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Results of Atlantic Salmon Tagging Study in Miramichi Bay, New Brunswick

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ABSTRACT

Reddin, D. G. 1984. Results of Atlantic salmon tagging study in Miramichi Bay, New Brunswick. Can. Tech. Rep. Fish. Aquat. Sci. 1301: iv + 22 p.

Results of tag returns from a study in Miramichi Bay, New Brunswick, in 1970 show that between 12% and 24% of the salmon were destined for rivers other than the Miramichi River. These fish were multi-sea-winter salmon and were caught between June 11-25, 1970. The sea age composition of the salmon catch was 44.8% 1-sea-winter, 51.8% 2-sea-winter, 2.1% 3-sea-winter, and less than 1% previous spawners. Mean fork lengths were 53.8 cm, 72.3 cm, 82.6 cm, and 78.7 cm for 1SW, 2SW, 3SW, and previously spawned salmon respectively. Comparisons are made to results of a previous study in the same area in 1937 by Belding and Prefontaine (1939).

RÉSUMÉ

Reddin, D. G. 1984. Results of Atlantic salmon tagging study in Miramichi Bay, New Brunswick. Can. Tech. Rep. Fish. Aquat. Sci. 1301: iv + 22 p.

Les étiquettes récupérées au cours d'une étude menée dans la baie Miramichi (Nouveau-Brunswick) en 1970 montrent qu'entre 12% à 24% des saumons étaient en route vers une rivière autre que la Miramichi. Ces poissons, qui avaient passé plusieurs hivers en mer, ont été capturés du 11 au 25 juin 1970. La répartition des années passées en mer était la suivante; 44,8%, 1 an; 51,8% 2 ans; 2,1%, 3 ans; et moins de 1% d'anciens géniteurs. Pour ces groupes respectifs, la longueur moyenne à la fourche s'élevait à 53,8 cm, 72,3 cm, 82,6 cm et 78,7 cm. On effectue des comparaisons avec les résultats d'une étude antérieure menée dans la même région en 1937 par Belding et Prefontaine (1939).

INTRODUCTION

Historically, the Miramichi River system in northeastern New Brunswick has been one of the major salmon producing rivers in eastern Canada. The salmon stocks of this river have contributed to distant fisheries around the coast of Newfoundland-Labrador and at West Greenland (Saunders et al. 1965, Saunders 1969) and to local commercial fisheries that have harvested substantial numbers of Miramichi salmon from trap nets in the tidal portion of the river system and from drift nets in Miramichi Bay (Elson and Kerswill 1955; Kerswill 1955). Much smaller numbers of Miramichi salmon were also harvested in commercial fisheries in other parts of New Brunswick, Quebec, and Nova Scotia. The Miramichi system also supports a large angling fishery in its two main branches and extensive series of tributaries. The commercial fisheries, in and around the estuary, were banned in 1972 because of decreasing stock levels and resumed in 1981 under quota management. At the same time the drift net fishery based at Port-aux-Basques, Newfoundland, ceased permanently because studies had shown this fishery intercepted a large proportion of fish originating in rivers in the Gulf of St. Lawrence region of New Brunswick and Quebec (Belding and Prefontaine 1938; May 1973).

The objective of this report is to summarize biological characteristics of catches and tag recapture information for salmon caught in drift gillnets in Miramichi Bay, 1970.

MATERIALS AND METHODS

The research vessel M.V. MARINUS operated in Miramichi Bay, New Brunswick, from June 11 to July 9, 1970. In all, 25 driftnet sets were made fishing 10 multifilament (ulstron) mesh nets of 114 mm, 15 multifilament (ulstron) mesh nets of 154 mm and 15 nets of monofilament nylon mesh measuring 150 mm. All net measurements were made while the nets were wet and 20 meshes were measured per net from knot to knot (length of mesh opening). These measurements were made during set 56 near the end of the tagging experiment. The nets were fished in different orders to determine the relative fishing efficiencies of the three mesh sizes and two mesh types by switching monofilament and multifilament from the center to the ends of the fleet. The order, during June 11-17 (Period 1) and June 26-July 3 (Period 3), was as follows: 114 mm multifilament nets followed by 150 mm monofilament nets followed by 154 mm multifilament nets. The order, during June 18-25 (Period 2) and July 4-9 (Period 4) was as follows: 114 mm multifilament nets followed by 154 mm multifilament nets followed by 150 mm monofilament nets.

Tagging was done from a small open boat whenever weather conditions permitted. Salmon were removed from the nets by cutting mesh with scissors, released into a small tank in the tagging boat, and held for a short recovery period prior to tagging. A double hollow needle was inserted through the dorsal musculature just below the anterior base of the dorsal fin; wires were then inserted into the needles; needles removed; and wires pulled tight and twisted leaving enough wire free for growth. The tags were yellow plastic, tapered 5.2 mm-3.5 mm wide, 42 mm long, and 0.5 mm thick.

Tagged fish were sampled for fork length (nearest cm) and scale samples were removed from the left side three to six scale rows above the lateral line on a line extending from the posterior edge of the base of the dorsal fin to the anterior edge of the anal fin. Scales were later mounted on plastic slides and freshwater and sea ages determined.

Fish not suitable for tagging were measured for fork length (nearest mm), gutted weight (nearest 0.1 kg), scales were removed (as above), and sex and maturity determined. One fish caught without a head was discarded. Salmon which had been caught in the commercial salmon driftnet fishery in Miramichi Bay were purchased from Loggieville Cold Storage to supplement the morphometric and meristic measurements taken from tagging mortalities.

RESULTS

CATCHES AND CATCH RATES

Three hundred and eighty-four (384) salmon were caught in 25 sets, including one fish caught without a head that was subsequently discarded. In addition, two salmon were lost while hauling back the gear. There were 302 fish tagged and released; including two salmon that were caught with tags already attached (Table 1). The remaining 80 plus 45 bought from Loggieville Cold Storage were sampled for detailed measurements.

