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Biological characteristics of Atlantic cod (Gadus morhua) from three inshore areas of western Trinity Bay, Newfoundland

by

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Abstract

Aggregations of cod were found at several locations in shallow (30-100 m) waters in Smith Sound and Northwest Arm, but not in Southwest Arm in western Trinity Bay during December 1995. Over 2000 fish caught with jiggers and feathered hooks were tagged with yellow t-bar spaghetti tags and released and another 204 were sampled for length, sex, maturity, and otoliths. Cod were generally large, with most between 40 and 80 cm and mean lengths typically around 56 cm. Ages of cod ranged from 3 to 8 years, but more than 50% were 5 year olds. Beginning of the year mean weights at age were higher than those reported for commercial samples of cod from 3L during recent (1990-95) years. Cod were generally in good condition, with mean values of Fulton's K (based on round weight) in the range 0.85 to 0.94. Most cod sampled were adults and examination of the gonads of females suggested they would spawn in the coming spring. In April 1996, as part of a hydroacoustic survey to estimate the biomass of cod in these inshore areas, further biological sampling of cod was conducted. Aggregations of cod were located in all three areas, particularly in Smith Sound and Southwest Arm. A total of 1542 cod were caught with otter trawl, jiggers and feathered hooks, and gill nets. Cod in all three areas were generally large and of comparable size range and condition to those seen in December 1995. Comparison of the maturities of females revealed a dense aggregation of spawning fish in deep water (>200 m) in the outer reaches of Smith Sound. In contrast, the cod in all other regions, including the inner reaches of Smith Sound, were mostly mature but not spawning and appeared destined to spawn later in the spring. The prevalence of the parasitic copepod Lernaeocera branchialis on cod in these inshore areas, particularly among larger fish and all sizes caught in Southwest Arm, was much higher than that of comparable sized fish sampled offshore over the past 13 years. Since transmission of the parasite occurs only during fall and mainly in the inshore, the high prevalences suggest that these fish had resided in inshore waters throughout the fall and winter months.

Résumé

En décembre 1995, des rassemblements de morues ont été observés à plusieurs endroits dans les eaux peu profondes (30 à 100 m) de la baie Smith et du bras nord-ouest, mais pas dans le bras sud-ouest de la partie ouest de la baie de la Trinité. Plus de 2 000 poissons capturés à la turlutte et avec des hameçons à plumes ont été marqués au moyen d'étiquettes spaghetti jaunes en t, puis libérés, tandis que 204 autres ont servi d'échantillons pour l'évaluation de la longueur, du sexe, de la maturité et pour l'examen des otolithes. En général, les morues étaient grandes, la plupart d'entre elles mesurant entre 40 et 80 cm, la longueur moyenne étant d'environ 56 cm. L'âge des morues se situait entre trois et huit ans, mais plus de 50 % d'entre elles avaient cinq ans. Les longueurs moyennes selon l'âge du début de l'année étaient supérieures à celles qui ont été rapportées pour les échantillons de prises commerciales de la division 3L depuis quelques années (1990-1995). La morue était généralement en bonne condition, les valeurs moyennes du coefficient de K de Fulton (basé sur le poids entier) se situant entre 0,85 et 0,94. La plupart des morues échantillonnées étaient des adultes, et l'examen des gonades des femelles a montré qu'elles auraient frayé au printemps suivant. En avril 1996, dans le cadre d'un relevé hydro-acoustique visant à évaluer la biomasse de morue dans ces eaux côtières, d'autres échantillons biologiques de morue ont été prélevés. Les rassemblements de morues ont été observés à trois endroits, particulièrement dans la baie Smith et le bras sud-ouest. Au total, 1 542 morues ont été capturées au chalut à panneaux, à la turlutte et avec des hameçons à plumes, et au filet maillant. Les morues des trois zones était généralement grandes; leur taille et condition étaient comparables à celles de décembre 1995. Une comparaison de la maturité des femelles a révélé une forte concentration de géniteurs en eau profonde (> 200 m) dans la partie extérieure de la baie Smith. Par contre, dans toutes les autres régions, y compris les parties intérieures de la baie Smith, la morue était presque mature, mais ne frayait pas et semblait destinée à se reproduire plus tard au printemps. La présence chez un grand nombre de morues de ces zones côtières du copépode parasite *Lernaeocera branchialis*, particulièrement chez les grands poissons et chez les individus de toute taille capturés dans le bras sud-ouest, était beaucoup plus fréquente que chez les poissons de taille comparable prélevés en haute mer depuis 13 ans. Puisque ce parasite ne se transmet qu'à l'automne et principalement dans les eaux côtières, sa forte présence indique que ces poissons ont résidé dans les eaux côtières à l'automne et pendant l'hiver.

