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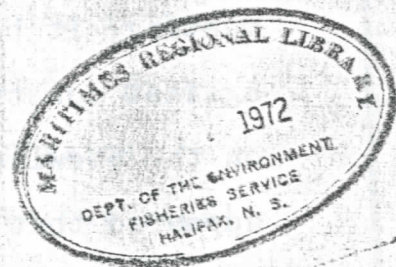
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Progress Report - Shubenacadie/Stewiacke Survey

1968

by

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**FISHERIES SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY OF CANADA
HALIFAX, N.S.**

INTRODUCTION

A comprehensive summary of available information pertaining to the Shubenacadie River watershed was prepared for the A.P.W.R.S. of fish resource data in January, 1969. This afforded an excellent opportunity to familiarise with past history of the Shubenacadie.

Two meetings were arranged in Truro by ARDA on August 16 and October 29, 1968, where agencies interested in the proposed Shubenacadie River causeway and flood control project in Stewiacke River could discuss effects of the causeway on their respective interests. These meetings were well attended, and a wide range of views were discussed. Detailed minutes were written up for each meeting (File 713-3-19). At the conclusion of the second meeting, it became obvious that the opinion of the majority was against construction of a causeway as such. Further discussion on the Stewiacke flood control project was postponed since it appeared that no further action on the project would be taken until flood control on the Musquodoboit River had proved to be practical, and the cost-benefit ratio evaluated.

The biological survey of the Stewiacke River extended from June 3 to November 30, 1968.

STEWIACKE RIVER

METHODS

1. Physical characteristics: Stream Survey Form 1 (Appendix 1) was used for recording information on shore vegetation and topography, stream measurements, stream banks, shade, stream components, substrate, obstructions, aquatic vegetation and observations on fish. The main river was surveyed from Eastville to confluence with Shubenacadie by boat, and a large part of the headwater section was covered on foot. Twenty tributaries were closely surveyed in the lower reaches, and general notes made of the headwater sections.
2. Water Analysis: Air and water temperature were determined with maximum-minimum thermometer ($^{\circ}\text{C}$), turbidity with standard secchi disc (ft.), depth with plumb line (ft.), velocity by floating chip method, and pH, DO_2 , alkalinity and CO_2 with Hach Kits, and data recorded on BIO-6. Five samples were collected and analyzed during the physical survey and twelve stations (5 in main river, 7 tributaries) were sampled coincidental with invertebrate collections.
3. Invertebrate Fauna: Surber samples were taken at 12 stations (as for water analyses), with 5 sub-samples collected at each station on a regular pattern of three upstream samples and two intermediate downstream samples. Data on sample sites and invertebrate counts were recorded on BIO-2. Samples were sorted to Order and total numbers recorded. A reference collection was started, with insects identified to genus and species where possible.

4. Fish Populations: Notes on distribution of species were made during the physical survey, and further information was collected at electro-seine stations.

Twelve electro-seine sites were sampled to estimate fish populations. Sites were selected specifically for sampling Atlantic salmon populations, and selection was dictated largely by accessibility and suitability for salmon. An attempt was made to sample important sections of the main river and major tributaries. Twelve sites were electro-seined from June 28 to July 17, and six sites were repeated from September 10 to September 18. At each site, total numbers of all species were recorded, length and weight measurements and scale samples were taken from obvious size groups for salmonids, and length-frequency data was collected for all salmon fry in September.

Observations on distribution of adult salmon and redd counts were made from October 2nd to November 18. These were facilitated by low water levels and exceptionally clear water.

There was no method of assessing the adult salmon population other than by examining angling catches. Scale samples and data on length, weight and sex of salmon were collected by Department of Fisheries Wardens by direct contact with anglers.

RESULTS

1. Physical Characteristics

Substrate was defined as silt (extremely fine inorganic particles deposited by sedimentation), sand (particles coarser than silt and up to 1/8 ins.), gravel (1/8 ins. - 1/2 ins.), pebble (1/2 ins. - 2 1/2 ins.), cobble (2 1/2 ins. - 10 ins.) and boulder (over 10 ins.).

Stream components were classified as pools (depth greater than 4 ft., little visible flow), flats (depth 12 ins. - 48 ins., slow water velocity), runs (depth 12 ins. - 48 ins., high water velocity), riffles (depth 3 ins. - 12 ins., profile regular) and rapids (depth variable from 12 ins. - 36 ins., profile irregular).

Sections of the main river and tributaries have been classed as suitable for salmon spawning areas (i.e. riffles with high percentage of gravel and pebble substrate) or nursery areas (riffles not classed as spawning areas, runs and flats). The fact that pools are not included in the latter class does not exclude the possibility that they are used as nursery areas for salmon parr.

The presence of aquatic vegetation was recorded as abundant, common or scarce.

Reference to mile points on the Stewiacke River indicates the number of miles along the main river above its confluence with Shubenacadie River. Mile points referred to in tributary streams indicate the number of miles from confluence of the tributary with Stewiacke River, or in the case of minor tributaries (branches of large tributaries) this refers to miles above confluence with the major tributary.

The Stewiacke River System has been arbitrarily divided into

six zones (See Fig. 1). The headwaters of the main river above mile 48 and Sutherland Brook comprise Zone 1. Zone 2 comprises the section of the main river from mile 36 - 48, and includes Big Stewiacke River, Little Stewiacke River, Sucker Brook, Cox Brook, Fulton Brook, Newton Brook and Chaplin Brook. Excellent spawning area occurs in the main river in Zone 3 from mile 32-36, which also includes Pembroke River. Zone 4 comprises extensive pool sections from mile 24 - 32, and includes tributary rivers South Branch of Stewiacke River, Goshen Brook, Tupper Brook, Nelsen Brook, McCulloch Brook, Steepbank Creek, Gullely Brook, North Meadow, Otter Brook, Dunlop Brook, Scott Brook, Rutherford Brook, Chapman Brook and Halfway Brook. Spawning area, nursery area and deep pools all occur in Zone 5 from mile 8-24 which also includes tributaries Putman Brook, Fisher Brook, Brenton Brook, East Brook, Johnson Brook, Watering Brook, Little River and Field Brook. Zone 6 consists of tidal water of Stewiacke River from mile 0-8, and includes tributaries, McKay Brook, Little Hurd Brook and Big Meadow Brook.

Estimates of percentage of stream components and substrate classes in river sections are very approximate, and are intended to serve only as a guide. The figures should not be used as a basis for detailed calculations.

The river profile (Fig. 2) shows stream components and zones.

