Status of Atlantic Salmon (*Salmo salar* L.) Populations in Crabbes, Robinsons, Middle Barachois Rivers, and Bay St. George, Newfoundland, 1996

by

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Abstract

Adult Atlantic salmon were visually counted in Crabbes, Middle Barachois, and Robinsons rivers during the last week of August by swimmers snorkeling down each river. Salmon were only found in pools, generally with water depths greater than 1 m. An adjustment factor was applied to the counts in each Section surveyed to account for fish not counted in the larger pools. The actual count and the adjusted count provided an estimate of the minimum and maximum numbers of salmon in each river. There were no known removals before or after the survey since only `hook and release' angling was permitted. The minimum and maximum estimate of the numbers of salmon counted in each river are: Crabbes River, 144-239 large and 592-844 small salmon; Middle Barachois, 34-36 large and 755-805 small salmon; and Robinsons 102-120 large and 659-768 small salmon. Neither river attained its conservation egg deposition requirements. Crabbes River obtained 44-68% of the egg deposition required for Conservation ; whereas, Middle Barachois River received 76-81% and Robinsons River received 57-67% of their conservation requirements. The estimated percentage of conservation levels attained for each river in 1996 was similar to that previously estimated for 1994 using angling exploitation rates. The information available did not lend itself to forecasting the abundance of salmon in 1997.

Résumé

Au cours de la dernière semaine d'août, les saumons atlantique adultes des rivières Crabbes, Middle Barachois et Robinsons ont fait l'objet d'un dénombrement visuel par plongeurs équipés de tuba qui ont descendu chacune des rivières. Des saumons n'ont été aperçus que dans les fosses, de profondeur généralement supérieure à 1 m. Un facteur de correction a été appliqué à chaque segment évalué afin de tenir compte des poissons non dénombrés se trouvant dans les plus grandes fosses. Le dénombrement réel et la valeur corrigée constituent des estimations du nombre minimum et maximum de saumons dans chaque cours d'eau. Il n'y a pas eu de récolte connue de poissons avant ou après le dénombrement car seule la pêche par capture et remise à l'eau était autorisée. Les valeurs minimum et maximum estimées du nombre de saumons dénombrés dans chaque rivière sont : 144-239 grands et 592-844 petits saumons dans la rivière Crabbes, 34-36 grands et 755-805 petits saumons dans la rivière Middle Barachois et 102-120 gros et 659-768 petits saumons dans la rivière Robinsons. La ponte nécessaire aux besoins de conservation n'a été atteinte dans aucune des rivières. Le pourcentage d'atteinte des besoins a été de 44-48 % dans la rivière Crabbes, de 76-81 % dans la rivière Middle Barachois et de 57-67 % dans la rivière Robinsons. Le pourcentage estimé des niveaux de conservation atteints dans chaque rivière en 1996 est semblable à celui estimé pour 1994 à partir des taux d'exploitation par les pêcheurs à la ligne. Les renseignements obtenus ne permettent pas d'estimer l'abondance du saumon 1997.

INTRODUCTION

Atlantic salmon populations in Bay St. George rivers declined in the 1970's (Porter and Chadwick 1983) and have been below conservation levels for most of the past 30 years (Reddin and Mullins, 1996). The total returns to rivers appear to have only marginally increased with the closure of the commercial fisheries in 1992. Direct measurements of salmon population sizes using conventional fish counting facilities are difficult to obtain due to the large size of the rivers and their extreme range in discharge. The assessments conducted by Reddin and Mullins (1996) used angling catch statistics and estimates of angling exploitation rates to estimate population sizes. In late August 1996 visual counts of salmon were carried out as a means to estimate the numbers of large and small salmon spawners in Crabbes River, Middle Barachois River and Robinsons River (Fig 1). This paper is an assessment of the status of the salmon populations in these rivers.

METHODS

Recreational Fisheries data

There were `hook and release' recreational fisheries on Crabbes, Middle Barachois and Robinsons rivers in 1996. However, no data were collected on fishing effort or numbers of salmon hooked and released.

Unrecorded mortalities

An estimate of all fish killed or naturally died before spawning is important for any stock assessment. Illegal activities do occur on the three rivers being assessed; however, no quantitative estimates of salmon mortality are available. The percentage of the released salmon that will die will vary with handling techniques and water temperature (Wilkie et al, 1996; and Brobbel et al, 1996). Mortality of hooked and released salmon at water temperatures below 20° C is believed to be less than 10%. Since no data are available on numbers of salmon hooked and released or numbers of salmon poached on Crabbes, Middle Barachois and Robinsons rivers, no estimates can be made of unrecorded mortalities.

Biological characteristics

The biological characteristics of Atlantic salmon that are most important for assessing the status of a salmon stock are: mean weight of large and small salmon, percent female of each size group, and relative fecundity. The values of these parameters determine the reproductive potential of the stock.

The mean weights (1.63 kg for small, 5.06 kg for large) and percentage female (71.9% for small, 86.8% for large salmon) used in this assessment are values for years 1992-94 from

Table 6a,b in Reddin & Mullins (1996). These values are the same for all three rivers. The estimated mean fecundity of 1540 eggs/kg of body weight was used (Porter & Chadwick 1983).

Conservation spawning requirements

Spawning requirements for Atlantic salmon represent an estimate of the number of eggs (or spawners) required for conservation of the stock (O'Connell & Dempson 1995). Juvenile salmon rear in both stream and lake habitat and thus spawning requirements should be based on both types (O'Connell & Dempson 1995). The available habitat in Crabbes, Middle Barachois and Robinsons rivers is mostly fluvial with little pond habitat (Table 1). Those lakes that are present are mostly found in the upper part of the watershed and are inaccessible to migrating salmon. Therefore, in relation to the river habitat, the contribution of parr produced in lakes to the total produced would be small but still important.

Conservation egg deposition requirements for Crabbes, Middle Barachois and Robinsons rivers are those calculated by Reddin & Mullins (1996) as target eggs. These numbers are:

$$
\begin{aligned}
\text{Crabbes} &\ldots\ldots\ldots\ldots 4{,}600{,}000 \text{ eggs} \\
\text{Middle Barachois} &\ldots\ldots 2{,}100{,}000 \text{ eggs} \\
\text{Robinsons} &\ldots\ldots\ldots\ldots 3{,}300{,}000 \text{ eggs}
\end{aligned}
$$

The conservation requirements in terms of small (CS_S) and large salmon spawners (CS_L) were calculated as follows:

(1)
$$
CS_{S \, or \, L} = \frac{CED * P_{S \, or \, L}}{(P_S * PF_S * MW_S * RF_S) + (P_L * PF_L * MW_L * RF_L)}
$$

where:

CED	= egg deposition required for Conservation
$P_{S \, or \, L}$	= proportion small or large salmon for conservation
$PF_{S \, or \, L}$	= percent female small or large salmon
$MW_{S \, or \, L}$	= mean weight for small or large salmon
$RF_{S \, or \, L}$	= relative fecundity for small or large salmon

The proportion small and large salmon used to determine the number of spawners required to achieve the egg deposition levels required for conservation for Crabbes, Middle Barachois and Robinsons rivers are the values observed in the visual survey in 1996. These proportions should represent the entire population since there was no known selective harvest. Other biological characteristics are those referenced above in the Biological Characteristics Section.

