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Status of Atlantic salmon in Salmon Fishing Areas 22 and 23 for 1995, with emphasis on inner Bay of Fundy stocks.

by

Peter G. Amiro and Eric M. Jefferson
Science Branch
Department of Fisheries and Oceans
P.O.Box 550
Halifax, N.S.
amirop@gfc.dfo.ca

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Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

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Abstract

Assessment of the status of Atlantic salmon(Salmo salar) stocks of Salmon Fishing Area (SFA) 22, the Bay of Fundy area of Nova Scotia and those of SFA 23 east of the Saint John River, known as inner Bay of Fundy, indicated that escapements of salmon to 5 assessed rivers were less than conservation requirements. All harvest and hook-and-release fisheries have been closed since 1991. Aquaculture origin salmon were recorded at a monitoring fence in the Stewiacke River and because the native salmon population remained low in 1995, aquaculture escapees may have contributed 49.1% of the egg deposition in 1995. Stewiacke River parr densities remain low at 3.90 age-0+, 6.49 age-1+ and 1.67 age-2+ parr 10^{-2} m^2. Escapements to the Petiticodiac River remained low in 1995 and although use of the fishway by salmon remains uncertain, wild parr were not detected in 5 spot check electrofishing sites. Observations and counts of salmon in Point Wolfe and Alma rivers were again low in 1995. Escapements to the Big Salmon River (BSR) were augmented for the second year with BSR-origin salmon grown in sea-cages and released into the river as mature adults. Mean density of age-0+ parr (fry) parr of five sites electrofished in 1995 in the BSR was 21.8 fry 10^{-2} m^2 and 6.44 age-1+ parr 10^{-2} m^2. Densities of 42.78 and 31.58 fry 10^{-2} m^2 at two sites in the BSR, proximate to 1994 releases of cage-reared adult salmon, were higher than the three other index sites. Gaspereau River, a river containing two-sea-winter salmon atypical of inner Bay of Fundy and highly impacted by hydroelectric development, was assessed in 1995. Only 39% of the egg deposition requirement for the area below Lanes' Mills not including Trout River was attained in 1995. Periodic episodic incidence of low marine survival is suggested as the reason for low returns to inner Bay of Fundy rivers in 1995 and since 1990.

Résumé

L'évaluation de l'état des stocks de saumon de l'Atlantique (Salmo salar) de la zone de pêche du saumon (ZPS) 22, la partie de la baie de Fundy de la Nouvelle-Écosse, et de la ZPS 23, à l'est de la rivière Saint-Jean dans le fond de la baie, montre que les échappées de saumons de 5 rivières examinées ont été inférieures aux besoins de conservation. Toutes les pêches, y compris celle par capture et remise à l'eau, sont fermées depuis 1991. Des saumons d'élevage ont été décelés à une barrière de dénombrement de la rivière Stewiacke et comme l'effectif des populations indigènes est demeuré faible en 1995, les poissons de pisciculture ont pu être à l'origine de jusqu'à 49,1 % de la ponte en 1995. La densité des tacons de la Stewiacke est demeurée faible à raison de 3,90 d'âge 0+, 6,49 d'âge 1+ et 1,67 d'âge 2+ tacons 10^{-2} par m^2. Les échappées de la rivière Peticodiac sont demeurées faibles en 1995 et, bien que l'utilisation de la passe à poissons par les saumons demeure incertaine, des tacons d'origine sauvage n'ont pas été décelés au cours de 5 essais ponctuels de pêche électrique. Les observations et les dénombrements de saumons réalisés dans les rivières Point Wolfe et Alma ont donné de faibles résultats en 1995. Les échappées de la rivière Big Salmon ont été augmentées pour la deuxième année par des saumons de la Big Salmon élevés en cages de mer et libérés dans la rivière à l'état adulte. La densité moyenne des tacons d'âge 0+ (alevins) à cinq points de pêche électrique dans la Big Salmon en 1995 s'élevait à 21,8 alevins 10^{-2} par m^2 tandis que celle des tacons d'âge 1+ était de 6,44 tacons 10^{-2} par m^2. Les densités de 42,78 et de 31,58 alevins 10^2 par m^2 notées en deux sites de la Big Salmon, dans les environs des mises à l'eau de 1994 d'adultes élevés en cages, étaient supérieures à celles notées aux trois autres sites. La rivière Gaspereau, qui abrite des saumons dibermarins non typiques du fond de la baie de Fundy et qui a fortement été altérée par un développement hydroélectrique, a aussi été évaluée en 1995. Un pourcentage de seulement 39% de la ponte nécessaire en aval de Lanes'Mills, à l'exception de la rivière Trout, a été atteint en 1995. Il semble que des épisodes de faible survie en mer expliquent le peu d'importance des remontées des rivières du fond de la baie de Fundy notées tant en 1995 que depuis 1990.

Summary Sheet

STOCK: Stewiacke River (SFA 22)
TARGET: 3.1 million eggs (1061 salmon of all ages)

Year	1990	1991	1992	1993	1994	1995	MIN[1]	MAX[1]	Mean[1]
First Peoples harvest									
In-river									
Angling catch									
Small	0	0	0	0	0	0	-	-	-
Large	0	0	0	0	0	0	-	-	-
Broodstock (small + large)	18	13	12	30	14	0	0	30	15
Counts at fence									
Small			37	178	211	uk	37	211	107
Large			119	47	10	uk	10	119	44
Efficiency of the fence (%)				65	55	uk	55	100	73
Population estimate (small + large)				240	409	uk	221	409	218
% Hatchery origin in the returns				1	4	uk	1	14	5
% of Adults required				23	39	uk	21	39	21
Average juvenile densities (# per 100m^2)									
# of sites	31	34	37	35	34	30	30	37	34
Age 0+	18.70	8.35	14.91	1.28	9.74	3.90	1.28	18.70	9.48
Age 1+	19.75	12.27	15.03	12.65	2.89	6.49	2.89	19.75	11.51
Age 2+	3.31	4.08	1.96	2.52	3.68	1.67	1.67	4.08	2.87

[1] 1990-95 data.

Harvests: The angling fishery has been closed since 1990.

Research data and assessment: Juvenile salmon are sampled by electrofishing and adult returns are enumerated at a counting fence located at the head of tidal influence. Fence data for 1995 are incomplete. Seven of twenty-one fish sampled were aquaculture escapees.

State of the stock: Stewiacke River and Big Salmon River are indices of for inner Bay of Fundy rivers. Stewiacke River parr densities and counts of adult salmon by electrofishing boat together with Big Salmon River counts of adult salmon indicate that rivers of the inner Bay of Fundy continue to be under escaped. Densities of juvenile salmon in Big Salmon River may no-longer accurately indicate the status of stocks because of the input from cage-reared adult releases and documentation of successful spawning and hatching.

Introduction

This document reviews the status in 1995 of inner Bay of Fundy Atlantic salmon (*Salmo salar*) stocks of Big Salmon River, Petitcodiac River, Point Wolfe River and Alma River, of Salmon Fishing Area (SFA) 23, New Brunswick and the Stewiacke River, Nova Scotia. The Gaspereau River, Nova Scotia, SFA 22, a non-inner Bay of Fundy stock type was also assessed. Salmon Fishing Area 22 consists of twenty eight rivers in Nova Scotia (Fig. 1.) and rivers east of the Saint John River, New Brunswick, which have stock characteristics more similar to inner Bay of Fundy Rivers than outer Bay of Fundy Rivers. Salmon of inner Bay of Fundy have a high proportion of the stock that recruit back to the rivers after only one winter at sea, probably do not migrate to the North Atlantic Ocean, have high survival between recruit and repeat spawning and usually enter rivers in the fall of the year (Amiro MS 1987). Important exceptions are the Annapolis and Gaspereau rivers in N.S. which have distant migrating, early river-entry two sea-winter recruits. The Big Salmon River, New Brunswick, has most of the characteristics of inner Bay of Fundy stocks but with earlier (June and July) river-entery.

Atlantic salmon assessments for the inner Bay of Fundy stocks in 1994 were reported by Amiro and Longard (MS 1995). Salmon were counted for the first time in 1995 through the White Rock Dam Fishway on the Gaspereau River, Kings County, Nova Scotia. The inner Bay of Fundy salmon stock has been in decline since 1989 and has historically shown periods of low abundance and recovery (Huntsman 1958).

In 1989 all salmon fisheries on rivers of the inner Bay of Fundy were closed until in-season assessments indicated conservation requirements on the Big slamon River and/or Stewiacke River were met. Not since 1990, in the Big Salmon River, have in-season forecasts indicated that conservation requirements would be met. All rivers of SFA 22 and rivers north of the Saint John River in SFA 23 have remained closed to all fishing since 1991.

Assessment Methodology

Biological characteristics necessary to estimate required conservation requirements for the Stewiacke and Big Salmon rivers were developed from sampling 3,290 salmon at a fence in the Big Salmon River, 1965-1973. Biological characteristics for the Stewiacke River were derived from 238 salmon sampled in the angling fishery of 1983, and 38 salmon sampled by boat electrofishing in 1983, (Amiro and McNeill MS 1986). Sea-age distribution of adult salmon for inner Bay of fundy rivers was assumed to be best represented by the Big Salmon River data and therefore that data was used to derive adult salmon requirements for conservation. Salmon habitat area was obtained by remote sensing techniques (Amiro 1993) and only stream areas greater than 0.12% stream-grade (map measured) were used to estimate salmon production area. Fecundity-length relationships were established for the Stewiacke (Amiro and McNeill MS 1986) and for the Big Salmon River ($Eggs=646.16e^{(0.0299 \cdot Fork\ length)}$, G. Farmer, pers. comm.)[1] An egg deposition rate of 2.4 eggs m^{-2} (Elson 1957, 1975, Anon. MS 1991) was used in conjunction with the biological characteristics to derive the required number of spawners.

Stewiacke River stock is assessed; using counts and caudal fin punches applied at a salmon trapping facility located at the head of tidal influence in 1992 to 1994; using an electrofishing boat operated above the salmon trapping facility to capture adult salmon in 1988 to 1993 and in 1995; using the count of smolts at a counting fence located 2.573 km up the Little River, a tributary, 7.570 km above the approximate head of tide, 1990 to 1995; by electrofishing of juvenile salmon at 27 to 44 mark-and-recapture sites throughout the Stewiacke River system, 1984 to 1995.

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[1] Dr. G. Farmer, Diadromous Fish Division, PO Box 550, Halifax, N.S., B3J 2S7.

Big Salmon River salmon stock was assessed using stream-side counts of salmon conducted by the New Brunswick Department of Natural Resources and Energy personnel (T. Pettigrew, pers. comm)[2]; and by removal electrofishing in five sites in the Big Salmon River.

Five electrofishing spot checks in the Petiticodiac River were conducted on September 15, 1995.

The Point Wolfe and Alma (Upper Salmon) rivers, wholly or partially within Fundy National Park, New Brunswick, are assessed by Parks Canada staff (D. Clay)[3].

Salmon were counted in a trap in the fishway at the Petitcodiac River Causeway by the New Brunswick Wildlife Federation under the direction of Mr. Garry Griffin. Salmon may also pass undetected upstream through a notch in the stop-log structure in the gates during most high tides. Spot-check electrofishing for juvenile salmon was conducted by DFO staff and Mr. G. Griffin.

Salmon were counted in a trap located in the White Rock Fishway, 2.969 km above the head-of-tide, on the Gaspereau River by the Kings County Wildlife Association. Electrofishing in the Gaspereau drainage was conducted by DFO seasonal personnel. Scale samples, gender and lengths-at-age were obtained from broodstock collected at the fishway. In the absence of a stock-specific length-fecundity curve for the Gaspereau River, the LaHave River length-fecundity curve (Eggs = $446.54 * e^{(0.0362 * \text{Fork length})}$, Cutting et al. MS 1987) was used. The LaHave length-fecundity curve was used because the stock characteristics of Gaspereau River salmon (one and two sea-winter recruits with a low incidence of repeat spawning fish) are more similar to those of the LaHave River salmon than the Stewiacke River salmon stock.