Introduction

During April 1995, a dense school of adult cod with a biomass estimated by hydroacoustics to be about 17,000 tons was located in Smith Sound, Trinity Bay (Rose 1996). The discovery of these fish was of considerable interest because this region is outside the area traditionally surveyed by research vessels, and the fall 1994 and fall 1995 stratified random trawl surveys did not locate any major concentrations of cod elsewhere in NAFO Divisions 2J-3KL. Reports of aggregations of adult cod in shallow inshore areas elsewhere off the northeast coast have also been received. A recent tagging study revealed that adult cod were present in Smith Sound and Northwest Arm in December 1995. From an assessment perspective these observations raise two issues: (1) what is the biomass of cod in these inshore waters that are outside the areas traditionally surveyed, and (2) what are the origins and biological characteristics of these cod.

Recent inshore studies have been directed toward addressing these issues. Since much of the inshore is untrawlable, a further hydroacoustic survey of cod in Smith Sound and adjacent areas (Fig. 1) was conducted (April 15-26th, 1996) to obtain further biomass estimates. Results are presently being analyzed. Tagging studies, including the December 1995 study, and previous ones employing sonic and conventional tags, have also been conducted to investigate the migration patterns and stock structure of these fish (Wroblewski et al. 1994; Taggart et al. 1995). However, minimal fishing activity due to the moratorium has resulted in few tag returns in recent years and further tagging may be suspended until fishing activity increases. Samples for genetic analysis have also been collected from inshore aggregations and results are presented elsewhere (Ruzzante et al 1996; Taggart 1996).

The present paper summarizes information on the distribution, catch rates, length frequencies, maturity stages, and parasite (Lernaeocera branchialis) infestation of cod collected from these inshore areas during the December 1995 and April 1996 studies. An age-length key is given for samples collected during December 1995. Findings are also compared with recent data from cod collected during the regular fall surveys of 2J-3KL (Shelton et al. 1996). Information on the bathymetry and environmental conditions within the sampled areas is also presented.

Material and Methods

Shamook Trip 250 (4-14th December 1995)

The primary purpose of this trip was to obtain live cod for tagging. All cod from Smith Sound and Northwest Arm were obtained using a Norwegian jigger and feathered hooks; cod in Southwest Arm were collected using a Yankee 36 otter trawl equipped with a 3/4" mesh liner in the cod-end (mechanical problems prevented use of the trawl in other areas). Information on the number of persons jigging and the duration of fishing was recorded so that catch rates could be standardized.

Live cod were placed in holding tanks until recovered and those in excellent condition were tagged with yellow t-bar spaghetti tags just below the first dorsal fin. The length (nearest cm), round weight (nearest gm), numbers of the parasitic copepod Lernaeocera branchialis, and tag number were recorded before each fish was released. An additional 204 cod, including those damaged during capture, were killed and sampled as above, except that sex, maturity (following the scheme of Templeman et al. 1978), and otoliths were collected. Blood samples for DNA analysis were also collected from approximately 100 cod. Temperature and salinity profiles at each fishing station and elsewhere in the study area were recorded using a SeaBird vertical cast CTD.

Shamook Trip 252 (15-26th April 1996)

The primary purpose of this trip was to conduct a hydroacoustic survey of cod in Smith Sound, Northwest Arm, and Southwest Arm. Biological sampling was conducted with three gear types; the Yankee 36 otter trawl equipped with a 3/4" mesh liner, jiggers and feathered hooks, and single (i.e. 50 fathom) 5.25 inch mesh gill nets. Fish were examined as per the December survey. Otoliths were collected from several hundred fish but ages are not yet available. Samples from Smith Sound were divided into two groups for analysis of maturity and parasite data; inner Smith Sound refers to samples collected in the shallower (< 160 m) western portion of the area (set nos 1, 2, 6, 7, 8) and outer Smith Sound refers to samples from the deeper (>200 m) eastern portion of the area (set nos. 3, 4, and 5). Samples were collected to verify the identity, size range, and density of targets observed on the hydroacoustic apparatus, as well as provide biological information on cod in the study area. Oceanographic date were collected as per the previous trip.

