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Review of Atlantic Salmon Fisheries of the Northwestern Atlantic

by

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INTRODUCTION

This document provides an overview of recent catches of Atlantic salmon and, in particular, looks at the conditions in 1983, and from catch data alone infers possible causes for the decline in recent catches. Estimates of fishing mortality rates, in general, do not exist and the relationship between catch and abundance has to be assumed. This document also provides an overview of the interception problem and the enhancement of salmon in the United States.

It should be noted that the catch statistics may be greatly in error, particularly in the last few years, and declines in catch may be due to factors other than declines in abundance. Poor catch reporting and inadequate tag returns made it impossible to calculate reliable exploitation rates for the various fisheries, or to know the optimum exploitation levels to allow for adequate spawning escapement.

The key to Atlantic salmon management is the maintenance of optimum levels of spawning escapements for each salmon river. Data on these levels are only known for major rivers in Canada. The effects of interception fisheries on individual river systems are not yet known and inferences can only be made for large areas, like provinces. Catch quotas, therefore, could be set on offshore and high seas fisheries to increase the return of salmon and grilse to the provinces or the U.S., but the benefits to specific rivers from restrictions on given fisheries are not yet known.

HOMEWATER FISHERIES

Decline in World Homewater Catches

Figure 1 shows the recent declines in world homewater catches of salmon and grilse from 1967 through 1982. Figure 2 shows that the world homewater catches closely parallel European catches, which are substantially greater than those from North America. Therefore, the decline in world homewater catches is mostly a function of changes in catches in Europe rather than changes in salmon catches in the Northwestern Atlantic.

To determine the effect on homewater fisheries of the interception fishery at West Greenland, which harvests fish that would return to homewaters as multi-sea-winter salmon, we separated the world homewater catches into catches of salmon and grilse assuming that interception fisheries do not effect homewater catches of grilse. Figures 3 and 4 and Table 1 show the breakdown of world homewater catches into salmon and grilse for those countries (Scotland, Ireland, Norway, and Canada) and years (1972-82) where data were available. Figures 3 and 4 indicate that the large decline in world homewater catches from 1974 to 1982 was caused by the decline in catches of grilse and not by the decline in catches of salmon. This suggests that the interception fisheries that harvest fish that will return to homewaters as multi-sea-winter fish are not responsible for this dramatic decline. A regression line (Figure 4) fitted to the decline in grilse catch was significant. The West Greenland fishery or other interception fisheries which are primarily responsible for reductions in multi-sea-winter fish are, therefore, not directly responsible for the decline shown in Figure 1. The salmon catches in Figure 4, however, decline from 1973 to 1979 and then dramatically increase in 1980 and 1981. The decline from 1973 to 1979 is also

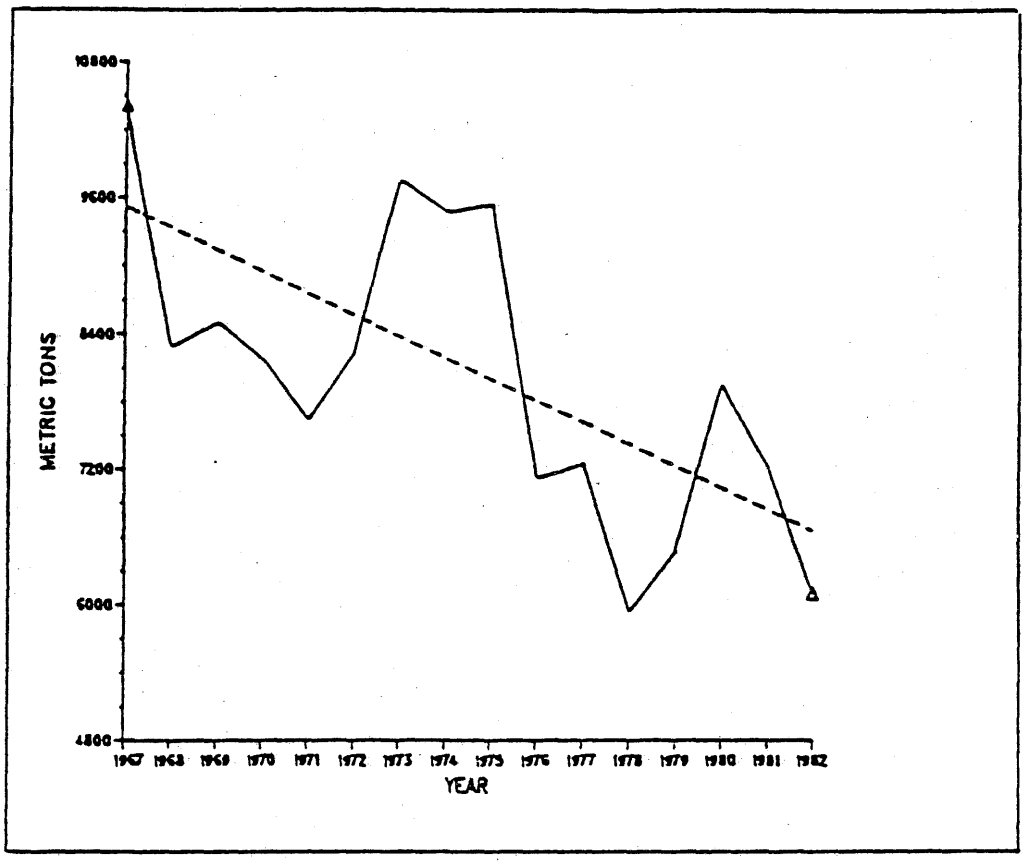


Figure 1. Total world homewater catch of Atlantic salmon (Canadian recreational catch added from 1967-69).

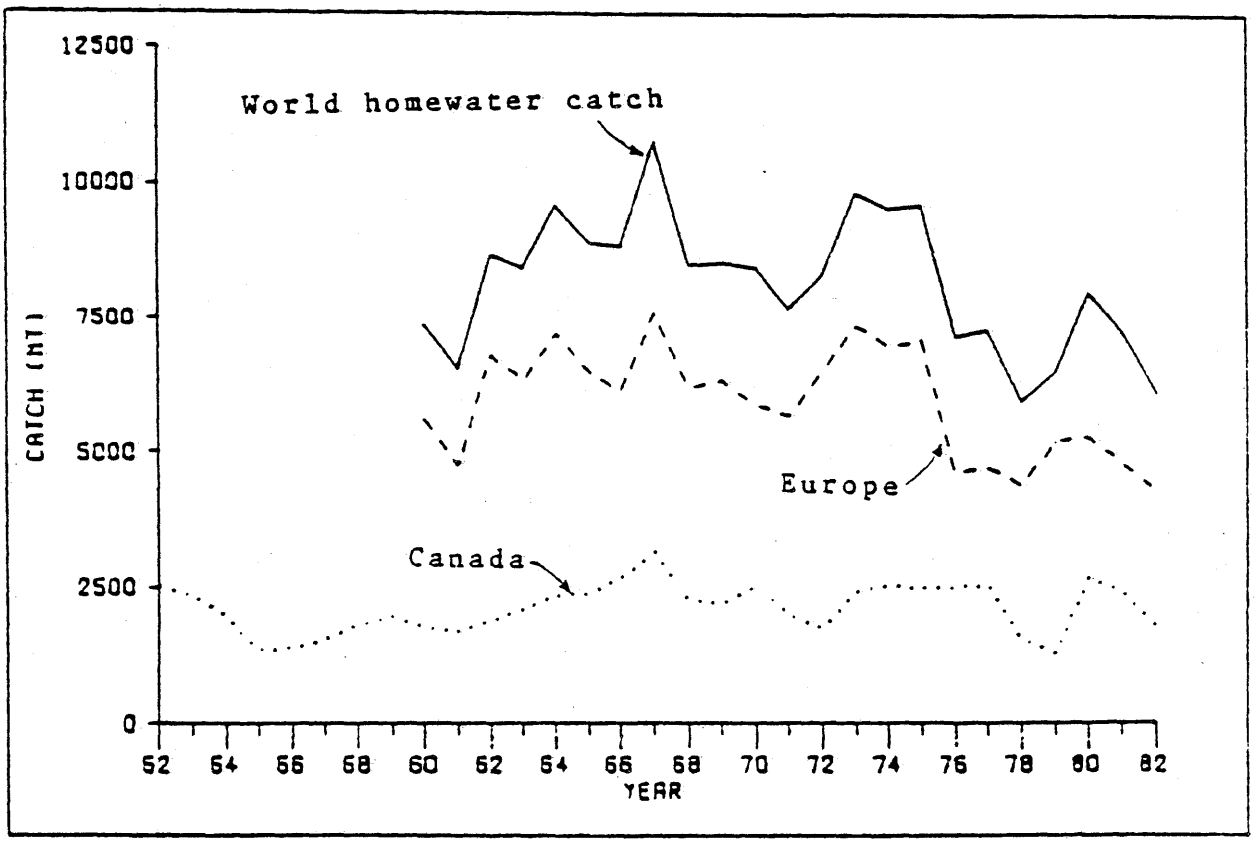


Figure 2. World homewater catch of Atlantic salmon separated by Canada and European countries.

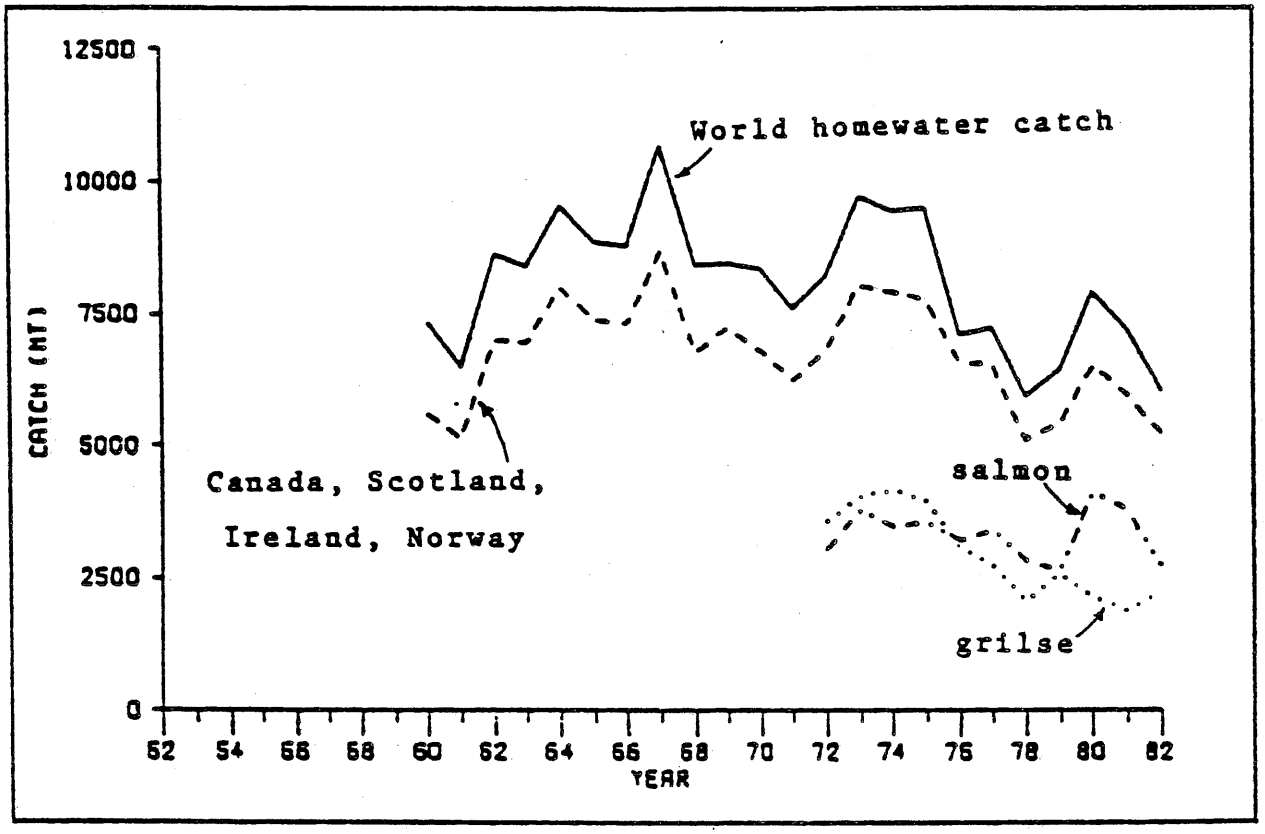


Figure 3. Separation of Atlantic salmon catches for Canada, Scotland, Ireland, and Norway into salmon and grilse.

Table 1. Total world homewater catch of Atlantic salmon compared with total and separate salmon and grilse catches from Canada, Scotland, Ireland and Norway in metric tons, 1960-82.

Year	World homewater	Canada, Scotland Ireland, Norway	Grilse	Salmon
1960	7326	5588	-	-
1961	6512	5128	-	-
1962	8630	7001	-	-
1963	8384	6949	-	-
1964	9533	8012	-	-
1965	8842	7402	-	-
1966	8785	7322	-	-
1967	10696	8698	-	-
1968	8448	6770	-	-
1969	8478	7244	-	-
1970	8379	6816	-	-
1971	7631	6257	-	-
1972	8241	6824	3781	3043
1973	9752	8054	4278	3776
1974	9477	7931	4445	3486
1975	9538	7799	4245	3554
1976	7122	6607	3386	3221
1977	7252	6536	3121	3415
1978	5937	5115	2295	2820
1979	6480	5440	2783	2657
1980	7950	6547	2423	4124
1981	7226	5968	2178	3790
1982	6097	5258	2520	2738

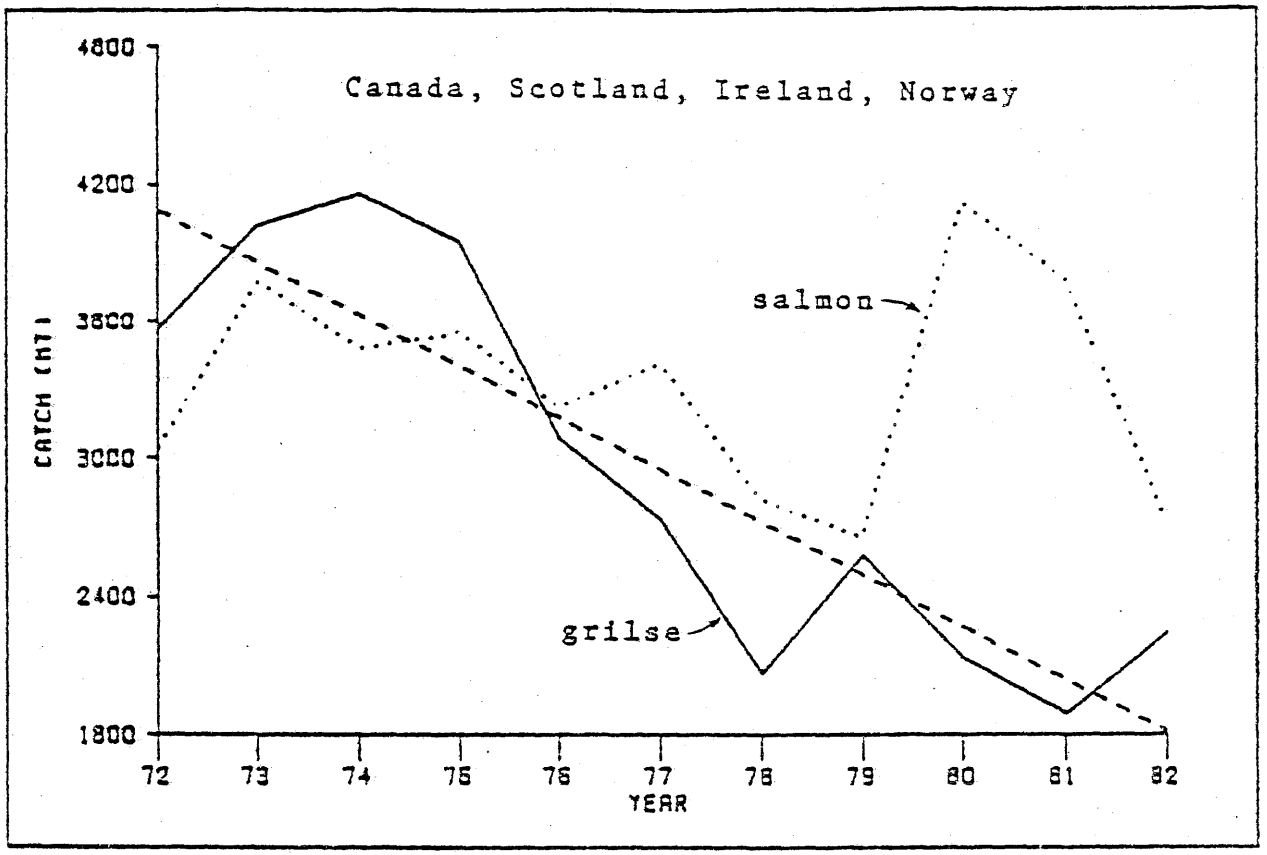


Figure 4. Separation of catches for Canada, Scotland, Ireland and Norway into salmon and grilse.

a function of the declines in Scotland and Ireland and not in the Western Atlantic and the cause is not known. In the Western Atlantic, as shown in Figure 5 and Table 2, there does not appear to be a significant decline in either salmon or grilse catch over the period of 1970 to 1982. This does not mean that fishing mortality did not increase, however, with a decline in spawning escapement.