Estimates of juvenile salmon habitat for the Gaspereau River were obtained by remote sensing and from a proximate survey conducted by Mr. B. Sabean in 1978 (pers. comm.)[4] These data were used to derive a conservation spawning requirement for the accessible and utilizable juvenile salmon production area of the Gaspereau River.

Conservation Objectives

Conservation of Atlantic salmon stocks is assessed by comparing estimates of the escapement of all salmon (or egg deposition) past fisheries to the number of salmon (or eggs) required to produce juvenile and adult salmon at a level expected to maximize production of the largest fish within the capabilities of the different rivers and stocks (Anon. MS 1986). This conservation requirement is known as the conservation objective and, in addition to maximizing production, satisfies the World Conservation Strategy produced by the United Nations Environment Program in that the ecological process, genetic diversity and fullest sustainable advantage is maintained (Anon. MS 1991). Thus in addition to the egg deposition objective, proportions of multi-sea-age salmon are sometimes also set and, therefore, numbers of grilse (one-sea winter) and salmon (multi-sea-winter) are stated in some target conservation requirements. In the absence of river or stock specific data to estimate production parameters a value of 2.4 eggs m^{-2}, determined to maximize production and yield in several Maritime salmon streams (Anon. MS 1991), is used to derive the conservation requirement.

Stewiacke River

Atlantic salmon conservation requirement for Stewiacke River was estimated at 1,061 salmon (of all ages) by Amiro MS (1990) and includes 772 recruit-grilse (fist time one-sea-winter spawner). Because of the complexity of the repeat spawning component, Marshall et al. MS (1992) rounded the small salmon requirement to 800 and the large salmon component to 300. Management is currently based on a conservation requirement of 1,100 salmon.

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[2] Mr. T. Pettigrew, New Brunswick Department of Natural Resources and Energy, Hampton, N.B., B0A 1B0.

[3] Dr. D. Clay Fundy National Park, PO Box 40, Alma, New Brunswick, E0A 1B0.

[4] Mr. B. Sabean, Nova Scotia Department of Natural Resources, Kentville, N.S. B4N 4E5

Big Salmon River

The Big Salmon River salmon stock is similar to that of the Stewiacke River (Amiro and McNeill MS 1986, and Amiro MS 1987). The conservation requirement totals 700 salmon comprised of 280 one-sea winter and 420 multi-sea winter fish of which the majority are repeat-spawning grilse (Marshall et al. MS 1992).

Petitcodiac River

A conservation requirement for the Petitcodiac River was estimated (Semple unpublished MS, 1984) at 1,688 grilse and 101 salmon for 2,815,000 m^2 of habitat measured using the techniques of the Department of Natural Resources and Energy, New Brunswick, (T. Pettigrew, pers. comm.) and a 2.4 eggs m^{-2} egg deposition rate. Stock composition was based on 1,211 salmon and grilse sampled in the fishway trap during 1983.

Gaspereau River

A conservation requirement for the Gaspereau River has, to date, not been established and information to derive a target for the accessible area is presented in this document.

Alma River

A conservation requirement for the Alma River has been set by Parks Canada (D. Clay pers. comm.) at 60 grilse and 29 salmon.

Point Wolfe River

A conservation requirement for Point Wolfe River has been set by Parks Canada Canada (D. Clay pers. comm.) at 139 grilse and 63 salmon.

Description of the fisheries

First Nations and Native Peoples

A total of 470 salmon fishery tags was allocated to the Native Council of Nova Scotia members in 1995 for the Bay of Fundy rivers.

No harvests of salmon were reported by aboriginal peoples from rivers east of the Saint John in SFA 23 or for SFA 22 in 1995.

Commercial

No commercial salmon fishery operated in SFA 22 or 23 in 1995 and no commercial salmon fishing licenses remain in the area.

Angling

The salmon angling season was again closed by variation order for most inner Bay of Fundy rivers in SFA 22 and SFA 23 in 1995. The angling fishery in the Gaspereau River, an outer Bay of Fundy type stock, did not open for angling in 1995. Management initiative for the Gaspereau River in 1995 was to keep the fishery closed contingent upon an in-season review utilizing counts collected at the fishway at the White Rock Dam.

Fishery data

No fishery opened in 1995.

Assessment Results

Stewiacke River

Adult salmon

The Stewiacke River counting fence began fishing on September 1, 1995, and was removed November 14, 1995, after being breached by high water. The first salmon were reported September 19 and the last on November 13. Totals of 37 salmon and 9 grilse were recorded and possibly caudal fin punched at the trap. It is unknown if these records are complete. Of the 21 aged scale samples seven fish were age 1.2 (one year smolt and two sea winters) averaging 88.4 cm in length. Two scale readers (E. Jefferson, D. Longard)[5] judged the scales of these 7 fish to be typical of aquaculture escapees. Only one of the wild fish sampled was a recruit-grilse (Table 1).

The low incidence of recruit-grilse observed indicates that marine survival for the Stewiacke River stock did not improve in 1995. In 1983, recruit-grilse made up 68.5% of the escapement and 53.2% of the egg deposition in the Stewiacke (Amiro MS 1990); 50 % of the escapement and 25% of the egg deposition in the Big Salmon River 1965-1973 was derived from recruit-grilse (Amiro and McNeill MS 1986). The balance of the escapement and egg deposition for these stocks is derived mostly from repeat-spawning grilse. In the Big Salmon River about 40% of the recruit-grilse survived to spawn again. Second and subsequent consecutive spawners survived at about 70%, 40%, 25%, 15% and 15% (ibid.).

Data from the Stewiacke fence, 1992-1994, indicate that survival from first-to-second spawning was only 4.4% in 1991and 9.0% in 1992 (Table 2). Consecutive-spawning survivals of first-to-second and second-to-third repeats were generally lower than those observed in the Big Salmon River. Only the 31.5% survival of the second-to-third spawning return in 1993-1994 (the 1991 smolt class) was near the average of 40% for these age groups as observed in the Big Salmon River.

The main Stewiacke River from Upper Stewiacke to Stewiacke River Park (41.09 km) was electrofished by boat on November 21, 1995 (Table 3). Only three salmon, an age 3.1 wild male, an age 2.2 spawned at age 2.1 wild female, and a 69.0 cm wild female salmon with unreadable scales, were captured or observed. None had been marked at the fence. The main river was again electrofished on December 5, 1995, and no salmon were observed or captured. No escapement or population estimate of salmon is possible with these data.

The 0.07 catch km^{-1} by the electrofishing boat, estimated on November 21, 1995, when conditions were good to excellent for operation, was among the lowest observed electrofishing boat catch rates. The catch rate did not improve by December, presumably after spawning had occurred and salmon move back to the main branch of the river and indicated a poor escapement of salmon in 1995.

The low escapement of 221 salmon postulated in the 1994 assessment (Amiro and Longard MS 1995), when similar breaches in the fence occurred and no follow-up electrofishing of adult salmon by boat was conducted, was supported by the low age-0+ salmon parr densities observed in 1995 (Summary sheet 1). The 1995 average age-0+ parr density , the second lowest observed since 1984 but, is not as low as 1993 when 230 salmon were estimated to have escaped into the Stewiacke River.

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[5] Mr. E. Jefferson and Mr. D. Longard, Salmon Assessment Technicians, Department of Fisheries and Oceans, Halifax, N.S., B3J 2S7.

Salmon stocking program

Survival rates of wild smolt-to-recruit-grilse are unknown for the Stewiacke River. Stocking of hatchery-reared Stewiacke-origin, adipose-clipped, smolts began in 1985. Recovery of tagged fish outside or within the river was rare prior to the installation, in 1992, of the Stewiacke River counting fence (Table 4). One-sea-winter return rates to the fence ranged from 0.02 to 0.42 % for the 1991 to 1993 smolt releases. Two-sea-winter return rates were 0.02 and 0.0% for the 1991 and 1992 releases. If return rates of hatchery smolts are half that of wild smolts then wild smolt return rate (0.1 and 0.2%) is at the lowest values of those observed by Jessop (1976) for wild smolts of the Big Salmon River. Ritter MS (1989) re-evaluated these numbers to account for handling mortality and suggested that river return rates for wild Big Salmon River fish, from 1966-1971, ranged from 0.68 to 7.58%, (mean 4.67%, sd=2.607). Based on the premise that hatchery return rates are half of wild return rates and adjustments by Ritter MS (1989), wild return rates observed in 1992 to 1994 to the Stewiacke River could be more than five times lower than the lowest observed in the Big Salmon River time series.

Enhancement of Stewiacke River salmon through annual broodstock collection and smolt stocking has been unsuccessful and discontinued. The last broodstock were collected in 1994 and the last stocking will be 1997. In an era of minimum river return rates the ecological ethics of using hatchery produced salmon smolts for research was questioned in 1993 by the Zone Management Advisory committee. Analysis of all brood stock collections and subsequent returns indicated that, from 1989 to 1991, 57 salmon taken for brood stock resulted in 54 recruits and 18 repeat spawners returning to the river after adjusting for annual efficiencies of the fence. These results are similar to the wild stock in which recruits did not replace spawners in nine out of ten estimations (Amiro MS 1987). These data indicate that while utilizing hatchery smolts for research purposes does not result in a net loss of production, enhancement of the stock is not feasible while return rates are low.

Population sustainability is dependent on repeat-spawners for inner Bay of Fundy salmon stocks because the number recruits (first time spawners) do not regularly replace the number of parental spawners. Repeat-spawners for inner Bay of Fundy stocks are derived from recruit-grilse rather than recruit-salmon (fish maturing after two winters at sea), therefore, an inner Bay of Fundy stock requires about 50% recruits in the escapement to provide enough potential repeats for stock stability. Only 5.0% (1 of 21 samples aged) were recruit-grilse in the Stewiacke in 1995 (Table 1) while 73% of the sample (152 of 207) were recruit-grilse in 1994. The improvement in grilse recruitment observed in 1994 did not continue in 1995.

Vaccinated (treated) or saline-injected (control) Stewiacke-origin hatchery-grown smolts survived at similar rates when held in sea-water conditions within the laboratory in 1989. This result differed from similar tests conducted on commercial aquaculture stocks in the Bay of Fundy (B. Zwicker, memo on file Department of Fisheries and Oceans, December 6, 1990) where smolts vaccinated against the seawater bacterial disease vibriosis, survived at higher rates.

None of 3,000 Vibrogen (Tm) vaccinated or 3,000 saline injected Stewiacke origin smolts released into the Stewiacke River in 1992, returned in 1993. Of the 20,300 smolts released in 1992 only 13 were observed returning to fence which had an estimated efficiency of 63%. Based on these results and further laboratory based seawater challenge testing in 1992, vaccination was rejected as a viable method of improving returns of hatchery smolts to Stewiacke.

Aquaculture impacts

The origin(s) of aquaculture fish in the Stewiacke is/are unknown. However, there is no possibility that the fish are of Stewiacke River origin and little possibility of inner Bay of Fundy origin. The probability of the aquaculture stock being properly identified and not of Stewiacke origin is high because all DFO hatchery-reared and released parr or smolt are marked by a clipped adipose fin and few inner Bay of Fundy stocks are captive in aquaculture operations. (Loss from small numbers of Big Salmon River fish in sea-cages was minimal.) Assuming a

Saint John River length fecundity relationship (the source of most commercial aquaculture salmon) and the percent female-at-age for the balance of the observed Stewiacke River fish (Amiro MS 1990), then the high incidence (33.3% or 7 of 21 aged salmon) of aquaculture escaped salmon, the large size of the fish (88.4 cm) and the high female component (71.4% or 5 of 7) indicates a potential contribution by escapees of 49.1% of the egg deposition to the Stewiacke River in 1995 (Table 1).

Parr

Densities (10^{-2} m^2) of age-0+ , age-1+ and age-2+ Atlantic salmon parr were determined in 30 sites at 15 locations in the Stewiacke River in 1995 (Fig. 2, Tables 5 and 6). Densities were determined by mark-and-recapture methods at standard sites and procedures reported in Amiro et al. (MS 1989) with re-surveys of 5 sites where stream alteration had occurred. Twenty-six of the 30 sites have been sampled for at least ten of the twelve years of record.

