WHOI-82-2

EFFECTS OF COMMERCIAL FISHING ON ADULT
ATLANTIC SALMON (Salmo salar) IN A QUEBEC RIVER

by

Frederick G. Whoriskey Jr. and Robert J. Naiman

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

January 1982

TECHNICAL REPORT

*Prepared by the Woods Hole Oceanographic Institution and
the Department of Recreation, Fish and Game of the Province
of Quebec.*

*Reproduction in whole or in part is permitted for any
purpose of the United States Government. This report
should be cited as: Woods Hole Oceanographic Institution
Technical Report WHOI-82-2.*

Approved for Distribution:

Ralph F. Vaccaro

Ralph F. Vaccaro, Chairman
Department of Biology

EFFECTS OF COMMERCIAL FISHING ON ADULT
ATLANTIC SALMON (Salmo salar) IN A QUEBEC RIVER

Frederick G. Whoriskey Jr.¹ and Robert J. Naiman²
Woods Hole Oceanographic Institution,
Woods Hole, Massachusetts 02543 USA

Despite an absence of freshwater exploitation, the adult salmon run in the Matamek River, Quebec, declined during 1975-1980 to <23% of the level thought to occur there prior to 1967. Returns in 1979 and 1980 of adults tagged as smolts were 1.0% and 0.9%, respectively. Numbers of emigrating smolts and their corresponding adult returns are not significantly correlated, although we observed a trend towards more salmon (2 sea year fish) returning with larger numbers of migrating smolts. Since 1967 there is noted a decrease in the age at which returning adults smolted and females appear to now constitute a larger percentage of returning grilse and salmon. These, and other changes in life history characteristics, appear to be caused solely by commercial exploitation.

I. INTRODUCTION

The North Shore of the Gulf of St. Lawrence is one of the most important and least disturbed Atlantic salmon (Salmo salar) producing areas of the Province of Quebec. Despite this, few studies describe the ecology and abundance of salmon in this region. Schiefer (1971) presents results from a survey of salmon in ten rivers on the North Shore, while Randall and Power (1979) report on their study of two additional rivers. Salmon at all of these locations are subject to both commercial and recreational exploitation.

¹ Present Address: Dept. de Biologie, Université Laval,
Cité Universitaire, Ste-Foy, Quebec G1K 7P4 Canada

² Author to whom correspondence should be addressed.

In 1975 yearly monitoring of the adult salmon run was initiated in the Matamek River, which is protected from recreational exploitation, providing one of the few extended data bases for an Atlantic salmon population on the North Shore and the only extended data base for a population subject to only commercial harvesting (Gibson, 1978a). Here we briefly report on some characteristics of the Matamek River adult salmon population noting some recent changes in their population dynamics as both forms of exploitation continue to impact other salmon populations in this region.

II. STUDY AREA

The Matamek River, 25 km east of Sept Iles, Quebec, is a sixth order stream (Strahler, 1957) draining a pristine 687 km² watershed vegetatively dominated by balsam fir (Abies balsamea) and black and white spruce (Picea marina and P. glauca). Mean yearly discharge is 21.8 m³ s⁻¹ but can vary from a spring flood level of about 113 m³ s⁻¹ to 2 m³ s⁻¹ in winter. Autotrophic productivity is low but higher than several other similar sized rivers nearby (Naiman, 1980). Prior to 1967 the Matamek River was the site of a private salmon club with 250-300 fish caught each year in a ratio of one salmon to three grilse. From 1968-1974 scientific sampling and recreational angling led to the capture of 323 adults (including 79 two sea year fish). In 1975 the watershed was designated a reserve by the Quebec Provincial government and all exploitation was prohibited with the exception of controlled fur trapping and scientific sampling. Since 1975 no adult salmon have been taken for scientific purposes and only a minimum number of juveniles.