The number of fish caught per mile-hour ranged from 0 in set 33 to 15.15 in set 54 (Table 1). The mean catch rate of 6.31 salmon per mile-hour in the 114 mm multifilament gear was significantly higher than the catch rate of 1.56 in the 150 mm monofilament gear ($Z = 3.25$, $N = 48$) and the 1.37 in 154 mm multifilament gear ($Z = 3.40$, $N = 48$) at 0.05 level of significance. Mean catch rates in the 150 mm monofilament and 154 mm multifilament gears were similar ($Z = -0.54$, $N = 48$) at the 0.05 level of significance (Table 2). The gear fished in the middle of the series always had the second best catch rate; although in Periods 1 and 2 there were no significant differences between catch rates and in Period 3 only the catch rate in 114 mm gear was significantly different from that of the 154 mm gear ($Z = 2.39$, $N = 14$). In Period 4, the catch rate of the 114 mm gear was significantly different from that of the 154 mm gear ($Z = 3.92$, $N = 10$) and 150 mm gear ($Z = 4.61$, $N = 10$).

TAG RECAPTURES

There were 134 recaptures from the 304 tagged salmon; 3 of the recaptures were from the Federal Department of Fisheries fish counting facilities on Miramichi River. Of the remaining 131 recaptures, 42.7% were recaptured in the Miramichi Bay drift net fishery, 40.5% were angled in the Miramichi River, 9.2% were caught in estuarine commercial fisheries, and 7.6% were recaptured outside of the Miramichi area (Fig. 1, Table 3). Of the latter group, 30% (3) were recaptured in other rivers, 30% (3) were recaptured in fisheries to the south of Miramichi Bay, 30% (3) to the north, and 10% (1) in other commercial fisheries (Table 3). A multi-sea-winter (MSW) fish was caught the year after tagging in commercial fishing gear at St. Modeste, Labrador, likely as a mended kelt.

It is also interesting that the recapture rate declines with later date of tagging. The percentage recapture of tagged fish declines from 65.3% in Period 1 to 34.6% in Period 4 (Table 3).

If it is assumed that all of the fish recaptured in rivers other than the Miramichi and in fisheries other than those in Miramichi Bay in the year of tagging were from non-Miramichi River stocks, and if recaptures at the fence site on the Miramichi River and recaptures in the year following tagging other than in the Miramichi are excluded, then 87.8% (65/74) of the fish exploited by the research vessel drift nets were Miramichi River fish (Table 4). All of the nine intercepted fish were MSW salmon. If only MSW salmon are included in a similar calculation then only 75.7% (28/37) of the fish exploited in research vessel drift nets were Miramichi River fish (Table 4). As well, all of these intercepted fish were tagged prior to June 26 (Table 4).

Of the 53 salmon recaptured in the Miramichi River by angling, 25 of them or 47.2% were recaptured the year following tagging. Thirty-two (60.4%) of the salmon recaptured in the Miramichi River by angling were 1-sea-winter (1SW) and, of these, 12 (37.5%) were caught in the year following tagging. Twenty-one (39.6%) of the salmon recaptured by angling were MSW and of these, 13 (61.9%) were caught in the year following tagging (Table 4).

Percentage returns were 27.7% and 56.7%, respectively, from the 137 and 164, 1SW and MSW salmon tagged (Table 5).

GEAR SELECTIVITY

Gear selectivity can be defined as the characteristics of the gear that give rise to differences in the probability of capture among the members of an exploited fish population. In this study, the mesh size of the gear used influenced the size of fish caught, numbers caught, and sea age distribution of the catch. The catch per mile-hour in the 114 mm nets was 409% and 365% higher than that in either the 150 mm or 154 mm mesh gear (Table 6).

As previously stated, the sea age distribution of the catch was also influenced by the selective properties of the fishing gear. The 114 mm nets caught more 1SW salmon than did the 154 mm or 150 mm nets, as well as catching a relatively large number of MSW salmon. For 1SW salmon, the catch per mile-hour in the 114 mm nets was 4.30 compared to 0.02 and 0.06 in the 150 mm and 154 mm nets respectively. For 2SW salmon, the catch per mile-hour in the 114 mm nets of 1.45 was similar to that of 1.46 in the 154 mm nets; but compared to the 150 mm nets, the 114 mm and 154 mm nets had a catch per mile-hour of 1.14% and 1.15% higher (Table 6). The relatively high number of 1SW and 2SW salmon caught in the 114 mm nets explains the bimodal peak in the fork length distribution of this gear compared to the unimodal distributions in the other two gears that did not catch many 1SW salmon (Fig. 2).

SEA-AGE DISTRIBUTION

The sea age distribution of the catch is also quite interesting. The total catch from experimental fishing including the sample from commercial

catches at Loggieville consisted of 40.1% - 1SW, 56.9% - 2SW, 1.9% - 3SW and 0.7% - previous spawners (Table 6). Of those fish unsuitable for tagging, 11% of the 1SW salmon and 79% of the 2SW salmon were female.

RIVER AGE DISTRIBUTION

The river age at smoltification for each sea age group of fish sampled during the experimental fishing operation (including Loggieville commercial samples) is given in Table 7. The mean river age for the total sample was 2.88 years, while that of 1SW fish was 2.99 years; 2SW fish was 2.79 years, and sea 3SW fish was 3.25 years (Table 7).

EXPLOITATION RATES AND PATTERNS

Exploitation rates were derived using the following formulae adapted from Ricker (1975):

$$\text{(Petersen)} \mu = \frac{R}{M} (\text{UL}, \text{LL})$$

μ -exploitation rate

R-number of marked fish recaptured in sample

M-number of fish marked

(UL, LL)-upper and lower confidence limits as derived from Ricker (1975, in Appendix II) assuming a Poisson distribution.

This formula assumes that all fish marked and released had survived and that all of the fish caught in various fisheries were examined for marks. Tagging mortality was adjusted for by assuming a mortality rate of 0.25 for those fish that died as a result of physical damage from being retained by the gear or from handling. Further correction was required as some fish tagged were not destined for Miramichi River but some other river.

$$\text{Thus,} \quad \text{(new)} \mu = \frac{R (\text{UL}, \text{LL})}{M(1-m') (1-i)}$$

where,

m' -tagging mortality rate

i -interception rate

Natural mortality occurring from the time that the tag was applied until the fishery occurred was assumed to be zero. That this assumption is reasonable is supported by the low natural mortality rates derived by Doubleday et al. (1979). The number of fish marked (M) was corrected for prior removals in the case of angling and commercial river fisheries.

