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Limited recovery of depleted Northwest Miramichi salmon follows ban on commercial fishery

by

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Decline in total stocks of Northwest Miramichi salmon and grilse has been particularly noticeable since about 1964. Variability in stocks as indicated by commercial fisheries is, however, one of the outstanding characteristics shown by 100 years of Canadian fisheries statistics for Atlantic salmon. Until the middle of this century such variability was attributed largely, and probably more or less correctly, to such natural causes as excessively high or low water during spawning and early freshwater life history, variable mortality from predation in freshwater and marine phases and other unrecognized factors. In Atlantic Canada degradation of stream environments was recognized as affecting some less important streams through damming for lumbering purposes and a limited amount of hydroelectric development, alteration of streams through agricultural and occasionally forest practices and even less commonly through more massive industrial pollution, especially in estuaries. For the most part, declines in stock were expected to, and generally did, remedy themselves within a very few years.

But in the post-war years of industrial expansion, still with us, man greatly increased his ability to have massive and more permanent impact on aquatic environments, as side effects from industrial activities. At the same time that environments were degenerating, fishing pressure on practically all species increased. In the case of Atlantic salmon, commercial pressure was nominally pegged at a constant level in Canada. But synthetic fibre nets, demonstrated on other species to be more effective than vegetable fibre nets, were introduced in the late fifties and early sixties. A new and large high seas fishery for Canadian and European salmon developed in the West Greenland area. Demand for recreational fishing which provides basis for an industry as well as recreation for residents also increased.

Stock abundance

Decline of salmon stocks in response to these varied pressures is exemplified in the Northwest Miramichi. On this river the Fisheries Research Board of Canada has counted grilse and salmon moving upriver each year since 1950. The data are given in Table 1.

Table 1 shows ascent of fish seasonally also. Fish ascending in the summer are used by commercial fishermen as they pass through the sea approaches and the estuary. Those reaching fresh water during summer are of particular interest to the angler. In this table those entering to August 31 are referred to as early-run (though in other context different criteria are used). Fish which enter fresh water after September 1 - late-run in Table 1 - may have been exposed to heavy commercial fishing in approaches and estuary during much of the summer. When not subjected to heavy angling pressure they can provide important reproductive potential for the river. However, in recent years data have accumulated to substantiate earlier belief that early fish and late fish composed somewhat different genetic segments of a river's total salmon population.

Furthermore, there is similar information to support belief that fish maturing after only one year at sea - grilse - may have a different genetic makeup from fish spawning first after two years at sea - salmon.

Table 1 should be examined with these various factors in mind. A general decline in the middle to late fifties is attributable in large part to DDT spraying of surrounding forests in 1954, 1956 and 1957 (Elson, 1967; Elson and Kerswill, 1964 and 1966).

Sometime around 1959-61 synthetic nets were introduced in the commercial fishery. While commercial catches stayed up moderately well, freshwater runs, especially of larger salmon, dropped rather abruptly from apparent mild recovery after the DDT effect. This implies heavier tax on a smaller stock by the newly geared fishery, but is difficult to substantiate. Despite occasional malfunction of the fence, it is believed to have intercepted, in general, 90 per cent or more of adult runs.

For Northwest Miramichi stocks there was further pressure beginning in 1960. The relative efficiency of synthetic (nylon) fibre nets versus vegetable fibre nets, mostly hemp, in the Miramichi, has not received specific study for Atlantic salmon. But nylon polyfilament nets have been shown to be more effective in other fisheries (Hewson, 1951). Comparing commercial landings for the Gulf of St. Lawrence area (Fig. 1) with counts through the Curventon fence (Table 1) seems to substantiate a fairly well maintained fishery up to 1968 despite decreasing river runs. In this connection it should be mentioned that measurements of abundance of Northwest Miramichi salmon stocks co-relate fairly well with measurements of salmon abundance for the Miramichi system as a whole (G.E. Turner, personal communication).

The salmon population of the Northwest Miramichi is now seen as having four essential components - early- and late-run 2-sea-winter salmon, and early- and late-run grilse. These are believed to be heterozygous populations, each with its own role in maintaining the total stock of salmon and probably responding each in its own way to changes in environmental parameters. In general, the early run reproduces in the upper part of the river (Saunders, 1967) and the late run in the lower.

Development of a base metal mine on a headwater stream resulted in copper and zinc pollution which not only delayed and prevented ascent of some adults (Saunders and Sprague, 1967), but also killed most young spawned from late-run parents in the lower reaches of the river (Sprague et al., 1965). This condition was substantially remedied in 1971 by new abatement measures introduced at the mine.

