Estimates of Harvest and Exploitation
Rates for Saint John River
Atlantic Salmon in Homewater and Distant Fisheries

by

T.L. Marshall
Biological Sciences Branch
Department of Fisheries and Oceans
P.O. Box 550
Halifax, N.S.
B3J 2S7

ABSTRACT

Estimates of distant harvest and exploitation rates for Saint John River salmon were developed from returns of 327 and 365 Carlin tags from non-maturing 1SW hatchery fish in Newfoundland-Labrador and West Greenland, 1974-1988 respectively, and 1,066 tagged 2SW fish of the same smolt class at Mactaquac Dam, 1975-1989. The estimated harvests, 1974-1988, for the hatchery and wild stock components originating at or above Mactaquac Dam totalled 45,755 1SW salmon in West Greenland and 33,084 1SW salmon in Newfoundland-Labrador. Homewater harvest of the same stock components, 1975-1989, was 44,292 2SW salmon; spawning escapement was estimated at 64,477 2SW salmon.

Exploitation rates were estimated by run-reconstruction assuming that 2SW returns were the survivors of either the West Greenland or Newfoundland-Labrador fisheries but not both. Assuming that 50% of homewater returns came from Newfoundland-Labrador and 50% were from West Greenland respectively, mean exploitation rates in these fisheries, 1974-1988, were 0.332 and 0.409. Values for West Greenland were correlated with those determined for Maine stocks, but no relationship exists between exploitation rates of the Saint John and Maine stocks in Newfoundland-Labrador.

RÉSUMÉ

On a élaboré des estimations des captures et des taux d'exploitation, en eaux lointaines, du saumon de la rivière Saint-Jean à partir d'étiquettes Carlin récupérées chez 327 saumons d'élevage unibermarins sans signe de maturité capturés dans les eaux de Terre-Neuve et du Labrador et 365 autres capturés dans les eaux du Groenland ouest (1974-1988), ainsi que chez 1 066 saumons dibermarins de la même classe de saumoneaux capturés au barrage de Mactaquac (1975-1989). Les captures estimatives de 1974 à 1988 pour ce qui est des composantes saumons d'élevage et saumons sauvages issues des eaux en aval et en amont du barrage de Mactaquac s'élèvent à 45 755 saumons unibermarins dans les eaux du Groenland ouest et à 33 084 saumons unibermarins dans les eaux de Terre-Neuve et du Labrador. Les captures des mêmes composantes du stock dans les eaux d'origine de 1975 à 1989 totalisaient 44 292 saumons dibermarins. L'échappée estimative se situe à 64 477 saumons dibermarins.

On a tenté de déterminer les taux d'exploitation en simulant la remontée à partir de la prémisse que les dibermarins amontants avaient échappé à la capture soit dans les eaux du Groenland ouest ou soit dans les eaux de Terre-Neuve et du Labrador, mais non aux deux endroits. En supposant que les retours aux eaux d'origine sont également partagés entre ces deux zones, on obtient des taux d'exploitation moyens respectifs de 0,332 et 0,409 pour la période 1974-1988. Les valeurs obtenues dans le cas des eaux du Groenland ouest sont en corrélation avec celles déterminées chez des stocks du Maine, mais il n'existe aucune relation entre les taux d'exploitation des stocks de la rivière Saint-Jean et du Maine dans les eaux de Terre-Neuve et du Labrador.

INTRODUCTION

Atlantic salmon of the Saint John River, N.B., particularly Carlin-tagged smolts released from Mactaquac Fish Culture Station, have previously been used to estimate the average contribution of Saint John River hatchery fish to distant fisheries (Gray 1973, Ruggles and Ritter 1980 and McPhee et al. 1981) and develop estimated reporting rates for tags returned from Greenland (Anon 1987). This document utilizes Carlin-tagged hatchery smolts released from Mactaquac 1973-1987 to estimate the harvest and exploitation rates in homewater and distant fisheries, 1974-1989 of hatchery and wild non-maturing 1SW and maturing 2SW salmon originating at and above Mactaquac Dam. The underlying assumption is that wild fish frequent the same areas and are equally vulnerable to fisheries as are fish of hatchery origin.

METHODS

Estimation of harvests in distant fisheries follows the procedure of Anon (1986) to estimate the harvest of USA-origin salmon in Canadian and Greenland fisheries i.e.,

$$H = T \times L/(R \times (1-NC) \times RATIO)$$

where:

H = total harvest of salmon of a given origin, smolt class and sea-age in a distant fishery (year i),

T = total number of tags returned from salmon of that smolt-class and sea-age in a distant fishery (year i),

R = reporting rate for tags captured in the fishery,

NC = non-catch fishing mortality,

$RATIO$ = total number of tagged 2SW salmon in that smolt-class that approach the Saint John River in year i+1 to the total number of salmon of that smolt-class approaching the river in year i+1 and

L = the proportion of salmon that retain tags between exposure to the fisheries in year i and return to homewaters in year i+1.

It is assumed that smolts of hatchery and wild origins frequent the same locations at the same time and are harvested at the same rates. In accordance with harvest estimates for US salmon (Anon 1987, 1988) reporting rates used were R = 0.9 for tags returned from Labrador, R = 0.7 for tags returned from insular Newfoundland and R = annually variable values of Anon (1987) 1975-1985 and 0.8 since 1986 for tags returned from West Greenland. Parameter values for NC were set at 0.1 (Newfoundland and Labrador) and 0.2 (W. Greenland); L was set at 0.9 (Anon 1987; 1988). All tags returned from 1SW fish captured in Newfoundland-Labrador were assumed to be those of potential 2SW maiden fish.

Estimation of the RATIO parameter, varied slightly from the approach outlined in Anon (1987) because i) tags in homewaters were returned from more than a recreational fishery, e.g., a by-catch fishery, commercial fishery and Indian fishery - each, in all probability, with a different tag reporting rate and each with some degree of annual variability and ii) estimates of total homewater MSW returns destined for Mactaquac were already available (Marshall, 1989 and 1990). Estimates of wild 2SW returns were derived from MSW returns by

removing the proportion of previous spawners, as determined from ageing of scales from 200-500 MSW fish sampled annually 1975-1989. Hatchery and wild fish were assumed to be the same composition of maiden and previous spawners. Harvest estimates in homewaters were approximated as the difference between estimated homewater returns destined for Mactaquac and the sum of the count at Mactaquac, sport, hook-and-release mortality and Indian removals above Mactaquac Dam.

