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Overfishing and depleted stocks of Northwest Miramichi salmon

by

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To judge by records of salmon (including grilse) caught in commercial and sport fisheries, stocks of Miramichi salmon reached an all-time low in 1971. In addition to catch statistics there is biological evidence that reproductive potential of present Miramichi stocks cannot support recent levels of exploitation. This is not to say that overfishing is the sole cause of depletion; there are other troubles involving industrially-based changes in the environment which have contributed heavily to depletion. The important point is that the combination of factors has so reduced stocks that recovery to levels of even a decade ago appears impossible unless provision is made for early, and greatly increased spawning escapement. Indeed, some Miramichi stocks, notably those of autumn-run, large (2-sea-year and older) salmon which use the lower reaches of streams for spawning and juvenile recruitment, appear to be verging on extinction, while early-run, large salmon have also decreased to a small fraction of former abundance.

A continuing program of biological research on Miramichi salmon was begun by the Biological Station, St. Andrews, in 1950. This work has centred and continues on the Northwest Miramichi. But at various times other large tributaries have also been brought into the research program.

Recent and severe depletion of Northwest Miramichi stocks is shown by the charts of data accompanying this report. Other data gathered under the same program up to 1965 and continued and extended by biologists of the Resource Development Branch in Halifax since then, indicate that the situation on the Northwest (about one tenth of the total Miramichi basin), though perhaps more severe than on other tributaries, does indicate the general trend on the entire Miramichi system.

Little attempt is made in this report to explain effects of environmental damage, such as forest spraying, mine pollution and estuarial pollution on stocks. Such damage has occurred and it has been severe. Some remedial measures have been implemented, hopefully others will follow. But it is doubtful that even if these causes were completely eliminated recovery of stocks could occur in less time than several decades unless much more spawning stock is allowed to enter rivers and reproduce.

An important aspect of stock depletion and recovery concerns the genetic constitution of various runs of salmon. Recent research has confirmed that there are more or less discrete genetic populations not only as between different areas and river systems but even within some rivers. For example, wild young salmon occurring in Northwest Miramichi headwaters appear to belong to a different population from those in the lower reaches. In experiments involving tagging hatchery-reared smolts derived from selected parents: for smolts of

virgin, 2-sea-year (large salmon) parentage (5 lots), 40,838 smolts tagged; 648 returns - 37% as grilse, 63% as salmon; for smolts of 1-sea-year (grilse) parentage (4 lots), 16,588 smolts tagged; 389 returns - 61% as grilse, 39% as salmon.

There are strong tendencies for salmon to beget salmon and grilse to beget grilse. It is likely that these tendencies would be greatly increased by programs of selective breeding to eliminate either big salmon or grilse. In fact, the Miramichi commercial fishery, especially, is geared to do this very thing by removing as many big salmon as possible while protecting the grilse, especially the smallest grilse.

Fishermen, perhaps especially anglers, have long believed that at least two different runs of salmon can be distinguished in many rivers - those entering early in the year and those entering late. Some biologists have held that these seasonal runs were governed by environmental conditions such as sea and river temperatures and patterns of river discharge, rather than being separate races.

One approach to this problem is to take early-run brood stock and late-run brood stock into a hatchery, rear their progeny separately but under similar conditions, tag and liberate the smolts at the same place and time and examine the returns for differences in behaviour patterns.

Experiments thus designed to test the reality of separate early- and late-run stocks have been done with Northwest Miramichi fish. The criterion used for early-run parents was ascent to the Board's counting fence, 7 miles above tidehead, before the end of July; to qualify as late-run ascent to the fence had to be no earlier than September 1 and only comparatively bright fish not long in from the estuary were used. Tagged smolts derived from early-run parents and liberated included 40,350 fish put out in 23 different lots. Those from late-run parents included 62,630 liberated in 26 lots.

