, and Big Careless Brook, the mean length for the combined sample was 69.0 mm. The total sample for the latter tributaries, however, was only 68 fish and was probably not representative of the area.

In the lower Gander the mean length was 101.4 mm. Barry's Brook, the first tributary on the lower Gander was found to contain several obstructions in the form of impassable dams, gates, sluices, and log jams, especially in its lower two miles. No fish of 90 mm or less were taken in Barry's Brook whereas 19 fish were taken at lengths between 140 and 229 mm. Absence of fish of 90 mm in length and less would seem to indicate failure of adult salmon

TABLE 2.—Percentage length composition of complete samples, July–August, 1951. Sample size in parentheses.

Length Group (mm)	(a) Upper Gander		(b) Lower Gander	
	S.W. Gander and its tributaries	Gander Lake tributaries, S.W. Gander excluded	Barry's Brook excluded	Barry's Brook included
30 — 39	7.7(21)	27.9(19)		
40 — 49	1.5(4)	1.5(1)	1.2(2)	0.9(2)
50 — 59	0.7(2)	2.9(2)	1.2(2)	0.9(2)
60 — 69	6.6(18)	13.2(9)	14.6(25)	11.2(25)
70 — 79	8.4(23)	16.1(11)	9.9(17)	7.8(17)
80 — 89	17.9(49)	16.1(11)	17.5(30)	13.8(30)
90 — 99	23.7(65)	13.2(9)	19.3(33)	17.0(37)
100 — 109	15.7(43)	4.4(3)	20.5(35)	20.2(44)
110 — 119	10.9(30)	2.9(2)	8.8(15)	10.6(23)
120 — 129	2.6(7)	1.5(1)	3.5(6)	5.5(12)
130 — 139	0.7(2)		2.9(5)	2.8(6)
140 — 149	1.5(4)			3.2(7)
150 — 159	0.4(1)			0.9(2)
160 — 169				1.4(3)
170 — 179	0.4(1)			1.4(3)
180 — 189				
190 — 199				1.4(3)
200 — 209			0.6(1)	0.5(1)
210 — 219	0.4(1)			
220 — 229	0.7(2)			0.5(1)
230 — 239	0.4(1)			
Totals	100(274)	100(68)	100(171)	100(218)
Mean length	91.9	69.0	92.5	101.4
Standard deviation	29.0 mm	25.5 mm	20.86 mm	29.0 mm
Standard error	1.70 mm	3.09 mm	1.59 mm	1.90 mm

to ascend during the year or two previous to 1951 and the presence of the higher length classes of 140 to 229 mm to the failure of smolts to descend, giving rise to post-smolts, a situation not uncommon where river obstructions, including beaver dams, exist. Only three post-smolts were taken in the upper Gander — at Camp 13 on the South West Gander River, but no obstructions to descending salmon were observed in this area.

When the mean length of 91.9 mm for the South West Gander River and its tributaries (upper Gander) is compared with the mean length of 101.4 mm for the lower Gander River, including Barry's Brook, a significant difference in length is indicated ($P<0.05$). When, however, the Barry's Brook sample of 47 fish is excluded from the lower Gander sample the mean length is 92.5 mm which indicates no significant difference ($P>0.05$) between the combined South West Gander — upper Gander sample and the combined lower Gander River sample.

