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ATLANTIC SALMON AND ALEWIFE PASSAGE THROUGH A POOL AND WEIR FISHWAY ON THE MAGAGUADAVIC RIVER, NEW BRUNSWICK, DURING 1983

by

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ABSTRACT

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The 1983 Atlantic salmon (Salmo salar) run on the Magaguadavic River, New Brunswick, monitored at the St. George fishway, totaled 940 fish, 637 salmon and 303 grilse, nearly double the highest previous count three decades ago. Female salmon outnumbered males 3.3:1 while male grilse outnumbered females 2.5:1, with an overall ratio of 1.5:1 in favor of females. Repeat spawners comprised 14.3% of the run. Strays, marked by fin clips, accounted for 5.5% of the run. The bacterial pathogen Edwardsiella tarda was identified in 4 of 13 salmon mortalities necropsied. Eight rainbow trout Salmo gairdneri as well as several thousand alewives (Alosa pseudoharengus) also ascended the fishway. Downstream migrations of juvenile alewives through the fishway occurred in August and October coincidental to full moons.

The need for fishway repairs and modifications to improve fish condition and passage efficiency was identified.

RÉSUMÉ

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La remonte des saumons atlantiques (Salmo salar) dans la rivière Magaguadavic, au Nouveau-Brunswick, en 1983, observée à la passe migratoire de St. George, a été de 940 poissons: 637 saumons et 303 madeleineaux, soit presque le double du maximum enregistré il y a trois décennies. Les saumons femelles ont surpassé les mâles dans la proportion de 3,3:1, tandis que les madeleineaux mâles ont surpassé les femelles dans la proportion de 2,5:1, le rapport global étant de 1,5:1 en faveur des mâles. Les reproducteurs récidivistes constituaient 14,3% de la remonte. Pour les vagabonds, marqués par ablation des nageoires, ce pourcentage était de 5,5. On a identifié la bactérie pathogène Edwardsiella tarda chez 4 des 13 mortalités de saumons étudiées. Huit truites arc-en-ciel (Salmo gairdneri) ainsi que plusieurs milliers de gaspareaux (Alosa gaspareaux (Alosa pseudoharengus) ont également remonté la passe migratoire. La descente de jeunes gaspareaux dans cette même passe eut lieu en août et octobre, au moment de la pleine lune.

On attire l'attention sur le besoin de réparer et modifier la passe migratoire afin d'améliorer la condition des poissons et faciliter leur passage.

INTRODUCTION

Redevelopment of the Mount Pleasant tin mine to a tungsten mine and construction of an ore milling facility, approximately 40 km north of St. George, New Brunswick, were begun by Brunswick Tin Mines Ltd. in 1980. Pollution from a base metal mine on a tributary of the Northwest Miramichi River from 1960-63 caused estimated losses of 8-15% of the total stock of adult Atlantic salmon (Saunders and Sprague 1967). Potential detrimental effects of mining effluent to fish life within the Magaguadavic River watershed prompted biological studies and fish resource inventory of the system. The Magaguadavic River supports an anadromous run of Atlantic salmon; however, information concerning numbers and characteristics of the run is scarce. Counts of adults have not been made since 1954 (MacEachern 1954). Surveys conducted by the New Brunswick Department of Natural Resources on the Magaguadavic River drainage (Reid and Gaskin 1976) yielded an estimated potential of 3,000 adults. The average annual return through the fishway at St. George was thought to be approximately 500 fish (Hooper and Cronin 1980). Approximately two thirds of the available salmon spawning and nursery areas of the Magaguadavic River system are above the confluence of the Piskahegan River. Water from the Mount Pleasant Tungsten Mine tailings pond drains into Hatch Brook which in turn empties into the Piskahegan River (Fig. 1). Only the lower 2.4 km of the Piskahegan River is accessible to salmon due to a natural 5-m high falls. This report presents information and observations concerning the 1983 adult Atlantic salmon and alewife spawning runs ascending the Magaguadavic River.

STUDY AREA

The Magaguadavic River originates in Magaguadavic Lake in southwest New Brunswick and flows in a southeasterly direction for 80 km, emptying into the Bay of Fundy at St. George. Drainage area is 1,812 km^2 (Fig. 1). A log dam was constructed in 1903 at a rock gorge at the head of tide in St. George to provide a headpond for the St. George Pulp and Paper Mill. A fish ladder was constructed in 1928 (Fig. 2). According to local residents, the native Atlantic salmon stock was able to maintain itself by ascending a small dam bypass stream. In 1934, a concrete dam replaced the log structure. The St. George Pulp and Paper Mill ceased operation in 1967. The dam, however, is still maintained for water storage for generation of hydroelectric power. Generating capacity is 3,700 kw. Water storage dams are controlled on the outlets of Kedron, Mill, McDougall, and Digdeguash Lakes, major tributaries of the Magaguadavic River, as well as at the headwater, Magaguadavic Lake.

The Magaguadavic system is popular for sport fishing. The most sought-after species are brook trout Salvelinus fontinalis, sea-run and landlocked Atlantic salmon Salmo salar, and smallmouth bass Micropterus dolomieui. Sport-catch statistics and angler effort for Atlantic salmon on the Magaguadavic (Table 1) were determined from reports by field personnel of the Conservation and Protection Division of the Department of Fisheries and Oceans (Dunfield 1970-1976; Mitham and Bernard 1977, 1978; O'Neil and Bernard 1982, 1983; Smith and Bernard 1979; Swetnam and Bernard 1980, 1981). A limited sport dipnet fishery in the spring for two populations of landlocked smelt also occurs annually in Lake Utopia tributary streams. A small commercial fishery for silver eels Anguilla rostrata on their fall, seaward migration exists in the lower section of the river. The annual spring run of alewives is occasionally fished for lobster bait in tidal waters under special permit.