Total Returns to the Rivers and Number of Spawners

Atlantic salmon were visually counted in Crabbes, Middle Barachois, and Robinsons rivers by surveyors snorkelling or, where the water was not deep enough, walking down each river. Only one tributary on each river was surveyed since all other tributaries were small and had very low water levels and salmon were unlikely to have ascended them. The main stem of each river which is accessible to sea-run Atlantic salmon was divided into five Sections with each section being less than 10 km in length (Fig. 2, 3 and 4). A crew of two or three people were assigned to each Section. For most sections, one or two surveyors would passively float or swim the river and count salmon, and one person would walk the river bank and record the information. Water levels in most riffle areas were too low for swimming, particularly in the upper sections (Sections 1 and 2) of each river. Sections 1-4 of Crabbes River and tributary (Little Crabbes Brook) (Fig. 2a) were surveyed on 28 August 1996 and Section 5 on 29 August. Section 1 of Middle Barachois (Fig. 2b) was surveyed on 28 August and Sections 2-5 and tributary (Big Dribble Brook) were surveyed 29 August. Sections 1-5 on Robinsons River (Fig. 2c) was surveyed on August 30, and its tributary, Northern Feeder was surveyed on 5 September. Information collected included: numbers of large and small salmon, and a description of the locations where salmon were observed. The procedure for the snorkel team was to float through a pool, preferably to one side, with as little movement as possible, and count the salmon. If the surveyors were unsure of the count , they would float through the pool a second or third time. In some pools, the river conditions and location of fish were such that it was possible for the snorkel team to hold position and count salmon.

No attempt was made to calibrate differences between teams or individuals since there are many factors which affect accuracy of the counts. These factors include water depth and width of pools, turbidity and colour of water, angle of sun, and light conditions in general.

The water levels in the rivers were very low and salmon were only found in pools; however some of the pools were too deep and/or too wide to obtain a complete count of salmon in them. Therefore, an adjustment factor was applied to the count in each Section to obtain an estimate of the maximum number of salmon in the each river. This factor was subjectively determined in consultation with the surveyors, taking into consideration the number and size of the pools in which complete counts could not be ascertained, and the number of salmon counted in adjacent pools. No adjustments were made for the possibility of salmon in other tributaries because the tributaries are small and water levels were so low that it was unlikely that salmon would be in them. Due to the low water levels it is unlikely that salmon moved between Sections during the period of the survey. The sizing of the salmon by the various survey teams were examined for possible differences or bias in sizing by comparing whether or not a particular team consistently recorded a higher or lower number of large salmon than other teams. No bias were found, so no adjustment were made to the proportion of large and small salmon recorded by each team.

The unadjusted counts are assumed to be the minimum number of salmon in each river and the adjusted numbers are believed to represent the maximum numbers of salmon in

each river. It is assumed that the results of the survey represent the total run to each river and the spawning escapement, since no information is available on unrecorded mortalities.

Egg deposition

The minimum and maximum egg deposition (ED_{mi} & ED_{mx}) for each river, in 1996, was calculated for small and large salmon separately then summed as follows:

(2) $\qquad ED_{mi} = (UN_S * PF_S * RF_S * MW_S) + (UN_L * PF_L * RF_L * MW_L)$

(3) $\qquad ED_{mx} = (AN_s * PF_S * RF_S * MW_S) + (AN_L * PF_L * RF_L * MW_L)$

where,

$UN_{S\ or\ L}$ = unadjusted numbers of small and large salmon counted in the survey

$AN_{S\ or\ L}$ = adjusted number of small or large salmon counted in the survey

Percentage of Conservation Level Achieved

The minimum and maximum percentage of the conservation egg deposition levels which were achieved in each river were calculated as follows:

(4)   Percentage of conservation level achieved = $(ED_{mi\ or\ mx} / CED) * 100$

RESULTS

Recreational Fisheries data

There were `hook and release' recreational fisheries on Crabbes, Middle Barachois and Robinsons rivers from 1 June to 20 August, 1996. The rivers were closed from 21 August to 2 September due to low water levels and high water temperatures. Retention of salmon was not permitted. No data were collected on the numbers of salmon hooked and released. However, the River Monitors reported that there were few anglers fishing. Historical angling data are provided in Appendices 1, 2, and 3.

Unrecorded mortalities

No estimates of hook and release mortality can be make due to the lack of angling catch statistics. No information are available on removals due to poaching; however it

was noted that very few salmon were observed with net marks or other physical injuries.

Biological characteristics

The parameter values for mean weights and percent female used to calculate the egg depositions are shown in Table 2. The proportions small and large salmon shown in Table 2 are those observed during the visual counts and are detailed in Tables 3-5. The same biological characteristics were used to calculate the number of small and large salmon required for conservation.

Conservation Spawning Requirements

The number of eggs required for conservation and equivalent numbers of fish are:

River	Eggs Required	Spawners Required	
		Small	Large
Crabbes	$4.6*10^6$	1,235	350
Middle Barachois	$2.1*10^6$	996	45
Robinsons	$3.3*10^6$	1,154	180

The relative proportions of small and large salmon in the `Spawner Required columns', for the three rivers, are based on the proportion of small and large salmon observed in during the visual spawner survey.

Total Returns to Rivers and Number of Spawners

The numbers of salmon counted in each Section of Crabbes, Middle Barachois and Robinsons rivers are provided in Tables 3, 4, and 5. The largest number of small salmon were counted in Section 1 of each river (Figs 2, 3, & 4). In Crabbes River, the largest number of large salmon were found in Section 4; whereas in Middle Barachois and Robinsons rivers most of the large salmon were found in Section 1. There were 592 small salmon and 144 large salmon counted in Crabbes River: 755 small salmon and 34 large salmon counted in Middle Barachois River; and 659 small and 102 large salmon counted in Robinsons River. There were very few salmon counted in the tributaries surveyed on Crabbes and Middle Barachois rivers. Forty-one small salmon were counted in Northern Feeder, tributary of Robinsons River; and 40 of these fish were in one pool in the lower portion of the tributary.

Salmon where highly concentrated in a small number of pools in each river. Densities of greater than 10 salmon were found in 17 pools on Crabbes River, 16 pools on Middle Barachois River and only 10 pools on Robinsons River (Tables 3, 4 and 5). No salmon were found in riffle areas and very few in water depths less than one meter. Some pools were too large or deep to get a complete count of the salmon in them. The adjustment factors that were developed for each Section ranged from 1.0 to 2.0 (Tables 3, 4 and 5). The least adjustment was required for Middle Barachois River, and the greatest adjustment was required for Crabbes River due to the number of large pools which could not be completely surveyed.