Main Stewiacke River

(i) General: Headwaters of Stewiacke River are located in Pictou County, and the river enters Colchester County at Mile 50. The river flows southwest and then south to Mile 41, where it makes a wide bend to west. From Upper

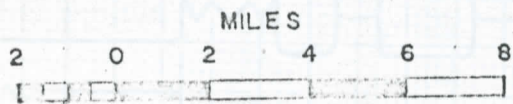
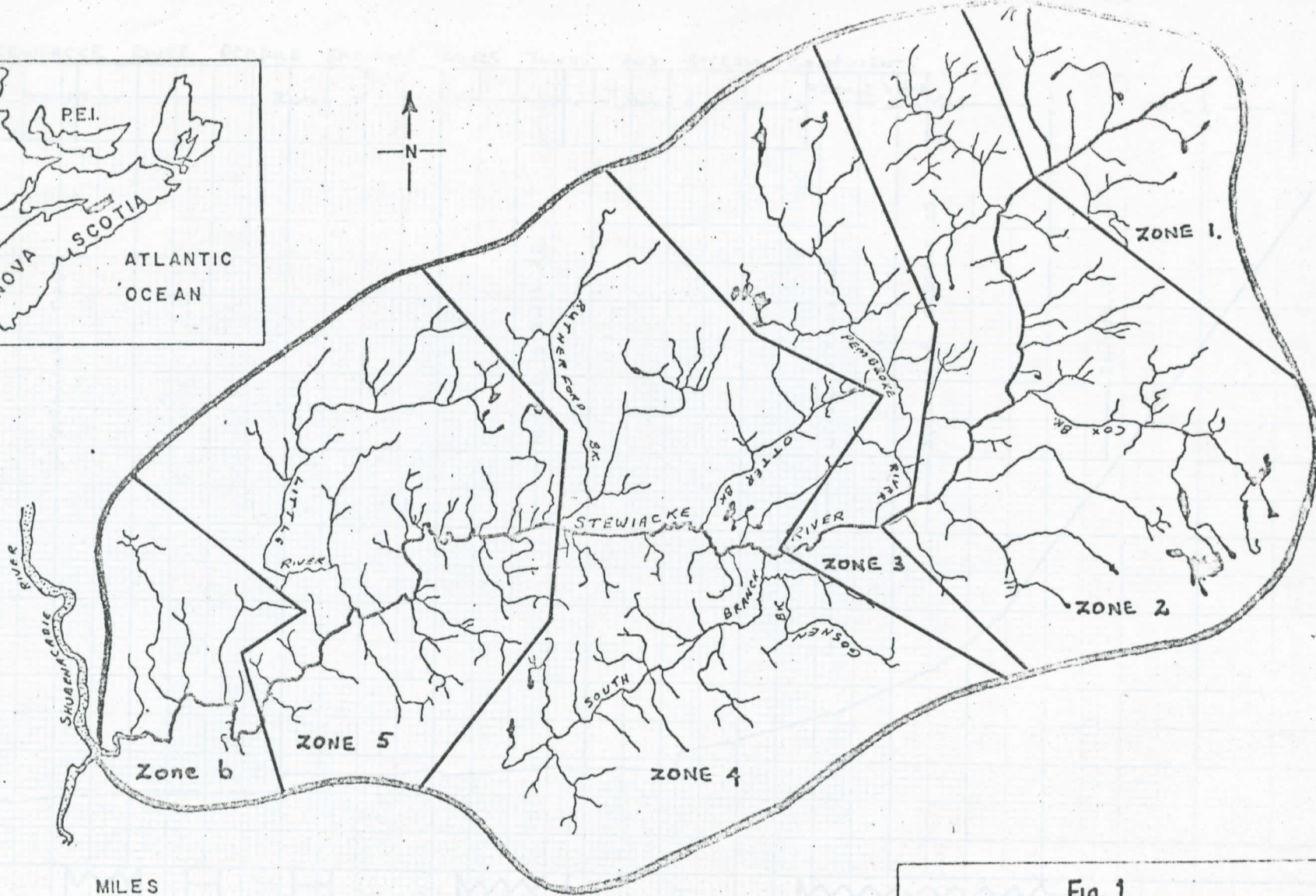
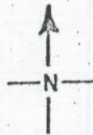
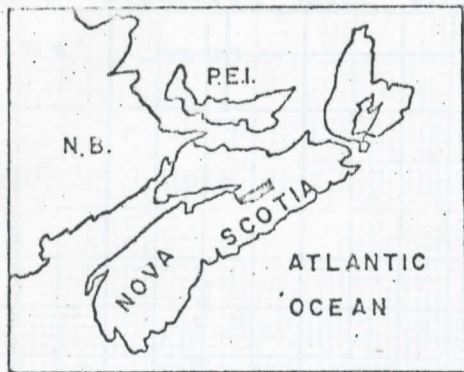
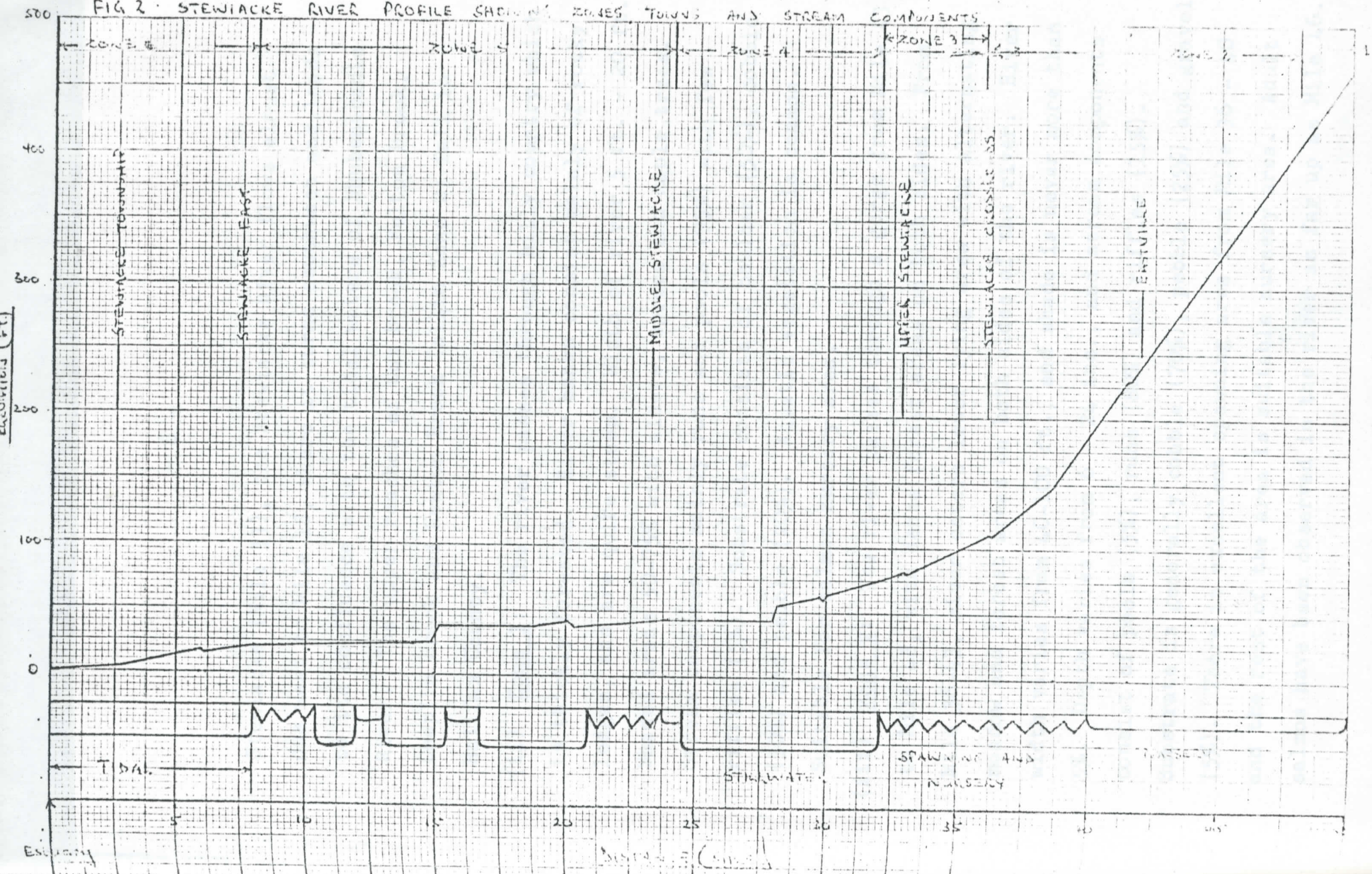