Fish ascending the Magaguadavic River must pass through the fishway at St. George. The fishway is a pool-weir type constructed of reinforced concrete. A series of 43 pools each 30.5 cm higher than the other provide access over the 13.4 m high dam. Two large resting pools are located at spaced intervals in the course of the fishway. At the upstream end, an exit hole approximately 1 m^2 in the face of the dam permits regulation of water flow in the fishway by raising or lowering a plate steel gate.

METHODS

Fish were trapped in the third pool from the top of the fishway. A 2.5 cm square mesh galvanized wire screen was installed in the weir between pools 2 and 3 to block upstream movement of fish. A funnel constructed of the same mesh was installed in the weir between pools 3 and 4. The funnel projected about 30 cm into pool 3 and reduced the weir opening to 17.5 cm to prevent downstream escapement of fish. Water flow through the fishway was interrupted each morning and afternoon, and on some days of heavy salmon passage in the evening also, by closing the control gate in the face of the dam. Although little water was flowing through the weirs, the pools remained full since their drains were plugged. Research personnel wearing chest-high waders entered the trap pool and captured fish with a dip net. Salmon were measured by sliding them into a wooden trough with a rubber covering on one end to help the fish remain calm. Fork and total lengths were recorded to the nearest millimeter while still maintaining the fish in the water. Salmon were categorized as being greater than, and grilse less than, 630 mm fork length. The trough containing the fish was then raised exposing the fish's back out of water. A sample of about 10 scales was taken between the dorsal fin and the lateral line. A 3.5 mm diameter hole was then punched in the upper lobe of the caudal fin. Sex was determined by examining kype development and belly shape. Scrapes, cuts, net marks, and other injuries as well as fin clips were also recorded. During September and October, salmon and grilse were tagged with orange FT1 cannula dart tags (Floy Tag Manufacturing Co.). Scale samples were later mounted on glass or acetate slides and aged with a dissection microscope. Fish were then released into the next pool upstream. When all fish in the trap had been sampled, the water control gate was reopened and the fish were free to move from the remaining two pools into the river. Water levels in the top two pools were maintained by stop logs in the upper weirs to about the same level as in the head pond. Turbulence was thereby reduced and gave the fish an opportunity to rest after handling. Also recorded in the daily trap record were numbers of each fish species, weather conditions, air temperature, water temperature, water level, and the time observations were made.

RESULTS

TRAP OPERATING PERIOD AND SALMON RUN DISTRIBUTION

The trap was operational from June 6, 1983, until November 21, 1983, with the exception of June 23-25 and June 28-July 6. Water temperatures and levels for this period are presented in Fig. 3. During the operational period, 637 salmon and 303 grilse entered the fishway. An additional 20 salmon are estimated to have passed through the fishway during the period the trap was out. The first salmon was caught in the fishway on June 20 and the first grilse on July 10. According to Fisheries Officers in St. George, salmon had been sighted jumping in the basin a few hundred meters downstream of the fishway since about June 1. The salmon run peaked during the last week of August when 42% of the total run ascended the fishway. The last salmon passed through the fishway on October 19. Numbers and sex of salmon and grilse ascending the fishway each week are presented in Fig. 4 and 5. A total of 10 postsmolts (smolt that had migrated to sea in the spring of 1983) ascended the fishway between August 2 and November 1.

Attempts to sex salmon yielded estimates of 447 (70%) females, 137 (22%) males, and 53 (8%) unknown. Female grilse numbered 81 (27%), males 206 (68%), and unknown sex 16 (5%). Salmon and grilse combined yielded 528 (56%) females, 343 (36%) males, and 69 (8%) unknown. Sex determination by external examination on early run fish was difficult; however, after mid August, kype development in males was quite pronounced. The salmon sex ratio after August 15 was 340 (81%) females to 82 (19%) males; grilse sex ratios were 67 (34%) female to 133 (66%) male; combined salmon and grilse sex ratio was 447 (65%) female to 225 (35%) male. Two of the 10 postsmolts were sacrificed to determine their sex and maturity by gonad examination and both were immature females.

LENGTH OF FISH

Mean fork lengths of Magaguadavic River salmon and grilse (Table 2) were 777.4 $\pm$ 43.3 mm and 548.4 $\pm$ 50.2 mm, respectively. Female salmon were larger than males, 797.6 $\pm$ 34.3 compared to 769.7 $\pm$ 58.6. Mean length of salmon of undetermined sex (8%) was 762.9 $\pm$ 46.6 mm. Female and male grilse had a mean length of 551.6 $\pm$ 45.3 mm and 550.7 $\pm$ 36.9 mm, respectively. Grilse of undetermined sex (5%) had a mean length of 529.9 $\pm$ 45.4 mm. Small salmon and grilse proved to be more difficult to sex than large ones. The 10 postsmolts had a mean length of 330.9 $\pm$ 60.0 mm.

