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A Review of the 1999 Newfoundland and Labrador Scallop Fishery

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Abstract

In 1999, total effort directed at scallop in the Newfoundland and Labrador Region declined 42% from the previous year; nominal catch was down some 54%. Overall St. Pierre Bank (NAFO Subdiv. 3Ps) continued to be the major source of scallop producing 43% and 39% of the total catch in each of 1998 and 1999 respectively. While some of the declines no doubt are due to localized depletions, much of the reductions are due to effort diversion into shrimp and crab, both relatively more abundant.

Only one research survey was completed in 1999. This was directed at aggregations in the Strait of Belle Isle (4R). While pre-recruit abundance continues to be low, two new deposits were discovered. Contributions from these to the overall biomass are yet to be estimated. Typically, scallops in the Strait show a history of encounters with fishing gear. Fifty-seven percent of scallops examined for “stress” or “shock” rings had registered one or more past encounters with fishing gear indicating intense past fishing activity in the area.

Résumé

En 1999, l'effort total de pêche dirigée des pétoncles dans la région de Terre-Neuve et du Labrador a chuté de 42 % par rapport à l'année précédente et les prises nominales, de quelque 54 %. Dans l'ensemble, le banc Saint-Pierre (sous-division 3Ps de l'OPANO) a continué d'être la source de pêche principale, alimentant 43 % et 39 % des prises totales en 1998 et 1999, respectivement. Bien qu'un pourcentage de cette baisse est sans aucun doute relié à un appauvrissement localisé, la plus grande partie des réductions résulte de la réorientation de l'effort vers les crevettes et les crabes, tous deux relativement plus abondants.

L'unique relevé de recherche exécuté en 1999 a ciblé les concentrations du détroit de Belle Isle (4R). Bien que l'abondance des prérecrues continue d'être faible, deux nouveaux dépôts ont été découverts. Les contributions de ces derniers à la biomasse totale n'ont pas encore été estimées. Les pétoncles du détroit montrent typiquement des signes de contact avec des engins de pêche. Ainsi, 57 % des pétoncles examinés pour voir s'ils portaient des anneaux de stress ou de choc avaient eu contact à une ou plusieurs reprises avec des engins de pêche, ce qui indique une activité de pêche intense dans la région par le passé.

Introduction

Two scallop species are commonly found over the shelves around Newfoundland: the sea scallop, Placopecten magellanicus and the Iceland scallop, Chlamys islandica. Up until 1970, only the sea scallop was prosecuted along coastal waters, particularly in Port au Port Bay, Placentia Bay and Fortune Bay. Beginning in 1953, the sea scallop was also harvested offshore intermittently by Maritimes'-based vessels. The Iceland scallop was first commercialized along the Strait of Belle Isle beginning in 1970. Nominal catches here average around 900 t round annually. It is thought to be among the oldest fishery for the species in the world. It's propensity to form dense aggregations, sedentariness and high value inevitably lead to overexploitation. With the downturn in Newfoundland of groundfish species, beginning in the early 1990's, considerable effort has been diverted into the exploration and commercialization of Iceland scallop elsewhere on the continental shelf, sometimes beyond the 200-mi Economic Zone (Fig. 1). Much of the new activity has been directed at aggregations over the large continental shelf to the south (3Ps) and southeast of the island of Newfoundland (3LN), commonly referred to as the Grand Banks of Newfoundland. Deposits closer to shore, some never-before fished, have also been intensively harvested. These include inshore aggregations over Cape Ballard Bank, Perch Rocks and aggregations along coastal Labrador as far north as Nain. Most of the significant deposits are under imposed catch limits. Sometimes, these are scientifically-derived from sample surveys onboard research vessels; more often, however, they are simply generous, managed-invoked pre-emptive levels. A total of ten aggregations is currently under TAC. Although it is a limited entry fishery there is already a large number of licences relative to resource availability. This document reviews by area recent trends in the Newfoundland scallop fishery. Catch and landed size frequencies are presented for 4R. These are from RV surveys and/or from observer information. For offshore aggregations individual meat-weight frequencies are used as proxies for size distributions of the catch.

Nominal landings (3,016 t, round) in 1999 declined significantly from those estimated in each of the two years preceding it (Table 1). There was considerable relief from the intense fishing pressure directed at the species over recent years. Much of the recent effort was diverted to shrimp and crab. With the exception of the Strait of Belle Isle, the number of active vessels prosecuting scallops has declined sometimes significantly (Table 2). Catch limits for most areas were not met (Table 3). In 1999, total effort (logged boat days) directed at scallop declined 42% from the previous year; nominal landings was down some 54%. Overall, St. Pierre Bank (NAFO Subdiv.3Ps) continues to be the major source producing, 43% and 39% of the total catch in 1998 and 1999 respectively (Fig. 2). Some of the observed declines are attributable to localized depletions. With a few exceptions, CPUE's have not shown expected declines. Evidently, the fleet continues to move around to locate and fish down new-found aggregations. This sequential pattern of depletion allows the fleet to maintain or improve threshold catch rates.

NAFO Subdiv. 4R, Strait of Belle Isle

In 4R, beds of Iceland scallop are distributed somewhat discontinuously along the Strait, near-shore to about 80m, from Belle Isle to the north, to Port Saunders to the south. It occurs much closer to shore along the Labrador coast. As a sedentary species, it is most commonly associated with hard bottom where embyssment is facilitated. Aggregations within this area are considered a single stock for assessment purposes (up until 1998, the catch levels were prescribed for the entire area).

The area is under a three-year Management Plan. While the scientific advice for catch limit in this area remained at 930 t round, the TAC had been exceeded in each of the first two years of the multi-year plan (by 377 t and 120 t respectively). Based on vigilante science, and an ad hoc downward adjustment to the conversion factor (7.6 from 9.2) to convert meat weight to round weight, removals in 1998 is estimated to have exceeded both the scientific advice (930 t) and the adjusted, management invoked TAC (1,100 t). The biological conversion factor of 9.2 was restored in 1999. It was argued that to the extent that it was intended to monitor removals from disparate aggregations year-round, it remained a defensible tool to achieve a legitimate goal for the Department (Naidu et al. 1999). Further, we argued that ad hoc changes to this factor to accommodate partisan demands would compromise prescribed exploitation rates for the species within any given area and, over time, render questionable cumulative fishery statistics for the species.

Continuation of the management-adjusted catch limit of 1,100 t, round into 1999 was conditional upon:

a. Provision by area fishers of fishing coordinates where seed scallops are purportedly abundant.
b. Fisher participation in a Science, Ocean and Environment (SOE) mission in May 1999 including the supply and use of traditional fishing gear.
c. The reinstatement of the conversion factor (9.2) temporarily abandoned in 1998.
d. Assisting SOE in the placement and retrieval of spat collectors.
e. Establishment of refugia.
f. Partitioning the 1999 TAC equally to the north and south of 51°25’ N.

Only three of the six conditions were met. viz. (a), (b) and (c).

Scallop landings from this area are summarized in Table 4 (Fig. 3). The stock has been assessed on two occasions since research mandate for the stock was returned in 1992 from the then Gulf Region to the Newfoundland Region (Naidu et. al. 1996, 1998). The fishery is regulated by a catch level, season and now, by area. In 1999, to discourage the propensity for continued localized depletion, it was decided to partition the TAC equally between two areas, north

and south of a line drawn across the Strait at 51°25'N. Number of active licenses varies widely, peaking in 1985 at 107 vessels. In 1999, 42 vessels were active (Table 4). Vessels generally are in the 35 – 55 ft range. Proximity of aggregations to shore allows vessels to make daily excursions to the fishing grounds. The fishing season here usually runs for about 10-12 weeks.

1999 Research Vessel Survey

Resource status here is updated irregularly. In 1999, a survey was directed to the area primarily to reconcile long-standing differences of opinion regarding the abundance of pre-recruit scallops. Science has long cautioned that the area has been characterized by a conspicuous absence of pre-recruits. At consultation meetings fishers have, time and time again, insisted that contrary to our (Science Oceans and Environment) data, there was an abundance of small scallops and that our failure to locate them was variously due to our seeming poor knowledge of the area, the research gear used, time of surveys and other imponderables. During the 1999 consultation with fishers and processors, we had asked fishers to provide us with coordinates where pre-recruit scallops were purportedly abundant. As in previous years, we had also invited them to participate in our survey. This mission took place between May 20-29, 1999. All sets provided to Science by area fishers (N=35) were occupied. Fisher sets were completed with the "Labrador Rake", the fishing gear commonly used in this area. Two rakes, each measuring 5' 6" wide and 5' 8" deep and equipped with 80mm loops (rings) mounted on a tow bar, were used. Two experienced fishers actively participated in all aspects of fishing operations and in sampling protocols along with scientific staff.

Pre-recruit Abundance - A Story Twice Told!

Fisher-selected locations (Fig. 4), ostensibly containing pre-recruit scallops, failed to locate significant numbers of seed scallops (Table 5). Overall, they contributed to only 1.4% of the total numbers caught (or 76 out of 5,321 scallops) and 0.2% of the total weight taken (or 1.14 out of 581 kg). Randomly generated survey stations over the entire area with an 8 ft New Bedford rake (research gear) also failed to support anecdotal reports of the abundance of pre-recruits. In fact, our observations were similar to those made in 1998 by Science staff who accompanied commercial vessels to scallop fishing grounds (Table 6). Catch weights and numbers were highly variable over the area. More significantly, the better catches came from areas to the north of 51^{o} 25' which have been only lightly fished and never surveyed in recent years (Fig. 4). By weight, the best catch (33 kg) was drawn from 69 m at 51^{o} 35'N, 56^{o} 33'W. Immediately after the mission, we had alerted the FFAW (Atkinson to Decker of the FFAW dated July 19,1999) about the discovery of one and possibly two new aggregations. Contributions from these new deposits to the overall biomass is yet to be determined.

