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## MANUSCRIPT REPORT

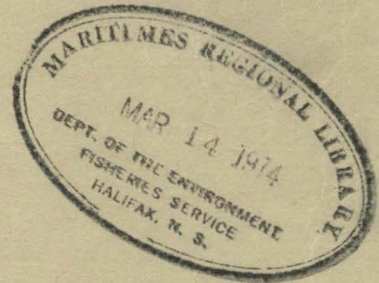
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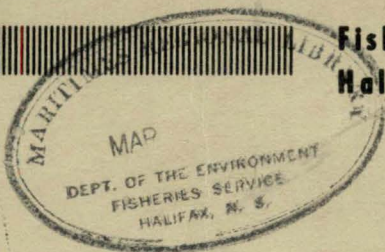
Shubenacadie and Stewiacke River, Nova Scotia  
Fisheries Survey, 1969.

by

J.R. Semple



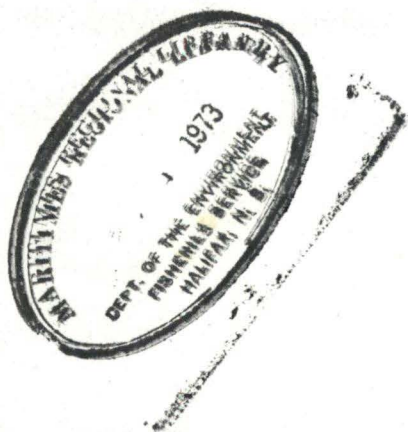
Fisheries Service  
Halifax, N.S.



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SHUBENACADIE AND STEWIACKE  
RIVER, NOVA SCOTIA,  
FISHERIES SURVEY, 1969.

NOV 9 1969



NOV 9 1970

by

J.R. SEMPLE  
RESOURCE DEVELOPMENT BRANCH  
DEPARTMENT OF FISHERIES AND FORESTRY  
FISHERIES SERVICE  
MARITIME REGION

JULY, 1970

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## INTRODUCTION

The intensive fisheries survey of the Shubenacadie River system (Stewiacke River included) commenced in the spring of 1968 and continued through the fall of 1969. The study was prompted by a proposal from the Department of Forestry and Rural Development (ARDA) to build a causeway across the Shubenacadie River estuary as detailed in the Department of Forestry and Rural Development, report (1967).

As the river's Atlantic salmon fishery is of chief interest, the major portion of this report deals with the distribution, abundance, production, vital statistics and exploitation of this species within the watershed.

Projections concerning the effects the causeway may have on the fishery are discussed in relation to the findings within the report.

## DESCRIPTION OF STUDY AREA

The Shubenacadie River is situated on Nova Scotia's west coast and empties into the Bay of Fundy via, Cobequid Bay, and Minas Basin, at Long  $45^{\circ}19'N$ , Lat  $63^{\circ}29'W$ , about 17.6 km (11 miles) west of Truro. At the point where the Shubenacadie River empties into Cobequid Bay, the tidal amplitude is one of the largest in the world. (Dept. of Forestry and Rural Development, 1967). Its maximum length to Lewis Lake on the Rawdon River extension is 97.3 km (60.8 miles) making it the eighth longest in the Province.

The river's lake drainage approximates  $390 \text{ km}^2$  (150 sq. mi.) and it is fed from an additional  $2,210 \text{ km}^2$  (850 sq. mi.) through its tributary streams, the main ones being - Five Mile River, Stewiacke River, St. Andrews River, Gays River and Nine Mile River (Dept. of Forestry and Rural Development, 1967). The Shubenacadie River drainage area ranks first in the Province and encompasses approximately five per cent of its total area (Dept. of Fisheries of Canada, 1968). The watershed covers areas in Colchester, Hants, Pictou, and Halifax counties.

On the river's southern divide the hills are at an approximate elevation of 180 m (600 feet) and on the northern divide, they vary between 210 m and 270 m (700 and 900 feet).

The geological formations underlying the river basin consist mainly of sedimentary rocks which are overlain with deep soils rich in calcium carbonate resulting in generally hard surface waters having a

comparatively high productive capacity for fish (Dept. of Fisheries of Canada, 1968).

The commercial drift net fishery in the Shubenacadie River estuary takes place from just below the confluence of the Stewiacke River to Black Rock.

## MATERIALS AND METHODS

### Fish Habitat and Distribution

Fish were either observed or captured by electrofishing during fish abundance studies or spot checks. Fyke nets and gill nets were also used on several occasions. Sampling extended from the spring of 1968 to the fall of 1969 but did not include November through March. In 1968 cyprinid specimens were not always keyed down to species; however, in 1969 a species breakdown for cyprinids was performed using specimens that had been preserved in 10% formaldehyde solution. A Baush and Lomb stereozoom dissecting microscope was used for closer inspection of cyprinids.

The common and scientific names of fishes used within this report follow those given in Bailey (1960).

Observations on fish habitat included water temperatures and stream components (riffles, runs, pools, flats and lakes where applicable). Riffles are herein defined as stream areas having a broken water surface with a depth of 7.5 - 30.0 cm (3 - 12 inches). Runs are defined as stream areas having a relatively higher water velocity and a depth range of 30.0 - 120.0 cm (12 - 48 inches). Flats are defined as stream areas with a depth of 7.5 - 120.0 cm (3 - 48 inches), a smooth unbroken water surface and a relatively slower water velocity. Pools are defined as stream areas with little visible flow and a depth 120.0 cm (4 feet).

Stream substrate was classified as: mud, gravel, - 0.3 to 1.2 cm ( $\frac{1}{8}$  to  $\frac{1}{2}$  inch) particles, pebble - 1.2 to 6.2 cm ( $\frac{1}{2}$  to  $2\frac{1}{2}$  inch) particles, cobble - 6.2 to 25.0 ( $2\frac{1}{2}$  to 10 inch) particles and boulder - particles 25 cm (10 inches).

Stream shade and instream cover were rated as nil, poor, fair, good or moderate, and excellent. Instream cover

is meant to include any item within the stream having protective or survival value for fish.

Anchored or rooted aquatic vegetations was rated as nil, poor, common and abundant.

Most of the areas checked were selected because of the predominance of riffles and runs although usually some portion of the section examined contained some flat.

In figures 1, 2, 3 and 4 showing the distribution of fishes, streams entering directly into the main stem of the Shubenacadie River are indicated on the map and have their sampling stations numbered in order proceeding upstream to the stream's origin. The numbers that these streams refer to are given in Appendix I.

#### Fish Census

Fish abundance was determined by electrofishing. The unit used was basically a modification of that employed by Smith and Elson (1950). Numbers of fish per unit area were determined by the catch per unit effort method described by De Lury (1951). At least three sweeps of the area were made and the numbers of fish in each category were tabulated after each sweep. The sites were blocked off with an upper and lower barrier net to prevent escapement from or recruitment to the area.

Spot checks were also implemented with the above-mentioned electrofishing gear. Ten minutes of effort were expended in collecting fish. Barrier nets were not employed and only one sweep of the area was performed. The numbers of each species of salmonid were recorded and the presence of other species of fish was tabulated.

#### Juvenile Atlantic Salmon Studies (parr and smolt)

Atlantic salmon smolts were collected in fyke nets on the Stewiacke River at Pembroke River (Figure 1, Station 22) and Rutherford Brook (Figure 1, Station 9). The nets consisted of 2.8 cm stretched mesh and the entire stream

width was screened off, in each instance, with metal racks having 1.3 cm spacing between the bars.

As the nets were installed before the smolt migration in the spring, the numbers of smolts captured are believed to correspond to the total upstream production of smolts from the respective streams (ie Pembroke River and Rutherford Brook). An estimate of the total biomass of smolts produced in the respective streams was made by determining the frequency distribution of smolt length classes with one cm intervals. The number of smolts in each length class, for the entire population, was then calculated and was multiplied by the average smolt weight for the respective length class.

A daily sample of smolts was preserved in 10% formaldehyde solution. These specimens were later weighed, measured, sexed and scale sampled.

Weighing was done to the nearest 0.1 g using a triple beam Ohaus balance. Fork length and total length were measured to the nearest mm using a measuring board. Total length was recorded for approximately 20 per cent of the sample and the linear regression for total length vs fork length was determined according to Alder and Roessler (1964).

A Baush and Lomb stereozoom dissecting microscope was used to examine smolt gonads removed for sexing. Smolts having gonads with a yellowish granular appearance were recorded as females while those having a milkish, nongranular appearance were recorded as males.

Scale samples were removed midway between the top of the back and lateral line along an imaginary line running from the hind insertion of the dorsal fin to the vent. Scale samples were subsequently aged using a Baush and Lomb microprojector. Age is designated with an arabic numeral and indicates the number of completed annuli.

The coefficient of condition of smolts was determined from the relationship -

$$K_{FL} = \frac{100,000W}{FL}$$

where  $K_{FL}$  = the coefficient of condition when fork length is used and  $W$  = weight in grams and  $L$  = fork length in millimeters.

Significant differences in 'K' between sexes and between locations was determined using a student t - test and the distribution of differences between means (Alder, et. al., 1964, p. 129).

The linear regression of fork length vs weight of smolts was determined according to Alder, et. al., (1964).

Daily maximum and minimum water temperatures were recorded during the smolt migration using a maximum-minimum Taylor thermometer. Degrees fahrenheit were converted to degrees centigrade. Daily water level fluctuations at the trapping sites were recorded to the nearest 0.1 ft. and converted to centimeters.

Salmon parr were sampled during electroseining operations. They were preserved in 10% formaldehyde solution and later weighed, measured, scale sampled and aged in the same manner as smolts.

#### Exploitation and Vital Statistics of Atlantic Salmon

The Atlantic salmon catches of 14 drift net fishermen in the Shubenacadie River estuary were sampled twice weekly from June to mid August, 1969. All fish were weighed to the nearest 0.2 lb. using a Pelouze dairy scale and converted to kilograms. Fork length was also recorded and the fish were scale sampled. Scale sampling and aging follows that mentioned previously for salmon parr and smolts.

When possible all statistics pertaining to a particular stretched mesh size were segregated and considered separately.

During the salmon angling seasons of 1968 and 1969 scale samples, fork lengths and weights were taken from salmon angled in the Stewiacke River in order to determine the age, length and weight characteristics of salmon captured in the sport fishery.

## RESULTS

### Fish Habitat and Distribution

#### Brook trout (Salvelinus fontinalis)

Brook trout were found most frequently associated with American eels, juvenile Atlantic salmon, lake chub, white suckers and creek chub (Table 1). Water temperatures at the time of capture ranged from 23.3°C - 10.0°C. Juvenile brook trout were captured most frequently in runs and riffles over cobble and pebble substrates. Preference appeared to be shown for shaded areas rated as \* good or excellent with good or fair instream cover. Rooted aquatic vegetation was usually absent or poorly established where this species was taken (Appendix 11).

Brook trout were found widely distributed throughout the lakes and streams of the Shubenacadie River system and its subsystems. All major subsystems, including - Five Mile River, Stewiacke River (particularly on the South Branch), St. Andrews River, Gays River, and Nine Mile River, contained brook trout. This species occurred most frequently in the feeder streams of the above-mentioned rivers and was distributed more widely in the Stewiacke River and Nine Mile River than in St. Andrews River and Gays River. Ryans Creek also had an extensive distribution of brook trout (Figure 1).

#### Brown trout (Salmo trutta)

Juvenile brown trout were found most frequently associated with juvenile Atlantic salmon, American eels, white sucker fry, and brook trout (Table 1). Water temperatures at the time of capture ranged from 21.7 - 15.6°C. Juvenile brown trout were most frequently found in runs and riffles over

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\* When habitat ratings are cited (eg. poor or good shade) the most frequent rating for the respective habitat variable is given first.



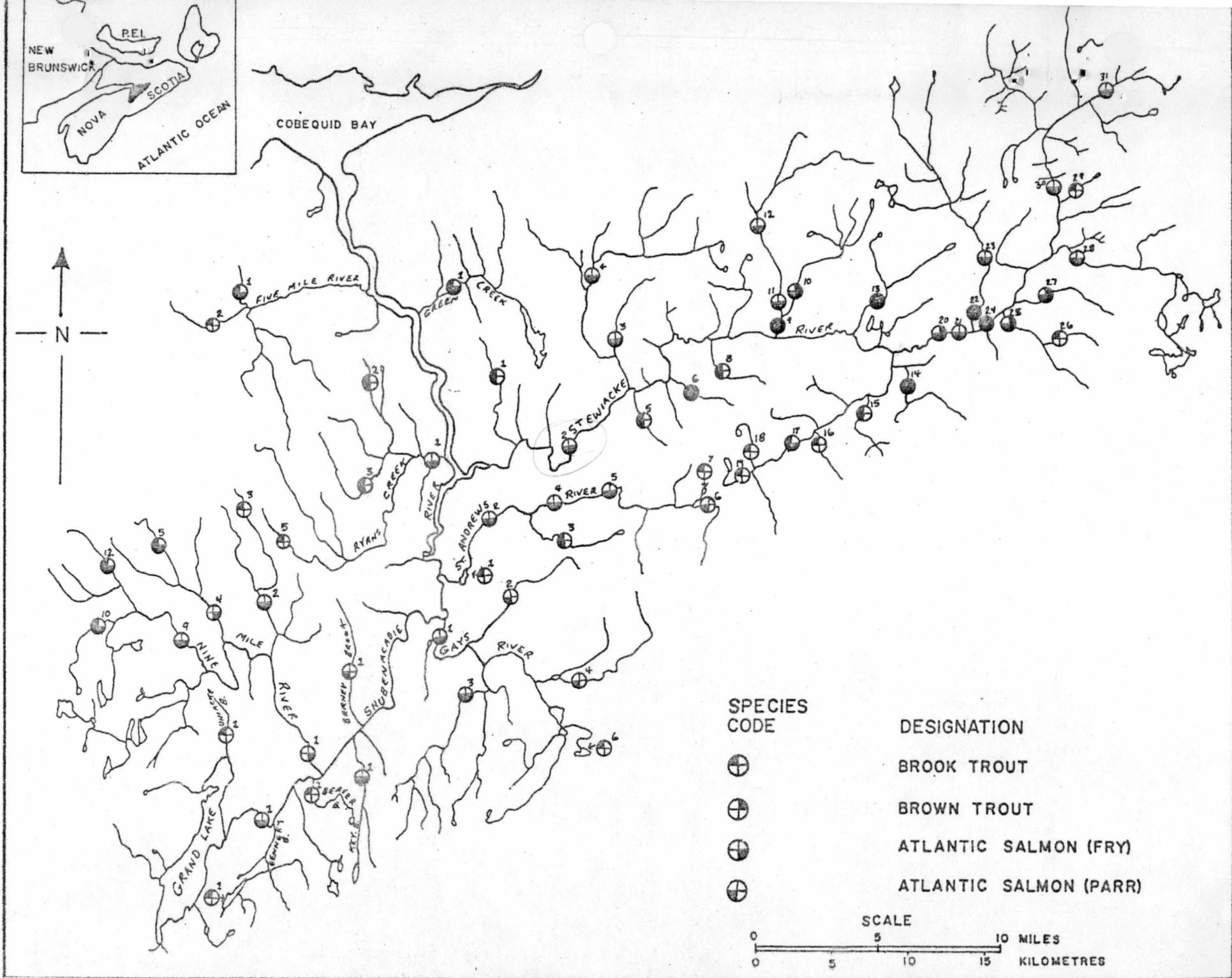


FIGURE 1. Distribution of Salmonidae in the Shubenacadie River system, 1968 and 1969.

cobble and pebble substrates. Shade and instream cover were usually poor or fair and aquatic vegetation was generally absent or poorly established (Appendix 11).