Relation Between Commercial and Recreational Catches

Recreational catches of Atlantic salmon off Canada accounted for between 7% and 16% of the Canadian total during 1952-82 (Figure 6 and Table 3). The importance of the recreational catch off Canada has increased in recent years, accounting for 9% of the Canadian total between 1959-71 and for 12% of the Canadian total during 1972-82. This change is attributed to a slight (5%) decline in commercial catches, and a 34% increase in recreational catches. The recreational fisheries off Labrador and Newfoundland are less important to the total catch in those areas than in Canada overall, accounting for an average of 1% and 4%, respectively between 1972 and 1982.

Relationship Between Salmon and Grilse Catches

Repeatedly throughout Canadian documents there is reference to the fact that there is a relationship between the numbers of grilse returning in one year to a given salmon river and the numbers of salmon returning to that river the following year. This implies that the size of that year class is fixed prior to the grilse stage, and is apparent at least for two successive years when that year class returns as both grilse and two-sea-winter fish. Thus, if such a relationship holds for a particular river, a poor return of salmon is probably a function of mortality which occurred in the early months of sea

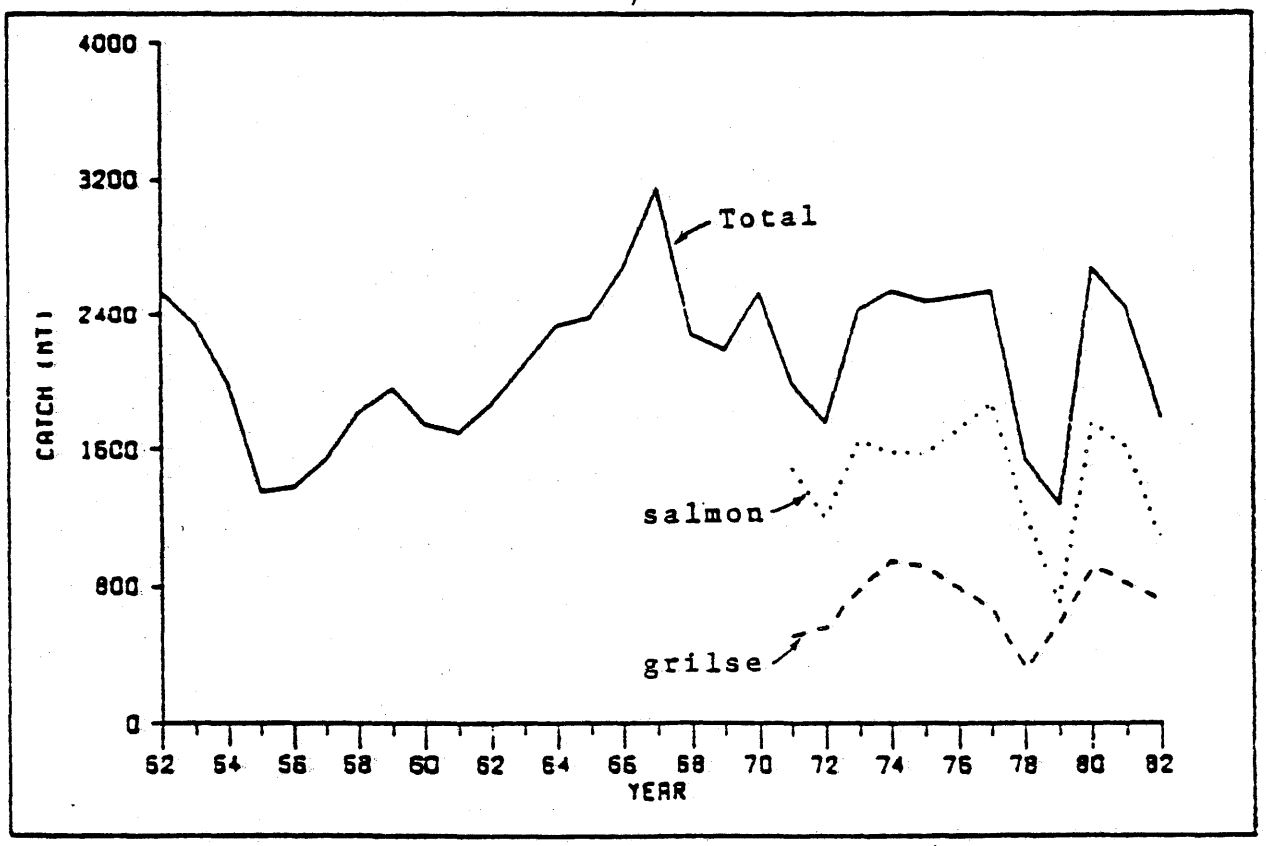


Figure 5. Separation of Canadian Atlantic salmon catches into salmon and grilse.

Table 2. Total Canadian commercial and recreational catch of Atlantic salmon (metric tons), with catch divided into tons and percent grilse and salmon for 1970-82.

Year	Total	Salmon		Grilse	
		no.	%	no.	%
1952	2527				
1953	2338				
1954	1974				
1955	1348				
1956	1387				
1957	1541				
1958	1818				
1959	1956				
1960	1750				
1961	1692				
1962	1866				
1963	2087				
1964	2334				
1965	2382				
1966	2669				
1967	3142				
1968	2280				
1969	2184				
1970	2529	1562	67	761	33
1971	1992	1482	74	510	26
1972	1759	1201	68	558	32
1973	2434	1651	68	783	32
1974	2539	1589	61	950	39
1975	2485	1573	63	912	37
1976	2506	1721	69	785	31
1977	2545	1883	74	662	26
1978	1545	1225	79	320	21
1979	1287	705	55	582	45
1980	2680	1763	66	917	34
1981	2437	1619	66	818	34
1982	1798	1082	60	716	40
Average					
1970-82		1466	67	713	33
1964-82	2291				

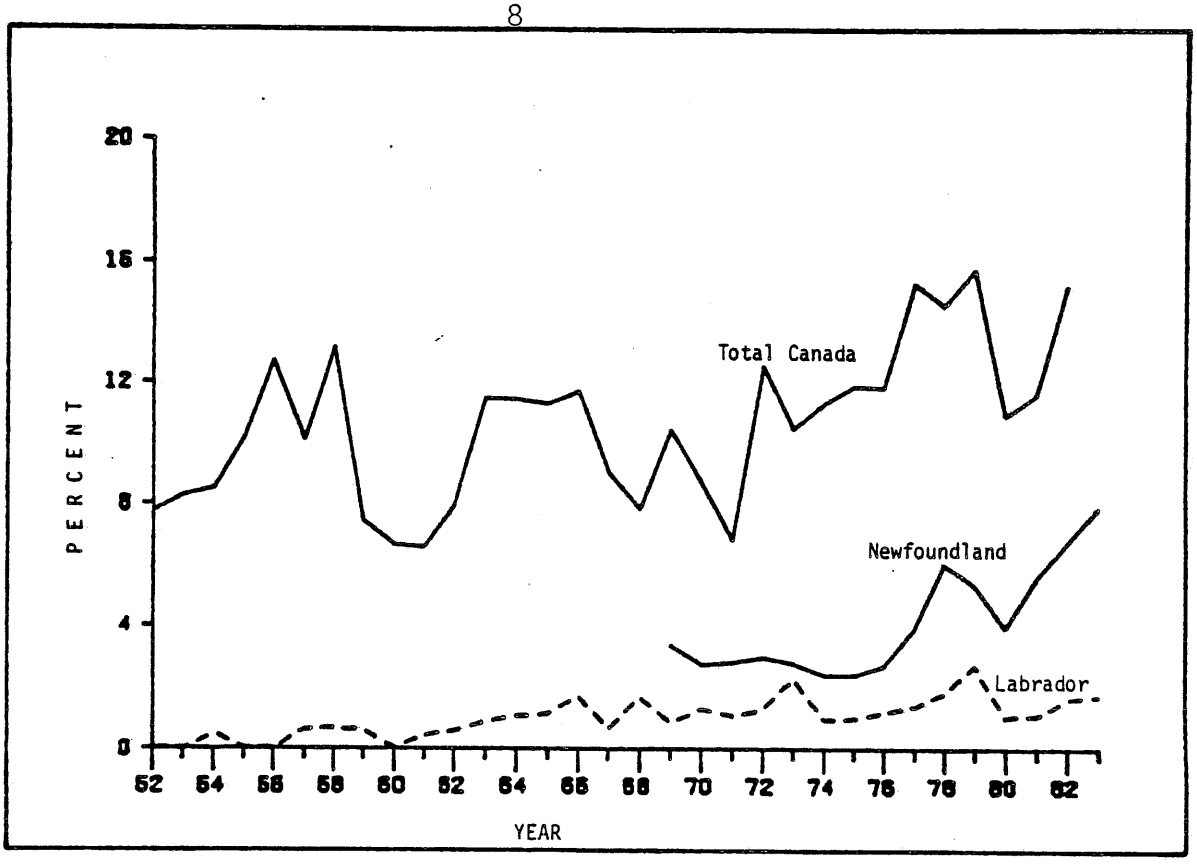


Figure 6. Percent of total Canadian, Newfoundland, and Labrador salmon catches taken in the recreational fisheries.

Table 3. Recreational and total catches (metric tons) of Atlantic salmon for all of Canada, and for Labrador and Newfoundland, including percent recreational catch, 1952-83.

	Recreational Catches			Total Catches			Percent Recreational		
Year	Canada	Labrador	Newfoundland	Canada	Labrador	Newfoundland	Canada	Labrador	Newfoundland
1952	195	0	--	2527	328	--	8	0	--
1953	193	0	--	2338	307	--	8	0	--
1954	167	2	--	1974	418	581	8	*	--
1955	137	0	--	1348	266	456	10	0	--
1956	175	0	--	1387	304	291	13	0	--
1957	155	2	--	1541	317	512	10	1	--
1958	239	2	--	1818	308	547	13	1	--
1959	145	2	--	1956	330	622	7	1	--
1960	116	0	--	1750	230	611	7	0	--
1961	110	2	--	1692	451	408	7	*	--
1962	147	2	--	1866	335	617	8	1	--
1963	239	3	--	2087	342	759	11	1	--
1964	266	5	--	2334	471	705	11	1	--
1965	269	4	--	2382	350	715	11	1	--
1966	312	6	--	2669	348	938	12	2	--
1967	284	3	--	3142	463	1257	9	0	--
1968	178	6	--	2280	354	1047	8	2	--
1969	227	4	34	2184	465	1014	10	1	3
1970	219	6	32	2529	464	1169	9	1	3
1971	135	7	27	1992	648	962	7	1	3
1972	221	7	26	1759	544	883	13	1	3
1973	254	15	39	2434	654	1408	10	2	3
1974	287	7	32	2539	721	1329	11	1	2
1975	295	7	33	2485	713	1372	12	1	2
1976	297	9	35	2506	766	1291	12	1	3
1977	390	10	50	2545	722	1276	15	1	4
1978	225	8	43	1545	443	718	15	2	6
1979	203	9	37	1287	334	698	16	3	5
1980	291	9	51	2680	862	1300	11	1	4
1981	282	9	64	2437	823	1158	12	1	6
1982	273	9	55	1798	557	826	15	2	7
1983	--	6	47	--	350	599	--	2	8

* < 0.5%

life, if the grilse returns the previous year were also poor. Figure 7 shows the relationship between total salmon catches in Canada in one year and total grilse catches in Canada the previous year. A significant relationship was not found but this was probably because the data were pooled and not analyzed on a river basis. We will look at this further as time permits on a river basis.

The recreational catch for all of Labrador shows significant relationships between the catches of salmon in a given year and the catches of grilse in the same year, as well as one year earlier. This would imply that the abundance of salmon is a function of both mortality before the grilse stage and some environmental factor in the year the salmon and grilse return to spawn. In this case, however, effort increased greatly in Labrador after 1956 and the relationships between salmon and grilse may be artificial, caused only by the effort increase. This will be examined further at a later date.

Evaluation of 1983 Catches

Catches of Atlantic salmon from homewater and interception fisheries from 1983 are presented in Table 4, by country. Commercial catches of both one-sea-winter and multi-sea-winter salmon were low in most of Eastern Canada in 1983 (CAFSAC Doc. 83/23). Landings of multi-sea-winter salmon were average or above average only on the west coast of Newfoundland, the west coast of Cape Breton, Northumberland Strait, Miramichi Bay, and the Upper Bay of Fundy. The catch at West Greenland was 310 tons or about 26% of the total allowable catch. Angling catches of large salmon were below average catches in many areas, particularly in the rivers of the Gulf of St. Lawrence, the Saint John River, rivers of the State of Maine, and Nova Scotia. Angling catches in rivers along the eastern and southern coasts of Newfoundland, however, and the

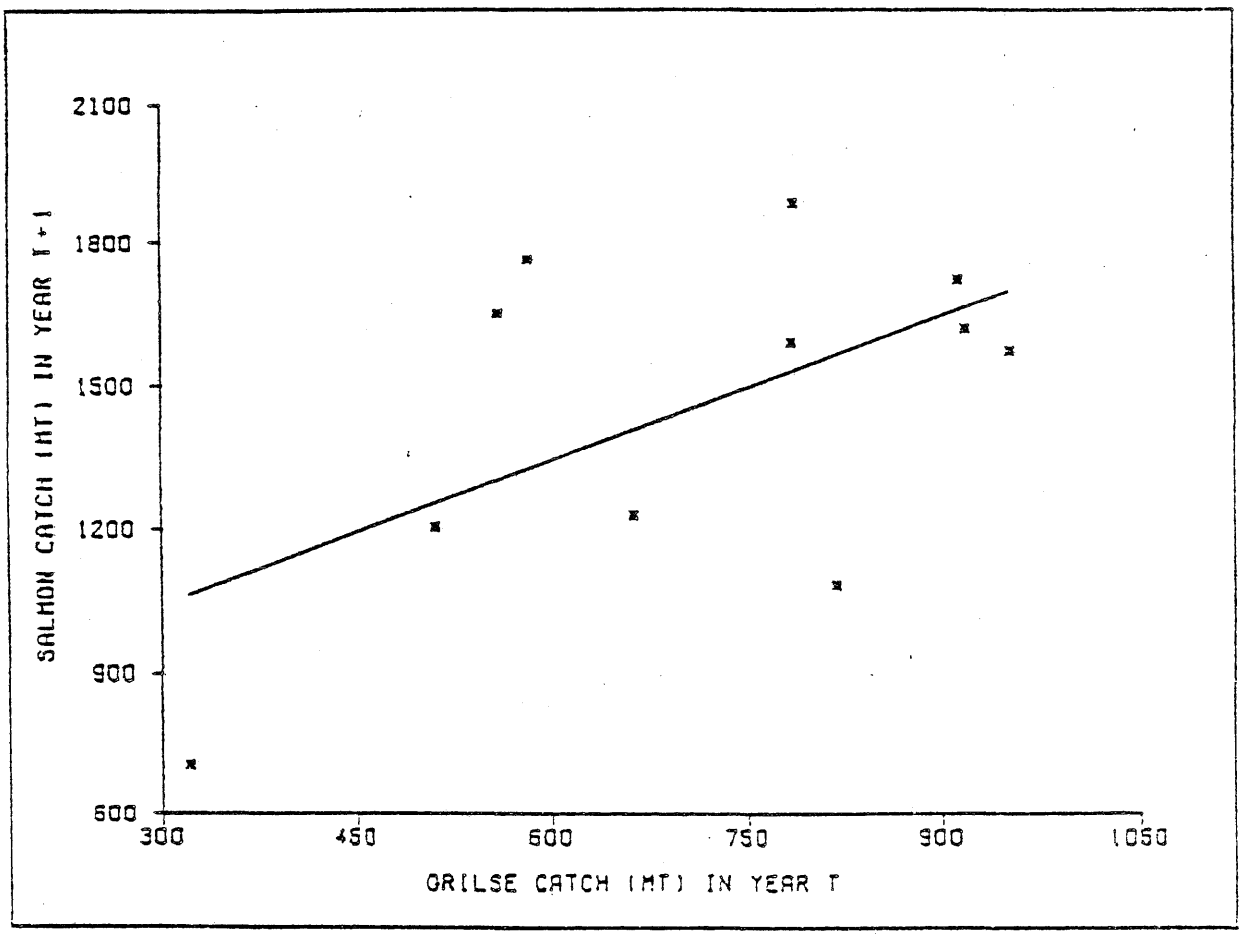


Figure 7 . Relationship of Canadian catches to Canadian catches one year later, from Canada.