Survivors which escaped fisheries to ascend the river as far as the counting fence (161 from early parents, 65 from late parents) showed the following seasonal patterns of return, expressed as percentage of the total run of each group:

	June	July	Aug.	Sept.	Oct.	Nov.	Mean date of return
Early-run							
grilse	4	75	1	6	8	0	July 27
salmon	3	2	0	0	1	0	July 10
overall	7	77	1	6	9	0	July 26
Late-run							
grilse	0	15	3	9	49	2	Sept.23
salmon	8	0	0	3	8	3	Sept.2
overall	8	15	3	12	57	5	Sept.18

Just as there is a tendency for salmon to beget salmon and grilse to beget grilse, so too is there a pronounced tendency for early-run fish to beget early-run and late-run to beget late-run. Fisheries procedures which do not take account of these

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heritable characteristics run the risk of producing an imbalance of natural stocks, including attendant depletion of those stocks most used in the fisheries.

As pointed out above, this does happen in Miramichi commercial fisheries in respect to heavy exploitation of salmon larger than grilse. That a similar situation of differential utilization also pertains in respect to early- and late-run stocks may be indicated by the preliminary analysis of catch data below:

Utilization of early- and late-run salmon liberated in the Northwest Miramichi River as tagged, hatchery-reared smolts of selected parentage, as percentage of total returns (in brackets) from each group of grilse and each group of salmon:

	In Commercial Fisheries					In River		
	Greenland*	Nfld.	N.S.	Dist.N.B. & P.Q.	Home water	Angled	Poached	Escapement
Early-run								
grilse (556)	0	8	9	3	29	29	2	21
salmon (342)	15	7	10	7	46	14	<1	2
Late-run								
grilse (279)	0	32	3	4	23	22	<1	17
salmon (488)	18	15	3	6	45	10	1	2

*No adjustment for incomplete returns from high seas fishery

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The early-run fish contributed more to inland angling but the late-run stocks contributed about equally to commercial fisheries, more in the case of late versus early grilse.

Most of the data presented here are derived from tagged, wild Northwest Miramichi smolts and thus indicate what happens to the natural production of the river.

Figure 1 shows the returns from tagged smolts liberated between 1959 and 1968. Survival rates varied between 1.5% and 4.0%. From about 50 to 75% of the fish returned as grilse. Considering numbers (but not pounds) the commercial fishery used almost as many grilse as salmon - from some year-classes (e.g., 1963, 1964, 1968 smolts), more. Most of the spawning escapement was composed of grilse and in some years no large salmon survived to spawn. In late years the sport fishery took out about half the grilse that entered fresh water; in most years it took out nearly all the big salmon.

In Figure 2 the patterns of utilization of large salmon can be seen more easily. The arrangement of data differs from that in Figure 1 in that percentages of Figure 2 are based only on the total returns of large salmon, whereas in Figure 1 they are based on the total returns of grilse plus salmon. The right-hand part of Figure 2 incorporates a correction for the fact that the Greenland high seas fishery withheld most tags taken from their fish until 1971. These adjusted data probably come much closer to the truth of the matter than do the unadjusted data on the left. In 1965 and 1967-70 the Greenland fishery took either almost as many or more Northwest Miramichi big salmon as compared to commercial fisheries (drift-net and estuarial combined) of the Miramichi area. In some years, but not all,

Newfoundlanders took almost as many big salmon as Miramichi commercial fishermen. Most of these were taken along the east and south coasts of Newfoundland, but *not* in the Port-aux-Basques drift-net fishery. (Newfoundlanders also take some grilse; the combined tribute of grilse and salmon extracted by that province ~~being~~ shown in Figure 1, second column from the right.) The low escapement rate of big salmon for spawning is again conspicuous.

While Figure 3 does not involve Miramichi salmon, it is included to show how commercial fisheries, especially distant ones, can use most stocks reared at considerable expense in other rivers. Fisheries which lie astride migratory paths of salmon are not very selective for stocks and can deplete those of distant rivers. Maritimers and Newfoundlanders who complain about the effects of the Greenland fishery on salmon reared in their waters might do well to re-examine their own attitudes towards salmon reared in Maine and Quebec!