Typically, scallops throughout the area consisted of large (old) animals (Fig. 5c). Mean and modal size-shell heights [mm, dorso-ventral axis] from three independent sources in 1999 are summarized in Table 7. Size distribution of scallop in this area from research vessel surveys remains unchanged over a 5-yr period with a constant modal height at 90mm, pointing to the continued absence of incoming year-classes/recruitment. These observations are corroborated by data collected from previous RV missions (1995, 1997, Table 8, Fig. 5), at-sea observations by scientific staff onboard fishing vessels (1998, Table 6), size frequency data from fisher-generated stations (1999) and data assembled by observers (1999, Table 7, Fig. 6).

Size-distribution of cluckers, on the other hand, indicates a relatively higher percentage of small scallops (Fig. 7). As hypothesized previously (Naidu et al. 1998), this might be indicative of selective mortality to young scallops through intense fishing activity. About 30,000 tows between one-half to one mile had been completed in the area in 1999.

In the last five years, somatic parameters such as meat weights have improved in this population (Table 9). On the average, meats are heavier ($\bar{\times}$=16.3 g. vs.11.7 g. in 1999 and 1995, respectively) and meat yields are correspondingly higher. In the early 1980's estimated meat counts (number/lb) typically were in the low to mid-sixties (Naidu et al. 1982). This might reflect reduced density (competition) amongst these filter feeders.

Typically, scallops here show a history of encounters with fishing gear. When sufficiently severe, these events are indelibly recorded on both valves as "shock" or "stress" rings. All of 15 samples (Fig. 8) examined showed evidence of previous encounters with fishing gear (Table 10). Fifty- seven percent of scallops examined (or 772 out of 1343) had registered one or more past encounters with fishing gear! Overall, the incidence varied from 31% to as high as 71% indicating intense fishing activity in the past. It is estimated that approximately 183,000 fishing tows had been made over the last five years!

Stock Status

Scallops here were last assessed in 1997 (Naidu et al. 1998). Based on an efficiency-corrected swept area methodology, fishable biomass here had been estimated at between 7,570-11, 035 t ($\bar{\times}$ = 9,302 t, round). The recommended catch is based on 10% of the biomass (or 930 t).

Natural Mortality

Natural mortality, computed from percent occurrence of cluckers (persistent paired valves still attached at the hinge line), was estimated as per Dickie (1955), Mercer (1974) and Naidu (1988) at 0.17. Overall, no significant differences were detected from previous years (Table 11). For the first time, we also report

separately mortality estimates for each of the two zones north and south of 51^{o} 25'N. The estimate for the area to the south was unexpectedly low suggesting perhaps that the method of computing mortalities from cluckers may be severely compromised in an intense fishery where cluckers are forcibly disarticulated by fishing and culling of catch on deck.

Starfish

Of the five species of starfish found in this area, two (Leptasterias polaris and Crossaster pappossus) are considered significant predators of scallops. Starfish numbers (Table12) do not appear to pose a threat to the resource at this time. Close monitoring may be necessary to ensure that we do not face a similar problem as was encountered in NAFO Subdivision 3Ps (Lawrence et al. 1997; Naidu et al. 1997). In any event, fishers should be encouraged to shuck scallops at sea and return shells to the beds. Discarded viscera may provide abundant food to starfish and reduce predation pressure on live scallops. Fishers should also consider returning bycatch of starfish for composting on land.

1999 Fishery

To discourage localized depletions it was decided that the TAC of 1,100 t, round would be partitioned equally into two zones, north and south of a line across the Strait at 51^{o} 25' N (Fig. 9). The fishery to the south commenced on June 07 with a provision to allow 12 vessels from the Cook's Harbour area to harvest north of the line. After seven weeks, on July 25, it was determined that the 50% quota south of the line had been taken. The fishery north of 51^{o} 25' opened July 26 and closed August 15. On closer inspection of information from dockside monitoring and fishing logs, it was determined that the bulk of the removals, estimated at 704 t (or 67%) had been taken from the southern zone (Table 13). Only 342 t (or 33%) came from the north. The 10-week fishery in 1999 expended a total of 1177 vessel days (logs from 3 vessels unavailable at time of analysis). A total of 108 t remains unaccounted for by logbook data. Only 30% (or 356 days were logged to the north).

Non-standardized CPUE (kg/tow) computed from fishing logs dropped to 29.9 kg from 33.6 kg in 1998, a decline of 11% (Table 14). The declines were evident for each month for comparable months over the three years preceding it. Overall, it was amongst the lowest seen in recent years. Effort (%), removals (%), for the whole area, by zone (north and south of 51^{o}25'), CPUEs by month, year and vessel-size class are summarized in Tables 15-17.

Observer Coverage

Observers participated for a total of sixteen sea days onboard six vessels. Much of their effort was directed at chronicling pre-recruit abundance (Fig. 6 and Table 7).

NAFO Subdiv. 3Ps - St. Pierre Bank

Research - No new information

Fishery

Canadian Zone

In 1999, areas under catch-limit regulation on St. Pierre Bank accounted for nearly 40% (1188 t round) of all scallop removals from Newfoundland (Fig. 2). Of this, 478 t (or 40%) came from the Perch Rocks area, closer to shore than other aggregations in the area (Fig. 1) In fact, there was an estimated 9% overrun on the catch limit (350 t, round) set here for vessels < 45 ft. Nowhere else within 3Ps was the TAC taken. Removals, effort expended (days fished), and CPUEs by area by month for three TAC areas are summarized in Table 18. Although CPUEs within aggregations in the Perch Rocks area were amongst the lowest encountered anywhere, it's proximity to land attracted most (85%) of the effort expended in this area. Average meat count here is estimated at 42/lb (N=1925). Data on meat weight/counts are unavailable from previous years. The CPUEs here have shown significant declines (~30%) from the 1997-98 levels.

Residual areas, (Management Areas 10 and 11), each also under generous pre-emptive catch limits (1,000 t round per area) produced a further 568 t (or 48% of the total from 3Ps). The remainder (2%) came from areas along the Eastern (85 t) and Western (57 t) TAC areas.

Trans-boundary Box

There was no fishing activity in this co-managed area, by either Canada or France. Scallop beds within this area have been ravaged by starfish to the point where fishing is no longer economic. The plant at Miquelon, purpose-built to process scallops from here has been dismantled.

NAFO Div. 3LNO-Grand Bank

Lilly /Carson Canyons & Cape Ballard Bank

Research – No new information

Fishery

Only six vessels participated in the scallop fishery over the Grand Bank, down from 21 the previous year (Table 19). Of these, four fished the Canyons offshore, the remaining spending time (five days) on the Cape Ballard Bank. Nearly 90% of the effort was directed into the once prolific grounds in the Lilly

Canyon and Carson Canyon (Table 20). Even here, both effort (Fig.10) and removals (134 t, round) have fallen to their lowest levels since deposits here were first commercialized (Table 21). Catch rates have declined progressively from about 80kg/tow in the 1995-98 period to only 74 kg/tow (Table 21). However, individual meat-weight frequency distributions show a bias toward slightly larger meats (Fig. 11) compared to 1998. Meat counts (number/lb) computed from mean adductor muscle weights has decreased correspondingly to 39 from 47 in 1998 (Table 22). This suggests that the fishery here is possibly still locating and fishing down accumulated cohorts of new-found aggregations.

Eastern 3L, 3LN and 3Nf

Research - No new information

Fishery - No activity

Labrador

Research - There have been no directed research into scallop aggregations in Labrador.

Fishery

As per recent years, inshore aggregations here were again harvested with nominal catches estimated at 644 t, round (161 t from Williams Hr. and 483 t from the Nain Area). Overall, landings were down compared to 1998 (1190 t). A late start and effort diversion into crab contributed to the lower landings (Judy Dwyer and Regina Anthony, Labrador Office, pers. comm.). There are no data on the resource status. The Provincial Department of Fisheries & Aquaculture had conducted a resource survey and concluded that there was little incremental potential for expansion off Nain (Shawn Melindy, pers. comm.). Details of the survey have not yet become available.

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Table 1. Nominal catches (t, round) of scallop from Newfoundland, 1969-99. The 1999 statistics are provisional.

Year	4R	3Ps		Div. 3LNO			Labrador	Total Iceland		Sea Scallops (offshore 3Ps)
				3L	3N	3O				
1969	248							248		
1970	192							192		
1971	167							167		
1972	2,596							2,596		
1973	2,189							2,189		
1974	244							244		
1975	-							-		
1976	-							-		
1977	-							-		
1978	-							-		191
1979	450							450		8
1980	1,133							1,133		291
1981	1.530							1,530		-
1982	349							349		5,951
1983	371							371		4,930
1984	1,523							1,523		3,428
1985	2,546							2,546		440
1986	1,942							1,942		1,270
1987	1,141							1,141		448
1988	447							447		8,176
1989	155		36					191		2,756
1990	88		507					595		1,270
1991	457		755					1,212		1,112
1992	1,296		5,967	20	2	0		7,285		556
		Core	Non-core							
1993	2,122	-	667	489	325	3		3,606		1,079
1994	2,294	-	440	86	3,844	11		6,675		407
1995	1,497	230	831	101	6,400	0		9,059		564
1996	1,204	306	302	406	9,048	0		11,266		-
1997	1,205	122	5,245	383	3,569	34	653	11,211		-
1998	1,307	0	2,763	187	1,122	1	1,190	6,570		108
1999	1,046	0	1,188	4	134	0	644	3,016		-

Table 2. Fishing activity (number of active licences) for Iceland scallop in NAFO Div. 4R + 3LNOPs, 1996-99.