Table 4. Atlantic Salmon Catches During 1983, by country, in metric tons.

COUNTRY	GRILSE	SALMON	TOTAL
HOMEWATER FISHERIES			
U.S.			1.3
Canada	513	911	1424.0
Iceland			198.0
Scotland	231	361	792.0
England/Wales			424.0
Ireland	1506	150	1656.0
N. Ireland			187.0
France			16.0
Norway	585	945	1530.0
Finland			57.0
Sweden			N/A
USSR			N/A
TOTAL			6285.3
INTERCEPTION FISHERIES			
W. Greenland			310.0
Faroes			740.0
Denmark			N/A
Norwegian Sea			383.0
TOTAL			1433.0

N/A indicates not yet available.

upper Bay of Fundy were generally average or above those of previous years (CAFSAC 83/23). The causes of the reduced catches and spawning escapements in 1983 are not clear. Interpretation of the low catch at Greenland is complicated by the reports of unusually cold water which plagued that area during the year. Sea ice was unusually severe throughout the spring and temperatures were as much as 10°C below normal around the southern tip of Greenland in July. The presence of ice along the coasts of Labrador and eastern Newfoundland early in the fishing season in 1983 also reduced fishing effort in these fisheries.

Low catches in Canada during 1978 and 1979 (Figure 5) suggest low spawning escapement in those years. If true, that low spawning escapement may have produced few smolts in 1981 and 1982, and could thus have been partially responsible for the low catches of grilse and salmon, in 1983. There is no direct evidence, however, of reduced smolt production in 1981 and 1982, and low smolt production does not explain low return rates for hatchery fish, or the generally poor returns for the runs in the United States. Thus, while low spawning escapements in 1978 and 1979 in many areas may be an important factor, they are not the entire explanation for events in the 1983 fishery. Catches of salmon at West Greenland also do not explain the low catches of grilse in 1983 since grilse are not available to the West Greenland fishery. Either few smolts were produced in 1982, or there was a very significant mortality in the early sea life of the smolts in 1982. Given the low abundance of grilse in 1983, the abundance of two-sea-winter salmon in 1984 is also expected to be below average.

Enhancement in the United States

The U.S. program for restoring the Atlantic salmon is a major effort. Enhancement programs have been very successful in the United States with the runs increasing rapidly. Several strategies have been employed in the U.S. to rebuild salmon populations. The first priority, although expensive, has been the restoration of formerly fishable wild runs of salmon through pollution abatement, removal of dams, and installation of fishways. Ambitious fish passage programs have been initiated in the Connecticut and Merrimack Rivers. These will provide access by salmon to the lower 250 miles of the Connecticut River and the lower 90 miles of the Merrimack River, by the late 1980's. Fish passage programs have been greatly successful in Maine during the last 15 years. Several fishways were completed in 1983 on major river systems in New England and salmon runs are now increasing in those rivers. Salmon are also returning to many U.S. rivers that formerly held significant runs of salmon. Some of the more notable rivers, which have seen no returns for 20 to 100 years, are the Connecticut, Merrimack, Pawcatuck, Saco, and St. Croix Rivers. Figure 8 demonstrates the rapid increase in catch in recent years, until 1983. In Maine salmon are presently stocked as fry, parr and smolts with an annual stocking of 650-750,000 first-year smolts. An additional 300,000 smolts are released annually in New Hampshire and Connecticut rivers. A total of 1.3 million fry and parr were also released into New England rivers in 1982. In 1983, over 220,000 smolts and 450,000 parr were released in Massachusetts rivers, and 98,000 parr and 538,000 smolts were released in Maine. In 1982 and 1983, federal brood stock holding facilities were constructed in New Hampshire and Massachusetts to hold approximately 200 and 500 adult salmon, respectively; and a smolt release facility was constructed in New Hampshire to exclusively serve the Merrimack

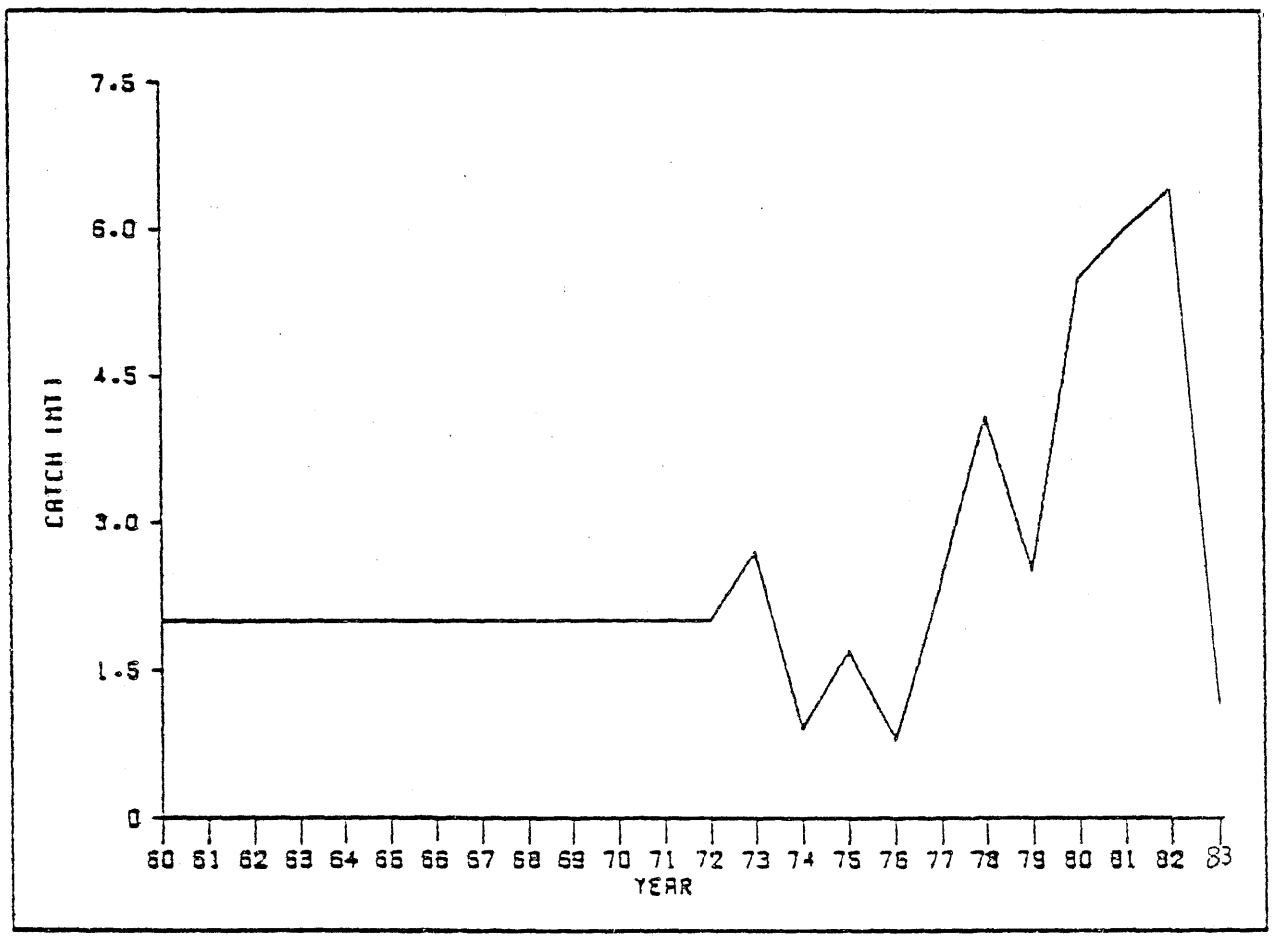


Figure 8. U.S. catch of Atlantic salmon, 1960-83.

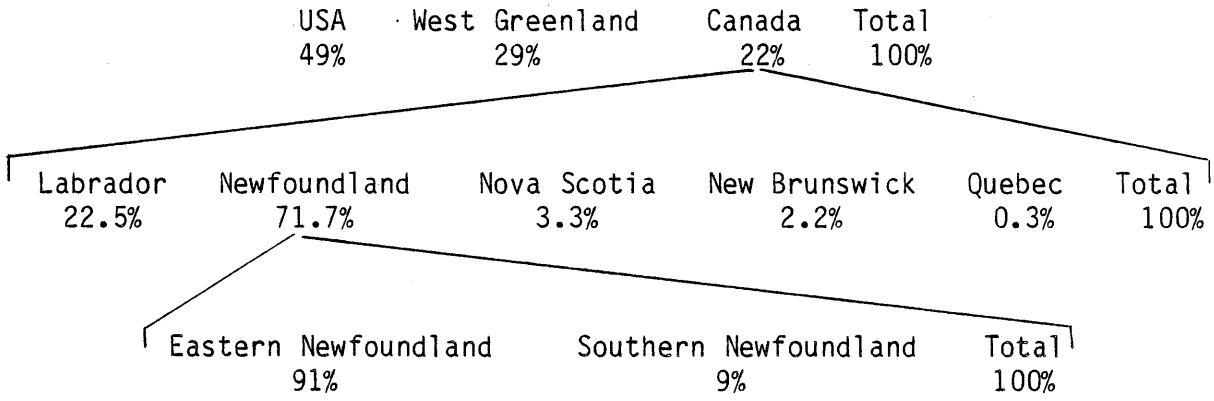
River. This brings the total to 18 federal and state Atlantic salmon facilities, including nine hatcheries, six adult holding installations and three release ponds. The minimum projected salmon release in 1984 is 1.4 million smolts and 1.3 million fry.

State and federal hatcheries are planning to produce and stock about 1.4 million smolts and 3.6 million fry and parr annually to rebuild the stocks. During the period from 1967 to 1982, approximately 65 million dollars were expended to restore Atlantic salmon in New England. Of this amount, about 29 million dollars was provided by private sources and the remainder by federal and state agencies. It is anticipated that an additional 114 million dollars (1983 dollars) will be expended over the next 25 years in support of the restoration program. Of this amount , about 67 million will be provided by private sources to develop fish passage facilities and the remainder will be provided by federal and state agencies to support hatchery production, monitoring, and research. The projected total U.S. stock that will develop as a result of the restoration effort is in the range of 28 to 43 thousand salmon if there is no change in the interception rate from the level that existed in the 1970's. The predicted egg requirements are in excess of 10 million, which should be reached by 1984. It is evident from the projections of the effect of the interception rate on the growth of the salmon stocks that the results of the restoration program would be enhanced by reducing the interception of salmon produced in U.S. waters by foreign fisheries.

INTERCEPTION FISHERIES

Results of Tagging Studies

The State of Maine has tagged and released over 700,000 Atlantic salmon smolts since initiating their hatchery-reared smolt tagging program in 1966 (Baum 1982). Data from this program have not been fully analyzed but a contract to complete analysis is underway this year. Preliminary results are available, however, and are summarized here. More than 4,000 of those fish have been recovered (Table 5), for a total recovery rate of about 1%. Of those returns, 49% have been in homewaters, with the remaining 51% being recovered off West Greenland and the eastern coast of Canada. During 1966-78, West Greenland recoveries accounted for 29% and Canadian recoveries for 22% of the total returns (Table 5), (5.1% off Labrador, 15.8% off Newfoundland, 0.3% off Nova Scotia, and 0.2% off New Brunswick). These data may be summarized as follows:



USA	West Greenland	Labrador	Newfoundland	Nova Scotia	New Brunswick	Quebec	Total
49%	29%	5%	15.8%	0.7%	0.5%	--	100%

Table 5. Distribution of Atlantic salmon tag returns from Maine hatchery-reared smolts released during the period 1966-1979.[1]

	Tagged smolts released		Distribution of Returns							
			Greeenland		Canada		Home		Total	
Release Year	No.	%[2]	No.	%	No.	%	No.	%	No.	%
1966	82,250	27	40	13	84	28	176	59	300	0.4
1967	60,880	29	1	4	12	52	10	44	23	0.0
1968	66,170	41	6	21	6	21	16	57	28	0.0
1969	79,190	88	54	34	42	26	65	40	161	0.2
1970	48,190	96	403	54	65	9	275	37	743	1.5
1971	29,830	89	93	30	25	8	195	62	313	1.0
1972	48,480	40	120	36	36	11	180	53	336	0.7
1973	38,030	30	334	39	123	14	393	46	840	2.2
1974	41,750	29	141	27	106	21	270	52	517	1.2
1975	28,980	17	39	17	102	43	93	40	234	0.8
1976	24,980	8	15	13	18	16	83	72	116	0.5
1977	48,800	13	10	20	8	16	33	66	51	0.1
1979	59,750	16	64	8	338	43	381	49	783	1.3
TOTAL	657,280		1,320	29	965	22	2,170	49	4,455	0.7
AVERAGE	50,560		102		74		167		343	

1 Source: Baum (1982)
2 Percent of total smolt releases that were tagged.

Maine Atlantic salmon tag return data from recoveries made off Newfoundland and Labrador during 1971-81 are summarized by month in Table 6 (E. Baum, Atlantic Sea Run Salmon Commission, pers. comm.). Of the tags recovered in that area, about 71% were taken from eastern Newfoundland, 22% from Labrador, and about 7% from southern Newfoundland (Figure 9). June and July accounted for the greatest returns overall, with significant recoveries during August off Labrador and during November off eastern Newfoundland. Statistical sections noted in Table 6 are indicated in Figure 10.

The Maine Atlantic Salmon Commission also tagged a total of 788 adults as they ascended the Narraguagus River to spawn during 1962 to 1965 (Cutting and Meister 1967). They estimated that no more than 580 of the tagged fish would survive spawning. Locations of recoveries of tags during 1963 to 1966 are presented in Table 7 and Figure 11 (from Cutting and Meister 1967). Of the 30 tag recoveries, 13% were from West Greenland, 27% from eastern Newfoundland, 40% from southern Newfoundland, and 20% from southern Nova Scotia. The Canadian Working Group on the Interception of Mainland Salmon in Newfoundland reviewed data from the results of tagging conducted during 1968-73 to determine the extent of the contribution of Atlantic salmon from Quebec and the Maritimes to the Newfoundland-Labrador commercial fishery. In their report (1982), the Working Group estimated that 24.6% of the Newfoundland-Labrador salmon catch during 1969-75 was of Quebec and Maritimes origin (13.6% and 11.0%, respectively) with the remaining 75.4% coming from rivers in Newfoundland and Labrador. However, they noted that Maine rivers also contributed to this fishery and even though they were not considered in the Working Group's analyses, any action oriented toward mainland-origin stocks in the fishery would likely affect the Maine stocks as well.