Mean age-0+ parr (fry) densities of 3.90 $\pm$ 6.58SD similar to 1993 (Fig. 3), confirmed the low estimated escapement of 221 salmon in 1994 (Amiro and Longard MS 1995). Densities of age-1+ parr increased from a mean of 2.89 in 1994 to 6.49 $\pm$ 6.70 SD in 1995 but are substantially lower than the 1993 value of 12.65 age-1+ parr. Using ANOVA post-hoc two-tailed comparison of mean density with 1995 as control, the 1995 age-1+ values are significantly ($p<0.05$) lower than three of the years prior to 1991 (Table 7) and indicate a reduced potential for smolt output in 1996. The age-2+ parr mean density of 1.67 $\pm$ 1.26 SD is the lowest of the 1984 to 1995 record indicating few age-3 smolts can be expected in 1996.

Smolts

The smolt counting fence in the Little River, tributary to the main Stewiacke River (Fig. 2) was installed May 9, 1995, and was operated off and on due to high water until June 30, 1995 (Table 8). The fence was opened due to flooding May 14 - 17, and June 7 - 10; over-topped June 14; and was breached June 15-16. The count of 407 smolt may not be directly comparable to the uninterrupted counts of 1990 - 1994.

The Little River tributary has 147,300 m^2 of accessible fluvial habitat. The Little River fence trap is located 2.573 km above the confluence with the Stewiacke River. The confluence of Little River with the Stewiacke is 7.570 km above the 10.0 m elevation point (approximate head of tide). Little River is 4.19% of the accessible fluvial water surface area of the Stewiacke River and 8.7% of the area with map measured surface gradient >0.12% (flats and stillwaters, no lakes included). The area above the trap is 112,097 m^2 and smolt production has ranged from a low of 1.16 10^{-2} m^2 in 1993 to a high of 3.66 10^{-2} m^2 in 1994. Counts of smolt migrating from the Little River, tributary to Stewiacke River, 1990 to 1995 with mean smolt density 10^{-2} m^2 and mean parr densities 10^{-2} m^2 at two electrofising sites (location 18) above the trap, 1989 to 1995 were as follows:

Year	Smolt Count	Smolt 10^{-2} m^2	Densities 10^{-2} m^2 in yr i-1		
			Age-1+	Age-2+	Age-1+2
1990	3,579	3.19	25.35	19.30	44.65
1991	3,144	2.80	72.50	6.25	78.75
1992	1,959	1.75	44.60	8.10	52.70
1993	1,303	1.16	44.90	2.00	46.90
1994	4,098	3.66	59.10	5.20	64.30
1995	407[a]		1.30	14.50	15.80
1996			4.00	1.05	5.05

[a] Incomplete count.

Big Salmon River

Adult salmon

Counts from shore of adult salmon were conducted on August 22 and September 26, and October 19, 1995. On August 22, observers reported 23 salmon and 10 grilse-sized fish in 15 pools. These 15 pools represented 74% the population when complete snorkel diver counts were conducted in 1991 (T. Pettigrew pers. comm.)[2]. An assumed observation rate of 70-75% and the proportion of river surveyed indicated a total population estimate of 60 to 65 salmon. The September 26 count reported 53 salmon and 18 grilse sized fish in 15 pools. Based on a proportional representation of 74% and an estimated observation rate of 90-95%, 100 to 110 salmon were estimated for the river. A re-survey of the area on October 19, 1995, indicated no new wild-origin salmon in the river.

Adult salmon from the 1993 Big Salmon River smolts grown in sea cages were released into the Big Salmon and Petiticodiac rivers in 1995. A total of 152 female salmon weighing an estimated average 4.99 kg and 75 male salmon of similar size were released into two pools of the Big Salmon River on October 3,4, and 5, 1995. At 1,543 eggs kg^{-1} , these fish had the potential to deposit $1.17*10^6$ eggs or 53% of the conservation egg deposition.

The average number of eggs per fish (all samples included) in the 1965 to 1973 counting fence samples was 3,290 (Amiro and McNeill MS 1986). Assuming a size and age distribution similar to prior samples, the egg deposition from the estimate of the 1995 wild salmon escapement could have been 329,000 to 361,900 eggs. The total egg deposition could have been $1.53*10^6$ eggs or 69.6% of the required deposition. At the higher estimate, the contribution from wild fish to the total egg deposition could have been 24% of the egg deposition.

Parr

Electrofishing was conducted at five removal electrofishing sites (site numbers 15, 2, 13, 11, and 7 on Fig. 4) in 1995. The area fished and density 10^{-2} m^2 of three age classes of Atlantic salmon were as follows:

Site	Name	Area	Age-0+	Age 1+	Age 2+
15	Anderson	352	2.23	9.01	3.33
2	Catt's Park	1699	5.23	1.16	0.74
13	Scroll's Dam	474	7.59	16.58	1.27
11	Crow Bk.	258	42.78	7.37	2.37
7	Mast Brow	298	31.58	0.67	3.79

Mean density of age-0+ parr in these five sites increased to 21.8 $\pm$18.36 age-0+ 10^{-2} m^2 from 10.4 $\pm$11.68 in four sites in 1994. This increase is the result of increased densities at Crow Brook (Site 11) and Mast Brow (Site 7). These sites were likely influenced by the release of 152 female cage-reared Big Salmon River grilse into the King and Bridge Pools below Crow Brook on October 6, 1994.

Mean density of age-1+ parr of 6.44 $\pm$7.41 is similar to densities determined in 1968, 1970 to 1973, and 1989 to 1994 and much lower than that determined in 1982 (Fig. 5). The mean density of age-2+ parr of 2.3 $\pm$1.30 shows a similar temporal pattern to that of age -1+ parr.

Electrofishing was connducted on July 20, 1995, in Falls Brook (above an impassable barrier to migrating salmon) and followed the outcome of the 1994 release of cage-reared Big Salmon River grilse in that location. Spot checks in the vicinity of previously observed and marked (1994) redds indicated more salmon fry than brook charr fry (2:1). Brook charr fry outnumbered salmon fry (2:1) in un-marked areas. The average total length of salmon fry was 56 mm (n=30) and the average length of the brook charr was 61 mm (n=16). These observations confirm the successful spawning, hatching and emergence of fry by eggs deposited by the stocked cage-reared grilse.

Petitcodiac River

No salmon were reported at the trap in the fishway in the Petitcodiac River causeway in 1995. On September 21, 1995, five sites were spot checked electrofished for juvenile salmon. Only one site, on the mainstem of the Petitcodiac at the Trans Canada Highway, had two age-1+ hatchery parr.

On October 10,1995, 16 female salmon and 13 male salmon of Big Salmon River stock from the cage rearing project conducted by the Big Salmon River Association, New Brunswick Department of Natural Resources and Energy and the Department of Fisheries and Oceans were released in the Pollett River tributary to the Petitcodiac River. The Coverdale River, also tributary to the Petitcodiac River, received 24 female and 14 male salmon from the same source. These fish weighed an average of 4.99 kg and, at an average of 1,543 egg kg^{-1}, may have deposited 230,987 eggs or 3.4% of the conservation egg deposition.

Gaspereau River

Description

The Gaspereau River is a hydro-electric controlled drainage combining the Black River and Gaspereau River (Fig. 6). Water is diverted through a series of dams and canals to the Black River for power generation at five generation facilities, Methals, Hollow Bridge, Lumsden Pond, Hells Gate (where the water rejoins the Gaspereau River channel) and at White Rock in the original Gaspereau River channel . Upstream passage is provided at White Rock for the entire migration season and at Lanes Mills Dam on Gaspereau Lake for the gaspereau (*Alosa* sp) run in May. Downstream passage is provided at Lanes Mills (Welton Landing), and by a diversion from Gaspereau Lake to Gaspereau River via Trout River. Downstream passage is designed and operated to maximize out-migration of adult gaspereau at Lanes Mills and juvenile gaspereau at Trout River. Informal maintenance flow agreements call for minimum flows at Lanes Mills of 7.5 cfs and at Trout River of 4.0 cfs. However, low summer water conditions and agreements with waterfront users in lakes above Gaspereau Lake result in prolonged periods of lower than maintenance flows.

Adult salmon enter as early as May and have provided an early angling fishery. Adult salmon hold in the White Rock headpond for the summer months and ascend to the mainstem of the original Gaspereau River to spawn in the fall. In 1994 all salmon were removed from the White Rock headpond before a complete draw-down for repairs to the White Rock facilities. Salmon were seined and held in the Coldbrook Fish Culture Station, spawned and released to the river.

Adult salmon

Restoration and enhancement were re-initiated in 1992. Broodstock were collected by angler donation and seining in the White Rock headpond in 1992, 1993 and by seining alone in 1994. No salmon were released into the river in 1994 because of the draw-down. The adult age structure obtained from these data indicate 45.8% age 2.2 salmon in 1992, 63.6% age 2.2 salmon in 1993 and 60.0% age 2.2 salmon in 1994 (Table 9).

Parr

Twelve 3-sweep removal non-barriered electrofishing spot checks were conducted on the Gaspereau River system in August, 1995 (Fig.6). No Atlantic salmon were found above the confluence of or in Trout River on the mainstem of the Gaspereau River. These data are consistant with previous data (Sabean MS 1978) indicating that salmon were not utilizing the mainstem or the network of streams above Trout River. These data indicate that fish passage and water flows may affect the distribution of spawning salmon in the Gaspereau River.

Conservation requirements

Remote-sensed habitat data and data from Sabean (MS 1978) for the section below Trout River and above the White Rock headpond indicated 126, 430 m^2 by remote sensing and 109,690 m2 by proximate survey (Table 10). Assuming 3 smolts 10^{-2} m^2 for 59,314 m^2 of "good" habitat and 2 smolts for 44,816 m^2 of "fair" habitat , an annual smolt production of 2,678 smolts was estimated (Sabean MS 1978). At 2.4 eggs m^{-2} , Sabean estimated a requirement of 250,000 eggs and at 70% female salmon and 50% female grilse, 36 salmon and 26 grilse to provide the eggs.

Using the lengths of 30 wild fish sampled for potential broodstock in 1995, the length-fecundity relationship LaHave River (a salmon stock with similar biological characteristics, Eggs= 446.54 $e^{0.0362 * \text{fork length cm}}$, Cutting et al. MS 1987), percent female at age and percent of population at age observed in the wild samples, 40 salmon and 27 grilse are required to provide 250,000 eggs (Table 11).

Inclusion of all remote-sensed rearing area below Lanes Mills raises the total area to 332,590 m^2 and the requirement to 798,216 eggs and, using the 1995 age and size composition, 127 salmon and 85 grilse would be required to seed the area at the standard of 2.4 eggs m^{-2}. There are 115,850 m^2 of water surface area below the White Rock Dam of which 71,450 m^2 are tidal (10 m contour). The remaining 216,740 m^2 above the fishway and below Lanes Mills, not including Trout River, would require 83 salmon and 55 grilse using the 1995 age structure. A minimum target to seed the area below Lanes Mills is 138 fish but only if the maintenance flow at Lanes Mills is provided throughout the year. If sufficient maintenance flow was maintained in Trout River to sustain juvenile production and move adult salmon above a rough cascade section in the lower portion of the river, then this target would need to be increased.

1995 assessment

The first hatchery returns from the 1992 collection were counted at a trap in the fishway in 1995. The first salmon were counted in the White Rock Dam Fishway Trap on June 23, 1995, and the last was counted on September 19, 1995. The median run time was July 17 when 50% of the run had passed through the trap. Totals of 19 salmon and 62 grilse were counted which included 29 clipped hatchery grilse. Thirty-six fish retained for brood stock provided a sample of the age structure, lengths and gender of the 1995 return (Table 12). Escapement, in 1995, was therefore, 4 salmon and 41 grilse in 1995 or 4.8% of the required salmon escapement and 74.3.% of the grilse requirement and 39.4% of the required egg deposition below Lanes Mills above White Rock and not including Trout River.