Fig. 1
STEWIACKE RIVER

FIG 2. STEWIACKE RIVER PROFILE SHOWING ZONES TOWNS AND STREAM COMPONENTS



Stewiacke (Mile 33), the Stewiacke River flows almost due west to Mile 18, where it turns southwest and leads to its confluence with the tidal waters of Shubenacadie River. The upper reaches of Cox Brook, Fulton Brook, Chaplin Brook and Newton Brook (all in Zone 2) fall in Halifax County.

(ii) Zone 1: The river passes through hilly country which is thickly forested. River banks consist mainly of rocky ledges, and are quite steep. Width of river 5 ft. - 20 ft. Shaded areas 50-75% with alders, spruce and maple trees. Stream components mainly runs and pools (95%) with few riffles (5%). Substrate consists of boulder (50%), cobble (30%) and pebble (20%). Aquatic vegetation is common. Suitable for salmon nursery area.

(iii) Zone 2: The river passes through a gorge from Mile 43 to Mile 48, with dense forest areas on both sides. From Mile 36-43, river enters lower lying area with alternating meadow and forest areas on both sides of the river. River width varies from 40-100 ft., and shade is never more than 5%. Depth varies from 6 - 24 ins., and stream components consist of pools (5%), runs (80%) and riffles (15%). Substrate is generally cobble (70%), pebble (25%) and gravel (5%). There is excellent spawning area from Mile 36 - 40 and the rest of the area is suitable nursery area. Adult salmon have been observed in the river as far up as Mile 46.

(iv) Zone 3: The river flows predominantly through low lying, flat areas with meadows and few forest areas on both sides of the river. Stream components in this section are pools (5%), flats (40%), runs (30%) and riffles (25%). Substrate in riffle areas comprised mainly gravel (20%) and pebble (80%), while in the flats and runs, cobble (90%) was predominant with some pebble (10%) present). Lamprey were observed preparing nests, which were usually located at the head of riffle areas. Shoals of suckers were commonly seen in pools, flats and runs, together with speckled trout and parr (salmon or brown trout). Shad were seen at Mile 33, which represented the uppermost point of their observed distribution. Riffle areas were excellent for spawning.

(v) Zone 4: From Mile 29 - 32, the river passes through meadow. Thereafter, from mile 24 - 29, river is surrounded by low lying areas of forest and woods consisting of alders, spruce and fir. Width of river is 50 - 75 ft. Consists predominantly of deep pools up to 10 ft. depth, with occasional riffle areas, few of which were considered suitable for spawning. Substrate often consisted of bedrock, but bottom of pools was generally sand and silt. Vegetation common in many areas, mostly Chara/Nitella. Shad were seen in nearly every pool, and suckers were common.

(vi) Zone 5: Stewiacke River flows from Mile 17 - 24 through flat meadowland, and then enters heavily forested area with few meadows along either bank from Mile 8 - 17. From Mile 21 - 24, river is 70 - 100 ft. wide, and stream components are riffles (30%), flats (60%) and pools (10%). Substrate in riffle area consists of gravel (20%), pebble (20%) and cobble 10%). In flats, substrate consists of pebble (10%) and cobble (90%) with average depth of approximately 3 ft. Riffles are considered excellent salmon spawning areas and flats as nursery areas. Below Mile 21, river narrows in many places down to 30 ft. width, average width being about 50 ft. down to Mile 17. Stream comprises 95% pools with sandy substrate. Deepest pool recorded was 26½ ft. at Mile 18½ (De Groot's Corner). Numerous logs and tree stumps observed in this section of the river. Occasional shallow bars occur across pools. Vegetation was common along the edges of pools and at shallow bars. Shad and suckers observed in pool sections. From Mile 10½ to Mile 17, pools comprise 90% of the stream components, runs 8% and riffles 2%. Substrate consists of bedrock and boulders, cobble (90%), pebble and gravel. Many pools have bottom covered with sand. Width is from 75 - 125 ft. and depths of pools up to 12 ft. Vegetation common in runs, scarce in pools. One good spawning area was found just below Mile 12, and numerous parr, suckers and shad seen. Mile 8 - 12 comprises good spawning and nursery area for salmon.

Stream components consist of pools (15%), runs (70%) and riffles (15%). Substrate in riffle areas consists of gravel (10%), pebble (80%) and cobble (10%). In the runs, substrate is primarily cobble (95%) with some pebble (5%).

(vii) Zone 6: Seven out of 8 miles of this section are subject to large fluctuations in water level from tidal movement. Water is dirty brown in color, and the bottom is covered with silt. Depth varies with tide level, but the main channel is never less than 5 - 7 ft. deep. Large sand banks are found from Mile 0 - 3 which are exposed at low tide. Striped bass are known to frequent this area, and positive identification has been made of this species feeding on salmon smolt. Good spawning and nursery areas are found from Mile 7 - 8, but an assessment will have to be made of whether salinity levels are low enough in this area to support juvenile salmon.

Similar notes are being prepared for 20 tributary streams in the Stewiacke watershed.

Relatively accurate measurements were made of salmon nursery areas in the main river with a planimeter and aerial photographs. This amounted to 14,763 x 100 sq. yd. units. Guesstimates were made of nursery area in 15 tributary streams (only 5 of those surveyed were considered unsuitable for salmon fry and parr), giving a sub-total of 5,761 x 100 sq. yd. units. Using this data for calculating smolt production (2 per 100 sq. yds.) and an 8% return of adults, it was estimated that the smolt run would be 41,500, and a return of approximately 3,320 adults could be expected.

Surface area of stillwater sections totalled 8,605 x 100 sq. yd. units, and it was estimated that 63% of the main Stewiacke River provided suitable habitat for salmon parr and fry.

Sampling Stations

The Stewiacke River watershed was divided into broad zones, and then further subdivided into sections, with each section representing either a part of the main river or a tributary. Final zonation is shown in Appendix 2.

Sampling stations were selected, and each assigned a station number according to the zone and section in which these stations were located, e.g. 4/B1 represents a station in zone 4, section B, and this is the first station from confluence with Stewiacke River.

In general, sampling stations for electro-seining, invertebrate sampling and water analyses were in much the same area, but samples were not all taken at the same time. A general description of each station is ^{given} ~~shown~~ in Appendix 3.