Tag recaptures in the commercial drift net fishery in Miramichi Bay show exploitation rates of 0.18 and 0.25 respectively for assumed tagging mortality rates of 0 and 0.25 (Table 8). For the multi-sea-winter fish, exploitation rates were 0.33 and 0.44 respectively for assumed tagging mortality rates of 0 and 0.25. For 1-sea-winter fish, exploitation rates were 0.01 and 0.01 for

tagging mortality rates of 0 and 0.25. Interception rates (recapture outside Miramichi Bay) for all sea-ages tagged were 0.12 and 0.16 respectively for assumed tagging mortality rates of 0 and 0.25. For the multi-sea-winter fish, interception rates varied from 0.24 to 0.32 respectively for assumed tagging mortality rates of 0 and 0.25. It was assumed that all of the 1SW fish were of Miramichi origin as none of the 1SW fish were caught in areas other than Miramichi Bay or Miramichi River, and no correction for interception rates was made.

If only fish recaptured in the year of tagging are considered, then angling exploitation rates of 0.13 and 0.18 were calculated for all sea-ages respectively for the assumed tagging mortality rates of 0 and 0.25. If it is assumed that overwintering mortality was negligible, then these rates would increase to 0.24 and 0.34 respectively for all sea-ages by including 'black' salmon (kelts) caught by angling in the spring. For MSW fish, exploitation rates were 0.25 and 0.37 and, for 1SW fish, 0.24 and 0.31 respectively for the assumed tagging mortality rates of 0 and 0.25. Exploitation rates for the "black" salmon fishery that exploits kelts descending to the sea were calculated assuming no overwintering mortality. Exploitation rates for all sea ages were 0.15 and 0.27 respectively for assumed tagging mortality rates of 0 and 0.25. For MSW salmon, exploitation rates were 0.23 and 0.92 respectively for assumed tagging mortality rates of 0 and 0.25. For 1SW salmon, exploitation rates were 0.11 and 0.16 respectively for assumed tagging mortality rates of 0 and 0.25.

Salmon were also exploited by a commercial fishery in the Miramichi River. Exploitation rates on all sea-ages were 0.05 and 0.08 respectively for 0 and 0.25 tagging mortality rates. Exploitation rates on MSW fish were 0.08 and 0.12 respectively if 0 and 0.25 tagging mortality rates are assumed and 0.24 and 0.32 interception rates are assumed. Exploitation rates for 1SW fish were 0.04 and 0.05 if 0 and 0.25 tagging mortality rates and 0 interception rates are assumed.

DISCUSSION

Comparison of catches in the multifilament and monofilament gear of approximately the same mesh size shows no difference in catching efficiency. This finding is rather surprising because Lear and Christensen (1980) demonstrated that monofilament nets were superior to multifilament nets of the same mesh size when fished during daylight hours. The reverse situation occurred in commercial vessels that fished at night. Thus, Lear and Christensen (1980) concluded this difference was caused by greater visibility of the multifilament nets compared to monofilament nets when fished during daylight hours. They concluded that the higher efficiency of multifilament nets fished at night was due to fish being caught by entanglement as opposed to the monofilament nets that caught fish only by gilling. May (1970) supported the same conclusion. Larkins (1963 and 1964) showed for Pacific salmon, using combinations of monofilament-multifilament nets arranged alternately, that relative efficiency of the monofilament nets was highest. The results of the Miramichi study could not be separated into periods of daylight and darkness because during a particular set fishing may have occurred over both periods and

this mixture of night and day fishing may explain why there was no difference between catch rates in the two gear types. As well, fishing effort for each mesh type may be biased as gear was set and hauled in a long string fishing each mesh type together so that one mesh type may have been fished longer depending on which end of the string was hauled first and set first.

Numbers at age and size of fish caught in the three mesh sizes were also different. The 114 mm multifilament gear, while being fished concurrently with the other two mesh sizes, had a catch per mile-hour considerably higher than that of the other two mesh sizes. The catch per mile-hour for 2SW salmon was similar in the 114 mm and 154 mm mesh nets and slightly less in the 150 mm. However, the catch per mile-hour for 1SW salmon was considerably higher in the 114 mm nets than in either of the other two mesh sizes (Table 6).

Mean fork lengths of salmon caught in the 114 mm multifilament nets were significantly smaller than those caught in 150 mm monofilament ($Z = 18.15$, $N = 297$) and 154 mm multifilament nets ($Z = -19.00$, $N = 303$). Mean fork lengths of salmon caught in 150 mm monofilament and 154 mm multifilament were similar ($Z = 0.73$, $N = 160$). Lear and Christensen (1980) for Atlantic salmon and Larkins (1963 and 1964) for Pacific salmon found, similarly to that which occurred in this study, that mean lengths of fish taken in monofilament nets were longer, though not statistically different, than those taken in multifilament nets.

The commercial sample obtained at Loggieville Cold Storage, consisting of 45 salmon, were all 2SW with a mean fork length of 70.9 cm (Table 6). Discussions with commercial fishermen at Escuminac, the main fishing centre, indicated that multifilament gear of 134-140 mm is mainly used in this fishery. Belding and Prefontaine (1939) stated that average mesh size in the commercial fishery was 165 mm (converted from 6.5 inches) in 1937.

The total catch, exclusive of the commercial sample, shows a catch of 384; of which, 44.8% were 1SW, 51.8% were 2SW, 2.1% were 3SW, and less than 1% had previously spawned (Table 6). The mean fork lengths were; 53.8 cm for 1SW, 72.6 cm for 2SW, 82.6 cm for 3SW, and 78.7 cm for previous spawners. Belding and Prefontaine (1939) reported catch composition of 2SW salmon -92.9%, 3SW salmon - 2.2%, and previously spawned salmon 4.9%. The major difference between 1937 and 1970 was the different mesh sizes of gear fished and this is reflected in the greater number of 1SW salmon caught in the later study, most of which were caught in the 114 mm gear. The 2SW salmon caught by Belding and Prefontaine (1939) averaged 77.9 cm fork length.