A total of 20,000 age-1+ parr were stocked in 1995. On-hand in Mersey and Coldbrook hatcheries is the potential for 22,000 one-year smolts and 4,000 two-year smolts in 1996 and 27,000 age-1+ parr and 27,00 age-0 parr and 27,000 age-1 smolt and 16,000 age-2 smolts in 1997. These fish may offset the underescapements of 1994 and 1995.

An additional undertaking to protect this stock against possible loss was to initiate stocking 6,000 age-0+ parr in the Parrsboro River, Colchester Co. Nova Scotia, in an attempt to re-establish a stock of Atlantic Salmon coincident with a planned fishway in the aboiteau barrage at the mouth of the river.

1996 forecast

In 1994, 28,959 age-1+ smolts of Gaspereau River stock were released above White Rock and below Lanes Mills. Returns to White Rock Dam in 1995 were 29 hatchery grilse or 0.1% return. The ratio of one-sea winter to two-sea winter returns for hatchery fish of this stock is unknown and therefore no forecast two-sea-winter hatchery returns in 1996 is available.

Fundy National Park

Point Wolfe River

Parks Canada staff have monitored the salmon return to Point Wolfe River using snorkel and shore counts from 1985 to 1990. Between 25 and 196 grilse and 4 to 39 salmon were observed in the river during these counts. Few salmon have been seen in the river since 1990. Counts of 7 fish were made in 1992 and 8 fish were counted in 1993. Despite effort, no adult salmon were observed or reported in 1995.

Alma River (Upper Salmon River)

Few salmon have been seen in the Alma River since last reported in 1991 by Parks Canada staff (Amiro MS 1992). Only 10 salmon were observed on November 10, 1992; 15 in 1994 and due to high water in 1995 no estimate was possible.

Electrofishing of established sites was re-initiated in two sites in the Alma River in 1993 and maintained at four to five sites in the Point Wolfe River. These data indicate declines in all but age-2+ parr and are consistant with estimates of low escapements to inner Bay rivers in 1993 and 1994.

Ecological considerations

Rumor persists of interception of salmon post-smolts in fisheries of the Bay of Fundy. There is little evidence that this interception occurs or, that it is a significant factor in the marine survival of inner Bay of Fundy salmon. Of the 37,150 tags applied to Stewiacke River hatchery smolts, one tag was recovered from a herring weir on Grand Manan Island and one tag was recovered from the stomach of a seal on Grand Manan (Fig. 7). Tag recoveries of smolts released in the Stewiacke and Big Salmon rivers from 1985 to 1990 compared to simultaneous releases in outer Bay of Fundy rivers and Atlantic coast rivers indicate that inner Bay of Fundy salmon were not intercepted in Atlantic coastal interceptory fisheries operating at that time (Table 13). Subsequently a Big Salmon River tagged smolt was recovered in the Salmon River, Guysborough Co. Nova Scotia. However, Big salmon River has a record of introductions of stocks known to migrate to the North Atlantic and two tags were previously recovered in the Newfoundland fishery (Jessop 1976) in earlier releases.

Hypotheses that place the downturn in inner Bay of Fundy stocks on causes impacting other than marine survival do not withstand information provided by electrofishing, smolt production, repeat spawner survival or hatchery stocking. Simple correlation of returns with the increase in aquaculture without a causal relationship is inconclusive and unwarranted. Hypotheses that link disease, predators or competition with the aquaculture industry require close scrutiny. Without information on marine foraging behavior of inner Bay of Fundy salmon, hypothesizing interactions is speculative. Information on distribution of, and foraging by, these stocks is required before further understanding of their marine survival is possible.

Observations of periodic downturns in salmon populations of inner Bay of Fundy rivers together with the age structure of inner Bay of Fundy salmon populations suggest that episodes of low marine survival can result in temporary but not catastrophic low stock abundance. Populations persist because of the repeat-spawning contribution and the generally high productivity of these rivers. These same features contribute to periodic large population sizes during episodes of high marine survival.

Imposition of aquaculture escapees, representing such a high potential proportion of the egg deposition, has not previously been observed in the returns of inner Bay of Fundy salmon. The threat of genetic introgression (reduction of fitness as the result of the influx of less fit genes or allele frequencies) has become a reality and policy concerning the actions taken at trapping locations concerning these fish must be developed quickly or risk being ineffective.

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Table 1. Contribution (%) to egg deposition by aged wild and aquaculture adult Atlantic salmon as indicated by samples collected at the Stewiacke River counting fence, 1995.

Age Fw.Sw_Sp[1]	No. at age	% of sample	Mean length	% female[2]	Eggs per female	% Contribution
3.1	1	5	48.00	73	2,547	1.8
1.2*	7	33	88.40	71	10,415	49.1
?.2_sp1	6	29	63.00	64	4,437	16.2
3.2_sp1	1	5	60.00	64	3,971	2.4
?.3_sp1,2	3	14	67.30	95	5,203	14.1
2.3_sp1,2	1	5	69.00	95	5,540	5.0
3.3_sp1,2	2	10	73.00	95	6,424	11.6
Totals	21				38,538	100.0

[1] Years in Freshwater.Total sea winters_Spawning after winters

[2] Percentages and fecundity based on Amiro MS (1990) for Stewiacke River fish and Saint John River biological characteristics for the aquaculture salmon.
* Suspected aquaculture escaped salmon.

? Undefinable age

Table 2. Numbers of salmon by post smolt age-class and smolt year-class (**A**), percent survival between consecutive spawning smolt class (**B**), and annual survival rates between consecutive spawning smolt classes (**C**), estimated above the Stewiacke River counting fence 1992-1994.

A - Numbers

	.Post smolt age and spawning record				
Smolt class	.1	.2 sp1	.3 sp1,2	.4 sp1,2,3	.5 sp1,2,3,4
1989	uk	uk	82	2	0
1990	uk	224	33	3	
1991	73	3	1		
1992	233	21			
1993	152				

Note: 1992 fence efficiency was 0.33
1993 fence efficiency was 0.63
1994 fence efficiency is unknown

B - Year class survival

Smolt class					
1989				1.9	0.0
1990			14.9	9.0	
1991		4.4	31.5		
1992		9.0			
1993					

C - Annual survival

	Years			
Smolt class	92-93	93-94	94-95	95-96
1989	1.9	0.0		
1990	14.9	9.0		
1991	4.4	31.5		
1992	-	9.0		
1993	-	-		

Table 3. Numbers of Atlantic salmon caught, salmon per kilometer, reach length weighted mean salmon per kilometer, length of reach fished and date of electrofishing-boat sampling on the Stewiacke River, 1988 to 1993 and 1995.

Reach	Date	Length	Salmon caught	Salmon /km	Len. wtd salm/km
Reynolds-Forest Glen	1-Nov-88	31.78	23	0.72	0.72
Reynolds-Park	31-Oct-89	35.2	19	0.54	0.54
Reynolds-Park	1-Nov-90	35.2	4	0.11	0.11
Reynolds-Middle	15-Nov-90	13.57	11	0.81	
Middle-Park	15-Nov-90	21.64	4	0.18	0.43
Reynolds-Birchill	28-Aug-91	23.66	1	0.04	
Birchill-Forrest Glen	28-Aug-91	8.12	2	0.25	
Forrest Glen-Park	28-Aug-91	3.44	2	0.58	0.14
Upper-Renyolds	15-Oct-91	5.88	9	1.53	
Reynolds-Middle	15-Oct-91	13.57	1	0.07	
Middle-Birchill	15-Oct-91	10.09	3	0.30	
Birchill-Park	15-Oct-91	11.55	4	0.35	0.41
Reynolds-Middle	25-Nov-91	13.57	19	1.40	
Middle-Birchill	25-Nov-91	10.09	10	0.99	
Birchill-Park	25-Nov-91	11.55	7	0.61	1.02
Reynolds-Middle	3-Nov-92	13.57	5	0.37	0.37
Upper-Renyolds	16-Nov-92	5.88	2	0.34	
Reynolds-Middle	16-Nov-92	13.57	2	0.15	
Middle-Birchill	16-Nov-92	10.09	3	0.30	0.24
Upper-Park	27-Oct-93	41.09	2	0.05	0.05
Upper-Park	16-Nov-93	41.09	1	0.02	0.02
Upper-Park	2-Dec-93	41.09	6	0.15	0.15
Upper-Renyolds	21-Nov-95	5.88	3	0.51	
Reynolds-Middle	21-Nov-95	13.57	0	0.00	
Middle-Birchill	21-Nov-95	10.09	0	0.00	
Birchill-Park	21-Nov-95	11.55	0	0.00	0.07
Upper-Park	5-Dec-95	41.09	0	0.00	0.00

Table 4. Number of juvenile Atlantic salmon released by growth stage into the Stewiacke River, 1985-1995, estimates of smolt migrants and counts of marked and tagged adult fish at the counting fence in year i+1and i+2 with estimated return rates. (Note: All releases were adipose fin clipped.)

Year of release	Stage at release: Fry	2	3	4	Yearling	1+	2+	Unlagged smolt migrants	Lagged smolt migrants	Year of migration	Returns and reports: smolt	adult yri+1	adult yri+2	Fence efficiency	River return 100^{-1} smolts: 1sw	2sw
1985						1,895 t		1,327	1,327 t	1985						
				17,061	11,156	19,219		18,414	13,453 u							
1986						2,973 t	1,687 t	3,599	3,599 t	1986						
						7,099	894	5,774	10,735 u							
1987						2,669 t	1,350 t	3,083	3,083 t	1987						
						4,363		3,054	3,054 u							
1990						5,150 a		3,605	3,605 t	1990	2					
						5,450		3,815	3,815 u				1			
1991						6,000 b		4,200	4,200 t	1991						
						13,400	7,900	16,490	16,490 u			1	2		0.02	0.02
1992						3,000 t	14,700 b	15,330	15,330 t	1992				0.33		
						7,100		4,970	4,970 u			13	0		0.42	0.00
1993						t	6,673 t	6,006	6,006 t	1993				0.63		
						19,976		13,983	13,983 u			27			0.19	
1994						t		0	0 t	1994				UK		
				20,400				3,264	0 u							
1995						t		0	0 t	1995						
						17,000		11,900	15,164 u							
Totals				37,461	11,156	115,294	33,204	118,814	118,814							

t =Tagged u=untagged
a 5,150 tagged (2,600 saline, 2,550 Vibriogen)
b 6,000 tagged (3,000 saline, 3,000 Vibriogen)

Survival rates		
	stage 4 to 1+ parr	0.40
	yearling to 1+ parr	0.50
	1+ to smolt	0.70
	2+ to smolt	0.90
	1+parr to 2yr smolt	0.40

STWSTOCK.XLS

Table 5. Site key for Stewiacke River electrofishing sites.

Number	River name	Contour interval (m)
1	Upper Stewiacke River Shepherds Junction	120-125
2	Upper Stewiacke River Roadside	70-75
3	Upper Cox Brook	150-165
4	Lower Cox Brook	50-55
5	Pembroke River at (above Falls)	95-110
6	Pembrooke River at Glenbervie (below Falls)	45-50
7	Upper Pembroke River	175-185
8	Newton Brook above Bridge	90-100
9	Little Branch Cox Brook	145-160
10	Mahailas Brook	55-95
11	South Branch Stewiacke River	75-90
12	Little River (upper site)	95-105
13	Little Branch Stewiacke	145-160
14	Newton Brook above bridge	35-40
15	Newton Brook above Dean	120-125
16	Goshen Brook	40-45
17	Fulton Brook	75-90
18	Little River at bridge (lower site)	80-85
19	Chapman Brook	105-115
20	Rutherford Brook Kennedys' Farm	20-25
21	Fall Brook	130-140
22	Scrubgrass Brook	60-65
23	Stewiacke River Landsdowne Road	100-105
24	Stewiacke at De Grootes	10-15
25	Stewiacke at Corbetts Bridge	10-15
26	Sucker Brook	65-75
27	Little River at Boys Camp	10-15
28	East Brook	15-20
29	Putnum Brook	20-25
30	Rutherford Brook Sheep Hill	40-45
31	South Branch Stewiacke	20-25
32	Blackie Brook	25-30
33	Big Branch Stewiacke	95-100
34	Sutherland Brook	110-115
35	Otter Brook	
36	Otter Brook	

Table 6. Location, date, area, number of age-0+,1+ and 2+ Atlantic salmon captured, estimated density 10^{-2} m^2 by age classes and coefficient of variation of the estimate derived by mark-recapture electrofishing at 30 sites in the Stewiacke River,1995.