Water Analyses

Data on water analysis for Stewiacke River in 1968 is summarized in Table 1. Water temperature in the main river and some brooks was high during July (up to 74°F) because of very low water levels and high air temperatures (up to 86°F). Water temperature in tributaries such as Little River, Rutherford Brook and Pembroke River was comparatively lower than main river temperatures, due to the presence of numerous spring outlets in these areas. pH was uniform

Station	Date	Water Temp °F	Depth (ft.)	pH	DO (ppm) ²	CO ₂ (ppm)	Alk. (ppm)
Stewiacke R. Mile 2	June 4	60	10	7.0	10	<5	17.1
" " " 4	June 4	60	S	7.0	10	<5	17.1
" " " 8	July 11	74	S	7.0	8	<5	20.5
" " " 17	June 6	62	-	6.5-7.0	10	<5	17.1
" " " 19 ³ / ₄	June 6	61	>11	6.5	9	<5	17.1
" " " 22	June 25	60	S	6.5	8	<5	13.7
" " " 32 ¹ / ₂	June 10	59	S	6.5	10	<5	13.7
" " " 34	June 27	64	S	6.5	10	<5	6.9
" " " 38 ¹ / ₂	July 2	68	S	6.5	8	<5	6.9
" " " 41	June 12	59	S	-	10	<5	4.3
" " " 46	July 13	71	S	6.5	8	<5	6.9
Little River	July 8	60	S	7.0	9	<5	27.4
Rutherford Brook (a)	June 24	60	S	6.5	10	<5	6.9
" " (b)	June 26	60	S	6.5	10	<5	6.9
Otter Brook	July 10	70	S	6.5-7.0	9	<5	13.8
Goshen Brook	July 10	67	S	6.5	9	<5	6.9
South Branch (a)	June 11	53	S	6.5	10	<5	17.1
" " (b)	July 9	62	S	6.5	8	<5	-
Pembroke River	July 1	56	S	6.5	9	<5	6.9

Note: "S" indicates water < 3 ft. deep

throughout the system from headwaters to tide head at 6.5, with the exception of Little River and Otter Brook (pH 6.5-7.0). The high pH in Little River may be attributed to high alkalinity (27.4 ppm). Oxygen levels did not vary significantly (8-10 ppm) through the system and over the period when samples were taken. CO₂ values were <5 ppm at all stations. There was a graduation in alkalinity (measured as CaCO₂) in the main river from 4-6 ppm in the headwaters to 17-20 in tidal water. Significantly high values for alkalinity were recorded in Little River, Otter Brook and South Branch (27.4 ppm, 13.8 ppm and 17.1 ppm respectively). Alkalinity in the Stewiacke System ~~are~~ generally higher than other Nova Scotia waters, and this is attributed to the fact that Stewiacke River lies in a highly productive limnological belt of Nova Scotia (Smith, 1963) where sedimentary rocks are a good source of lime.

Invertebrate Fauna

Table 2 shows the numbers of invertebrates collected at each station (5 samples per station) expressed as average number/sq. ft. No measurements have been made of volume of each sample, but number counts indicate that several stations should have at least average production of food organisms. Most abundant invertebrate groups were Ephemeroptera nymphs, Diptera larvae and Trichoptera larvae. Most productive stations appeared to be Rutherford Brook (4/N1 and 4/N2), Little River (5/H3), Main River at Mile 46 (2/A2) and South Branch (4/B1).

Table 2: Invertebrate Fauna Collected in Surber Sampler - Stewiacke River, 1968.
(Average Number/sq. ft.)

	Hemiptera	Odonata	Plecoptera	Ephemeroptera	Diptera Larvae	Neuroptera	Trichoptera Larvae	Trichoptera Pupae	Coleoptera Larvae	Megaloptera	Annelida	Mollusca	Miscellaneous	Totals
Main R. Mile 8½ (6/A1)	-	1.4	1.8	7.0	1.0	-	17.2	1.0	8.6	-	-	0.2	-	39.6
Main R. Mile 22 (5/A1)	-	-	1.0	9.6	3.0	-	3.6	-	2.0	-	-	-	-	19.4
Main R. Mile 34 (3/A1)	-	0.2	1.6	24.8	8.4	-	9.0	2.4	3.6	-	0.2	0.2	0.4	50.8
Main R. Mile 38 (2/A3)	-	-	1.8	50.6	5.8	-	11.2	1.2	0.8	-	-	-	-	71.4
Main R. Mile 46 (2/A2)	-	0.2	3.8	27.6	17.8	-	51.4	3.0	15.0	0.2	0.2	-	1.2	120.4
Little River (5/H3)	-	-	11.0	119.4	50.4	0.2	27.4	9.6	3.4	0.4	-	-	1.8	225.2
South Branch (4/B1)	-	0.2	4.0	71.6	5.8	-	9.2	5.6	2.4	0.4	0.6	0.2	0.8	100.6
Goshen Brook (4/C1)	0.2	-	5.6	33.8	17.8	-	7.2	3.2	0.2	-	0.2	-	0.6	68.8
Otter Brook (4/K2)	-	-	32.8	96.6	36.2	-	4.4	2.2	6.6	-	-	-	0.2	179.0
Rutherford Bk. (4/N1)	-	0.2	3.2	52.8	24.0	-	12.8	3.6	6.0	-	3.8	-	0.8	107.2
Rutherford Bk. (4/N2)	-	1.4	13.2	126.2	74.4	0.2	29.8	8.6	6.2	0.8	2.8	-	4.0	267.6
Pembroke R. (3/B1)	0.8	-	0.8	25.6	4.2	-	7.2	4.6	1.8	-	0.8	-	0.4	46.2
TOTALS	1.0	3.6	80.6	645.6	248.8	0.4	190.4	45.0	56.6	1.8		0.6	10.2	1,296.2

Fish Populations

1. Distribution

Atlantic salmon juveniles were well distributed throughout the system, being captured at all electro-seine stations. Adult salmon were first observed in the Stewiacke River in mid-July, but the major part of the run into the river took place from September to November, adults in Stewiacke River being predominantly late-run. Salmon slinks move out of the river in March-April. Speckled trout appear to be limited to tributary streams, although a few large speckled trout were observed in the main river. Brown trout were only caught with electro-seine gear in Otter Brook and Goshen Brook, but adults (few) were also seen in the main river above Upper Stewiacke during the spawning season. Eels were captured at every electro-seine station and were well distributed through the system. Suckers were abundant in pools and stillwater areas of the main river, and juveniles were captured in some tributaries. Lamprey were observed spawning in typical salmon spawning riffles in June, and juveniles were captured at 10 of the 12 electro-seine stations. Shad were observed as far upstream as Mile 32 in June-July and were most abundant in deep pools and stillwater sections. Striped bass were observed in the estuary in June during their spawning migration, and small striped bass (30-35 cms.) were captured with gillnets set on June 27 in stillwater at Mile 17. Alewives were captured with the same fleet of gillnets, but no others were observed in the system.