Area	1996	1997	1998	1999
4R	46	45	41	42
3LNOPs	228	133	79	37
Total	274	178	120	79

Table 3. Iceland scallop fishing aggregations, catch limits and removals from Newfoundland, 1999.

Area	TAC (t, round)	Removals (t, round)
Cape Ballard Bank (CBB) (<45')	250	2
Cape Ballard Bank (CBB) (>45')	250	2
Eastern 3L (EPL)	1,000	0
3LN	1,500	0
3Nf	400	0
Lilly/Carson Canyons (LCC)	900	134
Remainder of 3LNO	2,500	0
Total	6,800	138
Perch Rocks/Keys (PRK)(<45')	350	384
Perch Rocks/Keys (PRK) (>45')	350	94
Eastern St. Pierre Bank (EStP)	300	85
Western St. Pierre Bank (WStP)	500	57
Area 10 – North of 46°30'N	0	73
Area 10 – South of 46°30'N	1,000	165
Area 11 – North of 46°30'N	0	45
Area 11 – South of 46°30'N	1,000	285
Total (Canadian)	3,500	1,188
Transboundary Area (CORE)	30	0
4R	1,100	1,046
Labrador	0	644
TOTAL	11,430	3,016

Table 4. Iceland scallop landings and effort statistics[1] from the Strait of Belle Isle. A species-specific conversion factor of 9.2 is used throughout. The 1999 statistics are provisional.

Year	Landings (t, round)	No. of active licences	Effort (boat days)	Catch per unit effort (unadjusted)	
				kg (round) /boat/day	t (round) /boat/year
1969	248	-	-	-	-
1970	192	-	-	-	-
1971	167	-	-	-	-
1972	2596	-	-	-	-
1973	2189	-	-	-	-
1974	244	24	269	907	10.7
1975	-	-	-	-	-
1976	-	-	-	-	-
1977	-	-	-	-	-
1978	-	-	-	-	-
1979	450	16	459	981	28.1
1980	1133	14	774	1463	80.9
1981	1530	24	1262	1212	63.3
1982	349	24	413	845	14.5
1983	371	23	485	765	16.1
1984	1523	46	1272	1197	33.1
1985	2546	107	2887	882	23.8
1986	1942	88	2270	856	22.1
1987	1141	57	n/a	-	20.0
1988	447	30	n/a	-	14.9
1989	155	14	n/a	-	11.1
1990	88	11	n/a	-	8.0
1991	457	24	n/a	-	19.0
1992	1296	72	n/a	-	18.0
1993	2122	71	n/a	-	29.9
1994	2294	80	2769	828	28.7
1995	1497	43	2113	708	34.8
1996	1204	46	1385	869	26.2
1997	1205	45	1313	918	26.8
1998	1307	41	1364	959	31.9
1999	1046	42	1177	889	24.9

n/a = not available

[1] Sources of landing and effort statistics:
1969-81: CAFSAC Res. Doc. 82/02
1982-83: CAFSAC Res. Doc. 86/77
1984-90: Can. MS Rept. 2154
1990-92: Science Branch, Gulf Region
1993: Statistics Branch, Newfoundland Region
1994-99: Science Branch, Newfoundland Region

Table 5. Relative abundance (numbers and weights, kg round) of pre-recruit and commercial-sized scallop sampled along the Strait of Belle Isle in May 1999, C.C.G.S. Alfred Needler.

Source	No. of sets	Total measured weight (kg)	Total measured number	Percent <60 mm	
				By weight	by number
Fisher sets	35	580.97	5,321	0.20	1.43
Survey sets	102	583.55	5,053	0.10	0.67
Overall	137	1,164.52	10, 374	0.15	1.06

Table 6. Relative abundance of pre-recruit to commercial-sized scallop sampled onboard two fishing vessels in 1998 (F. M. Cahill and E. M. Seward, Science, Ocean and Environment Branch, sampled catch at sea onboard the M.V. Sea Pearl II and M.V. Cape Fisher, respectively).

Vessel	Total measured	> = 60 mm (%)	< 60 mm (%)
Cape Fisher	936	923 (98.6)	13 (1.4)
Sea Pearl II	855	847 (99.1)	8 (0.9)
TOTAL	1791	1770 (98.8)	21 (1.2)

Table 7. Mean and model shell heights (mm) of the Iceland scallop in the Strait of Belle Isle, 1999. Sources of data indicated.

Source	N	Mean shell ht. (mm) (± S.D.)	Modal shell Height (mm)	Range (mm)	
				Max.	Min.
Fisher sets	5,321	86.2 (±9.5)	90	114	5
Research sets	5,053	88.6 (±9.3)	90	117	4
Observer sets	10,409	83.1 (±14.0)	90	115	2

Table 8. Mean and modal shell heights (mm) of the Iceland scallop in the Strait of Belle Isle, 1995-99. Based on research vessel surveys.

Year	N	Mean shell ht. (mm) (± S.D.)	Modal shell Height (mm)	Range (mm)	
				Max.	Min.
1995	3,405	86.8 (± 8.6)	90	111	24
1997	3,257	87.3 (± 8.9)	90	114	25
1999	5,053	88.6 (± 9.3)	90	117	4

Table 9. Biological meat yields, average meat weight and count for the Iceland scallop from the Strait of Belle Isle. No corrections made for epibiont load.

Year	N	Whole wt. (kg)	Meat wt. (kg)	x meat Wt. (g)	Count		Yield (%)
					#/lb.	#/500 g	
1995	921	105.3	10.79	11.7	39	43	10.3
1997	555	68.7	8.77	15.8	29	32	12.8
1999	444	58.0	7.22	16.3	28	31	12.4

Table 10. Frequency occurrence of one or more "shock" rings on shells of the Iceland scallop in the Strait of Belle Isle in May, 1999.

Set no.	Latitude	Longitude	No. caught	No. sampled	No. with Shock rings (%)
14	5115.8	5714.3	158	154	87 (56.5)
17	5118.8	5711.9	205	117	65 (55.6)
18	5118.6	5711.4	202	109	73 (67.0)
32	5132.0	5637.8	163	76	30 (39.5)
33	5136.1	5637.8	76	74	27 (36.5)
34	5135.3	5632.1	129	54	17 (31.5)
66	5110.5	5656.9	55	26	17 (65.4)
85	5128.4	5633.1	49	49	31 (63.3)
86	5129.3	5631.0	98	87	62 (71.3)
87	5128.1	5628.2	108	100	61 (61.0)
101	5136.7	5613.3	74	130	74 (56.9)
105	5139.1	5605.9	111	109	64 (58.7)
124	5144.0	5606.5	130	125	80 (64.0)
129	5135.9	5622.4	84	73	51 (69.9)
138	5115.7	5702.2	66	60	33 (55.0)
15 sets			**1708**	**1343**	**772 (57.5)**

Table 11. Estimates of natural mortality for the Iceland scallop in the Strait of Belle Isle, 1995-99. Clucker numbers are adjusted by a factor of 1.221 to allow for tow-induced disarticulation.

Year	Total		M		
	Live	Clucker	Overall	North of 51°25'	South of 51°25'
1995	3,548	411.5	0.18	0.20	0.12
1997	3,788	393.2	0.16	0.24	0.03
1999	5,148	580.0	0.17	0.20	0.07

Table 12. Mean numbers, weights (kg), and size [arm radii (mm)] for four species of starfish north and south of 51°25' in the Strait of Belle Isle, 1997 and 1999.

Area	No. of sets	Leptasterias			Crossaster			Solaster			Asterias		
		mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)	mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)	mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)	mean #/tow (±S.D.)	mean wt. (kg)/tow (±S.D.)	mean arm length (mm) (±S.D.)
North of 51°25' (1999)	50	131.6 (±130.1)	10.9 (±11.2)	85.0 (±16.1)	31.0 (±45.4)	2.4 (±4.1)	65.0 (±20.9)	0.4 (±0.9)	0.06 (±0.1)	94.9 (±17.2)	0	0	0
South of 51°25' (1999)	52	15.6 (±18.0)	1.9 (±2.6)	98.4 (±26.4)	7.6 (±11.9)	0.7 (±1.2)	78.3 (±18.1)	0.3 (±0.9)	0.04 (±0.1)	87.8 (±34.1)	<0.1	<0.1	36.5 (±7.8)
Overall 1999	102	72.4 (±108.5)	6.3 (±9.2)	91.7 (±22.8)	19.1 (±34.7)	1.5 (±3.1)	72.6 (± 20.4)	0.4 (±0.9)	0.05 (±0.1)	91.4 (±26.8)	<0.1	<0.1	36.5 (±7.8)
Overall 1997	148	41.5 (±66.0)	3.9 (±6.3)	82.4 (±20.2)	14.2 (±26.7)	1.2 (±2.6)	67.5 (±15.5)	0.4 (±1.1)	0.06 (±0.2)	97.2 (±37.8)	<0.1	<0.1	85.0

Table 13. Distribution of fishing effort north and south of 51°25'N in the Strait of Belle Isle, 1999.

Area	DMP		Log data	
	Removals (t)	Effort	Removals (t)	Effort
South	704 (67%)	7 weeks (70%)	662 (70%)	821 days (70%)
North	342 (33%)	3 weeks (30%)	276 (30%)	356 days (30%)
Total	1,046	10 weeks	938	1,177

Table 14. CPUE estimates (non-standardized) for the Iceland scallop fishery in the Strait of Belle Isle 1994-99. Total removals for 1994-96 are based on combination of sales slip and log estimates. Total removals for 1997-99 are from the Dockside Monitoring Program.

