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Size, Distribution and Significance of the Commercial By-Catch of Atlantic Salmon (*Salmo salar* L.) in Mainland Nova Scotia

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Halifax, Nova Scotia

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Fisheries and Aquatic Sciences No. 1583

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SIZE, DISTRIBUTION AND SIGNIFICANCE
OF THE COMMERCIAL BY-CATCH OF ATLANTIC SALMON
(*Salmo salar* L.) IN MAINLAND NOVA SCOTIA

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ABSTRACT

Gray, R.W., D.L. Morantz and J.D. Cameron. 1980. Size, distribution and significance of the commercial by-catch of Atlantic salmon (*Salmo salar* L.) in mainland Nova Scotia. Can. MS Rep. Fish. Aquat. Sci. No. 1583 ix + 39 p.

The average annual by-catch of Atlantic salmon in mainland Nova Scotia is estimated to range between 15,203 kg and 48,000 kg, depending on the data source utilized. About 73% of this by-catch is taken at five locations - Herring Cove-Pennant, St. Margaret's Bay-Mahone Bay, Morden-Hall's Harbour, Little Harbour and Ecum Secum. Multi-species commercial fish traps are responsible for 55.6% of the mainland by-catch, while herring weirs, surface gill nets and groundfish gill nets account for 20.0%, 14.2% and 9.4%, respectively. The distribution and impact of specific non-salmon gear on Atlantic salmon in each salmon management zone is described. By-catch consists mainly of Nova Scotia salmon stocks; however, a small proportion, roughly 10%, is of Saint John River origin. Results of the 1978 St. Margaret's Bay by-catch study are presented.

Key words: By-catch, Atlantic salmon, salmon management zone, inshore commercial fishing gear distribution, gear impact, critical by-catch areas, by-catch stock origin.

RÉSUMÉ

Gray, R.W., D.L. Morantz and J.D. Cameron. 1980. Size, distribution and significance of the commercial by-catch of Atlantic salmon (*Salmo salar* L.) in mainland Nova Scotia. Can. MS Rep. Fish. Aquat. Sci. No. 1583 ix + 39 p.

On estime que les prises fortuites de saumon atlantique en Nouvelle-Écosse continentale se situent en moyenne entre 15 203 kg et 48 000 kg par année. Environ 73% de ces prises se font dans cinq secteurs: Herring Cove-Pennant, St. Margaret's Bay-Mahone Bay, Morden-Hall's Harbour, Little Harbour et Ecum Secum. Les trappes commerciales à espèces multiples sont responsables pour 55,6% des prises fortuites près des côtes de la Nouvelle-Écosse mis à part le Cap Breton, alors que les parcs à hareng, les filets maillants de surface et les filets maillants à poissons de fond en capturent respectivement 20,0%, 14,2% et 9,4%. On décrit la répartition et l'impact d'engins spécifiques, qui ne sont pas des engins de pêche du saumon, dans chaque zone de gestion du saumon. Les prises fortuites proviennent en grande partie des stocks de saumons de la Nouvelle-Écosse; cependant, une faible proportion, à peu près 10%, provient de la rivière Saint-Jean. On présente les résultats de l'étude effectuée sur les prises fortuites de St. Margaret's Bay en 1978.

Mots-clés: Prises fortuites, saumon atlantique, zone de gestion du saumon, répartition des engins de pêche commerciaux, impact des engins de pêche, régions de prises fortuites critiques, stock d'origine des prises fortuites.

INTRODUCTION

The capture of Atlantic salmon (*Salmo salar* L.) in gear licensed for other species, referred to as salmon by-catch, has occurred since fishermen began harvesting the inshore coastal areas of the Atlantic Region. Although such catches have been recognized for at least two decades, good documentation has been lacking. However, even the available conservative estimates have identified by-catch as a major source of salmon exploitation and consequently a serious problem for fishery managers. Despite this, fishery managers often overlooked conflicting resource-exploitation practices in the past because of their complexity and the economic instability of the inshore fishery. As downtrends in salmon stocks were identified in mainland Nova Scotia and as more restrictive fishery regulations were imposed on licensed salmon-resource users, pressure has mounted for managers to review the by-catch problem and to undertake practical, alternative, inshore fishing strategies to minimize such resource-harvesting conflicts.

The salmon by-catch problem is not restricted to mainland Nova Scotia but occurs widely throughout the Atlantic Region. Reddin (1978) estimated from survey data that about 30% of the total Newfoundland salmon catch was taken in non-salmon gear. A review in northeastern New Brunswick (Peppar, pers. comm.)¹ indicated that significant salmon by-catches were taken in areas of known salmon migration.

In fact, these by-catches were implicated as one of the major factors which hampered stock recovery in certain New Brunswick rivers following implementation of the selective commercial salmon-fishing ban in 1972 (Gray 1979). Although not widely reported, other areas such as Prince Edward Island and Cape Breton also have by-catch problems.

This report describes the size, distribution and significance of salmon by-catches in mainland Nova Scotia, based on previously published catch statistics, data collected from survey questionnaires, intradepartmental discussions and field investigations.

¹Peppar, J.L. Biologist. Freshwater and Anadromous Division, Resource Branch, Department of Fisheries and Oceans, Halifax, Nova Scotia.

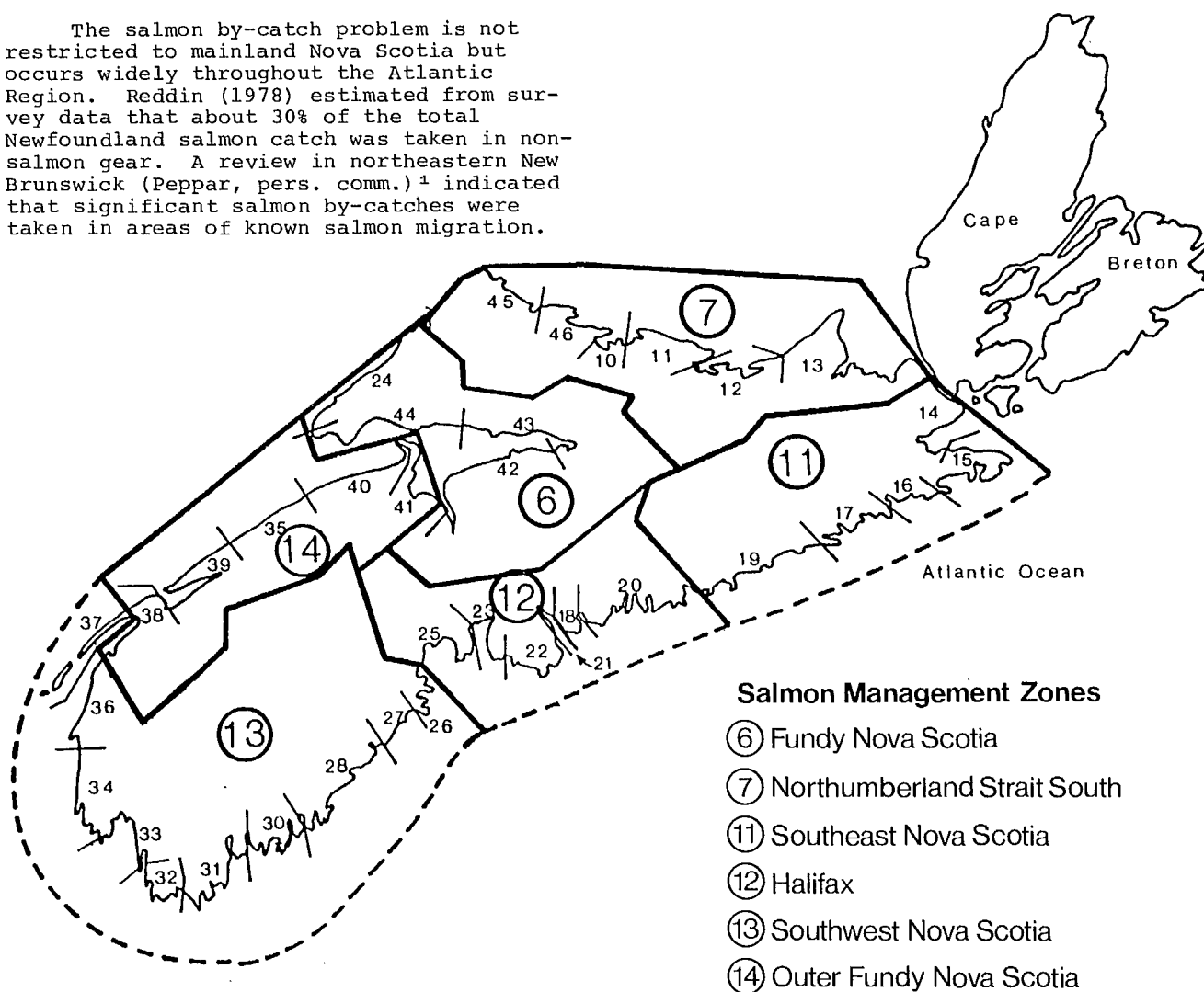


FIG. 1. Relationship between statistical districts and salmon management zones in mainland Nova Scotia.

MATERIALS AND METHODS

The data presented in this report are summarized for each of six salmon management zones in mainland Nova Scotia. Although the zonal concept (Fig. 1) is new, data can be compared with those presented in departmental statistical reports or "red books", by collating information from individual statistical districts.

As this review progressed, it became evident that by-catches were concentrated at five specific areas within these salmon management zones. These critical areas were Ecum Secum, Little Harbour, Herring Cove-Pennant, St. Margaret's Bay-Mahone Bay and Morden-Hall's Harbour; data for these areas were separated in the tables of this report to identify where the major by-catch problems occur and to simplify the task of designing alternative fishing strategies.

Survey questionnaires (Appendix A) were distributed to individual, non-salmon, commercial fishermen in several areas of mainland Nova Scotia: (1) Canso and Ecum Secum in southeast Nova Scotia, (2) Little Harbour, (3) Herring Cove-Pennant, (4) St. Margaret's Bay-Mahone Bay, (5) Morden-Hall's Harbour in Kings County and (6) Queens and Shelburne counties in southwest Nova Scotia. A total of 233 questionnaires were distributed to non-salmon commercial fishermen either by mail-out or personal delivery. All multi-species commercial fish-trap licenses in southeast Nova Scotia, Halifax County and Queens and Shelburne counties of southwest Nova Scotia were sampled by mail-out questionnaires. In addition, commercial fishermen licensed for other gear types were selected as a result of discussions with local fishery officers, who identified individuals who had caught salmon in the past while fishing for other species. A follow-up questionnaire was sent to fishermen who did not respond to the original request, and in critical areas such as Herring Cove-Pennant and St. Margaret's Bay-Mahone Bay, a third follow-up survey questionnaire was distributed to those who failed to respond to either the first or second. This approach provided good coverage of multi-species, commercial fish traps and an overview of other gear types purportedly catching salmon.

A more detailed survey questionnaire (Appendix B) was mailed to each local federal fishery officer in mainland Nova Scotia, to collect data on salmon by-catch and to receive input on possible alternative inshore-fishing strategies. These data, together with information received from federal fishery officers at a series of intradepartmental meetings held in January 1978, were used in various parts of this report.

Field studies were carried out in St. Margaret's Bay by three summer students from late May to July 30, 1978. The study area was divided into two sections because of its size; each section was sampled on

alternate days of the week, excluding weekends. Data were collected by interviewing fishermen, fishery officers and fish buyers, direct observation of fishing operations, biological sampling of Atlantic salmon catches, and documenting the location of fishing gear.

Other data sources used in this report include: (i) Departmental statistical reports or "red books" on commercial catches, published by the Freshwater and Anadromous Division, (ii) multi-species commercial fish-trap logs from St. Margaret's Bay, submitted to the Department on a voluntary basis each year, and (iii) catch statistics compiled by the Statistics Branch in each district.

RESULTS AND DISCUSSION

QUESTIONNAIRE RESPONSE

Out of a total of 233 questionnaires distributed to individual non-salmon commercial fishermen, 129 (55.4%) were returned (Table 1). Non-salmon commercial fishermen at Herring Cove-Pennant and St. Margaret's Bay-Mahone Bay, both high by-catch areas, exhibited a poor response rate; whereas the response rates at Ecum Secum, Little Harbour and Morden-Hall's Harbour, also high by-catch areas, were excellent (Table 1).

Federal fishery officers exhibited a 93.3% response rate; of 30 questionnaires distributed, responses were received from all districts except two, Districts 38 and 39.

DATA ACCURACY

While the information obtained from commercial fishermen could not be used to calculate an estimate of salmon by-catch, it did provide useful data on the economic importance of by-catch to individual fishermen, their harvest strategies and their reaction to by-catch control. Data provided by federal fishery officers from questionnaires generally agreed with existing departmental statistical reports.

Data for these statistical reports are obtained from three sources: a) purchase slips, voluntarily submitted by fish buyers; b) supplementary "B" purchase slips, which are estimates by fishery officers of quantities landed but not covered by regular purchase slips; and c) weekly effort reports, also provided by fishery officers. The reports are compiled annually and represent conservative estimates of salmon landings. This is particularly true for salmon taken as a by-catch, since they can be disposed of quickly and profitably on the wharf without any record of transactions, thus avoiding the need to declare this revenue for income tax purposes or present an appearance that by-catches are significant enough to warrant greater regulatory control. When questioned about the accuracy of salmon by-catch statistics, federal

TABLE 1. Response of non-salmon commercial fishermen to survey questionnaire distributed in Salmon Management Zones 11-14.

Salmon management zone	Zone number	Statistical districts	Questionnaire response		
			Number distributed	Number returned	Response rate (%)
<u>Southeast Nova Scotia</u>	11	14-17, 19	120	73	60.8
<u>Ecum Secum</u>			7	6	85.7
<u>Halifax</u>	12	18, 20-23, 25	83	38	45.8
<u>Little Harbour</u>			2	2	100.0
<u>Herring Cove-Pennant</u>			13	6	46.1
<u>St. Margaret's Bay-Mahone Bay</u>			68	30	44.1
<u>Southwest Nova Scotia</u>	13	26-28, 30-34, 36, 37	26	14	53.8
<u>Queen's-Shelburne County</u>			26	14	53.8
<u>Outer Fundy Nova Scotia</u>	14	35, 38-41	4	4	100.0
<u>Morden-Hall's Harbour</u>			4	4	100.0

fishery officers indicated that records of by-catch were accurate in areas of low by-catches; however, they suggested that data from areas of high by-catch were normally conservative.

Fishery officers were requested to comment on how these catch statistics could be improved. A number of responses indicated that fishermen were reluctant to provide actual fish landings to an enforcement arm of fishery management. Almost 75% of the fishery officers rejected the use of fishermen's log books to collect statistics because of the additional workload this would cause both fishermen and fishery officers and the difficulty entailed in verifying log-book data. Generally, responses indicated that without enforcement of Section 48 of the Fisheries Act, requiring declaration of catches, it would be difficult to obtain accurate catch data regardless of the methodology implemented.

ESTIMATED SALMON BY-CATCH

Estimates of by-catch derived from three different data sources are conflicting and point out the inadequacies of the present statistics collection system. The data presented below outline the magnitude of salmon by-catch in mainland Nova Scotia and provide an overview estimate of by-catch. However, the level of harvest could be 1-2 times higher in certain critical areas because of non-reporting.

The data on by-catch supplied by non-salmon commercial fishermen could not be used to derive an overall estimate of by-catch in mainland Nova Scotia. Initially it was planned to extrapolate data based on response rate and catch by gear type. However, on examination, it became evident that this approach was not valid for several reasons. These include the small sample size of surface and groundfish gill nets, differences in gear selectivity and efficiency from location to location, misinterpretation of the question on landings

by some fishermen, and submission of questionable catch information or the low response rate from fishermen in certain critical areas of known high by-catch. Nevertheless, the survey question on catches did provide insight into the significance of the by-catches involved. Also, the information from certain areas reinforced previous suspicions regarding the validity of present catch statistics. For example, at Ecum Secum, six of the multi-species fish-trap operators sampled indicated they caught 1,139 kg and 2,440 kg in 1977 and 1978, respectively; whereas departmental statistical reports recorded catches for that area of only 380 kg and 572 kg in all fishing gear, or less than one-third the landings reported by fishermen themselves (Table 2).