2. Salmon Fry and Parr Populations.

Twelve sites were electro-seined in June-July, and 6 of these were repeated in September to estimate survival rates for the summer and to estimate densities in September for comparative purposes with other systems. Data is summarized in Table 2, and exact location and description of each station can be obtained from Appendix 3 .

Fry populations were extremely high in the main river when suitable riffle areas were included, e.g. stations 3/A1 and 3/A2. It is interesting to note that at Station 3/A1, which is practically identical to 3/A2 (located 1 mile apart) except that 3/A1 is a gravel removal site, there was a fry population half that of 3/A2. Further studies will be made of gravel removal sites in 1969. Relatively high fry and parr population densities were recorded in some of the tributary streams, notably Goshen Brook and Otter Brook. These tributaries could be an important part of the system in that they provide cooler water than the main river during summer. If it is assumed that migration, if any, took place evenly through the system, then decrease in numbers from July to September can be attributed to mortality. On this assumption, survival of fry through summer was estimated as 36.2% and for parr 66.7%. Using the data for June-July from all stations, fry and parr densities in September were estimated as 29.4/100 sq. yds. and 12.5/100 sq. yds. respectively.

Length-frequencies were made of all fry captured in

Table 3: Population Estimates (number/100 sq. yds) of Salmon Fry and Parr in Stewiacke River, 1968.

<u>Station</u>	<u>June - July</u>		<u>September</u>	
	<u>Fry</u>	<u>Parr</u>	<u>Fry</u>	<u>Parr</u>
Main River, 6/A1	33.4	17.0		
Main River, 3/A1	84.0	-		
Main River, 3/A2	173.0	-	64.5	0.8
Main River, 2/A2	15.2	10.6		
Main River, 1/A1	60.3	0.8	49.3	3.1
Little River, 5/H2	145.8	9.2	38.8	9.3
Rutherford Bk., 4/N1	35.0	24.8	30.1	16.1
Rutherford Bk., 4/N2	5.4	8.6		
Otter Brook, 4/K2	163.6	58.1	21.7	5.6
South Branch, 4/B1	0.7	2.3		
Goshen Brook, 4/C1	164.8	76.8	64.5	78.2
Pembroke River, 3/B2	92.2	17.9		
TOTALS	973.4	226.1	268.9	113.1

Mean fry density in June-July = 81.1/100 sq. yds.

Estimated fry survival at 6 stations from July to September = 36.2%

Estimated fry density in September = 29.4/100 sq. yds.

Mean parr density in June-July = 18.8/100 sq. yds.

Estimated parr survival at 6 stations from July to September = 66.7%

Estimated parr density in September = 12.5/100 sq. yds.

Table 4: Length-Frequencies of Salmon Fry from 6 Stations, Stewiacke River, in September, 1968.

<u>Station</u>	<u>3+</u>	<u>4</u>	<u>4+</u>	<u>5</u>	<u>5+</u>	<u>6</u>	<u>6+</u>	<u>Total</u>
Main River, 1/A1	6	23	14	2				45
Goshen brook, 4/C1	1	18	28	5	1			53
Otter Brook, 4/K2		3	7	7	4	1	1	23
Main River 3/A2		5	31	62	23	7		128
Rutherford Brook, 4/N1			6	27	15	4		52
Little River, 5/H2			1	21	7	4		33
TOTALS	7	49	87	124	50	16	1	334

September, and data is summarized in Table 4. Differences between length frequencies of all stations were tested statistically, and station 1/A1 was significantly different ($p < 0.001$) from all stations except 4/C1. Other stations which showed significant differences between stations ($p < 0.01$) were 4/K2 - 5/H2, 3/A2 - 4/N1, and 3/A2 - 5/H2. Comparisons between 4/C1 and stations 4/N1 and 5/H2 had $p < 0.05$. It appears that stations 4/N1 and 5/H2 are significantly different from the other 4 stations, and that growth rate of fry is faster in Little River (5/H2) and Rutherford Brook (4/N1) than in other localities.

Parr were aged from scale samples ($n = 103$) and 79.7% were 1+ years, 18.4% were 2+ and 1.9% were 3+. This indicates that we can expect the majority of parr to become smolts after 2 years in fresh water.

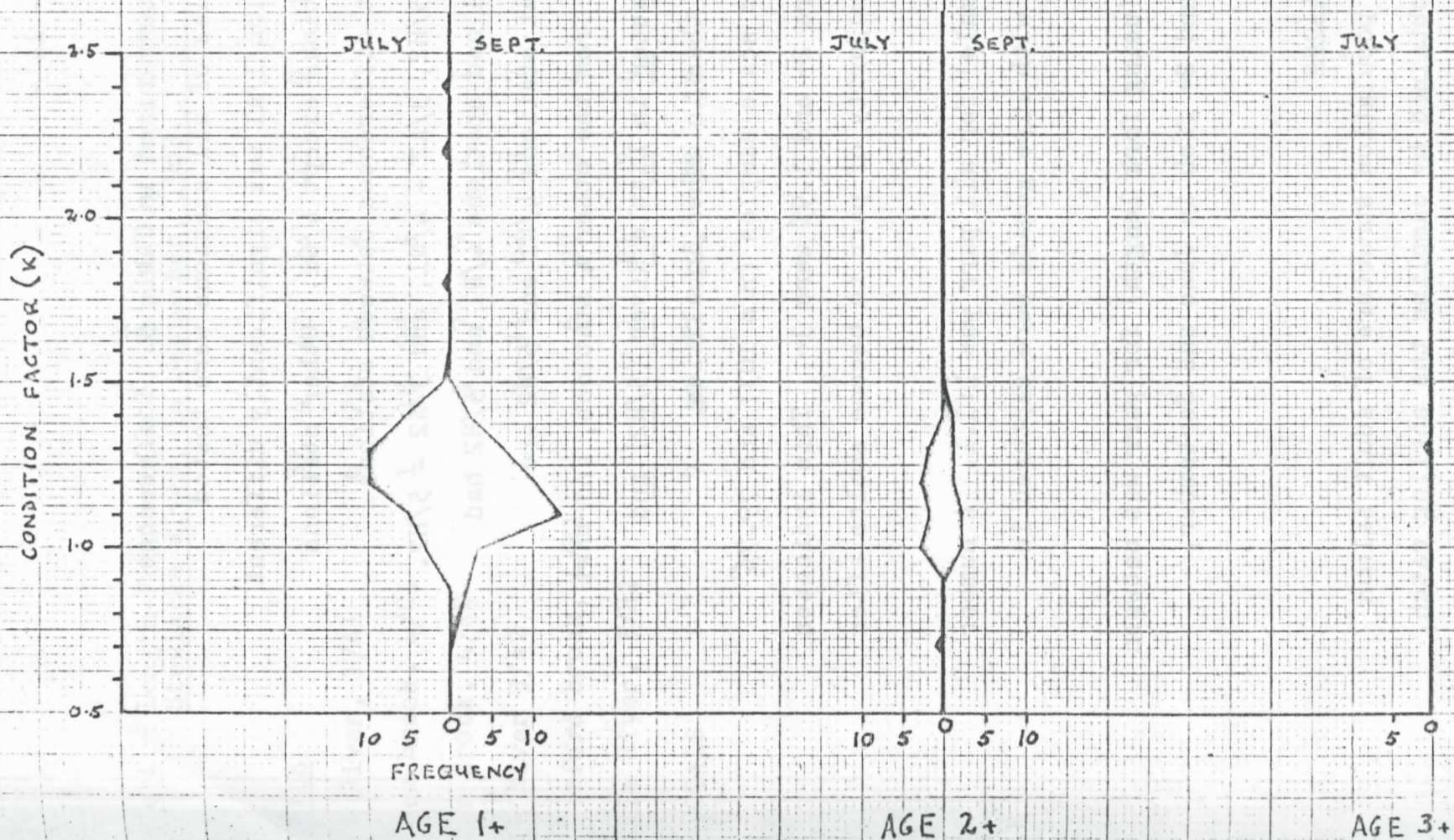
Sex ratio (male:female) for all parr was 1:1.1. A number of precocious male parr with ripe gonads were captured in September.