Atlantic salmon are found in the lower reaches of the Matamek River and its tributary, the Muskrat River. The Muskrat River, a 5th order stream, enters the Matamek approximately 2 km upstream from the estuary. It is a slow-flowing river of low productivity draining an extensive bog above a large waterfall, which is located near the confluence with the

Matamek River (Naiman, 1980); consequently, its contribution to the adult run is probably minimal. Salmon are distributed 5.8 km upstream in the Matamek River where a waterfall (4th Falls) prevents further migration.

The Matamek River, though small, may be difficult to transverse for returning adults. They must surmount at least two waterfalls and possibly a long reach of severe rapids to the spawning grounds. Possibly because of the difficult route we have recorded only one adult returning for a second spawning since 1967 (Schiefer 1971).

III. MATERIALS AND METHODS

During upstream migration, adults entering the fishladder at the first waterfall (1st Falls), 0.6 km from the sea, have fork lengths (FL) determined, scales taken for ageing, and are marked for identification with 5 cm serially numbered anchor tags. In most years we effected Petersen population estimates, as well as estimates of upstream migration rate, by recapturing fish in a trap net situated 3.2 km from the fishladder. Although the fishladder was built in 1975, the 1979 season was the first time it was open for the entire migratory period with about 70% of returning fish passing through it.

Sex ratios were determined by inspection of gonads from a few accidental mortalities during tagging and recapture operations, or from secondary sexual characteristics (the presence or absence of the male kype) of fish captured in the trap net. The fish we visually examined for secondary sexual characteristics had, in general, lost their oceanic silver sheen and bore a typical brown river coloration. Males had well formed kypes which minimized any errors in determining sex from external morphology. Because of the small number of returning spawners no adults were deliberately sacrificed for any reason.

IV. RESULTS

The Matamek River adult population is composed of one and two sea-year fish (termed grilse and salmon, respectively). Adults returning from ocean feeding grounds follow a route along the southeast coast of

Newfoundland and arrive in the Sept Iles area by late June (Belding and Prefontaine, 1961; Gibson, 1978b; Gibson and Côté, 1981). Adults begin to enter the Matamek River in early July. The migration peaks (as measured by the number of fish entering the fishladder per day) by mid July and tapers off through August, with 98% of the run entering by mid-August. In 1979 and 1980 the peak occurred during falling water temperatures, although absolute temperatures were considerably colder in 1980 than 1979 (Table 1). The 1979 peak corresponded to a decreasing river discharge, while in 1980 the run peaked on a rising discharge (Table 1). Returns in 1979 and 1980 of adults tagged as smolts were 1.0% and 0.9%, respectively.

The annual adult return to the Matamek River in the ten years prior to 1967 was >250 fish with the maximum number thought to be on the order of 500 fish (Ministère du Loisir, Chasse, et Pêche, file report). Samples obtained in 1968-1974 (mean of 46 fish $\text{yr}^{-1} \pm 16$ SE) were comprised of 24% salmon and 76% grilse. Population studies since 1975 have shown a precipitous and regular decline in the adult run through 1979 (Table 2). In 1980 the adult return was up slightly. We found no significant correlation between the total number of smolts emigrating from the river and the number of returning adults one and two years later (grilse: $r = -0.20$; $p > 0.05$, salmon: $r = 0.61$, $p > 0.05$, Table 3), although there appeared to be higher returns of salmon with larger numbers of smolts emigrating. There was a significant inverse correlation between the mean FL of smolts and the number of returning salmon ($r = -0.94$, $p < 0.05$). The same correlation for grilse not significant ($r = -0.19$, $p > 0.20$).

Based on mark and recapture dates from the fishladder and trap net, upstream migration proceeded at a mean rate of 0.08 km d^{-1} (maximum 0.2 km d^{-1} , minimum 0.04 km d^{-1} , $n = 21$). Adults move a maximum distance of 5.8 km upstream to the base of an impassable waterfall. Spawning probably takes place in late October or early November. No fish returning for a second spawning have been captured since 1975.