Figures 3 and 4 are taken directly from a document published in Redbook 1969, Part III, of the International Commission for the Northwest Atlantic Fisheries, as also are Tables 1, 2 and 3. These two figures show the distribution of fish tagged as smolts in 1966, liberated in the Northwest Miramichi at Curventon and later recaptured as grilse or salmon. Note the difference in proportion of distant recaptures, especially in the Bay of Fundy area, between wild smolts (Fig. 4) and hatchery-reared smolts (Fig. 5). Until additional data are examined there must be some uncertainty as to whether the increased wandering results from *any* artificial rearing, from rearing in hatcheries elsewhere than on the stream of liberation, or from the particular stocks (e.g., late-run versus early-run) involved. Most of the wild fish can be regarded as from early-run grilse parentage.

Tables 1 to 3 give summaries of the above returns as grilse versus salmon and show heavy average utilization in fisheries of large salmon from all three stocks - perhaps heaviest of all for early-run (81%) and lightest (71%) for late-run, with wild stocks intermediate (77%). Average escapement for large salmon contributing these data was under 4%.

Annual spawning runs of grilse and salmon into the Northwest Miramichi, as counted at the Curventon fence, are shown in the upper part of Figure 6. The lower part of this figure shows the reproductive potential represented by these runs. Actual reproduction would be at a somewhat lower level because of removals by angling, poaching and other causes of mortality. Potential egg deposition can be related to the ideal situation by reference to the grey band marked "Eggs needed for maximum production." For 2-year smolts about 5 million eggs are required; for 3-year smolts, about 7 1/2 million. Northwest smolts are a mixture of 2- and 3-year olds. Not surprisingly the decreasing numbers of grilse and salmon have resulted in potential egg production far below (between 1/5 and 1/10) that needed for maximum production.

Figure 7 shows how production of juveniles has also decreased, especially in the lower reaches, where copper-zinc pollution has for 10 years killed most of the young spawned there. Figure 7, as in the figure for potential egg deposition, also gives ideal population densities for the three important juvenile stages.

Discussion

The salient fact is that Northwest Miramichi salmon populations are sadly depleted. They can no longer sustain the degree of exploitation to which they are now subjected. Kerswill (1971. J. Fish Res. Bd. Canada 28: 351-363) reports that spawning escapement between 1950 and 1964 amounted to about 11% of total large salmon recaptures from Northwest stocks: in 1970 spawning escapement included only 2 to 3 per cent of the tagged, large salmon produced by the river.

Calculations show that for full production (based on 5 million eggs taken into the river), Northwest river runs at Curventon should include about 900 salmon and 2,500 grilse. For the 6 years from 1950-55 annual runs averaged 956 salmon and 2,303 grilse. To get such river runs now, *all* fishing would have to be eliminated. To assure recovery in the foreseeable future drastic curtailment of fishing is essential. It should be remembered that for 3-year smolts and 2-sea-year salmon a life-cycle span of 6 years is required between the spawning run of parents and the returning run of comparably-aged fish. Such life cycles determine the time span for recovery from present low stocks.