Two estimates of RATIO were examined. The first was based solely on tags and hatchery fish counted at Mactaquac. The second estimate of RATIO was based on tag returns from all homewater fisheries, a correction for non reporting of tags (as estimated by ratio of tags to estimated fish caught in the various homewater fisheries, relative to that at Mactaquac) and the independent estimates of 2SW hatchery returns to the Saint John that originated at Mactaquac Hatchery. The RATIO values used to estimate harvest in distant waters utilized counts of tagged 2SW fish and counts of hatchery plus wild 2SW fish at Mactaquac Dam.

Tagged smolts used in this analysis were restricted to groups reared at and released from Mactaquac Fish Culture Station, 1973-1987. Parent fish had all been collected at the same facility--principally from the Jun-Aug portion of the run. Smolts released previous to 1973 were excluded for several reasons, the most important of which was the absence of vetted estimates of homewater harvests and 2SW returns destined for Mactaquac Dam. Releases between 1973 and 1984 were principally of 2-year freshwater age (a few groups of 1-year smolts contributing to 16 tag returns from distant fisheries were included 1977-1979), those of 1985-1987 were all 1-year smolts. Previous to 1985, all smolts were both adipose clipped and tagged with small Carlin tags with monofilament attachment. Since 1985, adults of hatchery origin returning to Mactaquac have been identified by fin erosion and verified by scale reading as having been of 1-year freshwater age.

Estimation of exploitation rates in distant fisheries was based on the estimates of 2SW hatchery and wild salmon originating at and above Mactaquac that returned to the Saint John River and were destined for Mactaquac and the numbers of 1SW non-maturing salmon estimated to have been harvested in Newfoundland-Labrador and Greenland. Stock size in distant waters at the beginning of the fishery was estimated as the sum of the harvest and the proportion of homewater returns, increased by losses to natural mortality, that was assumed to have originated in Newfoundland-Labrador (p) and Greenland (1-p).

Basic assumptions are:

1. Wild fish frequent the same areas and are equally vulnerable to fisheries as are fish of hatchery-origin.

2. 2SW salmon returning to Mactaquac are the survivors of either the West Greenland fishery or the Newfoundland-Labrador fishery but not both.

3. Natural mortality is 0.12 per year.

4. During the period of the fishery, natural mortality is negligible.

5. Times of the fisheries in Newfoundland-Labrador and West Greenland are represented by the weeks in which the median number of tagged fish were captured, i.e., week 27 (July 02-08) year i, in the former and week 33 (Aug

20-26) year i in the latter; homewater returns and removals occurred on week
27 in yr i+1.

RESULTS

Over the period 1975-1989, 1,066 tagged 2SW hatchery salmon originating from
312,900 tagged smolts were counted at the Mactaquac sorting facilities (Table 1).
Tag returns from homewater fisheries and estimated to have been removed but not
reported suggested that a minimum of 1,673 tagged hatchery 2SW fish returned to
homewaters over the same period. Estimated reporting rates (Table 1) ranged from
0 to 1.0; values of 1.0 suggested fisheries and years in which independent
estimates of 2SW removals were most likely underestimated/underreported. Zero
reporting rates (tags bracketed) coincide with fisheries, which during certain
periods were illegal (by-catch, early-and-late Kingsclear) or out of control.

RATIOS were estimated for counts at Mactaquac of hatchery-tagged and untagged
2SW fish (RATIO$_c$) and estimates of hatchery-tagged and untagged 2SW fish (RATIO$_E$)
that returned to homewaters (Table 2). The difference between the estimated
harvest (H) of Mactaquac hatchery-origin fish in West Greenland by RATIO$_c$ and
RATIO$_E$, 1974-1988, was 364 fish or 4.5% of that estimated by RATIO$_E$ (Table 2).
Annual differences, however, were as high as the 41% in 1983.

Tag returns from Greenland, 1974-1988, numbered 365 and are summarized by
NAFO Division and year in Table 3. Annual summaries by standardized week (week 1
= Jan. 1-7) appear in Appendices 1 and 2. Tag returns from Statistical Areas of
Newfoundland-Labrador over the same period numbered 327 (Table 4) and are
summarized by year, Statistical Area and standardized week in Appendices 3 and 4.

Based on a RATIO of counted tagged and untagged wild and hatchery fish,
estimates of the 15-year harvest in Newfoundland-Labrador of wild and hatchery
potential 2SW Saint John River salmon destined for Mactaquac totalled 33,084
fish; those harvested in West Greenland totalled 45,755 (Table 5). Distant
harvest accounted for 42% of the 2SW and potential 2SW fish, 58% was accounted
for in homewater fisheries and escapements. Of the total estimated harvest,
1974-1989, 37% was taken in Greenland, 36% in homewaters, 23% in insular
Newfoundland and 4% in Labrador. Correlations were not significant between 2SW
returns in homewaters and harvests in previous years in distant fisheries nor
between wild 1SW fish of the same smolt class and individual or summed
returns/harvests of wild 2SW or potential 2SW fish (Table 6). Harvests of
potential 2SW fish in insular Newfoundland were, however, correlated with those
of Labrador (r^2 =0.49; $p < 0.01$).

Estimates of exploitation rates averaged 0.332 and 0.409 for Newfoundland-
Labrador and West Greenland, respectively, 1974-1988, if 0.5 of returns to
homewaters originated from the area of each distant fishery (Table 7). The
average annual exploitation rate in homewaters over the same period was 0.406.
Plots (Fig. 1 and 2) illustrate the annual variability in each fishery, and in
the case of Greenland, the low rates of 1977, 1983 and 1984.

DISCUSSION

Harvest estimates based on the RATIO of counts rather than fish estimates
avoid the error in estimating annually variable reporting rates for voluntary tag

returns. However count data for returning hatchery adults may be proportionally lower than for wild fish if, upon reaching the end of their migration just below Mactaquac, they were more vulnerable to the sport and Indian fisheries. A higher RATIO value would reduce the harvest estimates and exploitation rates in the distant fisheries.

Estimates of distant harvests, at least on the scale treated herein, do not account for additional variance in a presumed underlying stock-recruit relationship between wild 1SW and 2SW salmon of the same smolt class. Estimation of harvests by Statistical Areas and NAFO Divisions along with modelling of variable reporting rates in Newfoundland-Labrador may be enlightening.

Ratios of Greenland harvest/homewater return are positively correlated with ratios for Maine rivers (Anon 1989) in the same years, $r^2=0.704$; $p <0.01$, n = 13 (Table 8). The ratios developed for estimates of harvest in Newfoundland-Labrador are not correlated.