The adjusted numbers of salmon are: for Crabbes River, 844 small and 239 large; for Middle Barachois River, 805 small and 36 large; and for Robinsons River, 768 small and 120 large (Tables 3, 4 and 5). The percentage of the populations that were large salmon was 22.1% for Crabbes River, 4.3% for Middle Barachois River, and 13.5% for Robinsons River (Tables 3, 4 and 5).

The unadjusted numbers of salmon are considered the minimum numbers of salmon in the rivers and the adjusted numbers of salmon are considered the maximum numbers. It is assumed that the minimum and maximum numbers of salmon in the river at the time of the survey are equivalent to the minimum and maximum total returns to the rivers and spawning escapements, since no estimates were made for in-river mortalities.

Egg deposition

The egg deposition in Crabbes River, Middle Barachois River and Robinsons River, in 1996, are as follows:

	Minimum	Maximum	
Crabbes R	$2.0*10^6$	$3.1*10^6$	eggs
Middle Barachois R	$1.6*10^6$	$1.7*10^6$	eggs
Robinsons R	$1.9*10^6$	$2.2*10^6$	eggs

Percentage of Conservation Level Achieved

Table 6 provides the percentage of the conservation egg deposition requirements which were achieved in 1996. The minimum and maximum percent of the conservation egg requirement which were achieved are: Crabbes River 44% and 68% (mid-point 56%); Middle Barachois River 76% & 81% (mid-point 79%); and Robinsons River 57% and 67% (mid-point 62%).

DISCUSSION

The status of the salmon stock in Crabbes, Middle Barachois, Robinsons rivers in 1996 is similar to that derived for 1994 by Reddin and Mullins (1996) (Tables 7, 8 and 9, Fig. 5). All three rivers had egg depositions less than that which is required for conservation. The numbers of small salmon spawners (592-844) in Crabbes River in 1996 was the highest since 1984; and the number of large salmon spawners (144-239) was the highest since 1981 (Table 8). Crabbes River, in 1996, achieved the highest percentage of its conservation level (56%, mid-point of range) since 1965 (Table 9).

The estimated spawning escapement of small salmon (755-805) in Middle Barachois River in 1996, was the highest since 1981; but the number of large salmon (34-36) was the lowest estimate since 1991. The percentage of conservation level (76-81%) achieved in 1996, is only slightly higher than the 74% estimated for 1994 (Table 9). However it is the highest percentage of its conservation level achieved since 1980. The proportion of the total river escapement to Middle Barachois in 1996, which was large salmon (0.043) is lower than the 1992-94 mean (0.087) calculated from Reddin and Mullins (1996) (Tables 4 and 8).

The estimated spawning escapement of small salmon (659-768) and large salmon (102-120) in Robinsons River in 1996, was similar to that estimated for 1994 by Reddin and Mullins (1996) (Table 8). Thus the percentage of conservation level achieved (57-67%) is also similar to the estimates for 1994 (Table 9). The proportion of the total river escapement to Robinsons River in 1996, which was large salmon (0.135) is similar to the 1992-94 mean (0.146) calculated from Reddin and Mullins (1996) (Tables 5 and 8).

The number of spawners required to deposit sufficient eggs for conservation on each of the three rivers (Table 2) is less than the numbers of spawners calculated by Reddin and Mullins (1996). The differences is due to the differ values for biological characteristics used in the calculations. In this analysis, the proportions of large and small salmon are the proportions observed during the visual surveys; whereas, the percentage female salmon and mean weights are those calculated by Reddin and Mullins (1996) for years 1992-94 (see Table 6a,b in Reddin and Mullins, (1996)). Reddin and Mullins used the average biological characteristics for the period 1953-94 to calculate spawner requirements.

The absence of recent information on the mean weight and sex ratio of large and small salmon in Crabbes, Middle Barachois, and Robinsons rivers is a shortcoming of this assessment. An effort should be made to collect these data and incorporate them into the next assessment. The small salmon in Middle Barachois River appears, from the visual survey, to be smaller in size than the small salmon in Crabbes and Robinsons rivers. Techniques to improve the capability to count salmon in large pools should be developed. Also further surveys should consider observer effect.

There were very few net marked salmon observed during the visual surveys which suggests that marine by-catch in other species gear, and illegal netting in the rivers may be low.

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Table 1. Drainage area, available fluvial habitat, and egg deposition levels required for conservation in Crabbes, Middle Barachois and Robinsons rivers.

RIVER NAME	DRAINAGE AREA (sq. km)	FLUVIAL REARING UNITS (100 sq. m)	STANDING WATER (ha)	Conservation Requirement EGGS (x 10**6)
Crabbes	551	18,429	381	4.6
Middle Barachois	241	8,395	362	2.1
Robinsons	439	13,491	124	3.3
Total	1,231	40,315	866	10.0

Table 2. Conservation spawner requirements for Crabbes, Middle Barachois, and Robinsons rivers.

River	Small Salmon			Large salmon			Conservation Spawners	
	% of Total	% Female	Mean Wt(kg)	% of Total	% Female	Mean Wt(kg)	Small	Large
Crabbes	77.9	71.9	1.63	22.1	86.8	5.06	1235	350
Middle Barachois	95.7	71.9	1.63	4.3	86.8	5.06	996	45
Robinsons	86.5	71.9	1.63	13.5	86.8	5.06	1154	180
Total							3385	575

Table 3. Number of small and large salmon counted in Crabbes River, 28 & 29 August 1996 .

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	5	341	49	1.10	375	54	429	12.6
2	3	56	10	1.50	84	15	99	15.2
3	4	98	11	2.00	196	22	218	10.1
4	5	89	74	2.00	178	148	326	45.4
5	0	3	0	2.00	6	0	6	0.0
L Crabbes	0	5	0	1.00	5	0	5	0.0
TOTAL	17	592	144		844	239	1083	22.1

Table 4. Number of small and large salmon counted in Middle Barachois River, 28 & 29 August 1996.

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	6	355	18	1.05	373	19	392	4.8
2	7	315	10	1.05	331	11	341	3.1
3	1	32	5	1.10	35	6	41	13.5
4	2	52	1	1.25	65	1	66	1.9
5	0	0	0	1.00	0	0	0	0.0
Big Dribble	0	1	0	1.00	1	0	1	0.0
TOTAL	16	755	34		805	36	841	4.3

Table 5. Number of small and large salmon counted in Robinsons River, 30 August and in Northern Feeder, 5 Sept 1996 .