Estimates of salmon by-catch for the 1974-78 period, as collated in departmental statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979) for six salmon management zones of mainland Nova Scotia, are summarized (Table 2). According to these reports, salmon by-catch in mainland Nova Scotia during this period ranged from 9,826 kg-20,978 kg, with an average of 15,203 kg landed annually. These estimates are considered to be conservative for the reasons explained earlier in this report.

The data supplied by federal fishery officers in the catch-information section of their survey questionnaire suggest that salmon by-catch in mainland Nova Scotia ranged from 13,310 kg to 21,560 kg during the period 1977-78, with an average annual by-catch of 17,435 kg for these two years (Table 3). As expected, these estimates of by-catch corroborate those recorded in departmental statistical reports, since fishery officers estimated landings of salmon based on fish they had seen or that were reported to them by non-salmon commercial fishermen.

However, federal fishery officers, recognizing the difficulties and short-

TABLE 2. Salmon by-catch reported in each salmon management zone of mainland Nova Scotia, 1974-78¹.

Salmon management zone	Zone number	Salmon by-catch (kg)					x	SD
		1974	1975	1976	1977	1978		
<u>Fundy Nova Scotia</u>	6	619	361	220	285	248	347	161.2
<u>Northumberland Strait South</u>	7	0	159	0	0	611	154	264.6
<u>Southeast Nova Scotia</u>	11	1,004	2,727	1,426	1,158	1,493	1,562	681.0
<u>Ecum Secum</u>		326	866	443	380	572	517	215.4
<u>Halifax</u>	12	6,599	10,311	4,426	13,650	9,255	8,848	3,534.7
<u>Little Harbour</u>		1,836	2,123	1,275	1,644	1,520	1,680	320.7
<u>Herring Cove-Pennant</u>		335	4,057	922	4,461	4,905	2,936	2,137.8
<u>St. Margaret's Bay-Mahone Bay</u>		3,838	3,460	1,827	7,026	2,830	3,796	1,959.4
<u>Southwest Nova Scotia</u>	13	1,248	1,784	800	2,627	1,737	1,639	682.6
<u>Outer Fundy Nova Scotia</u>	14	2,268	3,593	2,954	3,258	1,196	2,654	950.2
<u>Morden-Hall's Harbour</u>		2,028	3,413	2,438	2,725	985	2,318	900.0
<u>Total, Mainland Nova Scotia</u>		11,738	18,935	9,826	20,978	14,540	15,203	4,707.3

¹Statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979).

TABLE 3. Estimates of salmon by-catch summarized from federal fishery officers' survey questionnaires and intradepartmental meetings held in January 1978. (Numbers in parentheses are percentages of large salmon.)

Salmon management zone	Zone number	Salmon by-catch (kg)		
		1977 ¹	1977 ²	1978 ²
<u>Fundy Nova Scotia</u>	6	1,510 (85)	270 (27)	300 (19)
<u>Northumberland Strait South</u>	7	45 (100)	70 (71)	140 (79)
<u>Southeast Nova Scotia</u>	11	5,140 (73)	1,060 (64)	1,480 (47)
<u>Ecum Secum</u>		2,992 (68)	340	540
<u>Halifax</u>	12	47,310 (25)	13,190	8,530
<u>Little Harbour</u>		3,629 (8)	1,930	730
<u>Herring Cove-Pennant</u>		22,680 (20)	4,660	3,960
<u>St. Margaret's Bay-Mahone Bay</u>		6,350 (80)	6,460	3,610
<u>Southwest Nova Scotia</u>	13	9,175 (99)	4,160 (93)	1,650 (82)
<u>Outer Fundy Nova Scotia</u>	14	3,260 (90)	2,810	1,210
<u>Morden-Hall's Harbour</u>		2,750 (90)	2,290	1,040
<u>Total, mainland Nova Scotia</u>		66,440 (44)	21,560	13,310

¹Data derived from intradepartmental meetings held in January 1978.

²Survey questionnaire data.

comings of the present statistical collection system, suggest that a large portion of the by-catch is never reported by fishermen on sales slips and is not seen by departmental personnel. Consequently, their annual reports of by-catch are admittedly conservative. A series of intradepartmental meetings was held in January, 1978, to estimate the magnitude of salmon by-catch landings based on fishery officers' experience and knowledge of the inshore fisheries. They

indicated that, although by-catch fluctuates considerably from year to year, in a year such as 1977, salmon by-catch in mainland Nova Scotia could be as high as 66,440 kg (Table 3), or roughly three times that reported in the departmental statistical report for 1977. Extrapolating these data to other years since 1974 suggests that the average annual salmon by-catch in mainland Nova Scotia could be as high as 48,000 kg, as opposed to the 15,203 kg reported.

CHANGES IN SALMON BY-CATCH

Some non-salmon commercial fishermen reported significant declines in salmon by-catch from the pre-1940s to the present. Smaller declines were reported for recent years, excluding 1977, an unusually high by-catch year. For example, in 1977, several fishermen in Queens and Shelburne counties reported catching salmon in groundfish gill nets for the first time ever. Fishery officers, on the other hand, indicated that according to their experience, by-catches were within normal annual fluctuations and without any apparent trend.

In areas where fishing effort and, more particularly, the use of monofilament gill nets have increased in recent years, by-catches have increased – for example, in the Halifax and Southeast Nova Scotia salmon management zones. Thus, while by-catch harvests have probably declined historically, the declines have not paralleled salmon stock declines in the province because of offsetting increases in gear efficiency and effort. Thus, if left uncontrolled, it might be expected that by-catch would take an increasing proportion of the total harvest of Atlantic salmon in mainland Nova Scotia and contribute further to the stock declines presently occurring.

SALMON BY-CATCH DISTRIBUTION BY SALMON MANAGEMENT ZONE

The proportion of the total salmon by-catch taken in each salmon management zone in mainland Nova Scotia, based on landings reported in departmental statistical reports during the period 1974-78 (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979), is outlined (Tables 2 and 4, and Fig. 2).

TABLE 4. Salmon by-catch distribution, expressed as a percentage of the total mainland Nova Scotia by-catch, 1974-78¹.

Salmon management zone	Zone number	Salmon by-catch distribution (%)						
		1974	1975	1976	1977	1978	$\bar{x}$	SD
Fundy Nova Scotia	6	5.3	1.9	2.2	1.4	1.7	2.5	1.59
Northumberland Strait South	7	0.0	0.8	0.0	0.0	4.2	1.0	1.82
Southeast Nova Scotia	11	8.6	14.4	14.5	5.5	10.3	10.7	3.86
Ecum Secum		2.8	4.6	4.5	1.8	3.9	3.5	1.20
Halifax	12	56.2	54.5	45.0	65.1	63.7	56.9	8.08
Little Harbour		15.6	11.2	13.0	7.8	10.5	11.6	2.91
Herring Cove-Pennant		2.9	21.4	9.4	21.3	33.7	17.7	11.94
St. Margaret's Bay-Mahone Bay		32.7	18.3	18.6	33.5	19.5	24.5	7.85
Southwest Nova Scotia	13	10.6	9.4	8.1	12.5	11.9	10.5	1.80
Outer Fundy Nova Scotia	14	19.3	19.0	30.1	15.5	8.2	18.4	7.91
Morden-Hall's Harbour		17.3	18.0	24.8	13.0	6.8	16.0	6.65
Total, mainland Nova Scotia		100.0	100.0	100.0	100.0	100.0	100.0	

¹Calculated from statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979).

The data supplied by federal fishery officers generally corroborates "red book" data with regard to by-catch distribution in the six salmon management zones (Tables 3 and 5).

Average annual by-catch in the Halifax zone was estimated at 8,848 kg or 56.9% (± 8.08) of the average annual mainland by-catch. The second highest by-catch was recorded in the Outer Fundy zone, where 2,654 kg or 18.4% (± 7.91) of the average annual mainland by-catch was taken. Southwest Nova Scotia and Southeast Nova Scotia accounted for 1,639 kg and 1,562 kg, respectively, or roughly 10.5% each of the average annual mainland by-catch; while the Inner Fundy and Northumberland Strait South zones were responsible for smaller proportions, 347 kg (2.5%) and 154 kg (1.0%), respectively, of the average annual mainland by-catch.

Within these zones, five critical areas accounted for at least 73% of the total mainland Nova Scotia by-catch; these critical areas in descending order of impact are: Herring Cove-Pennant, St. Margaret's Bay-Mahone Bay, Morden-Hall's Harbour, Little Harbour and Ecum Secum. These areas probably accounted for an even larger proportion of the total mainland by-catch, since existing statistical records underestimate by-catch landings in these areas. If by-catch was reduced at these critical locations, particularly those on the Atlantic coast which harvest a high proportion of Nova Scotia salmon stocks, a significant number of salmon would be released for spawning, which would subsequently enhance stock recovery in mainland rivers.

RELATIONSHIP BETWEEN LANDINGS IN SALMON VERSUS NON-SALMON GEAR

Proportionally, salmon landings in

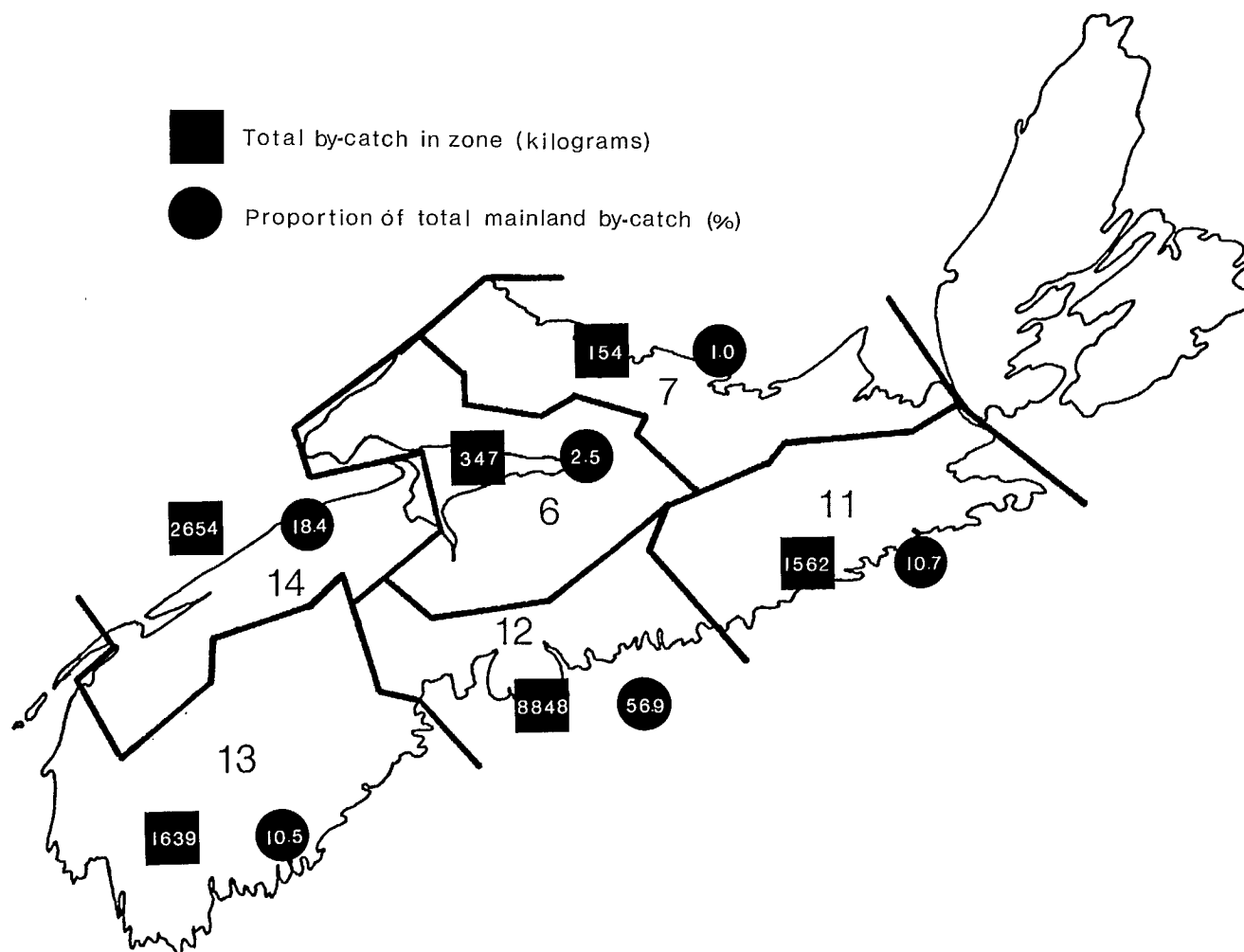


FIG. 2. Size and proportion of the average annual mainland Nova Scotia by-catch taken in each salmon management zone, 1974-78.

TABLE 5. Salmon by-catch distribution, expressed as a percentage of the total mainland Nova Scotia by-catch as reported by federal fishery officers.

Salmon management zone	Zone number	Salmon by-catch distribution (%)		
		1977 ¹	1977 ²	1978 ²
<u>Fundy Nova Scotia</u>	6	2.3	1.2	2.3
<u>Northumberland Strait South</u>	7	0.1	0.3	1.1
<u>Southeast Nova Scotia</u>	11	7.7	4.9	11.1
<u>Ecum Secum</u>		4.5	1.6	4.1
<u>Halifax</u>	12	71.2	61.2	64.0
<u>Little Harbour</u>		5.5	8.9	5.5
<u>Herring Cove-Pennant</u>		34.1	21.6	29.7
<u>St. Margaret's Bay-Mahone Bay</u>	13	9.6	30.0	27.1
<u>Southwest Nova Scotia</u>	13	13.8	19.3	12.4
<u>Outer Fundy Nova Scotia</u>	14	4.9	13.0	9.1
<u>Morden-Hall's Harbour</u>		4.1	10.6	7.8

¹Data calculated from information provided at the January, 1978, meetings.

²Data calculated from survey questionnaires.

TABLE 6. Salmon landings in licensed salmon gear and non-salmon gear in each salmon management zone, 1974-1978¹.
(Figures in parentheses represent percentage of annual salmon landings taken in each type of gear.)

Salmon management zone	Zone number	Salmon landings (kg)					x	SD
		1974	1975	1976	1977	1978		
<u>Fundy Nova Scotia</u>	6							
Salmon gear		551 (47.1)	65 (15.3)	1,255 (85.1)	169 (37.2)	1,016 (80.4)	611 (63.8)	518.6
Non-salmon gear		619 (52.9)	361 (84.7)	220 (14.9)	285 (62.8)	248 (19.6)	347 (36.2)	161.2
Total		1,170	426	1,475	454	1,264	958	485.5
<u>Northumberland Strait South</u>	7							
Salmon gear		23,131 (100)	11,879 (98.7)	7,436 (100)	13,280 (100)	18,847 (96.9)	14,915 (99.0)	6,139.8
Non-salmon gear		0	159	0	0	611 (3.1)	154 (1.0)	264.6
Total		23,131	12,038	7,436	13,280	19,458	15,069	6,223.1
<u>Southeast Nova Scotia</u>	11							
Salmon gear		1,495 (59.8)	3,243 (54.3)	2,800 (66.3)	2,408 (67.5)	2,680 (64.2)	2,525 (61.8)	649.9
Non-salmon gear		1,004 (40.2)	2,727 (45.7)	1,426 (33.7)	1,158 (32.5)	1,493 (35.8)	1,562 (38.2)	681.0
Total		2,499	5,970	4,226	3,566	4,173	4,087	1,261.5
<u>Halifax</u>	12							
Salmon gear		3,740 (36.2)	6,138 (37.3)	1,820 (29.1)	4,167 (23.4)	4,402 (32.2)	4,053 (31.4)	1,546.5
Non-salmon gear		6,599 (63.8)	10,311 (62.7)	4,426 (70.9)	13,650 (76.6)	9,255 (67.8)	8,848 (68.6)	3,534.7
Total		10,339	16,449	6,246	17,817	13,657	12,901	4,695.2
<u>Southwest Nova Scotia</u>	13							
Salmon gear		1,473 (54.1)	2,319 (56.5)	2,578 (76.3)	2,063 (44.0)	2,778 (61.5)	2,242 (57.8)	507.3
Non-salmon gear		1,248 (45.9)	1,784 (43.5)	800 (23.7)	2,627 (56.0)	1,737 (38.5)	1,639 (42.2)	682.6
Total		2,721	4,103	3,378	4,690	4,515	3,881	822.2
<u>Outer Fundy Nova Scotia</u>	14							
Salmon gear		0	0	0	0	0	0	
Non-salmon gear		2,268 (100)	3,593 (100)	2,954 (100)	3,258 (100)	1,196 (100)	2,654 (100.0)	950.2
Total		2,268	3,593	2,954	3,258	1,196	2,654	
<u>Totals, mainland Nova Scotia</u>								
Salmon gear		30,390 (72.1)	23,644 (55.5)	15,889 (61.8)	22,087 (51.3)	29,723 (67.2)	24,347 (61.6)	5,969.9
Non-salmon gear		11,738 (27.9)	18,935 (44.5)	9,826 (38.2)	20,978 (48.7)	14,540 (32.8)	15,203 (38.4)	4,707.3
Total		42,128	42,579	25,715	43,065	44,263	39,550	7,774.9

¹ Taken from statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979).

non-salmon gear are high in every zone except Northumberland Strait South (Table 6). By-catches accounted for all salmon landings in the Outer Fundy zone and for 68.6% of total salmon landings in the Halifax zone. In the Southeast Nova Scotia, Southwest Nova Scotia and Fundy Nova Scotia zones, by-catches in non-salmon gear were responsible for 38.2%, 42.2% and 36.2% of total salmon landings in these respective zones. These by-catches cannot be considered as 'incidental' when viewed in relation to the bona fide licensed commercial salmon catch. In the five critical by-catch areas, salmon landings by licensed commercial salmon fishermen were low (Table 7).