AGE OF FISH

Smolt age of Magaguadavic River Atlantic salmon at emigration to the ocean was 1-yr (3-0.3%), 2-yr (747-81.6%), 3-yr (156-17.1%), and 4-yr (9-1.0%) (Table 3). Similar percentages of female and male salmon had emigrated as 2- and 3-yr smolts; 84% of the female and 83% of the male salmon originated from 2-yr smolts while 15% of the female and 16% of the male salmon originated from 3-yr smolts. A higher percentage of male than female grilse originated from 2-yr smolts, 81.5% vs 61.5%, respectively. (The percentage of male to female grilse from 3-yr smolts was 17 to 35.9%, respectively.)

A total of 134 (14.3%) salmon had spawned previously (Table 4). Two (0.2%) salmon had spawned twice before the 1983 spawning run. Repeat spawners comprised 93 females and 37 males and four of undetermined sex. Fifty-nine or 45% of all the repeat spawners spawned as a grilse while 75 or 55% spawned first as a 2-sea-winter salmon. No virgin 3-(or more) sea-winter salmon were found. Eighty percent of the repeat spawners had been 2-yr smolts and 20% 3-yr smolts. Repeat spawning salmon returned to spawn the following year with the exception of four individuals which remained at sea an extra year.

HATCHERY FISH

Although the Magaguadavic River has no record of being stocked with hatchery-raised salmon (J. R. Semple, DFO Salmon Enhancement Unit, pers. comm.), 52 fish (5.5%) of the 1983 Magaguadavic River Atlantic salmon run had clipped or eroded fins, indicating hatchery origin (Table 5). Of 30 marked salmon, 24 were adipose fin clipped (one of which also had a missing dorsal fin), and six had missing or eroded dorsal fins (one of which also had a pelvic fin clip and a short operculum). Of 21 marked grilse, 14 were adipose clipped, four were adipose clipped with eroded dorsals, two had eroded dorsals only, and one had a pelvic fin clip. One of the four grilse that had an adipose clip and eroded dorsal fin bore Carlin tag-type attachment scars. Six marked grilse were checked with a magnetic detector and three were discovered to be carrying micromagnetic nose tags and had been released from the North American Salmon Research Center in Chamcook. One postsmolt had an adipose fin clip and eroded dorsal fin.

OTHER FISH SPECIES

Information concerning fish species other than anadromous Atlantic salmon passing through the St. George fishway is shown in Table 6. Two landlocked Atlantic salmon, identifiable by scale growth patterns, and two brook trout ascended the fishway June 21. These fish were thought to have been flushed over the dam during the spring freshet. A single sea run brown trout ascended August 27. A total of eight rainbow trout ascended between September 8 and October 2.

Alewives were sighted breaking the water surface in the Magaguadavic Basin near the St. George wharf in late May; however, they did not enter the fishway until June 18. Alewives were so numerous in the fishway (thousands on June 23), that it was necessary to remove the screens and let them pass upstream uncounted. From June 25-28, the trap screens were in place; however, significant alewife mortality began to occur due to crowding so the screens were again removed until July 6 when most of the alewives had passed upstream.

Subsequent to the adult alewife upstream spawning run, two distinct downstream migrations of juvenile alewives occurred through the fishway. The first seaward emigration began August 22 when descending juvenile alewives clogged the fishway, and ended August 24. The second emigration began October 19 and continued until October 24. These emigrations began and ended abruptly. It is interesting to note that both emigrations centered around full moons which occurred on August 23 and October 21. Water temperatures during August 22-24

remained fairly steady at 23°C and water levels rose by 6 cm in the headpond during this period. Water temperatures during October 19-24 ranged between 11-12°C and water levels rose by 3 cm.

The first sighting of eels Anguilla rostrata was on July 13 when four of them (estimated 200-300 mm in length) were seen in the fishway. Various numbers and sizes of pigmented elvers and eels were observed daily in the fishway throughout most of the summer but accurate records were not kept.

CONDITION AND MORTALITIES OF ATLANTIC SALMON IN THE ST. GEORGE FISHWAY

Records were maintained for dead or injured Atlantic salmon. Fourteen dead salmon and one dead grilse were recovered above the trap pool and 21 dead salmon and two dead grilse were recovered from the fishway below the trap pool. Poaching was responsible for three to four mortalities as gaff or pitchfork wounds were identifiable. Two pitchforks were recovered from fishway pools by Fisheries Officers. Three salmon died after becoming jammed head first in pool-drain orifices that were eroded in the older lower section of the fishway. Four salmon suffocated after they jumped from the trapping pool and were unable to return to the water. Remedial action was taken to rectify these problems as soon as they were recognized. Pool drains were blocked and the trapping pool was modified to prevent fish from jumping out of it.

Thirteen dead salmon were necropsied and four of them were found to be infected with the bacterial fish pathogen Edwardsiella tarda (M. I. Campbell, DFO Fish Health Unit, pers. comm.). Campbell stated "the fact that the organism was found in the kidneys of the fish suggests that they were systemically infected and likely suffering from the effects of the organism." In stressful situations, particularly warm-water temperatures, Edwardsiellosis can contibute to fish mortality. During exceptionally low water conditions, which persisted throughout July and August of 1983 at the St. George fishway, the water temperature remained high at 21-24°C.

A total of 152 fish, (127 salmon and 25 grilse) were recorded as having injuries. Most injuries were in the form of abrasions with patches of scales and sometimes skin missing in the affected areas. A few salmon had severe lacerations on the sides of the caudal peduncle with patches of flesh exposed. Other forms of injury were identified as puncture wounds (probably from pitchforks or gaffs) found on four salmon and three grilse, and net marks identifiable on seven salmon and one grilse.