Results

Bathymetry and topography

The study area consists of three adjacent fjords, ranging from approximately 20-30 nm long and 0.5 to 1.0 nm wide (Fig. 2). Smith Sound and Southwest Arm are extremely steep sided with deep (>200 m) central channels that converge with deep water in Trinity Bay which extends outward onto the continental shelf. In contrast, the central channel of Northwest Arm is not as deep (160 m) and has a relatively shallow (70 m) sill near the entrance. Within Northwest Arm the rough bottom and numerous submerged cables make trawling almost impossible in all except one small area, thereby limiting the range of sampling gears. Smith Sound and Southwest Arm have some trawlable areas in the deep central channel interspersed with areas of rough bottom. Jigging is possible throughout the shallower portions of inner Smith Sound and Northwest Arm, and at the extreme western end of Southwest Arm.

Temperature and salinity

During December 1995, water temperatures (not shown) in all three areas were generally between 2 and 3.6°C at the surface down to a depth of about 80 m, but decreased to a minimum of -1.2°C in areas where depth extended down to 200 m. Temperatures increased somewhat at depths below 200 m to 0.0°C at 290 m in the deepest areas near the mouth of Southwest Arm.

In April 1996, water temperatures were generally between 0 and 2.5°C at the surface in all areas (Fig. 3). Smith Sound and Southwest Arm showed similar temperature and salinity profiles, with a cold (-1.2°C) intermediate layer at depths of 60-200 m, and a relatively warm (0.5°C) deep layer below 200 m. In Northwest Arm, water temperatures were relatively uniform with increasing depth and were -0.5°C from 50 m down to the bottom. Salinity in Smith Sound and Southwest Arm increased with depth from 32.0 ppt at the surface to about 33.6 ppt at the bottom. Salinity in Northwest Arm was lower and more uniform, increasing with depth from 31.5 ppt at the surface to about 32.5 put at 50 m, but thereafter remained constant down to the bottom.

Catches of cod

During December 1995, cod were found to be abundant in shoal water (<90 m) in Smith Sound, and high catch rates using jiggers and feathered hooks (34.8 to 59.9 kg per person hr) were achieved at three sites in the inner reaches (see Table 1 and Fig. 4) giving a total catch of over 1100 fish. There was no evidence from the echosounder of a dense aggregation of cod in the deeper central channel in the outer section of Smith Sound. Cod were, however, widely distributed on the shallower slopes and shoals along the sides of the sound, particularly on the north side. Similarly, a survey of Northwest Arm with the echosounder revealed that fish, subsequently identified as cod, were abundant in shoal water at four sites, one near the mouth and three inside Northwest Arm. Catch rates were high but more variable than those in Smith Sound (7.4-46.3 kg per person hr) and a total of over 1200 fish were caught. Cod appeared to be scarce through the deep central channel of Southwest Arm and four sets with the trawl caught only 60 fish; cod may have been present in the shallow water in the extreme western end of Southwest Arm but this area was not surveyed during the study.

During April 1996, the hydroacoustic survey revealed a dense school of cod in deep (>200 m) water in the outer reaches of Smith Sound. Catches with the trawl were extremely high at two sites where the dense school was located (sets 4 and 5, Table 2 and Fig. 4). A smaller less dense school was also located further inside Smith Sound (set 7, Table 2). Jigging also revealed that cod were abundant on the shallower shoals at the sides of Smith Sound, although catch rates with jiggers (24.0 - 26.8 kg per person hr) were approximately half those recorded during December 1995 (Table 1).

Cod were widely distributed but not abundant in Northwest Arm (Table 2, Fig 4). Jigging gave generally lower catch rates (2.1-22.9 kg per person hr) than those reported during December 1995. Gill nets gave very poor catches and were often covered in slub, even after only 12 hr in the water.

Fish caught in gillnets also showed extensive skin and fin erosion, probably due to predation by scavenging amphipods. A single trawl set in the middle of Northwest Arm caught only 9 cod.

Cod were abundant in Southwest Arm and a large school approximately 8 km long, 1 km wide and 100 m deep was observed in the central part of the channel. The school was much less dense than that observed in Smith Sound. Trawling gave modest catch rates (51.8-111.2 kg) throughout the central channel of Southwest Arm. Jigging in the shallower western end of Southwest Arm failed to catch any cod.