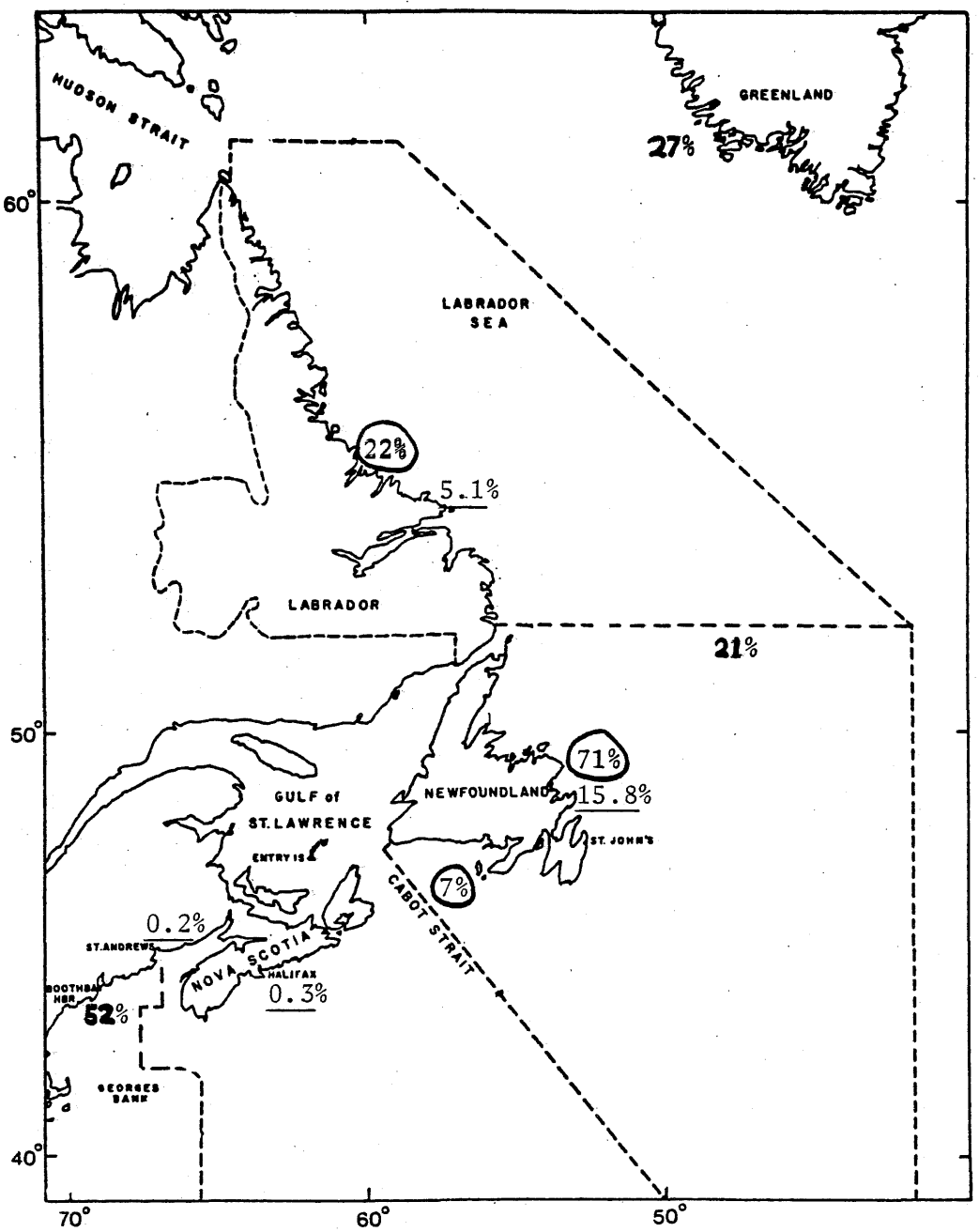


Figure 9. Distribution of tag returns for Maine hatchery-reared smolts released during 1966-1982, in percent of total returns by country (bold numbers), percent of total returns from Canada by area (underlined), and percent of returns from Newfoundland-Labrador only, by area (circled).

Table 6. Number and percent of returns of Atlantic salmon tagged in Maine (1971-81) and recovered in Newfoundland-Labrador, by month and area, and by month within area.

Area of tag returns	Statistical Area	Month of Tag Return								Total	
		May	June	July	August	Sept.	Oct.	Nov.	Dec.	No.	%
Overall Numbers and Percents											
Southern Newfoundland	G-J	0	16(2.3)	28(4.1)	3(0.43)	-	-	-	-	47	6.8
Eastern Newfoundland	A-F	9(1.3)	88(12.7)	225(32.5)	22(3.2)	2(0.29)	25(3.6)	84(12.1)	38(5.5)	493	71.2
Labrador	0	1(0.2)	7(1.0)	56(8.1)	61(8.8)	27(3.9)	-	-	-	152	22.0
Total		10(1.4)	111(16.0)	309(44.7)	86(12.4)	29(4.2)	25(3.6)	84(12.1)	38(5.5)	692	100.0
Within-area Percents by Month											
Southern Newfoundland	G-J	-	34.0	60.0	6.0	-	-	-	-		100.0
Eastern Newfoundland	A-F	1.8	17.9	45.6	4.5	0.4	5.1	17.0	7.7		100.0
Labrador	0	0.7	4.6	36.8	40.1	17.8	-	-	-		100.0

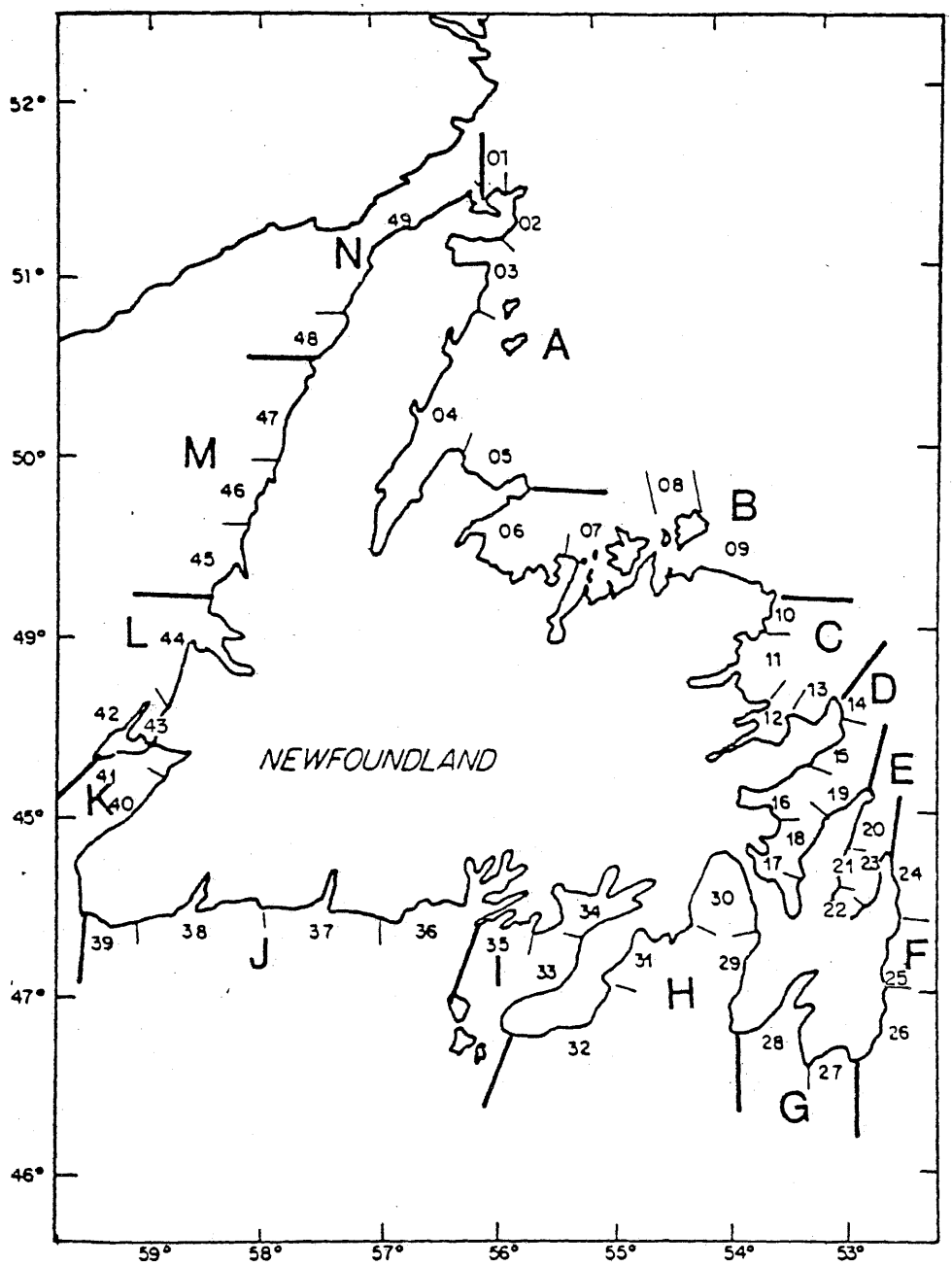


Figure 10. Boundaries of Statistical Sections (numerically indicated) and Statistical Areas (alphabetical) in insular Newfoundland.

Table 7. Recoveries of Atlantic salmon tagged in Maine as kelts during 1962-65, by location and month (from Cutting and Meister 1967).

Year Tagged	Month	Year Recaptured	ICNAF Divisions 1B	1C	1F	3K	3L	3Ps	4X	Totals
1962	June	1963	-	-	-	-	-	2	1	3
	July		-	-	-	-	2	1	2	5
	October		1	-	-	-	-	-	-	1
1963	June	1964	-	-	-	-	-	2	-	2
	July		-	-	-	-	1	-	-	1
	November		1	-	-	-	-	-	-	1
1964	June	1965	-	-	-	-	-	-	1	1
	July		-	-	-	-	-	2	-	2
	August		-	-	-	-	1	-	-	1
	September		-	-	-	-	-	-	1	1
	October		-	-	-	1	-	-	-	1
	November		-	-	-	1	-	-	-	1
1965	June	1966	-	-	-	-	-	2	-	2
	July		-	-	-	-	-	3	1	4
	August		-	-	1	-	-	-	-	1
	November		-	1	-	-	1	-	-	2
	December		-	-	-	-	1	-	-	1
Totals			2	1	1	2	6	12	6	30

Areas: 1B, 1C and 1F - West Greenland
3K and 3L - Eastern Newfoundland
3Ps - Southern Newfoundland
4X - Southern Nova Scotia

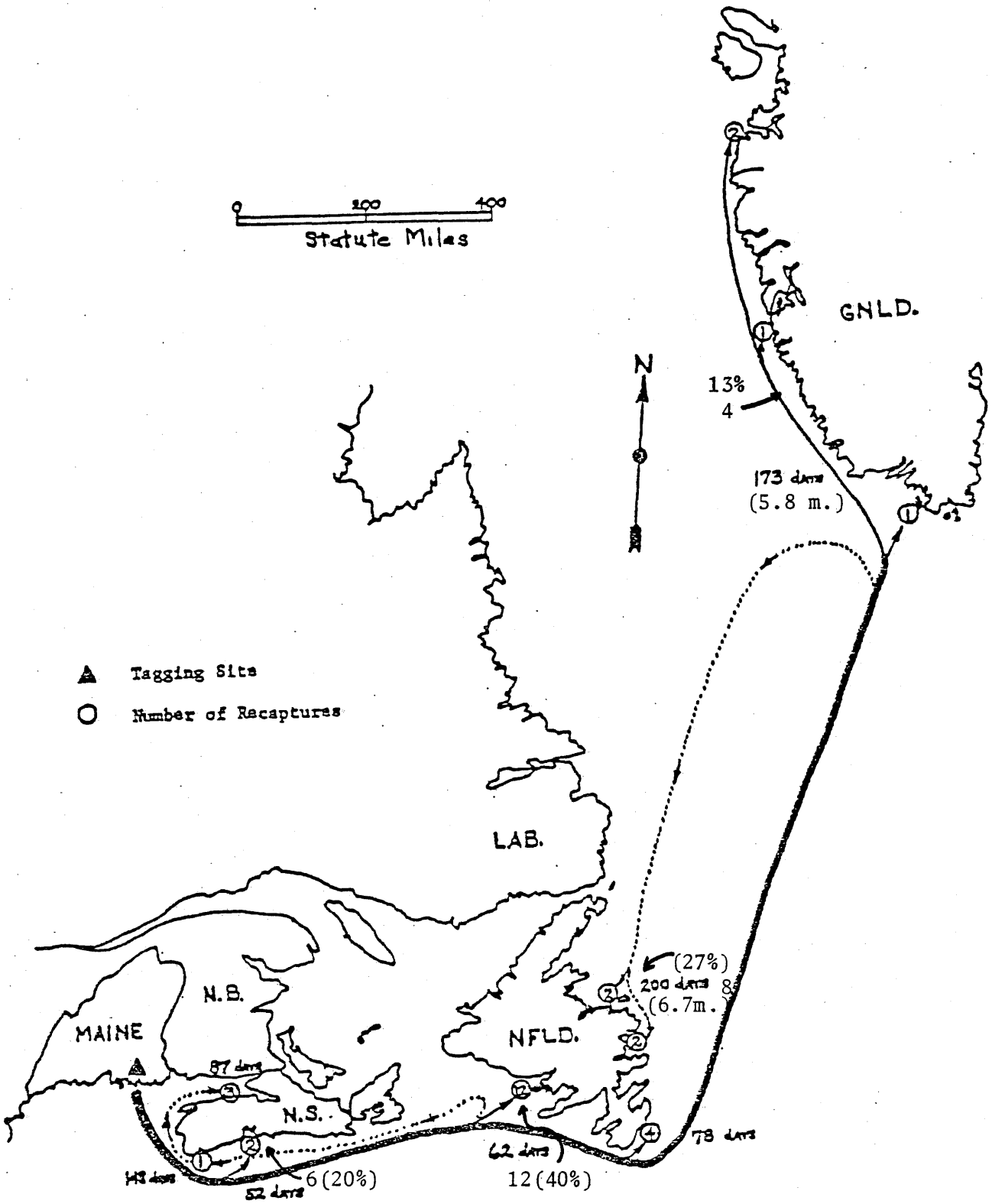


Figure 11. Recaptures of tagged Narraguagus Atlantic salmon kelts, for 1962-66, grouped by geographic area. Group mean time interval and probable migration routes are indicated (from Cutting and Meister, 1967).

Reddin and Misra (1978) indicate that the Twillingate, Newfoundland, fall fishery (October to December) exploits, to some extent, salmon and grilse from the U.S. Based on multivariate analyses of salmon scales these authors found that 10% of the catch at Twillingate during October to December was of U.S. origin. They also state that, even though the landings during this period are low in proportion to those earlier in the season, the proportion of tag returns from U.S. fish was high.

Catches by Interception Fisheries

The major interception fisheries in the North Atlantic occur at the Faroes (south of latitude 67°N and north of the Faroe Islands), in the Norwegian Sea (north of 67°N), at West Greenland, off Labrador, off Newfoundland, and off Nova Scotia. These fisheries are all of interest to the United States because the last four catch U.S. fish and the first two may affect the stock composition in the catches of West Greenland. Reduction of fish at West Greenland from the Faroes and the Norwegian Sea fisheries, for example, would mean that a greater proportion of U.S. fish would be caught at West Greenland.