River Section	# pools > 10 fish	Unadjusted Count		Adjustment Factor	Adusted Count			Percent Large
		Small	Large		Small	Large	Total	
1	2	343	66	1.20	412	79	491	16.1
2	1	37	0	1.10	41	0	41	0.0
3	1	76	16	1.05	80	17	97	17.4
4	3	86	17	1.20	103	20	124	16.5
5	2	76	3	1.20	91	4	95	0.0
N. Feeder	1	41	0	1.00	41	0	41	0.0
TOTAL	10	659	102		768	120	888	13.5

Table 6. Adjusted and unadjusted numbers of small and large spawners, estimated egg deposition and percentage of egg deposition required for conservation for Crabbes, M. Barachois and Robinsons rivers

River	Small salmon		Large salmon		Egg deposition		% Conservation level	
	unadjust	adjusted	unadjust	adjusted	Min	Max	Min	max
Crabbes	592	844	144	239	2042449	3139829	44	68
Middle Barachois	755	805	34	36	1592619	1696388	76	81
Robinsons	659	768	102	120	1879293	2197769	57	67

Table 7. Estimated total returns to Crabbes, Middle Barachois and Robinsons rivers, 1953-96.
Estimates for 1953-94 are based on angling exploitation rates (Reddin and Mullins 1996).
Estimates for 1996 are based on a visual salmon counts.

Year	Crabbes Small	Crabbes Large	Middle Barachois Small	Middle Barachois Large	Robinsons Small	Robinsons Large
1953	237	85	77	10	1630	380
1954	387	128	110	35	1233	508
1955	253	248	90	38	1210	265
1956	600	548	760	175	1960	498
1957	1103	778	557	170	2653	445
1958	447	685	363	218	1200	745
1959	787	460	197	40	1627	245
1960	490	125	287	38	2533	293
1961	1080	280	717	63	2440	415
1962	1897	490	787	118	3350	293
1963	1560	750	903	363	4020	975
1964	2727	728	1140	248	3117	705
1965	1433	605	1807	278	3403	500
1966	533	282	416	164	1120	258
1967	1078	365	1213	289	1882	302
1968	1004	413	1362	225	1789	267
1969	1851	425	1702	280	1260	133
1970	673	273	827	125	1153	145
1971	689	155	1222	98	829	104
1972	884	276	773	335	638	75
1973	740	193	1262	140	1822	155
1974	653	178	571	127	787	31
1975	600	164	1133	213	1358	76
1976	424	105	1169	84	1236	102
1977	482	229	1187	102	896	335
1978	471	397	285	1159	827	386
1979	782	44	692	0	1743	131
1980	1240	284	1619	273	2408	642
1981	1329	359	1172	34	3031	733
1982	1916	234	765	23	3186	233
1983	359	119	469	11	827	51
1984	1346	44	882	0	1767	131
1985	224	30	258	40	880	67
1986	819	108	526	82	804	61
1987	198	26	134	21	543	41
1988	670	89	531	83	684	52
1989	111	15	208	33	274	21
1990	264	35	363	57	547	42
1991	243	32	179	28	415	32
1992	682	126	584	72	967	130
1993	354	34	665	36	531	31
1994	774	113	732	81	910	115
1995						
1996	592 - 844	144 - 239	755 - 805	34 - 36	659 - 768	102 - 120
Mean 53-65	1000	454	599	138	2337	482
Mean 66-77	801	255	1070	182	1231	165
Mean 78-84	1063	212	840	214	1970	330
Mean 85-91	361	48	314	49	592	45
Mean 92-94	603	91	661	63	803	92

Table 8. Spawning escapement of Atlantic salmon in Crabbes, Middle Barachois, and Robinsons rivers, 1953-96. Estimates for 1953-94 are from Reddin and Mullins (1996)

Year	Crabbes		M. Barachois		Robinsons	
	Small	Large	Small	Large	Small	Large
1953	166	51	54	6	1141	228
1954	271	77	77	21	863	305
1955	177	149	63	23	847	159
1956	420	329	532	105	1372	299
1957	772	467	390	102	1857	267
1958	313	411	254	131	840	447
1959	551	276	138	24	1139	147
1960	343	75	201	23	1773	176
1961	756	168	502	38	1708	249
1962	1328	294	551	71	2345	176
1963	1092	450	632	218	2814	585
1964	1909	437	798	149	2182	423
1965	1003	363	1265	167	2382	300
1966	293	127	229	74	616	116
1967	593	164	667	130	1035	136
1968	552	186	749	101	984	120
1969	1018	191	936	126	693	60
1970	370	123	455	56	634	65
1971	379	70	672	44	456	47
1972	486	124	425	151	351	34
1973	407	87	694	63	1002	70
1974	359	80	314	57	433	14
1975	330	74	623	96	747	34
1976	233	47	643	38	680	46
1977	265	103	653	46	493	151
1978	333	270	234	1057	592	318
1979	553	30	568	0	1248	108
1980	877	193	1329	249	1724	529
1981	940	244	962	31	2170	604
1982	1355	159	628	21	2281	192
1983	254	97	385	10	592	42
1984	952	30	724	0	1265	108
1985	129	30	160	40	507	67
1986	472	108	326	82	463	61
1987	114	26	83	21	313	41
1988	386	89	329	83	394	52
1989	64	15	129	33	158	21
1990	152	35	225	57	315	42
1991	140	32	111	28	239	32
1992	393	126	362	72	557	130
1993	204	34	435	36	306	31
1994	600	113	578	81	750	115
1995						
1996	592 - 844	144 - 239	755 - 805	34 - 36	659 - 768	102 - 120
Mean 53-65	700	273	420	83	1636	289
Mean 66-77	441	115	588	82	677	74
Mean 78-84	752	146	690	195	1410	272
Mean 85-91	208	48	195	49	341	45
Mean 92-94	399	91	459	63	538	92

Table 9 . Percentage of the egg deposition level required for conservation acheived on Crabbes, Middle Barachois, and Robinsons rivers, 1953-96. Estimates for 1953-94 are from Reddin and Mullins (1996).