Revised March 15, 1972

Overfishing and Depleted Stocks of Northwest Miramichi Salmon

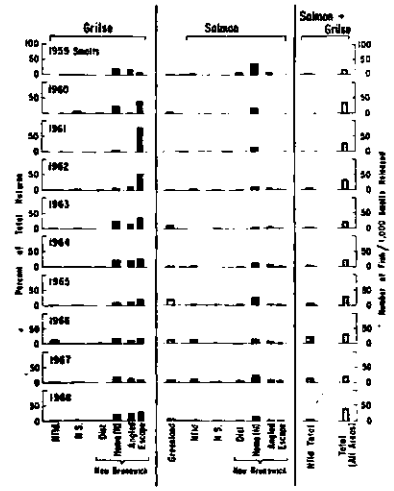

Figure 1. Recaptures of grilse and salmon tagged as wild smolts while descending the Northwest Miramichi River each year from 1959 to 1968. All vertical columns except extreme right-hand dotted indicate percentages of total returns used in various fisheries and recorded as escapement for reproduction. Escapement includes a few fish taken for hatchery brood stock as well as those passing up through Curventon counting fence and not subsequently caught. Angling catch includes a few fish suspected of having been taken illegally, but these constitute far less than 1/10th of the angling catches shown. Extreme right-hand (dotted) columns indicate overall rates of return (= survival rate) per 1,000 tagged smolts liberated each year. Numbers of tagged smolts liberated were:

1959 - 3,442	1964 - 12,966
1960 - 882	1965 - 15,361
1961 - 774	1966 - 8,450
1962 - 6,111	1967 - 11,763
1963 - 4,678	1968 - 31,708

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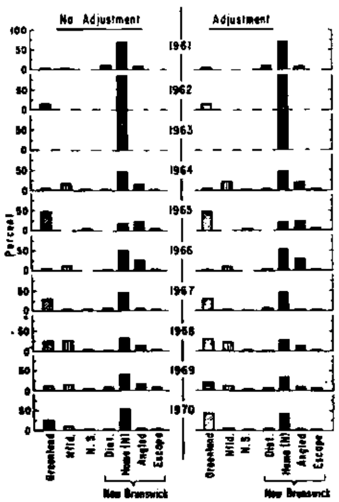

Figure 2. Utilization of 2-sea-year and older salmon (i.e., salmon larger than grilse) shown as percentage of total returns of large salmon derived from tagged Northwest Miramichi wild smolts. These values do not include returns as grilse which amounted to about 75% of total returns from smolts descending in 1960, 1961, 1962, 1963, 1964, 1968 and 50% from smolts descending in 1959, 1965, 1966, 1967. Records of recaptures in the Greenland area come almost entirely from the shore-based fishery during the period indicated. Very few tags were returned from the substantial high seas drift-net fishery that developed in 1965 and later, although it is known that tagged fish were taken and the tags not returned.

The left half of the figure shows proportionate returns from different fisheries using data as received. The right half involves an adjustment assuming that similar proportions of tags would have been taken in the Greenland shore-based and high seas fishery. The effect of this adjustment is to indicate that the fisheries of the Greenland area have, between 1967 and 1970, used almost as many of the large salmon as 'home water' commercial fisheries, indicated by 'Home (N)' in the figure. The catch in the columns labelled 'Angled' includes a very few fish known to have been taken from the home river illegally. Columns labelled 'Escape' include fish used for hatchery brood stock as well as those known to have passed upriver and not to have been subsequently caught.

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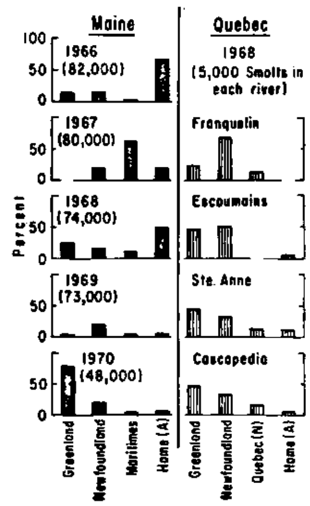

Figure 3. Utilization, as percent of total returns, of tagged, hatchery-reared smolts liberated in rivers of Maine and Quebec. Numbers in brackets are the numbers of tagged smolts liberated each year. The Maine data include liberations in several rivers each year. The Quebec data show, from top to bottom, returns from two North Shore, one South Shore and one Bay of Chaleur rivers. Column label 'Home (A)' indicates fish taken by angling in the stream in which smolts were liberated; column label 'Quebec (N)' indicates recaptures in Quebec commercial fisheries. These data indicate even greater distant water commercial utilization of expensive hatchery-reared stocks than pertains in the case of Northwest Miramichi wild smolts (see Figures 1 and 2).