This species was found in only one major subsystem of the Shubenacadie River complex, namely, the Stewiacke River. Within the Stewiacke River, brown trout were captured as far downstream as East Brook (Station 6) and as far upstream as Fulton Brook (Station 27). They were also taken at eight intervening stations (Figure 1).

#### Atlantic salmon (Salmo salar)

Juvenile Atlantic salmon were most frequently found associated with American eels, lake chub, white sucker fry, sea lampreys (ammocoetes) and brook trout (Table 1). Water temperatures at the time of capture ranged from 26.1°C - 12.8°C. Parr and fry occurred most frequently in runs and riffles over cobble and pebble substrates. Shade was usually rated poor or good and instream cover was generally rated fair or good. Aquatic vegetation was ordinarily absent or poorly established (Appendix 11).

Salmon fry were widely distributed in the Stewiacke River; however, in its small feeder streams, namely - Meadow Brook (Station 1), Watering Brook (Station 5), Fisher Brook (Station 8), Tupper Brook (Station 15), McCullough Brook (Station 16), Steepbank Brook (Station 18), Chapline Brook (Station 26), and Sucker Brook (Station 27) salmon fry were not captured (Figure 1). Salmon fry were also extensively distributed in Nine Mile River (Shubenacadie River system). Of the nine sites electroseined in this subsystem only Grumbleys Brook (Station 3) and Meadow Brook (Station 6) lacked fry. In the remaining four major subsystems (Five Mile River, RyansCreek, St. Andrews River, and Gays River) of the Shubenacadie River, the St. Andrews River had the widest distribution of salmon fry. Salmon fry were only

captured in the lower reaches of Ryans Creek. Gays River and Five Mile River also contained salmon fry (Figure 1).

Salmon parr were widely established throughout the entire Shubenacadie River system and were found in all of its major tributaries (Figure 1).

#### Lake chub (Hybopsis plumbea)

Lake chub were most frequently found associated with American eels, juvenile Atlantic salmon, white sucker fry, creek chub, and brook trout (Table 1). Water temperatures at the time of capture ranged from 26.1°C - 14.4°C. This species was generally taken in runs and riffles over cobble and pebble substrates when shade was good or poor and instream cover was fair or good. Aquatic vegetation was usually absent or poorly established (Appendix 11).

Lake chub were widely scattered throughout all major tributaries of the Shubenacadie River system, including Five Mile River, Ryans Creek, Stewiacke River, St. Andrews River, Gays River and Nine Mile River (Figure 2).

#### Northern redbelly dace (Chrosomus eos)

Northern redbelly dace were most frequently associated with white sucker fry, creek chub, American eels, lake chub and brook trout (Table 1). Water temperatures at the time of capture ranged from 20.6°C - 10.0°C. This species was usually captured in flats and riffle-runs, with cobble or pebble substrates, when shade was excellent or fair and instream cover was good or fair. Aquatic vegetation was generally abundant or absent (Appendix 11).

This species was not widely distributed in the Shubenacadie River system. Northern redbelly dace were captured in Five Mile River (Station 2), Stewiacke River (Stations 1, 5, 18 and 19), Gays River (Stations 3 and 7), and Nine Mile River (Station 3). This species was not encountered in St. Andrews River or Ryans Creek (Figure 2).

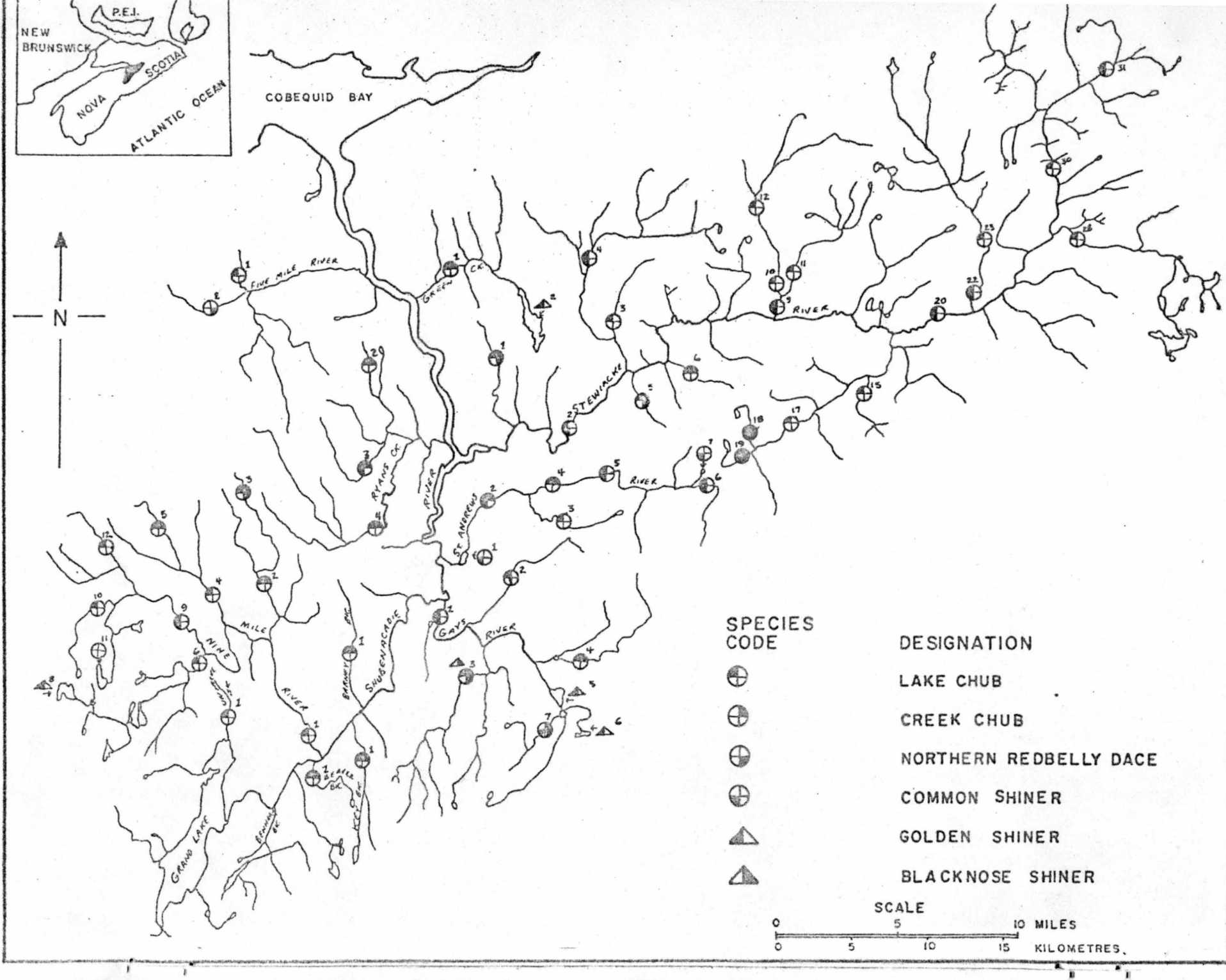


FIGURE 2. Distribution of Cyprinidae in the Shubenacadie River system, 1968 and 1969.

Common shiner (Notropis cornutus)

Common shiners were most often found associated with white sucker fry, American eels, lake chub, and juvenile Atlantic salmon (Table 1). Water temperatures at the time of capture ranged from 26.1°C - 13.9°C. This species was generally captured in runs and riffles over cobble and pebble substrates, when stream shade was poor or fair and instream cover was good or fair. Aquatic vegetation was usually absent or poorly established (Appendix 11).

Common shiners were not captured frequently and their distribution within the Shubenacadie River complex was not wide spread. During the survey they were taken in Ryans Creek, Stewiacke River, St. Andrews River, Gays River, and Nine Mile River (Figure 2).

Golden shiners (Notemigonus crysoleucas)

Golden shiners were most frequently associated with yellow perch, white perch, and brown bullheads (Table 1). Water temperatures at the time of capture ranged from 22.2°C - 21.7°C (Appendix 11).

This species was captured only in lakes on Green Creek (Station 1), Gays River (Stations 5 and 6) and Nine Mile River (Station 8). None were captured in the streams of the Shubenacadie River system (Figure 2).

Blacknose shiner (Notropis heterolepis)

This species was encountered only once during the survey. It was captured in a pool with a mud and pebble substrate on Gays River (Station 3) (Figure 2). At the time of capture the water temperature was 19.5°C. Shade was fair; instream cover was good, and aquatic vegetation was poorly established (Appendix 11).

Yellow perch (Perca flavescens)

Yellow perch were taken mostly in lakes but some were captured in pools and flats. Brown bullheads and white

suckers were its most common associates (Table 1). Water temperatures at the time of capture ranged from 23.3°C - 16.7°C (Appendix 11).

This species was found in lakes on Green Creek (Station 2), St. Andrews River (Station 1), Gays River (Station 5 and 6), and in fluvial waters of the South Branch (Station 19, Stewiacke River) (Figure 3).

#### White perch (Roccus americanus)

White perch were taken only in lakes and were most frequently found associated with golden shiners, yellow perch, brown bullheads and brook trout (Table 1). Water temperatures at the time of capture ranged from 23.3°C - 21.1°C (Appendix 11).

This species was captured only in the lacustrine waters of Green Creek (Station 2), Gays River (Stations 5 and 6) and Bennery Brook (Station 1) (Figure 3).

#### Brown bullhead (Ictalurus nebulosus)

Brown bullheads were most frequently taken in lakes and infrequently in streams. They were most often found associated with yellow perch, white suckers and brook trout (Table 1). Water temperatures at the time of capture ranged from 22.2°C, - 21.1°C (Appendix 11).

This species was captured only occasionally in the fluvial waters of the Stewiacke River (Station 22 and 19) and in lacustrine waters of St. Andrews River (Station 1 and 7) and Gays River (Stations 5 and 6) (Figure 3).

#### White suckers (Catostomus commersoni)

White suckers, usually fry, were most frequently found associated with American eels, lake chub, juvenile Atlantic salmon, creek chub, and brook trout (Table 1). Water temperatures at the time of capture ranged from 26.1°C -

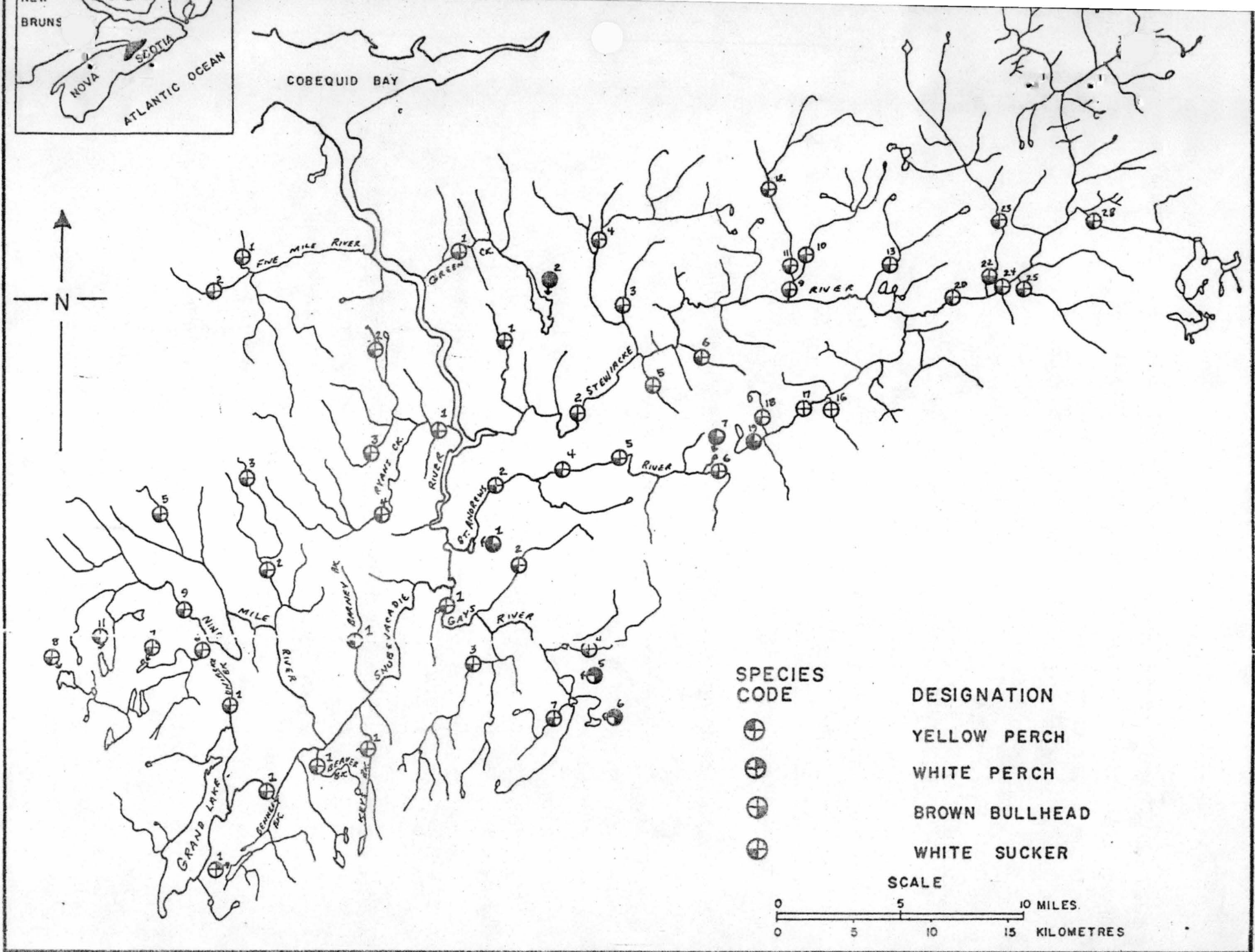


FIGURE 3. Distribution of Percidae, Serranidae, Ictaluridae and Catostomidae in the Shubenacadie River system, 1968 and 1969.