A biomass estimate for cod in these inshore areas is presently being worked on for comparison with the 1995 estimate.

Length frequency of cod

In December 1995, length measurements were obtained from over 1000 cod caught with jiggers in each of Smith Sound and Northwest Arm. The cod were generally large (mean lengths 57.9 and 55.4 cm, Fig. 5) and of comparable size range within each area, with few fish under 40 cm. In contrast, in Southwest Arm where the trawl was used, cod were scarce and generally of much smaller size (< 40 cm).

The size frequency of the total catch from these three inshore areas was also compared with that of the entire catch from the fall 1995 survey of 2J-3KL (Fig. 6), with the latter based on a stratified random design incorporating approximately 400 sets of about 15 min duration using the Campelen trawl. Although different gears were used in these studies, the contrast in size frequency is striking, with many large cod (>50 cm) in the inshore catches, but very few large cod in the more offshore portions of 2J-3KL.

In April 1996, cod caught in Smith Sound, Northwest Arm, and Southwest Arm were of comparable size range (mean lengths 55.1, 56.2, and 54.7 cm; Fig. 7) to those caught in all except the latter area four months previously. Large cod apparently moved into Southwest Arm some time during the preceding four months as fish of this size were not observed in Southwest Arm during December 1995 (see Fig. 5).

Age distribution

Ages were obtained from 204 of the cod sampled during December 1995. An age-length key was constructed from these samples and applied to the length-frequency of the entire catch to give an indication of the overall age composition (Table 3). Ages ranged from 3-8 years, although over 50% of the fish caught were 5 year olds (1990 year class).

Average weight at age (obtained by applying the standard cod length-weight regression parameters slope=3.0879 and intercept=-5.2106) were generally somewhat higher than those

reported in recent years for the 2J-3KL stock. Since our samples were collected within 3 wk of the end of the year, we added 1 year to the ages given in Table 3 for comparison with beginning of the year (i. e. Jan. 1) mean weights at age from commercial catches from recent years (see Shelton et al. 1996). After incrementing ages by one year, the average weights at age for 4, 5, and 6 year olds from the present study were 0.74, 1.12, and 1.56 kg, respectively. The range of corresponding weights at age from the commercial samples for the years 1990-1995 were 0.45-0.62 for 4 year olds, 0.70-1.01 for 5 year olds, and 1.0-1.38 for 6 year olds. Weights at age are clearly higher for the present samples, suggesting good growth rates for inshore cod sampled during the present study. The values reported here are comparable to those given in Shelton et al. (1996) for commercial catches for 1996 which are based largely on samples from the Sentinel Survey.

Condition indices

Scatter plots of cod condition (measured as Fulton's K based on round weight) revealed that cod sampled in December 1995 were generally in good condition, with average K values of 0.94, 0.92 and 0.85 for Smith Sound, Northwest Arm, and Southwest Arm, respectively (Fig. 8). This index can vary widely among individual fish; it is not entirely independent of length and includes the weight of the gonads, liver, and stomach contents, all of which can vary considerably. Nonetheless, few fish had K values less than 0.7 which is a reasonable threshold below which fish can be considered in poor condition. Most K values were in the 0.8 to 1.1 range, suggesting that most cod sampled were generally in good condition. Lower values for Southwest Arm can probably be attributed to the smaller size of cod sampled, given that K tends to increase with length.

The condition of cod sampled in April 1996 was comparable to that observed four months previously, with overall mean K values of 0.86, 0.93, and 0.91 for Smith Sound, Northwest Arm, and Southwest Arm (Fig. 9). Again there were few fish with K values less than 0.7, suggesting that cod were generally in good condition. The slightly higher K values for cod in Northwest Arm and Southwest Arm were possibly due to the weight of the stomach contents; cod were feeding heavily on amphipods in these areas.

Maturities of female cod

Most of the cod sampled during December 1995 were adult fish. Among females, the percentage of immatures was slightly higher in Northwest Arm (37.9%) than in inner Smith Sound (7.9%, Table 4) even though the average sizes were similar in each area. Most of the mature females had gonads at stage Mat AN and would have spawned in the coming year.