Condition factors (using fork length) for parr was between 1.0 and 1.5 for age 1+ and 2+ fish in June and September, 1963 (See Fig. 3)

3. Adult Salmon Populations

Information on the population structure of adult salmon in Stewiacke River was obtained by sampling the angling catch. One hundred scale samples were collected (27.5% of angling catch), and it was considered that the sample was representative

Fig. 3: Condition factors for Atlantic Salmon from Stewiacke River, 1968.



of the total catch (grilse:salmon ratio for sample was 1:1.06 and for angling catch was 1:0.97). One salmon was also captured in the estuary with a trawl net.

48.5% of adults sampled comprised grilse, and 51.5% comprised salmon. Of the salmon captured, 42% were repeat spawners, this figure being very much higher than the expected norm in Maritime rivers (5-15%). 95% of the repeat spawners had spawned for the first time as grilse (See Table 5). Male:female ratio of grilse was 1:1.48, for virgin salmon was 1:7, and for repeat spawners was 1:4.2.

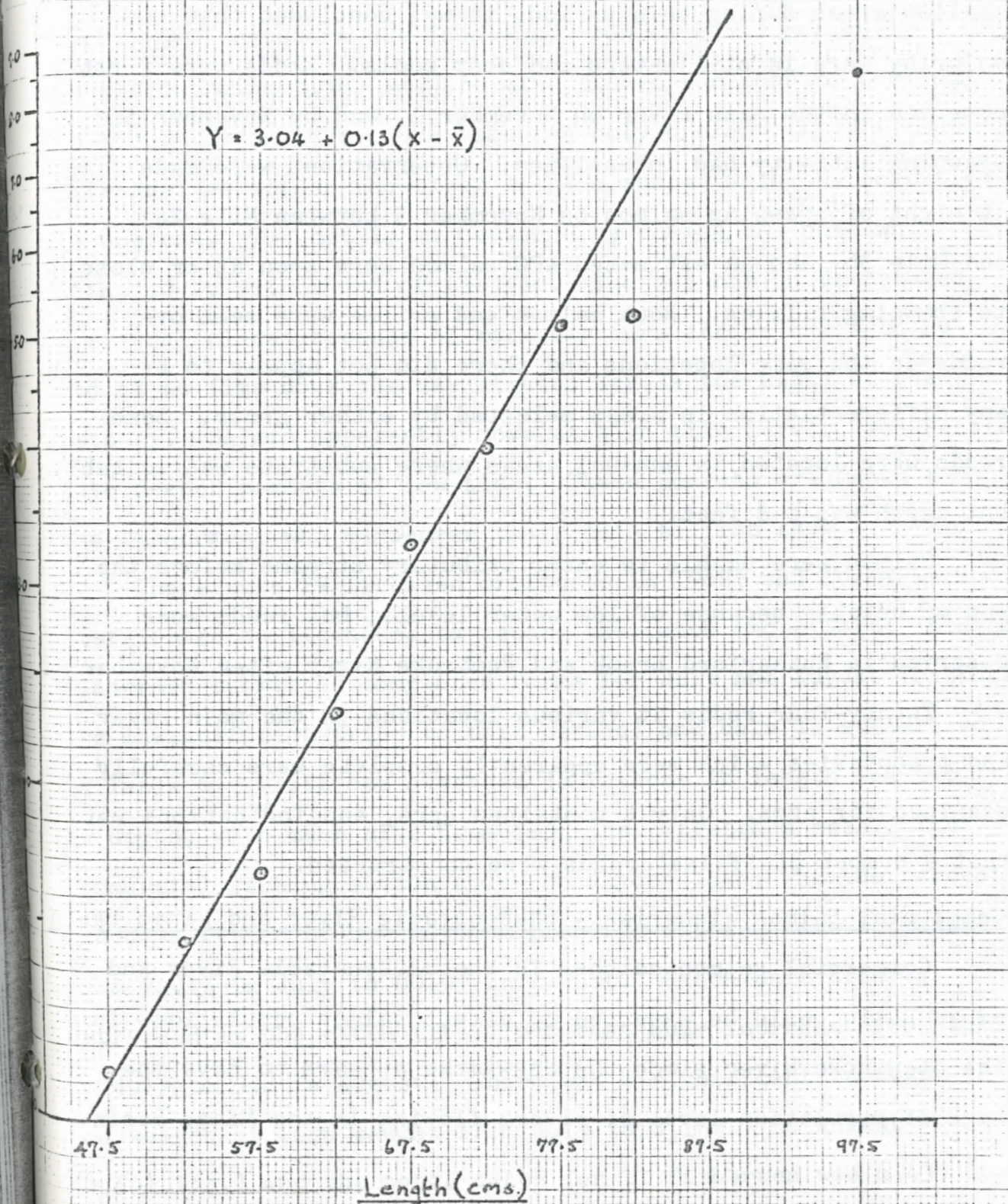
There is considerable variation in the adult population when separated according to age and spawning history (Table 5), although there were two dominant groups (grilse - 48.5%, and repeat spawners age 2+ - 29.7%). It appears that grilse are predominant in the adult population, and that survival is high for at least 1 year after spawning. Salmon also appear to adopt a useful strategy of providing variation in the time they return to the river, which would prevent catastrophic reductions in the population if there is a serious reduction in spawning success of one year class.

The length-weight relationship of all salmon grouped together is shown in Fig. ⁴~~3~~. Data was combined into 5 cm. length groups and the midpoint taken as representative of the class. The 97.5 cm. length group was only represented by one individual, and was not included in calculating the line of best fit.