10.0°C. White sucker fry were most frequently taken in runs and riffles over cobble and pebble substrates, when shade and instream cover were good or poor. Aquatic vegetation was usually poorly established or absent (Appendix 11).

This species is widely scattered throughout the entire Shubenacadie River system. It was captured in lacustrine waters of Green Creek (Station 2), St. Andrews River (Stations 1 and 7), and Nine Mile River (Stations 7, 8, and 11), and in fluvial waters of all major subsystems within the Shubenacadie River complex (Figure 3).

Alewife (*Alosa pseudoharengus*) and American shad (*Alosa sapidissima*)

These species were taken infrequently in lakes and streams and usually as fry. Water temperatures at the time of capture ranged from 23.3 - 18.5°C (Appendix 11).

Alewives have become established in the Stewiacke River and were captured at Stations 2, 7, 9, and 22. This species was also taken in lakes on St. Andrews River (Station 1) and Gays River (Station 6). Alewives were found in fluvial waters of Nine Mile River (Station 1) and on the main Shubenacadie River below Grand Lake (Station 1) (Figure 4).

American shad were captured in the Stewiacke River (Station 7) and Nine Mile River (Station 1) (Figure 4).

Sea lamprey (*Petromyzon marinus*)

Sea lampreys (mainly ammocoetes) were taken most frequently in runs and riffles over pebble and cobble substrates when shade and cover were either fair or poor (Appendix 11). They were most frequently captured along with Atlantic salmon fry, at water temperatures ranging from 26.1°C - 12.8°C. Aquatic vegetation was generally absent or poorly established (Appendix 11).

Sea lamprey larvae were captured at many locations on the Stewiacke River and St. Andrews River. Nine Mile River



also contained members of this species (Figure 4).

American eels (Anguilla rostrata)

This species was most frequently found associated with juvenile Atlantic salmon, white sucker fry, lake chub, brook trout and sea lamprey larvae (Table 1). Water temperatures at the time of capture ranged from 26.1°C - 10.0°C. They were most frequently captured in runs and riffles over cobble and pebble substrates when shade was poor or good and instream cover was poor or fair. Aquatic vegetation varied widely in abundance (Appendix 11).

American eels were widely scattered throughout the Shubenacadie River system and were found in all major subsystems, including - Five Mile River, Ryans Creek, St. Andrews River, Gays River and Nine Mile River (Figure 4).

Banded killfish (Fundulus diaphanus)

Banded killfish were most frequently associated with white sucker fry, American eels, juvenile Atlantic salmon and brook trout (Table 1). Water temperature at the time of capture ranged from 24.1°C - 18.0°C. This species was most frequently taken in runs and riffles over cobble and pebble substrates when stream shade was poor or fair and instream cover was fair or good. Aquatic vegetation was usually absent or poorly established (Appendix 11).

Banded killfish are present but not widely distributed in Stewiacke River, St. Andrews River, Gays River, Nine Mile River, and in the main Shubenacadie River (Figure 5).

Three spine stickleback (Gasterosteus aculeatus)

This species was found most frequently associated with American eels, juvenile Atlantic salmon, lake chub and white sucker fry (Table 1). Water temperatures at the time of capture ranged from 26.1°C, - 10.0°C. Three spine sticklebacks

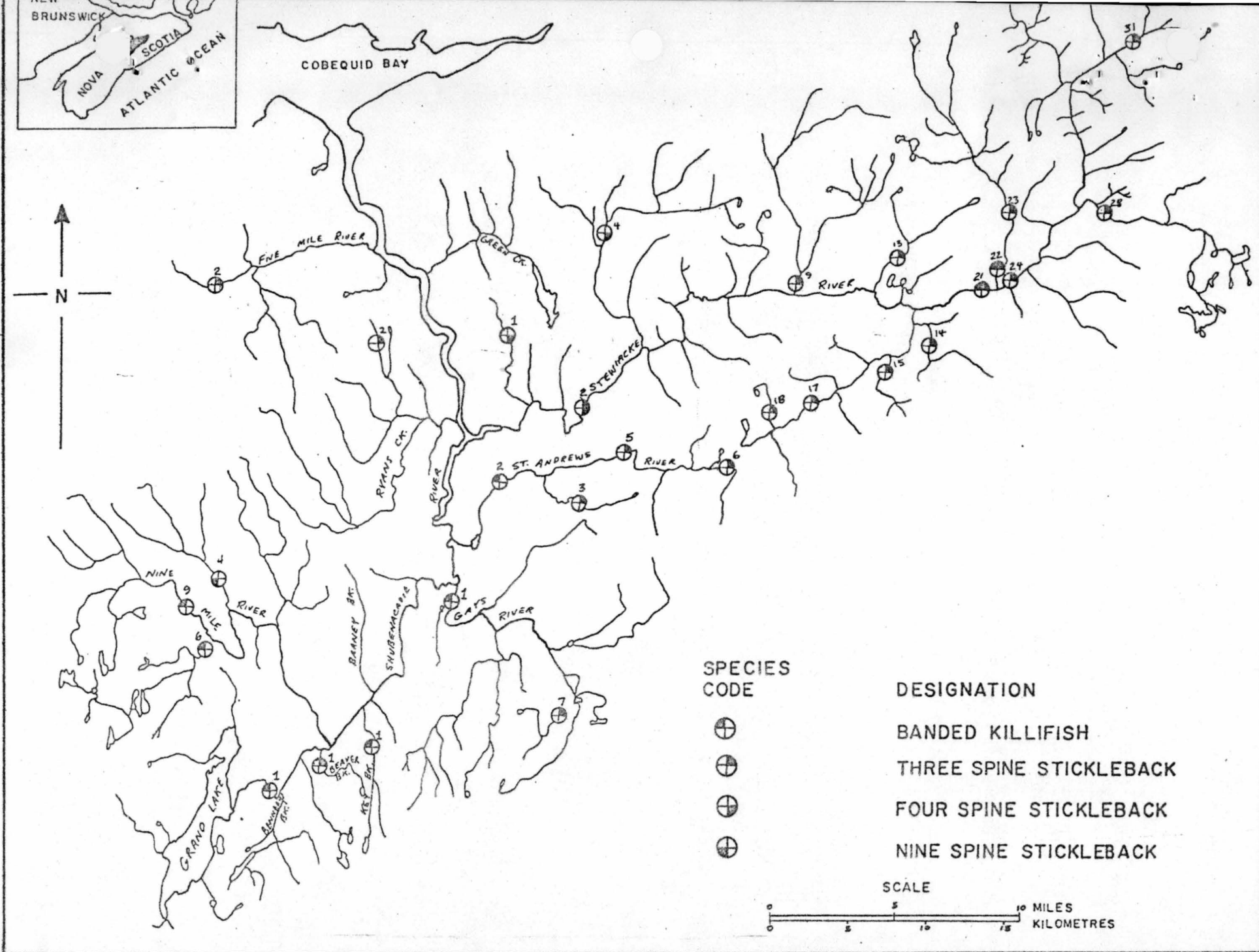


FIGURE 5. Distribution of Cyprinodontidae and Gasterosteidae in the Shubenacadie River system, 1968 and 1969.

were generally captured in runs and riffles over cobble and pebble substrates, when stream shade was poor or good, and instream cover was poor or fair. Aquatic vegetation varied widely in abundance (Appendix 11).

This species is fairly well distributed in the Stewiacke River. It was also found in St. Andrews River and Gays River but not in Nine Mile River, Five Mile River or Ryans Creek (Figure 5).

#### Four spine stickleback (Apeltes quadracus)

Four spine sticklebacks were most often associated with juvenile Atlantic salmon, lake chub, white sucker fry, and American eels (Table 1), Water temperatures at the time of capture ranged from 22.8°C - 15.0°C. They were taken most frequently in runs and riffles over cobble and pebble substrates where aquatic vegetation varied greatly in abundance (Appendix 11)..

This species was present, but not well distributed in the Stewiacke River. It was not captured elsewhere within the Shubenacadie River complex (Figure 5).

#### Nine spine stickleback (Pungitius pungitius)

The nine spine stickleback was captured only once throughout the survey in Nine Mile River (Station 4). It was not taken at any other location on the Shubenacadie River system (Figure 5). Habitat conditions were not recorded.

#### Fish Census

Population indexes of Atlantic salmon fry at eight locations on the Stewiacke River resampled in 1969 (Fig. 6), were generally lower than in 1968, whereas parr indexes were higher than the previous year (Table 11). This was true for both the main Stewiacke River and its tributaries.

Atlantic salmon fry indexes\* for 1968 and 1969 averaged 67.2 and 54.8, respectively. Salmon parr indexes

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\* Index is used to mean numbers/100 sq. yds.

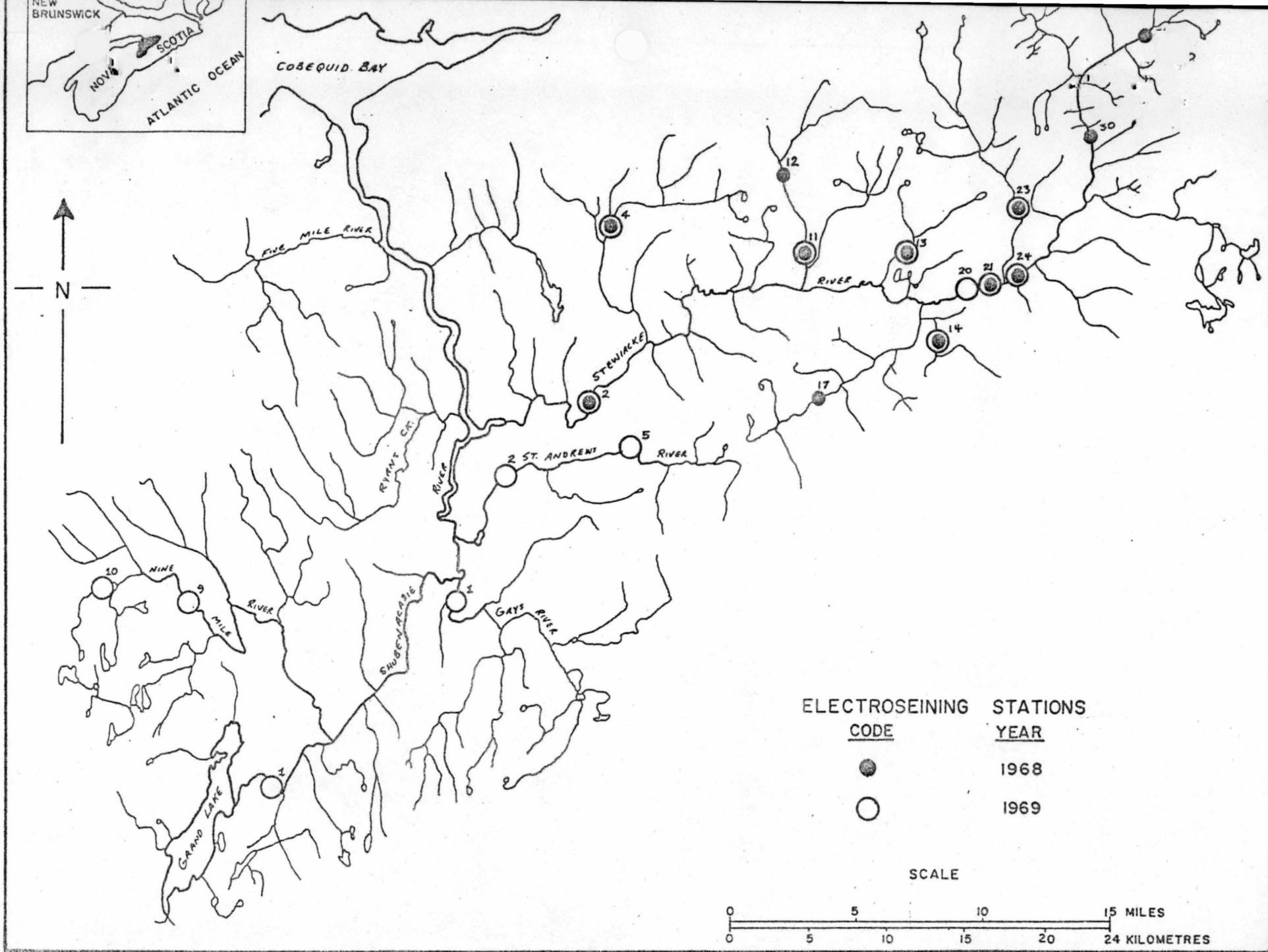


FIGURE 6. Shubenacadie River system, Nova Scotia, showing the 1968 and 1969 Fish census locations.

TABLE II. Comparison of 1968 and 1969 juvenile Atlantic salmon population indexes, and their relationship to the total population index of other associated species, Stewiacke River.