Sizes of returning salmon and grilse have not changed in a regular pattern between the years monitored (Table 4). The mean FL for salmon ranged from 70.5 - 74.5 cm, while grilse lengths ranged from 50.1-55.7 cm.

Returning salmon and grilse continue to be dominated by individuals smolting at age 3+ though we have noted in recent years the development of a relatively strong 2+ smolt component, while grilse smolting at age 4+ have largely disappeared. It is not clear whether the recent appearance of 2+ salmon smolts is a real shift in a population characteristic since 20% of the salmon in 1967 smolted at the same age (Table 5).

Sex ratios of returning adults also appear to be changing, with larger fractions of females in the returns of both salmon and grilse (Table 6). Salmon shifted from 63% female in 1967 to 85% female in 1975-1980, while grilse changed from 4% to 15% female in the same period. This observation, however, must be viewed with some caution as half (34 of 65) of the adults had sex determined from secondary sexual characteristics.

Occasional straying of adults to and from the Matamek River does occur. However, we have recovered only one tagged stray salmon in the Matamek since 1975. Released as a hatchery reared smolt in the Liscomb River, Nova Scotia, in May 1978 (R.E. Cutting, pers. comm.) it entered the Matamek River in August 1979. Currently we have only one tag return of a Matamek fish straying to another river. Marked as a grilse in July 1978 it was taken by an angler in the Medway River, Nova Scotia in June 1980.

V. DISCUSSION

No clear pattern emerged from our temperature and discharge data in relation to movements of adults into the Matamek River, although discharge has been implicated as a cue in the initial entry of salmon into other rivers (Banks 1969). Extremes in discharge at Matamek could render falls and rapids impassable for various periods and may partially explain the relatively slow 0.08 km d^{-1} upriver migration we observed, although the short distance of the migration (5.8 km) is certainly a factor.

Since 1975 adult returns declined to <23% (i.e. 57 fish in 1979) of levels estimated in years prior to 1967 (Table 2). This decline parallels a decrease in mean smolt age which appears to have partially maintained the number of smolts leaving per year at a level higher than would have occurred if only the 3+ age class continued to emigrate (Gibson, 1978a; Whoriskey et al., 1980). Despite this, adult returns continued to

decline. With the five years of data available we could not demonstrate a significant relationship between numbers of smolts emigrating and numbers of salmon and grilse returning. However, there was a tendency towards higher salmon returns with elevated numbers of migrating smolts. This tendency is contrary to other studies where a highly significant positive relationship between the number of smolts exported and grilse returning has been reported (Chadwick et al., 1978). We found a significant inverse correlation between the mean size of smolts exported and the returns of salmon, while for grilse this correlation was also inverse but not significant. The inverse relation between smolt size and adult survival is somewhat surprising since in other populations of Atlantic salmon (Carlin, 1969; Champion and Swain, 1972; both quoted in Baglinière, 1976) and Pacific salmon (Ricker, 1962) survival rates at sea have been observed to increase with increasing smolt size. However, there may be an explanation for our observation in that the trend in adult returns may be related more to commercial exploitation at sea rather than to smolt size alone, since smolt size over the years has been increasing as a result of lower parr densities and a stable food supply, which are directly related to decreased spawning escapement.

The Matamek watershed remains free of exploitation with the exception of controlled fur trapping. Thus declines in adult returns can probably be attributed to commercial fisheries and, possibly to some extent, illegal fishing. Commercial fisheries have been reported to take up to 87% and 32%, respectively, of tagged salmon and grilse during their sea migration (Saunders, 1969). Matamek fish are caught primarily in commercial fisheries off Newfoundland (Gibson, 1978b; Gibson and Côté, 1981). In addition, up to 70% and 50% of salmon and grilse, respectively, have been reported with gill net marks upon their return to the Matamek River (Gibson 1978b). However, we view this latter observation with caution as these marks may in part have been inflicted by the trap net used to make population estimates.