The increase in and the magnitude of the major interception fisheries (outside of Canada) is shown in Figures 12 and 13 and in Table 8. The West Greenland fishery peaked at a catch of 2,689 metric tons in 1971 and declined to a low of 310 metric tons in 1983 (Table 9). The Faroese area long-line fishery took a peak catch of 1,027 metric tons in 1981, dropping to 740 metric tons in 1983. The Norwegian Sea fishery had gradually declined from a high of 946 metric tons in 1970 to a low of 118 metric tons in 1979 and increased to 383 metric tons in 1983. This latter fishery intercepts fish generally bound for the USSR and Norway. Figure 14 and Table 10 indicate the proportion of

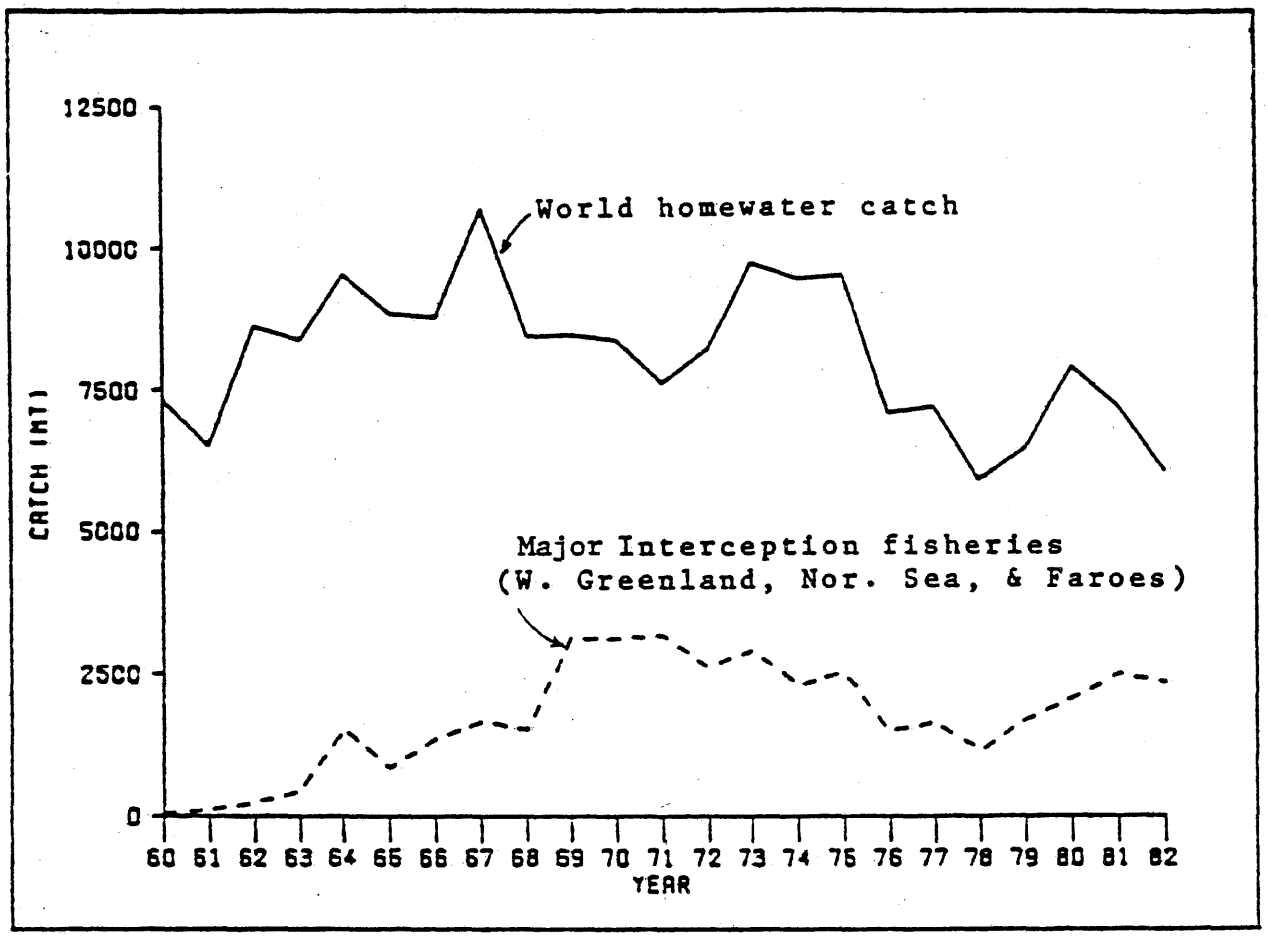


Figure 12. Catch of Atlantic salmon from major interception fisheries in relation to world homewater catches.

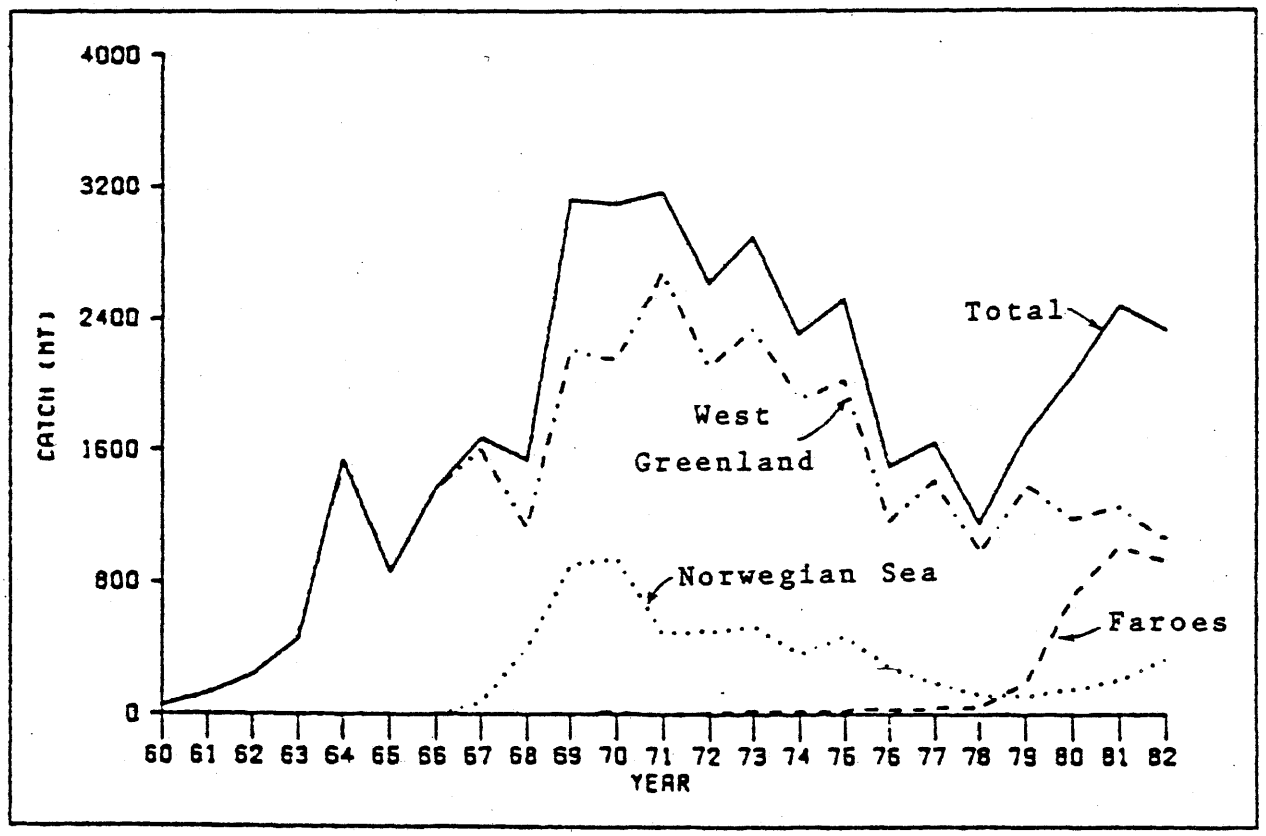


Figure 13. Separation of major interception catches into fisheries.

Table 8. Catch of Atlantic salmon in the major interception fisheries (Faroes, Norwegian Sea and West Greenland), and total world interception and homewater catches (metric tons).

Year	Faroes	Norwegian Sea	West Greenland	Total Major Intercept Catches	World Homewater Catches
1960	0	0	60	60	7,326
1961	0	0	127	127	6,511
1962	0	0	244	244	8,629
1963	0	0	466	466	8,384
1964	0	0	1,539	1,539	9,532
1965	0	0	861	861	8,842
1966	0	0	1,370	1,370	8,784
1967	0	77	1,601	1,678	10,696
1968	5	403	1,127	1,535	8,447
1969	7	911	2,210	3,128	8,478
1970	12	946	2,146	3,104	8,379
1971	0	488	2,689	3,177	7,631
1972	9	506	2,113	2,628	8,241
1973	28	533	2,341	2,902	9,752
1974	20	373	1,917	2,310	9,477
1975	28	475	2,030	2,533	9,538
1976	40	289	1,175	1,504	7,122
1977	40	192	1,420	1,652	7,252
1978	51	124	984	1,159	5,937
1979	194	118	1,395	1,707	6,480
1980	718	155	1,194	2,067	7,950
1981	1,027	213	1,264	2,504	7,226
1982	939	334	1,077	2,350	6,097
1983	740	383	310	1,433	6,283

Table 9. Fishery statistics from catches of Atlantic salmon made at West Greenland (000t).

Year	Column A West Greenland catch	Column B Percent of West Greenland catch from North America	Column C Amount of West Greenland catch from North America (based on annual estimates)	Column D Amount of West Greenland catch from North America (based on an average of 43% for all years)	Average amount of North American fish caught at West Greenland expressed in homewater units[1] (twice the amount in column D)	Average percent of North American fish caught at West Greenland, expressed in homewater units
1960	60	43	26	26	53	3
1961	127	43	55	55	109	6
1962	244	43	105	105	210	10
1963	466	43	200	200	401	16
1964	1539	43	662	662	1324	36
1965	861	43	370	370	741	24
1966	1370	43	589	589	1178	31
1967	1601	43	688	688	1377	30
1968	1127	48	485	485	969	30
1969	2210	51	1127	950	1901	47
1970	2146	35	751	923	1846	42
1971	2689	34	914	1156	2313	54
1972	2113	36	761	909	1817	51
1973	2341	49	1147	1007	2013	45
1974	1917	43	824	824	1649	39
1975	2030	44	893	873	1746	41
1976	1175	43	505	505	1011	29
1977	1420	43	610	611	1221	32
1978	984	38	374	423	846	35
1979	1395	47	656	600	1200	48
1980	1194	58	693	513	1027	28
1981	1264	43	544	544	1087	31
1982	1077	60	646	463	926	34
1983	310	40	124	133	267	16
					Average 1970-82 = 1439	

[1]Homewater units mean fish caught at West Greenland but expressed in terms of weight if caught in Canada or the U.S. (two times the North American catch at Greenland).

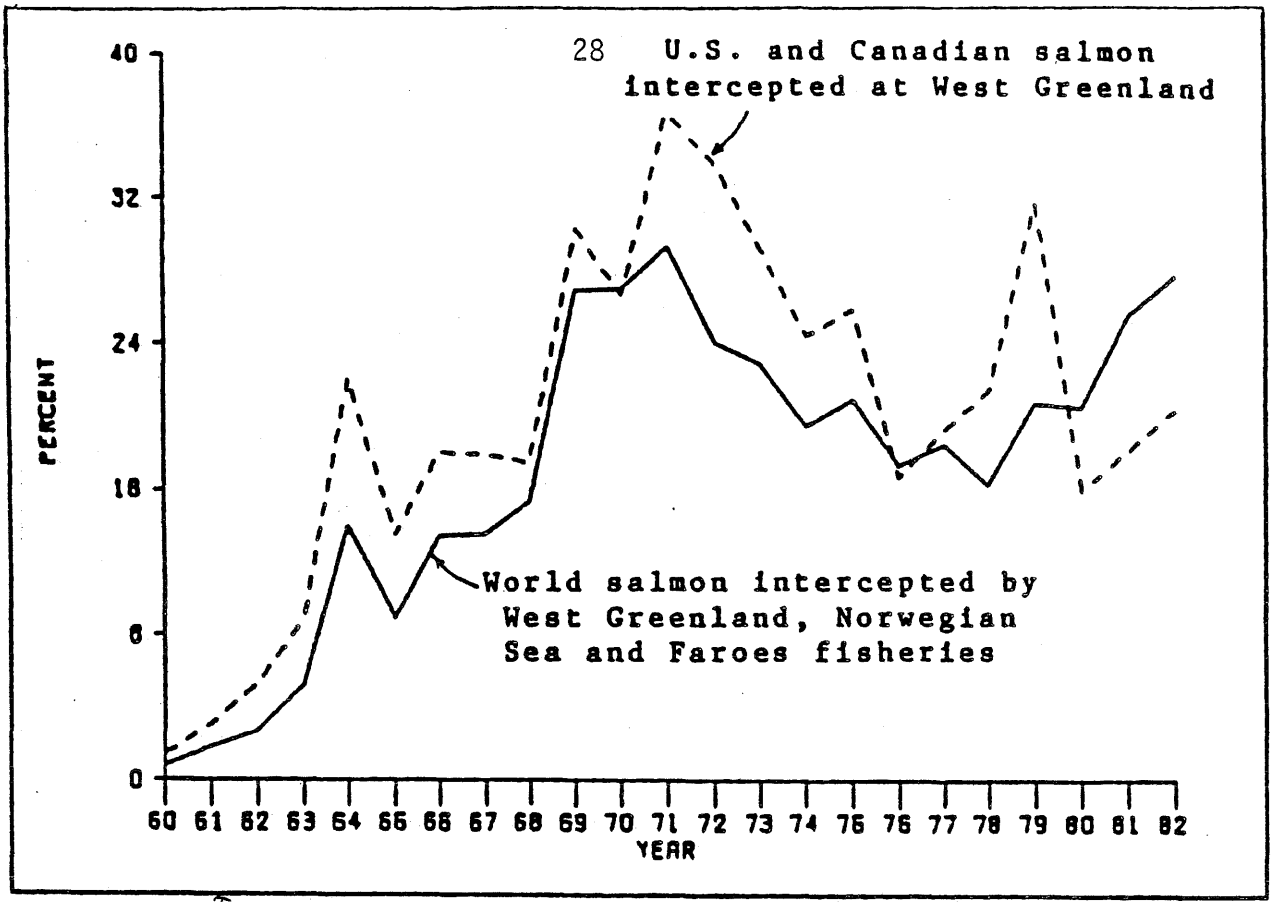


Figure 14. Percent of salmon caught by the major interception fisheries.

Table 10. World and Western Atlantic total Atlantic salmon catches (metric tons) and those attributed to interception fisheries. Including percent of world salmon and Western Atlantic salmon taken in interception fisheries (1960-82).

	Interceptions		Total Catches		Interceptions as percents of catch	
Year	West Greenland	World total	Western Atlantic	World total	World total	North American
1960	26	60	1778	7272	1	1
1961	55	127	1749	6530	2	3
1962	105	244	1973	8727	3	5
1963	200	466	2289	8614	5	9
1964	662	1539	2998	10807	14	22
1965	370	861	2754	9437	9	13
1966	589	1370	3260	9845	14	18
1967	688	1678	3832	12095	14	18
1968	485	1535	2767	9814	16	18
1969	950	3128	3136	11624	27	30
1970	923	3104	3454	11277	28	27
1971	1156	3177	3150	10808	29	37
1972	909	2628	2670	10869	24	34
1973	1007	2902	3443	12654	23	29
1974	824	2310	3364	11787	20	25
1975	873	2533	3360	12071	21	26
1976	505	1504	3012	8626	17	17
1977	611	1652	3158	8904	19	19
1978	423	1159	1972	7096	16	21
1979	600	1707	1889	8187	21	32
1980	513	2067	3199	10017	21	16
1981	544	2504	2987	9730	26	18
1982	463	2350	2268	8447	28	20
1983	133	1433				

West Greenland interceptions are estimated as 43% of the total West Greenland catch being of North American origin.

World interceptions include catches at West Greenland. the Faroes and the Norwegian Sea.

Western Atlantic catches include West Greenland. Canada and U.S.A. total catches.