L o c a t i o n	Station Number *	Date		Population index, number per 100 sq. yds. (83.6 sq. m.)				Ratio of juvenile Atlantic salmon to other species	
				Fry		Parr			
		1968	1969	1968	1969	1968	1969	1968	1969
Stewiacke River	21	July 9	Aug. 28	84.0	34.9	7.5	13.9	1.4	
Stewiacke River	24	10 July	2	173.1	227.6	6.7	25.3	12.0	
Stewiacke River	2	11 Aug.	14	33.4	5.7	17.0	4.6	0.2	
Pembroke River	23	15	13	92.2	40.8	17.9	28.3	0.4	
Little River	4	Sept 10	15	38.8	18.1	9.3	24.6	0.1	
Otter Brook	13	16	29	21.7	46.7	5.6	26.5	0.7	
Rutherford Brk.	11	17	12	30.1	11.4	16.1	29.5	0.8	
Goshen Brook	14	17	19	64.5	53.2	78.2	38.1	1.6	
Average				67.2	54.8	18.0	20.7	2.2	

\* See Fig. 6

for the respective years averaged 18.0 and 20.7 (Table 11).

Salmon parr densities decreased in 1969 at stations 2 (main Stewiacke River) and 14 (Goshen Brook) but increased at the remaining six sites resampled (Table 11).

Competition and/or predation from fish species associated with juvenile Atlantic salmon, as indicated by the ratio of juvenile Atlantic salmon to associated species was generally lower in 1968 than 1969. The ratio of juvenile Atlantic salmon to associated species averaged 6.1 : 1 in 1968 and 2.2 : 1 in 1969 (Table 11).

Salmon fry indexes on the main Stewiacke River decreased in 1969 at stations 2 and 21 but increased at station 24. All of the tributary streams resampled, except Otter Brook (Station 13), showed decreased numbers of fry in 1969 (Table 11).

Salmon parr densities decreased in 1969 at stations 2 (main Stewiacke River) and 14 (Goshen Brook) but increased at the six other sites that were resampled (Table 11).

Atlantic salmon fry indexes ranged from 104.6 to 5.9 on the main Stewiacke River in 1969 and from 53.2 to 11.4 in its tributary streams. Stations 20 and 24 had the highest densities of fry 104.6 and 227.6/100 sq. yds., respectively. The average fry density for the nine locations sampled was 60.3 fry/100 sq. yds. (Table 111).

Salmon parr indexes were low in the main Stewiacke River with a range of 7.5 to 4.4; however, high parr densities prevailed in its tributary streams and ranged from 38.1/100 sq. yds. at Goshen Brook to 24.6/100 sq. yds. in Little River (Table 111).

Brook trout were not numerous at any of the sampling locations, averaging 0.9 fry and parr/100 sq. yds. (Table 111).

Brown trout, though not widely distributed, had an average density of 3.3 fry and 1.2 parr/100 sq. yds. (Table 111).

TABLE III. Population indexes, numbers per 100 sq. yds. (83.6 sq. m), of gamefish and non-gamefish, and the relationship of the gamefish index to the population index of associated species, Stewiacke River system, 1969.

Location	Main Stewiacke River	Main Stewiacke River	Rutherford Brook	Pembroke River	Main Stewiacke River	Little River	Goshen Brook	Main Stewiacke River	Otter Brook	Average
Station number *	20	24	11	23	2	4	14	21	13	
Date	July 1	July 2	Aug. 12	Aug. 13	Aug. 14	Aug. 15	Aug. 19	Aug. 28	Aug. 29	Average
Gamefish										
Atlantic salmon fry	104.6	227.6	11.4	40.8	5.7	18.1	53.2	34.9	46.7	60.3
Atlantic salmon parr	4.4	6.7	29.5	28.3	4.6	24.6	38.1	7.5	26.5	18.9
Brook trout fry							2.5		4.3	0.9
Brook trout parr		0.3					7.6			0.9
Brown trout fry	0.9	1.9					13.8		12.8	3.3
Brown trout parr	0.1						5.3		5.6	1.2
Subtotal	110.0	236.5	40.9	69.1	10.3	42.7	120.5	42.4	95.9	85.4
Non-gamefish										
Cyprinidae	0.8		0.6	2.0	1.3	180.6		0.2	5.0	21.2
Sticklebacks				0.3	0.8	1.0	1.2		8.0	1.4
American eel	47.7	17.4	46.3	28.0	29.3	113.2	26.4	31.2	20.2	40.4
White sucker	0.8		0.3	7.4	12.0	45.9				7.4
Subtotal	49.3	17.4	47.2	37.7	43.4	340.7	27.6	31.4	33.2	69.8
Gamefish/non-gamefish ratio	2.2	13.6	0.9	0.4	0.2	0.1	4.4	1.4	2.9	2.9

\* See Fig 1

American eels were strongly represented at all census locations, averaging 40.4/100 sq. yds. (Table 111).

Competition and/or predation for gamefish was high at stations 2, 4, 11 and 23 as indicated by low gamefish/non-gamefish ratios (Table 111); however, juvenile Atlantic salmon predominated at stations 13, 14, 20, 21 and 24. (Table 111).

To determine the presence and semiquantitative abundance of gamefish and non-gamefish in the Stewiacke River, spot checks were made on 13 of the river's tributary streams. Barrier nets were not used and ten minutes of electrofishing effort were expended in collecting the fish samples. The following stations are ranked according to the numbers of salmon fry captured - Newton Brook (32)\*, Fulton Brook (22), Chapman Brook (16), East Brook (8), and Cox Brook (6). (Table IV). Salmon parr were most numerous in Fulton Brook (46), Cox Brook (38), Chapman Brook (35), Newton Brook (31), and East Brook (21) (Table IV).

Brown trout were not abundant at any of the 13 stations spot-checked. Six brown trout were captured in 10 minutes of electrofishing effort in Fulton Brook (Table IV).

Brook trout were very plentiful in Tupper Brook (62), Fisher Brook (61), and McCullough Brook (57) (Table IV).

In 1969, tributary streams of the Shubenacadie River, excluding the Stewiacke River, had average salmon fry and parr indexes of 33.9 and 16.6, respectively (Table V). The density of salmon fry ranged from 2.6/100 sq. yds. in Gays River, station 1, to 135.7/100 sq. yds. in Nine Mile River, station 10 (Table V). Salmon parr indexes ranged from 6.7 on the main Shubenacadie River, station 1, to 67.0 in Nine Mile River, station 10 (Table V).

During fish census investigations on the Shubenacadie River (excluding the Stewiacke River) brook trout

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\* The figures in brackets represent the numbers of fish captured in ten minutes of electrofishing effort.

TABLE IV. Numbers of brook trout, brown trout and Atlantic salmon fry and parr captured during ten minutes of electrofishing effort, Shubenacadie River system, 1969.\*

Location	Station Number **	Brook trout	Brown trout	Atlantic salmon fry	Atlantic salmon parr
Five Mile River ***					
Latties Bk.	1	1	0	47	59
Burton Lake Run	2	1	0	0	0
Greens Creek	1	1	0	1	33
Ryans Creek	1	0	0	2	3
Rose Bk.	2	13	0	0	1
MacPhee Bk.	3	2	0	0	1
Ryans Creek	4	0	0	0	0
Spring Bk.	5	14	0	0	0
Stewiacke River					
Meadow Bk.	1	1	0	0	1
Field Bk.	3	0	0	2	9
Watering Bk.	5	10	0	0	2
East Bk.	6	5	2	8	21
Fisher Bk.	8	61	0	0	10
Chapman Bk.	10	0	1	16	35
Tupper Bk.	15	62	0	0	4
McCullough Bk.	16	57	0	0	0
Steep Bank Ck.	18	9	0	0	0

Davis Lake Run	19	12	0	0	0
Newton Bk.	25	0	1	32	31
Fulton Bk.	27	0	6	22	46
Cox Bk.	28	0	0	6	38
St. Andrews River					
Main River	2	0	0	4	36
Wallace Bk.	3	29	0	0	18
Main River	4	0	0	24	17
Main River	5	0	0	12	31
Main River	6	0	0	0	12
Gays River					
McLean Bk.	6	0	0	0	12
South Branch	3	0	0	3	7
Ervin Bk.	4	0	0	0	3
Pond Bk.	7	0	0	0	0
Barney Bk.	1	0	0	0	3
Mill Bk.	1	0	0	0	0
Key Bk.	1	0	0	1	4
Nine Mile River					
Grants Bk.	2	0	0	16	11
Grumbley Bk.	3	3	0	0	0
Captain McPhee Bk.	12	4	0	27	18
Beaver Brook	1	10	0	0	0
Average		7.97	0.27	6.02	12.43

- \* Barrier nets were not used and only one sweep was made.
- \*\* See Figure 1.
- \*\*\* Streams entering directly into the main stem of the Shubenacadie River are set off from the tributary streams indented below them and are listed in order from the mouth to the origin of the river.

TABLE V. Population indexes, numbers per 100 sq. yds. (83.6 sq. m.) of game fish and non-game fish, and the relationship of the gamefish index to the population index of associated species, Shubenacadie River system\*, 1969.

Location	Main Shubenacadie River	St. Andrews River	Gays River	Nine Mile River	Nine Mile River (Carrigan Bk.)	St. Andrews River	Average
Station Number **	1	5	1	9	10	2	
Date	Aug. 8	Aug. 18	Aug. 21	Aug. 21	Aug. 22	Aug. 26	
<hr/>							
<u>Game fish</u>							
Atlantic salmon							
fry	43.4	6.3	2.6	11.1	135.7	4.5	33.9
parr	6.7	10.9	7.6	7.6	67.0		16.6
<u>Brook trout</u>							
fry					70.0		11.7
parr					66.3		11.0
Subtotal	50.1	17.2	10.2	18.7	339.0	4.5	
<hr/>							
<u>Non-game fish</u>							
Cyprinidae	19.7	2.7	6.8	151.9	1.0	8.6	31.8
Sticklebacks		0.6					0.1
American eel	75.9	74.5	85.3	41.1	7.0	46.6	55.1
White sucker	0.3	15.3	14.7	20.3		3.2	9.8
Banded Killfish	1.1		7.6	0.8		3.7	2.2
Subtotal	97.0	93.1	114.4	241.1	8.0	67.1	
<hr/>							
Game fish/non-game fish ratio	0.5	0.2	0.1	0.1	42.4	0.1	7.2

\* The Stewiacke River is not included.

\*\* See Fig. 6

were captured only once, and in extremely large numbers, in Carrigan Brook, a tributary of the Nine Mile River (Station 10). At this location, the brook trout fry and parr indexes were 70.0 and 66.3, respectively (Table V).

American eels and cyprinids were abundant at nearly all of the fish census stations on the Shubenacadie River, averaging 55.1 and 31.8/100 sq. yds., respectively (Table V).

Competition and/or predation for gamefish was high at stations 1 (main Shubenacadie River), 2 and 5 (St. Andrews River), 1 (Gays River) and 9 (Nine Mile River) as indicated by the low gamefish/non-gamefish ratios at these locations (Table V).

Spot checks at 24 stations on the Shubenacadie River (Stewiacke River excluded) system revealed the presence of relatively large numbers of salmon fry in Five Mile River, Station 1 (47)\*, St. Andrews River, stations 4 (24) and 5 (12), and Nine Mile River, stations 2 (16) and 12 (27). Salmon parr were numerous in Five Mile River - station 1 (59), Greens Creek, station 1 (33), St. Andrews River, stations 2 (36), and 3 (18), 4 (17), 5 (31) and 6 (12) and Nine Mile River, stations 2 (11) and 12 (18) (Table IV and Figure 1).

Brown trout were not abundant at any of the locations that were spot checked. Brook trout were fairly numerous in Ryans Creek, station 2 (13) and 5 (14), St. Andrews River, station 3 (29) and Beaver Brook, station 1 (10).

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\*The numbers in brackets indicate the number of fish caught in 10 minutes of electrofishing effort.

## Studies of Juvenile Atlantic Salmon

### Salmon parr

#### Age and length composition

A comparison of the length frequency distributions of salmon parr sampled during August and September of 1969 indicates that the distributions are similar in Stewiacke River and Shubenacadie River. Parr ranging from 7.0 - 8.9 cm predominated in both systems (Table VI). Parr 6.0 - 6.9 cm and 11.0 - 11.9 cm were scarce in both systems. Length frequency distributions of salmon parr in the Stewiacke River were different in 1968 and 1969 (Table VI). In 1969 parr ranging from 7.0 - 7.9 predominated while in 1968 parr in the 9.0 - 9.9 cm length range were prevalent. This phenomenon is partly due to the fact that the 1968 statistics refer mainly to parr that were sampled in September.

Age frequency distributions of Atlantic salmon parr in 1968 and 1969 for the Stewiacke River were quite similar in both years with age 1 parr predominating (Table VII). Over 75 per cent of the parr sampled in the Stewiacke and Shubenacadie River systems (both years) were age 1 (Table VII). Age 3 parr were scarce. The age frequency distributions of parr in both systems were similar in 1969. In Stewiacke River 84.6 per cent of the parr sampled were age 1 as compared to 83.0 per cent in the Shubenacadie River (Table VII). No age 3 parr were sampled in 1969.

#### Growth

The observed growth of parr in the Stewiacke River varied in 1968 and 1969. Age 1 parr showed the most variation, some of which is partly due to later sampling in 1968 (Table VIII). Age 2 parr showed the smallest variation in growth in both the Stewiacke and Shubenacadie River system with a total variation in length and weight of 10.3 - 10.7 cm and 14.1 - 14.4 g, respectively. Parr captured in both

TABLE VI. Length frequency distribution of Atlantic salmon parr, Shubenacadie River system, 1968 and 1969.

Fork length class - c.m.	<u>Stewiacke River</u>		<u>Shubenacadie River</u>
	1968*	1969	1969
6.0 - 6.9	2 ( 2.1)	6 ( 7.6)	3 ( 5.7)
7.0 - 7.9	7 ( 7.5)	26 (32.9)	17 (32.1)
8.0 - 8.9	21 (22.3)	21 (26.6)	13 (24.5)
9.0 - 9.9	29 (30.8)	10 (12.7)	7 (13.2)
10.0 - 10.9	22 (23.4)	14 (17.7)	13 (24.5)
11.0 - 11.9	7 ( 7.5)	1 ( 1.3)	
12.0 - 12.9	5 ( 5.3)		
13.0 - 13.9		1 ( 1.3)	
14.0 - 14.9	1 ( 1.1)		
Total	94	79	53

\* The numbers in brackets are percentages.