TAG RETURNS

Two tagged salmon angled in Lake Utopia in April 1984 were the only returns from 44 salmon and 21 grilse tagged in September 1983. There were no recaptures in the fishway of caudal fin-punched fish, indicating that recirculation of fish that had ascended the fishway did not occur.

DISCUSSION

The anadromous Atlantic salmon run on the Magaguadavic River in 1983 was considerably larger than previous counts, 940 compared to the 1952, 1953, and 1954 counts of 267, 58 and 580, respectively. This increase is possibly attributable to removal of the Flume Ridge Dam which was considered to be a partial obstruction to approximately one-third of the available spawning and nursery areas (MacEachern 1954). The Magaguadavic River salmon population is considered to be a late run stock as salmon usually start entering the fishway in late June (G. Eldridge, DFO Conservation and Protection, St. George, pers. comm.) and has peak runs during July and August (Kerswill 1960).

The ratio of salmon to grilse is 2.1:1 and is a desirable characteristic for managers and users of Atlantic salmon stocks. Kerswill (1960) stated that, in Charlotte County waters, no commercial gear is set especially for salmon but some are taken incidentally in the herring weirs. The lack of a gillnet fishery, which selects salmon over grilse due to mesh sizes commonly used, could help account for the larger ratio of salmon to grilse. Gillnet encounters of Magaguadavic salmon in the marine environment appear to be minimal as <1% were recorded as having net marks.

Evidence related to poaching activities in the fishway, in spite of surveillance by Fisheries Officers, suggests that poaching success could be reduced by screening over the two resting pools with wire mesh. Salmon tend to congregate in these two pools of reduced turbulence where they are more visible and susceptible to poaching.

Upgrading of the older lower section of the fishway with particular emphasis on resurfacing pools and weirs and repairing drain orifices should help reduce abrasion injuries. Salmon and grilse were at times reluctant to leave the uppermost pool via the 1 m^2 exit opening in the face of the dam guarded by a trash rack of vertical steel bars spaced about 20 cm apart. Fish which remained a day or two were manually introduced into the headpond. Reluctance to pass through the upper exit may have been influenced by warm river water temperatures, fatigue from handling, the presence of bars over the exit or light avoidance since the upper pools are always shaded because they are located under the dam service access. A continuation of the pool and weir design into the headpond may increase fish passage efficiency. Fisheries Officers in St. George commented on salmon reluctance to leave the uppermost pools in past years and they occasionally had to be dipnetted out and placed in the headpond.

Ewardsiellosis has long been considered a disease of warm-water fishes such as catfish reared in southern USA. In 1981, it was identified in Chinook salmon in the Rogue River, Oregon, and, in 1982, it was identified in brook trout held in the heated thermal power effluent at Minto, New Brunswick. Atlantic salmon parr held in the same thermal power effluent were also found to be carrying the disease (M. I. Campbell, DFO Fish Health Unit, pers. comm.). Although only four of the 13 salmon mortalities examined by the Fish Health Unit were systemically infected, it is possible that Edwardsiellosis had a significant impact on Magaguadavic River salmon. Power station crews at St. George Pulp and Paper reported seeing dead salmon in the river below the fishway and in the headpond, generally on the screens of the turbine intakes but accurate estimates were not obtainable.

The 52 fin-clipped salmon, which were almost certainly of hatchery origin, were possibly strays from stocking in other river systems, escapees from aquaculture operations (sometimes marked by fin clipping), and strays from sea ranching-genetics experiments at the North American Salmon Research Center (NASRC).

Three grilse which carried micromagnetic nose tags were returned alive to NASRC from where they had been released as smolts. Large numbers of hatchery-reared smolt are released annually in the St. John River and, in recent years, releases of hatchery-reared smolts have been made in the St. Croix River as part of an Atlantic salmon restoration program. These estuaries are 75 and 25 km, respectively, from the Magaguadavic River. Development of the aquaculture industry in the Fundy Isles region is also considered a source for stray Atlantic salmon. It is estimated that in the fall of 1983 over 20,000 postsmolts and market-sized salmon escaped when sea pens in the Fundy Isles region were damaged by storms and seals. Salmon runs in 1984 and 1985, particularly in tributaries to Passamaquoddy Bay, may benefit from these 1983 escapees. Selection of these fish has been toward late-run, 2-sea-yr salmon (E. Henderson, pers. comm.).

The 14.3% repeat spawner component of the Magaguadavic salmon run is substantial not only in numbers but also includes most of the largest fish. Besides being highly desirable by fishermen, larger salmon are also more fecund than smaller ones. Some measures could be taken to improve the number of repeat spawners. Considerable numbers of Atlantic salmon kelts are angled each spring as landlocked salmon which are also present in the Magaguadavic system. Creel limits in 1983 for landlocks were 5/day open to a wide range of tackle while kelt limits were 1/day with a 10 tag-season limit by fly fishing only. Positive identification between kelts and landlock salmon is by microscopic examination of scales by trained personnel. Landlock salmon are usually in the lakes and seldom in the river and are generally smaller than sea-run fish. Incorporation of a maximum size limit for landlocked salmon in the Magaguadavic River would provide an effective means for controlling this problem. Power-station crews also report many kelts in the St. George headpond, particulary in the "old mill pond" area each spring that they believe experience difficulty in finding downstream passage. Many eventually die and collect on the trash rack of the turbine intake.