Maine data supplied by courtesy of A.L. Meister, Maine Atlantic Sea Run Salmon Commission. Quebec data supplied by courtesy of B. Tétreault, Quebec Department of Tourism, Fish and Game and W.M. Carter, International Atlantic Salmon Foundation.

Figures 4 and 5 show places of recapture of tagged, wild and hatchery-reared smolts liberated at the Fisheries Service counting fence on the Northwest Miramichi River at Curventon, 7 miles above the head of tide.

(see p. 13)

These two figures and Tables 1, 2 and 3/are taken directly from "Utilization of three stocks of Atlantic salmon tagged and liberated as smolts in the Northwest Miramichi River from 1964 to 1967," by P.F. Elson. Redbook 1969, Part III. Selected papers from the 1969 Annual Meeting, International Commission for the Northwest Atlantic Fisheries, pp. 71-77.

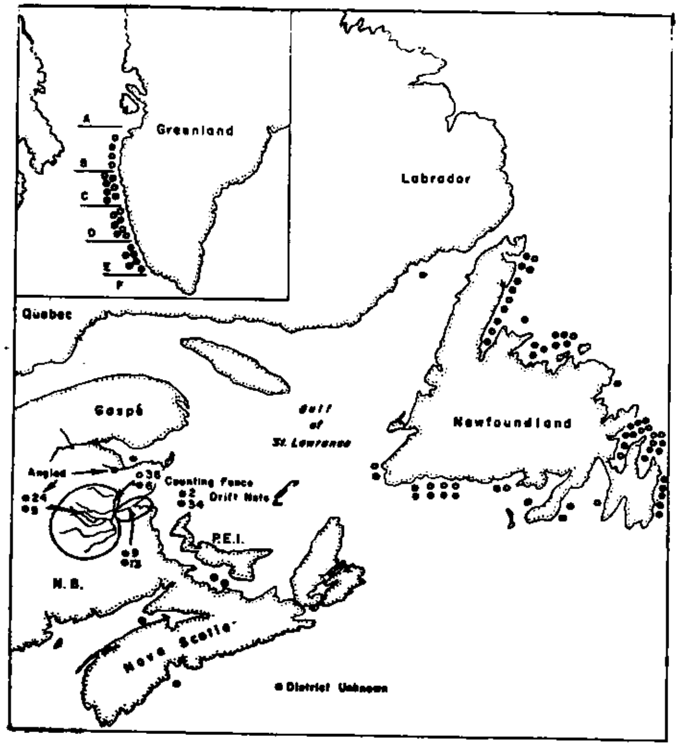

Figure 4

Recaptures from 8,450 Atlantic salmon tagged as wild, native smolts at a counting fence while descending the Northwest Miramichi River, New Brunswick, in May and June, 1966. Open circles - taken as 1-sea-winter fish (130); solid circles - taken as 2-sea-winter or older fish (93).