Harvesting policy is further complicated by the fact that some licensed salmon fishermen in areas such as Herring Cove-Pennant and St. Margaret's Bay also have multispecies, commercial-fish-trap licenses and may catch a portion of their landings in this non-salmon gear without acknowledging its true gear source. These data on landings suggest that alternate harvesting strategies are needed, particularly in areas of high by-catch, if the limited-entry salmon policy is to be meaningful in Nova Scotia.

TABLE 7. Salmon landings in licensed commercial salmon gear in the five critical areas of by-catch, 1974-78¹.

Critical by-catch areas	Salmon landings (kg)					x	SD
	1974	1975	1976	1977	1978		
Ecum Secum	86	80	29	33	18	49	31.4
Little Harbour	0	0	0	0	0	0	0
Herring Cove-Pennant	2,700	4,830	1,392	3,355	3,382	3,132	1,246.0
St. Margaret's Bay-Mahone Bay	860	1,069	251	660	734	715	302.1
Morden-Halls' Harbour	0	0	0	0	0	0	0

¹Taken from statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979).

IMPACT AND DISTRIBUTION OF NON-SALMON FISHING GEAR

The impact of specific non-salmon commercial gear on salmon taken as a by-catch in mainland Nova Scotia from 1974 to 1978 is outlined (Tables 8 and 9, and Fig. 3). Multi-species commercial fish traps accounted for 8,718 kg or 55.6% of the average annual mainland by-catch. While fish traps capture salmon in most areas where they are deployed, their impact is more critical at Ecum Secum, Little Harbour, Herring Cove-Pennant and St. Margaret's Bay-Mahone Bay. Herring weirs were responsible for 3,130 kg or 20.0% of the average annual mainland by-catch. While herring weirs in St. Mary's Bay and Minas Basin capture salmon, the severest impact occurs in the

Morden-Hall's Harbour area. Herring and mackerel surface gill nets accounted for 2,230 kg or 14.2% of the average annual mainland salmon by-catch, while groundfish gill nets were responsible for 1,472 kg or 9.4% of the average annual mainland by-catch. The by-catch problem created by herring and mackerel surface gill nets is complicated, because this gear is spread over a wide area in Salmon Management Zones 11-13 and is usually deployed 8-16 km offshore. While groundfish gill nets are similarly spread out in Zones 11-13, part of the by-catch problem created by this gear is attributed to the illegal setting of groundfish gill nets at the surface during periods of salmon migration - for example, fishermen stated this practice was occurring in the Halifax zone. Information

TABLE 8. Distribution of salmon by-catch in various non-salmon gear, 1974-78¹. (Figures in parentheses show the percentages of total annual by-catch taken in each type of gear.)

Gear type	Salmon by-catch (kg)					x	SD
	1974	1975	1976	1977	1978		
Multi-species fish traps	6,285 (53.5)	12,129 (64.1)	4,593 (46.8)	11,907 (56.7)	8,680 (51.2)	8,718 (55.6)	3,344.4
Herring weirs	2,722 (23.2)	4,257 (22.5)	3,297 (33.6)	3,852 (18.4)	1,520 (9.0)	3,130 (20.0)	1,069.8
Surface gill nets	1,400 (11.9)	1,215 (6.4)	495 (5.0)	2,719 (13.0)	5,322 (31.4)	2,230 (14.2)	1,905.7
Groundfish gill nets	1,034 (8.8)	1,260 (6.7)	1,376 (14.0)	2,425 (11.6)	1,267 (7.5)	1,472 (9.4)	546.9
Drift nets	296 (2.5)	74 (0.4)	62 (0.6)	79 (0.4)	166 (1.0)	135 (0.9)	98.8
Totals	11,737	18,936	9,823	20,982	16,955	15,687	4,748.4

¹Calculated from statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979).

TABLE 9. Salmon by-catch taken by specific non-salmon commercial gear in each salmon management zone based on average landings for the period 1974-78¹. (Figures in parentheses indicate percentages of the total mean annual by-catch taken in each type of gear.)

Salmon management zone	Zone no.	Fish traps	Weirs	Drift nets	Surface gill nets	Groundfish gill nets	Totals
Fundy Nova Scotia	6	0 (0.0)	227 (65.4)	109 (31.4)	9 (2.6)	2 (0.6)	347
Northumberland Strait South	7	81 (52.6)	0 (0.0)	0 (0.0)	33 (21.4)	40 (26.0)	154
Southeast Nova Scotia	11	863 (55.2)	0 (0.0)	17 (1.1)	361 (23.1)	321 (20.6)	1,562
Ecum Secum		517 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	517
Halifax	12	6,567 (74.2)	0 (0.0)	0 (0.0)	1,562 (17.6)	719 (8.1)	8,848
Little Harbour		1,680 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1,680
Herring Cove-Pennant		2,348 (80.0)	0 (0.0)	0 (0.0)	411 (14.0)	177 (6.0)	2,936
St. Margaret's Bay-Mahone Bay		2,523 (66.5)	0 (0.0)	0 (0.0)	737 (19.4)	536 (14.1)	3,796
Southwest Nova Scotia	13	726 (44.3)	253 (15.4)	9 (0.5)	261 (15.9)	391 (23.8)	1,640
Outer Fundy Nova Scotia	14	0 (0.0)	2,650 (99.8)	0 (0.0)	4 (0.2)	0 (0.0)	2,654
Morden-Hall's Harbour		0 (0.0)	2,318 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	2,318

¹Calculated from statistical reports (Dunfield 1975, 1976 and 1977; Mitham and Bernard 1978 and 1979).

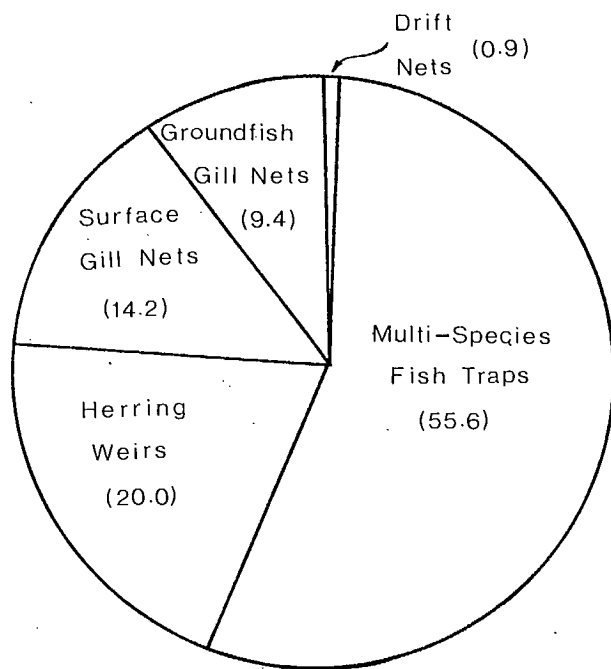


FIG. 3. Impact of specific non-salmon gear on mainland Nova Scotia by-catches, 1974-78.

from survey questionnaires corroborated departmental statistical data on the relative impact of various non-salmon gear on salmon.

The distribution of each type of commercial inshore fishing gear, together with information on regulated fishing seasons, operational fishing patterns, by-catch timing and gear impact are described in some detail for each of the six salmon management zones (Table 10). These data were collated

from discussions with and documentation by federal fishery officers and non-salmon commercial fishermen surveyed in this study. The outline of gear distribution (Figs. 4-7 and 9-11) is intended as an overview, since even federal fishery officers must usually rely on the word of fishermen that they are fishing the number of nets stated on their fishing license. Documentation of the number of gear units fished in each area at any given period of time is almost impossible to verify because of time constraints on the part of fishery officers or lack of equipment to patrol fishermen's nets. Summary data on average salmon landings in salmon and non-salmon gear and impact of each gear type on Atlantic salmon in each of the salmon management zones are presented in Tables 6 and 9, respectively.

Inner Fundy Nova Scotia (Zone 6) (Fig. 4)

Although average annual salmon landings in Zone 6 were low, by-catch accounted for 347 kg or 36.2% of this zone's annual salmon catch. The highest proportion of this by-catch (227 kg or 65.4%) was taken in roughly 14 herring weirs, which have no regulated season. Approximately 78 drift nets, concentrated in Cobequid Bay, the Shubenacadie estuary and Cumberland Basin, annually captured 109 kg or 31.4% of the Zone 6 by-catch. The regulated commercial season for shad in the province, May 1-August 15, has been modified in the tidal waters of the Shubenacadie River to May 1-June 15 to reduce by-catch. In Cumberland Basin, on the other hand, the season has been extended to May 1-September 30, where disparaging reports exist regarding the impact of the shad drift-net fishery on the salmon resource of the Maccan and other rivers entering Cumberland Basin. While the Minudie shad fishery is vitally important

TABLE 10. Estimated number of each type of commercial fishing gear, its regulated fishing season, operational fishing pattern and by-catch timing in each of the six salmon management zones.

Gear type/Zone	Approximate no. of units	Regulated allowable season	Operational fishing pattern	By-catch timing
<u>Fundy Nova Scotia</u>				
Gaspereau nets or traps	46	15 Mar-10 Jul	—	—
Shad drift nets	78	1 May-15 Aug ¹	1 May-15 Jun	1 Jun-1 Sep ¹
Herring gill nets	741	No season	Jun-Sep	1 Jun-1 Sep
Groundfish gill nets	18	No season	—	—
Weirs	14	No season	1 May-Oct	1 Aug-15 Aug
Salmon drift nets	15	1 May-15 Aug	1 Jun-15 Aug	—
<u>Northumberland Strait South</u>				
Herring gill nets	925	No season	1 May-31 Oct	—
Mackerel gill nets	81	No season	1 May-31 Oct	—
Groundfish gill nets	86	No season	—	—
Commercial fish traps	9	No season ²	1 May-10 Jun	—
Salmon trap nets	44	15 May-15 Aug	1 Jun-15 Aug	—
<u>Southeast Nova Scotia</u>				
Gaspereau gill nets	27	15 Mar-10 Jul	20 May-10 Jul	20 May-10 Jul
Herring and mackerel gill nets combined	3,080	No season	10 Apr-15 Oct	15 May-15 Jul
Groundfish gill nets	1,910	No season	15 May-20 Aug	15 May-15 Jul
Commercial fish traps	41	No season	10 Jun-15 Oct	1 Jun-15 Jul
Salmon trap nets	49	15 Apr-15 Aug	1 Jun-15 Aug	—
Salmon gill nets	5	15 Apr-15 Aug	1 Jun-15 Aug	—
<u>Halifax</u>				
Herring gill nets	225	No season	12 Apr-15 Aug	15 May-15 Jul
Mackerel gill nets	25	No season	12 Apr-15 Aug	15 May-15 Jul
Groundfish gill nets	400	No season	1 Apr-15 Aug	15 May-15 Jul
Commercial fish traps	143	No season	10 May-15 Aug	10 May-31 Jul
Salmon trap nets	28	15 Apr-15 Aug	1 May-15 Aug	—
Salmon gill nets	18	15 Apr-15 Aug	1 May-15 Aug	—
<u>Southwest Nova Scotia</u>				
Gaspereau gill nets	355	15 Mar-10 Jul	1 Apr-30 May	15 May-30 May
Herring gill nets	3,219	No season	12 Apr-30 Jun	—
Mackerel gill nets	2,500	No season	12 Apr-30 Jun	—
Groundfish gill nets	3,000	No season	1 May-30 Nov	15 Jun-15 Jul
Weirs	22	No season	1 May-30 Aug	24 May-15 Aug
Commercial fish traps	25	No season	1 May-30 Sep	15 May-15 Jul
Salmon gill nets	50	15 Apr-15 Aug ³	1 May-15 Aug	—
Salmon trap nets	2	15 Apr-15 Aug ³	1 May-15 Aug	—
<u>Outer Fundy Nova Scotia</u>				
Gaspereau gill nets	6	15 Mar-10 Jul	1 May-15 Jun	1 Jun-15 Jun
Shad gill nets	1	1 May-15 Aug	—	—
Herring gill nets	1,501	No season	—	—
Weirs	23	No season	15 May-30 Aug	15 May-15 Jul

¹1 May-30 Sep in Cumberland Basin; 1 May-15 Jun in Shubenacadie River tidal area.²Commercial fish traps are prohibited from fishing in George Bay from 11 Jun-15 Aug.³1 May-15 Aug (Digby, Yarmouth Co.).