Year	Crabbes	M. Barachois	Robinsons
1953	10	4	73
1954	15	9	75
1955	20	8	53
1956	46	52	92
1957	69	44	104
1958	52	43	95
1959	43	13	61
1960	17	16	87
1961	37	35	96
1962	64	45	107
1963	75	83	184
1964	94	76	138
1965	64	105	127
1966	19	25	32
1967	28	54	45
1968	30	51	42
1969	38	63	26
1970	20	30	25
1971	14	35	18
1972	22	50	14
1973	16	40	35
1974	15	25	13
1975	14	45	23
1976	9	32	23
1977	16	35	34
1978	38	254	70
1979	19	34	65
1980	45	136	146
1981	52	64	174
1982	55	42	117
1983	17	25	29
1984	30	43	65
1985	6	18	28
1986	24	36	25
1987	6	9	17
1988	19	37	22
1989	3	14	9
1990	8	25	17
1991	7	12	13
1992	34	53	57
1993	13	48	23
1994	41	74	65
1995	?	?	?
1996	44 - 68	76 - 81	57 - 67
Mean 53-65	47	41	99
Mean 66-77	20	40	28
Mean 78-84	37	86	95
Mean 85-91	10	22	19
Mean 92-94	29	58	49
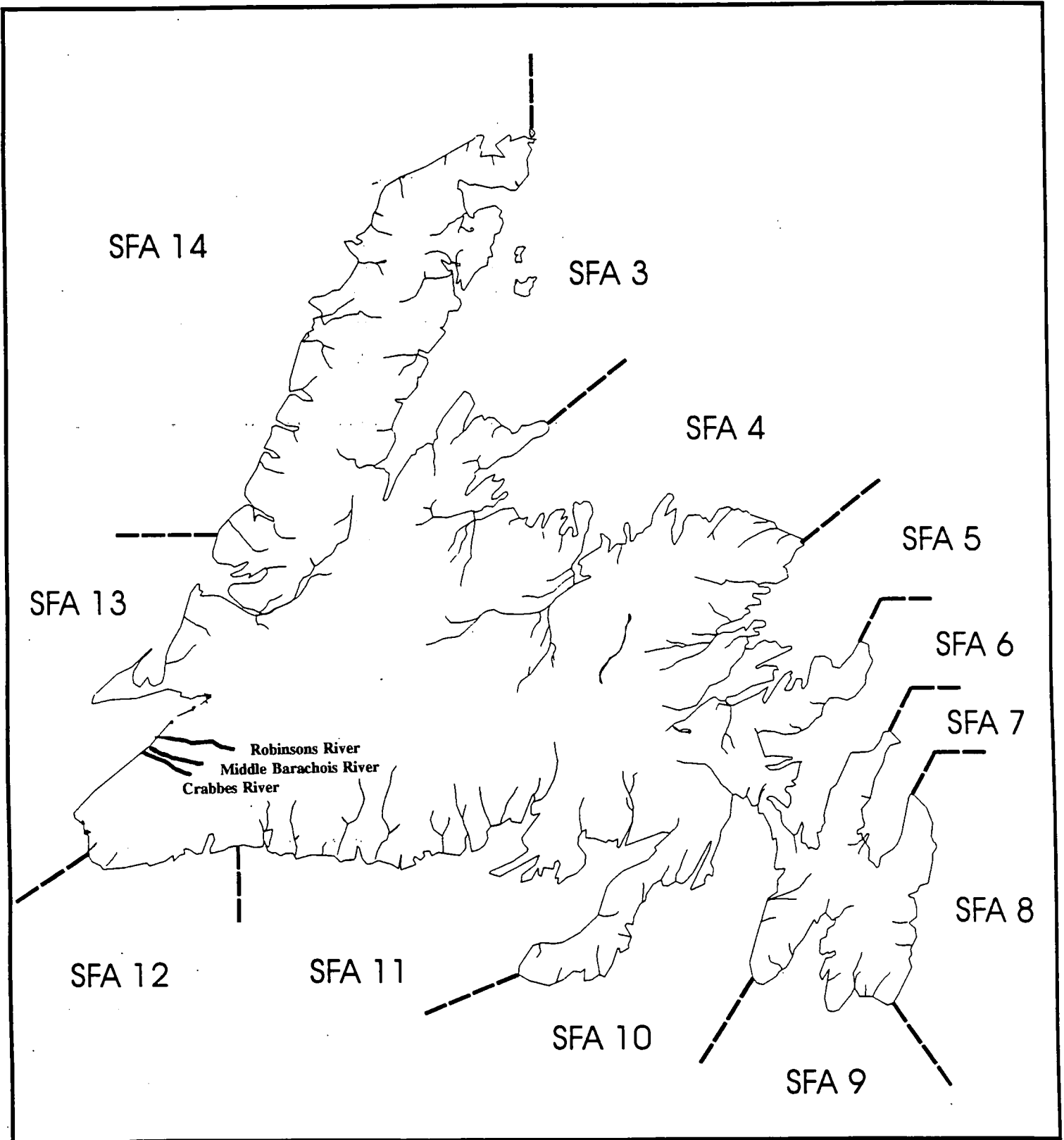
Figure 1. Map showing the salmon fishing areas for Newfoundland and locations of Crabbes, Middle Barachois and Robinsons rivers.

Figure 2. Sections of Crabbes River and Little Crabbes Brook in which visual surveys were conducted.
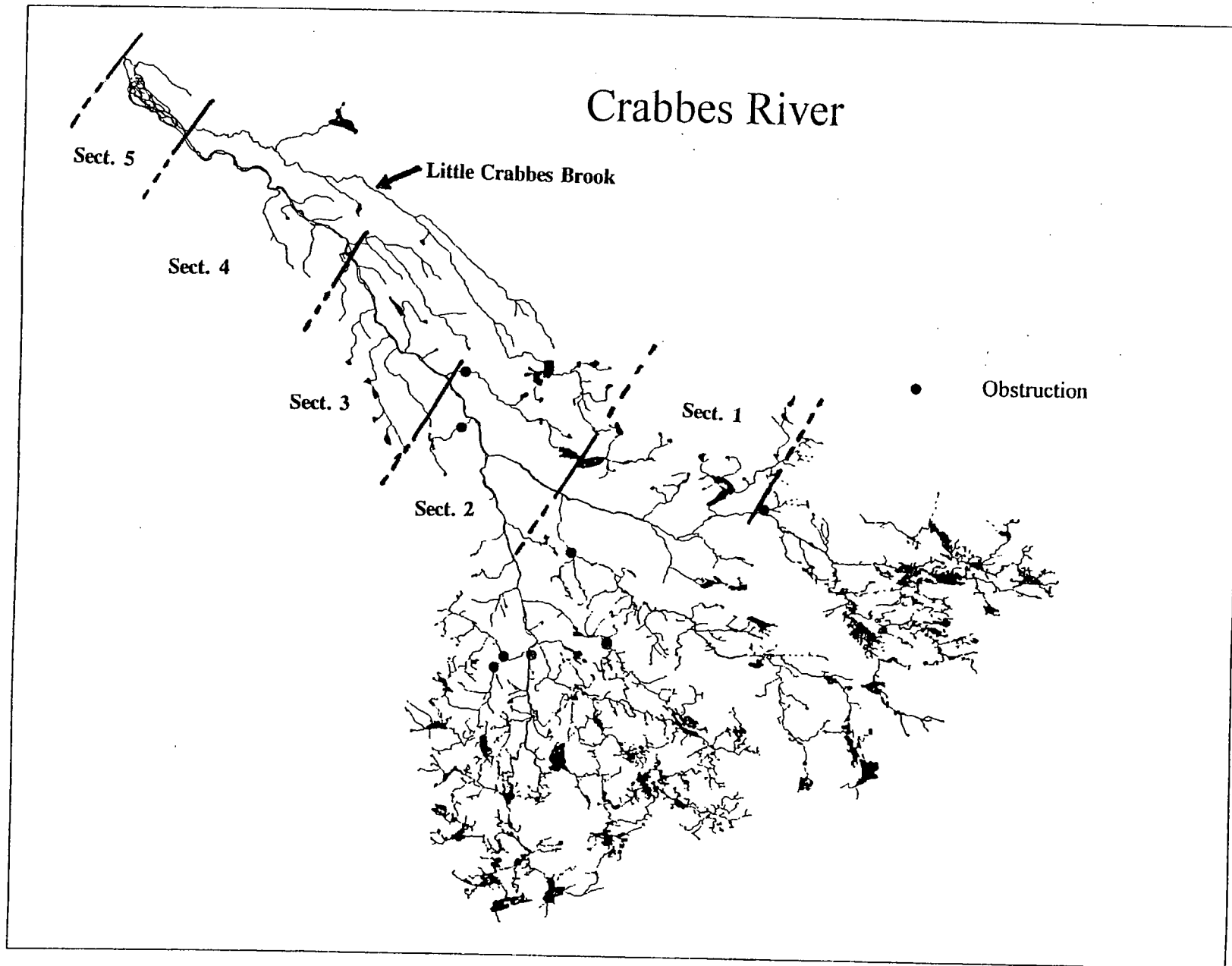
Figure 3. Sections of Middle Barachois River and Big Dribble Brook in which visual surveys were conducted.