Comparison of the maturities of females collected during April 1996 indicated two distinct groups of fish in the areas surveyed; female cod sampled in the outer reaches of Smith Sound had the largest average size (58.4 cm) and few (3.9%) were immature. In all other areas, the cod sampled were marginally smaller (average sizes 52.7 to 57.3) and the proportion immature was generally higher, ranging from 23.6% in Northwest Arm and to 54.4% in the inner reaches of Smith

Sound. Most notable was the presence of spawning fish in the outer reaches of Smith Sound, with >70% of those sampled at stages Mat BP or Mat CP (i. e. with some clear eggs). In contrast, ≤3% of the females in any of the other areas appeared to be spawning, although most appeared destined to spawn some time later in the spring of 1996. A few spent fish were also observed in each area.

Another notable finding was the unusually high percentage of large fish (>60 cm) in Southwest Arm that had undeveloped gonads. Of 53 female cod > 60 cm fork length collected in Southwest Arm, 34.0% had gonads that upon visual inspection appeared immature. Corresponding percentages, for Northwest Arm and Smith Sound (inner and outer areas combined) were 8.5% (N=47) and 9.8% (N=82). The reproductive status of these fish remains unclear. They possibly represent females that had spawned in previous years but would not spawn this year. Further analysis of maturity data are given in Morgan and Brattey (1996).

Parasites

The parasitic copepod Lernaeocera branchialis was common on the gills of cod in all three areas (Table 5) with prevalences mostly in the 5-25% range. Infection level tended to vary with length, but not in any consistent pattern in all areas. There were no distinct differences in the prevalence of the parasite between inner and outer Smith Sound; although 50-59 cm cod from the inner portion appeared more heavily infected (25%) than those from the outer portion (12.1%), the difference is not significant (χ^2 test, P>0.09). Overall, the percentage infection tended to increase from north to south and was particularly high in Southwest Arm.

Small cod (40-49 cm) from inner and outer Smith Sound showed prevalences (4.8 -6.9%) comparable to the long-term averages for cod of comparable size sampled during the spring (6.5%) and fall (6.8%) surveys. However, among other fish in Smith Sound and elsewhere, prevalences were higher than the long-term average for comparable sized cod sampled during the spring and fall surveys of 3L; the differences were particularly notable among the largest fish. The unusually high prevalences, particularly among the larger cod size classes, support the notion that these cod have remained inshore throughout the fall and winter months, as transmission of the parasite to cod appears to occur during fall mainly in the inshore areas.

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Table 1. Catch details for Shamook Trip 250, Dec. 1995. Inshore Trinity Bay. See Fig. 4 for set locations.

Area	Date	Set	Gear	Depth fished (m)		No. cod	Catch weight (kg)	Catch rates[1]
Smith Sound	951213	10	Jigger	49		424	810.3	34.8
	951214	11	Jigger	58		318	561.4	45.5
	951214	12	Jigger	51		425	857.2	59.9
					Total	1167	2228.9	
NW Arm	951204	1	Jigger	31		313	554.9	46.3
	951205	2	Jigger	30		443	706.4	38.6
	951207	3	Jigger	79		6	14.7	7.4
	951208	8	Jigger	59		217	312.9	13.4
	951211	9	Jigger	49		254	428.0	25.1
					Total	1233	2016.9	
SW Arm	951207	4	Trawl	155		34	11.0	4.1
	951207	5	Trawl	128		24	3.3	.6
	951207	6	Trawl	205		2	.3	.2
	951207	7	Trawl	270		0	.0	.0
					Total	60	14.6	
					Overall Total	2460	4260.4	

[1] catch rates are given as kg per 15 min. tow for trawl, or kg per person per hour for jigger plus four feathered hooks.

Table 2. Catch details for Shamook Trip 252, April 1996. Inshore Trinity Bay. See Fig. 4 for set locations.