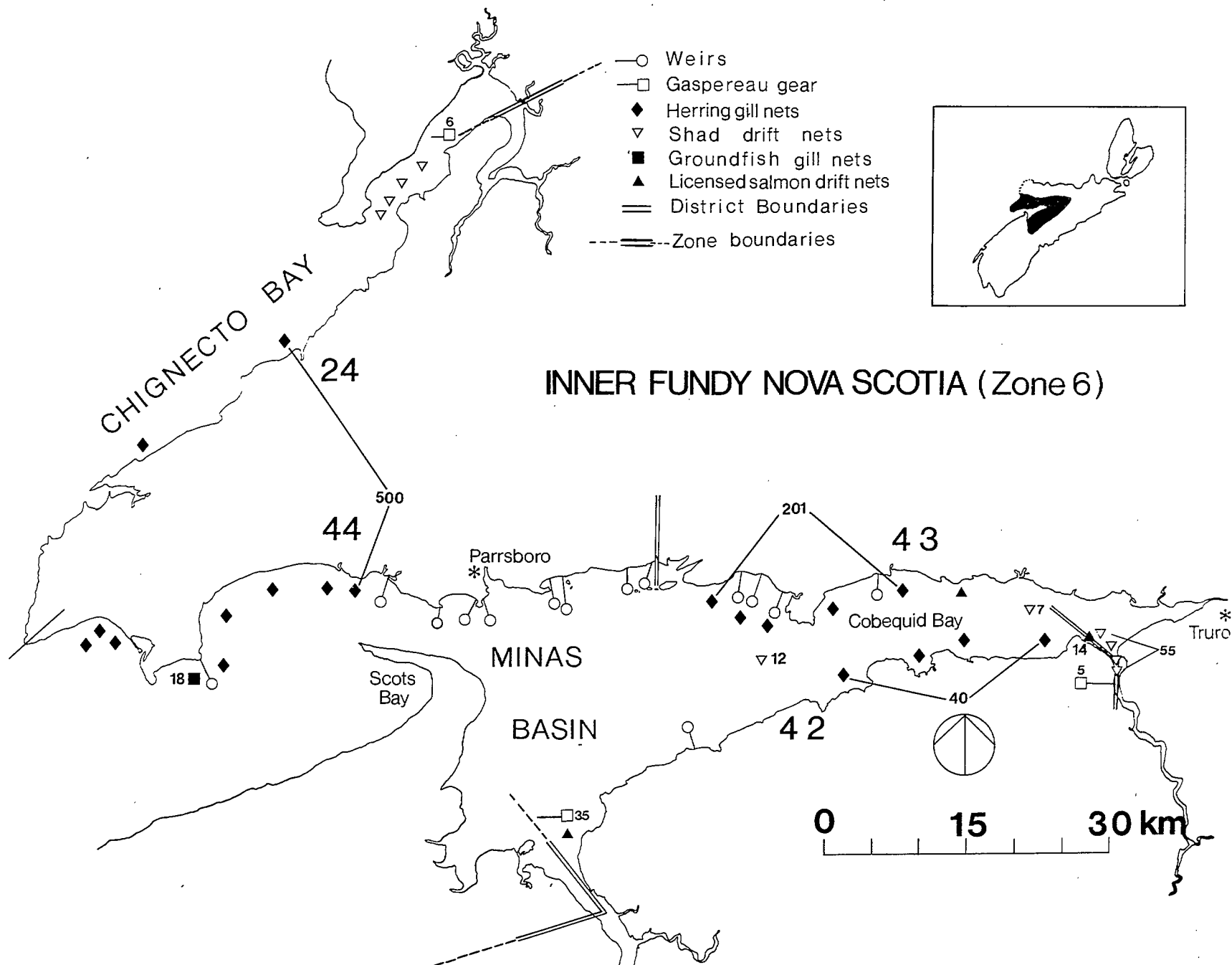


FIG. 4. Distribution of inshore commercial fishing gear in the Inner Fundy Nova Scotia Zone.

to local fishermen, salmon by-catch should be monitored to determine the impact of the shad fishery on salmon stocks. Other types of non-salmon fishing gear, such as herring surface gill nets (741), groundfish gill nets (18) and gaspereau nets (46), do not currently present a significant problem.

Northumberland Strait South (Zone 7) (Fig. 5)

Commercial landings of Atlantic salmon in Zone 7 were higher than in any other salmon management zone in mainland Nova Scotia. Despite this, according to departmental statistics, salmon by-catch accounted for only 154 kg or 1.0% of the zone's mean annual salmon catch. Nine multi-species commercial fish traps, concentrated in George Bay, accounted for 52.6% of the by-catch, while an estimated 86 groundfish gill nets and 1,006 herring and mackerel surface gill nets were responsible for the remaining 26.0% and 21.4% of the Zone 7 by-catch, respectively. Average landings of 14,915 kg were taken annually in 44 licensed salmon trap nets.

The apparent low by-catch in Zone 7, despite the fact that salmon landings were high in June and July, is noteworthy. *Multi-species commercial fish traps do not present a significant by-catch problem, since local regulations prohibit their deployment from June 11 to August 15, the peak in salmon-catch timing (Pushie, pers. comm.)¹. The effectiveness of this regulation in George Bay is clear; consequently, the feasibility of prohibiting the deployment of commercial fish traps during the crucial peak in salmon migration in other critical areas - such as, Ecum Secum, Little Harbour, Herring Cove-Pennant, and St. Margaret's Bay-Mahone Bay - should be explored. While by-catch is controlled in commercial fish traps in Zone 7, it is not clear why surface gill nets do not capture more salmon, particularly in George Bay during June and July, when salmon are in the bay.*

Southeast Nova Scotia (Zone 11) (Fig. 6)

Of the 4,087 kg of salmon landed annually in Zone 11 from 1974 to 1978, 1,562 kg (38.2%) was taken as a by-catch. Multi-species commercial fish traps accounted for 863 kg, or 55.2%, of this by-catch. Fish traps are concentrated in the Canso-Chedabucto Bay area, where specific trap locations were effective in capturing salmon. *However, the highest proportion of the commercial fish trap by-catch was taken at Ecum Secum, where 33.1% of the Zone 11 by-catch was taken. Fish traps are more effective than commercial salmon gear in capturing Atlantic salmon, since they have longer leaders, larger trap dimensions and smaller*

trap mesh size (1 1/2"-1 3/4") which retains grilse. Since they are not regulated by season and are often deployed in areas of known salmon migration, they threaten the already over-exploited salmon resource along Nova Scotia's Atlantic coast.

Herring and mackerel surface gill nets are dispersed along the southeast Nova Scotia coast; many of these nets are deployed 8 km-16 km offshore. This gear accounted for 361 kg or 23.1% of the Zone 11 by-catch. Since this gear also is not regulated by season, it can be set along the coast at times and in areas of known salmon migration. Mesh sizes used in surface gill nets are variable; an outline of the most common mesh sizes deployed, collated from survey questionnaires, is outlined below. Since the by-catch problem caused by surface gill nets is not concentrated at any specific area in Zone 11, the task of controlling it is difficult.

Fishery	Common mesh size (in.)	Range in mesh size (in.)
Smelt	1 1/2	1 1/4-1 1/2
Gaspereau	2 3/4	2 3/4-3
Herring	2 3/8-2 1/2	2 1/4-2 7/8
Mackerel	2 7/8	2 3/4-4
Groundfish	6	5 1/4-8
Fish traps	1 3/4	1 1/4-3 1/4

Salmon landings in gaspereau gill nets are not separated in this report from those taken in other surface gill nets. Since gaspereau gill nets are deployed mainly in river estuaries at times when salmon are present, they create a different by-catch problem. At present, the established fishing season for this gear, March 15 to July 10, has little relevance to gaspereau run timing in these rivers and should be revised.

Groundfish gill nets are concentrated off Canso, but are also dispersed along the southeast Nova Scotia coast. Annually, this gear was responsible for the capture of a reported 321 kg of salmon, or 20.6% of the Zone 11 by-catch. Groundfish gill nets are not regulated by season and have only general restrictions regarding mesh size (6") and set location, such as deployment outside the half-mile boundary of river estuaries or placement on the bottom in water of six fathoms or more at normal low tide. However, whether fisheries officers have the time or equipment to patrol the inshore fisheries adequately to enforce the stated provisions for gear deployment is questionable.

Halifax (Zone 12) (Fig. 7)

Salmon Management Zone 12 accounted for the second highest average annual landings

¹Pushie, E.C. Federal Fishery Officer, Conservation and Protection Division, Field Services Branch, Department of Fisheries and Oceans, Antigonish, Nova Scotia.

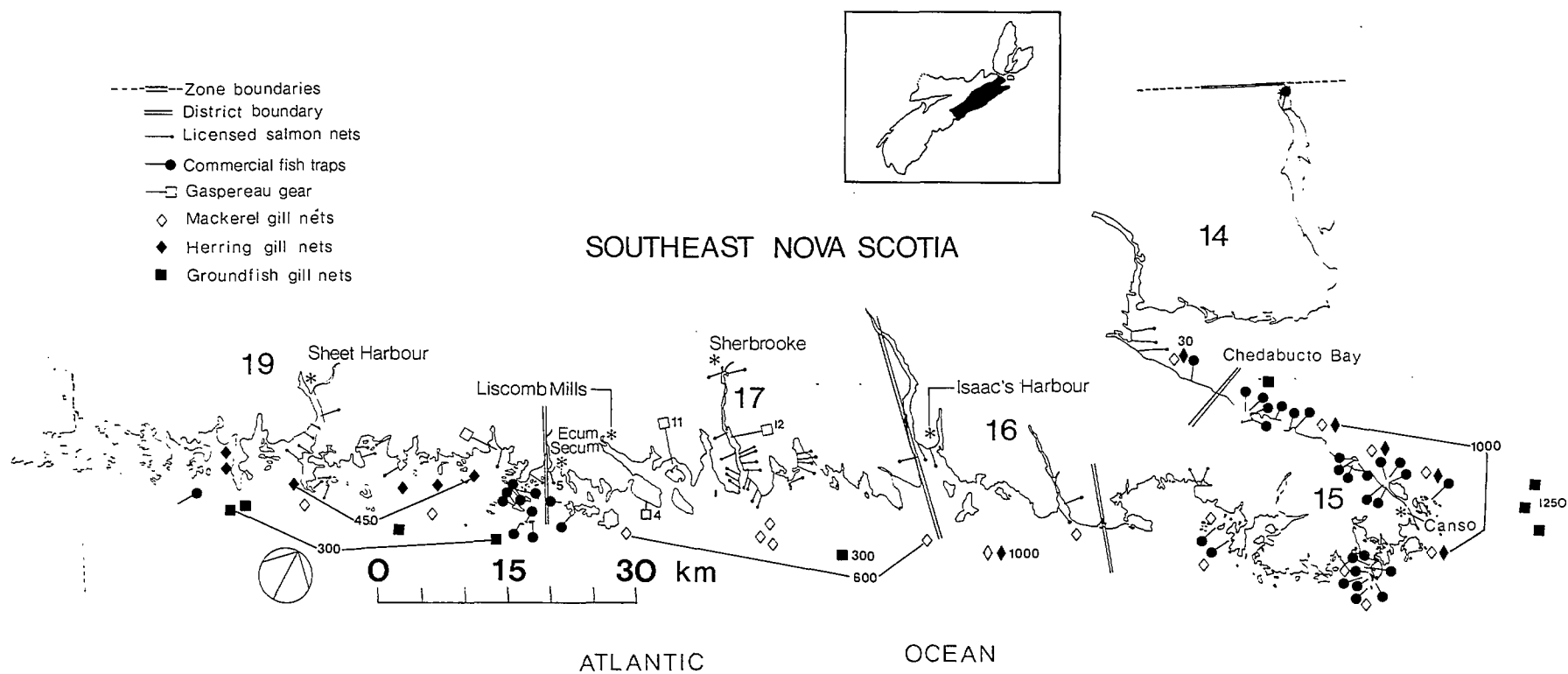


FIG. 6. Distribution of inshore commercial fishing gear in the Southeast Nova Scotia Zone.

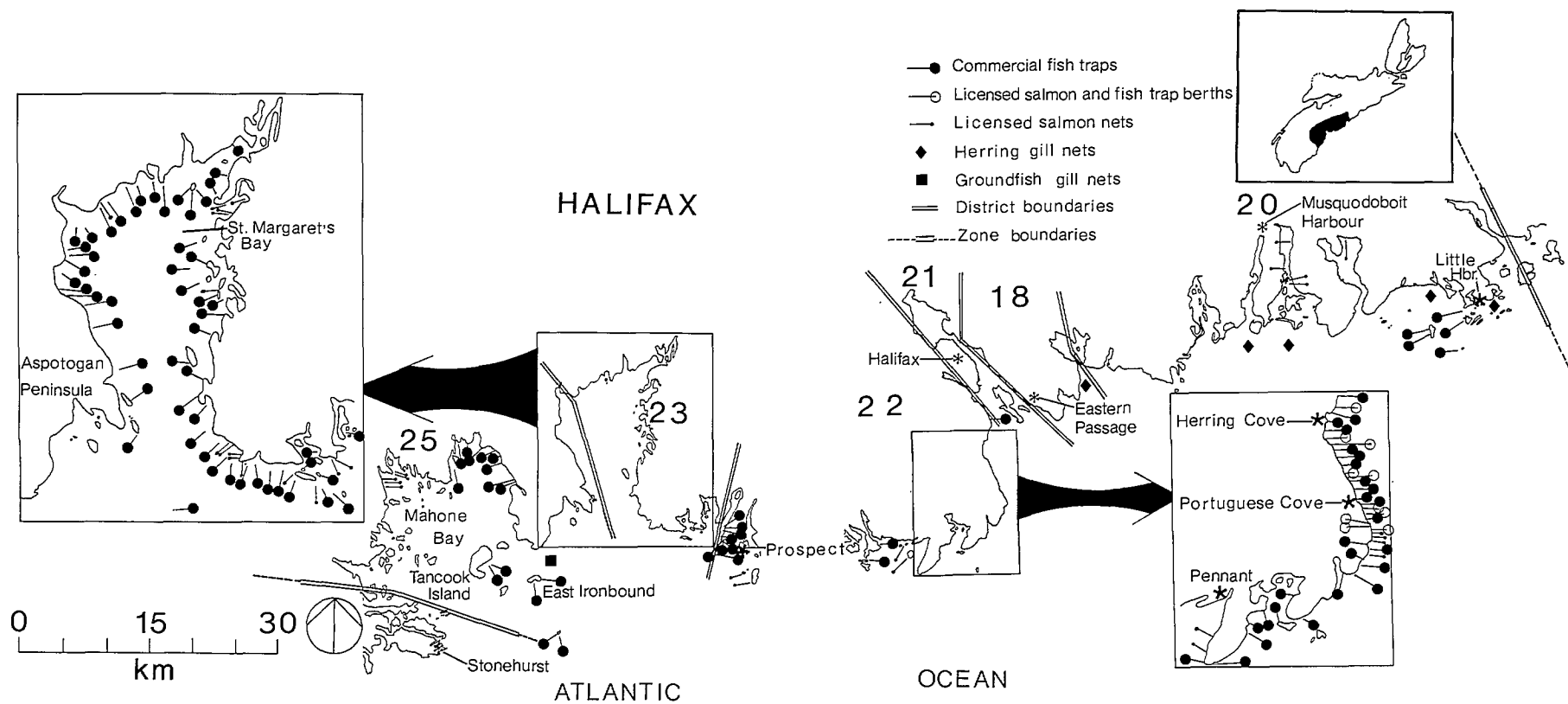


FIG. 7. Distribution of inshore commercial fishing gear in the Halifax Zone.

of salmon, 12,902 kg, in mainland Nova Scotia; 8,848 kg, or 68.6% of the annual catch, was taken by non-salmon gear. Multi-species commercial fish traps, particularly those at Little Harbour, Herring Cove-Pennant and St. Margaret's Bay-Mahone Bay, were responsible for 6,567 kg or 74.2% of the Zone 12 by-catch. Although the conditions laid down when issuing new commercial fish-trap licenses prohibit the retention of live salmon or tuna, older licenses do not have these provisions, and fishermen are allowed to keep salmon taken in their gear. Since many commercial fish traps, particularly in the Herring Cove-Pennant and St. Margaret's Bay-Mahone Bay areas, are fished in the same locale as licensed salmon gear and are more efficient, they have an adverse impact on stocks and the licensed commercial salmon fishery. In some areas, they are operated when the primary species for which they are licensed are not present in quantity or cannot be sold because of poor market conditions and, consequently, are purposefully set to capture salmon, which can be sold quickly and profitably. For example, in the Herring Cove-Pennant area, commercial fish traps are set in the water in advance of the arrival of substantial quantities of herring, mackerel or other species (Fig. 8) and capture over 2,300 kg of salmon. In the early 1960s, commercial fish traps were prohibited from setting before July 15 at Herring Cove-Pennant; however, since the waiver of this regulation, a lucrative unlicensed salmon fishery has developed.

An estimated 250 surface gill nets are deployed in the Halifax Salmon Management Zone. These nets capture at least 1,562 kg of salmon, or 17.6% of the Zone 12 annual by-catch. Although they are not as numerous as in Southeast Nova Scotia, these gill nets are deployed in areas of known salmon migration, a factor which may account for the higher salmon landings in this gear in Zone 12 than in Zone 11. Should the number of surface gill nets deployed in this zone increase without appropriate changes in their fishing pattern, they could pose an even more serious future by-catch problem.

Approximately 400 groundfish gill nets are fished offshore in the Halifax zone. They captured an estimated 719 kg of salmon annually or 8.1% of the Zone 12 annual by-catch. Since groundfish gill nets in Zone 12 are deployed in areas of known salmon migration, salmon are more vulnerable to capture than in Southeast Nova Scotia. A few fishermen suggested that groundfish gill nets are set illegally at the surface for the purpose of capturing salmon, and this may also explain the higher groundfish gill-net catch in Zone 12 than in Zone 11. If this contention is valid, federal fishery officers should be given the manpower and equipment to patrol these inshore areas to enforce provisions of the Fisheries Act.