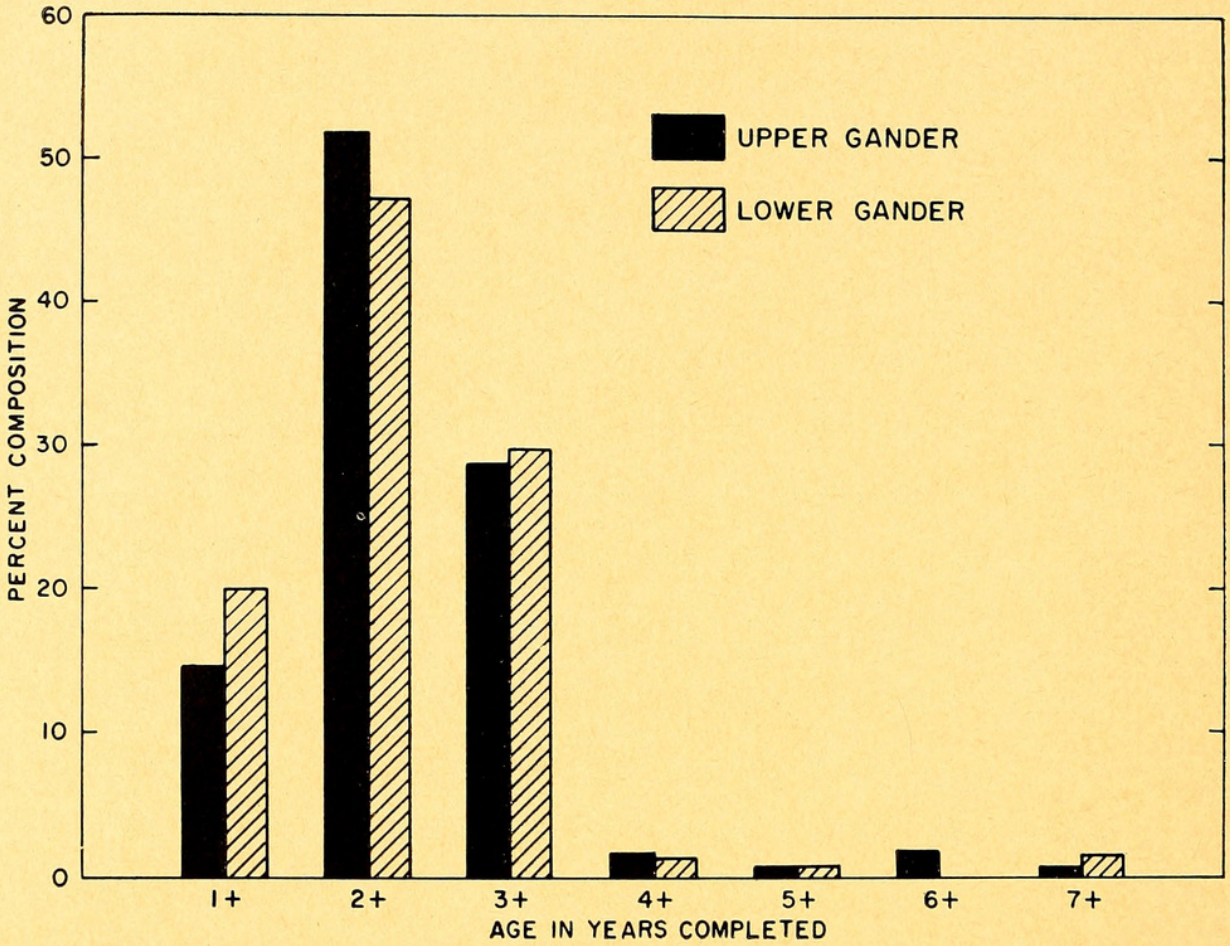

FIGURE 2. Length composition of young Atlantic salmon in the Gander River, summer, 1951.

Age Composition

Age composition of the upper and lower Gander River samples, Table 3 and Figure 3, show clearly the importance of the 2+ and 3+ year classes in the parr population. In the upper Gander, for example, 2+ and 3+ year-old parr made up 51.9 per cent and 28.8 per cent respectively of the sample, or a total of 80.7 per cent. The same year classes in the lower Gander (Barry's Brook excluded) constituted 47.1 per cent and 29.7 per cent respectively or a total of 76.8 per cent. Small percentages of 4+, 5+, 6+ and 7+ year-old fish were present in both areas; in the South West Gander (upper Gander) at Camp 13, 4 of the 15 young salmon taken were in the 5+, 6+ and 7+ year classes and 7 of the 44 fish taken in Barry's Brook (lower Gander) were 5+ years and older.