Year	Month	Removals (t, round)	Fishing days	CPUE (kg/tow)
1994	May	1.6	3	21.3
	June	822.9	936	37.6
	July	1,004.5	1,192	35.4
	August	252.1	369	28.6
	September	211.9	266	29.5
	October	1.1	3	29.0
	TOTALS	2,294.2	2,769	34.5
1995	June	259.9	352	28.1
	July	506.7	697	28.6
	August	477.5	627	29.9
	September	234.5	391	25.9
	October	18.6	46	22.7
	TOTALS	1,497.1	2,113	28.6
	% change 1994-95	-35%	-24%	-17%
1996	June	374.8	460	29.0
	July	476.1	532	32.2
	August	331.9	363	36.7
	September	20.4	29	33.1
	October	0.8	1	33.6
	TOTALS	1,204.1	1,385	32.2
	% Change 1995-96	-20%	-34%	+13%
1997	June	351.8	383	31.8
	July	446.2	527	35.8
	August	278.4	397	34.0
	September	1.9	5	24.9
	Unaccounted by logbook	126.5	1	-
	TOTALS	1204.8	1313	34.0
	% Change 1996-97	0%	-5%	+6%
1998	June	471.0	516	34.0
	July	459.5	572	33.1
	August	102.5	135	32.2
	September	106.4	141	33.1
	Unaccounted by logbooks	167.6	-	-
	Totals	1,307	1,364	33.6
	% change 1997-98	+8%	+4%	-1%
1999	June	357.9	449	29.7
	July	435.9	532	30.7
	August	144.5	196	28.1
	Unaccounted by logbooks	108.1	-	-
	Totals	1046.4	1,177	29.9
	% change 1998-99	-20%	-14%	-11%

Table 15. Iceland scallop effort, removals and CPUE's, north and south of 51°25'N in the Strait of Belle Isle, 1994-99. (CPUE's based on log entries only, not on dockside monitoring.)

Year	Total		South of 51°25'N		CPUE (kg/tow)		
	Removals (t, round)	Effort (days)	Removals (%)	Effort (%)	Overall	North of 51°25'	South of 51°25'
1994	2,294	2,769	43	42	34.5	29.9	38.1
1995	1,497	2,113	46	47	28.6	28.4	28.5
1996	1,204	1,385	67	61	32.2	22.8	40.7
1997	1,205	1,313	83	80	34.0	21.7	38.0
1998	1,307	1,364	94	93	33.6	23.5	34.4
1999	1,046	1,177	70	70	29.9	28.7	30.4

Table 16. Within-season, non-standardized catch rates for Div. 4R scallop, 1999.

Week	Dates	Removals (t, round)	Fishing days	CPUE (kg/tow)
1	June 7-13	88.4	116	29.5
2	June 14-20	98.1	116	30.2
3	June 21-27	104.4	126	30.0
4	June 28-July 4	100.3	148	28.3
5	July 5-11	108.3	134	31.3
6	July 12-18	79.4	91	30.8
7	July 19-25	108.9	134	30.4
8	July 26-August 1	109.1	120	31.5
9	August 2-8	87.0	109	29.0
10	August 9-15	54.4	83	26.7
Unknown	Not accounted in logs	108.1		
Overall		1046.4	1177	29.9

Table 17. Estimates of CPUE (kg/tow) by vessel size (LOA) for the Iceland scallop fishery in the Strait of Belle Isle, 1999.

Week	Dates	<35'	35-44'	45-54'	55-64'	Combined
1	June 7-13	34.4	27.3	23.3	-	29.5
2	June 14-20	37.3	28.2	22.7	-	30.2
3	June 21-27	36.8	26.6	24.9	-	30.0
4	June 28-July 4	34.0	26.1	22.5	-	28.3
5	July 5-11	35.3	30.2	25.6	-	31.3
6	July 12-18	39.2	29.5	22.0	-	30.8
7	July 19-25	36.9	27.9	26.5	-	30.4
8	July 26-August 1	31.9	32.2	29.4	-	31.5
9	August 2-8	30.6	27.9	28.8	-	29.0
10	August 9-15	28.9	25.3	25.0	-	26.7
	1999 Overall	34.7	28.1	25.2	-	29.9
	1998 Overall	37.9	33.0	27.8	-	33.4
	1997 Overall	40.1	33.9	26.0	43.1	33.9
	1996 Overall	45.3	29.7	24.4	54.4	32.1
	1995 Overall	27.2	26.3	23.6	27.2	25.9
	No. of vessels (1999)	18	18	6	-	42
	% of weight removed (1999)	35%	42%	13%	-	90%*

* 108.1 t of landings unaccounted for by logbook data

Table 18. Monthly non-standardized CPUE estimates (kg/tow, round) for various aggregations under TAC within NAFO Div. 3Ps, 1997-99.

Month	Perch Rocks / Keys			Eastern St. Pierre Bank			Western St. Pierre Bank		
	Removals[1] (t, round)	Fishing days	CPUE (kg/tow)	Removals[1] (t, round)	Fishing days	CPUE (kg/tow)	Removals[1] (t, round)	Fishing days	CPUE (kg/tow)
March	0	1	-	-	-	-	-	-	-
April	82	62	36	5	4	48	10	5	60
May	71	61	28	52	21	81	8	3	78
June	75	49	40	18	8	76	5	3	31
July	74	54	34	-	-	-	4	4	17
August	54	50	29	-	-	-	13	4	78
September	35	19	52	-	-	-	11	5	67
October	53	28	59	-	-	-	-	-	-
November	6	6	35	-	-	-	-	-	-
December	1	1	78	-	-	-	-	-	-
Overall 1999	451	331	35	75	33	76	51	24	51
1998	842	453	51	13	12	24	508	196	62
1997	1,197	695	52	1,321	659	58	1,497	388	128

[1] sum of daily log estimates x9.2

Table 19. Nominal catch (t, round) and effort (no. vessels) in the fishery directed at Iceland scallops in NAFO Div. 3LNO, 1992-99.

Year	No. of Vessels	Div. 3L	Div. 3N	Div. 3O	Total Div. 3LNO
1992	1	20	2	0	22
1993	10	489	325	3	817
1994	57	86	3,844	11	3,941
1995	48	101	6,400	0	6,501
1996	52	406	9,048	0	9,454
1997	52	383	3,569	34	3,986
1998	21	187	1,122	1	1,310
1999	6	4	134	0	138
Totals		1,676	24,444	49	26,169

Table 20. Summary of TACs, effort and removals for NAFO Div. 3LNO, 1999.

Area	TAC (t)	No. of Fishing days*	Removals (t)	
			Log estimates*	Dockside monitor
Eastern 3L (EPL)	1,000	1	0	0
3LN (3LN)	1,500	0	0	0
Lilly/Carson Canyons (LCC)	900	45	124	134
3Nf (3Nf)	400	0	0	0
Cape Ballard Bank (CBB)	500	5	4	4
Remainder of 3LNO (R3LNO)	2,500	0	0	0
Total	6,800	51	128	138

* based on log estimates only. Approximately 93% of total removals accounted for by log records

Table 21. Monthly non-standardized CPUE estimates for the Lilly/Carson Canyon area of NAFO Div. 3N, 1995-99.

Month	Removals[1] (t, round)	Fishing days	CPUE (kg/tow)
May	33	9	124
August	20	9	62
September	46	18	62
October	24	9	71
Overall 1999	124	45	74
1998	631	213	79
1997	2,495	920	77
1996	2,696	904	86
1995	3,023	977	98

[1] sum of daily log estimates x9.2

Table 22. Percent meat-count frequency in port samples from the Lilly/Carson Canyons (NAFO Div. 3N), 1998-99.

Meat count (#/lb)	1998	1999
10-19	-	0.3%
20-29	2.6%	11.8%
30-39	18.9%	35.8%
40-49	30.7%	30.7%
50-59	25.0%	14.7%
60-69	14.0%	4.5%
70-79	5.8%	1.4%
80+	3.0%	0.7%
x meat wt. (g) (± S.D.)	9.62 (±2.52)	11.62 (± 3.10)
N	3,368	2,989