Area	Date	Set	Gear	Depth fished (m)		No. cod	Catch weight (kg)	Catch rates[1]
Smith Sound	960416	1	Jigger	30		54	53.6	26.8
	960416	2 [2]	Trawl	105		7	15.8	.
	960417	3 [2]	Trawl	260		3	2.3	.
	960417	4	Trawl	278		444	826.6	538.6
	960418	5	Trawl	215		131	203.4	508.5
	960418	6	Trawl	148		0	0	.
	960418	7	Trawl	158		292	483.8	329.9
	960420	8	Jigger	23		112	192.1	24.0
					Total	1043	1777.6	
NW Arm	960420	9	Jigger	51		4	6.8	2.3
	960421	10	Jigger	30		70	153	17.0
	960421	11	Gill net	60		4	9.1	.
	960421	12	Gill net	56		1	2.4	.
	960421	13	Gill net	61		3	10.6	.
	960421	14	Trawl	105		9	6.5	12.2
	960421	15	Jigger	25		2	4.1	2.1
	960421	16	Jigger	31		128	228.5	22.9
	960422	17	Gill net	55		1	2.5	.
	960422	18	Gill net	70		2	5.5	.
	960425	26	Jigger	25		29	38.4	9.6
					Total	253	467.4	
SW Arm	960423	19	Trawl	173		69	111	111.0
	960423	20	Trawl	268		78	133.4	111.2
	960423	21	Trawl	290		0	.	.
	960423	22 [3]	Trawl	162		0	.	.
	960424	23 [3]	Trawl	214		16	26.9	.
	960424	24	Trawl	168		23	34.5	51.8
	960424	25	Trawl	215		60	103.7	64.8
					Total	246	409.5	
					Overall Total	1542	2654.5	

[1] catch rates are given as kg per 15 min tow for trawl, or kg per person per hour for jigger plus four feathered hooks.

[2] gear damaged.

[3] gear fouled.

Table 3. Age distribution of cod sampled from inshore areas of Trinity Bay during December 1995. Values were obtained by applying an age-length key from 204 aged samples to the length frequency of the entire catch.

Length	0	1	2	3	4	5	6	7	8
40				24					
43				20		40			
46				46		23	12		
49				9	35	65	9		
52					139	257	12		
55					98	345	94		
58					47	345	80		13
61						169	99		
64						56	94		9
67						40	34	27	
70						25	25	17	8
73							13	27	
79						2	2		2
82							3		3
85								4	
Totals	0	0	0	99	318	1368	476	74	36
Percent	0	0	0	4.18	13.41	57.70	20.08	3.12	1.52
Av/len(cm)	.	.	.	44.22	50.48	56.19	60.53	70.8	65.64
Av/Wt(kg)	.	.	.	0.74	1.12	1.56	1.96	3.18	2.52

Table 4. Maturity stages (according to the scheme of Templeman et al. 1978) and mean lengths of female cod sampled from inshore areas of Trinity Bay during December 1995 and April 1996.

	December 4-14th, 1995			
	Inner Smith Snd.	Outer Smith Snd.	NW Arm	SW Arm
No. cod	63	0	66	0
Mean length±SD	58.1±7.34	.	56.5±7.86	
% Immature	7.9	.	37.9	.
% Mat AN	82.5	.	62.1	.
% Mat AP	0.0	.	0.0	.
% Mat BP	0.0	.	0.0	.
% Mat CP	0.0	.	0.0	.
% Spent	9.5	.	0.0	.
% Other	.	.	.	.

	April 15-26th, 1996			
	Inner Smith Snd.	Outer Smith Snd.	NW Arm	SW Arm
No. cod	57	153	140	164
Mean length±SD	52.7±14.17	58.4±6.52	57.3±12.18	55.6±10.00
% Immature	54.4	3.9	23.6	43.9
% Mat AN	0.0	0.0	0.0	0.0
% Mat AP	38.6	23.5	74.3	52.4
% Mat BP	0.0	9.2	0.7	1.8
% Mat CP	1.8	62.1	0.7	1.2
% Spent	3.5	0.7	0.7	0.6
% Other	1.8	0.7	.	.

Table 5. Prevalence of the parasitic copepod Lernaeocera branchialis on the gills of cod from inshore areas within Trinity Bay during December 1995 and April 1996 compared to the average prevalence observed during the spring and fall surveys of NAFO Division 3L during 1982-95.