Middle Barachois River

Sect. 5

Sect. 4

Sect. 3

Sect. 2

Sect. 1

Big Dribble Brook

● Obstruction

km 2   0   4 km
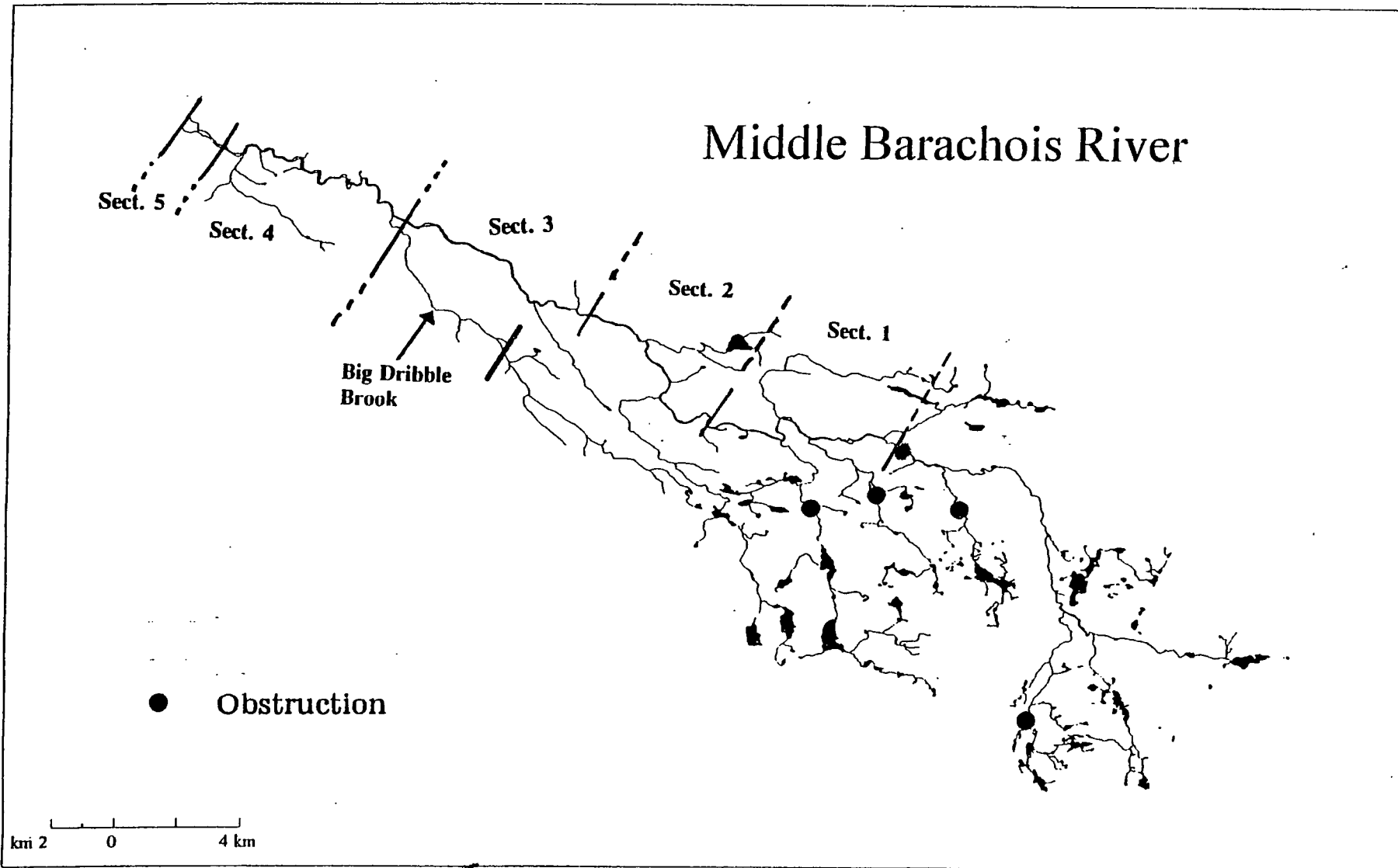
Figure 4. Sections of Robinsons River and Northern Feeder in which visual surveys were conducted.