Location .site	Date dd/mm	Area m^2	Age-0+ marks count	Age-1+ M	Age-1+ C	Age-1+ R	Age-1+ Mort[a]	Age-2+ M	Age-2+ C	Age-2+ R	Age-2+ Mort[a]	Parr 10^{-2} m^2 age-1+	Parr 10^{-2} m^2 age-2+	Parr 10^{-2} m^2 total	Parr 10^{-2} m^2 age-0+	Coefficient of variation age-1+	Coefficient of variation age-2+
1.1	10/07	304	0	17	12	4		2	3	2		15.4	1.3	16.7	0.0	32.0	50.0
1.2	10/07	234	0	10	13	6		2	3	1		9.4	2.6	12.0	0.0	25.0	40.8
4.10	01/08	482	45	23	11	6		2	2	2		8.5	0.4	9.0	16.7	22.8	0.0
4.11	01/08	472	32	25	27	14		1	2	1		10.3	1.1	11.3	13.2	17.0	33.3
4.12	01/08	907	63	25	25	11		0	1	0		6.2	0.2	6.4	15.7	20.4	50.0
8.1	25/07	984	38	38	51	20		9	9	5		9.8	1.7	11.5	9.8	16.5	97.6
8.2	25/07	761	13	36	40	14		12	10	6		13.3	2.7	16.0	4.8	19.9	96.4
15.1	28/07	567	0	4	7	2		7	7	5		2.4	1.9	4.2	0.0	39.5	18.9
15.2	28/07	388	0	12	9	6		8	6	4		4.8	3.2	8.0	0.0	19.4	21.8
15.3	28/07	379	0	5	3	2		6	6	3		2.1	3.2	5.3	0.0	25.0	29.3
16.1	06/07	283	0	26	21	5		1	3	1		35.0	1.4	36.4	0.0	32.2	40.8
18.1	24/07	380	0	4	4	1		5	3	2		3.3	2.1	5.4	0.0	44.7	25.0
18.2	24/07	368	0	4	3	0		8	5	4		5.4	2.9	8.4	0.0	61.2	16.7
19.1	06/07	273	0					1				0.0	0.7	0.7	0.0	****	0.0
27.10	26/07	1,302						1				0.0	0.1	0.1	0.0		****
27.4	26/07	1,251	32	17	19	7						3.6	0.0	3.6	6.8	25.8	
28.1	04/07	408	0	0								0.0	0.0	0.0 #	0.0		
28.8		246	0	0				2				0.0	0.5	0.5	0.0		****
29.1	05/07	450	0	23	19	10		12	4	2		9.7	4.8	14.5	0.0	19.4	31.6
29.2	05/07	447	0	17	12	4		4	1	1		10.5	1.1	11.6	0.0	32.0	0.0
29.4	05/07	317	0	9	2	2	1	5	5	2		3.5	3.8	7.3	0.0	0.0	35.4
30.1	18/07	904	75	26	33	14		15	12	5		6.8	3.8	10.6	19.5	18.7	27.7
30.2	18/07	1,009	88	34	29	13		10	10	9		7.4	1.2	8.6	19.2	18.9	9.1
32.2	11/07	453		18	11	7		1	4	1		6.3	1.1	7.4	0.0	19.2	44.7
33.1	12/07	791	7	16	12	6		8	5	2		4.0	2.3	6.3	1.7	24.0	35.4
33.2	12/07	1,112	72	11	10	7		8	6	4		1.5	1.1	2.6	9.7	17.4	21.8
34.4	11/07	643	0	16	10	8		3	2	1		3.2	0.9	4.2	0.0	13.5	33.3
34.5	11/07	565	0	8	9	4		3	2	2		3.2	0.7	3.9	0.0	28.9	0.0
34.6	11/07	695	0	9	8	3		2	6	2		3.2	1.0	4.2	0.0	33.3	37.8
36.1	14/07	809	0	16	32	11		12	11	7		5.8	2.4	8.2	0.0	22.1	19.2

a Count of fish-at-age during the mark run (M)
Total count of fish-at-age during the capture run (C)
Count of recaptured (marked) fish-at-age during the capture run (R)
Number of mortalities during mark run (Mort)

**** No estimate possible, density derived from total catch.

Table 7. Annual least squares estimates of mean annual density (10^{-2} m^2) of age-1+ Atlantic salmon and standard error of the estimate from 27-44 sites electrofished in the Stewiacke River and tributaries, 1984 to 1995, with probability of no difference between annual means and the 1995 mean density.

Year	Mean density age-1+	Std. error	N sites	p. of no diff. from 1995
1984	17.03	2.808	44	0.120
1985	28.87	3.584	27	0.000
1986	16.02	3.021	38	0.227
1987	33.63	3.104	36	0.000
1988	18.55	3.458	29	0.096
1989	16.46	3.345	31	0.229
1990	19.75	3.345	31	0.045
1991	12.27	3.292	32	0.812
1992	15.03	3.062	37	0.348
1993	12.65	3.148	35	0.735
1994	2.89	3.148	35	0.987
1995	6.49	3.400	30	1.000

Table 8. Days of operation, time of active fishing, water temperature, water elevation on trap mounted staff gauge, weather, number of Atlantic salmon smolts counted, number of smolts sampled and operators comments from the Little River smolt trap operation, 1995.

Date d/m/y	Time	Water Temp (C.)	Staff gauge (ft)	Weather	No. of smolt	No. Sampled	Comments
14/05/95				Snow turning to heavy rain			Water raising over most of the fence
18/05/95							Fence back in operation
27/05/95	21:00-22:30	12		Clear & Cold	4		10 chub
28/05/95	21:00-22:30	13		Sunny & Warm ,Mild Evening	11		7-chub, 2- Gaspereau, 1-eel
29/05/95	20:45-22:45	11	1.0	Overcast & rain	5		
30/05/95	20:30-23:15	11	4.5	Rain A.M. & Sunny P.M.	66	4	1-gaspereau,33-suckers,6-chub
31/05/95	21:00-23:00	12	3.0	Overcast	29	1	13-chub,1-gaspereau
1/6/95	21:00-23:30	12	2.5		22	1	16-chub,1-sucker,1-eel
2/6/95	20:45-22:00	18	1.0	Warm day - clear P.M.	29	1	2-trout,1-gaspereau,15-chub,1-eel,1s
3/6/95				Rain			Water level too low for operation.
4/6/95	21:00-24:00	16	6.0	Sunny & warm	102	6	47-suckers,14-chub,4-gaspereau
5/6/95	21:00-23:00	12	3.5	Rain	32		
6/6/95	21:00-24:00	13	3.0	Overcast	47		
7/6/95				Overcast & heavy rain P.M. of rain forecast.			
8/6/95				Heavy rain over night & today >75mm.of rain		River flooded	
9/6/95				River still too high & muddy to work in.			
10/6/95	20:30-23:00	13	8.5	Put conduit back in the fence	3		3-gaspereau,1-trout,8-suckers,16-chu
11/6/95	20:45-23:30	13	6.5	Overcast & windy	2		5-gaspereau,1-eel,1-sucker
12/6/95	20:30-23:30	12	6.5	Showers	19	1	3-trout, 11-chub
13/6/95	21:00-23:30	12	6.0	Showers	9		1-trout,1-gaspereau,1-eel
14/6/95				Showers River high & muddy ater over fence.			
15/6/95	20:00-23:30	11	2.8	Showers- Fence damaged	2		1-sucker, water over fence on one sid
16/6/95	21:00-24:00	14	2.1	Showers-Fence repaired A.M.	7		5-gaspereau,8- chub,2-eels,1-trout
17/6/95	20:30-4:30	11	7.5	Showers	17	2-lamprey,1-eel	7-gaspereau,1-trout,9-chub,4-shad
18/6/95	21:30-23:30	15	6.5	Repaired fence	0		12-chub,4-eels,1-lamprey
19/6/95	21:00-22:00	20	6.0	Sunny & warm	0		8-gaspereau,69-chubs
20/6/95	21:00-22:00	18	6.0	Showers-Thunder storm	1		84-chub,1-trout,3-lamprey
21/6/95	21:00-22:00	18	3.5	Sunny & Windy	0		7-chub
22/6/95	21:00-22:00	18	3.0	Sunny & hot	0		15-chub
23/6/95	21:00-22:00	18	2.0	Sunny & hot	0		1-lamprey,1-shad,1-gaspereau
24/6/95				Water too low didn't fish.			
25/6/95	Fished trap in the morning					2-eels	43-chub, 1-trout,2 -shad, 1-gaspereau
26/6/95				Water too low didn't fish			
27/6/95				Water too low didn't fish			
28/6/95				Water too low didn't fish			
29/6/95				Water too low didn't fish			
30/6/95				Water too low didn't fish			
				Total =	407		

Table 9. Age (fresh water years.sea winters to first return) of Atlantic salmon as determined by scale reading of Gaspereau River broodstock, 1992 to 1994.

Age	1992		1993		1994	
fw.sw	Number	Percent	Number	Percent	Number	Percent
1.2	1	4.2	3	27.3		0.0
2.1	13	54.2		0.0	14	40.0
3.1	4	16.7		0.0	3	8.6
?.1	1	4.2		0.0		0.0
2.2	1	4.2	7	63.6	18	51.4
3.2	2	8.3	1	9.1		0.0
?.2	2	8.3		0.0		0.0
Totals	24	100.0	11	100.0	35	100.0

Table 10. Lengths, widths, percent grade (slope) and area of of reaches between 5m contour intervals of the Gaspereau River, Kings Co., as determined from orthophotographic maps and photographs. Total area estimated by remote sensing is compared to a proximate survey reported by Sabean (1978).

Reach #	Contour interval	Length (m)	Avg Width (m)	% Grade (ortho)	Area 100m^2	Comment
1	6-10	3204	22.30	0.1	714.5	
2	10-15	927	16.19	0.5	150.1	
3	15-20	1852	14.50	0.3	268.5	
4	20-25	190	13.63	2.6	25.9	
5	25-30	18	13.59	27.8	2.4	White rock
6	30-35	18	13.55	27.8	2.4	
7	35-39	1548	18.92	0.3	292.9	top dam
8	39	1616		0.0	0.0	headpond
9	39-40	212	15.57	0.5	33.0	
10	40-45	339	8.20	1.5	27.8	
11	45-50	1339	13.35	0.4	178.8	
12	50-55	1007	14.02	0.5	141.2	
13	55-60	863	12.70	0.6	109.6	
14	60-65	662	8.20	0.8	54.3	
15	65-70	599	9.81	0.8	58.8	
16	70-75	513	9.27	1.0	47.6	
17	75-80	356	7.91	1.4	28.2	
18	80-85	454	6.55	1.1	29.7	
19	85-90	383	8.50	1.3	32.6	
20	90-95	406	12.20	1.2	49.5	
21	95-100	334	10.13	1.5	33.8	
22	100-105	489	9.09	1.0	44.5	
23	105-110	346	9.06	1.5	31.3	
24	110-115	577	10.77	0.9	62.1	
25	115-120	211	8.75	2.4	18.5	
26	120-125	258	8.38	1.9	21.6	
27	125-130	287	11.93	1.7	34.2	
28	130-135	360	8.77	1.4	31.6	
29	135-140	292	10.59	1.7	30.9	
30	140-145	252	7.87	2.0	19.8	
31	145-150	283	8.24	1.8	23.3	
32	150-155	669	13.95	0.8	93.3	
33	155-160	303	9.35	1.7	28.3	
34	160-165	510	13.27	1.0	67.7	
35	165-170	2455	17.19	0.2	422.0	
36	170-175	457	9.48	1.1	43.3	
37	175-180	1055	1.78	0.5	18.8	
38	180-185	503	10.54	1.0	53.0	
39	185-190	534		0.9	0.0	
40	190-195	443		1.1	0.0	
41	195-199	574		0.7	0.0	

Remote Survey Results all area below Lanes Mills = 3,326 $m^2 \times 100$

White Rock to Trout Bk.
Sum reach 9 to 33 = 11,794 — 1,264 $m^2 \times 100$

Sabean survey = 11,500 — 1,282 $m^2 \times 100$

Table 11. Estimation of the numbers of Atlantic salmon spawners necessary to provide conservation egg depositions above White Rock, Gaspereau River, Kings Co. (Biological information required for this estimate was derived form 30 wild salmon sampled during broodstoock collection, 1995.)