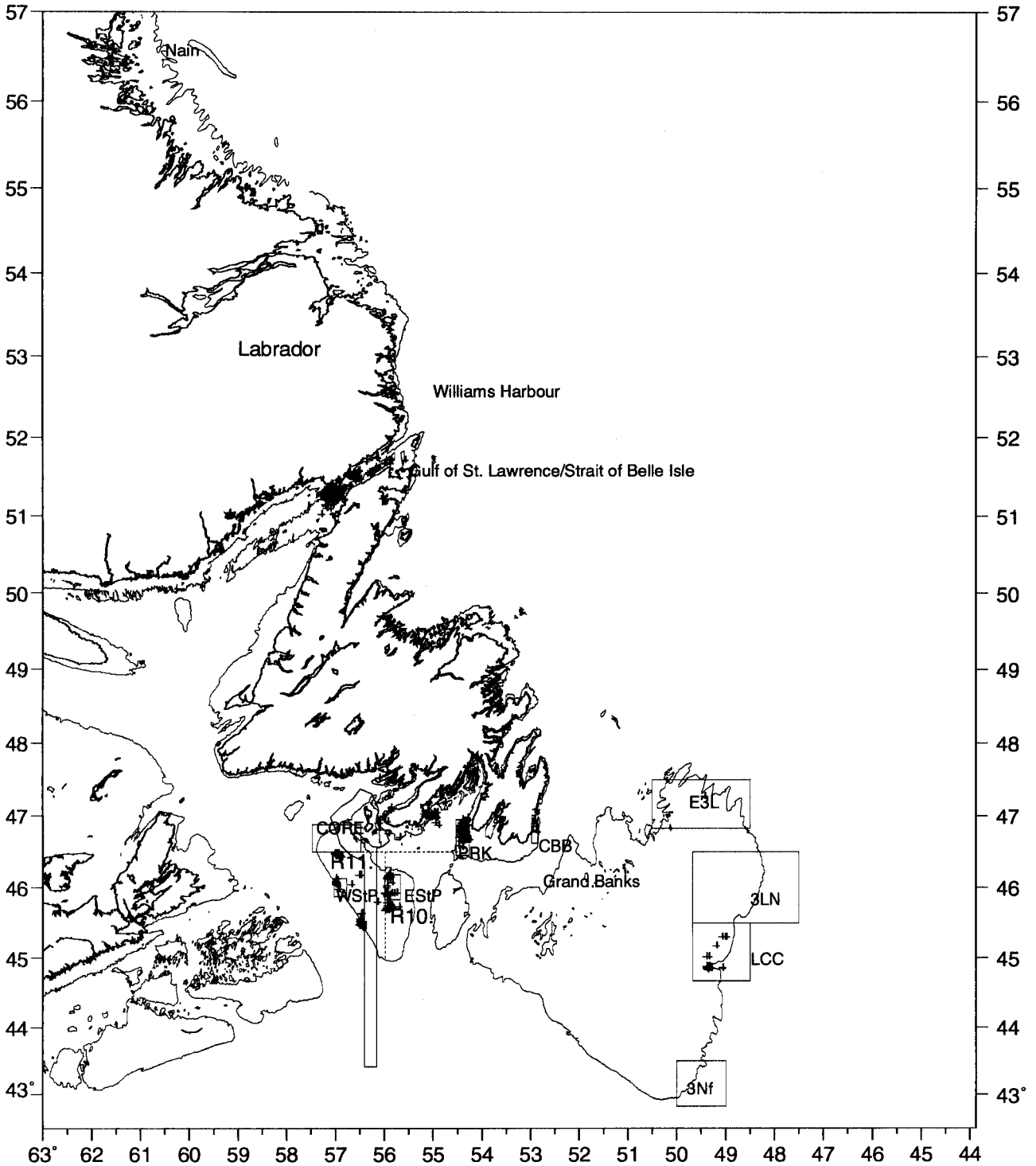

Fig. 1. Scallop aggregations fished in Newfoundland, 1999.

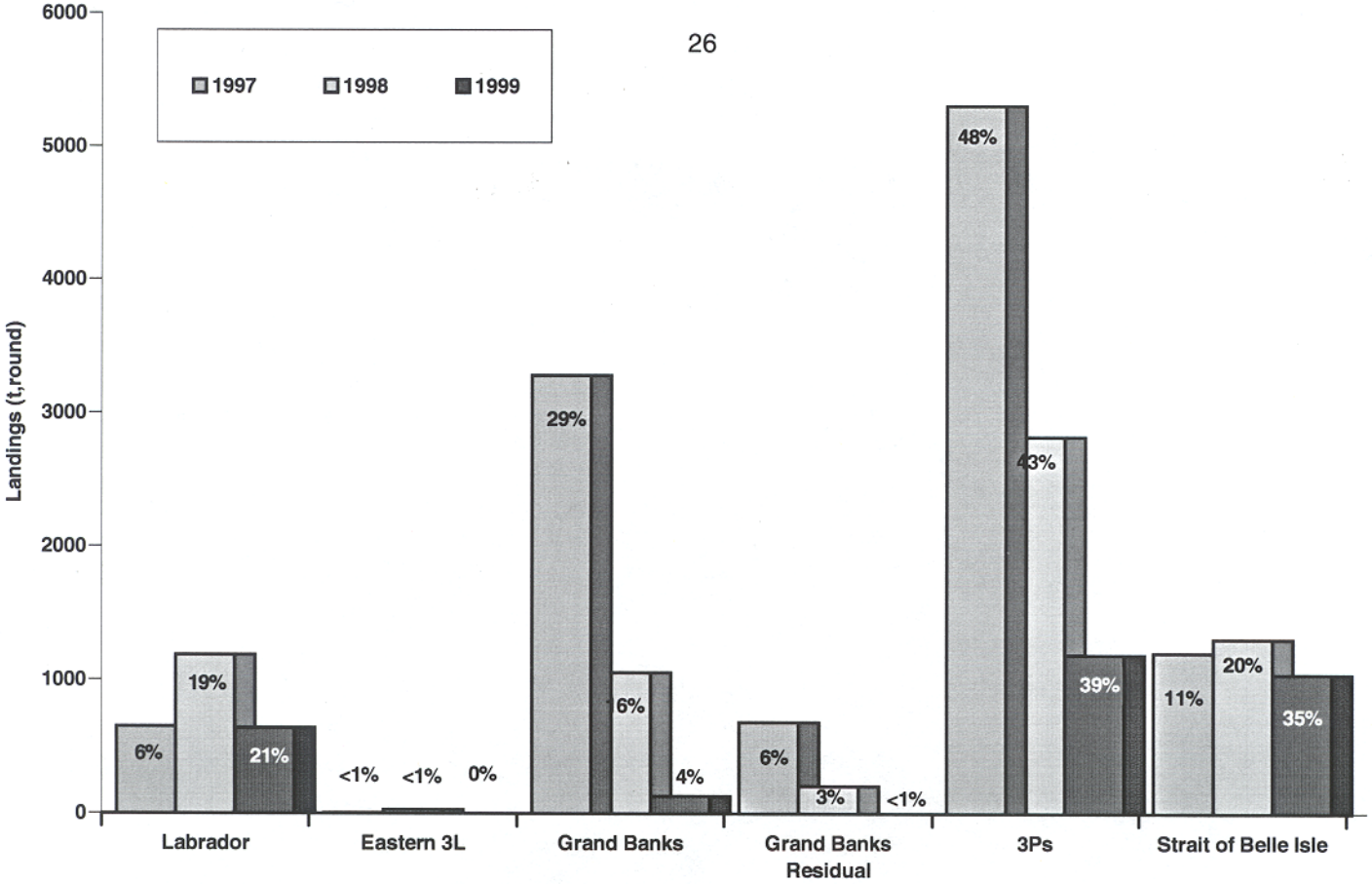

Fig.2. Nominal catch of Iceland scallop, by area, in Newfoundland, 1997-99.

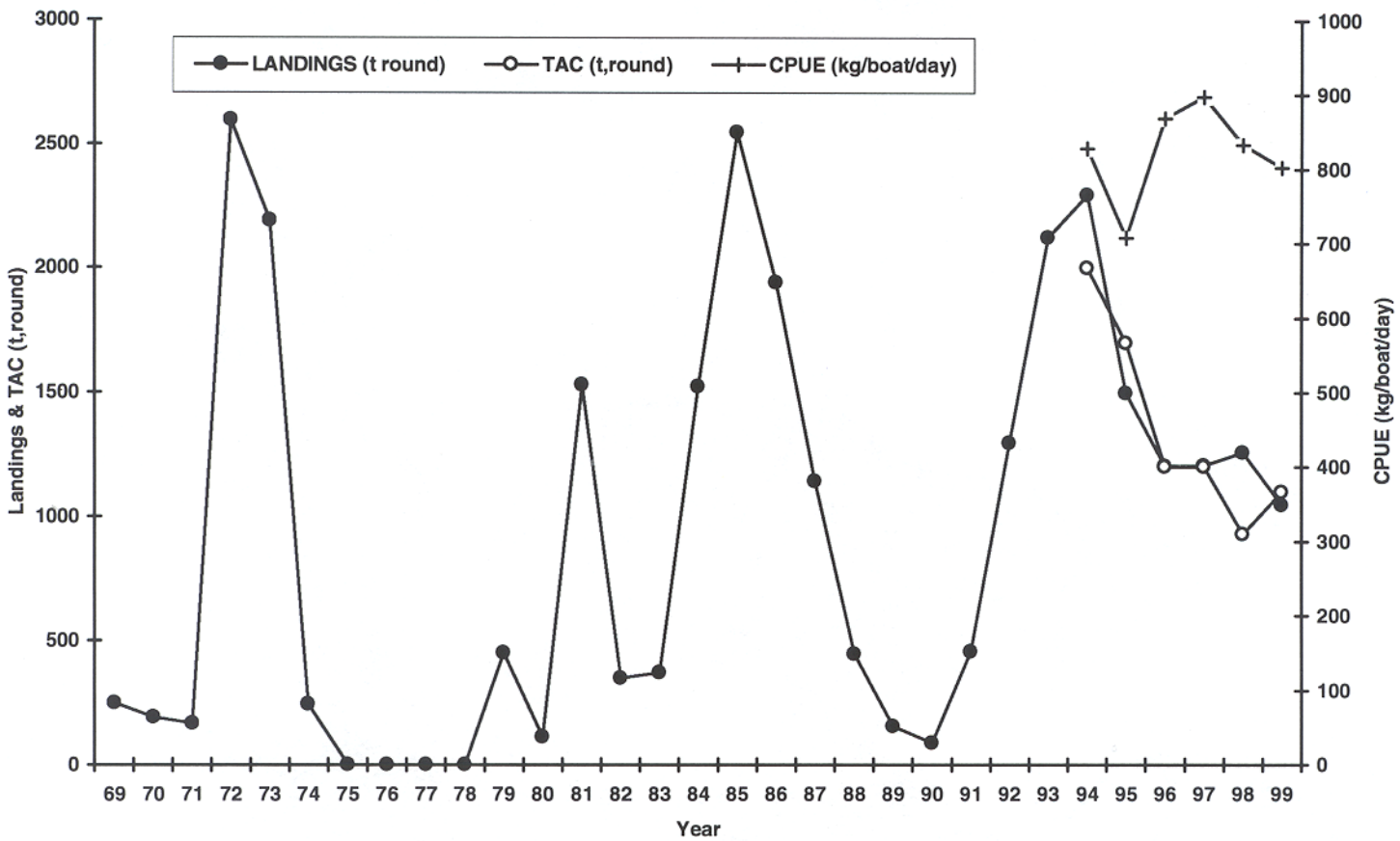

Fig.3.Scallop landings (t,round), TACs (t,round) and notional CPUEs (kg/boat/day) for the 4R, Strait of Belle Isle fishery.

