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Lower ocean survival rates for hatchery-reared Atlantic salmon (Salmo salar) stocks released in rivers other than their native streams.

by

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ABSTRACT

The paper presents an analysis of tag returns for hatchery-reared smolts of three genetic stocks released in rivers situated at different distances from their native streams. Tag return rates for the release groups show a clinal decrease with the distance the stocks were transplanted from their native streams. This is interpreted as representing a clinal decrease in ocean survival, the extent of which appears to vary with the coastal distance between the recipient river and the native stream of the particular stock.

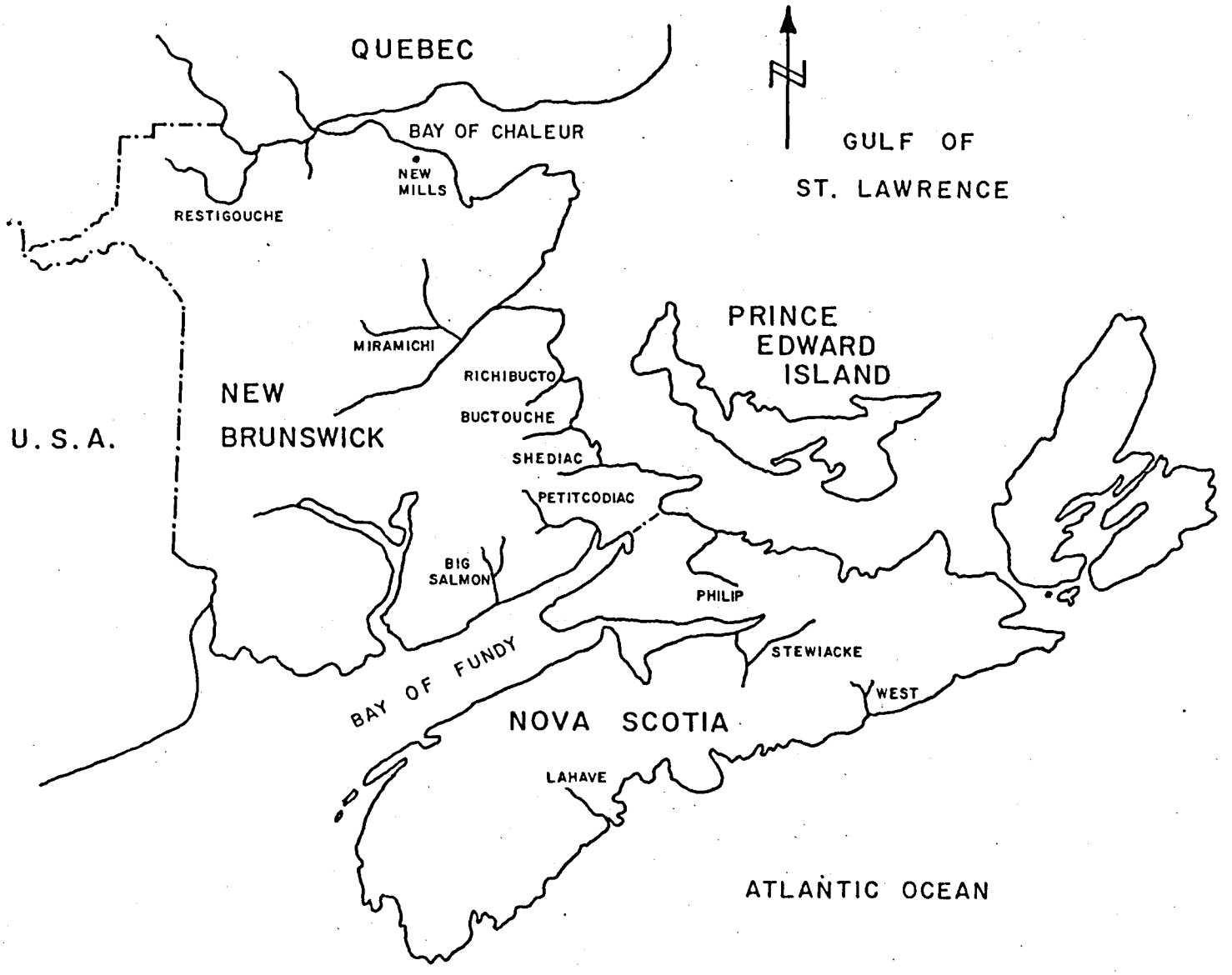
INTRODUCTION

Survival of hatchery-reared salmon smolts to the adult stage varies considerably among release groups. Although some variation in ocean survival can be attributed to the size and quality or health of the hatchery-reared smolt (Carlin 1968; Peterson 1971 and Frantsi et al 1972) it has been suggested that survival is also dependent on the location of the river in which the smolts are released (Ritter and Lister 1971 and Ritter 1972).