The pattern of annual variation in the harvest/run ratios is largely similar for the estimated exploitation rates. Estimated exploitation rates for Maine stocks in W. Greenland over 11 years between 1974 and 1986 (Rago, pers. comm.)[a] were also correlated with those of the Saint John ($r^2 = 0.794$; $p < 0.01$). The mean value for the Maine stocks was 0.544; Saint John was 0.386 if 50% ($p = 0.5$) of the stocks were in Greenland and 50% were in Newfoundland-Labrador.

ACKNOWLEDGEMENTS

LITERATURE CITED

Anon. 1986. Report of Meeting of the Working Group on North Atlantic Salmon, Woods Hole, Massachusetts, USA, 16-20 September 1985. ICES Doc. C.M. 1986/Assess:8.

Anon. 1987. Report of the Working Group on North Atlantic Salmon. ICES Doc. C.M. 1987/Assess:12.

Anon. 1988. Report of the Working Group on North Atlantic Salmon. ICES Doc. C.M. 1988/Assess:16.

---

[a]Rago, P.J. USDI, Fish and Wildl. Serv. Kearneysville, W. Va 25430.

Anon. 1989. Report of the Working Group on North Atlantic Salmon. ICES Doc. C.M. 1989/Assess:12.

Gray, R.W. 1973. Preliminary assessment of the contribution of hatchery-reared smolts (Salmo salar L.) released in 1970-71 in the Saint John River, New Brunswick, to various fisheries and the spawning escapement. ICES C.M. 1980/M:26, 15p.

Marshall, T.L. 1989. Assessment of Atlantic salmon of the Saint John River, N.B., 1988. CAFSAC Res. Doc. 89/77:vii + 29p.

Marshall, T.L. 1990. Assessment of Atlantic salmon of the Saint John River, N.B., above Mactaquac Dam, N.B. 1989. CAFSAC Res. Doc. 90/79 :vi + 16p.

McPhee, R.J., C.P. Ruggles and G. Farmer, MS 1981. Program evaluation Atlantic fisheries resource enhancement program. Dept. Fish. Oceans, Evaluation and Audit Br. 206p + App.

Pippy, J. (Chairman) 1982. Report of the Working Group on the interception of mainland salmon in Newfoundland. Can. MS Rep. Fish. Aquat. Sci. 1654:x+196p.

Ruggles, C.P. and J.A. Ritter. 1980. Review of North American smolt tagging to assess the Atlantic salmon fishery off West Greenland. Rap. R.- v. Reun. Cons. int. Explor. Mer. 176: 82-92.

Table 1. Summary of numbers of smolts released, reported and estimated tags and reporting rates from 2SW hatchery origin salmon in homewaters and destined for Mactaquac, Saint John River, 1973-1989.

Smolts (yr i)		Count Mact.	Kingsclear Indians	Angled below	Comm.	Loc.	Ukn.	Est. Total
Year	Number							
1973	47,956	143	(17)	4/0.4	2/1.0	2/0.5ᵃ	3	179.0
1974	11,984	51	(15)	9/1.0	0	0	0	75.0
1975	23,953	136	10/0.6	11/0.4	0	1/0.5ᵃ	0	182.2
1976	11,997	72	14/0.9	7/1.0	0	0	0	94.6
1977	29,946	60	24/1.0	7/1.0	0	1/0.5ᵃ	0	93.0
1978	35,908	233	48/0.8	29/1.0	0	1/0.5ᵃ	2	326.0
1979	37,849	135	32/0.9	9/0.5	69/0.5	0	1	327.6
1980	13,977	43	18/0.6	5/0.4	7/0.7	0	1	96.5
1981	12,000	15	2/0.2	1/0.9	18/1.0	0	3	41.1
1982	13,998	47	9/0.7	0	(5)	0	0	64.9
1983	10,000	30	(11)	0	(8)	0	0	49.0
1984	19,988	24	(14)	1	(2)	0	0	41.0
1985	15,900	38	3/0.2	0	(3)	0	0	56.0
1986	15,902	25	(7)	0	(1)	0	0	33.0
1987	11,550	14	0	0	0	0	0	14.0
Total	312,908	1,066						1,672.9

Tag returns/Est. reporting rate (yr i+2)

( ) Proportionate estimate.
ᵃ Guesstimated reporting rate.

Table 2. Counts and estimates of 2SW salmon of <u>hatchery</u> origin returning to the Saint John River, 1975-1989, RATIO values developed from tags (Table 1) and total returns and estimates of harvest in West Greenland, 1974-1988.

| Year i | Total hatchery count[a] | Total hatchery estimate[a] | RATIO$_c$ | RATIO$_E$ | Harvest in W. Grn. yr i-1 | |
					RATIO$_c$	RATIO$_E$
1975	1,732	2,060	0.08256	0.08689	1,650	1,567
1976	1,529	2,168	0.03336	0.03459	913	880
1977	1,750	2,305	0.07771	0.07905	1,043	1,017
1978	1,801	2,339	0.03998	0.04044	346	342
1979	707	942	0.08487	0.09873	344	295
1980	2,210	2,753	0.10543	0.11842	1,660	1,478
1981	993	2,382	0.13595	0.13753	559	552
1982	634	1,334	0.06782	0.07234	397	372
1983	264	513	0.05682	0.08012	410	291
1984	754	1,042	0.06233	0.06228	23	23
1985	498	771	0.06024	0.06355	71	67
1986	401	664	0.05985	0.06175	188	182
1987	263	370	0.14449	0.15135	175	167
1988	482	860	0.05187	0.03837	461	623
1989	339	363	0.04130	0.03857	272	292
Total					8,512	8,148

[a] Reduced by the proportions of previous spawners among wild returns and downriver-origin hatchery fish appearing at Mactaquac.

Table 3. 1SW tag returns from NAFO Divisions of Greenland for the years 1974-1988.

	NAFO Divisions							
Year	1A	1B	1C	1D	1E	1F	Uk	Total
1974	5	13	20	15	3	3	33	92
1975	1	2	5	3	1	0	11	23
1976	11	8	11	2	0	1	7	40
1977	1	1	2	0	0	0	5	7
1978	0	11	1	0	0	0	12	14
1979	8	32	26	6	0	0	20	84
1980	0	3	4	0	0	0	5	27
1981	0	5	0	1	0	0	0	11
1982	0	10	2	0	0	0	0	12
1983	0	0	1	0	0	0	0	1
1984	0	2	1	0	0	0	0	3
1985	2	2	2	0	1	0	1	8
1986	0	3	2	8	4	1	0	18
1987	0	5	5	3	2	2	0	17
1988	0	1	3	2	1	1	0	8
Total	28	98	85	40	12	8	94	365

Table 4. 1SW tag returns from Statistical Areas of Newfoundland-Labrador for the years 1974-1988.