TABLE VII. Age frequency distribution of Atlantic salmon parr in the Shubenacadie River system, 1968 and 1969.

Age	Stewiacke River		Shubenacadie River
	1968*	1969	1969
1	82 (79.7)	22 (84.6)	44 (83.0)
2	19 (18.4)	4 (15.4)	9 (17.0)
3	2 (1.9)		
Total	103	26	53

\* The numbers in brackets are percentages

TABLE VIII. Age and observed growth of Atlantic salmon parr, Shubenacadie River system, 1968 and 1969.

Age	Stewiacke River						Shubenacadie River		
	1968			1969			1969		
	Number of fish	Average Fork length	Average Weight	Number of fish	Average Fork length	Average Weight	Number of fish	Average Fork length	Average Weight
1	75	9.2	10.1	22	7.6	5.6	44	8.2	7.1
2	16	10.7	14.1	4	10.8	14.1	9	10.3	14.4
3	1	14.5	40.7						
Grand average		11.5	21.6		9.2	9.8		9.2	10.8

systems during 1969 had a grand average length of 9.2 cm. Parr averaged 14.1 g in the Stewiacke River and 14.4 g in the Shubenacadie River in 1969 (Table VIII).

### Salmon smolts

#### Smolt run

Smolts did not commence emmigrating from Rutherford Brook before the average daily water temperature reached  $10.3^{\circ}\text{C}$  on May 12 (Figure 7). Two minor runs (peaks) occurred on May 26 and 30, and one on June 13. The first minor peak in the smolt run took place on the third subsiding May freshet and the major run occurred on June 5 when 490 smolts were captured. On this date, average daily water temperatures reached  $13^{\circ}\text{C}$  and a small freshet was taking place.

Smolts began emmigrating from Pembroke River on May 1 when average daily water temperatures reached  $1.9^{\circ}\text{C}$ . Four minor peaks occurred in this run on May 18, 20, 27, and June 7. The major smolt emmigration took place on June 5 when the average water temperature reached  $15.6^{\circ}\text{C}$  (Figure 7).

#### Production

Rutherford Brook produced the largest number of smolts. Twenty-three hundred smolts weighing 42.3 kg (93.1 lbs.) passed through the smolt trap on this stream and 1,509 smolts weighing 22.2 kg (48.8 lbs.) passed through the trap on Pembroke River (Table IX).

If these figures are adjusted for the smolts unrecorded when the traps were out during high water (by taking the average of the number of smolts for the day previous to the net being out and the catch for the day following reinstallation of the net and multiplying this number by the number of days the trap was out), the smolt production for Rutherford Brook and Pembroke River is 2,332

2300

1509

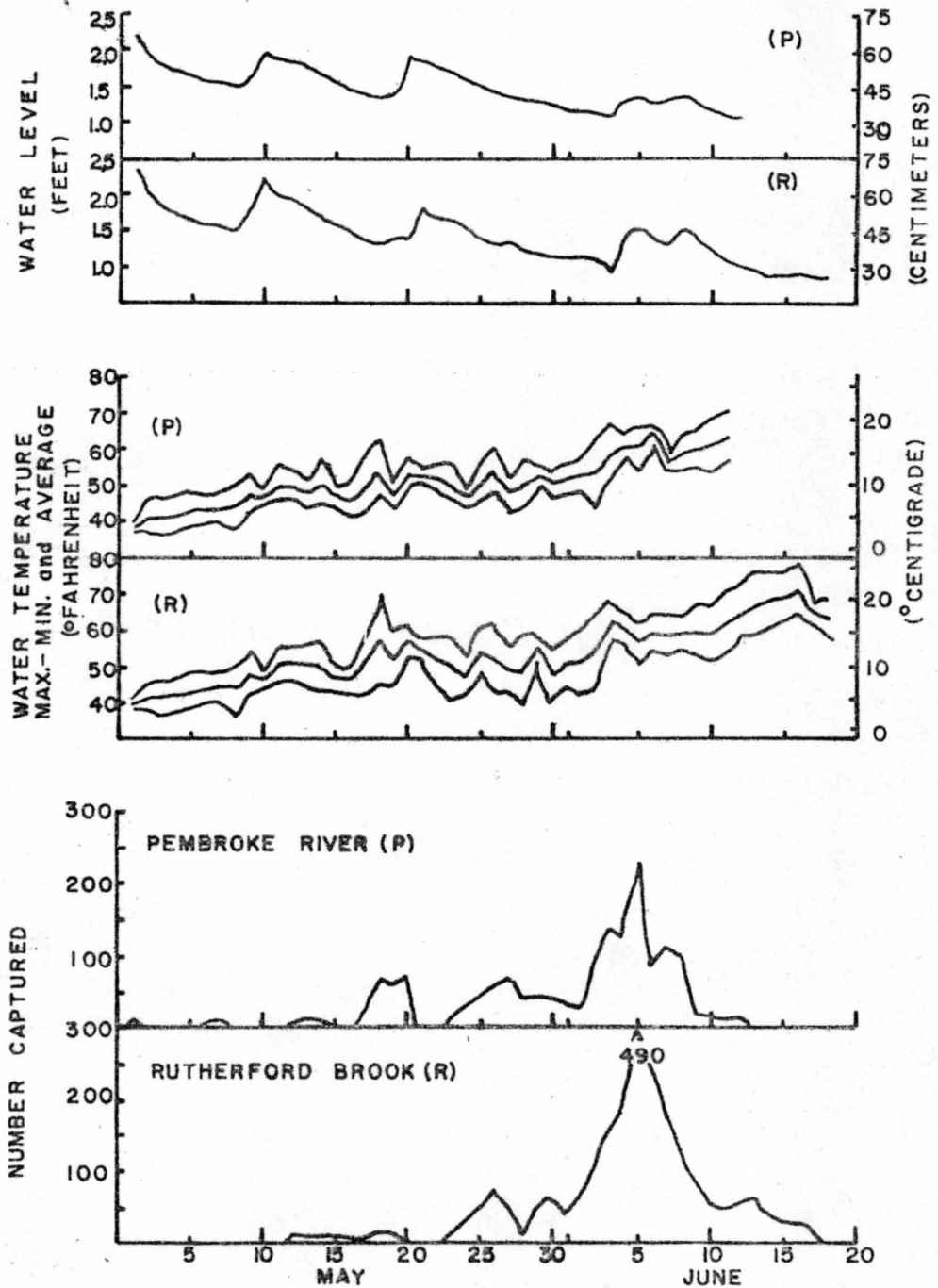


FIGURE 7. Fluctuations in the smolt run of Atlantic salmon and its relationship to water level and water temperature, in Pembroke River and Rutherford Brook, Stewiacke River subsystem, 1969.

TABLE IX. Production of Atlantic salmon smolts in Pembroke River and Rutherford Brook, Stewiacke River system, 1969.

Location	Production			
	Actual		Adjusted*	
	Number	Biomass	Number	Biomass**
Pembroke River	1,509	22.2(48.8)	1,596	23.7(52.1)
Rutherford Brook	2,300	42.3(93.1)	2,332	42.9(94.4)

\* Production adjusted for days when the trap was not operating due to high water.

\*\* Biomass is expressed in kilograms; pounds are in brackets.

smolts (42.9 kg) and 1,596 smolts (23.7 kg), respectively.

### Growth

In Pembroke River age 1 smolts averaged 9.8 cm in length and 10.2 g in weight. No age 1 smolts were taken in Rutherford Brook. Age 2 smolts had nearly equivalent average lengths and weights in both streams - 11.2 cm and 15.8 g in Pembroke River and 11.5 cm and 16.0 g in Rutherford Brook (Table X). The growth of age 3 smolts was also quite similar in both streams. Age 3 smolts averaged 12.5 cm in length and 20.9 g in weight in Pembroke River, and 12.7 cm and 18.6 g in Rutherford Brook (Table X). On an overall basis smolts were slightly smaller in Pembroke River, averaging 11.3 cm and 16.2 g, than Rutherford Brook where they averaged 12.2 cm in length and 18.6 g in weight (Table X).

Fork length and weight were highly correlated at  $r = 0.993$  and smolt weight can be calculated from the relationship  $Y = 29.41 + 4.02 X$  where  $Y =$  weight in grams and  $X =$  fork length in centimeters (Figure 8). Fork length can be converted to total length by using the relationship  $Y = 0.79 + 1.02 X$  where  $Y =$  total length and  $X =$  fork length in centimeters (Appendix III).

Coefficients of condition for smolts of similar age and length range were only significantly different for Pembroke River vs Rutherford Brook females ( $t_{.05} = 2.3756$ ). Within stream variation was only slight and ranged from  $K = 1.01 \pm 0.04^*$  (Males) to  $K = 1.04 \pm 0.14$  (Females) in Rutherford Brook. In Pembroke River males averaged  $1.08 \pm 0.10$  and females averaged  $1.11 \pm 0.15$  (Table XI). It is concluded that neither stream offers better habitat conditions than the other.

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\* The  $\pm$  values are standard deviations of the mean. Fork length was used in calculating  $K$  (the coefficient of condition).

TABLE X. Relationship between age, length and weight for Atlantic salmon smolts in Pembroke River and Rutherford Brook, Stewiacke River system, 1969.

Age	Pembroke River			Rutherford Brook		
	Number of fish	Average Fork length	Average weight	Number of fish	Average Fork length	Average weight
1	3	9.8	10.2			
2	166	11.2	15.8	68	11.5	16.0
3	12	12.5	20.9	25	12.7	22.0
Grand average .....		11.3	16.2		12.2	18.6

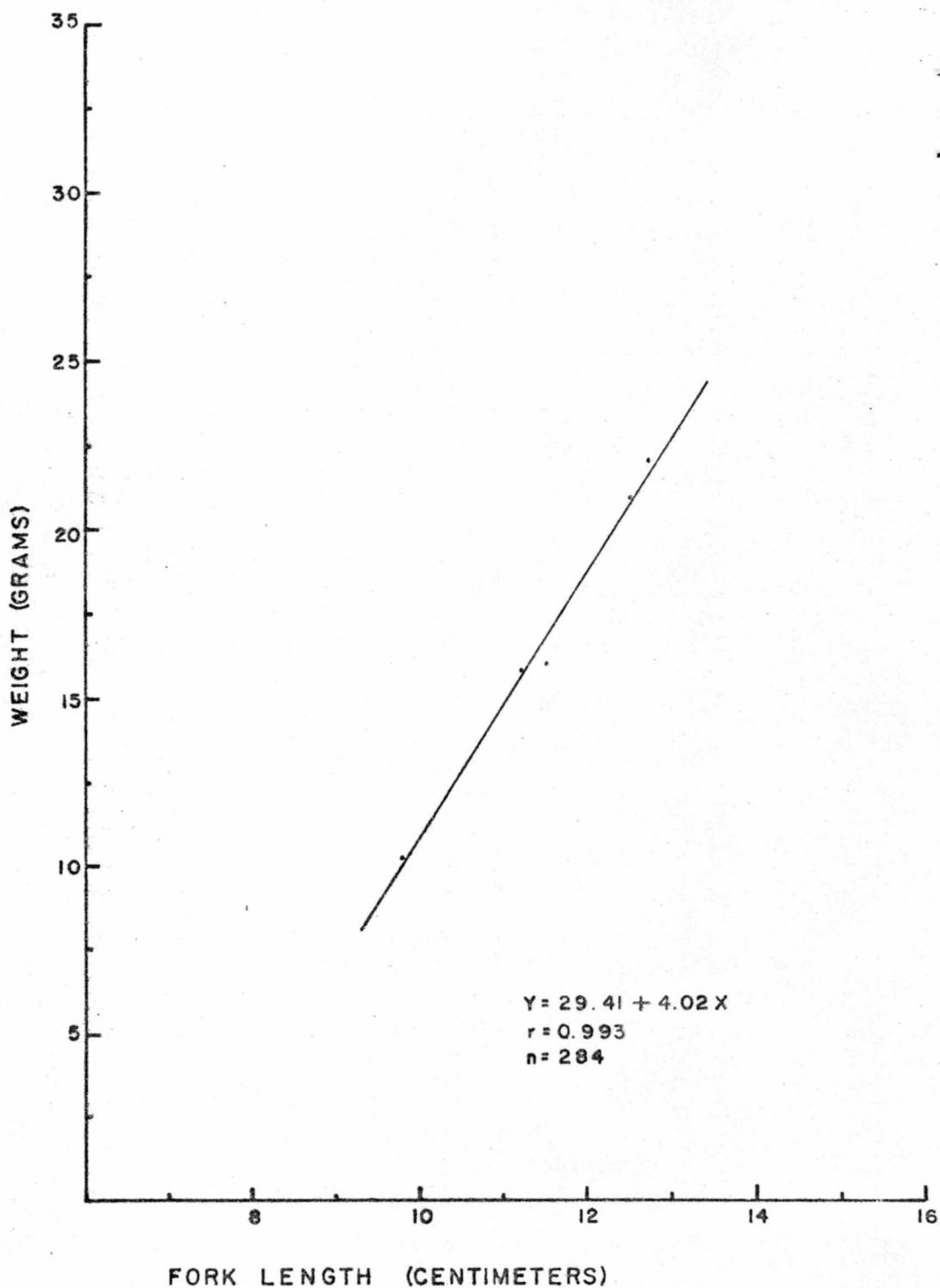


FIGURE 8. Length-weight relationship of Atlantic salmon smolts captured in Pembroke River and Rutherford Brook, Stewiacke River subsystem, 1969.

TABLE XI. Mean coefficients of condition of 2-year old Atlantic salmon smolts in the 11.0 - 11.9 centimeter length class for Pembroke River and Rutherford Brook, Stewiacke River system, 1969.

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Location	<u>Mean coefficient of condition</u>		Number of fish **
	Males	Females	
Rutherford Brook	1.01 $\pm$ 0.04	1.04 $\pm$ 0.14	31 (80.6)
Pembroke Brook	1.08 $\pm$ 0.10	1.11 $\pm$ 0.15	81 (77.8)

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\* The  $\pm$  values are standard deviations of the mean.