North American percent interceptions is the percent that West Greenland interceptions of North Amaerican origin fish was of the total Western Atlantic catch.

the salmon catch made by the various interception fisheries. The world interception fisheries (outside of Canada) increased sharply after 1978 mainly because of the Faroese fishery, although catches in the Norwegian Sea are also increasing. An average of 43% of the salmon caught at West Greenland (by weight) are of North American origin. Assuming these would have returned to the U.S. or Canadian homewater fisheries if they had not been caught, indicates that 37% of the total western Atlantic catch was taken at West Greenland in 1971. This proportion declined to a low of 16% in 1980 and averaged 20% from 1976 to 1982 (Figure 15 and Table 11). Although the catch of Atlantic salmon at West Greenland has only averaged one-fifth the catch made in Canada, in terms of large salmon only (multi-sea-winter fish), the West Greenland fishery has been as important as the Canadian fishery. The West Greenland interception fishery has had a profound effect on the spawning escapement to the rivers of North America because this fishery primarily catches salmon that would have returned to homewater rivers as large multi-sea-winter salmon which are extremely important in terms of egg production.

Loss to Homewater Fisheries

The catch of Atlantic salmon in the interception fishery of West Greenland does not have the same impact on the homewater stocks of salmon as do catches in homewater areas. There is generally about a 10 month period between the mid-point of the West Greenland and the homewater fisheries during which time salmon would have grown and suffered natural mortality. In addition, not all salmon killed at West Greenland are accounted for in the recorded catches. Some salmon catches are not recorded and there is significant mortality attributed to the fishing gear that does not result in catch.

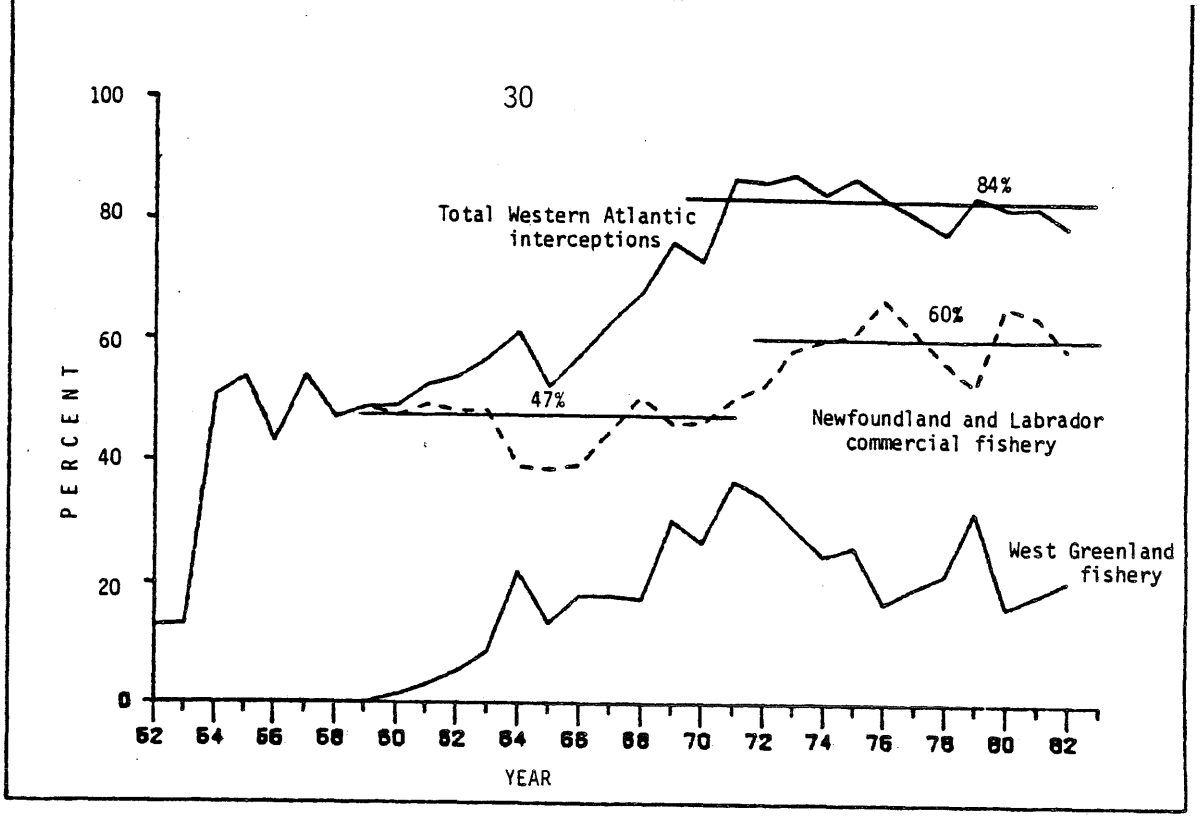


Figure 15. Percent of total Western Atlantic salmon catches due to interception fisheries, West Greenland catches not adjusted for increase if caught in homewaters.

Table 11. Total Western Atlantic salmon catches and those due to interception fisheries at West Greenland. and Labrador-Newfoundland. including percent of total due to each interception fishery. (West Greenland catches not adjusted for increase if caught in homewaters.)

	Intercept Catch (MT)			Total Western Atlantic catch	Interceptions as Percent of total Western Atlantic		
Year	West Greenland	Newfind-Labrador	Intercept total		West Greenland	Newfind-Labrador	Total Intercept
1952	0	328	328	2527	0	13	13
1953	0	307	307	2338	0	13	13
1954	0	997	997	1974	0	51	51
1955	0	722	722	1348	0	54	54
1956	0	595	595	1387	0	43	43
1957	0	827	827	1541	0	54	54
1958	0	853	853	1818	0	47	47
1959	0	950	950	1956	0	49	49
1960	26	841	867	1778	1	47	49
1961	55	857	912	1749	3	49	52
1962	105	950	1055	1973	5	48	54
1963	200	1098	1298	2289	8	48	57
1964	662	1171	1833	2998	22	39	61
1965	370	1061	1431	2754	13	39	52
1966	589	1280	1869	3260	18	39	57
1967	688	1717	2405	3832	18	45	63
1968	485	1395	1880	2767	18	50	68
1969	950	1441	2391	3136	30	46	76
1970	923	195	2518	3454	27	46	73
1971	1156	1576	2732	3150	37	50	87
1972	909	1394	2303	2670	34	52	86
1973	1007	2008	3015	3443	29	58	88
1974	824	2011	2835	3364	24	60	84
1975	873	2045	2918	3360	26	61	87
1976	505	2012	2518	3012	17	67	84
1977	611	1938	2549	3158	19	61	81
1978	423	1110	1533	1972	21	56	78
1979	600	986	1586	1889	32	52	84
1980	513	2102	2615	3199	16	66	82
1981	544	1908	2452	2987	18	64	82
1982	463	1319	1782	2268	20	58	79
1983		939					

Newfoundland and Labrador commercial fisheries. only.

In order to estimate the actual impact of the West Greenland interception fishery on the North American stocks and catches of Atlantic salmon, the ICES Atlantic Salmon Working Group and Ritter et al. (1980) considered the following:

1. Recorded catch at West Greenland was assumed to equal the present quota of 1,191 metric tons.
2. The proportion of reported catch which is of North American origin was assumed to be 41% by number, based on analysis of scale characteristics during 1969-76 and 1978 (Lear and Sandeman 1974, Reddin and Burfitt 1979).
3. The sea-age distribution of North American origin catch at West Greenland was assumed to be as determined by Reddin and Burfitt (1979). (One-sea-winter = 95.5%; two-sea-winters = 2.5%, and previous spawners = 2.0%.)
4. Mean weights by age group of the salmon caught at West Greenland were assumed to be as calculated by Reddin (1980). (One-sea-winter = 2.89 kg; two-sea-winters = 6.08 kg; previous spawners = 2.96 kg.)
5. Percent increase in weight between West Greenland and homewaters, by age group, was assumed to be: one-sea-winter = 58%; two-sea-winters = 24%; previous spawners = 52%.
6. Survival between West Greenland and homewaters was estimated to range from 85 to 90 percent (Doubleday et al. 1979).
7. The proportion of total fishing mortality not accounted for by the recorded catch was assumed by Ritter et al. (1980) to be within a range of 0.22-0.42 (i.e., recorded catches accounted for only 58 to 78% of total fishing mortality), and by the ICES Working Group to be

within 0.10-0.30 off West Greenland. Both groups assumed a range of 0.07 to 0.13 for homewater fisheries.

Based on these estimates the following calculations were made:

The number and weight of North American origin catch at West Greenland were estimated by first calculating the total number of salmon caught. The total weight, 1,191 metric tons, was divided by the overall average weight, including European origin fish (3.34 kg), as derived from Canadian research vessel catches in 1978 (Reddin and Burfitt 1979). Forty-one percent of the resulting 356,587 fish, or 146,201 fish, were assumed to be of North American origin. The average weight of individuals of North American origin in the catch was estimated as the weighted average of the three age groups of North American origin (2.97 kg). The total weight of North American origin salmon in the catch at West Greenland was, therefore, 434.4 metric tons.

The total number of North American origin salmon lost due to fishing at West Greenland was estimated by dividing the number caught (146,201) by the proportion of total fishing deaths represented by that number, e.g., 146,201/0.7 = 208,859.

There is about 85-90% survival of salmon in their migration between West Greenland and homewaters. The amount lost at West Greenland is, therefore, reduced by 10-15% to account for those that would have been lost even if there was no West Greenland fishery.

Final loss to the homewater stock was calculated by estimating the number per age group that would have survived to homewaters, and multiplying that number for each age group by its average weight at West Greenland and then by the percent increase in weight between West Greenland and homewaters. Loss to homewater catch was assumed to be the same as loss to the stock less that amount lost to homewater non-catch fishing mortality.

Table 12 summarizes the results of the calculations described above for the range of parameter estimates presented by Ritter et al. (1980).

Example: Calculations of Loss to Homewater Catch and Stock, Assuming:

- Catch at West Greenland is 1,191 tons;
- North American origin salmon average 41% of catch at West Greenland;
- Age and mean weights are as described above;
- Survival is 90%;
- Non-catch fishing mortality is 0.30 at West Greenland and 0.07 in homewaters.

The following calculations would then be carried out:

	Catch		Mean wt		% No. America		Recorded % Fishing		Total No. Lost
1)	(1191000 kg	÷	3.34 kg)	•	0.41	÷	0.70	=	208858 fish.

	Age			
	One-Sea-Winter	Two-Sea-Winter	Previously spawned	TOTAL
2) a) % at age	.955	.025	.020	100.0
b) No. lost (1 • a)	199459	5221	4177	208858
c) Mean wt. (kg)	2.89	6.08	2.96	--
d) Weight lost (kg) (b • c)	576437	31744	12364	620544
e) No. to homewaters (d • 0.9)	179513	4699	3759	187971
f) No. that could be harvested (e • (1.0 - 0.07)	166947	4370	3496	174813
g) Proportion wt. increase	1.58	1.24	1.52	--
h) Loss to homewater catch (kg) (f • c • g)	762313	32946	15729	810989 (811 mt)
i) Loss to homewater stock (kg) (c • e • g)	819692	35427	16912	872031 (872 mt)

Table 12. Loss to homewater stocks and catch, in metric tons and as a proportion, under various assumptions of non-catch fishing mortality and survival between West Greenland and homewaters. (Based on an assumed catch equivalent to the quota of 1,190 mt.)

Non-Catch F WGR	HW	Percent survival	Loss to Stock mt	ratio	Loss to Catch mt	ratio
0.0	0.07	0.90	610	1.41	568	1.31
	0.13	0.90	610	1.41	531	1.22
	0.07	0.85	576	1.33	536	1.23
	0.13	0.85	576	1.33	502	1.15
0.10	0.07	0.90	679	1.56	631	1.45
	0.13	0.90	678	1.56	590	1.36
	0.07	0.85	641	1.48	596	1.37
	0.13	0.85	641	1.48	557	1.28
0.30	0.07	0.90	872	2.01	811	1.87
	0.13	0.90	872	2.01	789	1.82
	0.07	0.85	824	1.90	766	1.76
	0.13	0.85	824	1.90	716	1.65
0.42	0.07	0.90	1052	2.42	979	2.25
	0.13	0.90	1052	2.42	916	2.11
	0.07	0.85	994	2.29	924	2.13
	0.13	0.85	994	2.29	865	1.99

Non-catch F is the proportion of the total mortality due to fishing which is not accounted for by the recorded catch.

Underlined values used in example calculations.

Based on the above calculations, from 1970 to 1982 the West Greenland fishery caught on the average the same amount of salmon (two-sea-winter fish) that were caught in the homewaters of North America had they been caught in North America and not at West Greenland. The annual average weight of salmon from 1970-1982 that would have been caught in homewaters, had they not been taken at West Greenland, would have been 1,439 metric tons (Table 9). Over that same period (1970-1982) the average catch of salmon (two-sea-winter fish) in Canadian waters weighed 1,466 metric tons (Table 2). In terms of North American homewater units, therefore, the North American catch would have approximately doubled had the fish caught at West Greenland been caught in North America. This means that the West Greenland fishery has reduced the escapement of large salmon to the North American rivers by the same amount as has the North American fishery. This is shown in Figure 16 and Table 13 where the West Greenland catch is expressed in North American homewater units.

Impacts on United States Stocks

Knowledge about which fisheries are most important in intercepting U.S. fish has been derived from the tag return information described previously. Again, from 1971 to 1981, tags were not only recovered at Greenland (29%) but off Labrador (5.1%), off Newfoundland (15.8%), off Nova Scotia (0.3%), off New Brunswick (0.2%), and in Maine (49%). The interceptions off Canada (22%) are as important as those at West Greenland (29%) because the Candian interceptions occur after a portion of the U.S. fish have been removed by the West Greenland fishery. The fishing off eastern Newfoundland produces the greatest Canadian interceptions, with 33% of the entire Canadian tag returns occurring in July (50% in June and July) in this area. This area also intercepts significant numbers of U.S. fish in the fall and accounts for 71%

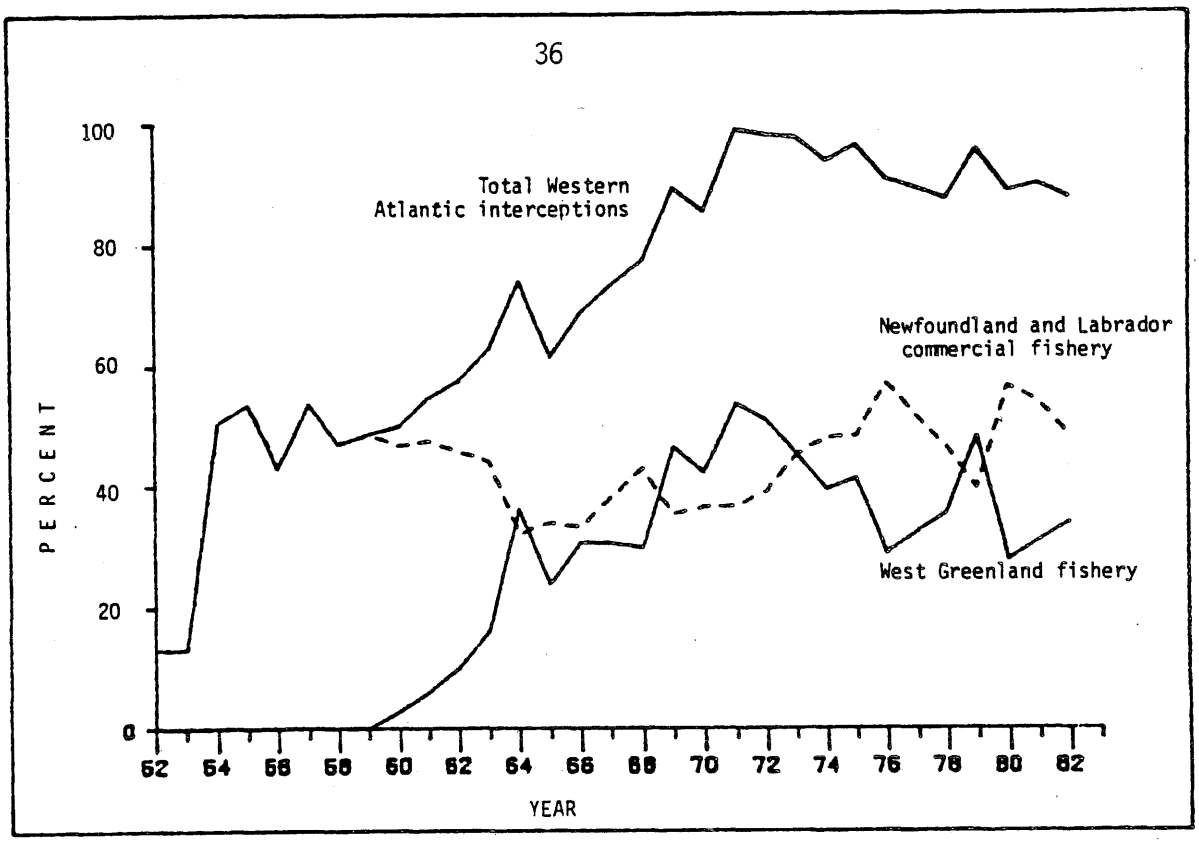


Figure 16. Percent of total Western Atlantic salmon catches due to interception fisheries at West Greenland and Newfoundland-Labrador. West Greenland catches expressed in North American homewater units. (Forty-three percent of West Greenland catch increased by a factor of 2.)