In this paper, further evidence is presented that hatchery-reared smolts experience lower ocean survival rates when released in rivers other than their native streams. The paper includes an analysis of tag return data for hatchery-reared smolts released in several Maritime rivers, situated at different distances from the native streams or the natural migration routes of the parent stocks.

A total of 110,500 2-year hatchery-reared smolts was released in 11 rivers in New Brunswick and Nova Scotia during 1968 and 1969 (Fig. 1). The smolts were progeny of fish collected in

Fig. 1. Map showing the location of the 11 rivers in which 110,500 hatchery-reared smolts were released in 1968 and 1969.



Miramichi and Restigouche rivers and the Bay of Chaleur, near New Mills, New Brunswick. Adult tagging has shown the Bay of Chaleur parent fish were destined principally for the Restigouche River. All smolts were tagged with modified Carlin tags, with polyethylene monofilament attachments (Saunders 1968).

ANALYSIS OF SMOLT TAGGING EXPERIMENTS

The 110,500 smolts yielded 959 adult tag recoveries (i.e., 8.7 per 1,000 smolts released), of which 904 tags (i.e., 8.2 per 1,000 smolts released) were returned from Greenland and Canadian commercial and angling fisheries. Among groups of smolts, total adult recovery rates ranged from 0.0 to 23.6 per 1,000 released (Appendix).

Rivers draining into the Gulf of St. Lawrence received 74,800 of the 110,500 tagged smolts released. These smolts yielded considerably higher contributions to all fisheries than did the other 35,700 released in rivers outside the Gulf area (Table 1).

Table 1. Comparison of tag recovery rates for hatchery-reared smolts of Gulf of St. Lawrence stocks released in 1968 and 1969 into rivers inside and outside the Gulf area.

	Rate of adult recovery per 1,000 smolts	
Fishery	Releases inside Gulf area	Releases outside Gulf area
Greenland	3.1	0.2
Canadian		
- Distant commercial	4.9	0.7
- Home commercial[1]	1.9	< 0.1
- Angling	1.8	0.1
- Partial escapement[2]	0.7	0.1
Total	12.4 (921)[3]	1.1 (37)[3]

[1]Recoveries identified under home commercial were made in and near the river in which the smolts were released.

[2]Miscellaneous recaptures made in river sampling traps, by poachers, etc.

[3]Total number of recoveries.

Relative smolt-to-adult survival rates for the two groups, as determined from estimates of total tags returned from fisheries and spawning escapements, indicate that the survival from releases in rivers outside the Gulf area was less than one-tenth that from releases in rivers within the Gulf area. Most significant is the even greater difference between the rates at which adults returned to the rivers inside and outside the Gulf area. Smolts released outside the Gulf area produced a rate of return to the spawning escapements and home fisheries (i.e., commercial and angling) approximately one-twentieth that estimated for those released inside

the Gulf area. Estimates of total tags returned from fisheries and in spawning escapements for smolts distributed inside and outside the Gulf area are 14.8 and 1.2 per 1,000 smolts released, respectively. For those rivers for which escapement data were not available, the estimated numbers of unrecovered tagged salmon present in the river were based on the assumption that anglers take 25% of the available spawning run. The 25% harvest by anglers is generally accepted as an average harvest rate for salmon stocks in the Maritime Provinces.

A detailed examination of data from the same tagging experiments indicates more clearly the variable nature of adult return rates for hatchery-reared smolts released in rivers other than their native stream. For instance, the release of Restigouche smolts in 1968 in eastern Nova Scotia (West River) and in southern New Brunswick (Big Salmon River) produced very low adult returns to fisheries and escapement (4.5 and 0.0 per 1,000 smolts released, respectively), while a comparable release in the Miramichi River produced a relatively high adult return to fisheries alone (19.7 per 1,000 smolts released) (Table 2). Moreover, for the eastern Nova

Table 2. Comparison of tag recovery rates for groups of Restigouche hatchery-reared smolts released in Miramichi, West and Big Salmon rivers in 1968.

