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Genetic polymorphism in Northwest Miramichi salmon, in relation to season of river ascent and age at maturation and its implications for management of the stocks

by

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That Northwest Miramichi salmon stocks are made up of four somewhat, but not entirely, discrete components was advanced in ICANF Res. Doc. 71/73. Møller (1970) has shown polymorphism between salmon stocks of different areas as indicated by blood transferrin frequencies. Some unpublished results of later studies at St. Andrews indicate probable genetic differences between parr taken from the headwater areas of the Northwest Miramichi as compared to parr from lower reaches of the same river. Behavioural differences between early-run salmon bound for headwaters and late-run salmon using the lower reaches for reproduction have been noted by Saunders (1967). Data leading to the statement in ICNAF Res. Doc. 71/73 was derived from as yet unpublished experiments involving selectively bred salmon reared in hatcheries and liberated as tagged smolts.

Season of ascent

Parent stock was selected at the Curventon counting fence on the Northwest Miramichi. To qualify as early-run parents the fish had to reach the fence 7 miles above head of tide, by July 15. A few times this date was extended to July 31 in order to get sufficient stock. To qualify as late-run, parent fish had to reach the fence on September 1 or later and had to be bright fish or have sea lice still attached. Progeny were reared separately to smolt stage in the Fisheries Service's hatcheries, mostly at the Miramichi (South Esk) hatchery. They were tagged at the smolt stage and liberated at the Northwest Miramichi Curventon counting fence at the peak of native smolt run.

These studies were begun in the early sixties, when Northwest runs had already entered a period of decline and it was sometimes difficult to get sufficient parents of one stock or another. Consequently, in no years were progeny of all four stock components liberated together. In the first experiments parent stocks included both grilse and salmon, only the early or late criteria being applied. In later studies the groups were separated more rigorously.

Early-run stock for which results are now available included the following parent groups:

mixed grilse and salmon	grilse only	2-sea-winter only
28,547 smolts	7,015 smolts	4,788 smolts

Late-run stocks have included:

mixed grilse and salmon	grilse only	2-sea-winter only
17,024 smolts	9,573 smolts	36,033 smolts

Returns from these smolts are summarized by area and mean date of recapture in Tables 1 and 2. Some fish of early-run stock entered fresh water as late as November, and some of late-run stock as early as June. But the majority of fish of early-run origin which ascended the river had reached Curventon by the end of July and most of those of late-run origin ascended past Curventon after August 31, the late run of these tagged fish peaking in October. Because of the number of years involved, with various conditions of water flow pertaining, it is believed that the dominant factor for season of ascent is to be found in the genetic constitutions of the different groups.

In the Northwest Miramichi there is little angling after August 31, so that late-running fish could not contribute heavily to the local sport fishery, whereas the early-run contributed heavily to angling.

But many fish of both early- and late-run stocks were in the estuary quite early so that both contributed well to the home commercial fishery. There is, however, indication that the commercial fishery, while it existed, taxed late-run large salmon more heavily than the early-run (30% compared to 18% of total returns). Similarly the distant fisheries taxed the late-run stock more heavily than the early-run (12% versus 6% in Greenland; 10% versus 2% in Newfoundland). For the Miramichi system at large, as for the Northwest, the late-run stocks are currently at a lower ebb than the early-run. It seems probable that these distant fisheries provide a good part of the explanation.

Age at maturation

Data for comparison of sea age at first maturation to sea age of parents at first maturation is given in Table 3. The data are given in 2 parts, the upper part pertaining to early-run stocks and the lower to late-run. The table is a reorganization of much, but not all, of the data used for Tables 1 and 2. Looking at the overall totals, 60% of the fish from grilse parents returned first as grilse, 40% returned first as salmon. Within this group, 62% of the early-run fish returned first as grilse, but only 57% of the late-run.

There was, particularly in the early years, more opportunity for early-run grilse to mate with salmon and less for late-run grilse to mate with salmon.

In the same general pattern the early-run salmon which had ample opportunity to mate with grilse show, in fact, a predominance (60%) of grilse offspring; but the late-run salmon with less opportunity for breeding with grilse show a predominance of progeny (71%) first returning as 2-sea-winter virgin fish*. The groups would appear to be heterozygous for these behaviour patterns, with the grilse factor perhaps dominant, at least for early-run fish.

The mechanisms envisaged as operating are those of both environmental genetics in providing ability to respond in certain patterns, and environmental parameters eliciting appropriate responses in terms of individual behaviour, e.g., responses to freshets in ascending streams or to very low, warm water and/or pollution in failing to ascend streams.

Different migratory patterns for different river stocks

That the migratory patterns followed by salmon stocks of different rivers may be different was suggested by Elson (1972; compare Figs. 2 and 3). Additional pertinent data are offered in Table 4. The table gives data obtained from stock indigenous to the Margaree River, N.S. Because only a limited number of wild native smolts were tagged over a period of years (part A), data from hatchery-reared indigenous smolts are also given (part B). Both show a preponderance of smolts recaptured as 2-sea-winter or older fish (70% to over 90%). About 30% of these were recorded from Greenland and 15% from home commercial fisheries. If allowance be made for non-return of tags from the high seas fishery, the Greenland take was much higher than 30%. During the years 1962-68 an intensive experiment to increase Margaree stocks by control of mergansers (Elson, 1962) was in operation. This was expected to approximately double stocks available to home fisheries in 1964-70. The improvement was barely discernable and this may have been related to the large proportion of stock abstracted in Greenland. In contrast, wild Northwest Miramichi smolts returned mostly (over 60%) as grilse and under 40% as salmon. Distant fisheries exploited a high proportion of the Margaree stocks, e.g., Greenland about 31% and Newfoundland 25 to 36%. But the distant fisheries took smaller though still substantial portions of the Miramichi fish (Greenland - 24% of the large salmon, and Newfoundland 4%; Newfoundland also took grilse for a total exploitation of over 7% of these Miramichi stocks.