Age-length Relationship

Mean fork length for each age group in tributaries of the upper and lower Gander River, Table 4 and Figure 4, show only slight variation among year classes 1+, 2+, and 3+. At 1+ years, for example, the lengths were 71.3 mm for the upper and 68.6 for the lower Gander (excluding Barry's Brook) respectively; and for 3+ years 113.3 mm and 109.0 mm respectively. Wider

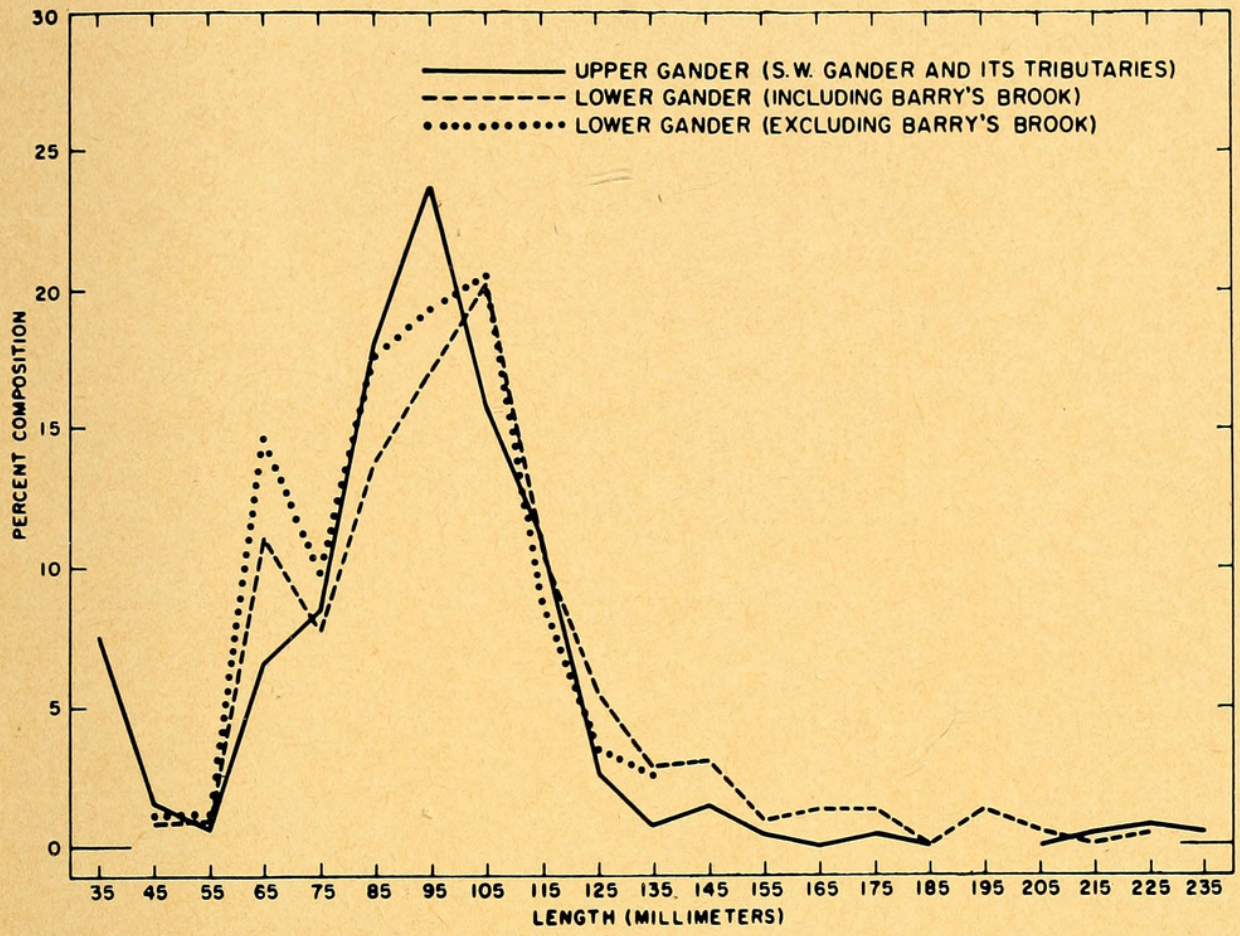

FIGURE 3. Age composition of young Atlantic salmon in the Gander River, summer, 1951.