Sea-age composition of the catch varied with period of fishing from 87.8% MSW in Period 1 to 35.2% in Period 4. Catch in Period 4 also consisted of 1.9% previous spawners (Table 5).

The commercial drift net fishery exploits salmon in Miramichi Bay using nets mostly between 134 mm and 140 mm in size. Thus, they must be exploiting some 1SW fish, as well as MSW fish, because the larger nets of the research fishing exploited 1SW fish. It was illegal to retain grilse, based on size under 5 lb weight, which may explain why none were seen in the "landed" or

marketed portion of the catch and why only one recapture of a tagged grilse resulted from the commercial fishery.

The observation that the mean fork length of 1SW and MSW salmon are significantly longer in the tagged population than the untagged (dead) population could be related to some aspect of non-catch fishing mortality. The longer, tagged fish that were viable for tagging may have been less firmly caught than the shorter untagged (dead) fish and did not suffer the same mortality. Doubleday and Reddin (1981) implied that the size of the escaping fish may be different than those retained by the gear.

The percentage of recaptured salmon that were of known origin (e.g. caught in a river) indicated that 12% of the salmon exploited by the research vessel gear were fish destined for rivers other than the Miramichi River. Because all of the "intercepted" fish were MSW salmon and fewer 1SW fish would be exploited by the commercial drift net fishery than in research drift nets, it may be better to eliminate all 1SW fish from the tagged population to compare to the actual exploited population. Then, 24% of the exploited population may have been intercepted. The actual percentage of fish "intercepted" by the commercial drift net fishery in Miramichi Bay probably was between 12% and 24%.

Belding and Prefontaine (1939) reported that 53% of the salmon caught in Miramichi Bay would have gone to Bay of Chaleur. In our study, only five tagged fish were recaptured in Bay of Chaleur or 13.5% of the MSW salmon. The mean fork lengths of each sea-age caught in the different mesh sizes of the two studies were similar, so the characteristics of the exploited population are approximated by the catch in the research vessel drift nets. These differences in recapture rates between the two studies may be related to: (1) differences in timing as Belding and Prefontaine (1939) fished longer and earlier in the season than in this study; (2) changes in exploitation rates between the times of the two studies; (3) changes in population sizes of Bay of Chaleur stocks relative to Miramichi Bay; and (4) differences in gear selectivity since Belding and Prefontaine (1939) fished using the then current mesh size of 165 mm that would not have exploited 1SW salmon.

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Table I. Summary of catches, dates, locations, surface temperatures, number tagged, and catch rates from experimental drift netting for Atlantic salmon in Miramichi Bay in 1970.

Period no.	Set no.	Date	Lat. N. Long. W.	Surface temperature (°C)	Time (EST) began	Duration hrs & 10ths	Gear			Effort mile-hrs	Fish caught		Fish tagged		No. sampled	Other species
							Mesh	Size (mm)	Amount (fms)		No./ mile-hrs	No./ mile-hrs	No.	No.		
1	33	June 11	47°10'30" 64°51'00"	12.8	0750	1.0	multi	114	250	.250	0	0	0	0	0	8 Mackerel
							mono	150	375	.375	0	0	0	0		
							multi	154	375	.375	0	0	0	0		
									<u>1000</u>	<u>1.000</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>		
1	34	June 12	47°09'00" 64°52'45"	11.7	0725	5.1	multi	114	250	1.275	4	3.14	4	0	0	
							mono	150	375	1.912	13	6.80	11	2		
							multi	154	375	1.912	2	1.05	2	0		
									<u>1000</u>	<u>5.099</u>	<u>19</u>	<u>3.73</u>	<u>17</u>	<u>3.33</u>		
1	35	June 13	47°09'15" 64°53'38"	12.5	0705	5.7	multi	114	250	1.425	5	3.51	4	1 ^a	1 Mackerel	
							mono	150	375	2.138	5	2.34	4	1		
							multi	154	375	2.138	3	1.40	3	0		
									<u>1000</u>	<u>5.701</u>	<u>13</u>	<u>2.28</u>	<u>11</u>	<u>1.93</u>		<u>2^a</u>
1	36	June 15	47°10'15" 64°52'30"	13.2	0700	6.3	multi	114	300	1.890	7	3.70	6	1	6 Mackerel	
							mono	150	500	3.150	2	0.63	2	0		
							multi	154	425	2.678	2	0.75	2	0		
									<u>1225</u>	<u>7.718</u>	<u>11</u>	<u>1.43</u>	<u>10</u>	<u>1.30</u>		<u>1</u>
1	37	June 16	47°09'38" 64°51'45"	12.9	0630	7.8	multi	114	375	2.925	3	1.03	1	2		
							mono	150	500	3.900	3	0.77	2	1		
							multi	154	375	2.925	2	0.68	2	0		
									<u>1250</u>	<u>9.750</u>	<u>8</u>	<u>0.82</u>	<u>5</u>	<u>0.51</u>		<u>3</u>
1	38	June 17	47°11'15" 64°53'30"	15.3	1305	5.4	multi	114	250	1.350	0	0	0	0	3 Mackerel	
							mono	150	500	2.700	1	0.37	1	0		
							multi	154	425	2.295	5	2.18	5	0		
									<u>1175</u>	<u>6.345</u>	<u>6</u>	<u>0.95</u>	<u>6</u>	<u>0.94</u>		<u>0</u>

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Table 1. (Cont'd.)