\*\* The numbers in brackets are percentages of females.

### Age, length and sex composition

Age 2 smolts in the 11.0 - 12.9 cm length range predominated in the smolt run of Pembroke River and Rutherford Brook (Table XII). Age 1 fish contributed 1.7 per cent of the total smolt run in Pembroke River. This age group was not represented in the Rutherford Brook smolt run. Age 3 smolts made a greater contribution to the smolt run of Rutherford Brook (26.9 per cent) than in Pembroke River (6.6 per cent) (Table XII).

On an overall basis 24.1 per cent of Pembroke River smolts were males as compared to 22.6 per cent for Rutherford Brook smolts (Table XIII). Female smolts were dominant in both streams and in all age groups (ie. age 1, 2 and 3) examined (Table XIII).

### Exploitation and Vital Statistics of Atlantic Salmon

#### Commercial drift net fishery

##### Size and age composition of catch

Of the salmon captured in 12.5 cm (5 inch) stretched mesh, fish ranging from 70.0 - 74.9 cm aged 4 and 5 predominated (Table XIV). The average fork length and weight of all salmon collected in this size mesh was 68.7 cm and 4.0 kg, respectively. Over 65 per cent of salmon taken in the 12.5 cm mesh measured between 50.0 and 79.9 cm. This mesh size sampled fish between 50.0 and 89.9 cm, aged 3 to 6 years. The average length and weight of age 3 fish were 53.0 and 1.8 kg while the respective length and weight averages for age 6 salmon were 77.6 cm and 5.6 kg (Table XIV).

The same length and age range of salmon which dominated the catch taken in 12.5 cm stretched mesh also predominated in the 12.8 cm (5 1/8 inch) mesh size (Table XV). The 12.8 cm mesh size sampled fish between 45.0 and 89.9 cm aged 3 to 7 years. All salmon taken in this mesh size averaged slightly longer and heavier than those taken

TABLEXII. Age and length composition of Atlantic salmon smolts in Pembroke River and Rutherford Brook, Stewiacke River system, 1969.

Fork length class - cm.	Pembroke River			Rutherford Brook				
	Number of fish*	Age		Number of fish	Age			
		1	2		3	1	2	3
9.0 - 9.9	6 ( 3.3)	1	5	1 ( 1.1)	1			
10.0 - 10.9	37 (20.4)	2	35	7 ( 7.5)	7			
11.0 - 11.9	86 (47.5)		82	4	31 (33.3)	29	2	
12.0 - 12.9	47 (26.0)		42	5	33 (35.5)	25	8	
13.0 - 13.9	5 ( 2.8)		2	3	18 (19.4)	6	12	
14.0 - 14.9					3 ( 3.2)		3	
Total	181	3	166	12	93	0	68	25
		(1.7)	(91.7)	(6.6)			(73.1)	(26.9)

\* The numbers in brackets are percentages of the total number sampled in each stream.

TABLE XIII. Sex ratios for different age classes of Atlantic salmon smolts in Penbroke River and Rutherford Brook, Stewiacke River system, 1969

Age	Penbroke River		Rutherford Brook	
	Number of fish	Percentage Males	Number of fish	Percentage Males
1	3	0.0	-	-
2	162	22.8	68	17.6
3	13	46.2	25	36.0
Total	178	24.1	93	22.6

TABLE XIV. Observed growth and age-length frequency of Atlantic salmon taken by Commercial drift nets with 12.5 cm. (5 inch) stretched mesh in the Shubenacadie River estuary, 1969.

Fork length class - cm.	Age				Total *
	3	4	5	6	
50.0 - 54.9	1	1			2 (4.4)
55.0 - 59.9		1			1 (2.2)
60.0 - 64.9		2	2		4 (8.7)
65.0 - 69.9		2		1	3 (6.5)
70.0 - 74.9		10	4	4	18(39.1)
75.0 - 79.9		2	8	2	12(26.0)
80.0 - 84.9			3	1	4 (8.7)
85.0 - 89.9				2	2 (4.4)
	1	18	17	10	
Number of fish * -	(2.2)	(39.1)	(37.0)	(21.7)	46
Average length	53.0	69.0	75.3	77.6	68.7
Average weight**	1.8	3.7	4.7	5.6	4.0

\* Numbers in brackets are percentages.

\*\* Weight is expressed in kilograms.

TABLE XV. Observed growth and age-length frequency of Atlantic salmon taken by Commercial drift nets with 12.8 cm. (5 1/8 inch) stretched mesh in the Shubenacdie River estuary, 1969.

Fork length class - cm.	Age					Total *
	3	4	5	6	7	
45.0 - 49.9	2					2 (6.7)
50.0 - 54.9	1					1 (3.3)
55.0 - 59.9						0
60.0 - 64.9		2	2			4 (13.4)
65.0 - 69.9		2				2 (6.7)
70.0 - 74.9		5	4	1		10 (33.3)
75.0 - 79.9		1	7	1		9 (30.0)
80.0 - 84.9					1	1 (3.3)
85.0 - 89.9				1		1 (3.3)
	3	10	13	3	1	
Number of fish *	(10.0)	(33.3)	(43.3)	(10.0)	(3.4)	30
Average length	49.7	70.5	73.1	79.5	84.5	71.5
Average weight**	1.3	3.8	4.5	5.9	6.4	4.4

\* Numbers in brackets are percentages.

\*\* Weight is expressed in kilograms.

in the 12.5 cm mesh size. The averages were 71.5 cm and 4.4 kg, respectively (Table XV).

With all mesh sizes combined (ie. 12.5, 12.8 and 13.1 cm), fish aged 4 and 5 years and 70.0 - 79.9 cm were prevalent. These mesh sizes sampled fish between 45.0 and 89.9 cm aged 3 to 7 years. The grand average length and weight of all salmon taken in drift nets was 71.5 cm and 4.4 kg, respectively (Table XVI).

The grilse to salmon ratio of the commercial catch was 1:19.\*

#### Spawning history of catch

Sixty per cent of all salmon taken in the commercial drift nets of the Shubenacadie River estuary had spawned at least once before the time of capture (58 per cent once before and 2 per cent twice before) (Table XVII). Forty per cent of the captured salmon, grilse included, were about to spawn for the first time, 5 per cent as grilse and 35 per cent as salmon 58 (96.6 per cent) spawned before as grilse, 8 (13.3 per cent) spawned before as 3 sea year old salmon (Table XVII).

#### Angling fishery

##### Size and age composition of catch

Age 3 and 4 salmon ranging from 45.0 to 84.9 cm prevailed in the angling harvest of Atlantic salmon. The average length and weight for all fish sampled was 71.8 cm and 4.0 kg and the fishery took salmon ranging from 3 to 7 years and 45.0 to 95.9 cm. The average yearly increment in length and weight were 9.5 cm and 1.2 kg for fish between 3 to 7 years (only fish with some salt water growth are included). Age 3 salmon (grilse) averaged 53.5 cm and 1.5 kg and age 7 salmon averaged 91.5 cm and 6.3 kg (Table XVIII).

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\* Taken from original data.

TABLE XVI. Observed growth and age-length frequency of the Atlantic salmon taken by Commercial drift nets with stretched mesh sizes 12.5, 12.8, 13.1 cm. (5, 5 1/8, and 5 1/4 inch) in the Shubenacadie River estuary, 1969.

Fork length class - cm.	Age					Total *
	3	4	5	6	7	
45.0 - 49.9	2					2 (2.0)
50.0 - 54.9	2	1				3 (3.0)
55.0 - 59.9		2				2 (2.0)
60.0 - 64.9		4	4			8 (8.1)
65.0 - 69.9		6	3	1		10 (10.1)
70.0 - 74.9		19	11	5		35 (35.4)
75.0 - 79.9		3	19	5		27 (27.3)
80.0 - 84.9			5	1	2	8 (8.1)
85.0 - 89.9				4		4 (4.0)
	4	35	42	16	2	
Number of fish *	(4.0)	(35.4)	(42.4)	(16.2)	(2.0)	99
Average length	51.3	69.3	74.6	79.2	83.3	71.5
Average weight**	1.6	3.7	4.8	5.8	6.1	4.4

\* Numbers in brackets are percentages.

\*\*Weight is expressed in kilograms.

TABLE XVII. Spawning history of Atlantic salmon taken in the Commercial drift net fishery of the Shubenacadie River estuary, 1969.

Category	Salt water age	Salt water age spawning marks	Number * and Percentage
Grilse	1	-	5
Virgin salmon	2	-	35
Repeat spawner 1	2	1	8
Repeat spawner 1	3	1	41
Repeat spawner 1	3	2	1
Repeat spawner 1	4	1	1
Repeat spawner 1	4	2	6
Repeat spawner 1	4	3	1
Repeat spawner 2	3	1,2	1
Repeat spawner 2	4	1,3	1

\*Number = percentage, because the total number of Fish samples equals 100.

TABLE XVIII Observed growth and age-length frequency of Atlantic salmon angled in the Stewiacke River, 1968 and 1969.

Fork length class - cm.	Age					Total *
	3	4	5	6	7	
45.0 - 49.9	3					3 ( 2.8)
50.0 - 54.9	26	5				31 (29.2)
55.0 - 59.9	16	1	1			18 (17.0)
60.0 - 64.9		10	5			15 (14.2)
65.0 - 69.9		8	5			13 (12.3)
70.0 - 74.9		6	4	3		13 (12.3)
75.0 - 79.9		5	3	1		9 ( 8.5)
80.0 - 84.9		2				2 ( 1.9)
85.0 - 89.9						0
90.0 - 94.9					1	1 ( 0.9)
95.0 - 95.9				1		1 ( 0.9)
	45	35	20	5	1	106
Number of fish*	(42.5)	(33.0)	(18.9)	( 4.7)	(0.9)	
Average length	53.5	65.9	69.9	78.1	91.5	71.8
Average weight**	1.5	3.1	3.9	5.1	6.3	4.0

\* Numbers in brackets are percentages.

\*\* Weight is expressed in kilograms.

## DISCUSSION

### Fish Habitat and Distribution

The extensive distribution of relatively large numbers of juvenile Atlantic salmon, lake chub, and white sucker fry, in salmon rearing areas of the Shubenacadie River system (ie. riffles and runs over pebble and cobble substrates) suggests that any stream alteration which would flood these areas would not only effect the distribution of fry and juvenile salmon but would similarly effect its associated species.

The impoundment caused by the proposed Shubenacadie River causeway would surely effect an undetermined amount of salmon rearing area above the obstruction.

It is apparent from Fig. 1 and Appendix II that salmon fry and parr coexist with brook trout only in areas where environmental conditions are mutually suitable. Both species preferred areas with riffles and runs with pebble and/or cobble substrates but stream shade requirements were less pronounced in salmon fry and parr, though instream cover preferences were the same.

Brook trout can not endure water temperatures as high as Atlantic salmon parr (Rounsefell and Everhart, 1953) and this is believed to be one of the main factors effecting the distribution of these species. Though brook trout can survive a water temperature of  $26.7^{\circ}\text{C}$  ( $80^{\circ}\text{F}$ ) for two days and temperatures of  $22.8 - 23.3^{\circ}\text{C}$  ( $73 - 74^{\circ}\text{F}$ ) for two weeks (Borgeson, 1966), depending on their thermal history, they move into cooler waters, if possible, when water temperatures rise above  $20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ) (Elson, 1942; Smith and Saunders, 1958; Baldwin, 1948). Atlantic salmon fingerlings died when water

temperatures reached  $30.5^{\circ}\text{C}$  ( $86.9^{\circ}\text{F}$ ) during a stream planting (McCrimmon, 1954); however, salmon parr could tolerate temperatures as high as  $28^{\circ} - 29.5^{\circ}\text{C}$  ( $82 - 85^{\circ}\text{F}$ ) at least temporarily but died under experimental conditions at temperatures of  $32.9^{\circ}$  and  $33.8^{\circ}\text{C}$  ( $90.2^{\circ}$  and  $91.8^{\circ}\text{F}$ ). Brown trout are also more tolerant of adverse environmental conditions, including higher water temperatures, than brook trout (Lagler, 1956). Brown trout tolerate temperatures from near freezing to  $26.7^{\circ}\text{C}$  ( $80^{\circ}\text{F}$ ) (Staley, 1966), and Embury (1922) reports them withstanding a temperature of  $28.5^{\circ}\text{C}$  ( $83.3^{\circ}\text{F}$ ) briefly.

Many of the small feeder streams on the Stewiacke River (see results, p. 12) lacked salmon fry yet contained moderate numbers of salmon parr. This phenomenon may be due to insufficient water during the salmon spawning season, making the areas unsuitable for spawning yet satisfactory for parr which are more tolerant of higher water temperature. These small streams although unsuitable for salmon spawning may support the parr segment of the population quite readily through migration.

The relatively high population indexes (Tables III and V) and wide distribution of salmon fry (Figure 1) throughout the Shubenacadie River system, particularly in Stewiacke River and Nine Mile River is evidence of good overall spawning success and adult salmon escapement during the fall of 1967 and 1968.

Brown trout are distributed along the main Stewiacke River and in tributary streams extending from and including East Brook to Fulton Brook (Fig. 1). The brown trout is indigenous to Europe but since its planting in the Stewiacke River it has developed a narrowly distributed self-sustaining population as indicated by the presence of brown trout fry (Table III).

A recent paper by Marshall and MacCrimmon, (1970) indicates that brook trout and brown trout are able to provide a good self-sustaining fishery in the headwater habitat of the

brook trout from which the brown trout has been often excluded in the past. Several attributes of the brown trout which favors its coestablishment with brook trout are its greater longevity, greater capacity for growth, potentially favorable rate of exploitation, lesser vulnerability to capture than brook trout and its ability to provide a sustained fishery despite intensive angling pressure (Marshall, et. al., 1970). Borgeson (1966); however, points out that brown trout are usually more piscivorous than brook trout. In addition, brown trout are reported to be better able to withstand competition from other trout species (Borgeson, 1966). Research in the state of Maine has shown that the similar life histories and habitat requirements of brown trout and landlocked Atlantic salmon, can offer a serious threat to the latter, and that brown trout can even displace landlocked salmon from streams and lakes which are utilized by both species (Fenderson, 1954).