The salient feature to note in Table 1 is the drastic fall-off in mean numbers of salmon, both early- and late-run, as between the 10-year periods, 1950-59 and 1962-71. The decrease was more pronounced for late- than for early-run fish. This is attributable in large part to mine pollution effects, but also to heavy exploitation of late-run fish holding in the estuary during the summer.

The important contribution of larger salmon to reproductive potential in the 1950's is indicated in Table 2. Local commercial fisheries were legally restricted to taking salmon and no grilse, although in fact substantial numbers of grilse were frequently "bootlegged" (see Elson, 1972, Fig. 1). With urban and industrial pollution in the estuary delaying upstream movement of salmon, especially the autumn run (Elson et al., 1972), these fish were held in the estuary where commercial nets had repeated opportunity to take them. With some abatement of this pollution in 1972, runs of late salmon have started recovery.

Between 1959 and 1964 there were several very large grilse runs. The biological background for these is not well understood.

With the 1972 ban on local commercial fisheries, river stocks increased noticeably. But only for grilse did they approach the levels of the 1950's. Large salmon, which provide a disproportionate amount of the reproductive potential for the river attained only half of the earlier levels. That is to say that the beneficial effects of the ban have not brought about a "one-shot" recovery and it will require stringent protection of a second generation of this year-class to assure full recovery.

Angling pressure and recruitment

Earlier assessments of reproductive potential of Northwest Miramichi runs were based on "potential egg deposition," i.e., eggs brought back to the river *before abstraction of fish by angling*. Evidence points to increasing removal through angling in recent years. Table 2 gives an evaluation of estimated egg deposition *after removal of potential spawners by angling*. In earlier years data on actual catch by angling from stocks passed by the counting fence were not available. They are available from 1966 on. In Table 2 abstraction by angling for the earlier years has been estimated by applying proportions, indicated by Kerswill (1971) as taken by angling above, to total counts passing through the fence. His figures indicate an average take of 9% of salmon and 20% of grilse. For years from 1966 on, reported catches were subtracted from counted numbers passing through the fence. Average catches for these years were salmon 40% and grilse 33%. Reported catches should be regarded as minimal. Estimated egg deposition for all years appears in the last 3 right-hand columns of Table 2. These were derived by assuming that 50% of large salmon were females carrying about 8,000 eggs each and 33% of grilse were females carrying about 2,000 eggs each. Note that the final column takes no account of heritability for early- versus late-running or maturation after one versus two or more years at sea.

If it is assumed that populations were in a more or less healthy, self-sustaining condition up to the early sixties (mildly questionable), then actual egg deposition should approximate a bit over 4 million eggs, with a range of about 3.5 to 5.0 million being required depending on whether most smolts are 2 or 3 years old at seaward migration. In the fifties about two-thirds were 3-year-olds: in 1972 about four-fifths were 2-year-olds. Whether this earlier maturation would be maintained in the face of denser parr populations remains to be seen.

Table 2 shows clearly that egg deposition has declined drastically in recent years and that the 1972 restrictions on fishing have at best given a reproductive base only about one-half to two-thirds of that required for full normal production from the river. Angling pressure in 1972 removed a substantial part of the gain made through eliminating the commercial fishery. Since 1972 offered particularly favourable water conditions for angling this tax may have been abnormally high. *But if rapid recovery of populations is a prime objective, additional restrictions warrant consideration.*

Initial reaction to the biology expressed in this report may well be that the appropriate management procedure would be to ban angling as well as commercial fishing. Such procedure is, however, considered unsatisfactory from the sociological aspects pertinent to the system and from the aspect of Departmental logistics. It is not believed that complete angling closure would in fact provide the required protection for spawning stocks. Poaching would doubtless increase, with perhaps more fish being removed than would be taken by limited angling. Moreover, gathering data on numbers of fish taken by poaching now poses substantial problems which would almost surely be magnified by the complete absence of anglers on the river.

Applicability of Northwest data to Miramichi system

Among Miramichi streams, or indeed Maritime salmon rivers, only for the Northwest Miramichi are there as detailed data available as outlined above. Anglers have suggested that the recreational catch on this stream is abnormally high because of the system of renting fishing rights by the Provincial Government.

Table 3 offers data pertinent to this point. It gives information for 1971, one of the poorer angling years on record, and for 1972, one of the best in the last 10 years.