	Statistical Areas							
Year	0	A	B	C	D	Oth	Uk	Total
1974	4	2	3	1	5	19	1	35
1975	5	0	3	10	2	8	0	28
1976	8	5	3	6	1	4	1	28
1977	9	12	9	5	5	6	0	46
1978	3	11	0	1	0	2	1	18
1979	7	8	2	2	1	4	0	24
1980	8	43	20	4	1	2	0	78
1981	2	0	2	3	0	1	0	8
1982	3	0	2	0	1	4	0	10
1983	2	3	3	1	0	1	0	10
1984	0	3	0	0	2	1	0	6
1985	1	1	4	0	1	3	0	10
1986	2	1	0	0	1	1	0	5
1987	3	6	2	3	1	6	0	21
1988	0	0	0	0	0	0	0	0
Total	57	95	53	36	21	62	3	327

Table 5. Counts and estimates of <u>hatchery</u> and <u>wild</u> 2SW salmon returning to Saint John River at/above Mactaquac, homewater harvest and 'RATIO' estimators used to calculate the harvests of the same smolt class in Newfoundland, Labrador and Greenland, 1974-1989.

| Year | Harvest (H) yr i | | | | | Homewaters (yr i+1) | | |
i	Nfld	Labr	Nfld + Labr	Greenl	Harvest	Est 2SW returns	2SW count	RATIO[a]
1974	2,495	250	2,745	7,672	2,065	8,995	8,058	0.01775
1975	4,595	777	5,372	4,258	4,118	9,871	7,134	0.00715
1976	1,957	609	2,566	5,504	3,989	10,522	9,315	0.01460
1977	3,660	693	4,353	957	2,040	6,050	4,985	0.01444
1978	1,030	160	1,190	1,402	1,090	3,126	2,885	0.02080
1979	1,089	349	1,438	7,851	5,084	12,803	10,451	0.02229
1980	2,616	232	2,848	1,986	5,474	7,846	3,530	0.03824
1981	596	155	751	1,871	3,496	5,689	2,990	0.01438
1982	1,294	431	1,725	3,011	2,392	3,843	1,941	0.00773
1983	1,901	370	2,271	234	4,171	10,578	7,817	0.00601
1984	1,989	0	1,989	991	4,447	10,915	6,956	0.00431
1985	2,220	192	2,412	1,943	2,646	6,357	4,143	0.00579
1987	2,511	326	2,837	2,335	1,394	4,436	3,430	0.01108
1988	0	0	0	3,451	540	4,318	4,291	0.00326
Total	28,339	4,745	33,084	45,755	44,292	108,769		

[a] 'Count Mact' (Table 1)/'2SW count' (Table 5).

Table 6. Estimates of <u>wild</u> 1SW and 2SW salmon destined for Mactaquac on the Saint John River, and homewater and distant harvests of the same smolt class, 1974-1989 (Estimates based on prop. 2SW wild and Table 5).

	1SW home retn's	Distant harvest (yr i)				Home (yr i+1)		
				Nfld +		Prop.	Est 2SW	Harvest
Yr i	yr i	Nfld	Labr	Labr	Greenl	2SW	return	2SW
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1974	3,656	2,164	217	2,382	5,915	0.771	6,935	1,592
1975	6,858	4,111	682	4,714	3,321	0.780	7,699	3,212
1976	8,147	1,720	535	2,255	4,299	0.781	8,218	3,115
1977	3,977	2,524	478	3,002	587	0.613	3,709	1,251
1978	1,902	810	126	936	980	0.699	2,185	762
1979	6,828	962	309	1,271	6,163	0.785	10,050	3,991
1980	8,482	2,048	182	2,230	1,382	0.696	5,461	3,810
1981	5,782	514	133	647	1,433	0.766	4,358	2,678
1982	4,958	1,245	415	1,661	2,577	0.856	3,290	2,048
1983	4,309	1,921	374	2,294	210	0.898	9,499	3,745
1984	8,311	2,065	0	2,065	915	0.923	10,075	4,105
1985	6,526	2,211	191	2,402	1,720	0.885	5,626	2,322
1986	7,904	392	204	596	2,062	0.901	3,997	1,213
1987	5,909	2,096	272	2,368	1,733	0.742	2,538	1,034
1988	8,903	0	0	0	3,096	0.897	3,893	484

Regression of:

Column (8) on (2) r^2 = 0.09
(5) on (2) r^2 = 0.01
(6) on (2) r^2 = 0.02
(5+6+8) on (2) r^2 = 0.05

Table 7. Estimated exploitation rates in homewaters and under assumptions of
0.3, 0.5 and 0.7 of the total population being available to Newfoundland-
Labrador and Greenland fisheries.

| Yr i | Nfld-Labr (yr i) | | | Greenland (yr i) | | | Homewaters yr i+1 |
	p=0.3	p=0.5	p=0.7	1-p =0.7	1-p =0.5	1-p =0.3	
1974	0.472	0.349	0.277	0.522	0.604	0.718	0.230
1975	0.615	0.489	0.406	0.356	0.436	0.563	0.417
1976	0.417	0.300	0.235	0.401	0.484	0.610	0.379
1977	0.678	0.559	0.475	0.168	0.221	0.321	0.337
1978	0.527	0.401	0.324	0.365	0.446	0.572	0.349
1979	0.248	0.165	0.124	0.440	0.524	0.647	0.394
1980	0.516	0.390	0.313	0.245	0.312	0.431	0.698
1981	0.279	0.189	0.142	0.296	0.371	0.495	0.615
1982	0.568	0.441	0.361	0.501	0.584	0.701	0.622
1983	0.386	0.274	0.213	0.028	0.038	0.062	0.394
1984	0.348	0.243	0.186	0.104	0.140	0.213	0.407
1985	0.527	0.400	0.323	0.281	0.354	0.477	0.416
1986	0.280	0.189	0.143	0.398	0.480	0.607	0.303
1987	0.709	0.594	0.511	0.466	0.550	0.671	0.408
1988	0.0	0.0	0.0	0.506	0.589	0.705	0.125
Mean	0.438	0.332	0.269	0.338	0.409	0.520	0.406

Table 8. Harvest/Run ratios for Saint John and Maine (Table 30, Anon 1989) salmon estimated to have been harvested in Greenland and Newfoundland-Labrador, 1974-1989.