Alewives were sighted in the basin a few hundred meters below the St. George fishway in mid May; however, the first alewives did not ascend the fishway until June 18. High spring runoff water levels spilling over the dam flooded the lower section of the fishway. When water levels receded sufficiently, water flowing from the fishway attracted fish into it. Dominy (1971) reported that the tailrace water levels at a dam on the Gaspereau River, Nova Scotia, had a greater influence on the seasonal timing of alewife movement through an adjacent pool and weir fishway than did temperature. Temperatures at which alewives began to enter fresh water determined by Richus (1974) for a Rhode Island river were found to be 7.4 and 6.0°C in two successive years. Peak adult alewife upstream spawning migrations for North Carolina and Rhode Island rivers occurred at 12.9-13.1°C (Tyus 1974) and 14-15.5°C (Richus 1974), respectively. Cooper (1961) (in Richus 1974) found a cessation of alewife spawning migration when water temperatures exceed 21°C. Water temperatures on June 18 in the St. George fishway had a minimum and maximum of 18.5 and 21°C, respectively. It seems apparent that alewife spawning migration was delayed by high-water levels. The solution suggested by Dominy (1971) of providing a second weir opening at a different level for high tailrace water levels on a pool and weir fishway on the Gaspereau River might also enable earlier ascent of fish in the St. George fishway.

Downstream emigrations of juvenile alewives were remarkable for their abrupt beginning and ending and coincidence with full moons. No explanation can be given for the fact that emigrations occurred at full moons in August and October but not in September. Cooper (1961) and Kissil (1974) (in Richus 1975) noted that seaward movement of juveniles normally accompanied heavy water outflow, usually following precipitation and Richus found similar results in his own study in conjunction with abrupt water temperature declines. However, Richus (1975) also stated that peaks of fish movement did not follow every occurrence of these factors, and the magnitude of these factors did not influence the magnitude of the migration. It is interesting to note that fishway staff visually distinguished and noted two size-classes of juvenile alewives, one group nearly twice the size of the other. Richus (1975) also reported the presence of bimodal length-frequency distributions in his study. His explanation for this phenomenon was the differences in food availability of the two main nursery "ponds" of the study river and corresponding growth differences. A similar situation may exist with Magaguadavic River alewives; however, an alternative explanation for the two size-classes might be the presence of Alosa pseudoharengus and Alosa aestivalis, both common in the area, and collectively referred to as alewives. No! Further investigation of alewife biology in the Magaguadavic River and the influence of lunar cycles on juvenile migrations is warranted to enable scheduling of fishway and generator repairs so as not to interfere with fish runs.

SUMMARY AND CONCLUSIONS

Observations of fish passage activities at the St. George fishway on the Magaguadavic River June 6-November 21, 1983, suggest that:

1. Earlier spring upstream migration of alewives and salmon would occur if improvements for locating attraction water during high-water periods could be made;

2. Improvements for downstream fish passage should be investigated as a means of enhancing both salmon and alewife runs;

3. Injury to Atlantic salmon ascending the fishway could be reduced by repairing or rebuilding parts of the existing facility;

4. Protective screening of the two fishway resting pools would reduce mortality from poaching in the fishway;

5. Research on the alewife run may add to knowledge of their biology as well as provide potential fishery resource information;

6. The Magaguadavic River Atlantic salmon sport fishing resource appears underutilized. Distribution of information concerning numbers and ratio of salmon versus grilse in the Magaguadavic might attract anglers and relieve high angling pressure on other rivers;

7. Monitoring in 1984 may indicate the fate and contribution of accidental aquaculture releases of both Atlantic salmon and rainbow trout;

8. Monitoring in 1984 for the recurrence of Edwardsiella tarda and its impact on Magaguadavic River salmon should be conducted.

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Table 1. Magaguadavic River Atlantic salmon sport catch statistics, 1970-83. (Dash indicates data not available; brackets indicate numbers obtained by occasional riverbank interviews and telephone survey of well-known anglers.)

Year	Grilse	Salmon	Total	Rod days
1970	5	5	10	-
1971	20	13	33	-
1972	5	16	21	-
1973	5	5	10	-
1974	1	5	6	-
1975	39	28	67	353
1976	25	12	37	200
1977	63	45	108	575
1978	3	4	7	60
1979	21	24	45	316
1980	13	23	36	247
1981	-	-	-	-
1982	-	-	-	-
1983	6 (18)	6 (10)	12 (28)	35

Table 2. Mean lengths and standard deviations (mm) of Magaguadavic River Atlantic salmon. Brackets indicate number of fish.

	♂ $\bar{X}$ S.D.	♀ $\bar{X}$ S.D.	Undetermined $\bar{X}$ S.D.	Combined $\bar{X}$ S.D.
Salmon	769.7 ± 58.6 (137)	797.6 ± 34.3 (447)	762.9 ± 46.6 (53)	777.4 ± 43.3 (637)
Grilse	550.7 ± 36.9 (206)	551.6 ± 45.3 (81)	529.9 ± 45.4 (16)	548.4 ± 50.2 (303)
Postsmolt		359.0 ± 50.9 (2) imm.		330.9 ± 60.0 (10)

Table 3. Smolt age composition expressed as percentage (numbers of fish in brackets) of male and female salmon and grilse.