Table 13. Western Atlantic salmon catches and those due to interception fisheries at West Greenland, Labrador and Newfoundland, including percent of total due to each interception fishery. (West Greenland catches adjusted for increase if caught increase if caught in homewaters.)

	Intercept Catch (mt)				Interceptions as Percent of Total Western Atlantic Catch		
Year	West Greenland	Newfoundland-Labrador[1]	Intercept Total	Total Western Atlantic Catch	West Greenland	Newfoundland-Labrador	Total Intercepts
1952	0	328	328	2527	0	13	13
1953	0	307	307	2338	0	13	13
1954	0	997	997	1974	0	51	51
1955	0	722	722	1348	0	54	54
1956	0	595	595	1387	0	43	43
1957	0	827	827	1541	0	54	54
1958	0	853	853	1818	0	47	47
1959	0	950	950	1956	0	49	49
1960	52	841	893	1804	3	47	50
1961	109	857	966	1803	6	48	55
1962	210	950	1160	2078	10	46	57
1963	401	1098	1499	2490	16	44	63
1964	1324	1171	2495	3660	36	32	74
1965	750	1061	1801	3124	24	34	62
1966	1178	1280	2458	3849	31	33	69
1967	1377	1717	3094	4521	30	38	73
1968	969	1395	2364	3251	30	43	78
1969	1901	1441	3342	4087	47	35	89
1970	1846	1595	3441	4377	42	36	85
1971	2313	1576	3989	4307	54	37	99
1972	1817	1394	3211	3578	51	39	98
1973	2013	2008	4021	4450	45	45	98
1974	1649	2011	3660	4189	39	48	94
1975	1746	2045	3791	4233	41	48	96
1976	1011	2013	3024	3517	29	57	91
1977	1221	1938	3159	3769	32	51	89
1978	846	1110	1956	2395	35	46	87
1979	1200	986	2186	2489	48	40	96
1980	1027	2102	3128	3712	28	57	89
1981	1087	1908	2995	3530	31	54	90
1982	926	1319	2245	2731	34	48	88
1983	--	939	--	--	--	--	--
AVERAGE:							
1970-82	1439						
1964-82	1378						

[1] Newfoundland and Labrador commercial catches.

of all returns throughout the year. The Labrador fishery is also clearly an interception fishery for U.S. fish and mainland Canada fish, with 6% of landings in Labrador coming from Quebec and the Maritimes (Pippy 1982). The southern Newfoundland area is not a great problem for the U.S., although this area is reported to intercept significant amounts of Canadian maritime fish.

Distribution of Western Atlantic Intercept Catches, Quota Suggestions, and Effects on Homewater Stocks

In Figure 17 and Table 14 the catches at West Greenland, expressed in North American homewater units, are added to the North American catches. That is, from 1960-1982, during the period of the West Greenland fishery, 43% of the West Greenland catch by weight was assumed to belong to the North American component. As described previously, if those fish had been caught at homewaters in North America, they would have produced twice the yield realized at West Greenland. Therefore, 43% of the catch for each year from 1960 to 1982 was doubled and added to the reported total homewater North American catches. This, then, depicts the exploitation of North American salmon had they all been caught at homewaters. The average catch from 1964 to 1982 was 3,669 metric tons, which was comparable to the average catch during the 1920's and 1930's. That level apparently led to a steep decline in catches which ended in 1955. The current level of catch, then, is clearly excessive and may lead to a reduction in abundance. In any event, if the spawning escapement must be increased, the catch data in Figure 17 would suggest a reasonable level of about 2,500 metric tons to arrest further declines in abundance. This indicates a reduction of 1,169 from the 1964-1982 line of 3,669 metric tons. This reduction should apply only to commercial fisheries, on the basis of interception problems, since the recreational catches are probably of non-

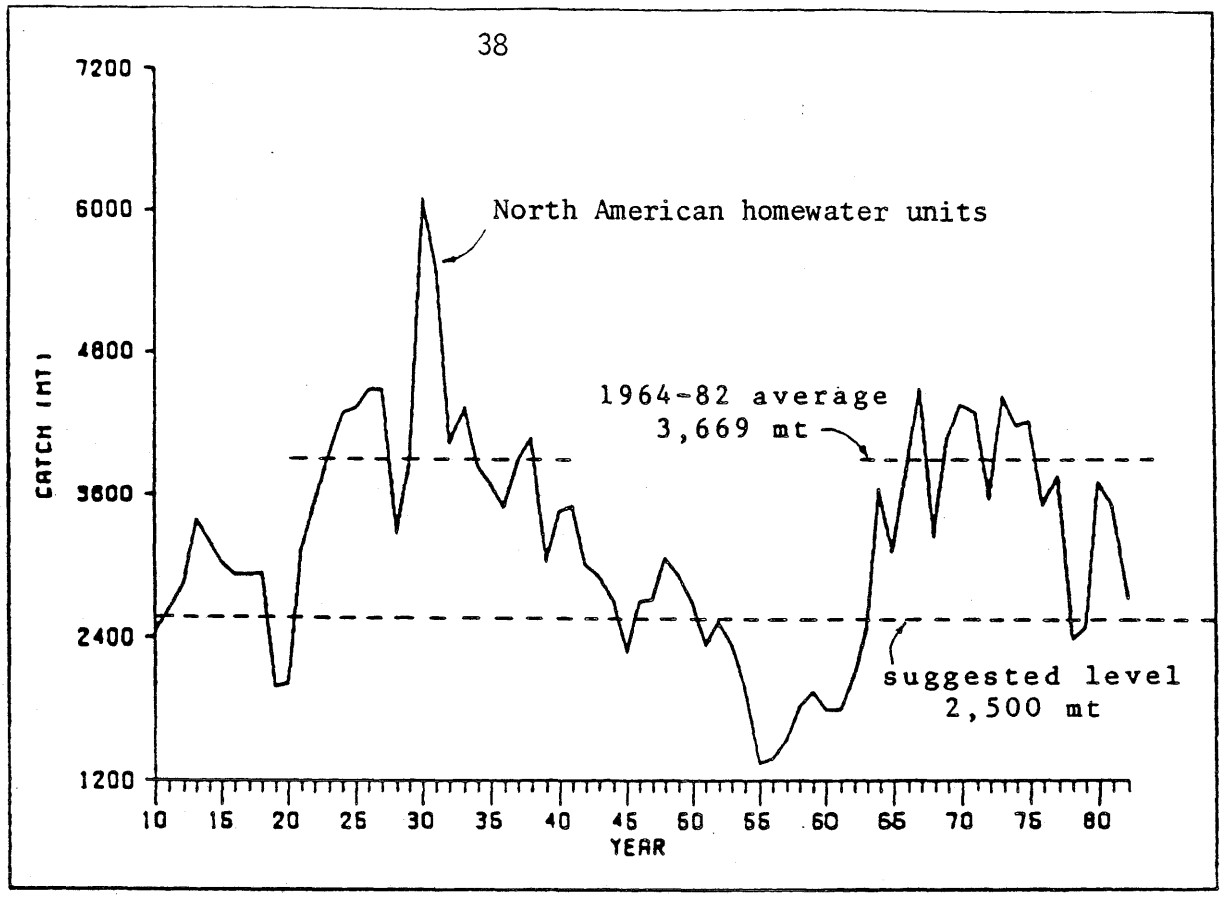


Figure 17. Total North American catch of Atlantic salmon in North American homewater units (catch data from 1960-82 include 43% of West Greenland catch multiplied by 2 to reflect catches had they been made in homewaters).

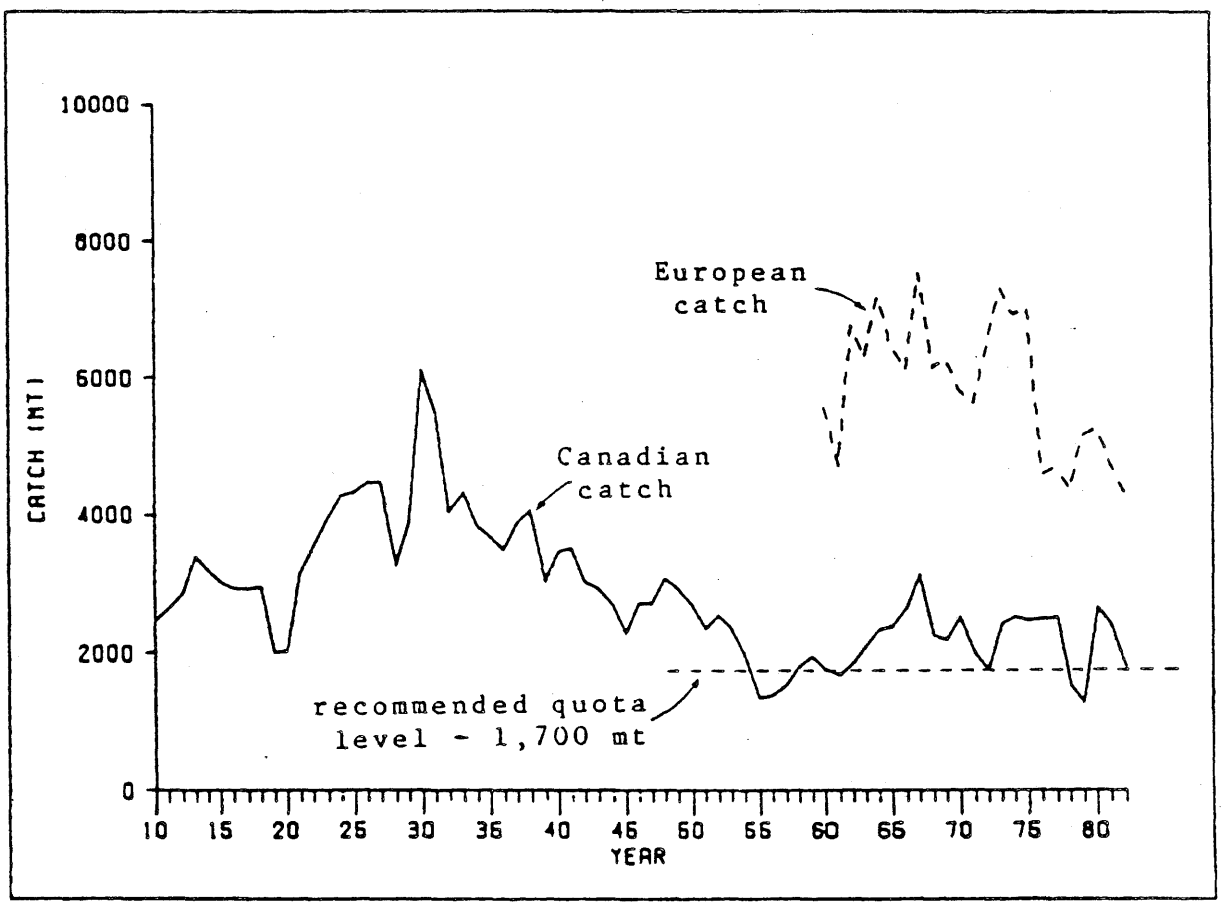


Figure 18. Canadian and European catches of Atlantic salmon in relation to the recommended quota level (Canadian catch prior to 1952 does not include recreational catch).

Table 14. Total catch of North American origin Atlantic salmon in North American homewater units, and total Canadian catches of Atlantic salmon, 1910-82.

Year	North America	Canada	Year	North America	Canada
1910	2455	2455	1947	2712	2712
1911	2629	2629	1948	3069	3069
1912	2852	2852	1949	2923	2923
1913	3382	3382	1950	2686	2686
1914	3201	3201	1951	2337	2337
1915	3028	3028	1952	2527	2527
1916	2925	2925	1953	2338	2338
1917	2924	2924	1954	1974	1974
1918	2938	2938	1955	1348	1348
1919	1990	1990	1956	1387	1387
1920	2019	2019	1957	1541	1541
1921	3142	3142	1958	1818	1818
1922	3528	3528	1959	1956	1956
1923	3949	3949	1960	1804	1750
1924	4291	4291	1961	1803	1692
1925	4330	4330	1962	2078	1866
1926	4483	4483	1963	2490	2087
1927	4488	4488	1964	3660	2334
1928	3270	3270	1965	3125	2382
1929	3867	3867	1966	3849	2669
1930	6100	6100	1967	4521	3142
1931	5518	5518	1968	3251	2280
1932	4044	4044	1969	4087	2184
1933	4336	4336	1970	4377	2529
1934	3843	3843	1971	4307	1992
1935	3688	3688	1972	3578	1759
1936	3483	3483	1973	4450	2434
1937	3883	3883	1974	4189	2539
1938	4078	4078	1975	4233	2485
1939	3034	3034	1976	3517	2506
1940	3456	3456	1977	3769	2545
1941	3498	3498	1978	2395	1545
1942	3014	3014	1979	2489	1287
1943	2914	2914	1980	3712	2680
1944	2692	2692	1981	3530	2437
1945	2279	2279	1982	2731	1798
1946	2703	2703			
			AVERAGE 1964-82 =	3669	2291

migrating salmon. This reduction, therefore, would not apply to the U.S. fisheries because the U.S. has no commercial fishery for salmon and does not intercept salmon bound for rivers of other nations. Since West Greenland and Canada have, for the period of 1970-1982, caught about the same amount of large salmon (if taken in homewaters), this reduction should be shared equally. This means that about 585 metric tons should be reduced from the average catches of each fishery. This implies multi-sea-winter fish in Canada and one-sea-winter fish at West Greenland. Since the West Greenland catch is expressed in North American homewater units, this means 293 metric tons if caught at West Greenland, which further implies a reduction in catch of 681 metric tons for the total fishery at West Greenland. Looking at this in another way, if 681 metric tons were not caught at West Greenland, 43% of that, or 293 tons, would be North American fish which, if caught in homewaters, would amount to 585 metric tons. The average catch at West Greenland from 1964-1982 was 1,603 metric tons, therefore, reducing that by 681 metric tons would leave a quota of 922 metric tons, as a recommended level. The Canadian catch from 1964 to 1982 was 2,291 metric tons and reducing that by 585 metric tons leaves 1,706 metric tons as a recommended quota for Canada. Rounding off these numbers, we could suggest a quota for Canada of 1,700 metric tons and for West Greenland of 920 metric tons. This is a catch for Canada slightly less than what it realized in 1982 but it is 20% greater than it caught in 1983. For West Greenland this would mean a 14% reduction from what it caught in 1982, but it is almost three times what West Greenland realized in 1983. The total catch in homewater units (2490 metric tons) then would be slightly more than the catches made in 1978 and 1979 (Figure 17 and Table 14).