Robinsons River

Northern Feeder

Sect. 5

Sect. 4

Sect. 3

Sect. 2

Sect. 1

● Obstruction

Crabbes River

1996 = 44 - 68

M. Barachois River

1996 = 76 - 81

Robinsons River

1996 = 57 - 67
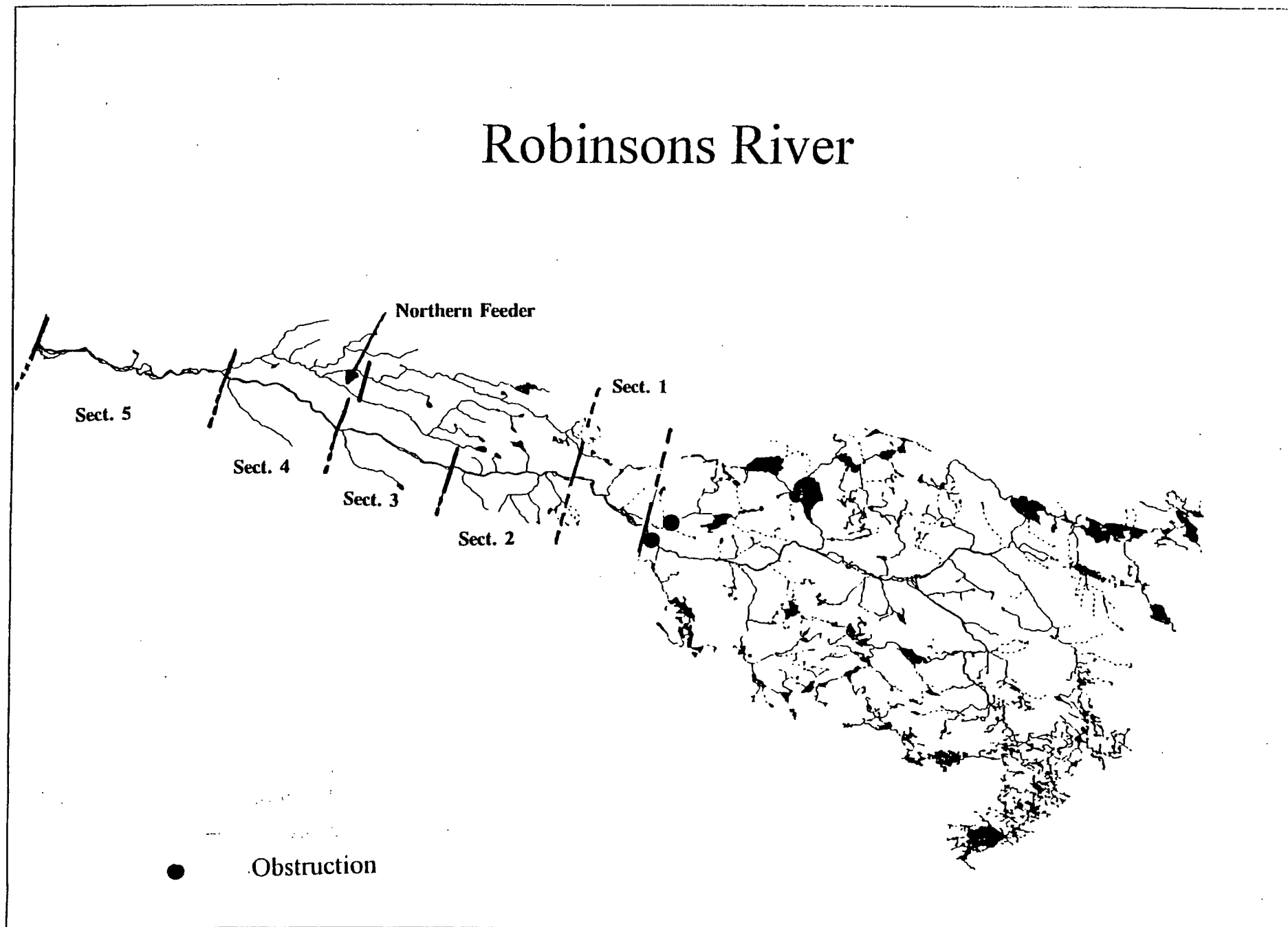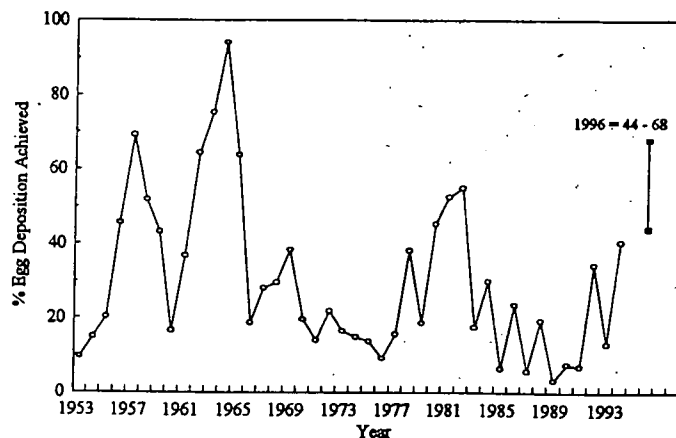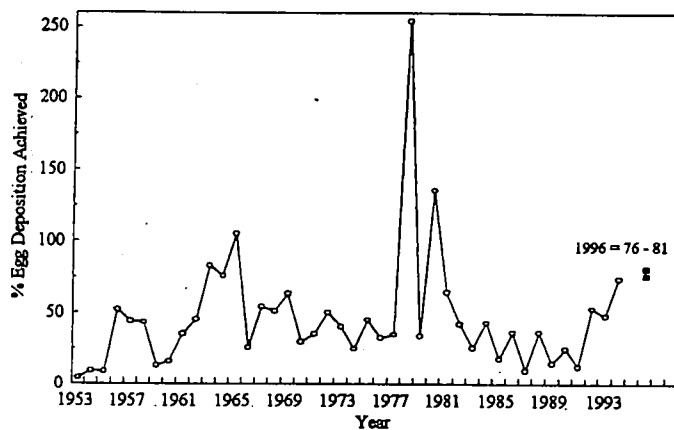
Fig. 5. Percentages of the egg deposition levels required for conservation which were achieved on Crabbes, Middle Barachois and Robinsons rivers 1953-94. Values for 1953-94 are from Reddin and Mullins (1996).

Appendix 1. Recreational catch and effort statistics for Crabbes River, 1974-95.

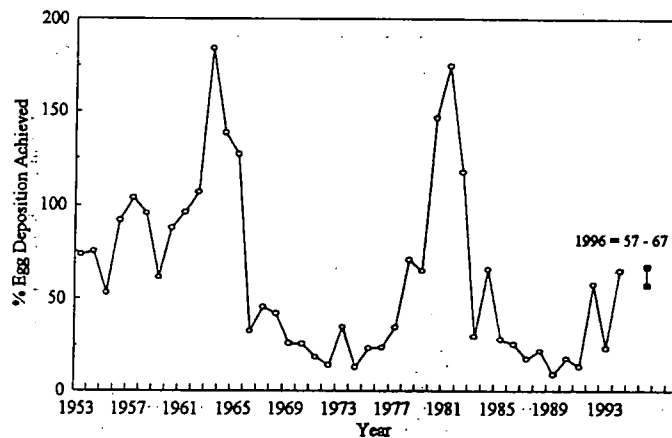| Year	Effort Rod Days	Small (<63 cm) Ret.	Rel.	Tot.	Large (>=63 cm) Ret.	Rel.	Tot.	Total (Small + Large) Ret.	Rel.	Tot.	CPUE
1974	1010	294	.	294	98	.	98	392	.	392	0.39
1975	1641	270	.	270	90	.	90	360	.	360	0.22
1976	859	191	.	191	58	.	58	249	.	249	0.29
1977	859	217	.	217	126	.	126	343	.	343	0.40
1978	907	138	.	138	127	.	127	265	.	265	0.29
1979	501	229	.	229	14	.	14	243	.	243	0.49
1980	902	363	.	363	91	.	91	454	.	454	0.50
1981	905	389	.	389	115	.	115	504	.	504	0.56
1982	1135	561	.	561	75	.	75	636	.	636	0.56
1983	758	105	.	105	38	.	38	143	.	143	0.19
1984	848	394	.	394	14	.	14	408	.	408	0.48
1985	602	95	.	95	*	3	3	95	3	98	0.16
1986	997	347	.	347	*	0	0	347	0	347	0.35
1987	377	84	.	84	*	4	4	84	4	88	0.23
1988	773	284	.	284	*	17	17	284	17	301	0.39
1989	419	47	.	47	*	5	5	47	5	52	0.12
1990	457	112	.	112	*	25	25	112	25	137	0.30
1991	385	103	.	103	*	9	9	103	9	112	0.29
1992	822	263	26	289	*	88	88	263	114	377	0.46
1993	737	150	0	150	*	24	24	150	24	174	0.24
1994	906	174	37	211	*	45	45	174	82	256	0.28
1995	268	26	5	31	*	32	32	26	37	63	0.24
1996**	.	.	.	.	.	.	.	.	.	.	.
84-89 X̄	669.3	208.5	.	208.5	.	5.8	7.2	210.8	5.8	215.7	0.32
95% CL	258.3	158.3	.	158.3	.	8.1	7.1	162.0	8.1	161.6	0.14
N	6	6	0	6	0	5	6	6	5	6	6
86-91 X̄	568.0	162.8	.	162.8	.	10.0	10.0	162.8	10.0	172.8	0.30
95% CL	269.9	128.0	.	128.0	.	9.8	9.8	128.0	9.8	127.3	0.09
N	6	6	0	6	0	6	6	6	6	6	6
92-95 X̄	683.3	153.3	17.0	170.3	.	47.3	47.3	153.3	64.3	217.5	0.32
95% CL	453.9	155.6	27.8	173.2	.	45.4	45.4	155.6	65.9	210.8	0.18
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1996 AND ON RETAINED FISH ONLY PRIOR TO 1985.
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.
**PRELIMINARY