	Rate of adult recovery per 1,000 smolts for		
Fishery	7,000 smolts released in Miramichi River	4,880 smolts released in West River	9,970 smolts released in Big Salmon River
Greenland	3.6	0.6	0.0
Canadian			
- Distant commercial	7.6	3.3	0.0
- Home commercial[1]	5.4	0.0	0.0
- Angling	3.1	0.0	0.0
- Escapement	N/A	0.6	0.0
Total	19.7 (137)[2]	4.5 (22)[2]	0.0 (0)[2]

[1]Recoveries identified under home commercial were made in and near the river in which the smolts were released.

[2]Total number of recoveries.

Scotia release, the proportion of adult returns to home fisheries (i.e., commercial and angling) and in the spawning escapement was considerably lower than that for the Miramichi release, which excludes escapement (14% vs 43%). According to these data, proportionately fewer of the available fish in the distant feeding areas, from the West River release, returned to home fisheries and escapement. This may indicate an increased straying and subsequent mortality during the return migration from the customary feeding areas.

The 1969 releases of Restigouche smolts in the Miramichi and West rivers show similar trends in adult return rates (11.7 versus 1.2 per 1,000 smolts released). Similarly, a later release of smolts in Big Salmon River, originating from broodstock collected at New Mills in the Bay of Chaleur, produced no adult returns to fisheries or the spawning escapement, while groups of smolts from the same parent fish, distributed in the Restigouche and Miramichi rivers in 1969, yielded relatively high adult returns to the fisheries alone (10.6 and 10.9 per 1,000 smolts, respectively). The zero adult return from the 1969 smolt release in Big Salmon River, provides further confirmation of the exceptionally poor ocean survival one may expect from transplanted Bay of Chaleur stocks (Restigouche and New Mills) released in Bay of Fundy Rivers.

The 1968 and 1969 releases in Big Salmon River, while yielding zero adult returns to fisheries and escapements, produced 50 post-smolt recoveries from herring weirs in the Bay of Fundy. These recoveries were made throughout the first summer following their releases.

Despite the dismal results obtained from the Big Salmon River releases of smolts originating from Bay of Chaleur stocks, distributions of Miramichi smolts in Big Salmon River in 1964, 1965 and 1966 produced slightly more favourable results. The releases of 56,000 tagged Miramichi smolts yielded 132 adult returns to fisheries and in spawning escapements (i.e., 2.4 per 1,000 smolts released). Although this is better than that produced by the Restigouche and New Mills releases, the results are poor, relative to adult return rates obtained from releases of Miramichi hatchery smolts in the Miramichi River in both the mid-1960's (May 1971; personal communication, P.F. Elson) and late 1960's (Table 3).

The total tag return for Big Salmon River releases was one-seventh that for the Miramichi River releases. Moreover, the Big Salmon River releases yielded proportionately more grilse to fisheries and escapements than did the Miramichi River releases in the same years (73% versus 50%). The distant fisheries off

Table 3. Comparison of tag recovery rates for groups of Miramichi hatchery-reared smolts released in Big Salmon and Miramichi rivers.

Fishery	Rate of recovery per 1,000 smolts for 56,000 smolts released in Big Salmon River 1964-66	58,470 smolts released in Miramichi River 1964-66[1]	16,550 smolts released in Miramichi River 1968-69
Greenland	0.1	1.8	1.9
Canadian			
- Distant commercial	0.1	4.7	6.0
- Home commercial[2]	0.4	6.0	3.0
- Angling	0.4	3.3	3.0
- Escapement	1.4	1.6	N/A
Total	2.4 (132)[3]	17.4 (1,020)[3]	13.9 (232)[3]

[1]Data from May (1971) and P.F. Elson, personal communication.

[2]Recoveries identified under home commercial were made in and near the river in which the smolts were released.

[3]Total number of recoveries.

the coasts of Greenland and Newfoundland-Labrador accounted for only 4 of the 132 tags recovered from the Big Salmon River releases. The Greenland fishery returned only one tag or less than one percent of total recaptures compared to 10% for the Miramichi River releases.

In addition to progeny of fish originating from rivers within the Gulf of St. Lawrence experiencing considerably low ocean survival rates when released in rivers outside the Gulf area, tag return data indicate that smolts from these same stocks distributed in rivers situated near the native streams of the stocks and inside the Gulf Region, may also be experiencing lower ocean survival rates than would be the case if released in their respective native streams. For instance, releases of Miramichi smolts in River Philip produced a lower total tag return to fisheries and escapements than did releases of Miramichi smolts in the Miramichi River (Table 4). The River Philip releases produced lower contributions to all fisheries, thus indicating lower ocean survival than that experienced by the releases in the Miramichi.

Table 4. Comparison of tag recovery rates for groups of Miramichi hatchery-reared smolts released into Miramichi River and River Philip in 1968 and 1969.