Commercial fishing is generally highly selective for larger fish (Saunders, 1969; Paloheimo and Elson, 1974; Gibson and Côté, 1981) and has been implicated as the major cause for an increase in the grilse to salmon

ratio in one river from 2:1 to 28:1 (Saunders, 1969). However, grilse to salmon ratios in the Matamek River, including the years of the salmon club, have ranged from 3:1 to 6:1 in no readily evident pattern (Table 2). Life history theory would suggest that since returns of both salmon and grilse are decreasing, factors responsible for the decline are not strongly selective for salmon (i.e. larger fish) alone. Nevertheless, it can also be argued that if salmon are being selectively taken at sea, and since they may be responsible for most of the egg deposition, then one could expect to see a decline in both salmon and grilse.

We noted no trends or marked changes in the mean length of returning salmon and grilse (Table 4), but did find a larger fraction had smolted at younger ages in recent years (Table 5). The latter observation agrees with a recent shift towards production of younger (2+) smolts already observed in the population. Several authors have discussed the relation between smolt age and age of return for first spawning among Atlantic salmon, noting fish of a particular smolt age often returned predominantly as either salmon or grilse (Gardner, 1976; Chadwick et al., 1978). The Matamek fish appear not to clearly hold this pattern as demonstrated by the 2+ and 3+ smolt components in roughly equal fractions in the returns of both salmon and grilse (Table 5).

Most egg production in the Matamek River has been generated by salmon, which are predominately female (Table 6), and have a higher fecundity than grilse (Schiefer, 1971; Paloheimo and Elson, 1974). From 1975-1980 we observed an increase in the percentage of females in both salmon and grilse returns, when compared with samples taken in 1967 (Table 6). The increasing percentage of female grilse may become critical in maintaining salmon stocks in the Matamek River, especially with salmon returns decreasing to a few as 10 individuals in recent years. In a similar but more extreme case, the total loss of the salmon component of the adult run in West Arm Brook, Newfoundland was documented (Chadwick et al., 1978).

It follows, therefore, that straying of fish to and from the Matamek River during spawning runs could have considerable significance as the population declines. One female salmon moving to another river in a bad

year represents a potential 5-10% loss of total egg deposition. Conversely, a stray male, if successful in spawning, could possibly introduce his genes into 5-10% of a year class.

Concomitant with changes in the adult returns, we have observed changes in the juvenile population of Atlantic salmon. Briefly these include: 1) declines in parr population size and increasing parr growth rates; 2) a younger mean smolt age; and 3) an increase in the percentage of precocious male parr (Gibson, 1978a; Montgomery and Naiman unpubl.). Parr population declines probably follow directly from the decrease in spawning adults, while the increase in parr growth rates may indicate fewer fish are now utilizing a relatively stable food resource and growing faster by receiving larger individual rations (Gibson, 1978a). The timing of parr smoltification is size related (Elson, 1956), thus faster parr growth rates are probably causing the observed decline in mean smolt age as the required size is reached sooner (Gibson, 1978a). The third change, an increase in the percentage of precocious male parr, may have a more complex explanation. Factors controlling and causing precocity in male parr are not well understood but in this situation reasons may include low parr densities, a relatively good food supply, or both. Supporting these contentions are observations in the Matamek River by Gibson (1978b) who noted an increase in numbers of mature male parr with decreasing parr population sizes and increased growth rates. A genetic influence on precocious maturation has also been demonstrated (Glebe et al., 1978, 1980). In any case, alterations of adult and juvenile populations in the Matamek River in recent years are indicative of a severe disequilibrium.

In summary, the Matamek River has shown marked depletions of returning adults in recent years. The most likely cause seems to be commercial fisheries, though evidence from returning spawners suggests the absence of a size selective element in the fishery. Paralleling changes in smolt population characteristics, an increasing percentage of returning fish is composed of adults which smoltified at younger ages. Finally, sex ratios appear to be changing with females constituting an increasing fraction of both salmon and grilse.