It is recommended at the present time, that further plantings of brown trout in the Shubenacadie River system not be made because - (1) landlocked salmon exist in Grand Lake on the main stem of the Shubenacadie River. The establishment of brown trout in the lake, through migration, may adversely effect this unique fishery. (2) Sea run Atlantic salmon and brook trout are native to the system and already support a good angling fishery and, therefore, should presently be given priority over non-native species.

A causeway across the Shubenacadie River estuary would have few undesirable effects on golden shiners, black-nose shiners, yellow perch, white perch, brown bullheads, adult white suckers and American eels as these species are regularly present in lakes and deep impoundments or sluggish stillwater sections of rivers (present study and Scott, 1967). Thus, with decreasing salinities above the causeway and the formation of a relatively freshwater impoundment, approximating

lacustrine conditions, the aforementioned species may become established in the headpond. The establishment of large populations of predatory yellow perch, white perch, American eels and possibly stripped bass at this location could adversely effect downstream migrations of Atlantic salmon smolts, as well as young alewives, American shad and stripped bass but this projection needs clarification and quantification.

### Fish Census

The relatively high population densities of fry and juvenile Atlantic salmon during 1968 and 1969 (Tables II, III, and V) are indicative of successful spawning and good escapement of adult salmon to the spawning grounds of the Shubenacadie-Stewiacke River system.

Elson and Kerswill (1955), indicate that the Miramichi can produce 39 salmon parr/100 sq. yd. without predatory bird control. Population densities of 20 to 30 parr/100 sq. yds. were monitored in Pollett River, New Brunswick (Elson, 1962). Elson (1967) considered a production of 12 parr/100 sq. yds., just prior to smoltification, a reasonable figure while Kerswill (1961) indicates that maximum smolt production can be attained if 10 parr/100 sq. yds. are produced, provided that parr smoltify in two years,\* and by the production of 20 parr/100 sq. yds., if the parr smoltify at age 3. Salmon parr densities on the main Stewiacke River (4 stations) were below 10/100 sq. yds. in 1969; however, all of its tributary streams examined (5 stations) had parr indexes exceeding 10/100 sq. yds., and ranging from 24.6/100 sq. yds. to 38.1/100 sq. yds (Table III). The lower parr densities in the main Stewiacke River are believed due to the migrations of parr into smaller tributary streams which serve chiefly as suitable rearing areas

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\* The Stewiacke River produces smolts in 2 years.

for salmon parr. Salmon parr indexes at six locations on the Shubenacadie River system (excluding Stewiacke River) were generally smaller than those encountered on the Stewiacke River (Tables III and IV). The average parr density at the six stations sampled was 16.6/100 sq. yds. (Table V). Station 10 (Carrigan Brook, Nine Mile River) had the highest salmon parr density on the entire Shubenacadie River complex, with 67.0 parr/100 sq. yds. in 1969. Average salmon parr densities in the Stewiacke River tended to be slightly higher in 1969 (20.7 parr/100 sq. yds.) than 1968 (18.0/100 sq. yds.) while salmon fry indexes tended to be lower in 1969 (54.8 fry/100 sq. yds.) than 1968 (67.2 fry/100 sq. yds.) (Table II).

The population densities of American eels were high i.e. 10/100 sq. yds. at nearly all locations (15 stations) on the Shubenacadie-Stewiacke River averaging 55.1/100 sq. yds. and 40.4/100 sq. yds., respectively (Tables III and V). Cyprinids were also numerous averaging 31.8/100 sq. yds. in the Shubenacadie and 21.2/100 sq. yds. in the Stewiacke River (Tables III and V). American eels adversely effect the standing crop of salmon fry through predation (White, 1933) and are their greatest competitor.

Fish census were usually made in salmon rearing areas. Brook trout were not ordinarily found in these areas; however, extremely high population indexes of salmon and trout (fry and parr) were recorded in Carrigan Brook (Nine Mile River) where Atlantic salmon fry and parr indexes were 135.7/100 sq. yds. and 67.0/100 sq. yds., respectively. At the same location, brook trout, fry and parr indexes were 70.0/100 sq. yds. and 66.3/100 sq. yds., respectively (Table V).

At Goshen Brook (station 19) and Otter Brook (station 29) on the Stewiacke River, moderately high densities of salmon fry and parr coexisted with the fry and parr of brown trout and brook trout (Table III). Further studies on the population dynamics of coexisting populations of fry and postyearlings of

Atlantic salmon, brook trout and brown trout in these areas would be useful for developing policies regarding the management of brown trout in the Maritimes.

#### Studies of Juvenile Atlantic Salmon

##### Salmon parr

Salmon parr grew relatively quickly in the Shubenacadie-Stewiacke River system during 1968 and 1969, particularly during the first year of life. Belding (1935) lists the growth of age 1, 2 and 3 parr for 21 rivers in Nova Scotia, New Brunswick and Quebec. In the rivers cited by him, age 1 parr ranged from 4.1 - 6.5 cm, age 2 parr ranged from 6.5 - 14.0 cm and age 3 parr ranged from 8.6 - 16.2 cm. Age 1 parr in the Shubenacadie-Stewiacke River system fell outside the above-mentioned length range of first year growth given by Belding (1935) which varied from 7.6 - 9.2 cm during 1968 and 1969 (Table VIII). The sizes of age 2 and 3 parr in the Shubenacadie-Stewiacke River system compared favorably to the sizes of similarly age parr collected elsewhere. Age 2 parr ranged from 10.3 - 10.8 cm (Table VIII) and one age 3 parr measured 14.5 cm, in the Shubenacadie-Stewiacke River system.

In 1969, over 50 per cent of all salmon parr captured in the Shubenacadie-Stewiacke River system ranged between 7.0 - 8.9 cm; however, in 1968 parr between 8.0 - 10.9 cm (76.5 per cent) predominated in the Stewiacke River (Table VI).

Age 1 parr prevailed throughout the entire Shubenacadie-Stewiacke River system (Table VII) and age 3 parr were extremely scarce which indicates that the majority of salmon smolts are recruited from age 2 salmon parr.

##### Salmon smolts

The initiation of smolt runs in the streams examined (ie. Pembroke River and Rutherford Brook) appeared to be associated with a small freshet preceded by three larger spates

during May and rising water temperatures. Minor smolt movements were not consistently related to rising or decreasing water levels (Fig. 7). The occurrence of the major smolt emmigration on the same day (June 5) in both streams appears to be related to similar water temperature regimes and proportional fluctuations in water levels at both locations. The peak of the smolt run took place when average water temperatures at both locations were between  $13.0^{\circ}\text{C}$  and  $15.6^{\circ}\text{C}$  (Fig. 7).

Fabricius (1950) has discussed heterogeneous stimulus summation in the release of spawning activities in fish. His views on the summation of different stimuli in producing spawning might also be applicable to the release of the migratory urge in Atlantic salmon smolts. Various stimuli from freshets, light, water temperatures, etc. may have to be summed up to a critical threshold before smolts are induced to emmigrate. White (1939) found that the emmigration of smolts from a brook was related to increase in water temperatures and light intensity rather than to rain or rise in water level. The present findings suggest that stimulus summation related to rising water temperatures and decreasing water levels, preceded by several freshets induces smolts to migrate to the sea. Differential timing in the smolt migration of individual fish may possibly be attributable to differences in the threshold level required to release the migratory urge.

Pembroke River produced 1,596 smolts or 23.7 kg and Rutherford Brook produced 2,332 smolts or 42.9 kg (Table IX). Elson, (1962) estimated a smolt production of 5/100 sq. yds. of salmon nursery area in Pollett River. Using this production figure it is estimated that there are approximately 26,689  $\text{m}^2$  (46,640 yds.) in Rutherford Brook. In terms of biomass production this would mean that Pembroke River produced 8.5 kg of smolts/ha and Rutherford Brook produced 11.0 kg of

smolts/ha.

Age 2 smolts averaging 11.2 - 11.5 cm and 15.8 to 16.0 predominated in the smolt runs from both study streams (Table XII). Age 1 smolts were poorly represented in both streams and numbers of age 3 smolts ranged from 6.6 per cent in Pembroke River to 26.9 per cent of the total run from Rutherford Brook (Table XII).

The average smolt length for the rivers of Canada is 12.5 - 17.5 cm (5 - 7 inches) (Power, 1968). In the two study streams, average smolt lengths ranged from 11.2 - 12.2 cm which is slightly lower than the average sized smolt that migrates from most Canadian rivers.

Sex ratios of smolts in the study streams exceeded 75 per cent females (Table XIII). The higher proportion of females in these runs may afford very desirable recruitment, through egg deposition, to the Stewiacke River, if it is assumed that the mortality rates of both sexes are equivalent.

## Exploitation and Vital Statistics of Atlantic Salmon

The exploitation of different age and length groups of Atlantic salmon in the commercial and angling fisheries of the Shubenacadie-Stewiacke River system are quite different. Because of the selectivity of different mesh sizes in the commercial fishery the age and size composition of the catch is highly biased.

Grilse comprise only 5 per cent of the commercial catch (Table XVI) as compared to 48.5 per cent grilse in the

angling harvest (Carey, 1968). Age 5 salmon are exploited most frequently in the commercial fishery (Table XVI) whereas 3 year old fish (grilse)(Carey, 1968) contribute the greatest numbers to the angler. Age 4 salmon contributed the second greatest catch in both sport and commercial fisheries (Tables XVI and XVIII).

Salmon in the 50.0 - 59.9 cm (46.2 per cent) length range are taken most frequently in the angling catch (Table XVIII) whereas salmon in the 70.0 - 79.9 cm (62.7 per cent) are most frequently taken in the commercial fishery (Table XVI).

The commercial fishery harvests higher percentages of repeat spawners (60 per cent) and virgin salmon (35 per cent) (Table XVII) than anglers. Carey (1968) reports that 41.6 per cent of salmon angled in the Stewiacke River were repeat spawners and 10 per cent were virgin salmon.

The high proportion of repeat spawners captured in sport and commercial fisheries of the Shubenacadie-Stewiacke River system indicates that black salmon (spawned out salmon that overwinter in the river and migrate to the sea in the spring) can make the best contribution to both fisheries by allowing them to escape to the sea so that they can accentuate the potential egg deposition of first spawners the following year. In the Miramichi sport fishery, black salmon angling is permitted because few salmon (< 10 per cent) return to spawn again (Elson and Kerwill, 1955).

The commercial fishery for Atlantic salmon in the Shubenacadie River estuary is not large. Only 23 drift nets were licensed in the Shubenacadie River estuary in 1969. The Shubenacadie River lies in the Department of Fisheries and Forestry statistical district 42 which extends from and includes Avon River to Shubenacadie River. In this district, 2260 kg (4,980 lbs.) of salmon were taken in 1969. Using the statistics

of Table XVI it is estimated that the commercial fishery took 542 salmon in this district. Most of these fish were taken in the Shubenacadie River estuary since only 22.6 kg (50 lbs) were captured in 2 weirs (Avon River) and 5 drift nets (one in Cobequid Bay and four in Avon River) outside the Shubenacadie River estuary (Colin Wykes, personal communication).

As indicated by the percentages of grilse and salmon in the sport fishery (42.5 per cent and 57.5 per cent, respectively) (Table XVIII), the Shubenacadie-Stewiacke River is a grilse and salmon river with a somewhat larger proportion of salmon. According to Jones (1959) grilse form the predominant age group of salmon spawning in small streams. This phenomenon may account for the wide distribution and relatively high salmon fry densities encountered in small streams throughout the Shubenacadie-Stewiacke River system (Tables III and V).

The sizes of different sea aged salmon is considerably smaller for Shubenacadie-Stewiacke River salmon than those for other waters - sea age 2 salmon, 3.1 kg (present study); Restigouche River, 4.9 kg (Dymond, 1963); Grand Cascadepedia River, 5.3 kg (Dymond, 1963); Miramichi River, 4.5 kg (Dymond, 1963); east coast of Newfoundland including Labrador, 5.2 kg (Blair, 1943). Sea age 3 salmon in the Shubenacadie-Stewiacke River system averaged 3.9 kg (present study). In other waters, sea age 3 salmon were much heavier - Miramichi River, 8.8 kg (Dymond, 1963) age 3 and 3+ salmon combined; Grand Cascadepedia River, 10.7 kg (Dymond, 1963); east coast of Newfoundland including Labrador, 8.8 kg (Blair, 1943)..

Grilse averaged 1.5 kg and 53.5 cm in the Shubenacadie-Stewiacke River system (Table XVIII). Grilse from this system usually spend 2 years in freshwater. In the Miramichi River grilse captured in the commercial fishery averaged 1.6 kg and 53.1 cm (Kerr, 1961); however, these grilse usually spend 3 years in freshwater. Grilse captured in the commercial fishery

of the Shubenacadie-Stewiacke River had similar lengths and weights as those taken in the Miramichi commercial fishery (1.6 kg and 51.3 cm, Table XVI). Huntsman (1958) reported that grilse captured in the Shubenacadie River estuary averaged 2.3 kg and 60.0 cm.

Under existing policies no new salmon drift net licenses are permitted on the Shubenacadie-Stewiacke River system. The commercial fishery takes approximately 543~~0~~ kg (1200 lbs) (Dept. of fish, 1968) or 131 salmon in this system, annually. Commercial fishing for Atlantic salmon in Stewiacke River (the principle spawning and angling river on the Shubenacadie River system) was abolished in 1962. (Dept. of Fish, 1968). Since the commercial fishery is small and non-expanding, no new policies regulating the commercial fishery are recommended at the present time.

The sport fishery does not appear to be harming the spawning escapement to the system as indicated by the relatively high salmon fry and parr densities throughout the Shubenacadie-Stewiacke River system. Between 1962 and 1966 catches ranged from 53 to 288 salmon (grilse included) on the Stewiacke River and in 1967; 841 salmon were captured surpassing the salmon angling harvest of all Nova Scotian Rivers. Between 1963 and 1968 the angling catch of Atlantic salmon on the Shubenacadie River (excluding Stewiacke River) ranged from 5 to 178 salmon the low and high years being 1963 and 1967, respectively.

The value of the commercial fishery in the Shubenacadie-Stewiacke River basin is approximately \$10,500, annually. American shad, alewives, stripped bass, Atlantic salmon and American eels are taken in this fishery (Dept. of Fish, 1968).