Years	Ratio Greenl Harvest/Run		Ratio Nfld-Labr Harvest/Run	
	Saint John (1)	Maine (2)	Saint John (3)	Maine (4)
1974-75	0.853	1.308	0.343	0.378
1975-76	0.431	1.136	0.612	0.886
1976-77	0.523	0.877	0.274	1.280
1977-78	0.158	0.249	0.809	0.264
1978-79	0.448	0.663	0.428	0.192
1979-80	0.613	-	0.126	-
1980-81	0.253	0.502	0.408	1.052
1981-82	0.329	0.369	0.149	0.220
1982-83	0.784	0.775	0.505	0.965
1983-84	0.022	0.188	0.242	0.655
1984-85	0.091	0.204	0.205	0.320
1985-86	0.306	0.310	0.427	0.480
1986-87	0.516	0.996	0.149	0.260
1987-88	0.683	0.854	0.933	0.239
1988-89	0.799	-	0	-

Regression of:

Column (2) on (1), $r^2 = 0.704$ ($p < 0.01$), n=13
Column (4) on (3), $r^2 = 0.055$, n = 13

Newfoundland - Labrador
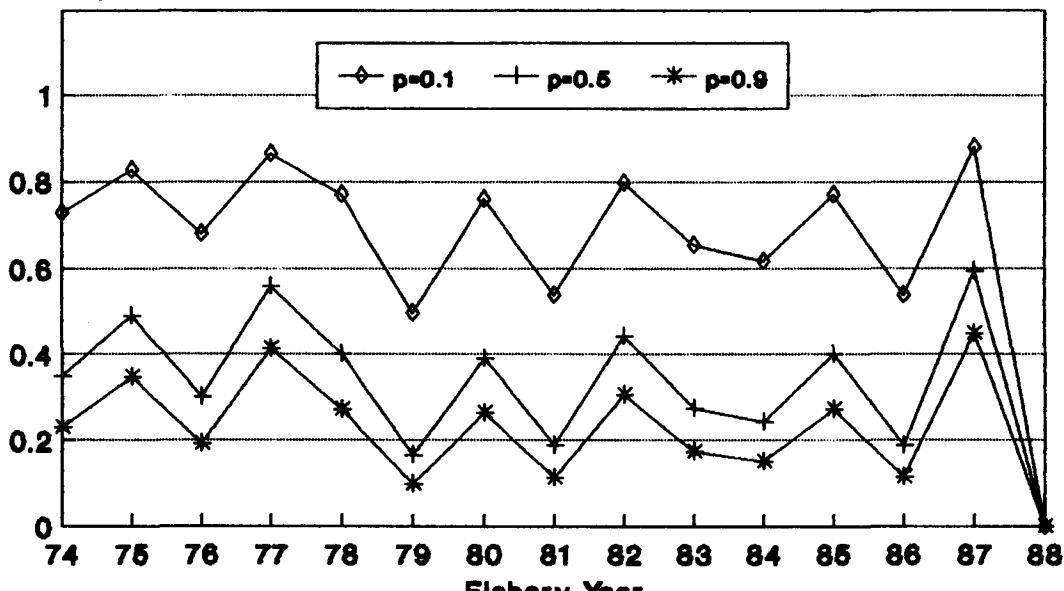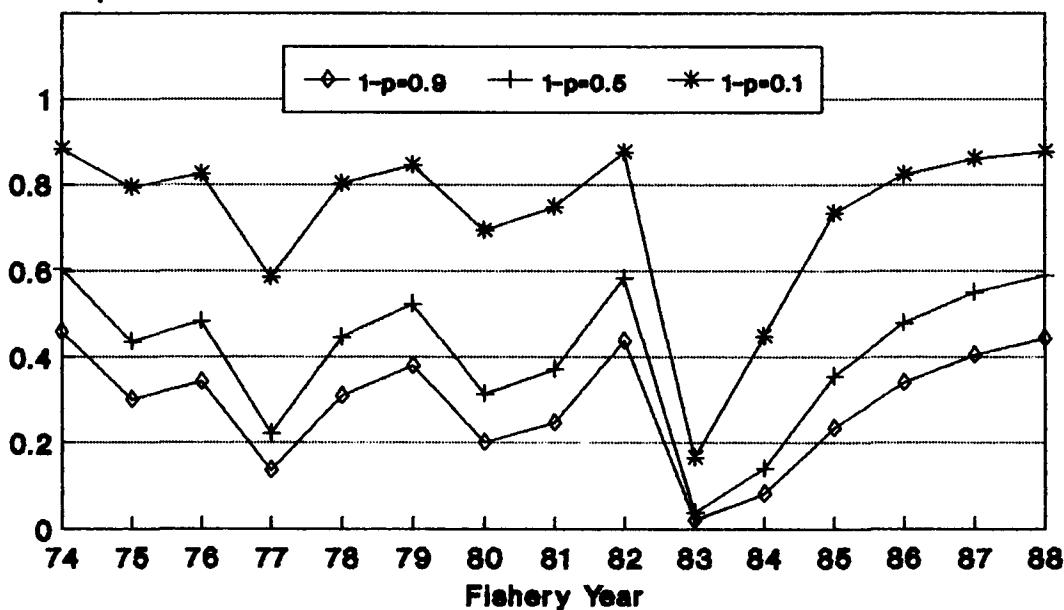
West Greenland

Fig. 1. Estimated exploitation rates of the West Greenland and Newfoundland-
Labrador fisheries, 1974-1988, on non-maturing 1SW salmon originating
at and above Mactaquac, Saint John River, N.B. (p is the proportion of
stock assumed to be returning from the Newfoundland-Labrador fishery;
the remainder of the stock (1-p) is assumed to have returned from the
West Greenland fishery.)