Conclusion

In view of the different compositions of stocks from different rivers in respect to season of return, age at maturation, and probably different migratory patterns, it is unlikely that they can be managed effectively and exploited optimally when there is heavy fishing mortality distant from home waters. Such fishing appears to have contributed greatly to the present low levels of Canadian salmon stocks. This condition cannot be expected to improve until more rational management is instituted.

*For early- and late-run stocks combined, 63% of the progeny returned as virgin 2-sea-winter fish.

References

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Table 1. Recaptures from tagged hatchery-reared smolts of early-run parentage released in the Northwest Miramichi River, 1963-69.

Total released = 40,350. Total salmon + grilse recaptured = 881

Location	% of salmon and grilse recaptures			Range of months	Mean date of capture
	Grilse	Salmon	Total		
Greenland	0	6	6	8-12	October 10
Newfoundland	5	2	7	3-12	July 13
Nova Scotia	5	4	9	5-9	July 4
Dist. New Brunswick and Prov. Quebec	2	3	5	6-11	July 17
Home waters					
- commercial	18	18	36	5-9	July 2
- angled	18	3	21	6-10	July 25
- poached	1	<1	1	6-10	July 20
- escapement	14	1	15	6-11	July 31
Total	63	37	100	3-12	July 18

Table 2. Recaptures from tagged hatchery-reared smolts of late-run parentage released in the Northwest Miramichi River, 1961-69.

Total released = 62,630. Total salmon + grilse recaptured = 736

Location	% of salmon and grilse recaptures			Range of months	Mean date of capture
	Grilse	Salmon	Total		
Greenland	0	12	12	5-12	October 17
Newfoundland	12	10	22	5-11	July 5
Nova Scotia	1	2	3	6-11	July 9
Dist. New Brunswick and Prov. Quebec	2	4	6	6-10	July 22
Home waters					
- commercial	9	30	39	5-10	July 15
- angled	8	2	10	6-11	August 9
- poached	<1	1	1	6-10	July 10
- escapement	6	1	7	6-11	September 20
Total	38	62	100	5-12	July 31

Table 3. Recaptures from tagged, hatchery-reared smolts from selectively bred parents of Northwest Miramichi stock collected at Curventon, and smolts liberated at Curventon during peak of native smolt run.

	Grilse parents - recaptured as		Salmon parents - recaptured as	
	Grilse	Salmon	Grilse	Salmon
Early-run parentage (11,803 smolts)				
Location of capture				
Greenland	-	24	-	11
Newfoundland	12	8	4	6
Nova Scotia	8	7	18	15
Dist. New Brunswick and Prov. Quebec	8	6	3	5
Home waters				
- commercial	51	37	28	24
- angled	45	7	22	5
- poached	5	0	0	0
- escapement	22	0	26	1
Sub-total	151	89	101	67
Late-run parentage (45,606 smolts)				
Greenland	-	9	-	73
Newfoundland	25	9	55	63
Nova Scotia	1	0	5	14
Dist. New Brunswick and Prov. Quebec	5	6	2	23
Home waters				
- commercial	25	37	24	170
- angled	25	4	36	17
- poached	0	0	1	2
- escapement	12	4	22	4
Sub-total	93	69	145	366
Total	244	158	246	433

Table 4. Comparison of captures in various fisheries, and spawning escapement of Margaree River and Northwest Miramichi River smolts tagged and liberated during the natural smolt runs in these streams.

A. Native wild smolts released at Margaree, N.S., 1962-69

Number released = 5549. Number adult recaptures = 42

	% total adult recaptures	
Location	Grilse	Salmon
Greenland	0	31
Newfoundland	0	36
New Brunswick	0	0
Distant Nova Scotia	0	10
Home waters		
- commercial	0	14
- angled	7	2
- poached	0	0
- escapement	0	0
Total	7	93

B. Hatchery smolts of indigenous Margaree stock released at Margaree, N.S., 1961-69

Number released = 52,444. Number adult recaptures = 153

Greenland	0	31
Newfoundland	9	16
New Brunswick	0	<1
Distant Nova Scotia	0	2
Home waters		
- commercial	3	16
- angled	11	5
- poached	0	0
- escapement	7	0
Total	30	70

C. Native wild smolts released at Curventon, Northwest Miramichi, 1962-70

Number released = 91,541. Number grilse + salmon recaptures = 3003

Greenland	0	10
Newfoundland	4	4
Nova Scotia + Prince Edward Island	<1	1
Distant New Brunswick and Prov. Quebec	<1	1
Area unknown - commercial	0	<1
Home waters		
- commercial	13	19
- angled	17	2
- poached, etc.	5	<1
- escapement	22	2
Total	61	39