Period no.	Set no.	Date	Lat. N. Long. W.	Surface temperature (°C)	Time (EST) began	Duration hrs & 10ths	Gear			Fish caught		Fish tagged		No. sampled	Other species	
							Mesh	Size (mm)	Amount (fms)	Effort mile-hrs	No.	mile-hrs	No.			mile-hrs
2	39	June 18	47°08'45" 64°55'45"	14.2	1205	4.7	multi	114	250	1.175	6	5.11	4		2	1 Mackerel
							multi	154	375	1.762	2	1.13	2		0	
							mono	150	375	1.762	1	0.57	1		0	
									<u>1000</u>	<u>4.699</u>	9	<u>1.91</u>	7	1.49	2	
2	40	June 19	47°16'00" 64°44'15"	13.5	1910	3.8	multi	114	250	.950	0	0	0		0	51 Mackerel
							multi	154	375	1.425	1	0.70	1		0	
							mono	150	375	1.425	0	0	0		0	
									<u>1000</u>	<u>3.800</u>	1	<u>0.26</u>	1	0.26	0	
2	41	June 20	47°15'30" 64°43'45"	13.5	0030	4.1	multi	114	250	1.025	0	0	0		0	61 Mackerel
							multi	154	375	1.538	1	0.65	1		0	
							mono	150	375	1.538	2	1.30	1		1	
									<u>1000</u>	<u>4.101</u>	3	<u>0.73</u>	2	0.49	1	
2	42	June 22	47°10'08" 64°52'30"	13.0	0600	7.5	multi	114	250	1.875	3	1.60	2		1	
							multi	154	375	2.812	1	0.36	1		0	
							mono	150	375	2.812	3	1.07	3		0	
									<u>1000</u>	<u>7.499</u>	7	<u>0.93</u>	6	1.46	1	
2	43	June 23	47°09'15" 64°54'00"	13.5	0910	8.1	multi	114	250	2.025	3	1.48	2		1	
							multi	154	425	3.442	5	1.45	4		1	
							mono	150	375	3.038	3	0.99	3		0	
									<u>1050</u>	<u>8.505</u>	11	<u>1.29</u>	9	1.06	2	
2	44	June 24	47°09'23" 64°54'45"	14.0	1155	5.1	multi	114	250	1.275	2	1.57	1		1	
							multi	154	425	2.168	2	0.92	2		0	
							mono	150	375	1.913	0	0	0		0	
									<u>1050</u>	<u>5.355</u>	4	<u>0.75</u>	3	0.56	1	

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Table 1. (Cont'd.)

Period no.	Set no.	Date	Lat. N. Long. W.	Surface temperature (°C)	Time (EST) began	Duration hrs & 10ths	Gear			Effort mile-hrs	Fish caught		Fish tagged		No. sampled	Other species
							Mesh	Size (mm)	Amount (fms)		No.	mile-hrs	No.	mile-hrs		
3	45	June 26	47°10'15" 64°55'53"	12.4	0700	8.0	multi	114	250	2.000	5	2.50	5		0	1 Common lumpfish
							mono	150	375	3.000	6	2.00	6		0	
							multi	154	375	3.000	4	1.33	4		0	
								<u>1000</u>	<u>8.000</u>	<u>15</u>	<u>1.88</u>	<u>15</u>	1.88	<u>0</u>		
3	46	June 28	47°08'30" 64°56'30"	11.4	1330	13.8	multi	114	250	3.450	11	3.19	8		3	
							mono	150	375	5.175	9	1.74	9		0	
							multi	154	375	5.175	12	2.32	11		1	
								<u>1000</u>	<u>13.800</u>	<u>32</u>	<u>2.32</u>	<u>28</u>	2.03	<u>4</u>		
3	47	June 29	47°10'00" 64°55'30"	11.4	0515	3.5	multi	114	250	.875	0	0	0		0	
							mono	150	375	1.312	0	0	0		0	
							multi	154	375	1.312	0	0	0		0	
								<u>1000</u>	<u>3.499</u>	<u>0</u>	<u>0</u>	<u>0</u>	0	<u>0</u>		
3	48	June 30	47°08'45" 64°56'00"	12.5	0745	5.6	multi	114	250	1.400	2	1.43	1		1	
							mono	150	375	2.100	2	0.95	2		0	
							multi	154	375	2.100	2	0.95	2		0	
								<u>1000</u>	<u>5.600</u>	<u>6</u>	<u>1.07</u>	<u>5</u>	0.89	<u>1</u>		
3	49	July 2	47°08'15" 64°54'45"	13.2	1715	4.8	multi	114	250	1.200	8	6.67	6		2	
							mono	150	375	1.800	5	2.78	5		0	
							multi	154	375	1.800	0	0	0		0	
								<u>1000</u>	<u>4.800</u>	<u>13</u>	<u>2.71</u>	<u>11</u>	2.29	<u>2</u>		
3	50	July 3	47°08'08" 64°55'08"	18.2	1505	1.4	multi	114	250	.350	0	0	0		0	
							mono	150	375	.525	0	0	0		0	
							multi	154	375	.525	0	0	0		0	
								<u>1000</u>	<u>1.400</u>	<u>0</u>	<u>0</u>	<u>0</u>	0	<u>0</u>	6 Mackerel	

. . . Cont'd.

Table 1. (Cont'd.)

Period no.	Set no.	Date	Lat. N. Long. W.	Surface temperature (°C)	Time (EST) began	Duration hrs & 10ths	Gear			Effort mile-hrs	Fish caught		Fish tagged		No. sampled	Other species
							Mesh	Size (mm)	Amount (fms)		No. / mile-hrs	No. / mile-hrs				
3	51	July 3	47°07'30" 64°56'15"	15.3	2025	2.5	multi	114	250	.625	6	9.60	4		2	31 Mackerel
							mono	150	375	.938	1	1.07	1		0	
							multi	154	375	.938	2	2.13	1		1	
								1000	2.501	9	3.60	6	2.40	3		
4	52	July 4	47°09'30" 64°56'45"	14.5	1830	10.0	multi	114	375	3.750	^b 37	9.87	24		12	23 Mackerel
							multi	154	375	3.750	9	2.40	7		2	3 Shad
							mono	150	375	3.750	5	1.33	3		2	1 Cod
								1125	11.250	51	4.53	34	3.02	17		
4	53	July 5	47°08'23" 64°55'00"	14.4	1945	8.3	multi	114	375	3.112	23	7.39	15 ^c		8	34 Mackerel
							multi	154	375	3.112	5	1.71	5		0	3 Shad
							mono	150	375	3.112	5	1.61	4		1	3 Cod
								1125	9.336	33	3.53	24 ^c	2.57	9		
4	54	July 6	47°08'15" 64°55'45"	15.5	2000	3.5	multi	114	250	.875	36	51.14	27 ^d		9	5 Mackerel
							multi	154	375	1.312	12	9.14	11		1	
							mono	150	375	1.312	5	3.81	4		1	
								1000	3.499	53	15.15	42 ^d	12.00	11		
4	55	July 7	47°07'15" 64°55'15"	14.9	0105	1.5	multi	114	250	.375	5	13.33	5		0	
									250	.375	5	13.33	5	13.33	5	
4	56	July 8	47°07'53" 64°56'00"	16.4	1950	5.2	multi	114	250	1.300	27	21.54	19		8	
							multi	154	375	1.950	3	1.54	2		1	
							mono	150	375	1.950	4	1.54	4		0	
								1000	5.200	34	6.54	25	4.81	9		

. . . Cont'd.