Saint John River and Approach
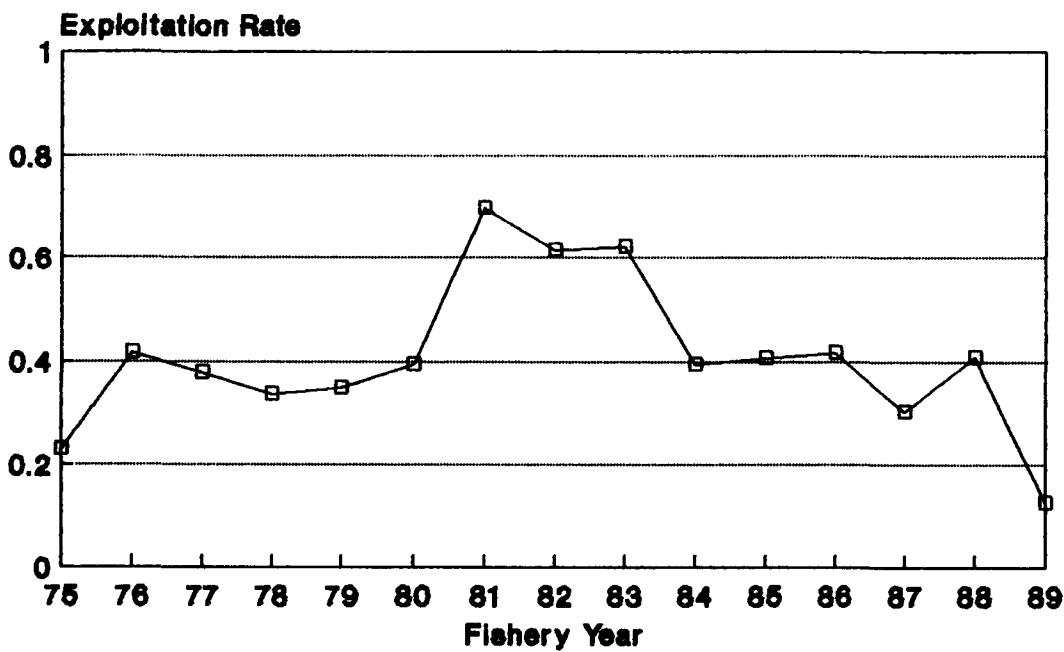
Fig. 2. Estimated exploitation rates of homewater and approach fisheries, 1975-1989, on mature 2SW fish originating at or above Mactaquac, Saint John River, N.B.

App. 1. Tag recoveries in West Greenland, 1974-1988, from non-maturing
1SW salmon of Mactaquac Hatchery orign.

NAFO Areas

Standard Week	1A	1B	1C	1D	1E	1F	UK GRN	TOTAL
26.000	0	0	0	0	0	0	1	1
28.000	0	0	0	0	0	0	1	1
29.000	0	0	4	1	0	0	0	5
30.000	0	0	4	1	0	0	0	5
31.000	0	14	16	1	1	1	5	38
32.000	1	9	10	4	0	1	5	30
33.000	0	8	18	7	2	2	7	44
34.000	5	5	9	10	1	1	5	36
35.000	6	10	9	7	5	2	3	42
36.000	6	10	3	4	1	0	3	27
37.000	3	5	3	0	0	0	6	17
38.000	4	4	1	1	0	0	3	13
40.000	0	0	2	0	0	0	2	4
41.000	0	0	0	0	0	0	1	1
45.000	0	0	0	0	0	0	1	1
46.000	0	0	0	0	0	0	3	3
53.000	3	33	6	4	2	1	48	97
TOTAL	28	98	85	40	12	8	94	365

App. 2.   Tag recoveries in West Greenland, 1974, from non-maturing
1SW salmon of Mactaquac Hatchery orign.

NAFO Areas

Standard Week	1A	1B	1C	1D	1E	1F	UK GRN	TOTAL
28.000	0	0	0	0	0	0	1	1
29.000	0	0	2	0	0	0	0	2
30.000	0	0	2	1	0	0	0	3
31.000	0	1	3	0	1	0	0	5
32.000	0	0	1	3	0	1	0	5
33.000	0	1	1	4	1	1	0	8
34.000	1	0	5	3	0	1	1	11
35.000	3	3	3	0	0	0	1	10
36.000	0	0	0	0	1	0	1	2
37.000	0	0	0	0	0	0	2	2
38.000	1	0	0	0	0	0	2	3
40.000	0	0	0	0	0	0	2	2
53.000	0	8	3	4	0	0	23	38
TOTAL	5	13	20	15	3	3	33	92

App. 2. (Cont'd; 1975)

NAFO Areas

Standard Week	1A	1B	1C	1D	1E	UK GRN	TOTAL
29.000	0	0	1	1	0	0	2
30.000	0	0	2	0	0	0	2
31.000	0	0	0	1	0	0	1
33.000	0	0	1	0	0	1	2
34.000	0	0	0	1	0	0	1
35.000	1	1	1	0	0	0	3
36.000	0	1	0	0	0	1	2
37.000	0	0	0	0	0	3	3
53.000	0	0	0	0	1	6	7
TOTAL	1	2	5	3	1	11	23

App. 2. (Cont'd;1976)

NAFO Areas

Standard Week	1A	1B	1C	1D	1F	UK GRN	TOTAL
29.000	0	0	1	0	0	0	1
33.000	0	0	8	2	1	0	11
34.000	1	0	1	0	0	0	2
35.000	1	0	0	0	0	1	2
36.000	6	1	0	0	0	1	8
37.000	2	0	1	0	0	0	3
38.000	1	0	0	0	0	0	1
45.000	0	0	0	0	0	1	1
46.000	0	0	0	0	0	3	3
53.000	0	7	0	0	0	1	8
TOTAL	11	8	11	2	1	7	40

App. 2. (Cont'd; 1977)

NAFO Areas

Std Week	1A	1B	1C	UK GRN	TOTAL
33.000	0	1	0	0	1
35.000	1	0	1	0	2
37.000	0	0	1	0	1
53.000	0	0	0	3	3
TOTAL	1	1	2	3	7

App. 2. (Cont'd; 1978)

NAFO Areas

Std Week	1B	1C	UK GRN	TOTAL
33.000	0	1	0	1
38.000	0	0	1	1
53.000	11	0	1	12
TOTAL	11	1	2	14

App. 2. (Cont'd; 1979)

NAFO Areas

Standard Week	1A	1B	1C	1D	UK GRN	TOTAL
31.000	0	12	12	0	2	26
32.000	1	9	9	1	2	22
33.000	0	6	3	1	1	11
34.000	3	2	1	1	1	8
35.000	0	2	1	1	0	4
36.000	0	1	0	1	0	2
37.000	1	0	0	0	1	2
38.000	1	0	0	1	0	2
53.000	2	0	0	0	5	7
TOTAL	8	32	26	6	12	84

App. 2. (Cont'd; 1980)

	NAFO Areas			
Standard Week	1B	1C	UK GRN	TOTAL
26.000	0	0	1	1
31.000	0	1	3	4
32.000	0	0	3	3
33.000	0	2	5	7
34.000	0	1	3	4
35.000	0	0	1	1
36.000	1	0	0	1
37.000	1	0	0	1
41.000	0	0	1	1
53.000	1	0	3	4
TOTAL	3	4	20	27

App. 2. (Cont'd; 1981)