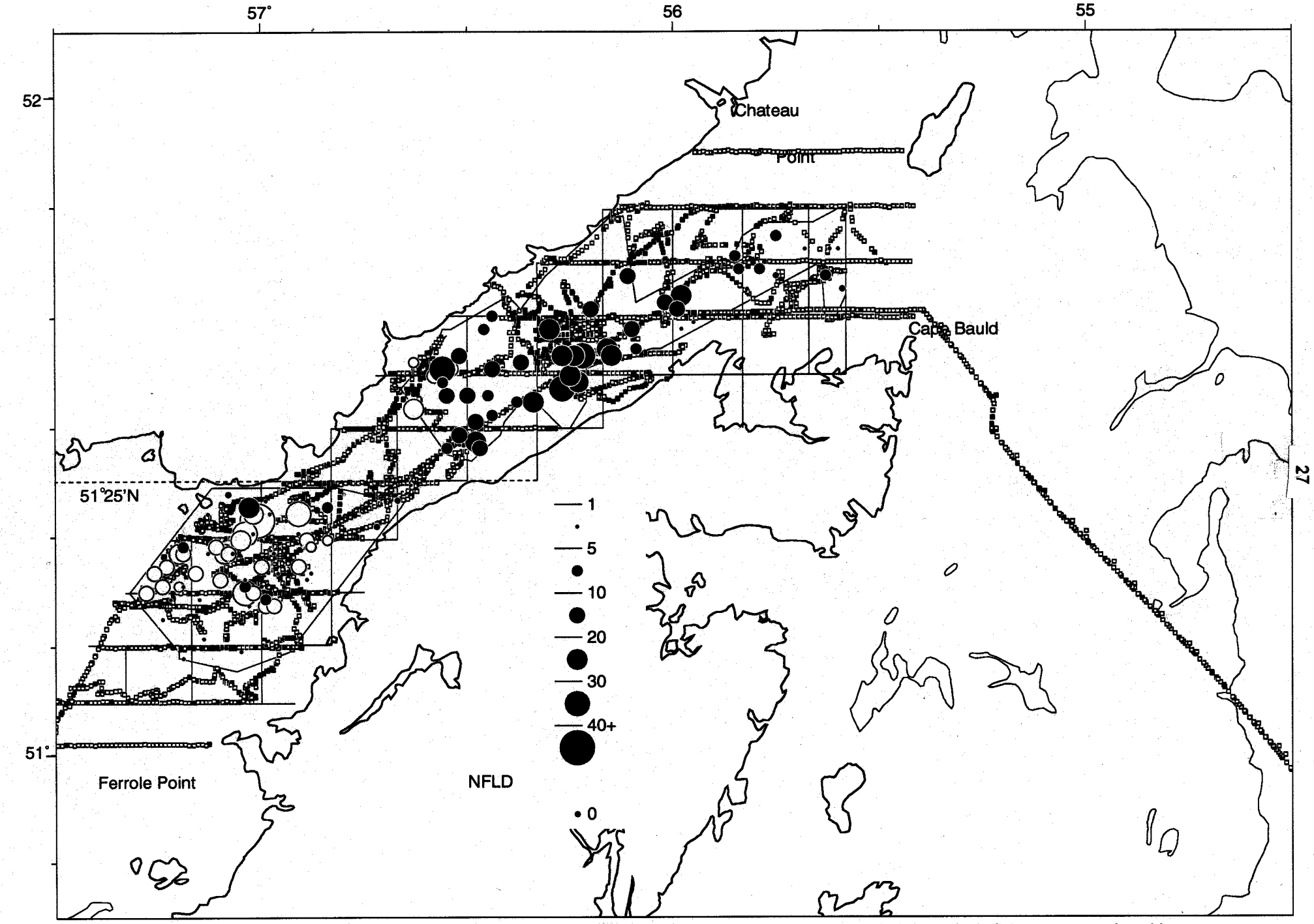

Fig.4. Distribution of RV catches in 1999, ALFRED NEEDLER. Solid circles represent survey catches, open circles are from fisher generated positions. Previously collected Roxann is represented by solid squares for grounds suitable for presence of scallops and open squares for unsuitable grounds.

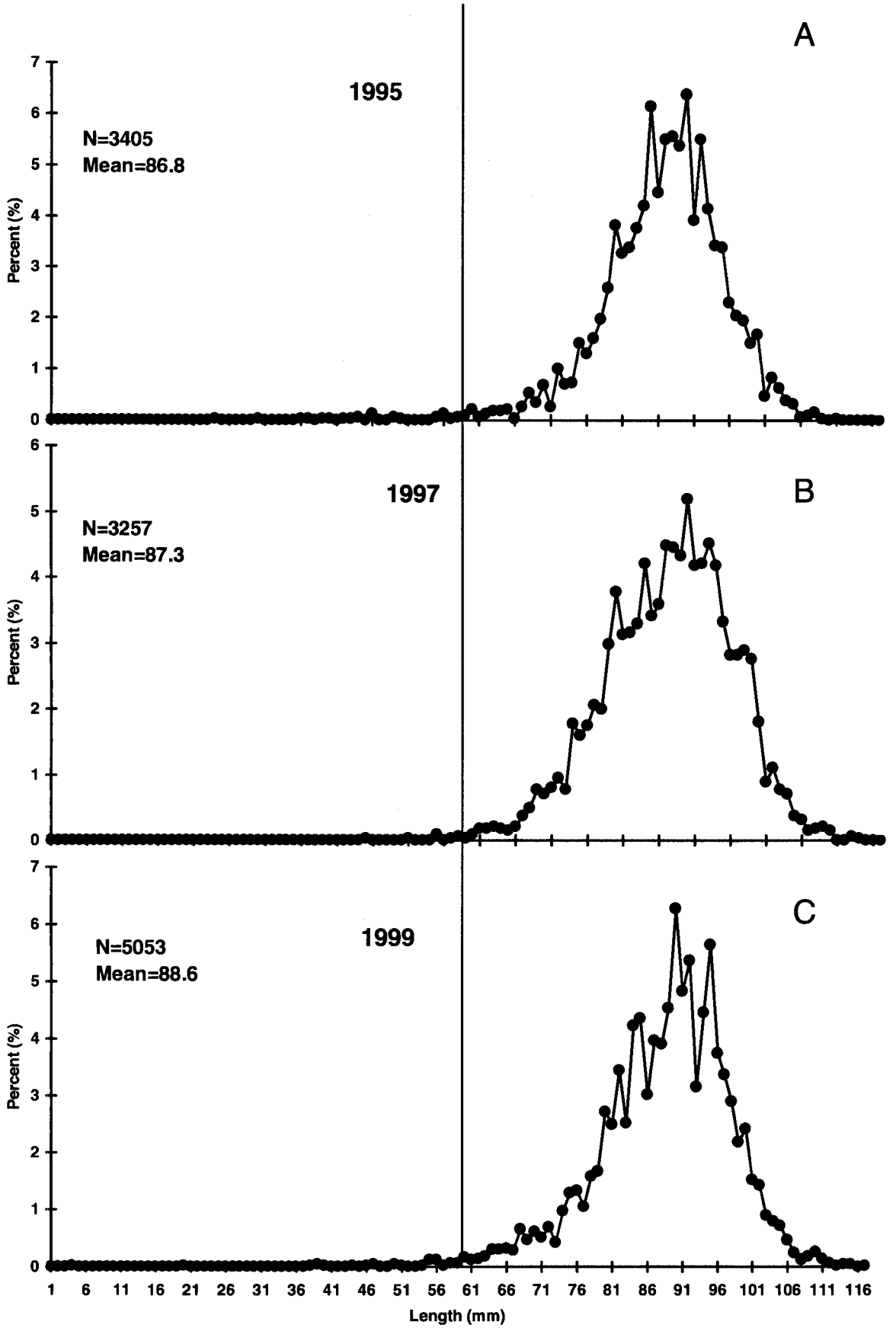

Fig.5. Size-frequency distributions (shell-height, mm) of the Iceland scallop, 1995, 1997 and 1999.