Age at 1st. maturity	Number sampled	Mean length females (cm)	Mean fecundity (eggs)	Percent female	Percent[1] of total	Eggs per fish	Percent contribution to egg deposition	Required spawners		
								Females	Males	Total
1sw	16	55.1	3,282	69	40.0	2,255	23.9	38	17	55
2sw	14	69.8	5,588	86	60.0	4,783	76.1	71	12	83
Totals	30				100		100	109	29	**138**

[1] (Sabean MS 1978) Assumed proportion pending further sampling.

Required egg deposition = area*2.4 eggs m^{-2} = 520,176

Required spawners were:

Female grilse	=(Req'd egg dep./ proportion contributed to deposition of grilse)/eggs per fish at age
Male grilse	= Female grilse*((1-proportion female at age)/proportion female at age)
Female salmon	=(Req'd egg deposition/ proportion contribution to deposition of salmon)/eggs per fish at age
Male salmon	= Female salmon*((1-proportion female at age)/proportion female at age)

Table 12. Lengths, classification by age at first maturity and percent distribution by age and gender of Atlantic salmon collected from the Gaspereau River, 1995.

	Salmon				Grilse			
	Wild		Hatchery		Wild		Hatchery	
	Male	Female	Male	Female	Male	Female	Male	Female
	94.0	69.0		69.8 *a*	52.8	52.0	50.4	
	78.5	74.3			53.2	52.5	56.4	
		71.2			53.2	53.9	51.0	
		68.3			55.2	58.6	55.5	
		66.6			60.7	55.3	53.2	
		68.5				58.0		
		70.0				53.4		
		69.9				58.0		
		72.0				53.4		
		67.6				56.0		
		68.3				55.2		
		72.4						
Average length(cm)	86.3	69.8			55.0	55.1	53.3	
Count	2	12			5	11	5	
Percent	5.7	34.3			14.3	31.4	14.3	
Distribution of wild fish								
by gender		14.3		Male		31.3		
at sea age		85.7		Female		68.8		

a. Foreign stock stray not used in estimates of requirements.

Table 13. Numbers of tagged hatchery-grown Atlantic salmon smolts released in twelve rivers in three areas of Atlantic Canada and numbers of recaptures of maturing salmon in two distant fisheries and returned to the river-of-release, 1985 to 1990.

Area Stock	Number released	River returns	Newfoundland fishery	Greenland fishery	Other
Inner Bay of Fundy					
Big Salmon River	16,692 *a.*	0	0	0	0
Stewiacke	15,652	0	0	0	0
Outer Bay of Fundy					
Saint John	130,520	673	62	84	2
Saint John	10,948 *a.*	3	2	0	0
Gaspereau	9,446	2	1	1	0
Annapolis	6,830	0	1	6	0
Atlantic Coast					
Tusket	5,953	16	3	9	0
Medway	16,875	10	11	1	1
LaHave	76,702	622	58	101	0
Gold	5,907	10	0	4	0
Musquodoboit	21,648	14	6	34	0
Liscomb	25,804	113	2	13	2
North (Victoria Co.)	7,961	11	2	11	0

a. Released in the Petitcodiac River.

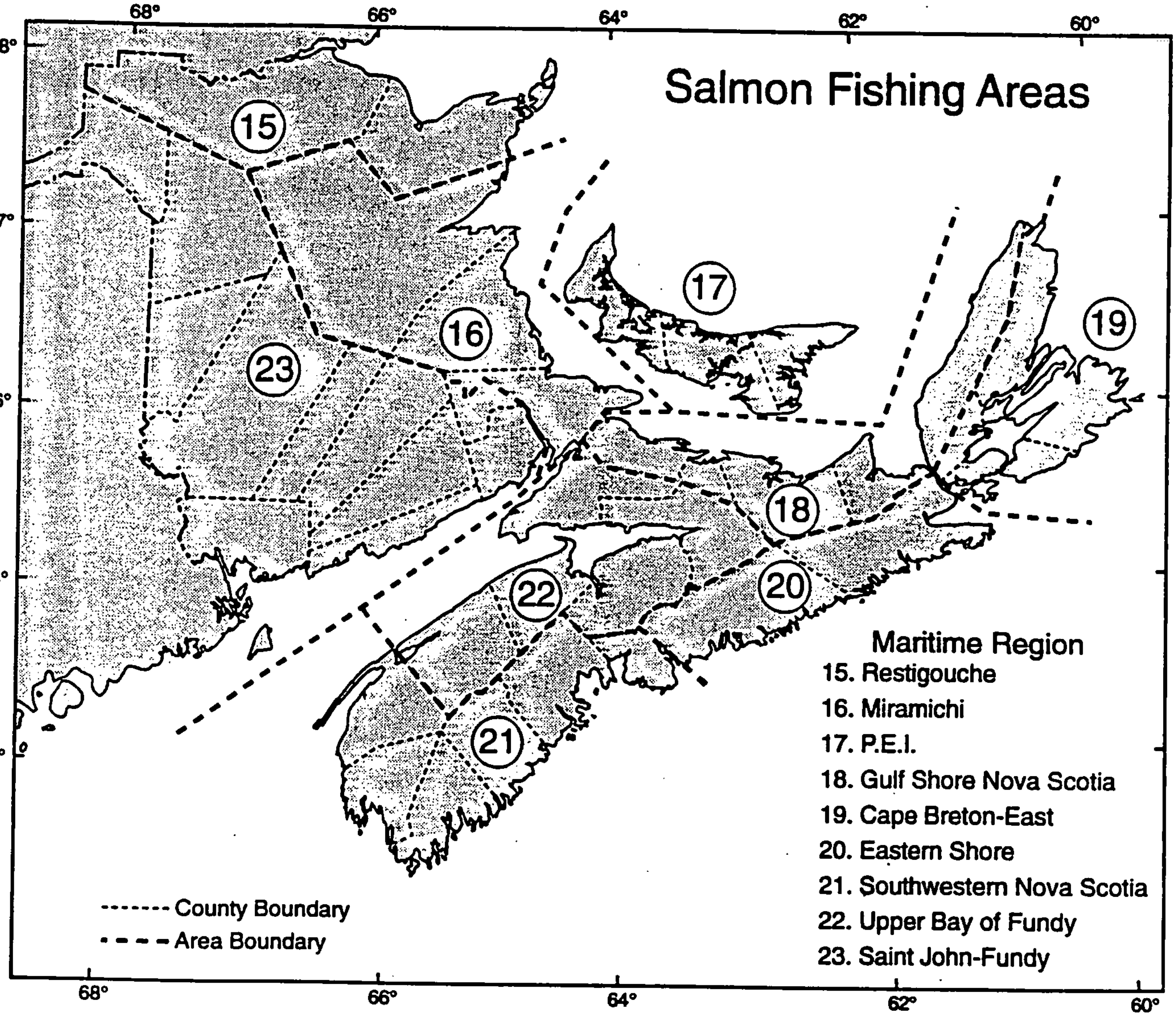

Figure 1. Map of Salmon Fishing Areas of the Maritimes Region of the Department of Fisheries and Oceans, Canada.

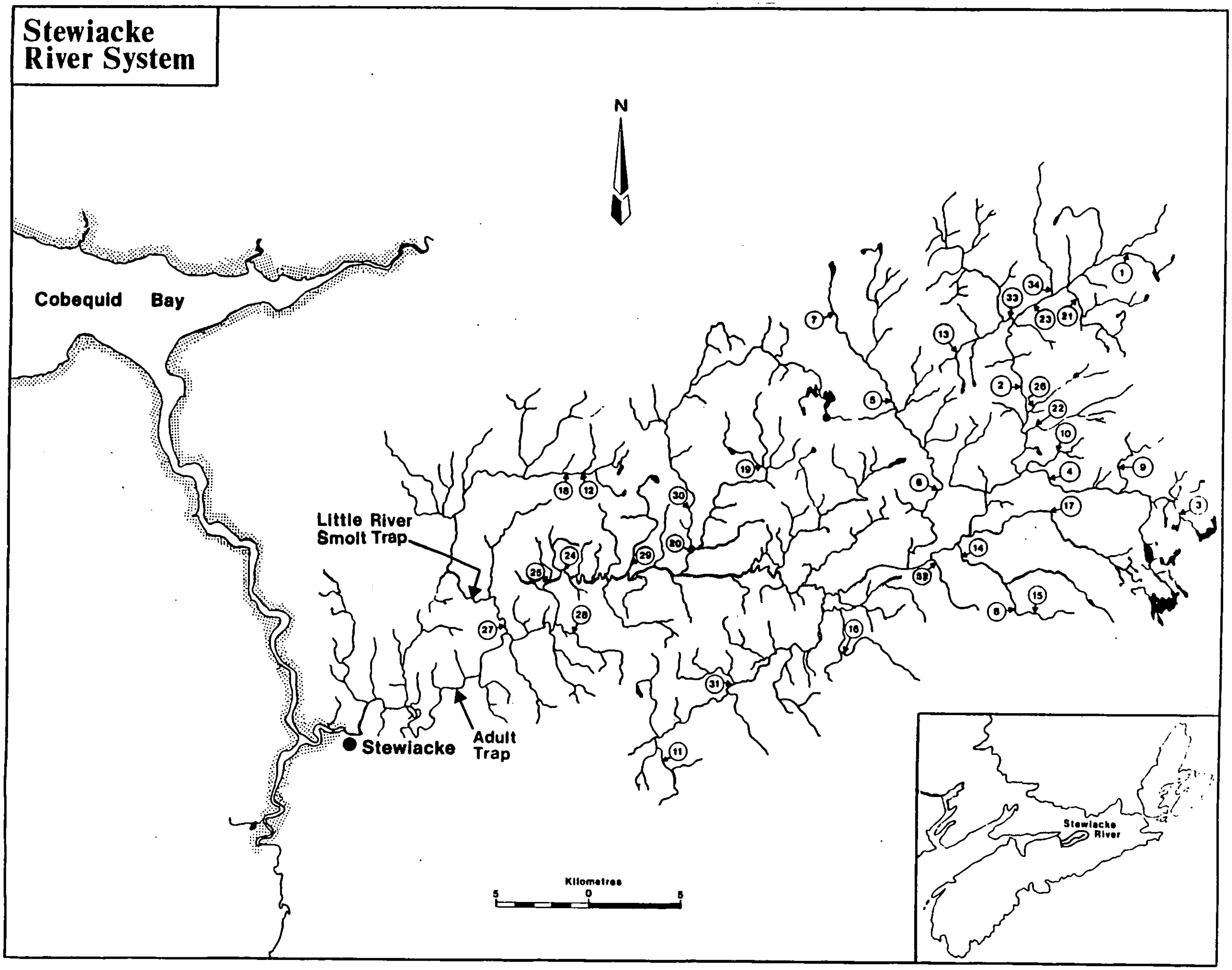

Figure 2. Map of the Stewiacke River showing the locations of electrofishing (see Table 5. for location names and Table 6 for locations and sites fished in 1995), location of the upstream Atlantic salmon trap on the mainstem of the Stewiacke River and the downstream smolt trap on Little River.