	NAFO Areas			
Std Week	1B	1D	UK GRN	TOTAL
35.000	0	1	0	1
53.000	5	0	5	10
TOTAL	5	1	5	11

App. 2. (Cont'd; 1982)

	NAFO Areas		
Standard Week	1B	1C	TOTAL
35.000	0	1	1
36.000	4	0	4
37.000	4	0	4
38.000	2	0	2
53.000	0	1	1
TOTAL	10	2	12

App. 2. (Cont'd; 1983)

NAFO Area

Std Week		1C	TOTAL
	38.000	1	1
	TOTAL	1	1

App. 2. (Cont'd; 1984)

NAFO Areas

Std Week		1B	1C	TOTAL
	35.000	0	1	1
	38.000	1	0	1
	53.000	1	0	1
	TOTAL	2	1	3

App. 2 (Cont'd; 1985)

NAFO Areas

Standard Week		1A	1B	1C	1E	UK GRN	TOTAL
	31.000	0	1	0	0	0	1
	33.000	0	0	1	0	0	1
	34.000	0	1	0	0	0	1
	38.000	1	0	0	0	0	1
	53.000	1	0	1	1	1	4
	TOTAL	2	2	2	1	1	8

App. 2. (Cont'd; 1986)

NAFO Areas

Standard Week	1B	1C	1D	1E	1F	TOTAL
33.000	0	1	0	1	0	2
34.000	1	0	4	1	0	6
35.000	1	0	4	2	0	7
36.000	1	0	0	0	0	1
53.000	0	1	0	0	1	2
TOTAL	3	2	8	4	1	18

App. 2. (Cont'd; 1987)

NAFO Areas

Standard Week	1B	1C	1D	1E	1F	TOTAL
34.000	0	1	1	0	0	2
35.000	3	1	1	2	2	9
36.000	1	3	1	0	0	5
38.000	1	0	0	0	0	1
TOTAL	5	5	3	2	2	17

App. 2. (Cont'd; 1988)

NAFO Areas

Standard Week	1B	1C	1D	1E	1F	TOTAL
31.000	0	0	0	0	1	1
34.000	1	0	0	0	0	1
35.000	0	0	0	1	0	1
36.000	0	0	2	0	0	2
37.000	0	1	0	0	0	1
40.000	0	2	0	0	0	2
TOTAL	1	3	2	1	1	8

App. 3. Tag recoveries in Newfoundland-Labrador, 1974-1988, from non-maturing 1SW salmon of Mactaquac Hatchery origin.

Statistical Areas

Standard Week	A	B	C	D	E	F	G	H	I	J	N	O	UK	TOTAL
20.000	0	0	0	0	0	4	0	0	0	0	0	0	0	4
21.000	0	0	1	0	0	0	0	1	0	0	0	0	0	2
22.000	0	0	5	0	1	0	0	0	0	0	0	0	0	6
23.000	2	2	5	2	1	7	0	0	1	0	0	0	1	21
24.000	1	3	5	3	2	0	0	1	1	0	1	0	0	17
25.000	5	9	6	2	2	0	0	1	2	1	0	0	0	28
26.000	11	9	3	2	4	0	0	2	0	0	0	5	0	36
27.000	18	3	5	3	3	2	2	2	2	2	1	7	0	50
28.000	23	2	1	2	1	0	1	2	1	0	0	12	0	45
29.000	12	6	1	2	3	0	0	1	0	0	0	2	0	26
30.000	13	2	0	1	2	0	0	0	2	0	0	4	1	25
31.000	1	0	0	0	0	0	0	0	0	0	0	2	0	3
32.000	2	0	0	2	0	0	0	0	0	0	0	5	0	9
33.000	1	0	0	1	0	0	0	0	0	0	0	1	0	3
35.000	2	0	0	0	0	0	0	0	0	0	0	2	0	4
36.000	0	0	0	0	0	0	0	0	0	0	0	5	0	5
37.000	0	0	0	0	0	0	0	0	0	0	0	2	0	2
38.000	0	0	0	0	0	0	0	0	0	0	0	2	0	2
40.000	0	0	0	0	0	1	0	0	0	0	0	0	0	1
41.000	0	1	0	0	0	0	0	0	0	0	0	0	0	1
42.000	0	1	0	0	0	0	0	0	0	0	0	0	0	1
43.000	1	5	0	0	0	0	0	0	0	0	0	0	0	6
44.000	0	4	1	0	0	0	0	0	0	0	0	0	0	5
45.000	0	1	1	0	0	0	0	0	0	0	0	0	0	2
46.000	0	2	1	0	0	0	0	0	0	0	0	0	0	3
47.000	0	1	1	0	0	0	0	0	0	0	0	0	0	2
53.000	3	2	0	1	2	0	0	0	0	0	0	7	1	16
TOTAL	95	53	36	21	21	14	5	10	9	3	2	57	3	327

App. 4. Tag recoveries in Newfoundland-Labrador, 1974, from non-maturing
         1SW salmon of Mactaquac Hatchery origin.

Statistical Areas

Standard Week	A	B	C	D	O	OTH	UK	TOTAL
20.000	0	0	0	0	0	1	0	1
21.000	0	0	0	0	0	1	0	1
23.000	0	0	0	0	0	3	1	4
24.000	0	0	0	2	0	2	0	4
26.000	0	0	0	0	0	3	0	3
27.000	0	0	0	1	0	3	0	4
28.000	0	0	0	1	1	4	0	6
29.000	1	1	0	0	0	2	0	4
32.000	0	0	0	1	1	0	0	2
33.000	1	0	0	0	0	0	0	1
36.000	0	0	0	0	2	0	0	2
43.000	0	1	0	0	0	0	0	1
46.000	0	1	1	0	0	0	0	2
TOTAL	2	3	1	5	4	19	1	35

App. 4. (Cont'd; 1975)

Statistical Areas

Standard Week	B	C	D	O	OTH	TOTAL
22.000	0	1	0	0	0	1
23.000	0	3	0	0	1	4
24.000	0	1	1	0	1	3
25.000	0	1	1	0	1	3
26.000	1	1	0	0	3	5
27.000	0	2	0	0	1	3
28.000	0	0	0	1	0	1
30.000	1	0	0	0	0	1
35.000	0	0	0	1	0	1
36.000	0	0	0	1	0	1
44.000	1	0	0	0	0	1
45.000	0	1	0	0	0	1
53.000	0	0	0	2	1	3
TOTAL	3	10	2	5	8	28

App. 4. (Cont'd; 1976)