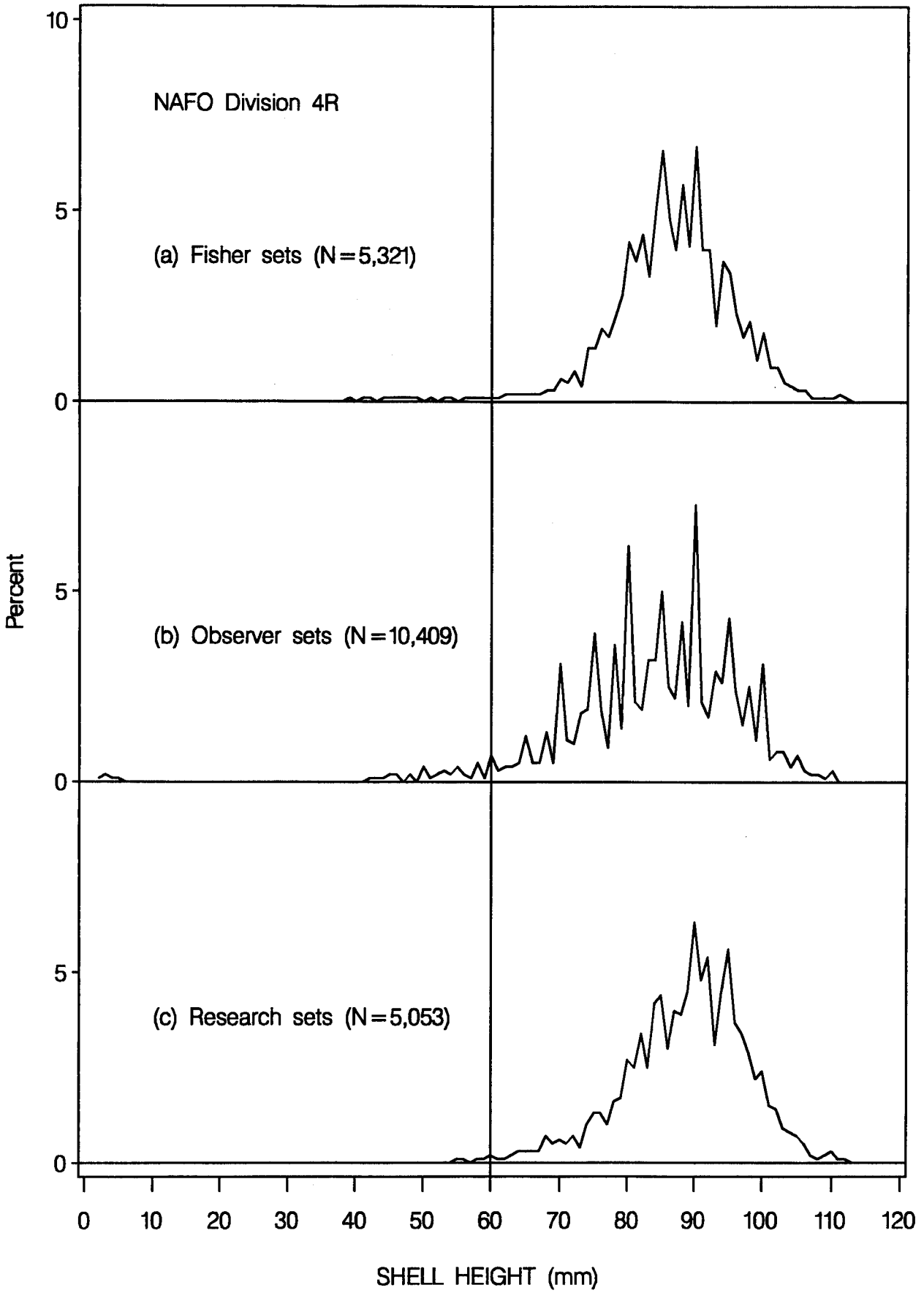

Fig. 6. Size-frequency distributions (shell-height, mm.) of the Iceland scallop in the Strait of Belle Isle, 1999. (a) Fisher-provided locations (b) observer data and (c) research sets.

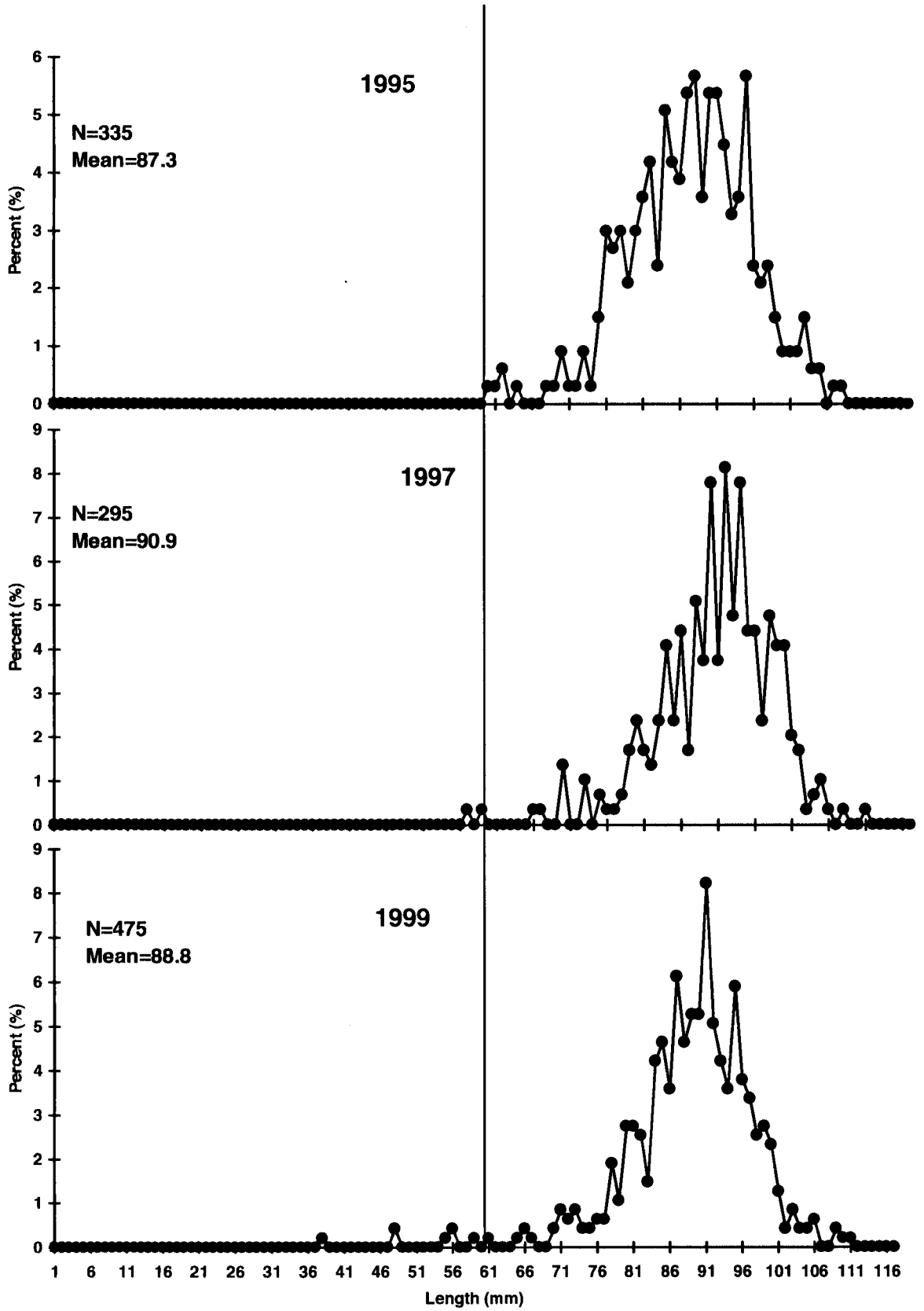

Fig.7. Size-frequency distributions (shell-height, mm) of the Iceland scallop cluckers, in the Strait of Belle Isle, 1995, 1997 and 1999.