Table 1. River temperature and discharge characteristics during the peak of the adult run.

Year	Date of Migration Peak	Temperature		Discharge	
		Range (°C)	Rate of Change (°C d ⁻¹)	Range (m ³ s ⁻¹)	Rate of Change (m ³ s ⁻¹ d ⁻¹)
1979	13-17 July	21.7-20.5	-0.3	21.0-16.3	-4.7
1980	5-12 July	19.7-14.5	-0.6	25.3-10.0	+2.2

TABLE 2. Population estimates of salmon and grilse for each year the fishladder has been in operation

YEAR	SALMON			GRILSE			SOURCE
	NO. OF FISH	95% CONF. LIMITS	METHOD	NO. OF FISH	95% CONF. LIMITS	METHOD	
1975	30	-	1	130	70 - 180	4	Gibson 1978a
1976	30	20 - 50	2	90	50 - 190	5	Gibson 1977
1977	No Data	No Data		No Data			-
1978	12	4 - 23	1	68	42 - 116	4	Whoriskey 1979
1979	10	-	1	47	43 - 51	4	This study
1980	18	-	3	65	-	3	This study

1. Ratio of salmon to grilse in fishladder
2. Schnabel multiple census
3. Direct count in fishway; value is a minimum estimate
4. Petersen estimate
5. Adjusted Petersen estimate

Table 3. Population estimates used in calculating correlation coefficients.

Year	Smolts		Salmon		Grilse	
	No. Estimated	x FL (cm)	Year	No. Estimated	Year	No. Estimated
						Source
1974	3360	14.2				
			1976	30	1975	130
						Gibson and Côté 1981
1975	1030	15.7	1977	N.D.	1976	90
						Gibson and Côté 1981
1976	2600	14.9	1978	12	1977	N.D.
1977	640	14.9	1979	10	1978	68
						Whoriskey 1979
1978	4160	14.4	1980	18	1979	47
						This Study
1979	6257	15.2	-	-	1980	65
						This Study

N.D. = No Data.

TABLE 4. Mean fork length (FL) and standard deviation in centimeters of returning salmon and grilse by year; n = sample size.

YEAR	SALMON			GRILSE			SOURCE
	x	SD	n	x	SD	n	
1975	73.7	3.5	17	51.8	3.1	67	Whoriskey and Gibson (unpubl.)
1976	71.9	4.4	9	50.2	2.3	19	Whoriskey and Gibson (unpubl.)
1977	70.5	-	23	50.1	-	6	Gibson 1977
1978	74.5	6.0	2	51.7	2.8	28	Whoriskey 1979
1979	71.3	4.9	8	51.6	3.0	34	This Study
1980	73.1	4.9	17	55.7	3.3	65	This Study

TABLE 5. Percentages of returning of salmon and grilse smolting at given ages; number of fish are in parentheses

YEAR	SALMON			GRILSE		
	2+	3+	4+	2+	3+	4+
1967	20 (9)	75 (33)	5 (2)	4 (2)	80 (35)	16 (7)
1975	0	100 (17)	0	5 (3)	90 (60)	6 (4)
1976	0	100 (9)	0	0	84 (16)	16 (3)
1977	-	-	-	-	-	-
1978	0	100 (1)	0	20 (3)	73 (11)	7 (1)
1979	12 (1)	88 (7)	0	12 (4)	88 (30)	0
1980	23 (4)	77 (13)	0	6 (4)	92 (60)	1 (1)

TABLE 6. Sexual characteristics of salmon and grilse. Sex determined in 1975-1980 by examination of accidental mortalities or from fish recaptured in the trap net after development of obvious secondary sexual characteristics. Among the accidental mortalities 21 were grilse (19♂, 2♀) and 10 were salmon (2♂, 8♀).