Cod length (cm)	December 4-14th, 1995 Inner Smith Snd. % (N)	Outer Smith Snd. % (N)	NW Arm % (N)	SW Arm % (N)	Fall survey average 1982-95 % (N)
20-29	.	.	.	27.0 (37)	4.0 (869)
30-39	.	.	.	33.3 (15)	6.5 (1344)
40-49	4.8 (83)	.	9.1 (230)	.	6.5 (1446)
50-59	9.2 (694)	.	14.0 (695)	.	4.0 (1411)
60-69	7.4 (253)	.	11.9 (253)	.	2.4 (1177)
≥70	16.7 (44)	.	11.4 (44)	.	1.1 (1958)

Cod length (cm)	April 15-26th, 1996 Inner Smith Snd. % (N)	Outer Smith Snd. % (N)	NW Arm % (N)	SW Arm % (N)	Spring survey average 1982-95 % (N)
20-29	.	.	.	.	8.9 (990)
30-39	.	.	.	.	9.4 (1593)
40-49	5.7 (35)	6.9 (29)	13.3 (45)	21.6 (51)	6.8 (2237)
50-59	25.0 (24)	12.1 (140)	10.6 (113)	22.1 (104)	5.4 (2297)
60-69	5.0 (20)	7.5 (93)	11.1 (63)	22.1 (60)	3.6 (1576)
≥70	.	0 (12)	9.5 (21)	13.3 (60)	0.5 (3052)

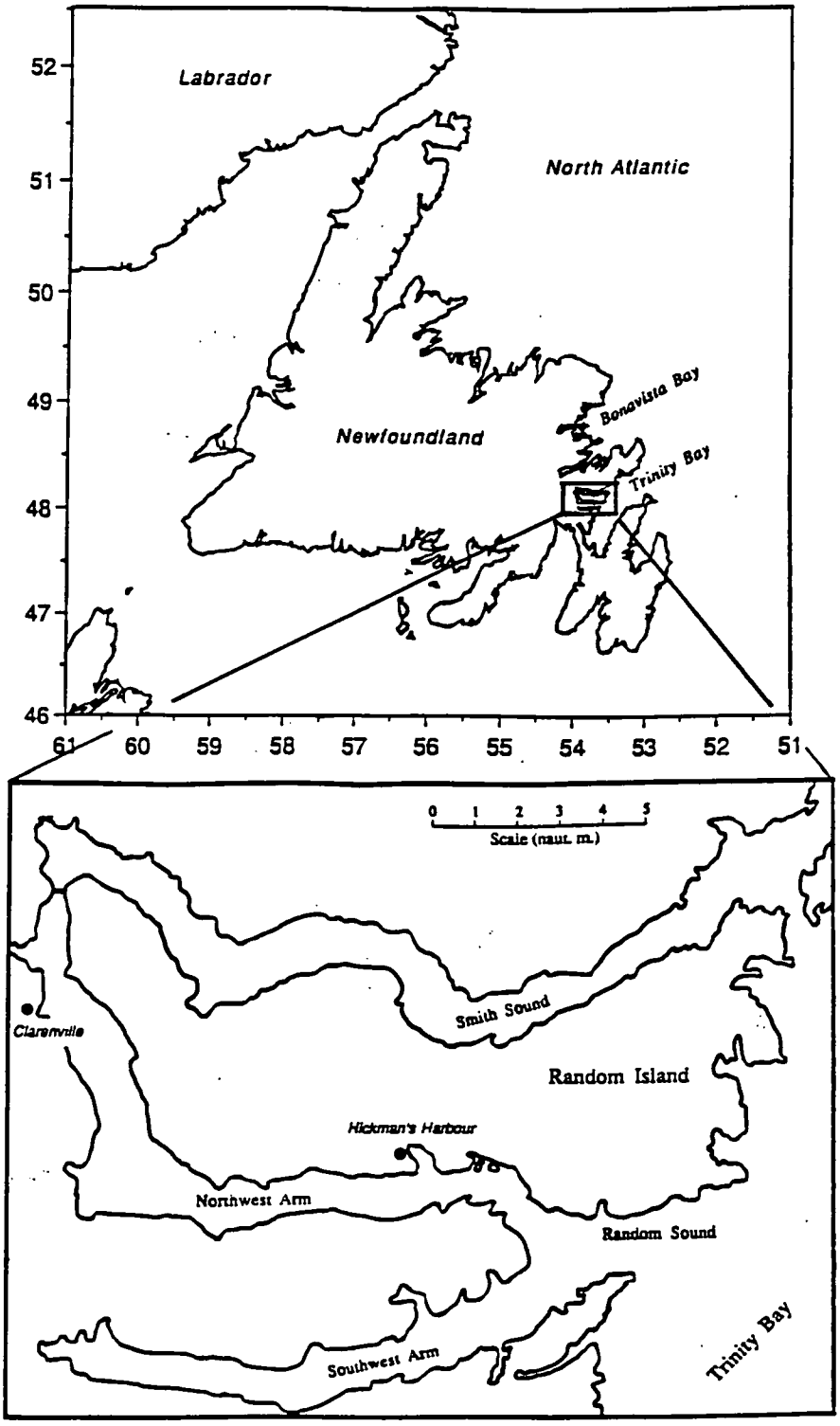

Fig. 1. Location of the study area in western Trinity Bay.