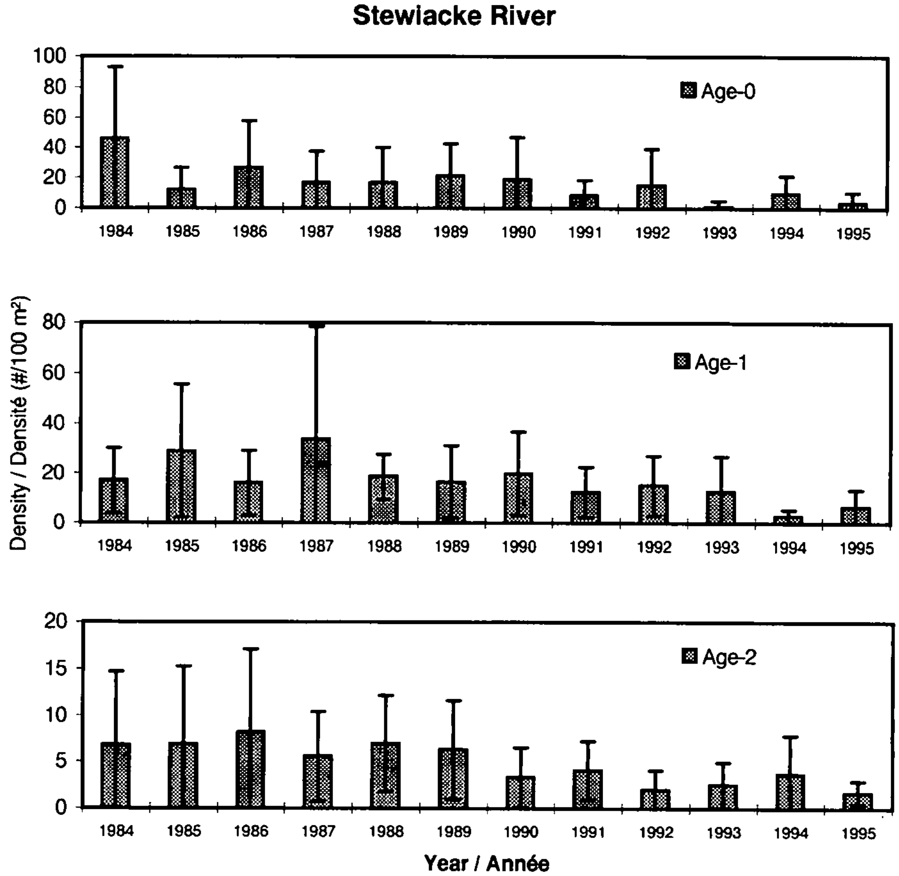

Figure 3. Densities, numbers 10^{-2} m^2, of juvenile Atlantic salmon electrofished from 44 to 27 sites in the Stewiacke River, 1984 to 1995. Bar height represents mean density while vertical lines indicate one standard deviation of the mean.

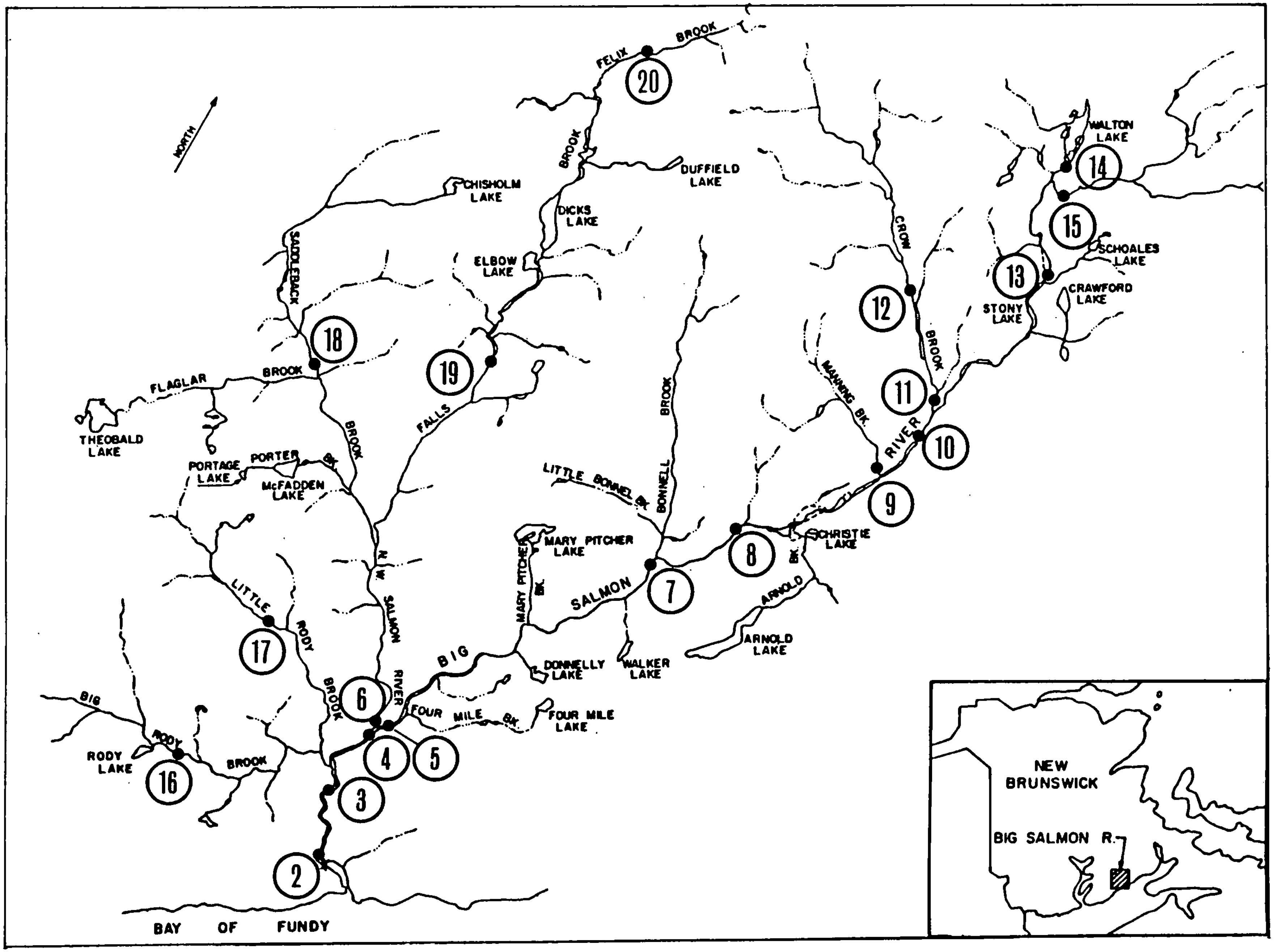

Figure 4. Map of the Big Salmon River, New Brunswick, showing the locations of electrofishing. Sites 2, 7, 11, 13 and 15 were fished in 1995.

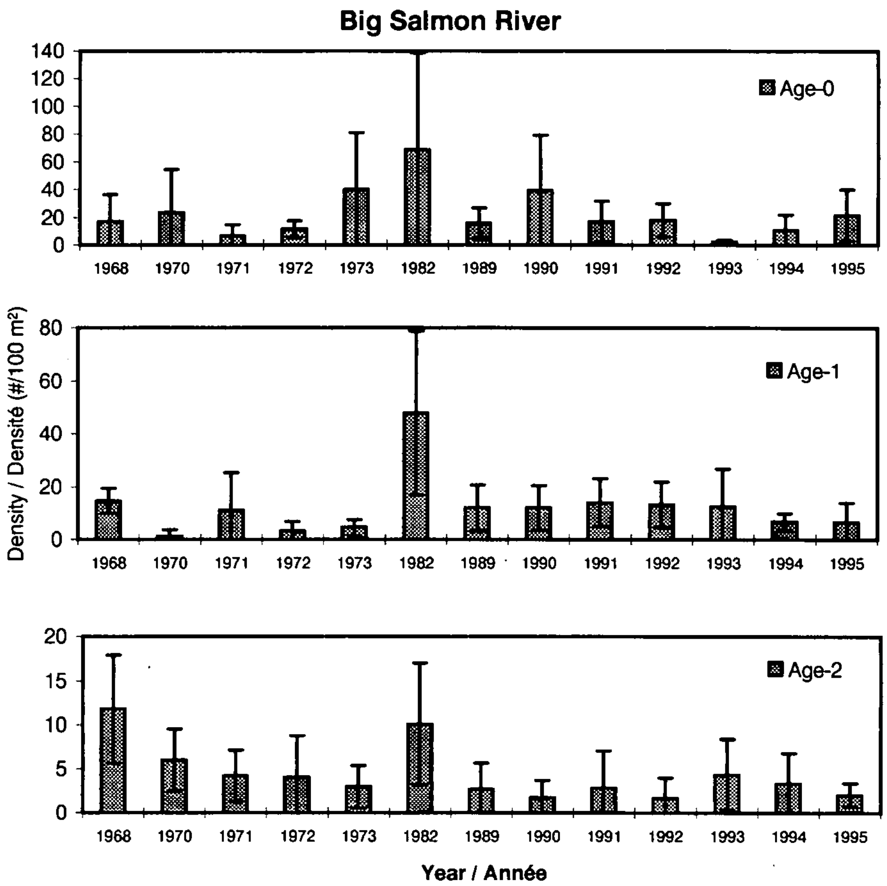

Figure 5. Densities, 10^{-2} m^2 , and standard deviation of Atlantic salmon parr at three to five standard sites (sites 2,7,11,13 and 15) in the Big Salmon River, 1968, 1970 to 1973, 1982, and 1989 to 1995. Bar heights indicate the mean densities while lines indicate one standard deviation of a mean.

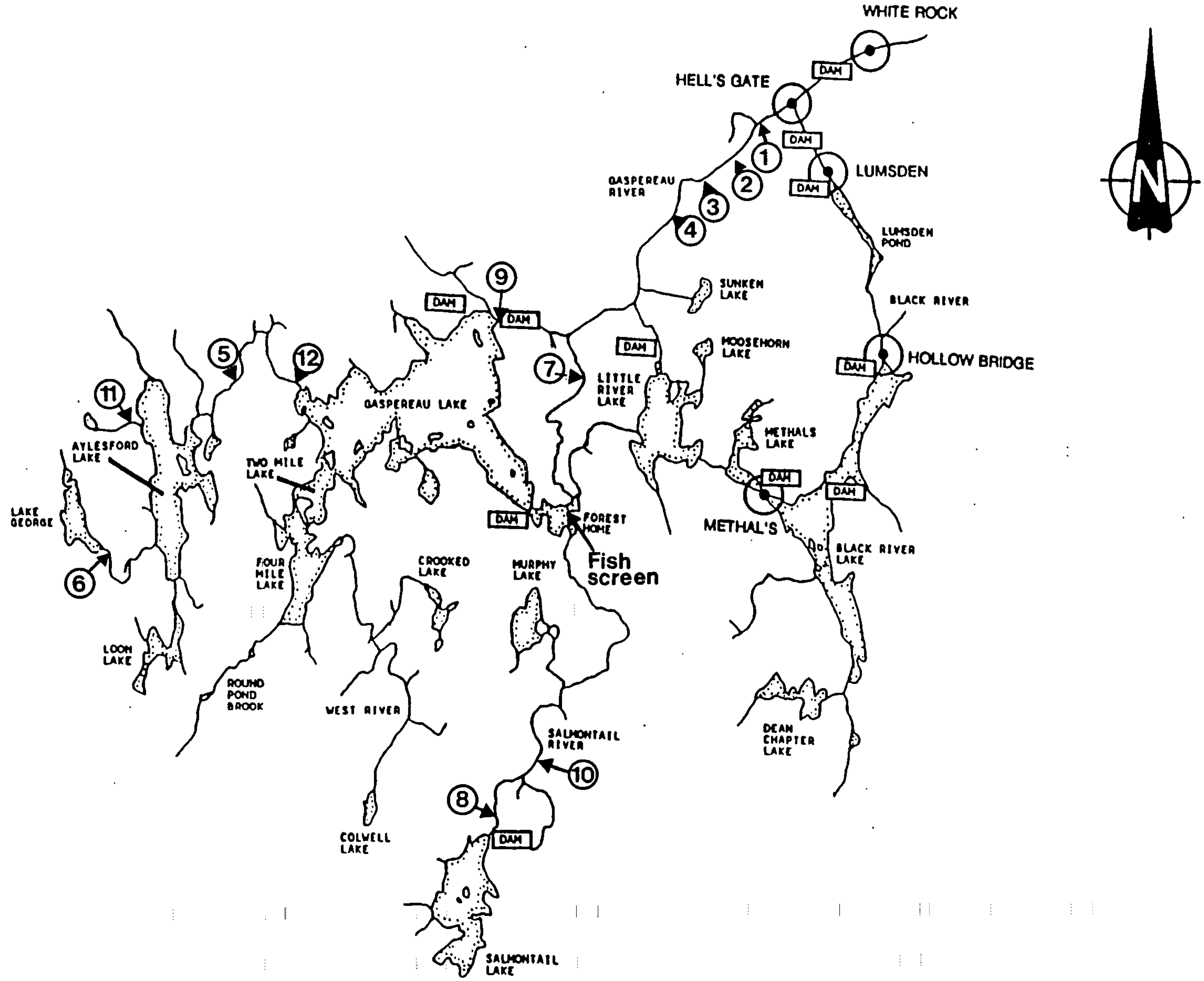

Figure 6. Map of Gaspereau/Black River, Nova Scotia showing locations of dams, power stations (⊙), fish diversion screens, lakes and headponds and locations of electrofishing spotchecks (①,②,③...) conducted in 1995.