Southwest Nova Scotia (Zone 13) (Figs. 9 & 10)

Of the total average annual salmon landings in Zone 13, 42.2%, or 1,639 kg,

was taken as by-catch. Approximately 25 multi-species, commercial fish traps - concentrated in the Stonehurst-Cape LaHave Island, West Baccaro and Clark's Harbour-Lower West Pubnico areas - accounted for a reported 726 kg, or 44.3% of the Zone 13 annual by-catch. Commercial fish traps at the mouth of the LaHave River capture salmon destined for that river. Although the two commercial fish traps in Queens County are required by license provisions to release salmon alive, whether or not this provision is enforced is unknown. In Shelburne County, most of the commercial fish traps can legally retain salmon, and local residents, fish plant employees and fishermen indicated that commercial fish traps off McNutts Island at the entrance to Shelburne Harbour, at West Baccaro and those off Clark's Harbour capture salmon. In view of the magnitude of the by-catch in commercial traps in Zone 13 and disparities in fish-trap license conditions, changes are needed to ensure the release of salmon alive from this gear.

Groundfish gill nets were responsible for the capture of 391 kg, or 23.8%, of the average annual Zone 13 by-catch. Groundfish gill nets are found in Queens County, 16 km-64 km offshore in Shelburne County and in the Meteghan-Belliveau Cove area. The Queens County, groundfish gill-net fishery, concentrated on Roseway Bank, was surveyed by federal fishery officers (Forbes, pers. comm.)¹ to determine the size of the by-catch in 1977, a year of higher than normal by-catch. Fishermen indicated in this survey that they landed about 190 salmon (860 kg), of which 44 were taken after September 1 and several as late as the end of November. Since the by-catch problem in groundfish gill nets is spread out in Zone 13 and represents less than 1.5% of the value of landed groundfish, the major finfish fishery in this zone, the task of implementing by-catch control is impractical without further study.

Herring and mackerel surface gill nets are widespread throughout the Southwest Nova Scotia Zone and accounted for 261 kg, or 15.9%, of the Zone 13 annual by-catch of salmon. Since this fishery was not sampled and is not well understood, further study is needed to determine its impact on salmon.

Salmon by-catch taken in gaspereau surface gill nets is not separated in this report from that taken in herring and mackerel surface gill nets. Gaspereau gill nets purportedly capture significant quantities of salmon in the Medway, Tusket and other river estuaries. Although individual river variation orders have been used to control the capture of salmon in gaspereau gear in certain years, the present fishing season, March 15-July 10, as laid

¹Forbes, J.J. Federal Fishery Officer, Conservation and Protection Division, Field Services Branch, Department of Fisheries and Oceans, Liverpool, Nova Scotia.

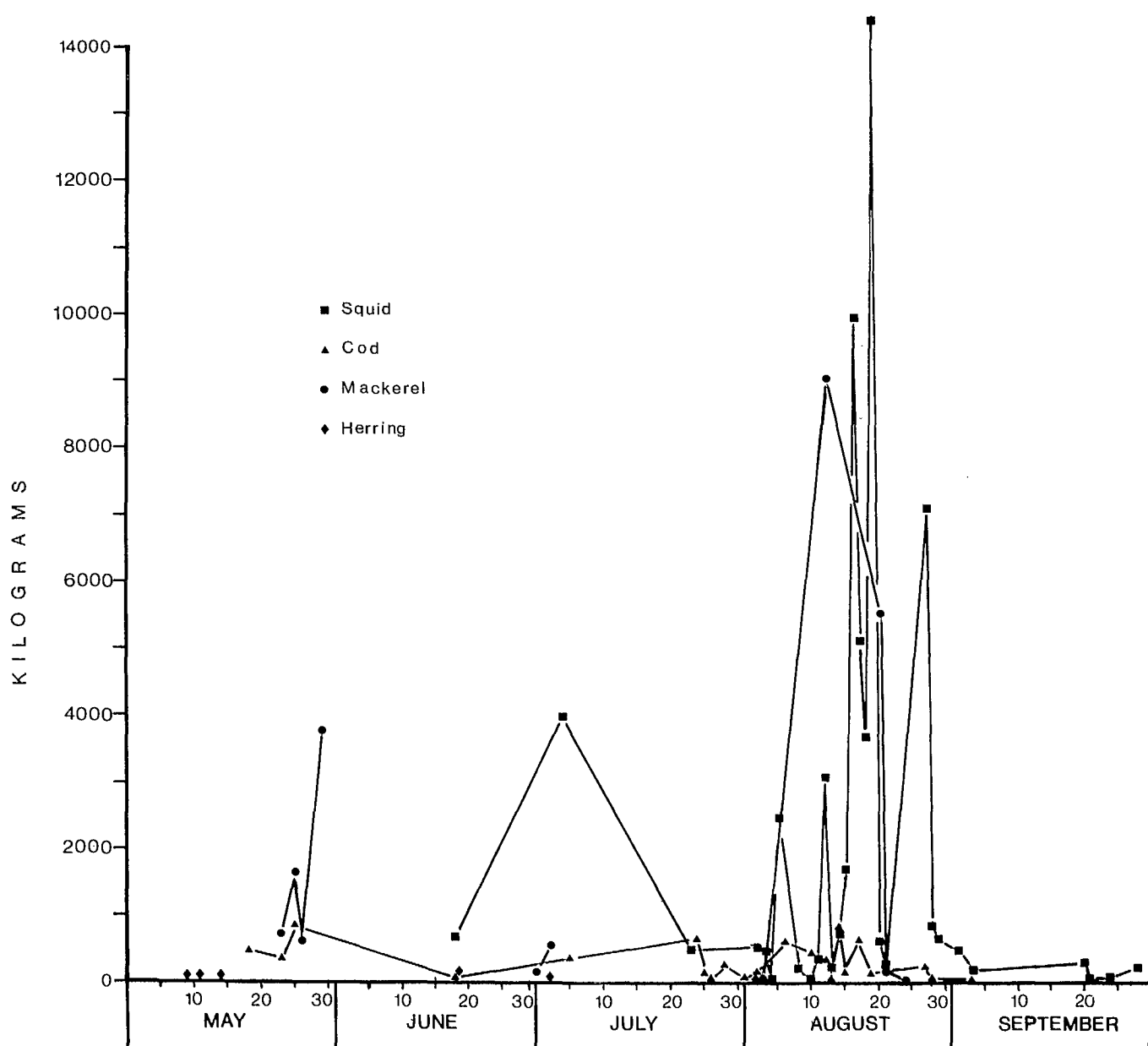


FIG. 8. Catch timing of other species in commercial fish traps in the Herring Cove-Pennant area in 1979. (Data from Statistics Section.)

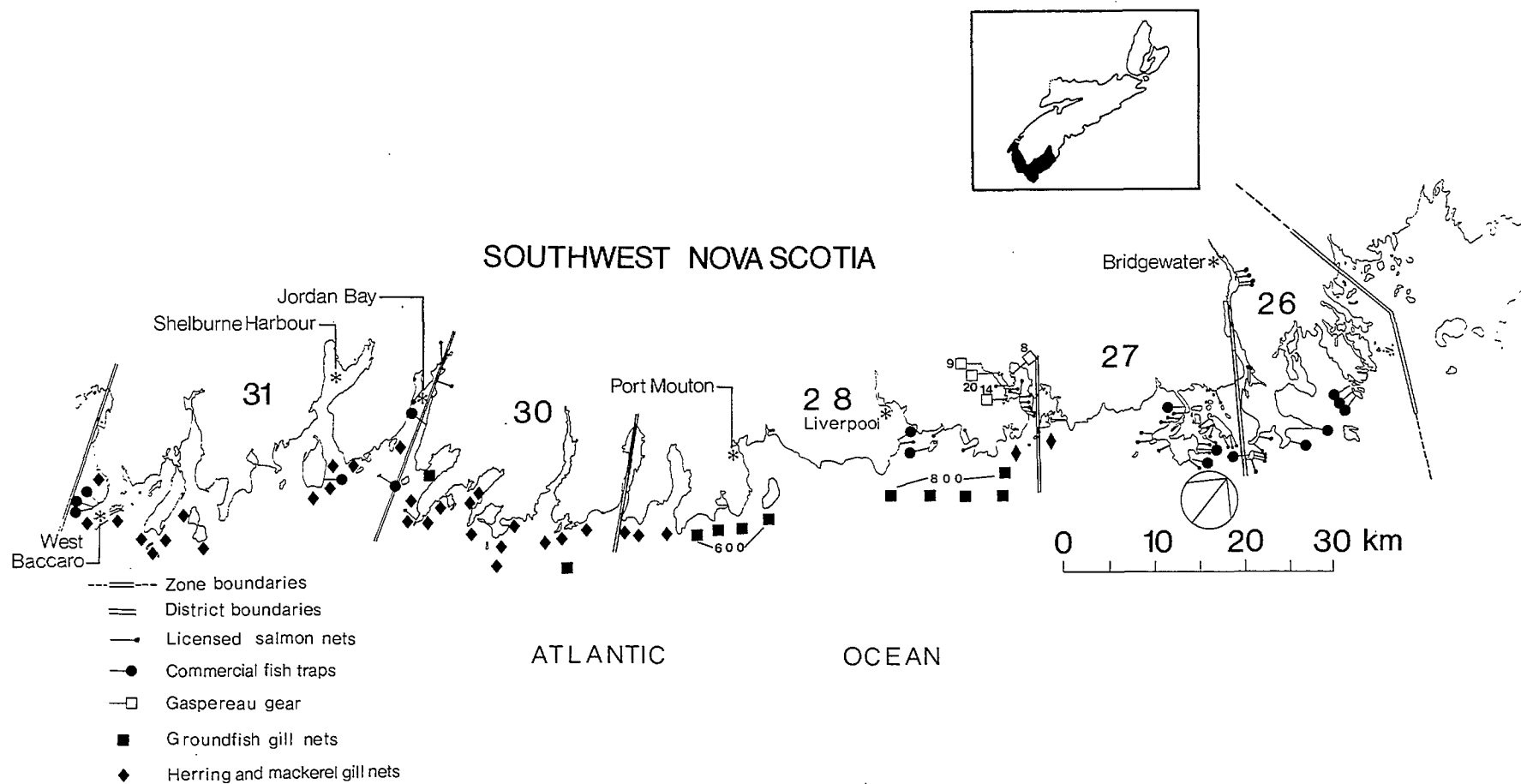


FIG. 9. Distribution of inshore commercial fishing gear in the Southwest Nova Scotia Zone (Part 1).

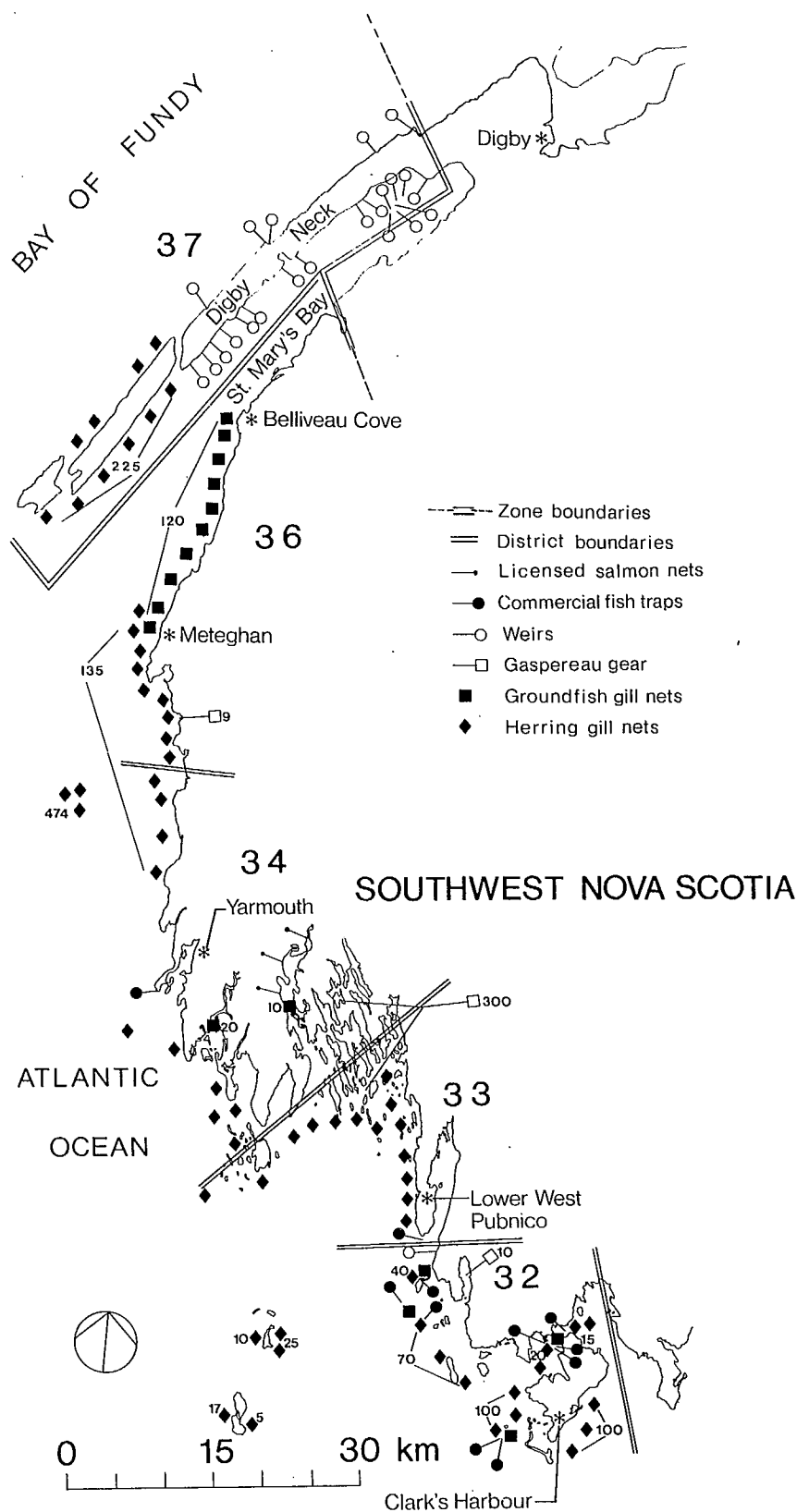


FIG. 10. Distribution of inshore commercial fishing gear in the Southwest Nova Scotia Zone (Part 2).

down in the regulations, has little relevance to existing gaspereau migration timing and should be revised.

Approximately 22 herring weirs in the St. Mary's Bay-Digby Neck area captured 253 kg or 15.4% of the annual salmon by-catch of Zone 13. While by-catch in this gear may be higher than this in some years, such as 1977, not enough information is available to suggest changes to their present fishing practices.

Outer Fundy Nova Scotia (Zone 14) (Fig. 11)

Since no licensed salmon gear exists in Zone 14, all salmon landings (2,654 kg) were taken as a by-catch. Virtually all this by-catch, 2,650 kg or 99.8%, was taken in herring weirs. While one or two weirs in the Digby area accounted for a small salmon by-catch, 2,318 kg, or 87.3% of the Zone 14 average annual salmon by-catch, was taken in herring weirs in the Morden-Hall's Harbour area. Although there are six weir sites in Kings County (Fig. 11), only four licenses were active in 1978 - Ross Creek, Hall's Harbour, Black Rock Point and Morden. Fishermen sampled by survey questionnaire indicated that the four active weirs in this area collectively harvested 1,721 kg in 1977 and 1,504 kg in 1978, whereas departmental statistical reports recorded 2,725 kg and 985 kg landed in this area in 1977 and 1978, respectively (Table 2). Despite the disparity in catch statistics, salmon by-catch in this area is vitally important to the fisherman - in fact, three out of the four weir fishermen sampled indicated that greater than 50% of their fishing income is derived from salmon. Consequently, by-catch control in weirs in the Morden-Hall's Harbour area would effectively put these fishermen out of business. Although over 1,500 surface-gill nets are deployed in Zone 14, by-catch does not presently appear to be a significant problem.