Economic benefits of the sport fishery for Atlantic salmon have been studied. In New Brunswick the value per angled salmon is about \$25 (Grasberg, 1956) and in Quebec an angled salmon is worth about \$160 (Maheux, 1956). If we take

the smaller value and project it on the total angling harvest of the Shubenacadie-Stewiacke River system for the years 1966, 1967 and 1968, we find that the average worth of the angling fishery is \$14,450, being \$7,425 in 1966; 25,475 in 1967, and 10,450 in 1968. The average value of the angling harvest from the Stewiacke River alone during these years is \$12,442.

If the proposed Shubenacadie River causeway becomes reality, the drift net fishery in the Shubenacadie River estuary would be effectively destroyed. It is conceivable that the sport fishery for stripped bass and Atlantic salmon and the commercial fisheries for American shad, alewives, stripped bass and American eels would also suffer to some extent, the reasons being - (1) The constriction of the river's outflow would pose problems to the upstream and downstream migration of juvenile and/or adult Atlantic salmon, American shad, alewives, American smelt, stripped bass, American eels and sea run brook trout all of which spend part of their lives in freshwater. Kerswill (1960) doubts that fishways suitable for other anadromous species would pass American smelts. There is the problem of attracting salmonids (sea run brook trout and Atlantic salmon) to the outflow of such a fishway, although Gilson (1966) indicates that there are rivers on the rocky west coast of Scotland with a minimum of estuary, that have runs of salmon and sea trout (Salmo trutta) (2) The barrier may also adversely effect salmon smolts by delaying their downstream migration, making them available to predatory species, in the headpond for a longer time and/or by extinguishing their migratory urge as suggested by Pyefinch (1966). These projections do not hold exclusively for Atlantic salmon as lake or reservoir populations of alewives, sea lampreys and stripped bass have developed elsewhere, either from this cause or the selection of genetic mutations. The spawning area of stripped bass at the head of tide would also be lost (Dept. of Fish, 1968). (3)

Furthermore, the lack of tidal flushing would accentuate incoming organic and inorganic pollution in the headpond, from sewage outfalls, industries and runoff water tainted with agricultural fertilizers, insecticides and fungicides. The temperature regime in the headpond above the causeway would likely be quite different from precauseway days and compound the effects of accumulated organic pollution if undesireably high.

One last comment which does not directly concern the commercial or sport fisheries is the observation that interstitial sea water held temporarily in bottom deposits above the causeway would favor the growth of sulphate reducing bacteria and the formation of an 'evil-smelling' mud of the type common in estuaries (Gilson, 1966).

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APPENDICIES

APPENDIX I. Details concerning access to electrofishing stations on the Shubenacadie River system, 1968 and 1969.

Location and station number *	Details concerning access to station
Stewiacke River: 2 (6/A1)	Main river (mile 8). Reached by taking trail through hayfield on south side of river, approximately 1 mile above Stewiacke school.
4 (S/H2)	Little River, approximately 200 yards below bridge on Brookfield to Middle Stewiacke road.
11 (4/N1)	Rutherford Brook (mile 1) approximately 100 yards below bridge on the Middle Stewiacke to Upper Stewiacke Road. Approximately half way between bridge and confluence of Chapman Brook.
12 (4/N2)	Rutherford Brook (mile 5½) just below bridge crossing brook on the gravel road leading to the Camden and Harmony area.
13 (4/K2)	Otter Brook (mile 2) immediately above and under the bridge on the gravel road running along Otter Brook.
14 (4/C1)	Goshen Brook (mile 1½, approximately). First small trail leading to above (or south of) first bridge on Southvale to Middle Musquodobort Road.
17 (4/B1)	South Branch (mile 10) just below bridge on the road leading to the gravel pit, which leads off road from Meadowville to Lanesville.
20	Main river (mile 33 3/4). First road on the south side, above Upper Stewiacke bridge.
21 (3/A1)	Main river (mile 34½), second road on the south side, leading to the river above the Upper Stewiacke bridge.

- 23  
(3/B2)      Pembroke River (mile  $5\frac{1}{2}$ ) just below bridge on road leading to farm house, approximately 3 miles north of Stewiacke Crossroads on the road following the Pembroke River.
- 24  
(3/A2)      Main River (mile  $35\frac{1}{2}$ ), approximately 100 yards above confluence of Pembroke River; reached by road following the river on the south side.
- 30  
(2/A2)      Main River (mile  $44\frac{1}{2}$ ) approximately 100 yards above bridge crossing river three miles above Eastville.
- 31  
(1/A1)      Main River (mile  $49\frac{1}{2}$ ) just above junction of old woods road and the main river.
- St. Andrews River:
- 2      Main river (mile  $5\frac{3}{4}$ ) just above woods road crossing stream (no bridge) approximately 300 yards below town of Stewiacke pumping station.
- 5      Main river (mile  $12\frac{1}{2}$ ) on a sharp bend in the river at Lanesville.
- Gays River:
- 1      Main river (mile  $2\frac{1}{2}$ ) just above Big Pond Brook, by sharp curve in the river.
- Nine Mile River:
- 9      Main river (mile 17) approximately 100 yards above the bridge crossing river, just above or north of Green Valley tenting grounds.
- 10      Carrigan Brook, just below bridge crossing the brook on the Upper Rawdon to Beaver-bank road.
- Shubenacadie River:
- 1      Main river, immediately under and below the bridge crossing the river at Enfield on old number 2 highway.

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\* The numbers in brackets are used by Carey, 1968 and correspond to the new numbering system given in this report.

APPENDIX II. Data used in the study of the habitat and distribution of fishes in the Shubenacadie River system, 1968 and 1969.

Location	Station number	Date	Water temperature °C.	Basis for identification	Stream					Vegetation	Brook trout	Brown trout	fry Atlantic salmon parr	Lake chub	Creek chub	Northern redbelly dace	Common shiner	Golden shiner	Blacknose shiner	Yellow perch	White perch	Brown bullhead	White sucker	Alewife	American shad	Sea lamprey	American eel	Banded killifish	Three spine stickleback	Four spine stickleback	Nine spine stickleback
					Components	Substrate	Shade	Cover	Average width																						
Five Mile River:																															
Latties Brook	1	3/9/69	15°	S Run R.	C.P	G	F	-	N	x		x/x	x									x				x					
Burton Lake Run	2	3/9/69	10°	S E.P	M.C	G	G	-	A	x					x							x				x					
Greens Creek:																															
Greens Creek	1	3/9/69	15.6°	S Run R.	C.B	G	F	-	P	x		x/x	x	x								x				x					
Shortts Lake	2	7/8/69	22.2°	GN Lake	-	-	-	-	-							x		x	x	x	x	x									
Ryans Creek:																															
Rose Brook	1	3/9/69	18.°	S Run	M.C	G	F	-	A			x/x										x									
Rose Brook	2	3/9/69	17.8°	S Run	M.D	E	G	-	N	x		x/x	x	x								x						x			
MacPhee Brook	3	3/9/69	15.6°	S Run F.	C.B	G	G	-	C	x		o/x	x	x		x						x				x					
Ryans Brook	4	3/9/69	19.4°	S Run F.	C.F	G	F	-	C				x	x								x				x					
Spring Brook	5	3/9/69	13.9°	S Run F.	M.F	N	G	-	A	x																					
Stewiacke River:																															
Meadow Brook	1	3/9/69	15.°	S Run	M.C	G	F	-	A	x		o/x	x	x	x							x				x			x		
Main River	2	11/7/68	25.°	E Run R.	P.C	P	P	11.9	A			x/x	x			x									x	x		x			
" "	2	14/8/69	22.8°	E Run R.	P.C	P	P	12.8	A			x/x	x			x						x	x			x		x			
Field Brook	3	2/9/69	19.4°	S E.P	C.B	G	F	-	P			x/x	x									x				x					
Little River	4	16/7/68	24.°	E Run R.	P.C	N	P	5.8	P			x/x	x												x	x					
" "	4	10/9/68	13.9°	E "	"	N	P	5.8	P			x/x	x			x						x			x	x					
" "	4	15/8/69	20.6°	E "	"	N	P	5.9	P			x/x	x			x						x			x	x			x		



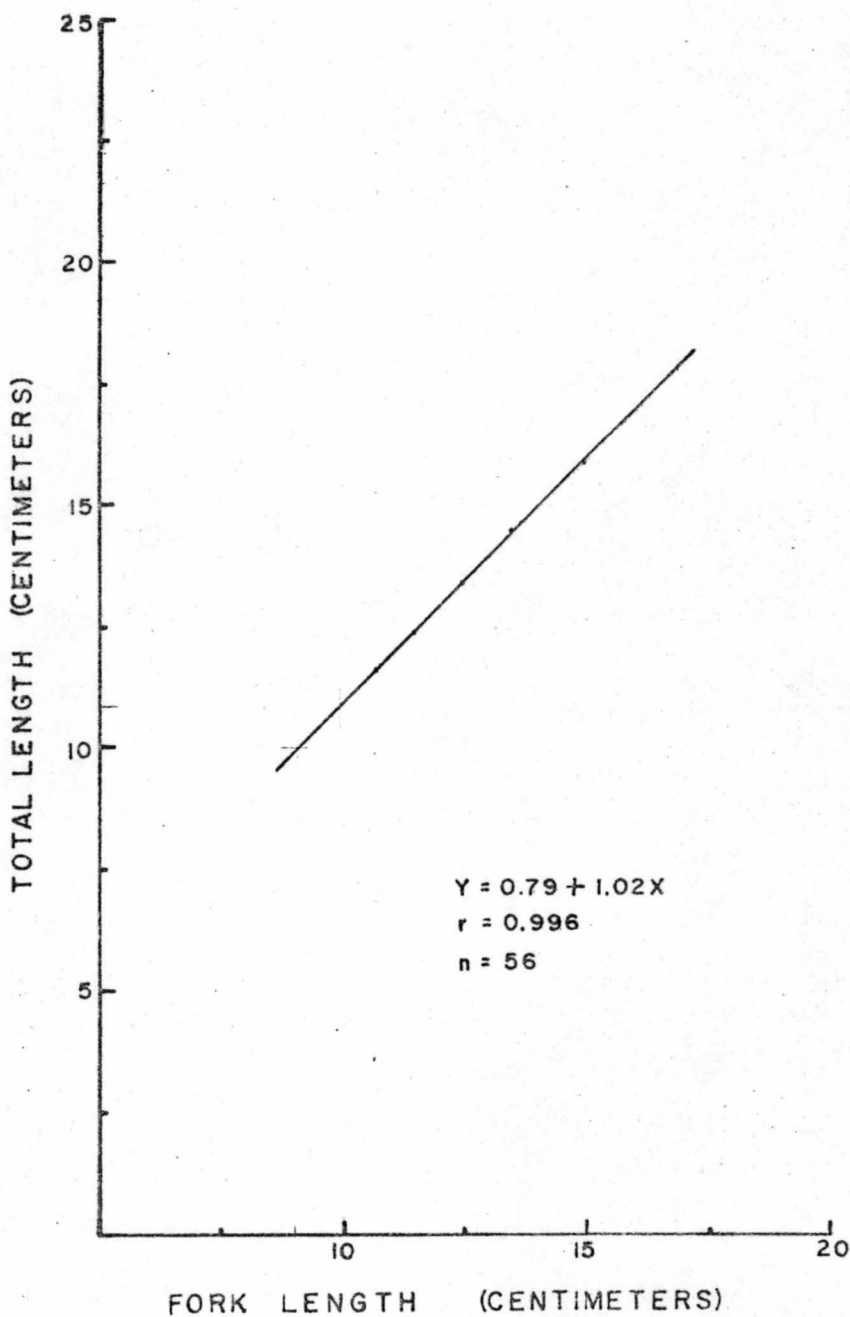






Location	Station number	Date	Water temperature °C.	Basis for identification	Stream					Vegetation	Brook trout	Brown trout	Fry Atlantic salmon parr	Lake chub	Creek chub	Northern redbelly dace	Common shiner	Golden shiner	Blacknose shiner	Yellow perch	White perch	Brown bullhead	White sucker	Alewife	American shad	Sea lamprey	American eel	Banded Killifish	Three spine stickleback	Four spine stickleback	Nine spine stickleback	
					Components	Substrate	Shade	Cover	Average width																							
(Nine Mile R.)																																
Meadow Brook	6	23/7/69		O																												
Three Cornered Lake	7	30/7/69	21.1	GN	Lake																	X										
McGrath Lake	8	5/8/69	21.7	GN	"												X					X										
Main River	9	21/8/69	20.	E	Run	P.C.	G	G	6.2	P		x/x	x		x									x	x	x						
Corrigan Brook	10	22/8/69	13.9	E	"	C.P.	G	G	3.5	C	x	x/x	x																			
Story Lake	11	7/3/69	24.4	GN	Lake																	X										
Cpt. MacPhee Br	12	4/9/69	16.1	S	Run	C.P.	E	G	2-3	C	x	x/x	x																			
Beaver Brook	1	26/8/69	18	S	F.R	M.C.	E	G	-	C	x		x	x																		
Shubenacadie River	1	27/8/69	18.5	E	Run	C.P.	F	G.	11.1	A		x/x																				
Bennery Brook (Ben Lake)	1	17/7/69	21.1	GN	Lake						x										x											
Uniacke Brook	1	27/8/69	15	S	F.R	M.C.	E	P	2-3	P	x		x																			

\* Basis for identification: S = Spot Check, E = electroseining, GN = Gill netting, T = Trapping, O = Observation  
Stream Components: R = Riffle, Run = run, P = Pool, F = Flat, Lake = Lake  
Stream Substrate: M = Mud, P = Pebble, C = Cobble, B = Boulder.  
Stream Shade: N = Nil, P = Poor, F = Fair, G = Good or Moderate, E = Excellent.  
Stream Cover: N = Nil, P = Poor, F = Fair, G = Good, E = Excellent.  
Vegetation: P = Poor, C = Common, A = Abundant, N = Nil.



APPENDIX III. The relationship of fork length to total length for Atlantic salmon smolts taken in Pembroke River and Rutherford Brook, Stewiacke River system, 1969.