YEAR	SALMON			GRILSE			SOURCE
	% MALE	% FEMALE	n	% MALE	% FEMALE	n	
1967	37	63	43	96	4	47	Schiefer (1969)
1975	0	100	1	100	0	4	Whoriskey and Gibson (unpubl.)
1976	29	71	7	80	20	5	Whoriskey and Gibson (unpubl.)
1977	No Data		-	No Data		-	
1978	0	100	2	83	17	23	Whoriskey and Gibson (unpubl.)
1979	0	100	3	82	18	17	This Study
1980	-	-		100	0	3	This Study
<hr/>							
TOTAL 1975-1980	15	85	13	85	15	52	

ACKNOWLEDGEMENTS

We thank T. Dickson, P. Heinermann, F. Cotton, J. Critchley, and G. Black for rendering excellent assistance in the field, and D. Steele for typing the manuscript. R.J. Gibson initiated the yearly monitoring program and was responsible for collection of much of the early data. Yvon Côté and Pierre Bertrand, Ministère du Loisir, Chasse et Pêche also provided valuable support. W. L. Montgomery, G. Power, Y. Côté, R. Morin, A. Bielak, and R.J. Gibson critically read the manuscript, offering helpful suggestions.

REFERENCES

- Baglinière, J.L. (1976) Les populations de saumon Atlantique (Salmo salar L., 1766) en Bretagne---Basse-Normandie I. Caractéristiques des smolts de la Rivière Ellé. Ann. Hydrobiol. 7, 141-158.
- Banks, J.W. (1969) A review of the literature on the upstream migration of adult salmonids. J. Fish Biol. 1, 85-136.
- Belding, D.L. and G. Préfontaine. (1961) Rapport sur le saumon de la Côte Nord du Golfe du St-Laurent et de la Côte Nord-Est de Terre-Neuve. Contribution du Département des Pêcheries, Québec - No. 82. 104 p.
- Chadwick, E.M.P., T.R. Porter and P. Downton. (1978) Analysis of growth of Atlantic salmon (Salmo salar) in a small Newfoundland river. J. Fish. Res. Board Can. 35, 60-68.
- Elson, P.F. (1957) The importance of size in the change from parr to smolt in Atlantic Salmon. Can. Fish. Cult. 21, 1-6.
- Gardner, M.L.G. (1976) A review of factors which may influence the sea age and maturation of Atlantic salmon Salmo salar L. J. Fish Biol. 9, 289-327.
- Gibson, R.J. (1974) Matamek Annual Report for 1974. Woods Hole Oceanographic Institution, Tech. Rept., 87 p.
- Gibson, R.J. (1975) Matamek Annual Report for 1975. Woods Hole Oceanographic Institution, Tech. Rept., WHOI-75-72, 121 p.
- Gibson, R.J. (1977) Matamek Annual Report for 1976. Woods Hole Oceanographic Institution, Tech. Rept., WHOI-77-28, 116 p.
- Gibson, R.J. (1978a) Recent changes in the population of juvenile Atlantic salmon in the Matamek River, Quebec, Canada. J. Cons. Int. explor. mer 38, 1-7.
- Gibson, R.J. (1978b) Matamek annual report for 1977. Woods Hole Oceanographic Institution, Tech. Rept. WHOI-78-92, 154p.
- Gibson, R.J. and Y. Côté. (1981) Production de saumonets et recaptures de saumons étiquetés à la rivière Matamec, Côte-Nord du Golfe Saint-Laurent, Québec. Nat. Canad. (In press.)