BY-CATCH STOCK ORIGIN

Tag returns of one-sea-winter or older salmon released as hatchery smolts in various Maritime rivers from 1974 to 1978 indicate that salmon by-catch taken at Ecum Secum, Little Harbour and the Herring Cove-Pennant area is comprised of predominantly Nova Scotia stocks (Table 11). By-catch stock origin in St. Margaret's Bay is discussed in more detail in the next part of this report and depicts a similar pattern (Tables 12-14).

SALMON BY-CATCH STUDY - ST. MARGARET'S BAY

Statistics collected by the Department of Fisheries and Oceans have indicated for a number of years that salmon landings in non-salmon gear have exceeded the catch in licensed salmon gear in St. Margaret's Bay. This conflict in harvest strategy, in view of the restricted-entry salmon policy, prompted the Resource Branch to initiate a preliminary by-catch study in St. Margaret's Bay in the summer of 1978. Quantification of by-catch with the resources available for the study was considered to be virtually impossible for a variety of reasons - the study area was large, fishermen operated from many wharves in the bay and landed their catches at roughly the same time each day, salmon were quickly sold at the wharf on arrival from the traps, and non-salmon fishermen were reluctant to divulge their salmon by-catch. Consequently, the study concentrated on other aspects of the by-catch problem, such as identification of the non-salmon gear responsible for by-catch, documentation of the location and number of gear units fished, salmon by-catch timing, catch timing of other finfish species, stock origin of by-catches, biological sampling and collection of information on the disposal of salmon taken as a by-catch.

TABLE 11. Contributions of various salmon stocks to by-catch at Ecum Secum, Little Harbour and the Herring Cove-Pennant area, as indicated by tag returns of one-sea-winter or older salmon, 1974-78. (Figures in parentheses indicate percentages of total annual tag recoveries.)

Year of recapture	Numbers of tagged salmon recovered from each release location				Totals, Nova Scotia	Overall totals
	Saint John River	LaHave River	East River	Medway River		
1974	1 (12.5)	7 (87.5)			7 (87.5)	8
1975	1 (14.3)	5 (71.4)	1 (14.3)		6 (85.7)	7
1976			15 (100.0)		15 (100.0)	15
1977		9 (81.8)	1 (9.1)	1 (9.1)	11 (100.0)	11
1978		11 (64.7)	6 (35.3)		17 (100.0)	17
Totals	2 (3.4)	32 (55.2)	23 (39.7)	1 (1.7)	56 (96.6)	58

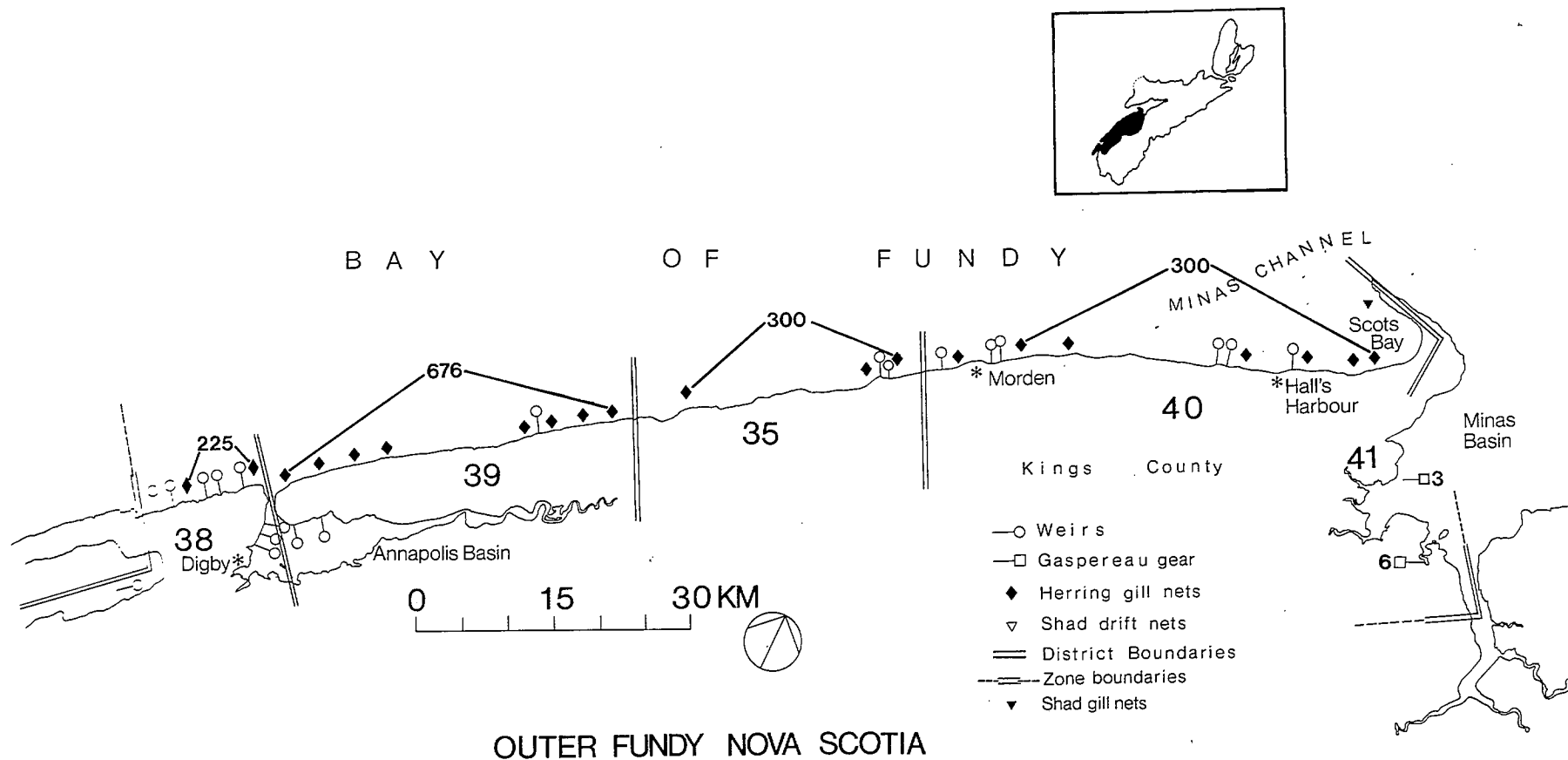


FIG. 11. Distribution of inshore commercial fishing gear in the Outer Fundy Nova Scotia Zone.

TABLE 12. Analysis of age, length and weight of salmon taken as a by-catch in St. Margaret's Bay in 1978. (Figures in parentheses represent the percentage of the total sample.)

Age-class	Number of fish	Mean length (cm)	Mean weight (kg)
One-sea-winter			
2.1	31		
3.1	2		
Total	33 (40.2)	51.0±9.09	1.7±0.33
Two-sea-winter			
2.2	26		
3.2	2		
Total	28 (34.1)	74.3±7.85	5.0±0.69
Three-sea-winter			
2.3	7		
3.3	1		
Total	8 (9.7)	85.5±8.40	7.1±1.10
Previous spawning grilse			
2.1 sp 2.2	8		
3.1 sp 3.2	3		
2.1 sp 2.3	1		
2.1 sp 2.2 sp 2.3	1		
Total	13 (15.9)	68.9±13.15	3.3±1.01

TABLE 13. Sex ratios of salmon taken as a by-catch in St. Margaret's Bay in 1978 in relation to saltwater age.

Age-class	Sample size	Numbers of fish	
		Male	Female
One-sea-winter	23	7 (30.4)	16 (69.6)
Two-sea-winter	26	7 (26.9)	19 (73.1)
Three-sea-winter	8	2 (25.0)	6 (75.0)
Previous-spawning grilse	9	3 (33.3)	6 (66.7)

TABLE 14. Contributions of various salmon stocks to by-catch in St. Margaret's Bay, as indicated by tag returns of one-sea-winter or older salmon, 1974-78. (Figures in parentheses represent the percentages of total annual tag recoveries.)

Year of recapture	Numbers of tagged salmon recovered from each release location					Overall totals
	Saint John River	LaHave River	Other rivers (Nova Scotia)	Other rivers (Maritimes)	Totals, Nova Scotia	
1974	2 (20.0)	8 (80.0)			8 (80.0)	10
1975	4 (21.1)	13 (68.4)	2 (10.5)		15 (78.9)	19
1976	1 (50.0)	1 (50.0)			1 (50.0)	2
1977	1 (3.6)	15 (53.6)	11 (39.2)	1 (3.6)	26 (92.9)	28
1978	3 (23.1)	7 (53.8)	3 (23.1)		10 (76.9)	13
Totals	11 (15.3)	44 (61.1)	16 (22.2)	1 (1.4)	60 (83.3)	72

The study area (Fig. 12) extended from Terence Bay to the southern tip of the Aspotogan Peninsula at New Harbour, a distance of over 80 km. It was determined early in the study that most surface gill nets and groundfish gill nets were located outside the bay and could not be sampled regularly. Consequently, efforts were concentrated on multi-species fish traps, which were responsible for most of the by-catch inside the bay.

Approximately 75 multi-species, commercial fish traps and 16 salmon traps and gill nets are licensed in St. Margaret's Bay. Five of the licensed commercial salmon fishermen also hold multi-species fish trap licenses. Commercial fish traps, although not regulated by season, are generally set from mid-May to October, with periodic removal in mid-summer for cleaning purposes.

Two basic trap designs are used in St. Margaret's Bay - the bowl or bottom trap (Fig. 13) and the wall or straight trap (Fig. 14). While each type of trap has several variations in design, their general specifications are outlined below and compared to commercial salmon-trap specifications.

	Multi-species fish trap	Salmon trap
Leader length	50-150 fathoms	50 fathoms
Leader mesh size	5-6 in.	5 1/2-6 in.
Headrope length	100 fathoms	—
Trap mesh size	1 1/4-1 3/4 in.	5 1/2-6 in.
Trap depth	9-13 ft	15-20 ft

No regulations currently exist regarding leader length or other commercial fish-trap dimensions; consequently, dimensions are generally dictated by material and labour costs. Since commercial fish traps are not species specific or size selective because of the small mesh size used in the trap itself, they can be more effective than salmon traps when deployed in areas of known salmon migration. Although salmon caught in these fish traps remain alive until the trap is emptied, during the peak herring and mackerel season, salmon and other species can be killed when confined to a small part of the net during the pursing operation. These occurrences are the exception rather than the rule; and instances have been cited where salmon and tuna were separated and removed from these traps alive, while leaving other species in the trap.

A total of 203 salmon was counted during the study period, from May 29 to July 30, 1978. Two peaks were evident in by-catch timing - an early June peak, corresponding to increased catches of pre-dominantly large salmon, and a late-June, early-July peak, corresponding to increased catches of one-sea-winter salmon (Fig. 15). Eighty-two of these fish were sampled for age, length weight and sex. Sampling data

indicated that 40.2% were virgin one-sea-winter salmon, 34.1% were two-sea-winter salmon, 9.7% were three-sea-winter salmon and 15.9% were previous spawning grilse (Table 12). The freshwater age of the sampled fish was predominantly two years (90.2%), while 9.8% of the sample had a freshwater age of three years. Data on the sex ratios of sampled fish indicated a high proportion of females in the virgin one-sea-winter salmon and previous spawning grilse samples (Table 13). These characteristics closely resemble those of salmon stocks along the Atlantic coast of Nova Scotia. These characteristics, together with the data from tag returns (Table 14) suggest that salmon by-catch in St. Margaret's Bay is comprised of mainly Nova Scotia stocks.

It was found that the majority of salmon caught by non-salmon commercial fishermen were sold quickly and profitably on the wharf to local individuals, tourists and fish peddlers who await the arrival of fishermen from their trap nets. Local seafood outlets, fish buyers and restauraners readily purchased surplus salmon. While the proportionate disposal of salmon to the various consumers was not determined, a value of \$6.50-\$7.00 per kg, round weight, was common the wharf; this revenue therefore provides trap-net fishermen with a lucrative "bonus" to their fishing income.

Catch timing of other finfish species in multi-species commercial fish traps indicates that significant quantities of herring, mackerel and cod are taken from late May to mid-July (Fig. 16). Since salmon by-catches also peak during this period (Fig. 15), by-catch control by seasonal restrictions on commercial fish traps would appear impractical.

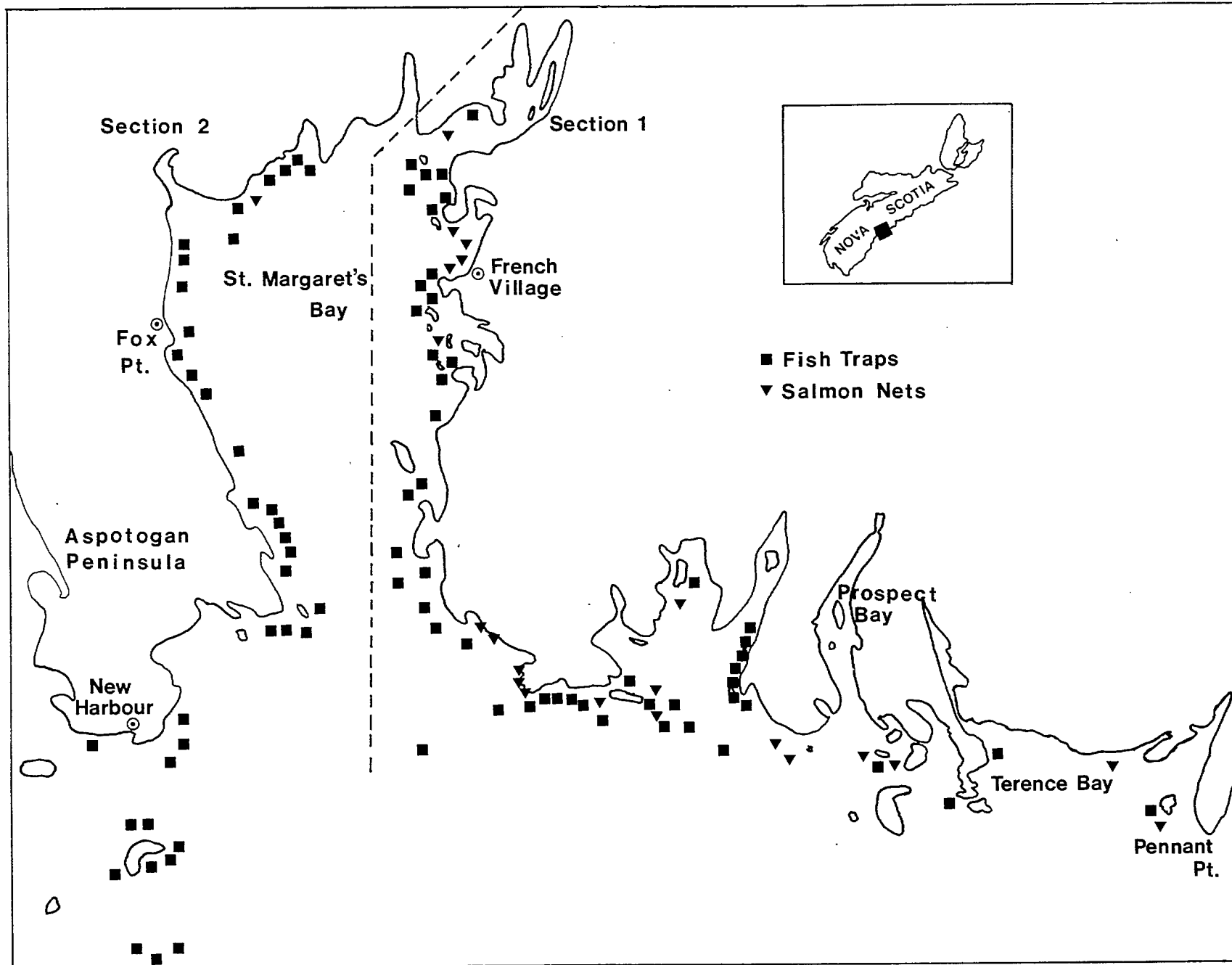


FIG. 12. Location of commercial fish traps and salmon nets in the 1978 St. Margaret's Bay salmon by-catch study area.