Data for the Main Southwest Miramichi in 1972 are considered somewhat more questionable than for other branches and two estimates are given. A point to be considered in regard to this stream is that many New Brunswick residents go to it when fishing is reported to be good - or stay away when it's reportedly poor. Good records are probably more difficult to obtain, and more likely to be minimal, than for streams where private owners, camp operators, and difficult access limit free public fishing.

Data in column 3 and the two right-hand columns of Table 3 do seem to indicate that fishing pressure and quality for the Northwest above the counting fence are not grossly out of line with the rest of the system. If this assumption is correct, the statement above about desirability of closer control of angling if rapid population recovery is a goal, *applies to the whole system, not just the Northwest Miramichi.*

Environmental quality for upstream migration

As intimated in the introduction, heavy fishing is not wholly responsible for decrease in Miramichi salmon stocks. Degradation in water quality associated with industrialization, including mining, forest management and processing of forest products, have played their parts.

Base metal pollution of river water has held back or diverted salmon in their upstream migration. Table 4 shows that more fish marked as smolts descending the Northwest Miramichi have been taken as grilse or salmon in the Sevogle while mine pollution was a problem, between 1960 and 1970, than before or after. Abatement occurred in 1971 and 1972 and in these years strays of Northwest marked smolts reverted to the average value pertaining in the fifties.

Similarly, diversion at the confluence of the Northwest and Southwest branches, in the estuary, was greater in the late sixties with expansion of pulpmill operations than in the fifties or in 1971 and 1972 when substantial abatement measures were introduced by a mill at the mouth of the Northwest. In the sixties the Southwest was relatively less polluted because of less industrial effluent and because of substantially greater freshwater flow in this system. Data of Table 4 do appear to hint that there is *still, in 1972, room for substantial improvement in avoidance-causing effluents entering the Northwest Miramichi.*

Available evidence indicates that many Miramichi salmon which would otherwise get back to home water are used in distant fisheries. Table 5 provides data on proportionate use of wild fish tagged as smolts descending the Northwest Miramichi. What proportion of those taken in Greenland or Newfoundland would normally reach home waters must still be regarded as an open question. We know that some would, but can as yet only make 'educated guesses' as to how many. As the high seas fishery approaches phase-out in 1976 (ICNAF Comm. Doc. 72/33), we should be able to make a better evaluation. Abstraction both here and in Newfoundland varies somewhat from year to year (Elson, 1972). Probably the point of chief concern is that Canada must manage the salmon that do return to her waters to best advantage. If we are to continue to have salmon at all, reasonable water quality and reasonable escapement for reproduction must be assured. Salmon can no longer be fished without regard to the biological necessities of suitable environment and sufficient reproductive escapement.

Prospect

The analyses presented in Tables 6-8 bolster the foregoing analysis and extend some of its implications farther afield than home fisheries and into the future.

Table 6 provides the only available check on the estimates of total production given in Table 5. The check was obtained by comparing the estimated catch by anglers, both above and below the counting fence, to Departmental creel census figures for the entire main stem of the Northwest Miramichi. Catch in the lower reaches includes some fish on their way to the Sevogle River, a tributary entering 1 mile below the counting fence, in addition to fish produced above the counting fence and some produced in the lower main stem. It is to be expected, therefore, that the estimates in Table 5 would fall below the creel census. They average 83% of the creel censuses for most year-classes included in the analysis. It should be mentioned that the years selected were chosen because substantial numbers (4,000 or more) of tagged smolts had been liberated earlier, giving proportional recaptures in various fisheries. In 1966, with only 1 tagged, 2-sea-winter salmon passing through the counting fence as "escapement," the estimate of catch by angling is unrealistic and this probably results in the entire estimate of production for that group of fish being much too high. Nevertheless it is believed that most of the estimates of total production in Table 5 are reasonable, probably well above one half and well below double the true values.

Table 7 is a forecast of the 2-sea-winter salmon production from the river above Curventon. This is arrived at by relating grilse:salmon ratios in the various fisheries from other year-classes (1967 and 1969 smolts) to the grilse productions shown for the 1971 smolt-class by 1972 fisheries. These two earlier years were chosen because they showed wide variation in grilse:salmon ratios. For the two estimates, proportions of fish which were taken from the earlier year-classes by the commercial fishery were allocated to 1973 angling, escapement and "other" on *pro rata* bases indicated by the early year-classes. This analysis gives no reason to expect a larger run of 2-sea-winter salmon in 1973 than occurred in 1972 - the 1973 run could, indeed, be less.