TABLE 3. — Percentage age composition of complete samples, July–August, 1951. Sample size in parentheses

Location	Age in years completed							Total fish
	1+	2+	3+	4+	5+	6+	7+	
Upper Gander	14.7(26)	51.9(92)	28.8(51)	1.7(3)	0.5(1)	1.7(3)	0.5(1)	177
Lower Gander excluding Barry's Brook	20.0(31)	47.1(73)	29.7(46)	1.3(2)	0.6(1)	—	1.3(2)	155
Lower Gander including Barry's Brook	16.1(32)	41.2(82)	33.1(66)	4.5(9)	4.0(8)	—	1.1(2)	199

variation exists among the older year classes (4+, 5+, 6+ and 7+) but the number of fish in the latter year classes was small, numbering less than 10 in each case.

TABLE 4. — Age-length relationship of young salmon in the upper (S.W. Gander River) and lower Gander River. May–August 1951. Figures in parentheses indicate number of fish in each age-class. Italics are calculated lengths (Y = Ax + b; see Text)

Location	Age in years completed							
	1+	2+	3+	4+	5+	6+	7+	
	mm	mm	mm	mm	mm	mm	mm	
Upper Gander	71.3(15) *71.3*	97.7(91) *92.3*	113.3(54) *113.3*	134.6(3) *134.3*	219.5(2) *155.3*	209.6(3) *176.3*	334.0(1) *197.3*	169
Lower Gander including Barry's Brook	69.3(33) *69.3*	93.8(80) *90.7*	112.1(66) *112.1*	141.5(9) *133.5*	178.3(6) *154.9*	171.0(1) *176.3*	195.5(2) *197.7*	197
Lower Gander excluding Barry's Brook	68.6(32) *68.6*	92.5(71) *88.8*	109.0(46) *109.0*	136.0(2) *129.2*				151

Calculated growth rates for upper and lower Gander, using the straight line equation $Y = aX + b$ (where Y = length, X = age, a = slope of the line, and b = the Y intercept) are represented by the equation

$$Y = 21.0\ X + 50.3 \quad \text{(1)}$$

for upper Gander, and for lower Gander with Barry's Brook excluded, because of tributary obstructions (see above).

$$Y = 20.2\ X + 48.4 \quad \text{(2)}$$

When Barry's Brook is included the slope of the line for lower Gander River is increased as shown in the following equation:

$$Y = 21.4\ X + 47.9 \quad \text{(3)}$$

The graph of the above equations is shown in Figure 4.

DISCUSSION AND CONCLUSIONS

The Gander River system, perhaps one of the best salmon producing areas in the whole of Newfoundland, is almost completely free of either man-made or natural obstructions and has available extensive spawning grounds. Density determinations as described in this survey are admittedly crude since the use of a handseine varies not only between individuals, but from one day to the next in the hands of the same individual. As might be expected, however, density is seldom uniform in such a system and varies with the physical conditions in the various parts of the river.

A study of length composition reveals no significant difference ($P>0.05$) in growth between upper and lower Gander River when Barry's Brook fish of the lower Gander are excluded from the comparison. The influence of the Barry's Brook sample is strongly felt when included in the total lower Gander sample and creates a significant difference in growth ($P<0.05$) when