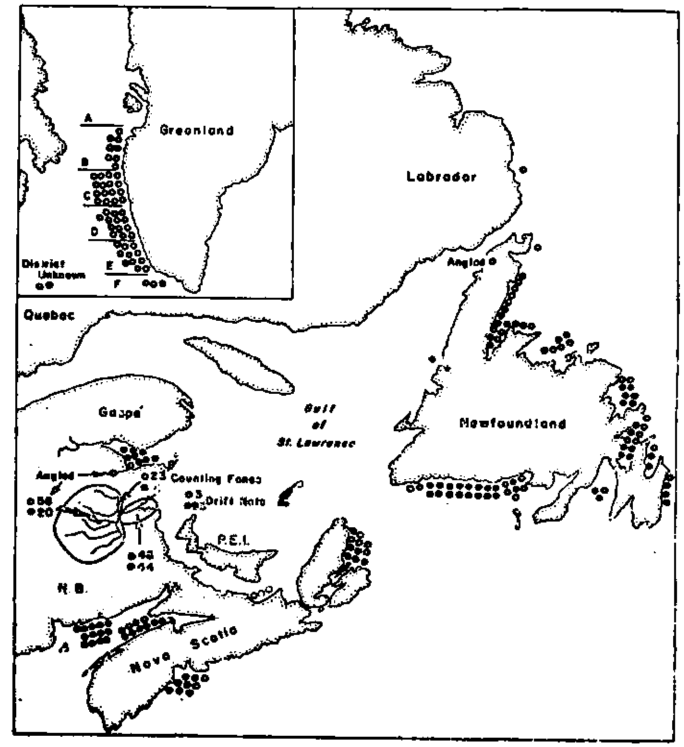

Fig. 5. Recaptures from 18,314 Atlantic salmon hatchery-reared smolts of late-run mixed grilse and salmon parentage and 13,802 hatchery-reared smolts of early-run mixed grilse and salmon parentage; liberated in the Northwest Miramichi River, New Brunswick, in late May 1966. Open circles - taken as 1-sea-winter fish (243); solid circles - taken as 2-sea-winter or older fish (241).

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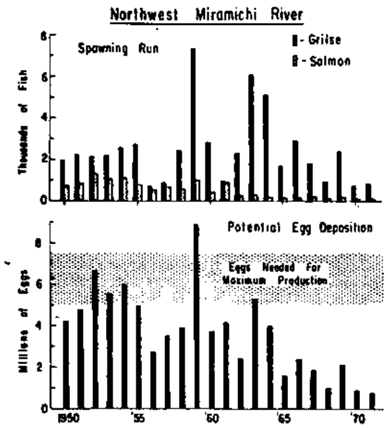

Figure 6. Annual runs of grilse and salmon up through the Fisheries Service counting fence on the Northwest Miramichi River at Curventon, 7 miles above head of tide, and potential egg deposition represented by these runs. About 50% of large salmon (average wt. about 10 lb) and 33% of grilse (average wt about 3 lb) in this river have been found to be females. Fecundity (number of eggs per female) was assumed to be 8,000 eggs for large females and 2,000 eggs for grilse, based on the work of Baum and Meister on Maine salmon (see J. Fish. Res. Bd. Canada, 1971, 28: 764-767.)

Egg requirement for maximum production is based on Elson, P.F. 1957. Canadian Fish Culturist No. 21, pp. 19-23, and the same author in Atlantic Salmon Journal No. 2, pp. 16-18, June, 1962.

Potential egg deposition shown in the lower part of the figure takes no account of grilse and salmon removed by anglers, poachers, adverse effects of mine effluent or other causes of mortality after they passed through the fence. Nor does it make allowance for the fact that out of a sample of about 20 female grilse held for brood stock in 1971, about half were barren.

The recent downward trend in both adult runs and reproductive potential of the river population is conspicuous.

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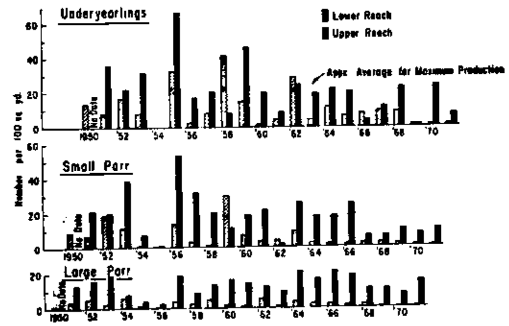

Figure 7. Comparative abundance of juvenile salmon found by electroseining in the same sample areas of the Northwest Miramichi River between 1950 and 1971. Data are provided for three size groups which approximate, but do not exactly represent year-classes. Separate data are presented for the lower reach (below Tomogonops tributary) directly affected by mine effluent (cross-hatched columns) and the upper reach affected only indirectly by partial obstruction of upward-migrating spawners (black columns).