Table 8 shows the estimated possible total catch of Northwest Miramichi salmon in the Greenland fishery for the years 1971 to 1976, assuming the 1971 catch to have a value of 100. Ratios were taken from ICNAF Comm. Doc. 72/33. Considering the reduced spawning base (row 4) on which these numbers of salmon could be taken (row 3), it should not be expected that the proposed reduction in the Greenland fishery could have any useful or identifiable benefit to Northwest Miramichi stocks before 1976 (in Greenland) and 1977 (in home waters) at the earliest. If smolt age reverts to predominantly 3 years as pertained in 1966 and earlier, rather than predominantly 2 years as pertained in 1972, recovery would be delayed an additional year.

Because of the ban on home commercial fisheries, all populations of grilse and salmon in the Miramichi should increase in 1976 (2-year smolts maturing as grilse) and subsequent years. This is likely to obscure any salutary results from the 1976 reduction in the Greenland fishery.

Although the Northwest Miramichi stocks may have decreased more than general stocks in the Miramichi, there is, as pointed earlier, good reason to believe that they reflect moderately well the general situation for the whole system.

Considering current status of Miramichi stocks, it would be biologically inadvisable to re-open home water commercial fisheries before 1977. The Greenland, and to a similar but somewhat lesser extent Newfoundland, commercial fisheries can be expected to exploit the large salmon as fully as the stocks can support, perhaps more, at least until 1977.

References

Elson, P.F. 1967. Effects on wild young salmon of spraying DDT over New Brunswick forests. J. Fish. Res. Bd. Canada 24: 731-767.

1972. Overfishing and depleted stocks of Northwest Miramichi salmon. ICANF Res. Doc. 72/83, Annual Meeting, June 1972.

Elson, P.F., and C.J. Kerswill. 1964. Forest spraying and salmon angling. The Atlantic Salmon Journal, 1964, No. 3, p. 20-29.

1966. Impact on salmon of spraying insecticide over forests. Advances in Water Pollution Research, Vol. 1, Munich, 1966: 55-74.

Elson, P.F., L.M. Lauzier, and V. Zitko. 1972. A preliminary study of salmon movements in a polluted estuary. *In* Marine Pollution and Sea Life, ed. M. Ruivo. Fishing News (Books) Ltd. p. 325-330.

Hewson, L.C. 1951. A comparison of nylon and cotton gill nets used in the Lake Winnipeg winter fishery. The Canadian Fish Culturist 11: 7-9.

ICNAF Comm. Doc. 72/33. Proposal regarding conservation of Atlantic salmon. Ann. Meeting, June 1972.

Kerswill, C.J. 1971. Relative rates of utilization by commercial and sport fisheries of Atlantic salmon *(Salmo salar)* from the Miramichi River, New Brunswick. J. Fish. Res. Bd. Canada 28: 351-363.

Saunders, Richard L. 1967. Seasonal pattern of return of Atlantic salmon in the Northwest Miramichi River, New Brunswick. J. Fish. Res. Bd. Canada 24: 21-32.

Saunders, Richard L., and John B. Sprague. 1967. Effects of copper-zinc mining pollution on a spawning migration of Atlantic salmon. Water Research, Vol. 1, p. 419-432.

Sprague, J.B., P.F. Elson, and R.L. Saunders. 1965. Sublethal copper-zinc pollution in a salmon river - a field and laboratory study. Int. J. Air Wat. Poll. Pergamon Press, Vol. 9, p. 531-543.

Table 1. Salmon and grilse moving upstream through FRB counting fence in the Northwest Miramichi River at Curventon, N.B.