	Age composition (%)			
	1	2	3	4
Salmon ♂	0	82.9 (116)	16.4 (23)	0.7 (1)
♀	0.2 (1)	84.1 (355)	15.2 (64)	0.5 (2)
Sexes combined	0.2 (1)	83.8 (471)	15.5 (87)	0.5 (3)
Grilse ♂	0	81.5 (163)	17 (34)	1.5 (3)
♀	0	61.5 (48)	35.9 (28)	2.6 (2)
Sexes combined	0	75.9 (211)	22.3 (62)	1.8 (5)

Table 4. Sex and sea-winter age of repeat spawners.

Sex	Sea-winter age at 1st spawning	No. having previously spawned Once	Twice
♂	1	33	-
♂	2	4	-
♀	1	22	-
♀	2	69	2

Table 5. Fins clipped or missing indicating fish of hatchery origin.

	Adipose clip	Missing dorsal	Adipose clip & missing dorsal	Pelvic clip
Salmon	23	6 (1 also had pelvic clip)	1	-
Grilse	14	2	4 (1 Carlin tag scar) (3 nose tagged NASRC)	1
Postsmolt	-	-	1	-

Table 6. Species other than anadromous Atlantic salmon ascending fishway.

Species	Number	Length (mm) $\bar{X}$	S.D.	Date
Landlocked Atlantic salmon	2	395	± 14.1	June 21
Brook trout	2	~200		June 21
Brown trout	1	480		Aug. 27
Rainbow trout	8	282	± 56.9	Sept. 8-Oct. 2
Alewives (adults)	? x 10^4	-		June 18-mid July
(juvenile)	? x 10^5	-		Aug. 22-24, Oct. 19-24
American eel	? x 10^3	-		July 13-Oct.

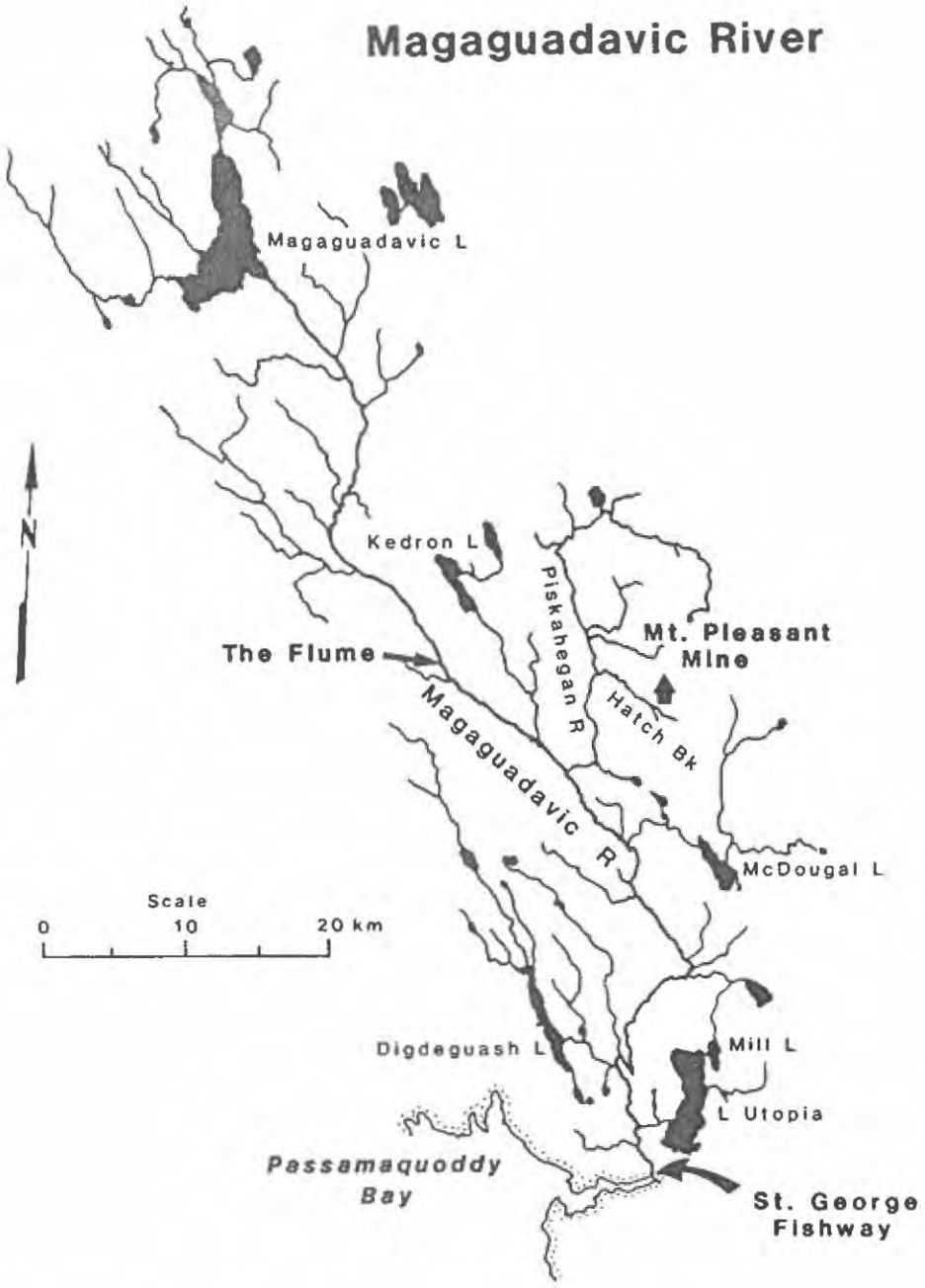

Fig. 1. Magaguadavic River (drainage area 1812 km^2).