Table 1. (Cont'd.)

Period no.	Set no.	Date	Lat. N. Long. W.	Surface	Time (EST) began	Duration hrs & 10ths	Gear			Effort mile-hrs	Fish caught		Fish tagged		No. sampled	Other species
				temperature (°C)			Mesh	Size (mm)	Amount (fms)		No./ mile-hrs	No./ mile-hrs	No.	No.		
4	57	July 9	47°08'00" 64°56'00"	16.5	1950	4.6	multi	114	250	1.150	32	27.83	24		8	3 Shad
							multi	154	375	1.725	8	4.06	8		0	12 Mackerel
							mono	150	375	1.725	1	1.16	0		1	
									1000	4.600	41	8.91	32	6.96	9	

^aCaught, tagged salmon, J03984 (St. Andrew's tag) included in No. sampled.

^b1 fish caught with no head and discarded, included in No. caught.

^cCaught, tagged salmon, A44426 (Halifax) measured, scale sample and released, included in No. tagged.

^dCaught, tagged salmon, A36164 (St. Andrew's) measured, scale sample and released included in No. tagged.

Table 2. Summary of catch and catch effort from experimental drift netting in Miramichi Bay in 1970 by gear type and fishing order.

Dates	Gear		Catch				Dates	Catch				Total catch			
	Mesh size (mm)	Type	# Sets	Total	Mean (mi-hrs) ⁻¹	s.d. ^a		# Sets	Total	Mean (mi-hrs) ⁻¹	s.d. ^a	# sets	Total	Mean (mi-hrs) ⁻¹	s.d. ^a
June 11-17	114	multi	6	19	1.90	1.75	June 26-July 3	7	32	3.34	3.58	13	51	2.67	2.87
June 11-17	150	mono	6	24	1.82	2.57	June 26-July 3	7	23	1.22	1.03	13	47	1.50	1.84
June 11-17	154	multi	6	14	1.01	0.74	June 26-July 3	7	20	0.96	1.01	13	34	0.98	0.86
June 11-17	all sizes	both	6	57	1.54	1.31	June 26-July 3	7	75	1.65	1.37	13	132	1.60	1.29
June 18-25	114	multi	6	14	1.63	1.87	July 4-9	5 ^b	155	21.40	13.79	11	169	10.61	13.58
June 18-25	154	multi	6	12	0.87	0.39	July 4-9	5 ^b	37	3.87	3.20	11	49	2.23	2.58
June 18-25	150	mono	6	9	0.66	0.56	July 4-9	5 ^b	20	1.88	1.21	11	29	1.21	1.07
June 18-25	all sizes	both	6	35	0.98	0.57	July 4-9	5 ^b	212	7.73	4.63	11	247	4.05	4.60
Total	114	multi	24 ^b	220	6.31	10.04									
	150	mono	24	76	1.56	1.92									
	154	multi	24	83	1.37	1.51									
	all sizes	both		379	2.72	3.41									

^aStandard deviation

^bDoes not include set number 55

Table 3. Total tag returns from Atlantic salmon tagged from fish caught by research vessel fishing in Miramichi Bay, 1970.

Period	Tagging date	Miramichi River commercial	Miramichi River angled	Miramichi drift net fishery	Other rivers	Other fisheries			Total	Tags applied	Percent of Tags applied per period	Percent recaptures of tags applied		Fence recaptures ^a
						South	North	Other				per period	per period	
1	June 11-17	4	3	19	2	3	1	-	32	49	16.1	65.3	1	
2	June 18-25	1	3	10	1	-	2	-	17	28	9.2	60.7	1	
3	June 26-July 3	4	10	12	-	-	-	-	26	65	21.4	40.0	-	
4	July 4-July 9	3	37	15	-	-	-	1	56	162	53.3	34.6	1	
	Total	12	53	56	3	3	3	1	131	304			3	
	Percent	9.2	40.5	42.7	2.3	2.3	2.3	0.8	100.0					

^a Northwest Miramichi River

Table 4. Tag returns by year of recapture of Atlantic salmon tagged from gill nets in Miramichi Bay, 1970.

Period	Tagging Date	Miramichi River commercial		Miramichi River recreational		Miramichi Bay fishery		Other rivers		Other fisheries			Fence		Total			
		1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW	South	North	Others	1SW	MSW				
Year of tagging																		
1	June 11-17	2	2	-	1	-	19	-	2	-	3	-	1	-	-	1	-	31
2	June 18-25	-	1	1	2	1	9	-	1	-	-	-	2	-	-	1	-	18
3	June 26-July 3	1	3	6	-	-	12	-	-	-	-	-	-	-	-	-	-	22
4	July 4-9	2	1	14	4	-	15	-	-	-	-	-	-	-	-	-	1	37
Total		5	7	20	8	1	55	-	3	-	3	-	3	-	-	2	1	108
Year after tagging																		
1	June 11-17	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2
2	June 18-25	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	June 26-July 3	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	4
4	July 4-9	-	-	9	9	-	-	-	-	-	-	-	-	-	1	-	-	19
Total		-	-	12	13	-	-	-	-	-	-	-	-	-	1	-	-	26

Table 5. Distribution of sea ages within each tagging period from gill net catches of Atlantic salmon in Miramichi Bay, 1970.

Tagging period	Number tagged			Total
	ISW	MSW	PS	
June 11-17	6	43	-	49
June 18-25	8	20	-	28
June 26-July 3	21	44	-	65
July 4-9	102	57	3	162
Total	137	164	3	304

Table 6. Mean fork lengths, numbers, and catch-effort of Atlantic salmon caught by research vessel in 1970 in Miramichi Bay, New Brunswick, by sea-age and mesh size.