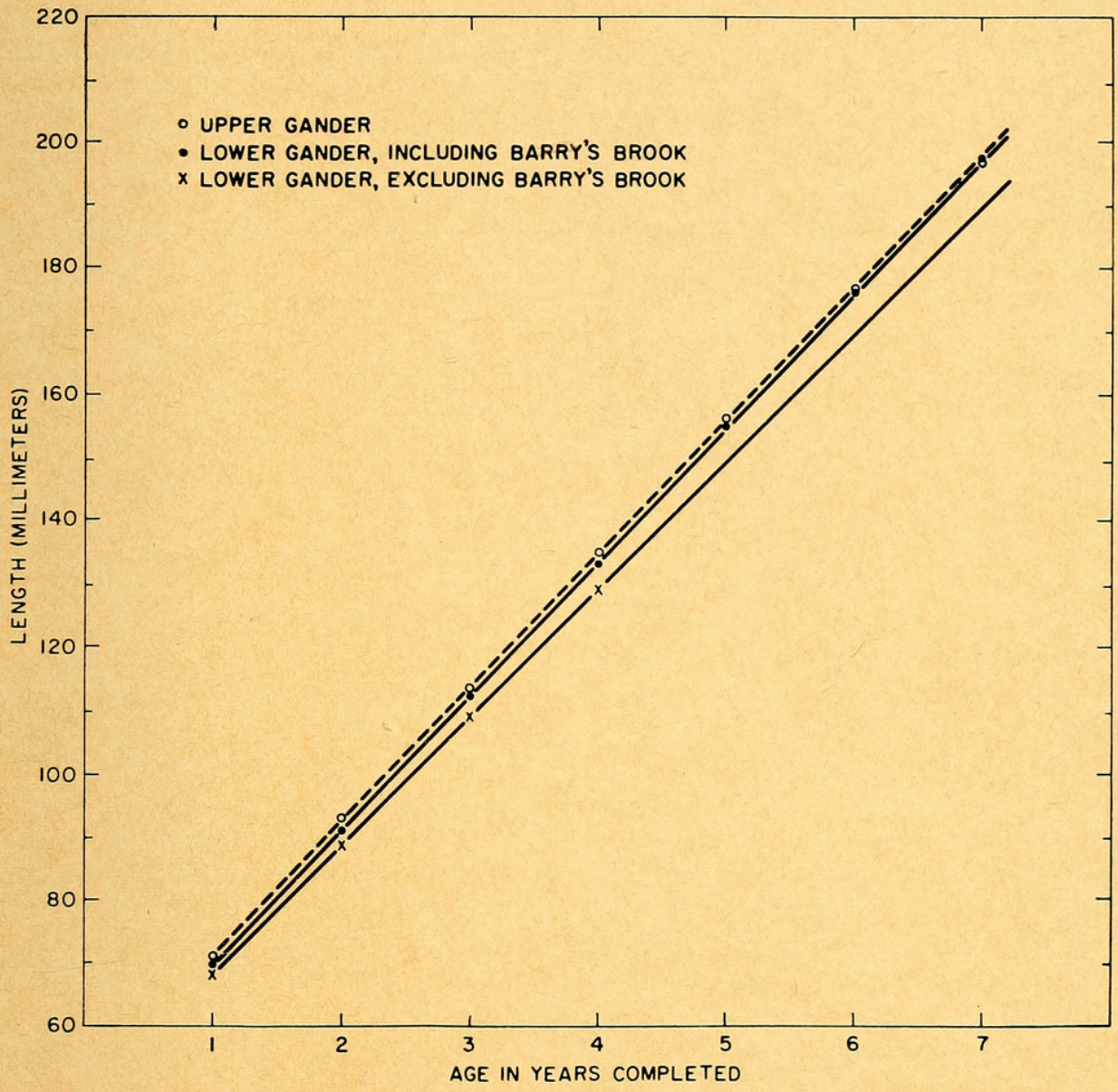

FIGURE 4. Age-length relationship of young Atlantic salmon in the Gander River, summer, 1951.

upper and lower Gander samples are compared. However, because of the unusual conditions of this tributary, with its man-made obstructions, at the time of this survey, it seems best to omit Barry's Brook when comparing growth between the upper and lower Gander areas.

When length is plotted against age only slight variations exist for a given age group between the upper and lower Gander River samples when Barry's Brook is excluded, and intermediate but small differences exist when Barry's Brook is included.

The dominant age-class of 2+ and 3+ years indicate that most smolts in the Gander River migrate to sea in the spring of the fourth year. Lindsay and Thompson (1932) state that Newfoundland salmon spend relatively high number of years (about four on the average) of parr life in the rivers. For

the south and west coast rivers, however, a lower average, one around three to three and a half years was found. Blair (1943) in a study of Atlantic salmon of the east coast of Newfoundland and Labrador found the dominant river age-class to be 4 years for the 1+ sea age-class (commonly called grilse) in all areas except Trinity Bay. For the 2+ age-class he found the river age class to be three years in sections 1 to 5 of the coast (Cape Broyle to Cape St. John) and four years in only one section of the coast (Section 9, Hamilton Inlet, Labrador).

Assuming that these east coast fish are related to the rivers in the area sampled, the predominance of the four year river age-class among the 1+ sea age-class and the fact that smolts leave the Gander system, in the main, in the fourth year, raises the question as to whether or not Gander is primarily a grilse producing river. This hypothesis may be further strengthened by the fact that Dr. A. A. Blair, 1951, reported that of the incoming adult salmon run caught in a wooden fish trap at the mouth of the Gander River in 1951 (9700 fish) 80 per cent of the upstream migrants were estimated to be grilse of six pounds and under.