TABLE 5: Summarized Data of Age, Length and Weight of Atlantic Salmon Angled in Stewiacke River, 1968

Group	S.W. Age	Sp. Marks S.W. Age	Number	%	Mean Length (cm)	Average Weight (g)
Grilse	1+	-	49	48.5	53.7	1.50
Virgin Salmon	2+	-	10	9.9	73.3	4.49
Repeat Spawners 1(a)	2+	1+	30	29.7	66.5	2.87
Repeat Spawners 1(b)	3+	1+	3	3.0	77.8	5.14
Repeat Spawners 1(c)	3+	2+	2	2.0	80.0	5.22
Repeat Spawners 2	3+	1+, 2+	6	5.9	72.4	4.12
Repeat Spawners 3	4+	1+, 2+, 3+	1	1.0	96.3	8.62
Totals			101	100.0		

Fig. 4: Length-weight relationship of Atlantic salmon (adults)
from Stewiacke River, 1968



Considerable time was spent observing the location and time of construction of redds by salmon during the spawning season. Unusually low water levels were recorded in September and October, and since very few adults were observed in shallow areas during this period, it was concluded that the majority were in stillwaters and deep pools. Redds were first observed in the main river on November 1, and by November 5, spawning activity had intensified. Observations were made at night of spawning salmon on November 5 between Mile 24 and Mile 36, and an estimated 400 salmon were seen at or close to spawning riffles. Both salmon and grilse were seen over redds in the same locations and there did not appear to be any differentiation in areas selected by either group. Some redds were located in unusual areas where substrate was suitable but depth was 6-8 feet.

Salmon were unable to enter tributary streams before the end of October because of low water levels, but redds were observed in Rutherford Brook and Pembroke River after November 1.

Twenty-four redds at various locations in the main river and tributaries which were apparently complete were carefully examined for eggs. Only 4 contained eggs, and indications were that a number of "false" redds were constructed.

Commercial Salmon Fisheries - Shubenacadie River and Minas Basin

Commercial salmon catches in the Shubenacadie River and Minas Basin could be expected to effect salmon populations in the Stewiacke River since the Stewiacke appears to have the highest population level of rivers flowing in the Minas Basin.

The commercial fishery in the Shubenacadie River takes place from just below Stewiacke River confluence to Black Rock. Driftnets are set from small rowing boats generally in the outgoing tide, and are also fished for shorter periods on the incoming tide. One boat can only operate one driftnet. Nets are set across the river in an S shape, with the boat tied to one end. The net is manoeuvred by rowing the boat while attached to either end of the net. The net has to be removed at several places because of rock barriers across the estuary and at no time does the net stretch across the width of the estuary. Salmon apparently move at high tide levels, and settle into deeper pockets at low tide. These pockets are known to the fishermen, who manoeuver their nets to fish them.

There were 29 licensed driftnets in 1968, and forms were distributed to licensees to record the catch and effort. Eleven fishermen submitted completed forms for July and August (catches are insignificant prior to this period) and data is summarized in Table 6. Driftnets averaged 35 fathoms in length and 4-6 ft. in depth, with mesh size from 5-5 $\frac{3}{4}$ ins. stretched mesh. The commercial fishing season ended on August 15th, and the percent man days fished of the maximum possible fishing time increased from 24.1% in July to 60.0% in August. Catch/unit effort, expressed as the catch (lbs.) per boat hour, increased from 1.67 in July to 9.2 in August. There was a significant increase in the weight of fish caught from July (878 lbs.) to August (6,561 lbs.) and the total catch for 11 fishermen was 6,439 lbs. The projected catch of salmon from this data for the commercial

Name	Gear	Length	Depth	Mesh (ins)	Hrs. Fished		Days Fished		No. Salmon		Weight (lbs)	
					July	Aug.	July	Aug.	July	Aug.	July	Aug.
Harrison	-	-	-	-	-	-	-	-	-	-	-	-
Parnham	Driftnet		?	5½	111	92	20	11	6	63	64	521
Watson	"	35 fthm	5 ft.	5	106	66	11	9	23	47	238½	441
Gass	"	"	6 ft.	5	196	100	22	10	33	104	333½	971
Dickie	"	"	?	5¾	Estimated 416	Estimated 424	2	3	-	17	-	140
Stone	"	"	4 ft.	5	9	41¼	3	7	2	86	23	682
MacDonald	"	"	20 mesh	5 1/8	62	70	8	8	16	61	168	877
O'Neil	"	"	?	?	5	10	1	1	1	14	9	156
L. Stone	"	"	5 ft.	5	6	48	1	4	1	91	13	1,068
Meadows	"	125 fthm	20 mesh	5¼	14	72	3	11	3	44	29	363
Turpel	"	35 fthm	20 mesh	5¼	-	80	-	9	-	40	-	342
Sub-total					525	603¼	61	73	85	567	878	5,561
Total					1,128		134		652		6,439	

fishery is 1,720 salmon weighing 17,000 lbs. This is considerably higher than the commercial catch determined by the Protection Branch of 1,334 fish weighing 10,807 lbs.

The average weight for salmon caught in Shubenacadie Estuary was 9.72 lbs. (4.35 kgms.). Salmon falling into this group from Stewiacke River would be 70-75 cms., and includes predominantly salmon that have spawned previously with male:female ratio of 1:6.3.

There is only one licensed driftnetting unit in Minas Basin which sets a fleet of nets 1,500 ft. long and 12 ft. in depth, with stretched mesh size of 5 ins. Records were kept of the daily catch by this unit. Effort was high, with the unit fishing 52% of the maximum possible time in July and 72.7% in August. Catch/boat hour in July was 8.8 lbs. and 15.1 lbs. in August, with catches of 130 salmon weighing 1,264 lbs. being made in July and 164 salmon weighing 1,450 lbs. in August.

Scale samples and lengths and weights were taken from 45 salmon caught in the Minas Basin (15% of total catch). Average length of fish in this sample was 72.6 cms. and the estimated average weight was 9.9 lbs. (4.5 kgms.). Only 11.2% of the sample was comprised of grilse, which substantiated reports from Shubenacadie estuary that very few grilse were caught by commercial fishermen. Male to female ratio was 1:7.2, and there were 28 repeat spawners (70% of the salmon). Of the repeat spawners, 93% had spawned for the first time as grilse.

DISCUSSION

One objective of this survey was to examine the potential for salmon production in the Stewiacke River prior to submitting recommendations (if required) of possible effects on fishery resources of constructing a causeway across the Shubenacadie River estuary.

Physical characteristics indicated excellent potential for salmon production with no evidence of pollution or barriers to migration. Spawning areas were extensive and well distributed in the main river and tributaries, and there were substantial nursery areas capable of producing an estimated number of 41,000 smolts. There were also numerous stillwater areas and deep pools for holding adult salmon in freshwater during low water level periods.

Estimated fry density (29.4/100 sq. yds.) was above the norm quoted by Elson (1967) for New Brunswick rivers (24/100 sq. yds.), but density of parr (majority age 1+) was below that given by Elson for small parr (18/100 sq. yds.). This indicates an unexpectedly high mortality from fry to parr stages considering the relatively mild conditions and comparatively fertile water in the Stewiacke River compared with New Brunswick waters (Smith, 1963). High densities of fry and parr were recorded in some tributaries (Little River, Otter Brook and Goshen Brook - See Table 3), and it is possible that overcrowding occurred when fry moved away from spawning locations into nursery areas. Nursery areas are compacted in smaller brooks, and with large populations of parr already present in nursery

areas, there would be severe territorial competition between fry and parr when fry moved to deeper water from riffles, especially since the water level decreases substantially in small streams during summer months. Jones (1959) also considered that grilse formed the predominant age group spawning in small streams, and since the salmon population appears to have a large proportion of grilse, there may be excessive egg production in tributaries. On the other hand, fry populations in the main river would be easily absorbed into the extensive nursery areas, and mortality should not be as high as in tributaries. Parr populations at main river sampling sites appeared to be less than expected (Table 3) and nursery areas in the main river may not be utilized to their fullest extent. However, Ducharme (pers. comm) (1957) estimated parr densities of 2 to 4/100 sq. yds. for West River, Sheet Harbour, in Nova Scotia and figures for parr density in Stewiacke River were considerably higher than this. Elson also considered that a density of 12 parr/100 sq. yds. just prior to their becoming smolts was a reasonable figure, and since it appears that the majority of parr in Stewiacke River become smolt at age 2, production of salmon from the egg to smolt stage can be considered satisfactory.