	Early - to Aug. 31			Late - from Sept. 1			Total for year		
Year	Salmon	Grilse	Total	Salmon	Grilse	Total	Salmon	Grilse	Total
1950	188	1610	1798	538	361	899	726	1971	2697
1951	374	1972	2346	438	211	649	812	2185	2995
1952	98	1747	1845	1209	395	1604	1307	2142	3449
1953	432	1845	2277	601	320	921	1033	2165	3198
1954	597	2236	2833	484	365	849	1081	2601	3682
1955	240	2281	2521	542	475	1017	782	2756	3538
1956	174	652	826	389	122	511	563	774	1337
1957	126	308	434	580	567	1147	706	875	1581
1958	122	1188	1310	458	1232	1690	580	2420	3000
1959	242	6854	7096	760	501	1261	1002	7355	8357
1960	25	1856	1881	352	936	1288	377	2792	3169
1961	577	679	1256	300	275	575	877	954	1831
1962	96	2091	2187	128	194	322	224	2285	2509
1963	187	4110	4297	122	1978	2100	309	6088	6397
1964	104	3621	3725	42	1506	1548	146	5127	5273
1965	40	1162	1202	80	527	607	120	1689	1809
1966	46	2403	2449	65	510	575	111	2913	3024
1967	80	1030	1110	92	779	871	172	1809	1981
1968	29	755	784	45	216	261	74	971	1045
1969	119	2302	2421	6	66	72	125	2368	2493
1970	85	535	620	25	187	212	110	722	832
1971	50	842	892	0	26	26	50	868	918
1972	256	2094	2350	197	229	426	453	2323	2776
Means									
1950-59	259	2069	2329	600	455	1055	859	2524	3383
1962-71	84	1885	1969	60	599	659	144	2484	2628

Table 2. Estimated egg deposition in Northwest Miramichi River above Curventon.

	Curventon Up-trap			Estimated Angling Above Fence			Estimated Escapement			Estimated Egg Deposition (millions)		
Year	Salmon	Grilse	Total	Salmon	Grilse	Total	Salmon	Grilse	Total	Salmon	Grilse	Total
1950	726	1971	2697	65	399	464	661	1572	2233	2.644	1.048	3.692
1951	812	2183	2995	72	442	514	740	1741	2481	2.960	1.161	4.121
1952	1307	2142	3449	117	434	551	1190	1708	2898	4.760	1.139	5.899
1953	1033	2165	3198	92	438	530	941	1727	2668	3.764	1.151	4.915
1954	1081	2601	3682	96	526	622	985	2075	3060	3.940	1.383	5.323
1955	782	2756	3538	70	558	628	712	2198	2910	2.848	1.465	4.313
1956	563	774	1337	50	157	207	513	617	1130	2.052	0.411	2.463
1957	706	875	1581	63	177	240	643	698	1341	2.572	0.465	3.037
1958	580	2420	3000	52	490	542	528	1930	2458	2.112	1.287	3.399
1959	1002	7355	8357	89	1489	1578	913	5866	6779	3.652	3.911	7.563
1960	377	2792	3169	34	565	599	343	2227	2570	1.372	1.485	2.857
1961	877	954	1831	78	193	271	799	761	1560	3.196	0.507	3.703
1962	224	2285	2509	20	462	482	204	1823	2027	0.816	1.215	2.031
1963	309	6088	6397	28	1232	1260	281	4856	5137	1.124	3.237	4.361
1964	146	5127	5273	13	1038	1051	133	4089	4222	0.532	2.726	3.258
1965	120	1689	1809	11	342	353	109	1347	1456	0.436	0.898	1.334
				Actual Angling			Actual Escapement					
1966	111	2913	3024	36	690	726	75	2223	2298	0.300	1.482	1.782
1967	172	1809	1981	92	373	465	80	1436	1516	0.320	0.957	1.277
1968	74	971	1045	71	165	236	3	806	809	0.012	0.537	0.549
1969	125	2370	2495	78	1080	1158	47	1290	1337	0.188	0.860	1.048
1970	110	722	832	43	600	643	67	122	189	0.268	0.081	0.349
1971	50	868	918	22	284	306	28	584	612	0.112	0.389	0.501
1972	453	2323	2776	100	771	871	353	1552	1905	1.412	1.035	2.447

Table 3.

1971 Salmon Angling

	Miles	Rod Days	Rod Days Per Mile	Salmon	Grilse	Total	Catch Per Rod Day	Catch Per Mile
Main Southwest Miramichi	132	7565	57	383	2481	2864	0.38	21.7
Little Southwest Miramichi	57	2110	37	106	1260	1366	0.65	24.0
Dungarvon	46	472	10	37	89	126	0.27	2.7
Renous	48	457	10	22	62	84	0.18	1.8
Sevogle	30	1280	43	57	720	777	0.61	25.9
Cains	50	-	-	-	-	-	-	-
NWM - above Curventon	56	904	16	18	264	282	0.31	5.0
- below Curventon	19	1010	53	36	520	556	0.55	29.3
- total	75	1914	26	54	784	838	0.44	11.2
Miramichi Total	438	13798	32	659	5396	6055	0.44	13.8