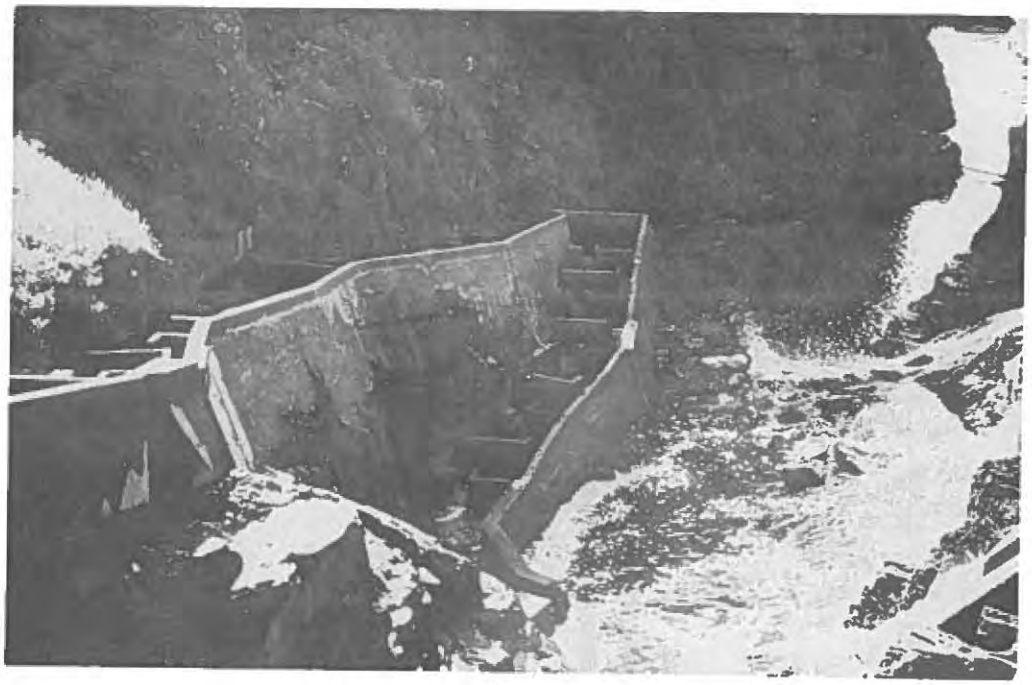

Fig. 2. Fishway on Magaguadavic River at St. George.

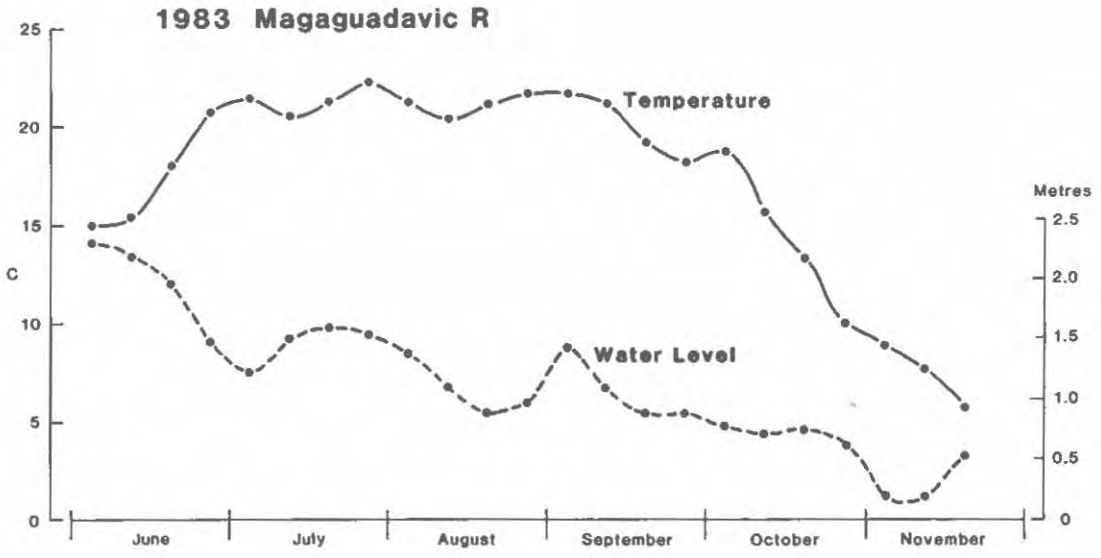

Fig. 3. Magaguadavic River water temperatures and levels during the 1983 fish trapping period.