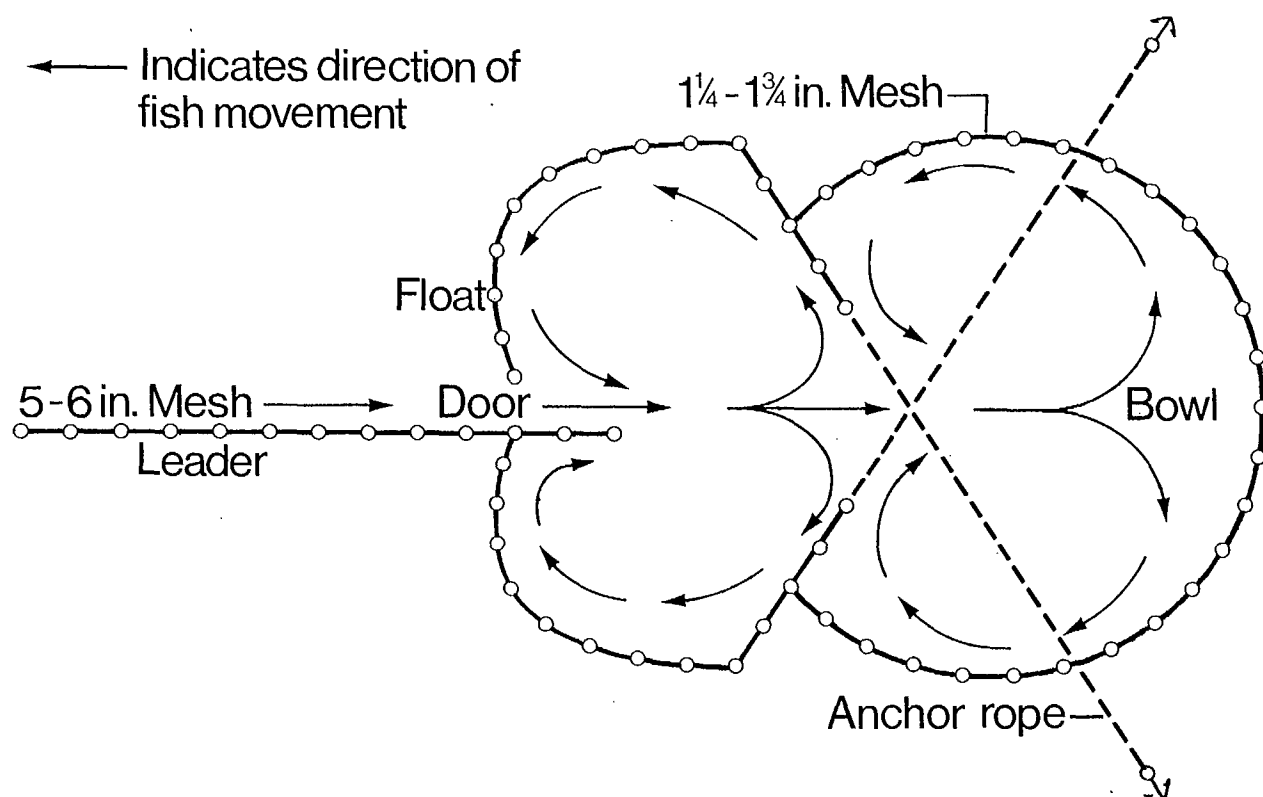


FIG. 13. The bowl or bottom fish trap commonly used in St. Margaret's Bay.

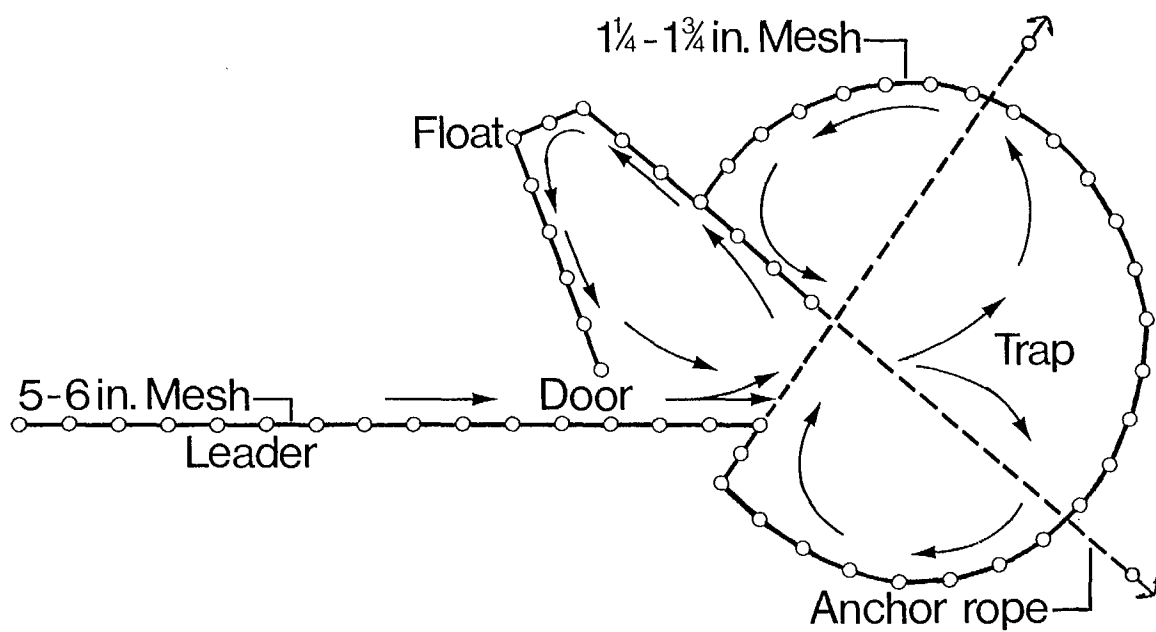


FIG. 14. The wall or straight fish trap commonly used in St. Margaret's Bay.

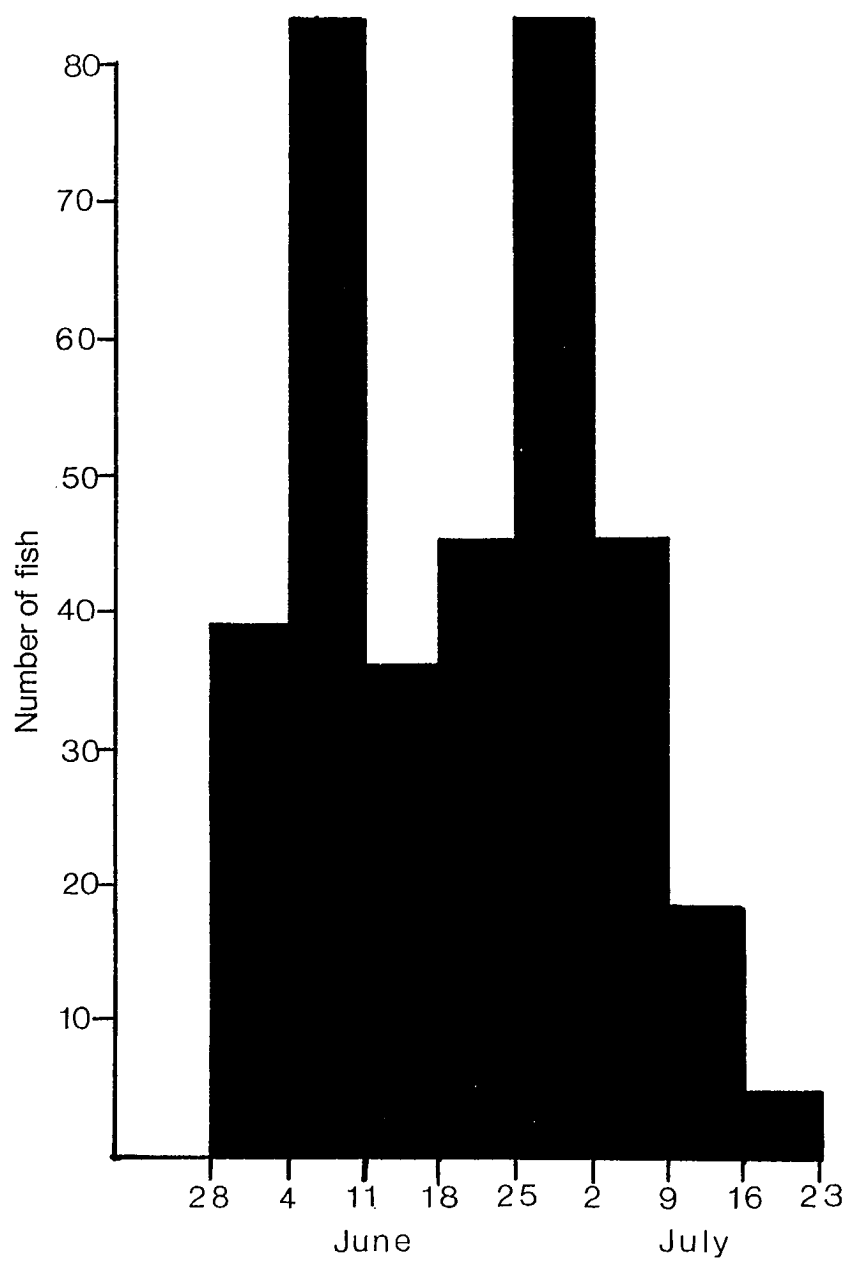


FIG. 15. Salmon by-catch timing in St. Margaret's Bay, 1977-78.

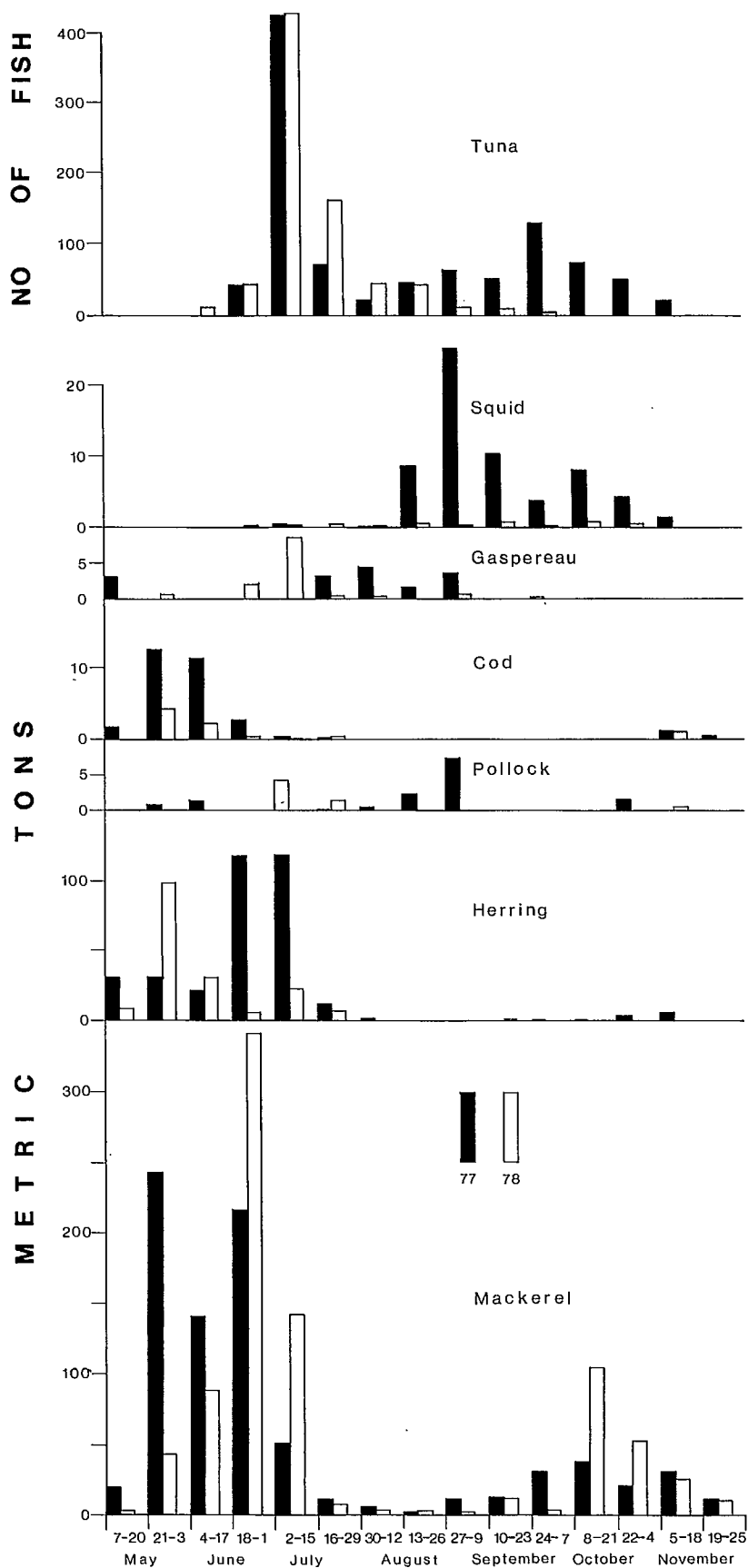


FIG. 16. Catch timing of other finfish species in commercial fish traps in St. Margaret's Bay, 1977-78.

SUMMARY AND CONCLUSIONS

Salmon by-catch statistics as they are presently collected are inadequate for management purposes. However, they do provide an overview of by-catch distribution in each salmon-management zone and in each type of non-salmon commercial fishing gear. A new tagging program for all landed salmon and a new statistical collection system is advocated.

Average annual salmon landings from 1974 to 1978 in non-salmon gear ranged from 15,000 kg to 48,000 kg, depending on the data source employed. Although by-catches fluctuate annually and probably have declined historically, recent catch declines have not paralleled salmon stock declines in mainland Nova Scotia, because of offsetting increases in gear efficiency and effort.

Five critical areas accounted for greater than 70% of the annual mainland Nova Scotia salmon by-catch. These areas in descending order of impact are Herring Cove-Pennant, St. Margaret's Bay-Mahone Bay, Morden-Hall's Harbour, Little Harbour and Ecum Secum.

Proportionately, salmon landings in non-salmon gear are high in every salmon-management zone except Northumberland Strait South. According to departmental statistics for the period 1974-78, by-catch accounted for 27.9%-48.7% ($\bar{x}$ 38.4%) of total annual salmon landings in mainland Nova Scotia. However, it is suggested that this proportion is even higher because of non-reporting in areas of high by-catch. If by-catch control measures are not introduced, it is likely that the proportion of all salmon landings taken as a by-catch will increase.

Multi-species commercial fish traps accounted for the largest proportion, 55.6%, of the average annual mainland by-catch. Other gear types responsible for by-catch in descending order of impact were herring weirs (20.0%), surface gill nets (14.2%) and groundfish gill nets (9.4%), according to departmental statistics.

The analysis of gear distribution data suggests that multi-species commercial fish traps are concentrated in specific areas such as George Bay, Canso, Ecum Secum, Little Harbour, Herring Cove-Pennant, St. Margaret's Bay-Mahone Bay, Stonehurst-Cape LaHave Island and West Baccaro-Pubnico Harbour. Herring weirs are found mainly in the St. Mary's Bay, Digby and Morden-Hall's Harbour areas. Surface gill nets, on the other hand, are dispersed throughout all salmon management zones; however, most of their impact is felt along the Atlantic coast in Zones 11-13. Gaspereau gill nets, a component of the surface gill-net fishery, create a special problem in that they are deployed in the estuaries of major salmon rivers at times when salmon are present in abundance. Groundfish gill nets are mainly dispersed along the Atlantic coast in Zones 11-13.

Freshwater age composition, sex ratios of virgin one-sea-winter salmon and repeat-spawning grilse, and tag returns of one-sea-winter and older salmon released as hatchery smolts suggest that the salmon by-catch in mainland Nova Scotia is comprised of a high proportion of Nova Scotia stocks.

Multi-species, commercial fish traps were responsible for most of the by-catch taken inside St. Margaret's Bay. It was not possible to quantify by-catch in the bay because of difficulties in sampling and the reluctance of non-salmon fishermen to divulge their landings. Salmon taken as a by-catch are sold quickly and profitably (\$6.50-\$7.00/kg) on the wharf to local residents, tourists and fish peddlers who await the arrival of fishermen from their traps. Although catch-timing analyses indicated that salmon were taken over a relatively short period, from early June to early July, other finfish species were also taken in substantial quantities during this period, therefore making it seemingly impractical to control by-catch through seasonal restrictions on fish traps.