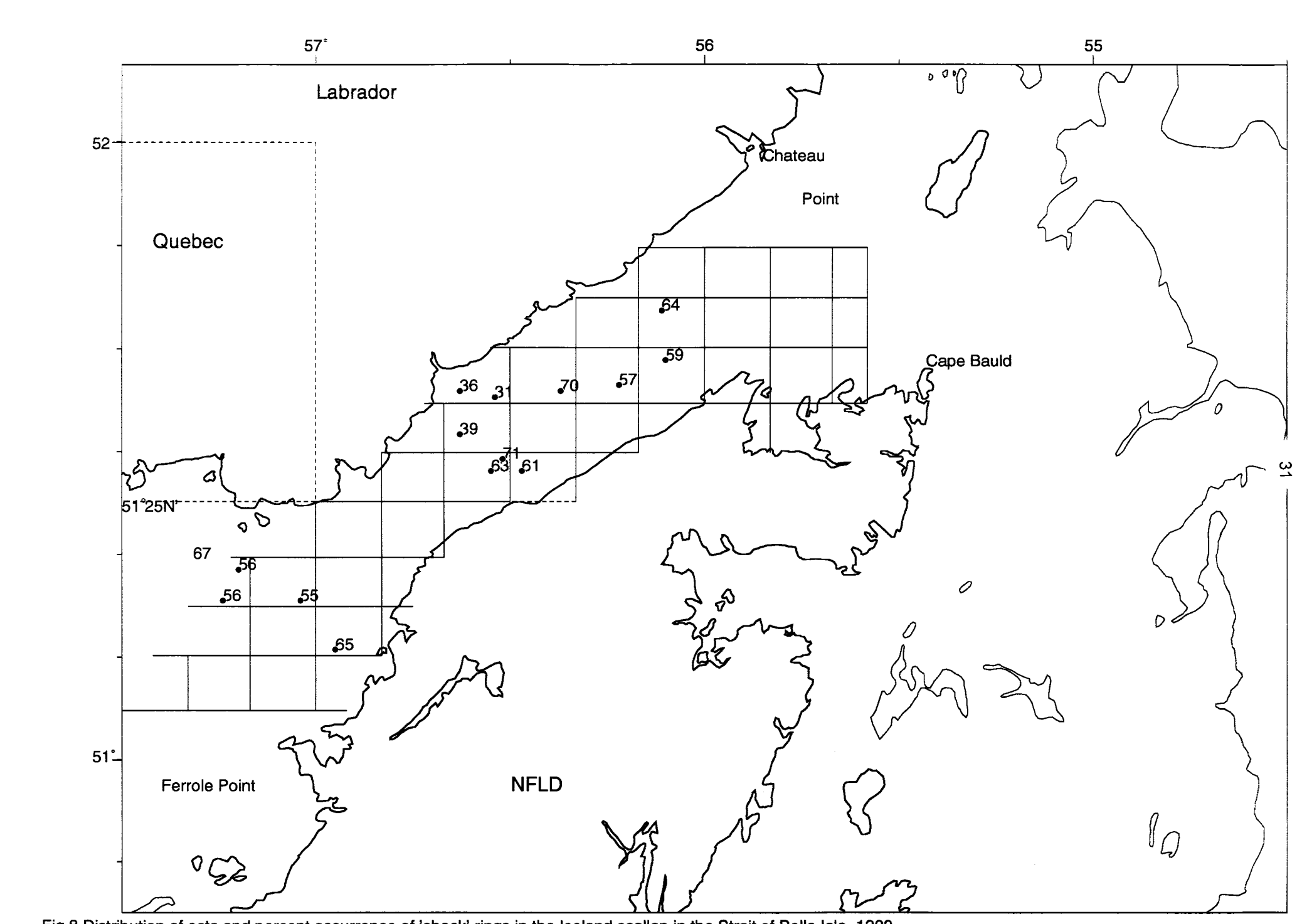

Fig.8.Distribution of sets and percent occurrence of 'shock' rings in the Iceland scallop in the Strait of Belle Isle, 1999.

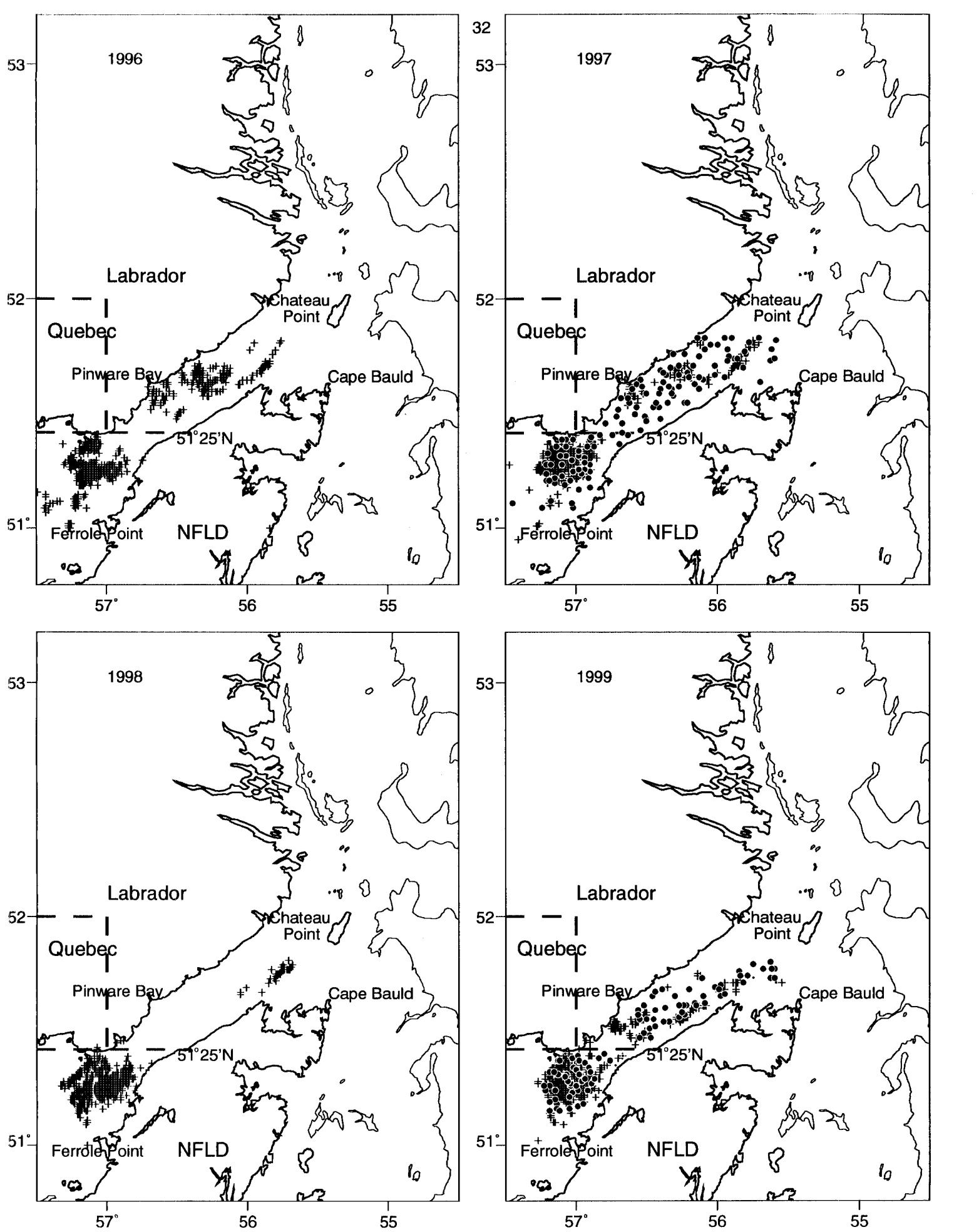

Fig.9. Distribution of logged commercial effort [+] relative to RV survey stations [o] in the Strait of Belle Isle, 1996-99

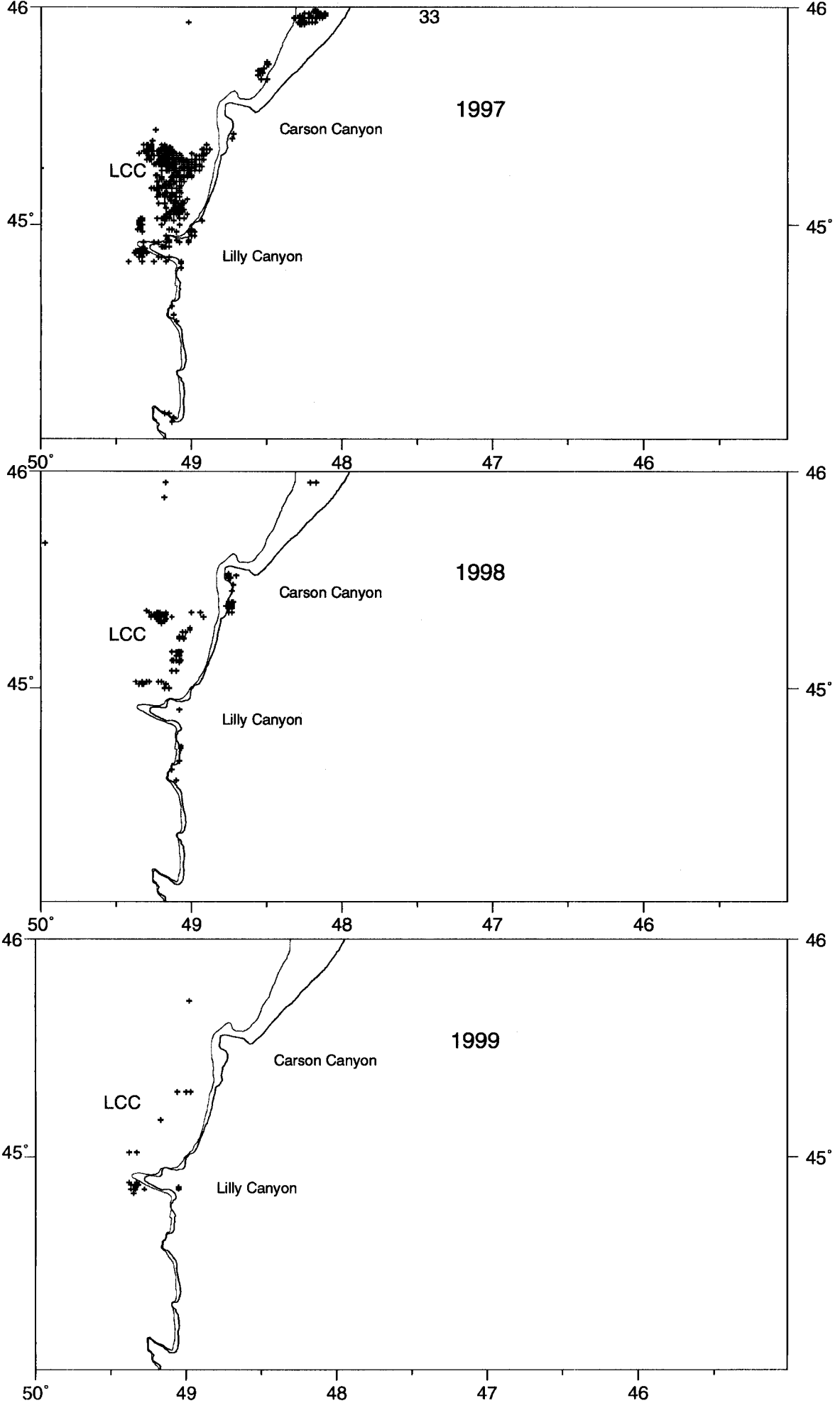

Fig.10. Distribution of commercial effort in Lilly/Carson Canyon, 1997-1999.

Fig. 11. Commercial meat-weight frequency distributions from the Lilly Canyon/Carson Canyon area, 1994 – 1999.