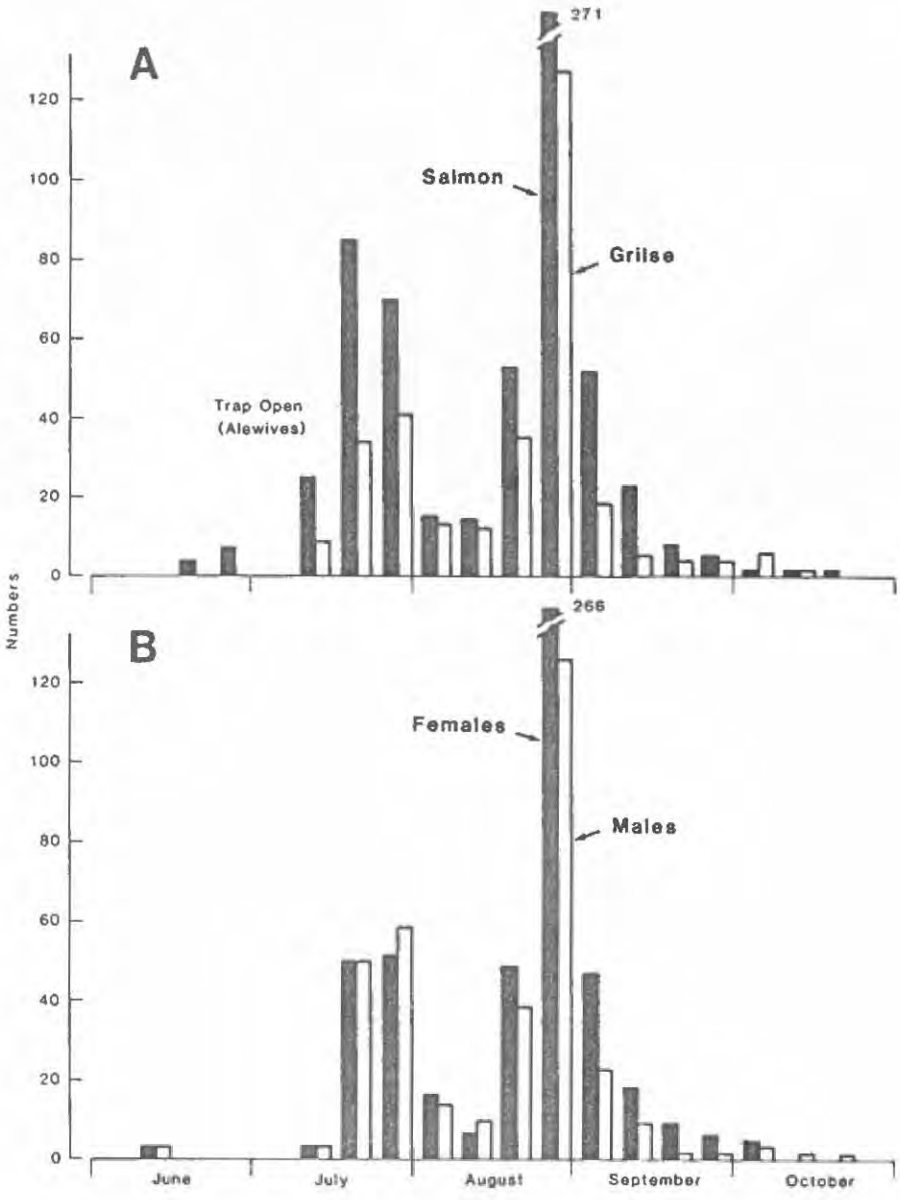

Fig. 4. A. Weekly numbers of salmon and grilse ascending the Magaguadavic River fishway, June-October, 1983.

B. Weekly numbers of female and male salmon and grilse ascending the Magaguadavic River fishway, June-October, 1983.

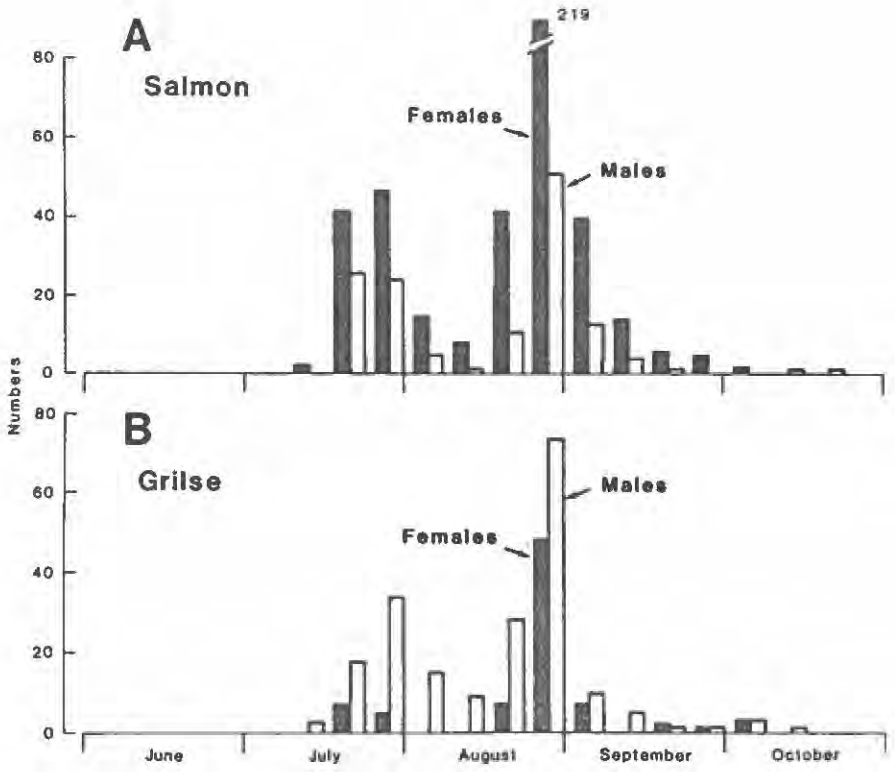

Fig. 5. A. Weekly numbers of female and male salmon ascending the Magaguadavic River fishway, June-October, 1983.

B. Weekly numbers of female and male grilse ascending the Magaguadavic River fishway, June-October, 1983.