- Glebe, B.D., W. Eddy and R.L. Saunders. (1980) The influence of parental age at maturity and rearing practice on precocious maturation of hatchery-reared Atlantic salmon parr. Intern. Counc. Expl. Sea, Mariculture Committee, F.8.
- Glebe, B.D., R.L. Saunders, and A. Sreedharan. (1978) Genetic and environmental influence in expression of precocious sexual maturity of hatchery reared Atlantic salmon (Salmo salar) parr. Can. J. Genet. Cytol. 20, 444.
- Naiman, R.J. (1980) Matamek annual report for 1979. Woods Hole Oceanographic Institution, Tech. Rept., WHOI-80-31, 270p.
- Paloheimo, J.E. and P.F. Elson. (1974) Reduction of Atlantic Salmon (Salmo salar) catches in Canada attributed to the Greenland fishery. J. Fish. Res. Board Can. 31, 1467-1480.
- Randall, R.G. and G. Power. (1979) Atlantic salmon (Salmo salar) of the Pigou and Bouleau Rivers, Québec. Env. Biol. Fish. 4, 179-184.
- Ricker, W.E. (1962) Comparison of growth and mortality of sockeye salmon during their last two years of life. J. Fish. Res. Board Can. 19, 531-560.
- Saunders, R.L. (1969) Contributions of salmon from the Northwest Miramichi River, New Brunswick to various fisheries. J. Fish. Res. Board Can. 26, 269-278.
- Schiefer, K. (1969) Ecology of Atlantic salmon (Salmo salar L.) in the Matamek River system. M.Sc Thesis, Univ. of Waterloo. 63 p.
- Schiefer, K. (1971) Ecology of Atlantic salmon, with special reference to occurrence and abundance of grilse on north shore Gulf of St. Lawrence rivers. Ph.D Dissertation, Univ. of Waterloo. 129 p.
- Strahler, A.N. (1957) Quantitative analysis of watershed geomorphology. Trans. Am. Geophys. Union. 38, 913-920.
- Whoriskey, F.G. (1979) Matamek Annual Report for 1978. Woods Hole Oceanographic Institution, Tech. Rept. WHOI-79-49, 100 p.
- Whoriskey, F.G., R.J. Naiman and J. Critchley. (1980) The smolt run p. 119-124. In R.J. Naiman (ed.), Matamek Annual Report for 1979, Woods Hole Oceanographic Institution, Tech. Rept. WHOI-80-31.

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-82-2	2.	3. Recipient's Accession No.
4. Title and Subtitle EFFECTS OF COMMERCIAL FISHING ON ADULT ATLANTIC SALMON (<i>Salmo salar</i>) IN A QUEBEC RIVER		5. Report Date January 1982	
7. Author(s) Frederick G. Whoriskey Jr. and Robert Naiman		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543		10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)	
12. Sponsoring Organization Name and Address Department of Recreation, Fish and Game of the Province of Quebec		13. Type of Report & Period Covered Technical 14.	
15. Supplementary Notes This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept. WHOI-82-2.			
16. Abstract (Limit: 200 words) Despite an absence of freshwater exploitation, the adult salmon run in the Matamek River, Quebec, declined during 1975-1980 to <23% of the level thought to occur there prior to 1967. Returns in 1979 and 1980 of adults tagged as smolts were 1.0% and 0.9%, respectively. Numbers of emigrating smolts and their corresponding adult returns are not significantly correlated, although we observed a trend towards more salmon (2 sea year fish) returning with larger numbers of migrating smolts. Since 1967 there is noted a decrease in the age at which returning adults smolted and females appear to now constitute a larger percentage of returning grilse and salmon. These, and other changes in life history characteristics, appear to be caused solely by commercial exploitation.			
17. Document Analysis a. Descriptors 1. Atlantic salmon 2. Commercial fishing 3. Life history b. Identifiers/Open-Ended Terms c. COSATI Field/Group			
18. Availability Statement		19. Security Class (This Report) Unclassified 20. Security Class (This Page)	21. No. of Pages 17 22. Price