Data for small parr, mostly yearlings, have been offset 1 year to the left in comparison to underyearling data; data for large parr, mostly 2 year olds, are offset 2 years to the left. The development of a single year-class can thus be read vertically downward, in general. But where growth was slow, underyearlings (e.g., for 1951) contributed small parr in 2 successive years (e.g., in 1952 and 1953). Similarly, small parr could contribute large parr in 2 successive years. When growth was faster than usual, underyearlings could contribute 1 year earlier to large parr populations. This happened when many 1970 underyearlings appeared as large parr, admittedly below average size for this group, in 1971.

Grey bands indicating approximate average for maximum production are drawn from Elson, 1967, J. Fish. Res. Bd. Canada 24: 731-767, but have been broadened to allow for higher production of 2-year-old smolts resulting from recent extensive cutting of the forest and consequent warmer water and faster growth.

As with potential egg deposition, a severe downward trend in recent production of pre-smolt parr is evident. This is especially the case for the lower reach of the river.

Table 1. Returns from tagged, wild Northwest Miramichi smolts. (Escapement = fish recorded in counting weirs and brood stock collection but not subsequently in fisheries).

Year tagged	Number tagged	Total returns: number	Total returns: % of tagged smolts	Grilse reported in Canada as % of total adult returns	2-sea-winter & older fish as % of total large salmon returns: Greenland fisheries	Canada: fisheries	Canada: escapement
1964	12,996	267	2.1	65	10	88	2
1965	15,361	429	2.8	38	27	70	3
1966	8,450	225	2.7	48	21	74	5
1967	11,763	80*	0.7*	-	(13 fish)**	-	-

* Grilse in Canada and 2-sea-winter fish in Greenland (to Feb.28 1969) compare with 1.4, 1.5 and 1.6% returns from 1964, 1965 and 1966 liberations.

** Ratio of grilse in Canada: 2-sea-winter fish in Greenland for smolts of 1964 - 25:1, 1965 - 2:1, 1966 - 5:1, 1967 - 5:1.

Table 2. Returns from tagged, hatchery-reared smolts from late-run mixed grilse and salmon parentage, liberated in the Northwest Miramichi River. (Escapement = fish recorded in counting weirs and brood stock collections but not subsequently in fisheries).

Year tagged	Number tagged	Total returns: number	Total returns: % of tagged smolts	Grilse reported in Canada as % of total adult returns	2-sea-winter and older fish as % of total large salmon returns: Greenland fisheries	Canada: fisheries	Canada: escapement
1964	11,533	28	0.2	64	30	60	10
1965	4,797	120	2.5	45	15	80	5
1966	18,314	248	1.4	18	22	77	1
1967	14,440	66*	0.5*	-	(7 fish)**	-	-

* Grilse in Canada and 2-sea-winter fish in Greenland (to Feb.28 1969) compare with 0.2, 1.3 and 0.5% returns from 1964, 1965 and 1966 liberations

** Ratio of grilse in Canada: 2-sea-winter fish in Greenland for smolts of 1964 - 6:1, 1965 - 5:1, 1966 - 1:1, 1967 - 8:1.

Table 3. Returns from tagged, hatchery-reared smolts from early-run mixed grilse and salmon parentage, liberated in the Northwest Miramichi River. (Escapement = fish recorded in counting weirs and brood stock collections but not subsequently in fisheries).

Year tagged	Number tagged	Total returns: number	Total returns: % of tagged smolts	Grilse reported in Canada as % of total adult returns	2-sea-winter and older fish as % of total large salmon returns: Greenland fisheries	Canada: fisheries	Canada: escapement
1965	10,026	330	3.3	58	25	75	0
1966	13,802	236	1.7	61	10	88	2
1967	15,517	150*	1.0*	-	(2 fish)**	-	-

* Grilse in Canada and 2-sea-winter fish in Greenland (to Feb. 28 1969) compare with 2.2 and 1.1% returns from 1965 and 1966 liberations.

** Ratio of grilse in Canada: 2-sea-winter fish in Greenland for smolts of 1965 - 6:1, 1966 - 16:1, 1967 - 74:1.