The adult salmon population in Stewiacke River appears to comprise mainly grilse, and salmon which have spawned at least once (usually as grilse). Huntsman (1958) considered that adult salmon from the Shubenacadie River had no need to go beyond Minas Basin where food was plentiful. This may be optimistic, but it is reasonable to assume that grilse probably do not travel farther

than Bay of Fundy, firstly because of the presence of an abundant food supply and secondly because of the distance involved in travelling to distant feeding grounds, such as Newfoundland, and returning to the home river in 1½ years. There are no commercial fisheries to speak of in Bay of Fundy except in estuaries where salmon are caught returning to specific rivers, and commercial exploitation of salmon is considered to be insignificant. This is substantiated to some degree by the abnormally high percentage of repeat spawners in Stewiacke angling catches (c.f. Miramichi River and West River, Sheet Harbour). Exploitation in commercial fisheries in Minas Basin and Shubenacadie estuary also follows a satisfactory pattern whereby a large proportion of the catch consists of salmon that have spawned previously. Although angling pressure has increased on the Stewiacke River since 1964 (see A.P.W.R.S report for Shubenacadie/Stewiacke Rivers) success is not always assured by the presence of salmon alone, and it is unlikely that angling could be expected to have deleterious effects on escapement of adults. Poaching of adults in freshwater has also been well controlled by Protection Branch staff since the Stewiacke River became recognized as an important salmon river in Nova Scotia.

In summary, the Stewiacke River appears to have excellent potential for salmon production; there is a viable population of salmon, and there are no known factors threatening this valuable resource.

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B. Shubenacadie River

A fish mortality involving an estimated 3,000 - 4,000 juvenile gaspereau and small numbers of shad juveniles and eels was reported at Elmsdale, Shubenacadie River, on November 3, 1968. The cause of mortality was traced to Bennery Brook, where CO_2 values of 25-45 ppm. and pH of 4.3 were recorded. Similar mortalities of alewives at this time of year have been recorded in three of the past five years, and in each case mortality was probably due to runoff from Bennery Brook. The headwaters of this brook originate in the vicinity of Halifax International Airport, and it was considered by Scott (1961) that exposure of iron pyrites during construction of the airport increased presence of iron compounds in runoff water and, facilitated by acid waters from peat bogs and bacterial action, there has been a general reduction of pH in waters draining from this location. Mortalities have occurred in fall soon after the first heavy rains, and it seems likely that badly contaminated water which has accumulated in the brook during low water level periods in summer is flushed out in sufficient concentration to cause fish mortality.

Reference:

Scott, J.S. 1961. Toxicity of surface waters in a part of Shubenacadie drainage system. Geological Survey Canada, Topical Rept. No. 34

APPENDIX 1: STREAM SURVEY FORM - 1

DATE: _____

Name of Stream: _____ System: _____

Stream Section: _____

Description of Shore (Vegetation, Topography): _____

Stream Measurements: Length: _____ Width: _____ Depth: _____

Stream Banks: Type, Height, Composition, Cover, Vegetation, Shade: _____

Stream Components (Tick off below):

Pools: Flats: Runs: Riffles: Rapids: Cascades:

Notes: _____

Stream Bed Bottom Materials: (Tick off and give percentage)

Clay: Silt: Sand: Gravel (Up to $\frac{1}{2}$ inch):

Pebble ($\frac{1}{2}$ ins. - $2\frac{1}{2}$ ins.) Cobble ($2\frac{1}{2}$ ins. - 10 ins.)

Boulder (Over 10 ins.)

Notes: _____

Obstructions: Type _____ Height: _____ Width: _____

Notes: _____

Aquatic Vegetation: (Tick off below)

Abundant: Common: Scarce:

Notes: _____

Notes on Fish Observations: _____

Water Analysis Record No: _____

Recorder: _____

Appendix 2: ZONATION OF STEWIACKE RIVER

The Stewiacke River System has been arbitrarily divided into the following zones:

<u>Zone</u>	<u>Section</u>	<u>Description</u>
1	A	Main river from Mile 48 to headwater
	B	Sutherland River
2	A	Main river from Mile 36 to 48
	B	Big Stewiacke River
	C	Little Stewiacke River
	D	Sucker Brook
	E	Cox Brook
	F	Fulton Brook
	G	Newton Brook
	H	Chaplin Brook
3	A	Main river from Mile 32 to Mile 36
	B	Pembroke River
4	A	Main River from Mile 24 to Mile 32
	B	South Branch of Stewiacke River
	C	Goshen Brook
	D	Tupper Brook
	E	Nelson Brook
	F	McCulloch Brook
	G	Steepbank Creek
	H	Gulley Brook
	J	North Meadow
	K	Otter Brook
	L	Dunlop Brook
	M	Scott Brook
	N	Rutherford Brook
	O	Chapman Brook
P	Halfway Brook	
5	A	Main river from Mile 8 to Mile 24
	B	Putnam Brook
	C	Fisher Brook
	D	Brenton Brook
	E	East Brook
	F	Johnson Brook
	G	Watering Brook
	H	Little River
	J	Field Brook
6	A	Main River from Mile 0 to Mile 8
	B	McKay Brook
	C	Little Hurd Brook
	D	Big Meadow Brook

Appendix 3: Location of Sampling Stations in Stewiacke River

- 1/A1 Main river, Mile 50 (Run below shallow riffle)
2/A2 Main river, Mile 46 (Run)
2/A3 Main river, Mile 38 (Riffle)
3/A1 Main River, Mile $34\frac{1}{2}$ (Entirely riffle)
3/A2 Main river, Mile $35\frac{1}{2}$ (Riffle and run)
3/B1 Pembroke River, Mile $4\frac{3}{4}$ (Shallow riffle)
3/B2 Pembroke River, Mile $5\frac{1}{5}$ (Riffle and pool)
4/B1 South Branch, Mile 10 (Riffle and pool)
4/C1 Goshen Brook, Mile $1\frac{1}{2}$ (Riffle and pool)
4/K2 Otter Brook, Mile 2 (Riffle and pool)
4/N1 Rutherford Brook, Mile 1 (Riffle and Run)
4/N2 Rutherford Brook, Mile $5\frac{1}{2}$ (Riffle and run)
5/A1 Main river, Mile 22 (Riffle)
5/H2 Little River, below Brookfield (pool below shallow riffle)
5/H3 Little River, above Brookfield (riffle and run)
6/A1 Main River, Mile 8 (riffle and run)