Statistical Areas

Standard Week	A	B	C	D	O	OTH	UK	TOTAL
23.000	0	0	1	0	0	0	0	1
24.000	0	0	0	0	0	1	0	1
25.000	0	0	1	0	0	0	0	1
26.000	1	2	1	0	3	0	0	7
27.000	0	0	1	0	1	1	0	3
28.000	0	0	1	0	1	1	0	3
29.000	0	1	1	0	1	1	0	4
30.000	2	0	0	0	0	0	1	3
31.000	1	0	0	0	0	0	0	1
33.000	0	0	0	1	1	0	0	2
53.000	1	0	0	0	1	0	0	2
TOTAL	5	3	6	1	8	4	1	28

App. 4. (Cont'd; 1977)

Statistical Areas

Standard Week	A	B	C	D	O	OTH	TOTAL
20.000	0	0	0	0	0	1	1
21.000	0	0	1	0	0	0	1
22.000	0	0	1	0	0	0	1
23.000	1	1	0	2	0	2	6
24.000	0	1	1	0	0	1	3
25.000	0	3	0	1	0	0	4
26.000	0	0	0	0	1	0	1
27.000	7	1	1	2	1	2	14
28.000	4	1	0	0	1	0	6
30.000	0	0	0	0	3	0	3
32.000	0	0	0	0	1	0	1
35.000	0	0	0	0	1	0	1
42.000	0	1	0	0	0	0	1
44.000	0	1	1	0	0	0	2
53.000	0	0	0	0	1	0	1
TOTAL	12	9	5	5	9	6	46

App. 4. (Cont'd; 1978)

Statistical Areas

Standard Week	A	C	O	OTH	UK	TOTAL
25.000	0	1	0	2	0	3
26.000	2	0	0	0	0	2
27.000	2	0	1	0	0	3
28.000	6	0	0	0	0	6
29.000	1	0	0	0	0	1
30.000	0	0	1	0	0	1
53.000	0	0	1	0	1	2
TOTAL	11	1	3	2	1	18

App. 4. (Cont'd; 1979)

Statistical Areas

Standard Week	A	B	C	D	O	OTH	TOTAL
22.000	0	0	1	0	0	1	2
24.000	0	1	0	0	0	0	1
25.000	1	0	1	0	0	2	4
26.000	0	1	0	1	0	0	2
27.000	0	0	0	0	2	0	2
28.000	2	0	0	0	1	0	3
29.000	2	0	0	0	0	0	2
31.000	0	0	0	0	2	0	2
32.000	1	0	0	0	0	0	1
36.000	0	0	0	0	1	0	1
37.000	0	0	0	0	1	0	1
53.000	2	0	0	0	0	1	3
TOTAL	8	2	2	1	7	4	24

App. 4. (Cont'd; 1980)

Statistical Areas

Standard Week	A	B	C	O	O	OTH	TOTAL
20.000	0	0	0	0	0	1	1
22.000	0	0	1	0	0	0	1
23.000	0	1	0	0	0	0	1
24.000	0	1	1	0	0	0	2
25.000	4	4	1	0	0	0	9
26.000	8	2	1	0	1	0	12
27.000	6	2	0	0	1	0	9
28.000	9	1	0	0	3	0	13
29.000	7	1	0	0	1	0	9
30.000	8	1	0	1	0	1	11
35.000	1	0	0	0	0	0	1
43.000	0	2	0	0	0	0	2
44.000	0	1	0	0	0	0	1
45.000	0	1	0	0	0	0	1
46.000	0	1	0	0	0	0	1
47.000	0	1	0	0	0	0	1
53.000	0	1	0	0	2	0	3
TOTAL	43	20	4	1	8	2	78

App. 4. (Cont'd; 1981)

Statistical Areas

Standard Week	B	C	O	OTH	TOTAL
20.000	0	0	0	1	1
22.000	0	1	0	0	1
23.000	0	1	0	0	1
25.000	2	0	0	0	2
28.000	0	0	2	0	2
47.000	0	1	0	0	1
TOTAL	2	3	2	1	8

App. 4. (Cont'd; 1982)

Statistical Areas

Standard Week	B	D	O	OTH	TOTAL
27.000	0	0	0	4	4
28.000	0	1	0	0	1
29.000	1	0	1	0	2
32.000	0	0	1	0	1
38.000	0	0	1	0	1
53.000	1	0	0	0	1
TOTAL	2	1	3	4	10

App. 4. (Cont'd; 1983)

Statistical Areas

Standard Week	A	B	C	O	OTH	TOTAL
24.000	1	0	0	0	0	1
26.000	0	2	0	0	0	2
27.000	1	0	1	1	1	4
28.000	1	0	0	1	0	2
29.000	0	1	0	0	0	1
TOTAL	3	3	1	2	1	10

App. 4. (Cont'd; 1984)

Statistical Areas

Standard Week	A	D	OTH	TOTAL
27.000	1	0	1	2
29.000	1	1	0	2
30.000	1	0	0	1
53.000	0	1	0	1
TOTAL	3	2	1	6

App. 4. (Cont'd; 1985)

Statistical Areas

Standard Week	A	B	D	O	OTH	TOTAL
27.000	0	0	0	0	1	1
29.000	0	0	0	0	1	1
30.000	0	0	0	0	1	1
32.000	0	0	1	0	0	1
37.000	0	0	0	1	0	1
41.000	0	1	0	0	0	1
43.000	1	2	0	0	0	3
44.000	0	1	0	0	0	1
TOTAL	1	4	1	1	3	10

App. 4. (Cont'd; 1986)

Statistical Areas

Std Week	A	D	O	OTH	TOTAL
26.000	0	1	0	0	1
30.000	1	0	0	1	2
32.000	0	0	1	0	1
36.000	0	0	1	0	1
TOTAL	1	1	2	1	5

App. 4. (Cont'd; 1987)

Statistical Area

Standard Week	A	B	C	D	O	OTH	TOTAL
23.000	1	0	0	0	0	3	4
24.000	0	0	2	0	0	0	2
25.000	0	0	1	0	0	1	2
26.000	0	1	0	0	0	0	1
27.000	1	0	0	0	0	0	1
28.000	1	0	0	0	1	0	2
29.000	0	1	0	1	0	0	2
30.000	1	0	0	0	0	1	2
32.000	1	0	0	0	1	0	2
35.000	1	0	0	0	0	0	1
38.000	0	0	0	0	1	0	1
40.000	0	0	0	0	0	1	1
TOTAL	6	2	3	1	3	6	21

App. 4. (Cont'd; 1988 —no returns)