This study points out the need to review existing inshore fishing patterns and the regulations controlling these fisheries. The harvest conflicts identified in this study could be reduced by more precise synchronization of fishing seasons with the time periods when primary species for which the gear is licensed are available in each zone; introducing more precise mesh sizes, appropriate for the species the licensee is allowed to catch; prohibiting the use of monofilament surface gill nets; prohibiting the deployment of certain gear types in areas where severe harvest conflicts occur; and controlling the number of licenses issued, number of nets allowed per license and net length. Such a review would result in a more integrated inshore fishery strategy - particularly with regard to herring, mackerel and gaspereau fisheries - to prevent over-exploitation, reduce harvest conflicts, protect the licensed commercial salmon fishery presently managed under a restricted-entry policy, and maximize economic returns to fishermen under existing market conditions.

APPENDIX A

SURVEY QUESTIONNAIRE DISTRIBUTED TO
NON-SALMON COMMERCIAL FISHERMENCONFIDENTIAL WHEN COMPLETEDSALMON BY-CATCH QUESTIONNAIRE - For Biological Purposes Only

1) Catch Information:

	Primary species fished	Primary species catch (lb)	Gear description (length, depth, mesh size, etc.)	Fishing location	Est. by-catch (lb)		By-catch timing	
					Gr.	Sal.	Time range	Peak period
1977	1							
	2							
	3							
	4							
1978	1							
	2							
	3							
	4							

- 2) Do you consider the value of your salmon by-catch to be an important part of your fishing income? Yes _____ No _____

Approximately what percentage of your total fishing income was derived from the salmon by-catch in 1977: _____% 1978: _____% ?

- 3) Please comment on the importance to you of your salmon by-catch relative to your total catch of all other species?
- 4) The current spawning escapement of Atlantic salmon to Nova Scotia rivers has been shown in juvenile salmon population studies to be well below the estimated requirements. The proper management of the salmon resource is dependent on accurate statistics of salmon landings in licensed commercial salmon gear, other-species gear (herring, mackerel and groundfish gill nets, weirs, and commercial fish traps), and in the sport fishery. If it is decided that the salmon by-catch must be reduced to release more salmon for spawning and stock rehabilitation, could you suggest any changes to the existing regulations which would not significantly reduce your catch of other species for which you are licensed?

- 5) What noticeable changes have there been in your salmon by-catch in recent years?

- 6) Additional comments:

Signature: _____

Address: _____

Date: _____

APPENDIX B

SURVEY QUESTIONNAIRE - DISTRIBUTED TO
FEDERAL FISHERY OFFICERS OF THE CONSERVATION AND PROTECTION DIVISION

1) Catch Information:

Gear	Estimated salmon by-catch							
	1 9 7 7				1 9 7 8			
	Grilse		Large salmon		Grilse		Large salmon	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
Trap nets								
Herring gill nets								
Mackerel gill nets								
Groundfish gill nets								
Weirs								
Other (Specify _____)								
TOTALS								

- 2) a) Comment on the probable accuracy of salmon by-catch statistics reported by fishermen to you.
How could by-catch statistic estimates be improved?
- b) Comment on the possible usefulness of a mandatory fisherman's Log Book in which all catches must be recorded.
- 3) Do you feel that fishermen in your district are setting their gear (other than licensed salmon gear) in ways or at times specifically to catch salmon? Please elaborate.
What proportion (%) of the salmon by-catch is truly incidental?
- 4) What changes have you observed in the salmon by-catch in recent years?
- 5) If it is decided that the salmon by-catch must be reduced to release more salmon for spawning, the commercial salmon fishery, and the sport fishery, what changes to existing regulations could you suggest which would not reduce fishermen's catches of other species for which they are licensed?
- 6) How would imposed salmon by-catch restrictions affect fishermen's incomes in your district?

APPENDIX B. Continued

- 7) A number of options have been proposed in other parts of the Atlantic Provinces to regulate the by-catch of salmon. Please comment on each of the following suggestions considering their usefulness in salmon protection, effect on the primary species' catch for which the gear is licensed, and enforcement practicality:
- a) Herring and mackerel gill nets must be set not less than 1 1/2 fathoms below the water surface.
 - b) The herring and mackerel gill net fishery will be closed from mid-June to mid-July in critical areas of interception except under special permit. (eg., for fishermen requiring bait).
 - c) Selected critical bays and estuaries where salmon by-catches are significant be designated closed areas to all fishing.
 - d) All fishing gear must be taken out of the water from sunset Saturday to sunset Sunday from June 15 to August 15 in critical areas of interception.
 - e) Regulate the setting of herring and mackerel gear as follows: Gill nets and trap leaders must be set parallel to and not perpendicular to the nearest shoreline and not set shorefast. Trap leaders must not be less than 6" mesh and no longer than 50 fathoms.
 - f) What additional methods might be effective?
- 8) A salmon tagging program has been proposed for both the sport and commercial fisheries. Fishermen would be supplied with tags which must be attached to all salmon caught. The possession or sale of untagged fish would be prohibited. The quota allowed each fisherman would be dependent on location, gear type, and previous catches. Please comment on the possible effectiveness of such a program, its administrative practicality, enforcement problems, and probable acceptance by fishermen.

APPENDIX C

RESPONSE OF NON-SALMON COMMERCIAL FISHERMEN
TO SURVEY QUESTIONNAIRES

Excerpts from the responses received to questions posed in the survey questionnaire (Appendix A) distributed to non-salmon commercial fishermen are summarized below.

Approximately what percentage of your total fishing income was derived from the salmon by-catch in 1977 and 1978?

Zone/Area	% of fishing income	
	1977	1978
Fundy Nova Scotia	N/A	N/A
Northumberland Strait South	N/A	N/A
Southeast Nova Scotia	10.0	14.6
Ecum Secum	20.0	30.0
Halifax	11.6	9.5
Little Harbour	20.0	20.0
Herring Cove-Pennant	12.5	10.4
Southwest Nova Scotia	N/A	N/A
Queens-Shelburne counties	4.0	4.0
Outer Fundy Nova Scotia	N/A	N/A
Morden-Hall's Harbour	43.0	43.0

Please comment on the importance of your salmon by-catch relative to your total catch of all other species.

Non-salmon commercial fishermen at Ecum Secum, Little Harbour and Morden-Hall's Harbour indicated that salmon was an important part of their fishing income. Atlantic salmon is easily marketed and the ensuing income is used to offset expenses and supplement other fishing income. Without this revenue, fishermen at Morden-Hall's Harbour indicated they could not make a suitable living based solely on catches of species such as herring or mackerel. In Southeast Nova Scotia, the salmon by-catch according to fishermen is economically unimportant except at Ecum Secum. The responses received from the Herring Cove-Pennant area generally indicated that if salmon by-catch was lost, incomes would not be significantly reduced. The non-salmon commercial fishermen from the St. Margaret's Bay area who responded were divided in their assessment of the impact of the salmon by-catch on their income; most commented that its value was negligible relative to other species landings. Commercial fishermen in Queens and Shelburne counties generally indicated that salmon by-catch was a pleasant "surprise" but was economically unimportant except for perhaps a few trap operators.

studies to be well below the estimated requirements. The proper management of the salmon resource is dependent on accurate statistics of salmon landings in licensed commercial salmon gear, other-species gear and in the sport fishery. If it is decided that the salmon by-catch must be reduced to release more salmon for spawning and stock rehabilitation, could you suggest any changes to the existing regulations which would not significantly reduce your catch of other species for which you are licensed?

Only 53 of the 130 questionnaires returned offered any comment on this question; some of their suggestions included:

1. Release all grilse and salmon alive.
2. Restrict the sport fishery until stocks recover.
3. Trap leaders should not be set shorefast but should begin in 2.5 fathoms of water at normal low tide during the salmon run.
4. Surface gill nets should have smaller mesh size during the salmon season.
5. Prohibit the use of monofilament gill nets in the inshore fishery.

Additional comments:

Several non-salmon commercial fishermen in Southeast Nova Scotia indicated that seals were adversely affecting their income by removing substantial quantities of fish, including salmon, from their nets; they also suggested that cormorants were preying on large numbers of young salmon. Non-salmon fishermen alluded to excessive sport catches and poaching as factors adversely impacting on salmon stocks and stated that the burden of rebuilding salmon stocks should not be placed on the shoulders of commercial fishermen. One fisherman suggested that salmon enhancement efforts should be expanded by releasing more hatchery-reared smolts. In the Herring Cove-Pennant area, fishermen indicated that floating groundfish nets were being set illegally to capture salmon.

The current spawning escapement of Atlantic salmon to Nova Scotia rivers has been shown in juvenile salmon population

APPENDIX D

RESPONSE OF FEDERAL FISHERY OFFICERS
TO SURVEY QUESTIONNAIRES

Excerpts from the responses of federal fishery officers to some of the questions posed in the survey questionnaire (Appendix B) are summarized below.

Comment on the probable accuracy of salmon by-catch statistics reported by fishermen to you. How could by-catch statistics be improved?

Fishery officers indicated that in general salmon by-catch statistics were accurate in areas where by-catches were low; however, catch estimates from areas of high by-catch were not reliable.

Comment on the possible usefulness of a mandatory fisherman's log book in which all catches must be recorded.

Almost 75% of the fishery officers responded negatively to the introduction of a mandatory fisherman's log book. They commented that fishermen would reluctantly fill out the log books and data accuracy would not be improved over that received from present statistical collection methods. They suggested that it would be virtually impossible to verify data entered in the log books or enforce its use unless the Fisheries Act requiring fishermen to declare their catches was enforced.

Do you feel that fishermen in your district are setting their gear (other than licensed salmon gear) in ways or at times specifically to catch salmon? What proportion (%) of the salmon by-catch is truly incidental?

Federal fishery officers indicated that non-salmon commercial fishermen in areas where salmon by-catches are high are setting gear to purposefully capture salmon. In the Herring Cove-Pennant area, for example, about 80% of the by-catch is thought to be a directed salmon catch. They stated that other by-catch problems were caused by floating groundfish gill nets, illegal salmon traps, modification of fish traps to capture salmon, deployment of gaspereau gill nets in estuaries after gaspereau had moved upstream, and setting surface gill nets in the shape of a trap. However, outside areas of known salmon migration, the fishery officers suggested that 90% of the by-catch was truly incidental.

If it is decided that the salmon by-catch must be reduced to release more salmon for spawning, the commercial salmon fishery, and the sport fishery, what changes to existing regulations could you suggest which would not reduce fishermen's

catches of other species for which they are licensed?

The following suggestions were offered by federal fishery officers in response to this question:

1. Prohibit gill netting in river estuaries during the period of salmon migration.
2. Release all Atlantic salmon alive from multi-species fish traps.
3. Multi-species fish traps should be licensed for specific periods or seasons and removed after primary species catches indicate they are not present in quantity, particularly in the areas of high by-catch - for example, fish traps should not be deployed in the Herring Cove-Pennant area before July 15.
4. Gaspereau gill netting should cease in river estuaries where salmon are concentrated after June 1.

In areas of low salmon by-catch, fishery officers suggested few changes and indicated that better enforcement of present regulations was the preferred approach. Fishery officers had mixed opinions regarding the release of salmon from non-salmon gear, particularly since most salmon captured in surface gill nets or groundfish gill nets are dead when the nets are fished. The wastage which would result from releasing dead salmon would have to be assessed against the difficulty of enforcing a regulation which requires that salmon taken in non-salmon gear such as multi-species fish traps be released alive. Alternative solutions suggested included the following: (1) allow fishermen to tag and land these fish, (2) donate salmon by-catch to charitable organizations for a tax credit, (3) release all salmon dead or alive from fish traps only, (4) release live salmon only, or (5) release all salmon dead or alive from all gear types.

A number of options have been proposed in other parts of the Atlantic Provinces to regulate the by-catch of salmon. Please comment on each of the following suggestions considering their usefulness in salmon protection, effect on the primary species catch for which the gear is licensed, and enforcement practicality:
(a) Herring and mackerel gill nets must be set not less than 1 1/2 fathoms below the water surface.

Nearly 80% of the fishery officers rejected this suggestion as being potentially damaging to the herring and mackerel in-shore fisheries and too difficult to enforce. Some officers stated that this regulation would be unnecessary in their districts but possible would be useful in river estuaries where nets are actually being set for salmon.

(b) The herring and mackerel gill net fishery should be closed from mid-June to mid-July in critical areas of interception except under special permit (eg., for fishermen requiring bait).

This regulation change was rejected by about 90% of the fishery officers - most indicated that this time period was critical for the herring and mackerel fishery and thought that fishermen would suffer economically from this restriction unless it could be shown that catch timing for herring and mackerel peaked outside this time period.

(c) Selected critical bays and estuaries where salmon by-catches are significant be designated closed areas to all fishing.

The majority of the fishery officers thought that this was a good suggestion provided that closures were based on the size and economic importance of the salmon by-catch in the area relative to other fisheries within the closed waters. One specific suggestion would close all bays and estuaries traversed by salmon less than 0.5 mile in width - it was noted that closures of this type were already in effect in some areas.

(d) All fishing gear must be taken out of the water from sunset Saturday to sunset Sunday from June 15 to August 15 in critical areas of interception.

Just over one-third of the fishery officers agreed with this suggestion; some recommended that the weekend closure should be longer. However, the majority of the fishery officers did not feel that such a regulation would be practical because of the work involved in removing and resetting gear. Alternatives such as tying up leaders or closure of fish trap doors during the weekend were suggested.

(e) Regulate the setting of herring and mackerel gear as follows: Gill nets and trap leaders should be set parallel to and not perpendicular to the nearest shoreline and not set shorefast. Trap leaders should not be less than 6" mesh and no longer than 50 fathoms.

This suggestion comprises several possible regulation changes. Most fishery officers rejected the idea of setting gill

nets and trap leaders parallel to shore, believing that this would significantly reduce herring and mackerel catches. Two fishery officers offered compromise suggestions: (1) If a net is within 200 feet of shore it must be set parallel; or (2) the inside end of any net set perpendicularly to shore must be placed in water not less than one fathom at normal low tide - fishery officers generally agreed that nets should not be set shorefast. Fishery officers were divided in their opinion regarding the establishment of a minimum mesh size of six inches for trap leaders. Those who rejected this suggestion did so because they believed this mesh size would allow too many mackerel and herring to escape. Almost all officers thought that the leader length of fish traps should be determined by berth location, and that 50 fathoms would be too short to reach out of protected bays.

(f) What additional methods might be effective?

The following list of suggestions was offered by individual fishery officers to reduce salmon by-catch:

1. Herring, mackerel and gaspereau gill nets should not have a mesh size greater than three inches.
2. All live salmon caught in fish traps should be released.
3. All salmon, live or dead, should be released from any gear unless licensed to capture salmon.
4. Fish trap leaders should be set at least 20 fathoms from shore.
5. Fish trap leaders should be made of heavy-gauge material to reduce the chance of meshing fish.

A salmon tagging program has been proposed for both sport and commercial fisheries. Fishermen would be supplied with tags which must be attached to all salmon caught. The possession or sale of untagged fish would be prohibited. The quota allowed each fisherman would be dependent on location, gear type and previous catches. Please comment on the possible effectiveness of such a program, its administrative practicality, enforcement problems, and probable acceptance by fishermen.

Although the majority of fishery officers favoured some form of tagging program for all landed salmon, some felt that setting individual tag quotas would be unfair and that small salmon (grilse) would be discarded so that tags could be saved for large fish. Those opposed to a

tagging program indicated that individuals would still be able to keep untagged fish for sale to a large segment of the public who would be unconcerned about buying illegal fish; they also stated that monitoring such a program would result in an excessive work load. Conversely, those who favoured a tagging program identified such benefits as more public acceptance of conservation, improvement in the accuracy of catch statistics, improved efficiency in catching and prosecuting marine and river poachers, and relative ease of administration. Although some opposed the tagging program, changes in its design, such as eliminating the individual quota concept, should make the proposal more attractive.

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