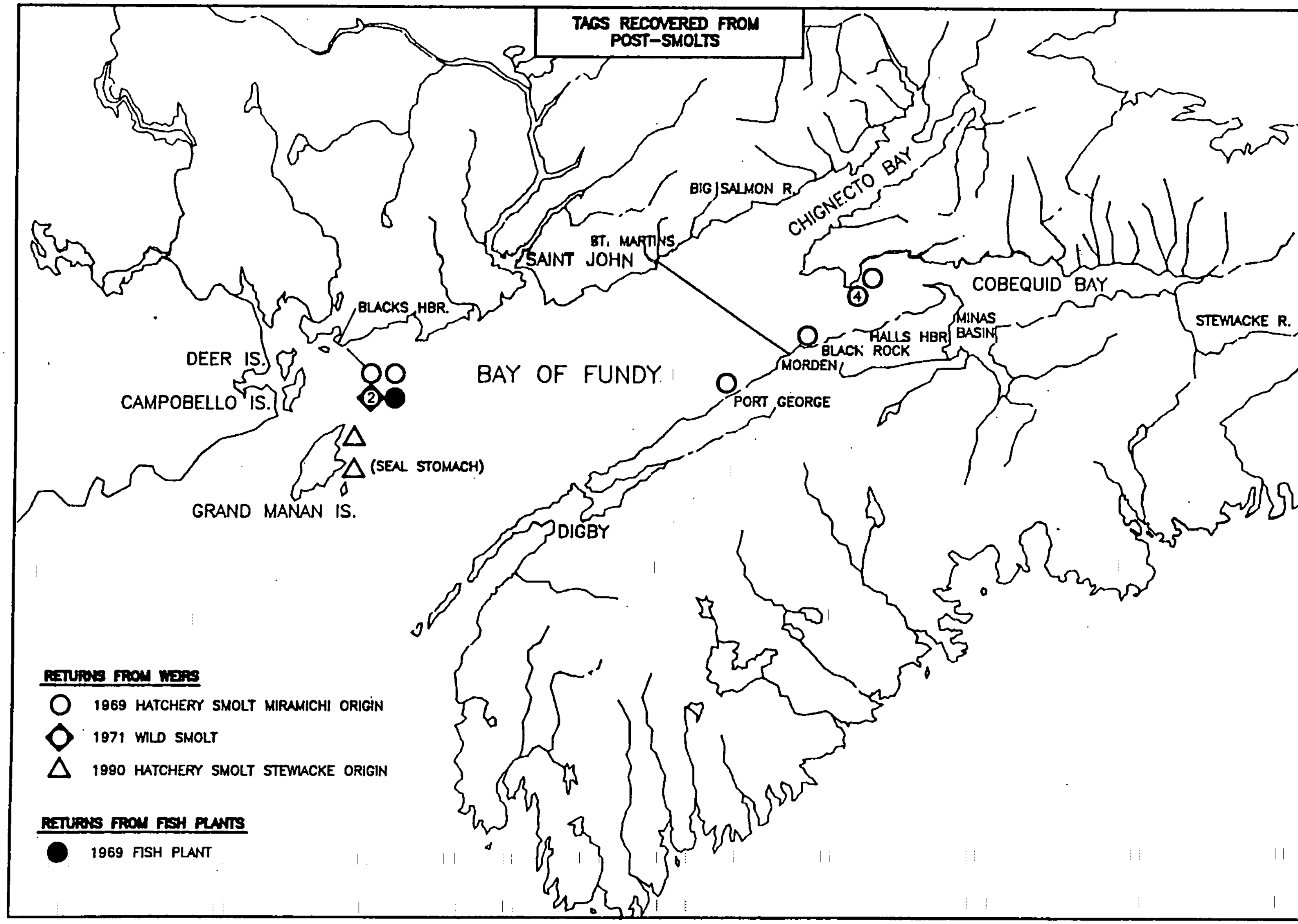

Figure 7. Map of Bay of Fundy showing locations of recaptures of tagged smolts released into the Stewiacke River, 1969, 1971 and 1990.

Consultation

Consultation with stakeholders took place December 18,1995, (minutes attached, Appendix I). All in attendance were in agreement that stocks of salmon in inner Bay of Fundy Rivers were critically low. Several items arose out of the meeting:

1) Determine the origin of the aquaculture fish scale sampled at the Stewiacke River fence.
2) Investigate interactions between aquaculture and wild salmon stocks.
3) Allocation to Native Council for inner Bay of Fundy stocks while a conservation closure is in effect was questioned.
4) Would another adult salmon monitoring site be a benefit to assessing the stocks?

Gaspereau River was also discussed and specific items were.

1) What is the production potential in the Gaspereau River from Lanes Mills to White Rock, Trout River, and downstream of White Rock?

The committee accepted the idea of initiating another location for the Gaspereau River stock, specifically the Parrsboro River.

Appendix I

SUMMARY MINUTES

Zone 22 Salmon Management Advisory Committee
Best Western Glengarry
Truro, NS

December 18, 1995

1. Introduction

The meeting commenced at about 10:30 am. Because the usual chairman, Terry Matheson, was delayed, Greg Stevens acted as chairman and secretary. The purpose of the meeting was to provide Science personnel with a forum to consult with stakeholders prior to the up-coming peer review of the 1995 stock assessments. This new Regional Assessment Process (RAP) gives stakeholders a preview of the stock status in their respective Zones and provides them an opportunity to provide input, ask questions and make recommendations so that Science programs can better respond to client needs.

Carl Purcell asked that the Minutes record that there were no Native representatives at the meeting. Given the serious state of the stocks in Zone 22 and the co-management approach adopted for salmon management since 1990, there needs to be a commitment by Native people to attend these meetings: otherwise, they are really non-meetings.

2. Science Consultations

Stewiacke and other Inner Bay rivers

Peter Amiro, the DFO biologist for Zone 22, explained that the RAP was new and the information provided today was preliminary and not yet reviewed by other biologists. Nevertheless, Committee members were asked what direction DFO should take in terms of its future assessment work for Zone 22.

A seven (7) page handout was circulated. The first page summarized the scale samples taken from the Stewiacke counting fence in 1995. This was a bad news story. Only 21 of the 49 fish recorded through the counting fence had scale samples taken. Indications are from both scale samples and electrofishing, that the number of maiden grilse was lower than the number of repeat spawners. This is the reverse of what the situation should be in the Stewiacke and other Inner Bay rivers.

In response to a question as to why so few scales samples were taken in 1995, Greg Stevens responded that we will be reviewing the contract for the fence operation with the contractor and, hopefully, holding a Stewiacke River Counting Fence Steering Committee meeting in January.

Given the recent stock statues, there have been no fisheries (Native or recreational) for three consecutive years, including 1995. The estimated number of salmon in the Stewiacke River in 1995 was less that in 1994. With this situation, we can expect parr levels to remain low for several years.

If the Inner Bay stock situation continues to erode, a couple of short term options could be considered in a attempt to ensure that some sort of salmon run can be maintained in Inner Bay rivers: (1) cryo-preservation of sperm from an Inner Bay stock; and (2) introducing a nearby non-Inner Bay stock to a river in the Inner Bay. (One possible example would be to stock Gaspereau River salmon in the Parrsboro River. This would reintroduce a run to the Parrsboro River which no longer has salmon and, at the same time, preserve the uniqueness of the Gaspereau River stock which is in some jeopardy from lost habitat resulting from hydro development.)

Although the adult salmon counts in the Inner Bay remain at critically low levels, there was a peak count (4000) for smolt in the Little River (tributary to the Stewiacke) in 1994. In 1995, only about 400 smolt were counted before the fence was breached.

At a previous ZMAC meeting a Committee member requested information on hatchery stocking programs on the Stewiacke River. The information was provided in the handout, and explained by Peter Amiro, for the 10 year period from 1985 to 1995. The only evidence of Inner Bay stocks migrating to North Atlantic waters is 3 tags of suspicious nature. All other evidence suggests that Inner Bay stocks don't migrate beyond the outer reaches of the Bay of Fundy and Gulf of Maine. One Committee member indicated that he received some anecdotal information that very small salmon (post smolt) were picked up early this summer by herring seiners in the Bay.

Action:

1. At the next ZMAC meeting, committee members asked that information be provided on the origin of aquaculture salmon (about 33%) found in the Stewiacke River in 1995.

2. Committee members also asked for information on what is currently known about the interactions between aquaculture salmon and wild salmon stocks.

3. In a recent Agreement signed between DFO and the Native Council of Nova Scotia, 400 salmon are allocated to Council members from Zone 22. Given that all stocks in Zone 22 are at critically low levels, and there was no fishery for anyone in Zone 22 in 1995, what is the plan for allocation in future years? This question is to be addressed at the next ZMAC meeting.

4. The Cobequid Salmon Association asked if there would be any benefit to funding another count in a nearby Inner Bay river. DFO's suggestion was that an adult count on the Little River may be more beneficial.

Gaspereau River

Peter Amiro asked Committee members for advice on how we should manage the Gaspereau River. For the past 40 years this has been basically a man made system. What species should we be concentrating on? According to Barry Sabean's current salmon production estimate (for the area from Trout Brook to White Rock), 67 fish are required to meet spawning target. If we were to look at the production area downstream from Lanes Mill, including a maintenance flow, and the main stem downstream from White Rock we could be looking at a required escapement of 212 fish.

Action:

Committee members specifically asked that DFO calculate the salmon production potential of the Gaspereau River; a) from Lanes Mill downstream to White Rock, b) for Trout River, and, c) downstream from White Rock.

Committee members expressed interest in the proposal to stock some Gaspereau River salmon in the Parrsboro River. They posed two questions. How long would stocking have to be continued and what will be the impact of hatchery divestiture on this proposal. Peter Amiro indicated that we should see success within 5 years if the transplanting is going to be a successful exercise. Until all details of hatchery divestiture are know, it is premature to state the impact on the transplanting proposal.

LIST OF ATTENDEES

Max Spicer	Cumberland Co. River Enhancement Committee
Carl Purcell	Nova Scotia Salmon Association
Tom Kennedy	Outfitter
Scott Cook	Fish Committee, NSWF
Rick Pryor	Cobequid Salmon Association
Mike MacAdam	Atlantic Salmon Federation

Province

Nancy Adams	Nova Scotia Department of Fisheries

Department of Fisheries and Oceans

Greg Stevens	Senior Advisor, Anadromous
Peter Amiro	Biologist (ZMAC 22)
Vincent Smith	Fishery Officer (ENS)
Terry Matheson	Field Supervisor (Digby)