1972 Salmon Angling

	Miles	Rod Days	Rod Days Per Mile	Salmon	Grilse	Total	Catch Per Rod Day	Catch Per Mile
				(4453	(10301	(14754	(0.81	(111.8
Main Southwest Miramichi	132	18225	138	(1915	(4965	(6880	(0.38	(52.1
Little Southwest Miramichi	57	4350	76	313	3450	3763	0.87	66.0
Dungarvon	46	834	18	143	454	597	0.72	13.0
Renous	48	704	15	92	379	471	0.67	9.8
Sevogle	30	1298	43	172	898	1070	0.82	35.7
Cains	50	1847	37	425	1135	1560	0.84	31.2
NWM - above Curventon	56	1230	22	100	771	871	0.71	15.6
- below Curventon	19	1180	62	108	670	778	0.66	40.9
- total	75	2410	32	208	1441	1649	0.68	22.0
				(5806	(18058	(23864	(0.80	(54.5
Miramichi Total	438	29668	68	(3268	(12722	(15990	(0.54	(36.5

Table 4. Straying of Northwest Miramichi grilse and salmon tagged and released as native smolts at the Curventon counting fence and recaptured by angling in the Miramichi system - Percent per year based on actual numbers of recaptures which appear in brackets under the various years.

	1952-1962* (total 465)	1967 (43)	1968 (45)	1969 (284)	1970 (108)	1971 (62)	1972 (105)
Main Southwest Miramichi	9.2	30.2	20.0	26.8	22.2	25.8	13.3
Little Southwest Miramichi	0	14.0	2.2	3.5	9.3	0	1.9
Sevogle	8.2	16.3	15.6	9.5	14.8	6.5	7.6
Total strays	17.4	60.5	37.8	39.8	46.3	32.3	22.8
NWM - above Curventon	54.6	9.3	6.7	29.6	25.9	32.3	33.3
- below Curventon	28.0	30.2	55.6	30.6	27.8	35.5	43.8
Total	82.6	39.5	62.3	60.2	53.7	67.8	77.1
Total angled	100	100	100	100	100	100	100

*Data from Kerswill, C.J. 1971. J. Fish. Res. Bd. Canada 28: 351-363

Table 5. Estimated total production (utilization + escapement) of grilse and salmon from the Northwest Miramichi above the Curventon counting fence, based on proportionate adult recaptures of native smolts tagged* at Curventon (nos. in brackets under smolt years) and on total escapement above the fence (from Table 2). Fish caught in Greenland at age 1 sea-winter are considered to contribute to the total for 2-sea-winter and older fish, with no allowance made for interim mortality, rather than to the total for grilse. Age: 1+ = grilse; 2+ = 2 or more sea-winters. Years of capture in brackets under age.

Smolts in	1950-61* (total 174,509)		1962 (4,029)		1964 (12,966)		1967 (11,299)		1968 (28,043)		1969 (8,916)		1970 (11,722)	
Production at age	1+ (1951-1962)	2+ (1952-1964)	1+ ('63)	2+ ('64)	1+ ('65)	2+ ('66)	1+ ('68)	2+ ('69)	1+ ('69)	2+ ('70)	1+ ('70)	2+ ('71)	1+ ('71)	2+ ('72)
PLACE														
Greenland	-	-	187	0	157	150	806	19	386	25	93	14	809	0
Newfoundland	76	223	93	931	157	825	430	160	134	123	44	79	467	87
Nova Scotia + Prince Edward Island	25	27	280	133	45	75	53	28	23	4	0	5	33	13
Dist. New Brunswick + Prov. of Quebec	19	22	0	0	0	75	53	38	11	14	5	9	50	0
Home waters														
- Commercial	498	1846	1494	2394	898	3829	806	772	1008	798	122	103	275	0
- Millbank trap	123	92	187	0	359	0	215	9	84	7	3	0	50	0
- Dungarvon fence	6	0	not operated	----	----	----	----	----	----	----	----	----	----	----
- Angled	662	136	1494	1330	1145	1502	1396	169	1026	148	176	23	809	175
- Poached	0	0	0	133	0	0	107	19	443	17	42	9	275	13
- (Escapement above (Curventon fence	1948	630	4856	133	1347	75	806	47	1290	67	122	28	584	353
- Camp Adams fence	0	0	93	not operated	----	----	----	----	----	----	----	----	----	----
Total	3357	2976	8497	5241	3951	6688	3866	2067	4019	1589	700	363	2543	1450

*Data from Kerswill, C.J. 1971. J. Fish. Res. Bd. Canada 28: 351-363 (Kerswill's fish were marked by fin-clipping, not tagged).