In the Miramichi River, New Brunswick, Blair (1935) found that "of the four smolt ages among all fish, the three-year smolts were predominant (78.1 per cent) and followed in order by two-year smolts (15.1 per cent), four-year smolts (6.6 per cent) and five-year smolts (0.2 per cent)". Belding (1937) reported that practically two-thirds of the salmon in six rivers of the west coast of Newfoundland, chiefly in St. George's Bay, leave the river at or before the end of the third year. The remaining one-third for the most part leave at the end of the fourth year. Yet Belding refers to these west coast rivers as "small salmon" rivers where grilse are numerous. Murray (1962, mimeograph report) states that in the Little Codroy River of western Newfoundland between 60 and 73 per cent of the smolts have been three year old fish. Thus it seems that west coast Newfoundland smolts behave more like Miramichi smolts than do Gander River smolts with respect to age at migration.

The fact that Gander River parr tend to stay in the river somewhat longer than west coast Newfoundland and Miramichi parr is in all probability related to size at smoltification. Elson (1957) states that "Observations by Canadian investigators indicate that size, or physiological condition associated with size, of parr in their pre-smolt year seems to be a more important factor than age in the change from parr to smolt. As a working approximation an arbitrary dividing line between large parr, likely to become smolts next spring and small parr, not likely to, has been set at about 10 cm. or 4 in. total length, measured from tip of snout to tip of tail." Climatic influence in eastern Newfoundland, particularly the influence of the Labrador Current on temperature conditions would, it seems, tend to delay reaching the prescribed length of Elson as compared with points farther west.

ACKNOWLEDGEMENTS

Mr. G. L. Wiggins (now Dr. G. L. Wiggins of the Royal Ontario Museum, Toronto, Ontario) accompanied the author on this survey and assist-

ed in the collection of data. Dr. W. Templeman and Dr. D. H. Steele reviewed the manuscript.

REFERENCES

BELDING, D. L. 1937. Atlantic salmon parr of the west coast of Newfoundland. Transactions of the American Fisheries Society. 66: 211-214.

BLAIR, A. A. 1935. Ages at migration of Atlantic salmon (*Salmo salar*) in Miramichi River. Journal of the Biological Board of Canada. 1, (3), 159-169.

———— 1943. Salmon investigations. 2. Atlantic salmon of the east coast of Newfoundland and Labrador, 1939. Research Bulletin No. 13 (Fisheries), Department of Natural Resources, St. John's.

————. 1951. Annual Report of the Fisheries Research Board of Canada, 1951.

ELSON, P. F. 1957. The importance of size in the change from parr to smolt in Atlantic salmon. Canadian Fish Culturist. 21, pp. 1-6.

LINDSAY, S. T., and H. THOMPSON. 1932. Biology of the salmon (*Salmo salar* L.) taken in Newfoundland waters in 1931. Report of the Newfoundland Fishery Research Commission. Vol. 1, No. 2, pp. 1-80.

MURRAY, 1963. Mimeograph report, Fisheries Research Board of Canada, St. John's, Nfld.

Received for publication 25 February 1965

UNDERWATER OBSERVATIONS OF THE SQUID *ILLEX ILLECEBROSUS* LESUEUR IN NEWFOUNDLAND WATERS

G. R. WILLIAMSON

Fisheries Research Station, Skek Pai Wan Road,
Aberdeen, Hong Kong

INTRODUCTION

LARGE numbers of *Illex illecebrosus* congregate close to the shore of Newfoundland during the warm water months (July to October) of most years. Fishermen catch the squid in a variety of ways, the simplest of which is on jiggers (Figure 1). Some of the squid are used locally as cod bait while quantities are frozen for export.

The specific characters of *Illex illecebrosus* and some habits of the live animals are described by Verrill (1881). The distribution, relative annual abundance, growth, sexual maturity, food and parasites of *Illex* in Newfoundland waters are documented by Squires (1957) who also (1959) discusses the annual migratory movements of the species in the area. Data regarding living squid of numerous species are compiled in Lane's *Kingdom of the Octopus* (1957).