Mesh (mm)	Total effort (mile- hours)	Type	Sea age			Total	PS ^a	Unreadable	Total
			1	2	3				
114	37.88	multi	53.8	71.2	86.0	58.2	80.0	-	58.3
			168 ^b	55	1	224	1	0	225 ^b
			4.30	1.45	0.03	5.78	0.03	-	5.81
150	53.37	mono	49.1	73.3	81.7	73.5	79.0	80.2	73.7
			1	68	5	74	1	1	76
			0.02	1.27	0.09	1.39	0.02	0.02	1.42
154	52.17	multi	53.0	73.1	83.0	72.6	77.0	-	72.7
			3	76	2	81	1	1 ^c	83 ^c
			0.06	1.46	0.04	1.55	0.02	0.02	1.59
All gear	-	-	53.8	72.6	82.6	64.3	78.7	80.2	64.4
			172	199	8	379	3	2 ^c	384
Commercial sample	-	-	-	70.9	-	70.9	-	-	70.9
			0	45	0	45	0	0	45
Total ^d	-	-	53.8	72.3	82.6	65.0	78.7	80.2	65.1
			172	244	8	424	3	2 ^c	429

^aPrevious spawners.

^bIncludes 5 fish in Set 55 not included in catch-effort.

^cIncludes 1 fish caught that was missing its head.

^dIncludes samples from Loggieville Cold Storage.

Table 7. River age (number and percent) of each sea-age class of Atlantic salmon sampled during Miramichi Bay tagging experiment in 1970.

Sea age	River age					Total	Unreadable	Mean river age
	1	2	3	4	5			
1	0 0%	25 14.8%	120 71.0%	24 14.2%	0 0%	169	4	2.99
2	0 0%	66 27.7%	157 66.0%	14 5.9%	1 0.4%	238	6	2.79
3	0 0%	1 12.5%	4 50.0%	3 37.5%	0 0%	8	1	3.25
Previous spawners	1 33.3%	2 66.7%	0 0%	0 0%	0 0%	3	0	1.67
All	1 0%	94 22.2%	281 67.7%	41 9.8%	1 0.2%	418	11	2.88

Table 8. Exploitation and interception rates derived from 1970 tagging experiment for fisheries exploiting Miramichi River salmon.

Source	Sea ages					
	Total		MSW		1SW	
	$m' = 0$ $i = 0$	$m' = 0.25$ $i = 0$	$m' = 0$ $i = 0$	$m' = 0.25$ $i = 0$	$m' = 0$ $i = 0$	$m' = 0.25$ $i = 0$
Miramichi Bay commercial	0.18 ² (0.24, 0.14)	0.25 (0.32, 0.19)	0.33 (0.43, 0.25)	0.44 (0.57, 0.34)	0.01 (0.04, 0)	0.01 (0.05, 0)
Interception factor in Miramichi Bay fishery	0.12 (0.23, 0.05)	0.16 (0.31, 0.07)	0.24 (0.46, 0.11)	0.32 (0.62, 0.14)	0	0
Miramichi R. assumptions	$m' = 0$ $i = 0.12$	$m' = 0.25$ $i = 0.16$	$m' = 0$ $i = 0.24$	$m' = 0.25$ $i = 0.32$	$m' = 0$ $i = 0$	$m' = 0.25$ $i = 0$
Total angling (over two years)	0.24 (0.32, 0.19)	0.34 (0.44, 0.26)	0.25 (0.38, 0.15)	0.37 (0.56, 0.23)	0.24 (0.33, 0.16)	0.31 (0.44, 0.21)
Angled in year of tagging (bright fishery)	0.13 (0.19, 0.09)	0.18 (0.26, 0.12)	0.09 (0.19, 0.04)	0.14 (0.28, 0.06)	0.15 (0.23, 0.09)	0.20 (0.30, 0.12)
Angled in year after tagging (black fishery)	0.15 (0.22, 0.10)	0.27 (0.40, 0.18)	0.23 (0.40, 0.12)	0.92 (1.0, 0.49)	0.11 (0.19, 0.06)	0.16 (0.28, 0.08)
Miramichi R. commercial	0.05 (0.10, 0.03)	0.08 (0.13, 0.04)	0.08 (0.17, 0.03)	0.12 (0.25, 0.05)	0.04 (0.09, 0.01)	0.05 (0.11, 0.02)

¹Assumptions about tagging mortality (m') and interception factor (i).

²(Upper, lower) confidence limits at 1-P = 0.95 level calculated from Ricker (1975), p. 343.