<p>Woods Hole Oceanographic Institution WHOI-82-2</p> <p>EFFECTS OF COMMERCIAL FISHING ON ADULT ATLANTIC SALMON (Salmo salar) IN A QUEBEC RIVER by Frederick Whoriskey, Jr. and Robert Naiman. 17 pages. January 1982. Prepared for Woods Hole Oceanographic Institution and for the Department of Recreation, Fish and Game of the Province of Quebec.</p> <p>Despite an absence of freshwater exploitation, the adult salmon run in the Matamek River, Quebec, declined during 1975-1980 to <23% of the level thought to occur there prior to 1967. Returns in 1979 and 1980 of adults tagged as smolts were 1.0% and 0.9%, respectively. Numbers of emigrating smolts and their corresponding adult returns are not significantly correlated, although we observed a trend towards more salmon (2 sea year fish) returning with larger numbers of migrating smolts. Since 1967 there is noted a decrease in the age at which returning adults smolts and females appear to now constitute a larger percentage of returning grilse and salmon. These, and other changes in life history characteristics, appear to be caused solely by commercial exploitation.</p>	<p>1. Atlantic salmon</p> <p>2. Commercial fishing</p> <p>3. Life history</p> <p>I. Whoriskey, Jr., Frederick G.</p> <p>II. Naiman, Robert</p>	<p>Woods Hole Oceanographic Institution WHOI-82-2</p> <p>EFFECTS OF COMMERCIAL FISHING ON ADULT ATLANTIC SALMON (Salmo salar) IN A QUEBEC RIVER by Frederick Whoriskey, Jr. and Robert Naiman. 17 pages. January 1982. Prepared for Woods Hole Oceanographic Institution and for the Department of Recreation, Fish and Game of the Province of Quebec.</p> <p>Despite an absence of freshwater exploitation, the adult salmon run in the Matamek River, Quebec, declined during 1975-1980 to <23% of the level thought to occur there prior to 1967. Returns in 1979 and 1980 of adults tagged as smolts were 1.0% and 0.9%, respectively. Numbers of emigrating smolts and their corresponding adult returns are not significantly correlated, although we observed a trend towards more salmon (2 sea year fish) returning with larger numbers of migrating smolts. Since 1967 there is noted a decrease in the age at which returning adults smolts and females appear to now constitute a larger percentage of returning grilse and salmon. These, and other changes in life history characteristics, appear to be caused solely by commercial exploitation.</p>	<p>1. Atlantic salmon</p> <p>2. Commercial fishing</p> <p>3. Life history</p> <p>I. Whoriskey, Jr., Frederick G.</p> <p>II. Naiman, Robert</p>	<p>Woods Hole Oceanographic Institution WHOI-82-2</p> <p>EFFECTS OF COMMERCIAL FISHING ON ADULT ATLANTIC SALMON (Salmo salar) IN A QUEBEC RIVER by Frederick Whoriskey, Jr. and Robert Naiman. 17 pages. January 1982. Prepared for Woods Hole Oceanographic Institution and for the Department of Recreation, Fish and Game of the Province of Quebec.</p> <p>Despite an absence of freshwater exploitation, the adult salmon run in the Matamek River, Quebec, declined during 1975-1980 to <23% of the level thought to occur there prior to 1967. Returns in 1979 and 1980 of adults tagged as smolts were 1.0% and 0.9%, respectively. Numbers of emigrating smolts and their corresponding adult returns are not significantly correlated, although we observed a trend towards more salmon (2 sea year fish) returning with larger numbers of migrating smolts. Since 1967 there is noted a decrease in the age at which returning adults smolts and females appear to now constitute a larger percentage of returning grilse and salmon. These, and other changes in life history characteristics, appear to be caused solely by commercial exploitation.</p>	<p>1. Atlantic salmon</p> <p>2. Commercial fishing</p> <p>3. Life history</p> <p>I. Whoriskey, Jr., Frederick G.</p> <p>II. Naiman, Robert</p>
--	--	--	--	--	--