Table 6. A. Comparison of estimated total utilization of Northwest Miramichi salmon and grilse by angling, from Table 5, and Departmental creel census records of anglers' catches of salmon and grilse in the Northwest Miramichi (excluding Sevogle River). B. Data for evaluation and derivation of estimated utilization by angling. Age: 1+ = grilse; 2+ = 2 or more sea-winters. Years of capture in brackets under age.

A.

Smolt years	1950-61		1962		1964		1967		1968		1969		1970	
Age at capture	1+ (1951-1962)	2+ (1952-1964)	1+ ('63)	2+ ('64)	1+ ('65)	2+ ('66)	1+ ('68)	2+ ('69)	1+ ('69)	2+ ('70)	1+ ('70)	2+ ('71)	1+ ('71)	2+ ('72)
1. Creel census (count)	821	238	1082	*	2753	153	689	188	2368	146	1620	54	784	208
2. Est. of number angled	662	136	1494	1330	1145	1502	1396	169	1026	148	176	23	809	175
3. $\frac{\text{Est. x 100}}{\text{Creel census}}$ (%)	81	57	138	*	42	982**	203	90	43	101	11	43	103	84

4. Mean ± s.e. = 83% ± 15%

* No creel census breakdown into grilse and salmon in 1964
** Not included in mean because of restricted data for estimate

B.

	1950-61 1+	1950-61 2+	1962 1+	1962 2+	1964 1+	1964 2+	1967 1+	1967 2+	1968 1+	1968 2+	1969 1+	1969 2+	1970 1+	1970 2+
Nos. of tagged angled	339	126	16	10	51	20	26	18	269	42	68	5	50	14
Nos. of tagged as escapement	998	583	52	1	60	1**	15	5	338	19	47	6	36	28

In 1950-65 only combined creel censuses for Northwest and Sevogle available, but from 1966 on censuses available separately for Sevogle and for Northwest Miramichi above and below Curventon.

Northwest creel census as % of Northwest + Sevogle creel censuses														
						60	47	60	56	62	59	49	52	55

Mean of above = 55.5%

For 1950-65 Northwest creel census was estimated as 55.5% of Northwest + Sevogle creel censuses

Table 7. Prediction of total numbers (utilization + escapement) of 2-sea-winter salmon to be produced in 1973 from 1971 smolt-class of Northwest Miramichi River above Curventon counting fence: 1-sea-winter fish caught in Greenland in 1972 are considered to be a component of the total 2-sea-winter salmon production with no allowance made for interim mortality. (1+ = age 1 sea-winter; 2+ = age 2 sea-winter)

Area of Utilization	Actual nos. tagged fish recaptured in 1972	Estimated total 1+ production in 1972	A. Prediction based on 1972 tagged and untagged grilse counts and grilse:salmon ratio in various fishery areas for 1967 smolt-class, adjusted as though there were no home commercial fishery in 1968 and 1969 — Predicted 2+ returns in 1973		B. Prediction based on 1972 tagged and untagged grilse counts and grilse:salmon ratio in various fishery areas for 1969 smolt-class, adjusted as though there were no home commercial fishery in 1970 and 1971 — Predicted 2+ returns in 1973	
	1+		tagged	total production	tagged	total production
Greenland	48	418	-	-	-	-
Newfoundland	26	227	55	84	26	423
Nova Scotia and Prince Edward Island	2	17	6	9	2	32
Dist. New Brunswick + Prov. of Quebec	1	9	4	6	1	16
Home waters						
- Commercial	0	0	0	0	0	0
- Millbank trap	13	113	10	15	0	0
- Angled	82	715	181	277	12	195
- (Escapement above (Curventon fence	178	1552*	187	286	44	715
- Other	4	35	11	17	1	16
Totals	354	2668	454	1112	86	1815

Mean estimate for total production of 2+ fish = 1464 (range 1112-1815)

*from Table 5

Table 8. Relation of 1972 ICNAF agreement on conservation of Atlantic salmon (ICNAF Comm. Doc. 72/73) to estimated production of salmon from the Northwest Miramichi River above Curventon.