Fishery	Rate of recovery per 1,000 smolts for 16,550 smolts released in Miramichi River	9,800 smolts released in River Philip
Greenland	1.9	1.0
Canadian		
- Distant commercial	6.0	3.3
- Home commercial[1]	3.0	N/A
- Angling	3.0	1.0
- Escapement	N/A	4.1
Total	13.9 (232)[2]	9.4 (92)[2]

[1]Recoveries identified under home commercial were made in and near the river in which the smolts were released.

[2]Total number of recoveries.

However, the smolts released in River Philip produced an adult return to fisheries and escapements four times that of the earlier releases of Miramichi smolts in Big Salmon River (9.4 versus 2.4 per 1,000 smolts released). The River Philip releases also appeared to experience considerably higher ocean survival rates than did any of the Miramichi, Restigouche or New Mills smolts released in rivers outside the Gulf of St. Lawrence.

To summarize, the release of hatchery-reared smolts in rivers other than their native streams tends to have a marked influence on their ocean survival. The extent of this influence appears, in part, to vary with the coastal distance between the recipient river and the stock's native stream (Table 5). The results support a hypothesis that ocean migration routes vary with the genetic stock and are heritable. Progeny of fish originating from rivers draining into the Gulf of St. Lawrence and transplanted to streams outside the Gulf area would conceivably have more difficulty linking up with their natural migration routes than they would when released in streams near their native rivers. This is a plausible explanation for the highly variable results produced by the different tagged groups of smolts.

Table 5. Clinal change in tag recovery rates with the area of release for hatchery-reared smolts of Gulf of St. Lawrence stocks released in 1968 and 1969. The four areas under which the recoveries are summarized are listed in order of distance from the native streams of the hatchery stocks released.

Area of Smolt Releases	Number Released	Recoveries		
		Fisheries	Other	Total
Inside Gulf Area				
- Native rivers	27540	350	5	355 (12.9)[2]
- Other rivers	47260	519	47	566 (12.0)[2]
Outside Gulf Area				
- Coastal Nova Scotia rivers[1]	11800	33	3	36 (3.1)[2]
- Bay of Fundy rivers	23900	1	1	2 (0.1)[2]

[1]Includes West and LaHave rivers on the eastern and southern shores of Nova Scotia.

[2]Numbers in parenthesis represent rate of recovery expressed in numbers per 1,000 smolts released.

The tagged groups of smolts were reared at several different hatcheries and marked by different tagging crews. Variation in viability or tag loss, therefore, could have produced some of the variation observed in tag return rates for the different release groups. However, the consistency of the pattern emerging from the analysis of data suggests that these factors were secondary, and that release location was the dominant factor influencing tag return rates discussed in this paper.

APPENDIX

SUMMARY OF TAG RECOVERIES FOR 21 GROUPS OF HATCHERY-REARED SMOLTS RELEASED INTO 11 RIVERS IN NEW BRUNSWICK AND NOVA SCOTIA

(The release groups were progeny of fish collected in the Miramichi and Restigouche rivers and Bay of Chaleur, near New Mills, New Brunswick. The rivers in which the smolts were released are listed in order of year of release and increasing coastal distance from the native river of the smolts.)

Year of Release	Release River	Number Released	Recoveries		
			Fisheries	Escapement	Total
Miramichi River stock					
1968	Southwest Miramichi	6750	155	(4)[1]	159
	Philip	4800	29	32	61
	Petitcodiac	990	0	(1)[1]	1
1969	Southwest Miramichi	9800	77	(1)[1]	78
	Richibucto	1690	8	N/A	8
	Buctouche	1590	13	N/A	13
	Shediac	1680	6	N/A	6
	Philip	5000	23	8	31
	Stewiacke	3000	1	N/A	1
Restigouche River stock					
1968	Restigouche	1000	12	N/A	12
	Southwest Miramichi	7000	137	(1)[1]	138
	West	4880	19	3	22
	LaHave	1990	8	N/A	8
	Big Salmon	9970	0	0	0
1969	Northwest Miramichi	2000	36	3	39
	Southwest Miramichi	8500	99	2	101
	West	4930	6	N/A	6
New Mills stock (Parent fish destined principally for Restigouche River)					
1968	Southwest Miramichi	5000	60	N/A	60
1969	Restigouche	9990	106	N/A	106
	Southwest Miramichi	10000	108	(1)[1]	109
	Big Salmon	9940	0	0	0

[1]Numbers in parentheses represent miscellaneous recoveries made in river sampling traps.

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