Appendix 2. Recreational catch and effort statistics for Middle Barachois River, 1974-95.

Year	Effort Rod Days	Small (<63 cm) Ret.	Rel.	Tot.	Large (>=63 cm) Ret.	Rel.	Tot.	Total (Small + Large) Ret.	Rel.	Tot.	CPUE
1974	894	257	.	257	70	.	70	327	.	327	0.37
1975	1129	510	.	510	117	.	117	627	.	627	0.56
1976	1572	526	.	526	46	.	46	572	.	572	0.36
1977	1218	534	.	534	56	.	56	590	.	590	0.48
1978	273	51	.	51	102	.	102	153	.	153	0.56
1979	342	124	.	124	0	.	0	124	.	124	0.36
1980	622	290	.	290	24	.	24	314	.	314	0.50
1981	487	210	.	210	3	.	3	213	.	213	0.44
1982	313	137	.	137	2	.	2	139	.	139	0.44
1983	292	84	.	84	1	.	1	85	.	85	0.29
1984	320	158	.	158	0	.	0	158	.	158	0.49
1985	422	98	.	98	*	1	1	98	1	99	0.23
1986	683	200	.	200	*	23	23	200	23	223	0.33
1987	208	51	.	51	*	0	0	51	0	51	0.25
1988	565	202	.	202	*	11	11	202	11	213	0.38
1989	395	79	.	79	*	1	1	79	1	80	0.20
1990	547	138	.	138	*	7	7	138	7	145	0.27
1991	293	68	.	68	*	6	6	68	6	74	0.25
1992	535	222	0	222	*	22	22	222	22	244	0.46
1993	916	230	23	253	*	11	11	230	34	264	0.29
1994	785	154	25	179	*	14	14	154	39	193	0.25
1995	341	53	2	55	*	24	24	53	26	79	0.23
1996**	.	.	.	.	.	.	.	.	.	.	.
84-89 X̄	432.2	131.3	.	131.3	.	7.2	6.0	131.3	7.2	137.3	0.32
95% CL	178.7	67.6	.	67.6	.	12.3	9.8	67.6	12.3	75.3	0.10
N	6	6	0	6	0	5	6	6	5	6	6
86-91 X̄	448.5	123.0	.	123.0	.	8.0	8.0	123.0	8.0	131.0	0.29
95% CL	189.6	70.5	.	70.5	.	8.8	8.8	70.5	8.8	78.0	0.07
N	6	6	0	6	0	6	6	6	6	6	6
92-95 X̄	644.3	164.8	12.5	177.3	.	17.8	17.8	164.8	30.3	195.0	0.30
95% CL	408.3	130.4	21.2	138.4	.	9.9	9.9	130.4	12.2	131.9	0.14
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
CPUE IS BASED ON RETAINED + RELEASED FISH FOR 1985-1996 AND ON RETAINED FISH ONLY PRIOR TO 1985.
* NOT ALLOWED TO RETAIN LARGE SALMON IN INSULAR NEWFOUNDLAND.
**PRELIMINARY

Appendix 3. Recreational catch and effort statistics for Robinsons River, 1974-95.

Year	Effort Rod Days	Small (<63 cm) Ret.	Small (<63 cm) Rel.	Small (<63 cm) Tot.	Large (>=63 cm) Ret.	Large (>=63 cm) Rel.	Large (>=63 cm) Tot.	Total (Small + Large) Ret.	Total (Small + Large) Rel.	Total (Small + Large) Tot.	CPUE
1974	1134	354	.	354	17	.	17	371	.	371	0.33
1975	1556	611	.	611	42	.	42	653	.	653	0.42
1976	1842	556	.	556	56	.	56	612	.	612	0.33
1977	1184	403	.	403	184	.	184	587	.	587	0.50
1978	671	235	.	235	68	.	68	303	.	303	0.45
1979	989	495	.	495	23	.	23	518	.	518	0.52
1980	1352	684	.	684	113	.	113	797	.	797	0.59
1981	1527	861	.	861	129	.	129	990	.	990	0.65
1982	1648	905	.	905	41	.	41	946	.	946	0.57
1983	2580	278	.	278	210	.	210	488	.	488	0.19
1984	1884	502	.	502	23	.	23	525	.	525	0.28
1985	1905	373	.	373	*	7	7	373	7	380	0.20
1986	2344	341	.	341	*	37	37	341	37	378	0.16
1987	1276	230	.	230	*	15	15	230	15	245	0.19
1988	1528	290	.	290	*	9	9	290	9	299	0.20
1989	971	116	.	116	*	11	11	116	11	127	0.13
1990	1182	232	.	232	*	22	22	232	22	254	0.21
1991	818	176	.	176	*	10	10	176	10	186	0.23
1992	1552	386	24	410	*	75	75	386	99	485	0.31
1993	1284	225	0	225	*	18	18	225	18	243	0.19
1994	1051	160	88	248	*	38	38	160	126	286	0.27
1995	719	73	38	111	*	23	23	73	61	134	0.19
1996**	.	.	.	.	.	.	.	.	.	.	.
84-89 X̄	1651.3	308.7	.	308.7	.	15.8	17.0	312.5	15.8	325.7	0.20
95% CL	517.9	137.8	.	137.8	.	15.2	11.9	145.1	15.2	142.5	0.05
N	6	6	0	6	0	5	6	6	5	6	6
86-91 X̄	1353.2	230.8	.	230.8	.	17.3	17.3	230.8	17.3	248.2	0.18
95% CL	571.1	83.7	.	83.7	.	11.3	11.3	83.7	11.3	91.5	0.03
N	6	6	0	6	0	6	6	6	6	6	6
92-95 X̄	1151.5	211.0	37.5	248.5	.	38.5	38.5	211.0	76.0	287.0	0.25
95% CL	562.6	210.4	59.1	196.0	.	41.0	41.0	210.4	74.7	233.4	0.11
N	4	4	4	4	0	4	4	4	4	4	4

IN THE ABOVE TABLE A PERIOD INDICATES NO DATA FOR THAT YEAR.
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**PRELIMINARY