After 1975 the catch of salmon at West Greenland decreased considerably as the high seas fishery was phased out. Therefore, catch quotas should be measured against the catches from 1976 to 1982. With the same 40% reduction in two-sea-winter salmon caught in Canada, the Canadian TAC would be 1,528 tons, about the same percentage reduction as before (28% less than the 1976-1982 average), but 15% instead of 5% less than the 1982 catch. A major difference would occur at West Greenland, however, where a 681 ton reduction in catch from the 1976-1982 average leaves a TAC of only 535 tons (56% less than the 1976-1982 average and 50% less than the catch in 1982). However, catch reductions at West Greenland and off Labrador and Newfoundland have the same potential for reducing U.S. interceptions and therefore, should be linked.

Based on the interceptions of U.S. salmon, the reduction in catch by Canada should occur off eastern Newfoundland and Labrador. Figure 15 shows the increase in proportion of the western Atlantic salmon catch taken by the Newfoundland and Labrador commercial fishery after 1971. From 1959 to 1971, this fishery, which accounts for 94% of the Canadian returns of U.S. tags, took 47% of the Atlantic salmon caught in the Western Atlantic. From 1972 to 1982 this percentage increased to 60%. Figure 19 and Table 15 indicate the percent of the total Canadian-caught fish taken by the commercial fishery off Newfoundland and Labrador. This fishery accounted for 55% of the Canadian catch from 1959-1971, but increased to 78% from 1972-1982. Figure 20 and Table 15 show the actual catch levels of the Labrador and Newfoundland commercial fishery compared with the total Canadian catch of salmon. This fishery has increased its percent of the harvest in recent years and is the main Canadian interception fishery for U.S. salmon. It is, therefore, reasonable to suggest that the percent harvest should be reduced to its

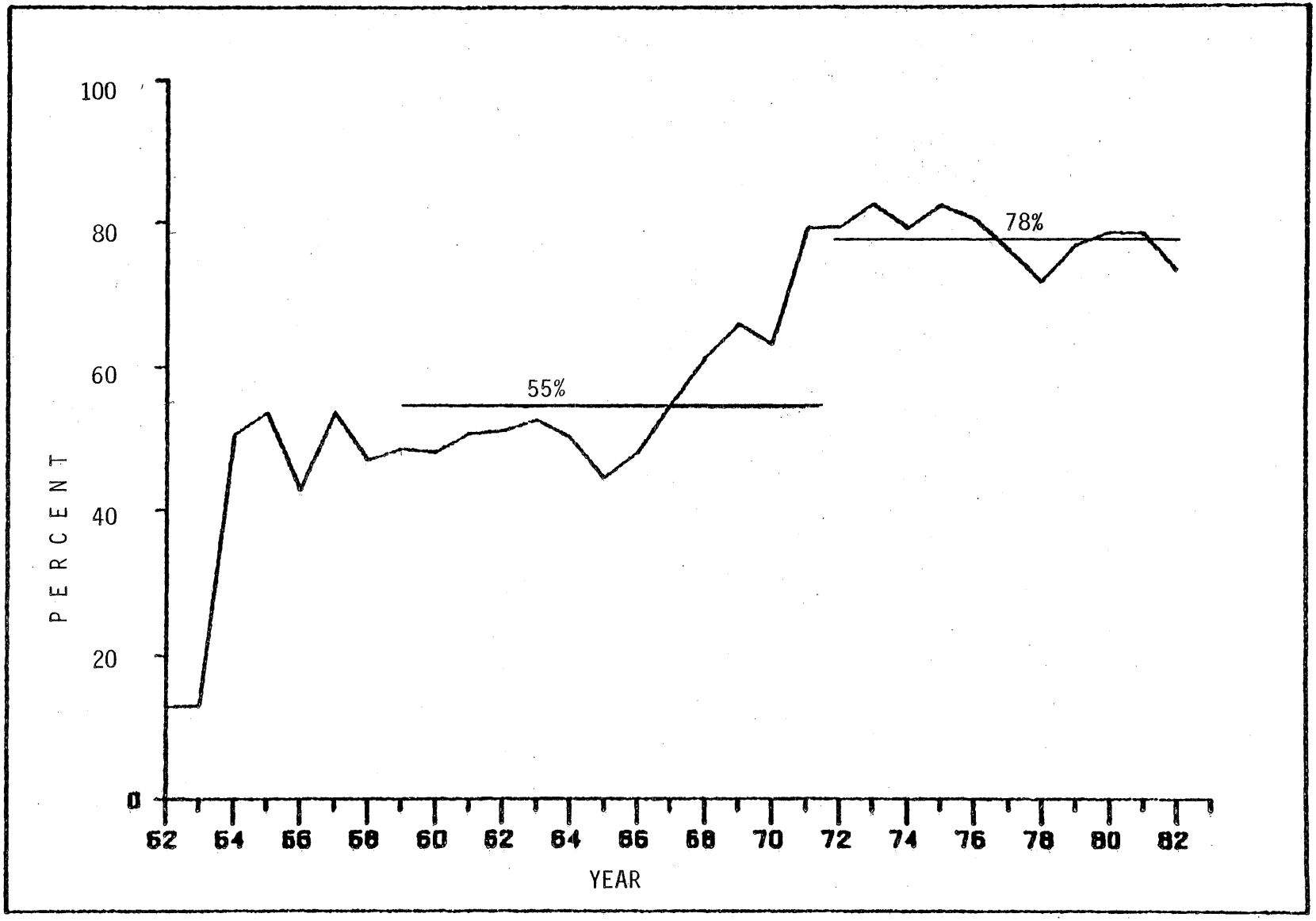


Figure 19. Percent of total Canadian-caught Atlantic salmon due to the commercial fishery of Newfoundland and Labrador.

Table 15. Total Canadian (commercial and recreational) catch of Atlantic salmon, with commercial catch at Newfoundland and Labrador in metric tons and as percent of total, 1952-83.

Year	Newfoundland and Labrador	Total Canada	Percent intercept
1952	328	2527	13
1953	307	2338	13
1954	997	1974	51
1955	722	1348	54
1956	595	1387	43
1957	827	1541	54
1958	853	1818	47
1959	950	1956	49
1960	841	1750	48
1961	857	1692	51
1962	950	1866	51
1963	1098	2087	53
1964	1171	2334	50
1965	1061	2382	45
1966	1280	2669	48
1967	1717	3142	55
1968	1395	2280	61
1969	1441	2184	66
1970	1595	2529	63
1971	1576	1992	79
1972	1394	1759	79
1973	2008	2434	82
1974	2011	2539	79
1975	2045	2485	82
1976	2013	2506	80
1977	1938	2545	76
1978	1110	1545	72
1979	986	1287	77
1980	2102	2680	78
1981	1908	2437	78
1982	1319	1798	73
1983	939	1424	66
Average			
1959-71	1226	2220	55
1972-82	1712	2183	78
1969-83	1626	2143	76

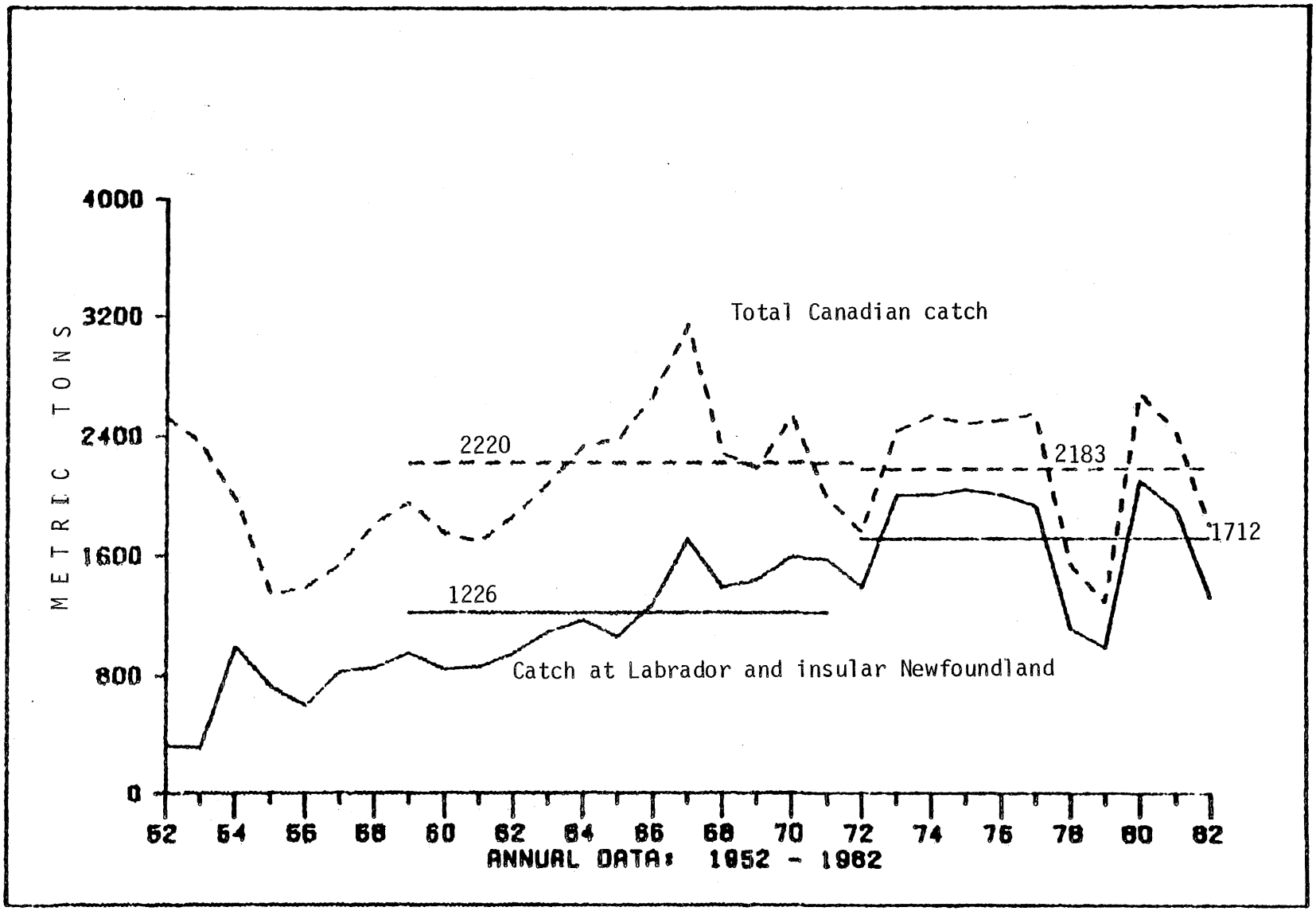


Figure 20. Catch of Atlantic salmon in Canada, Labrador and insular Newfoundland.

earlier level of 47% of all western Atlantic catches or 55% of the Canadian catch. A Canadian TAC of 1,705 tons or 1,528 tons should be limited to catches of 938 tons or 840 tons, respectively, for the combined Labrador-Newfoundland fishery. These catch levels are 55% and 49%, respectively, of the average catch (1,712 tons) from 1972-1982, and 77% and 69% of the average catch (1,226 tons) for 1959-1971.

Table 16 and Figure 21 indicate the catches of Atlantic salmon for Labrador, eastern Newfoundland (Statistical Areas A-F), and southern Newfoundland (Statistical Areas G-J). Table 16 also contains catches for the relatively small fisheries off western Newfoundland. Over the period of 1969 to 1983, 37%, 42%, 17%, and 4% of the Labrador-Newfoundland catch came from Labrador, eastern Newfoundland, southern Newfoundland and western Newfoundland, respectively. A catch quota of 938 tons might, therefore, be logically proportioned into 347, 394, 159 and 38 tons for the three areas.

In terms of tags returned per 1,000 tons of catch from 1972 to 1982, 4.2 times as many U.S. salmon are present in eastern Newfoundland as in southern Newfoundland, and 2.9 times as many are present in eastern Newfoundland as off Labrador (Table 16). No U.S. tags have been recovered from western Newfoundland.

Regardless of the reduction in catch proposed by Canada, therefore, we recommend that the proportion caught at Labrador and at insular Newfoundland not exceed 55% of the total, and that the catch allocation for eastern Newfoundland be reduced as much as possible.

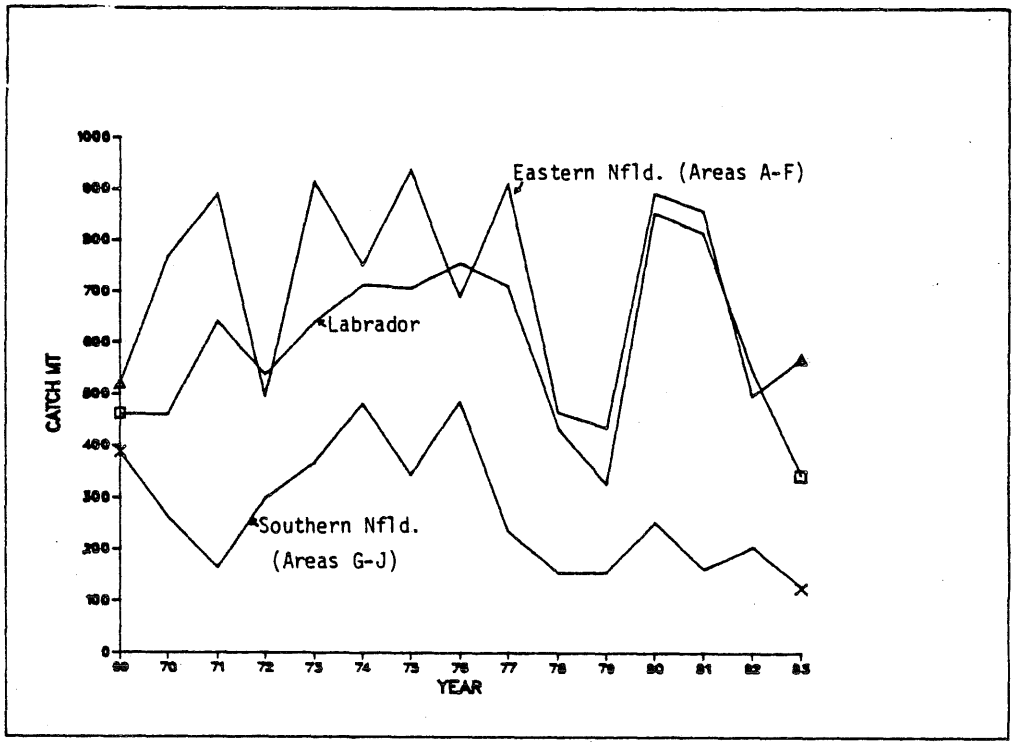


Figure 21. Commercial Atlantic salmon catch off Labrador and eastern and southern Newfoundland, Statistical Areas A-F, G-J, and O.

Table 16. Total commercial Atlantic salmon catch from Newfoundland and Labrador, by area, 1969-83.

Year	Newfoundland A-F	Newfoundland G-J	Newfoundland Total	Labrador O	Areas A-F, G-J, O Total	Other Newfoundland K-N	Total Newfoundland & Labrador
1969	520	387	907	462	1,369	73	2,349
1970	767	264	1,031	458	1,489	106	2,626
1971	730	163	893	642	1,535	42	2,630
1972	494	299	793	537	1,330	64	2,187
1973	915	368	1,283	638	1,921	86	3,290
1974	751	480	1,231	714	1,945	66	3,242
1975	939	343	1,282	705	1,987	49	3,318
1976	689	485	1,174	757	1,931	82	3,187
1977	910	235	1,145	712	1,857	81	3,083
1978	465	154	619	435	1,054	56	1,729
1979	432	156	588	326	914	73	1,575
1980	892	254	1,146	853	1,999	103	3,248
1981	857	162	1,019	814	1,833	75	2,887
1982	495	206	701	547	1,248	70	2,019
1983	401	117	518	345	863	136	1,695
Total (1969-83)	10,257	4,073	14,333	8,945	23,278	1,119	24,397
Average catch (1969-83)	684	272	956	596	1,574	75	1,626
Percent of total	42.1	16.7	58.8	36.6	95.4	4.6	100.0
Number of US tags returned (1972-82)	493	47	540	152	692	0	692
Number of US tags per 1000 tons of catch	62.9	15.0	37.7	21.6	29.7	0.0	28.4

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