	1971	1972	1973	1974	1975	1976 and later
Agreed Greenland total catch						
(1) metric tons	2615	2110	1935	1865	1800	1100
(2) as % of 1971 catch	100	81	74	71	69	42
Estimated possible numbers of Northwest Miramichi salmon in Greenland catch (value 809 for 1971 from Table 5) if proposed rate of reduction is followed	809	655	599	574	558	340
Ratios of estimated egg deposition in Northwest Miramichi above Curventon, using 1967 value from Table 2 as 1.0 and assumption of mostly 2-year-old smolts as in 1972	1.0	0.4	0.8	0.3	0.4	1.9

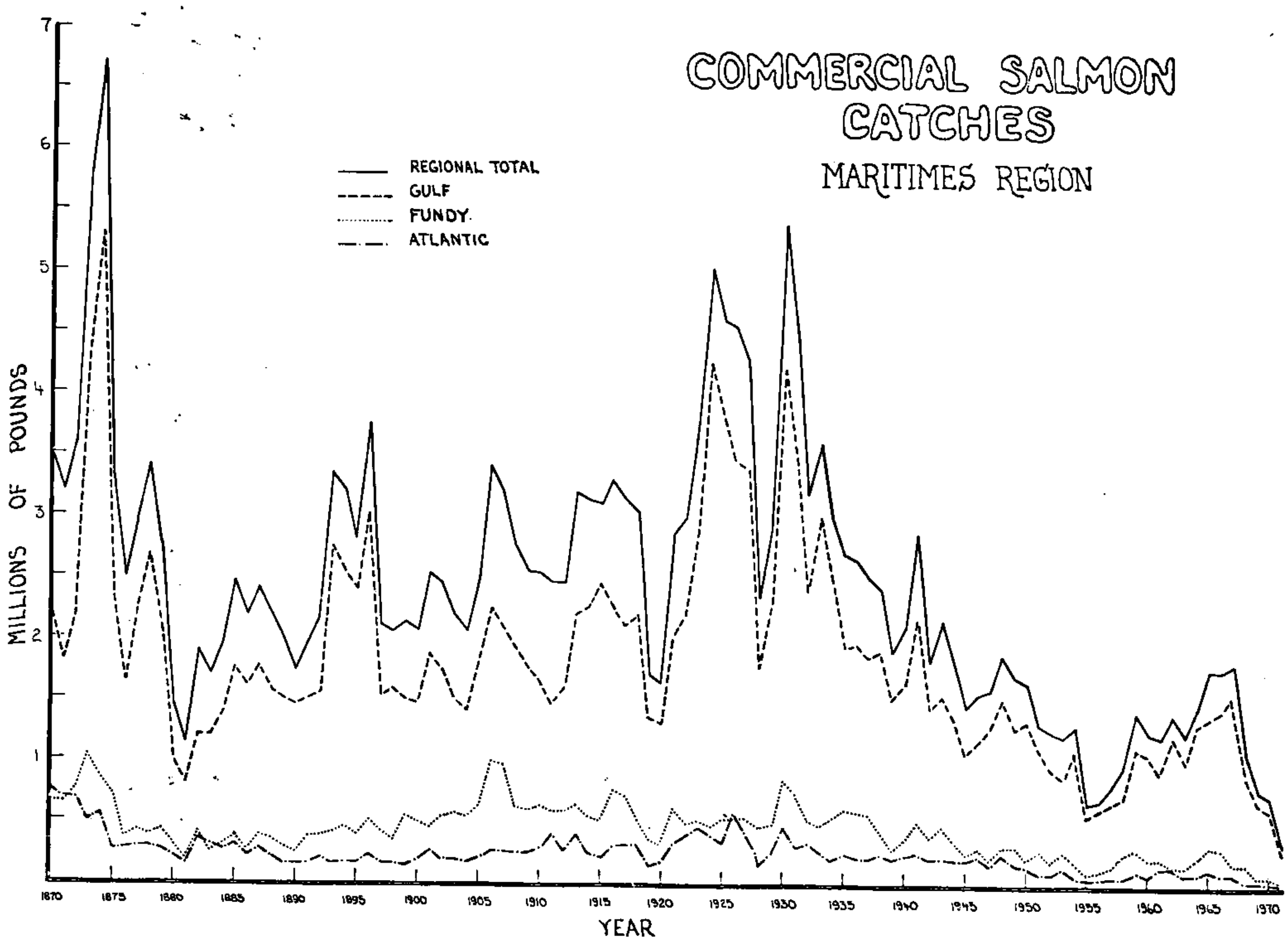

Fig. 1. Atlantic salmon landings in the Maritime provinces of Eastern Canada (not including Quebec). Gulf area extends from Restigouche River to northern extremity of Cape Breton Island (Chart prepared by C.E. Wykes, Fisheries Service, Halifax).