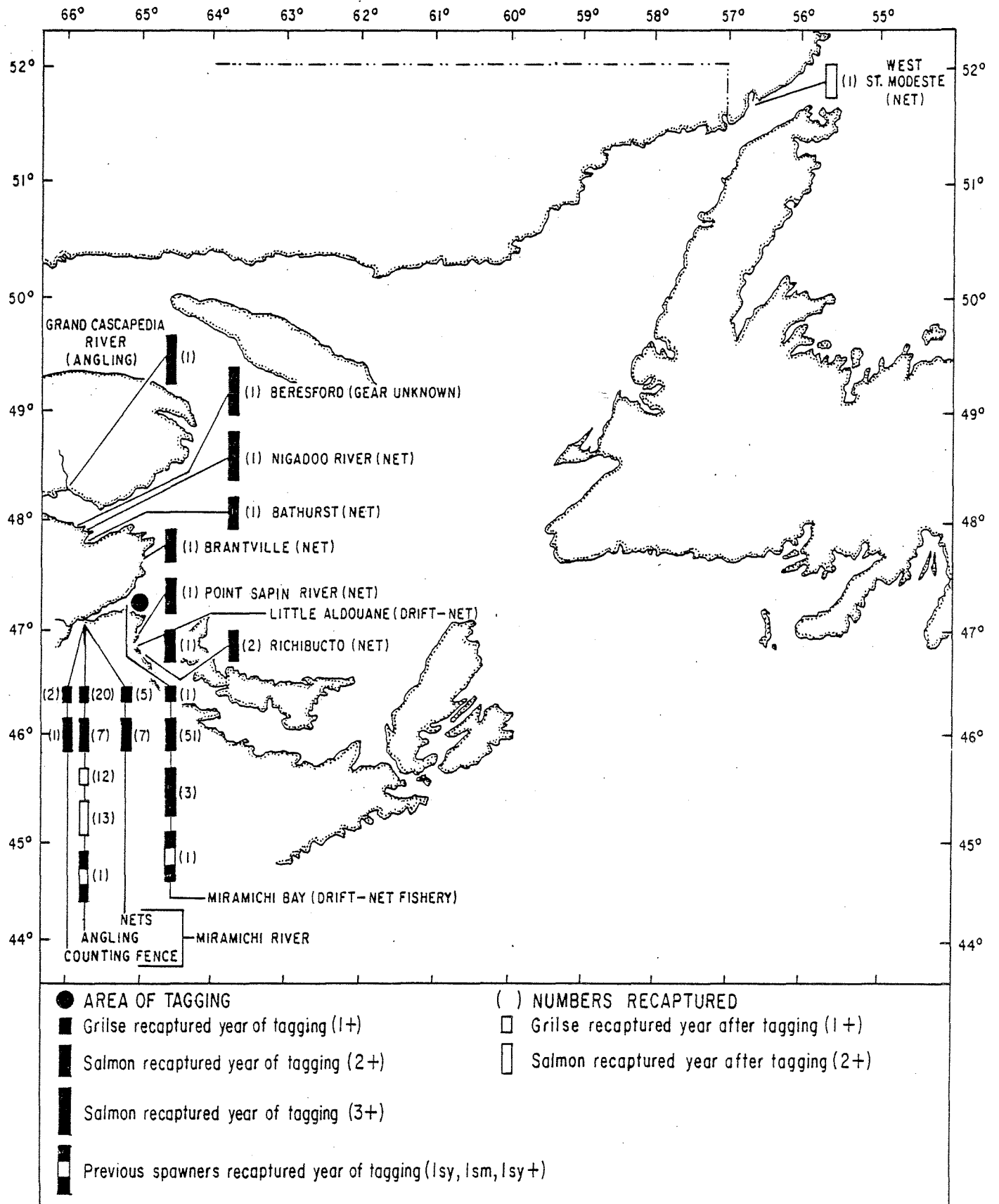


Fig. 1. Tag recaptures of Atlantic salmon tagged in Miramichi Bay, New Brunswick in 1970.

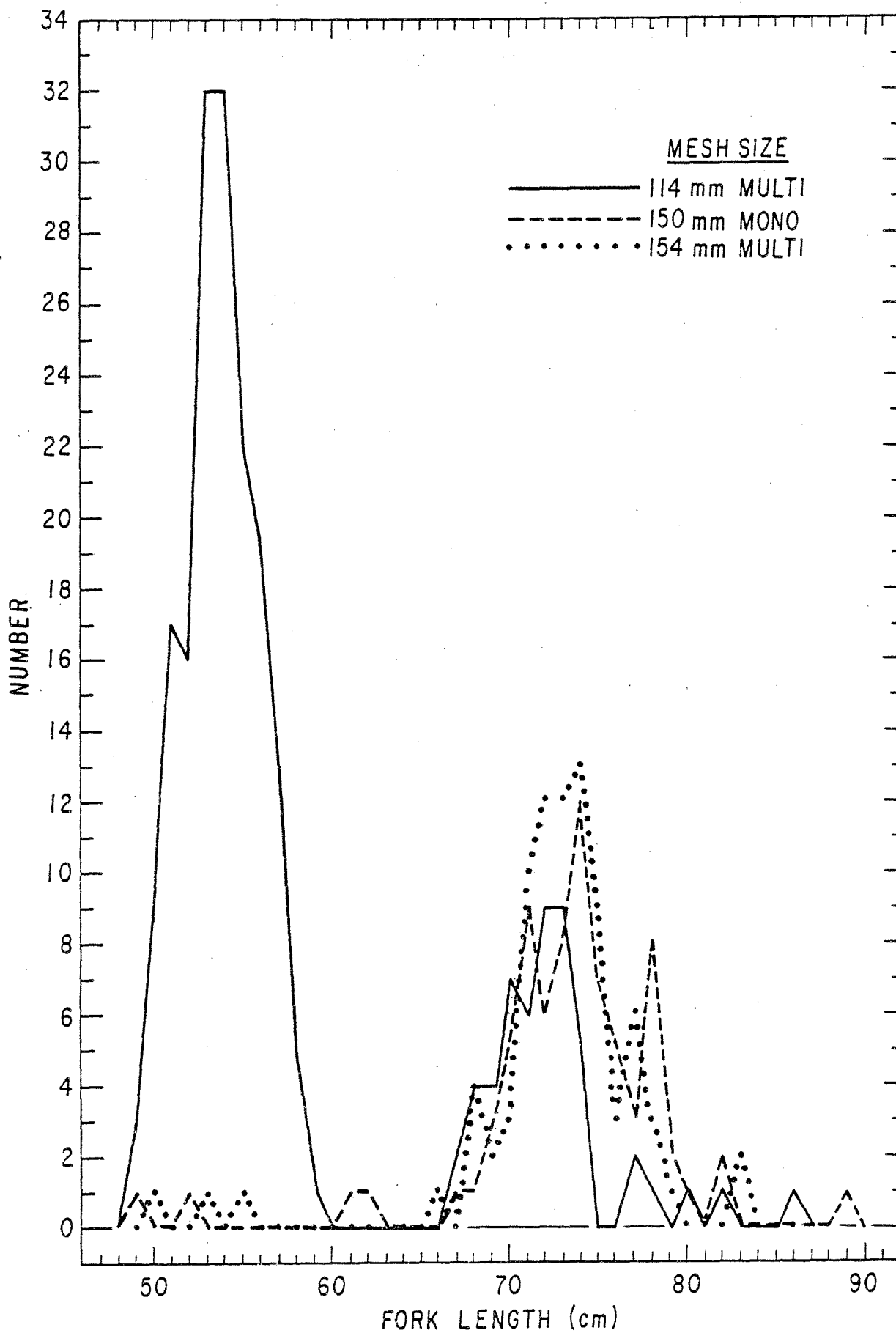


Fig. 2. Distribution of fork length of salmon caught in Miramichi Bay, 1970.