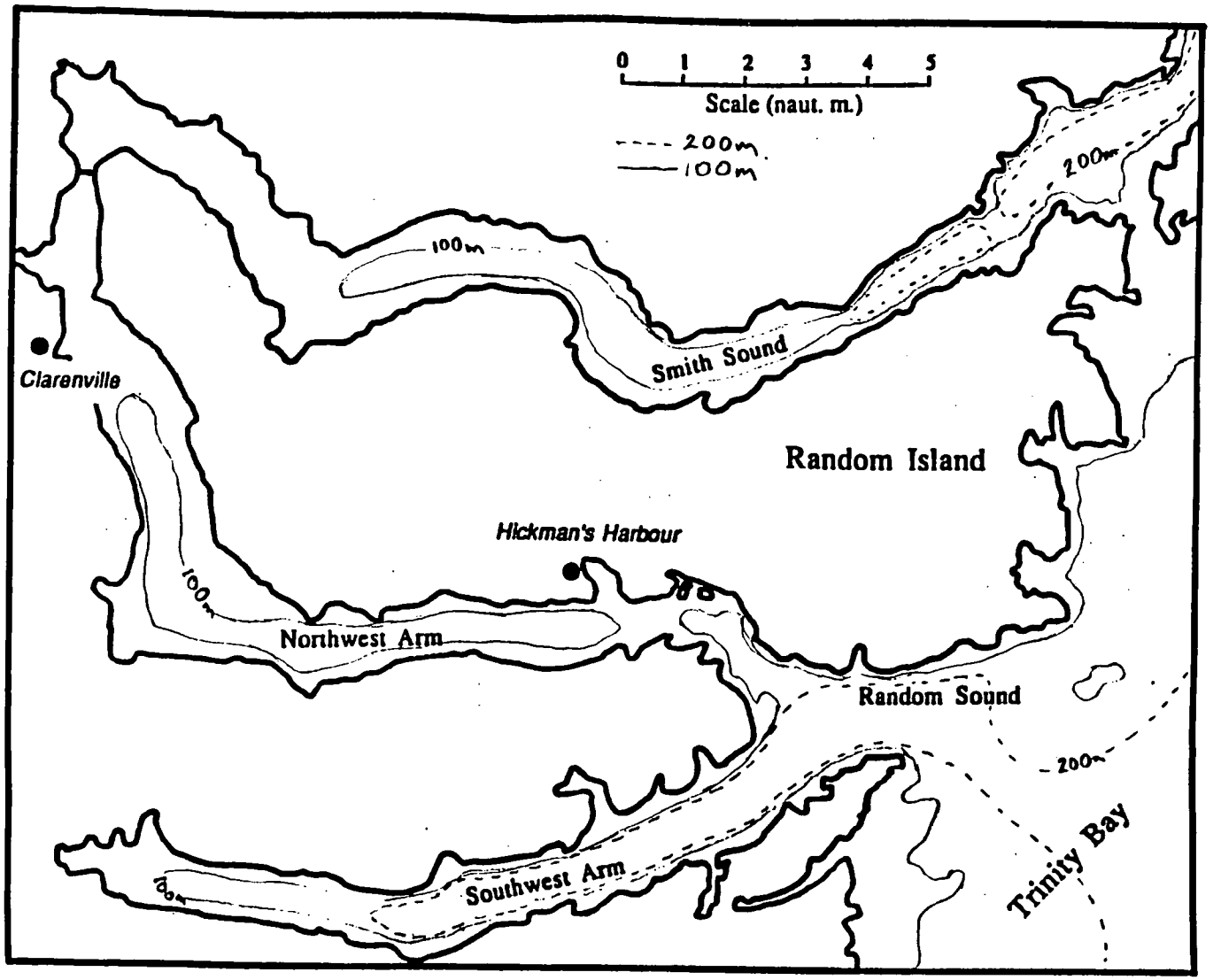

Fig. 2. Bathymetry of the study area.

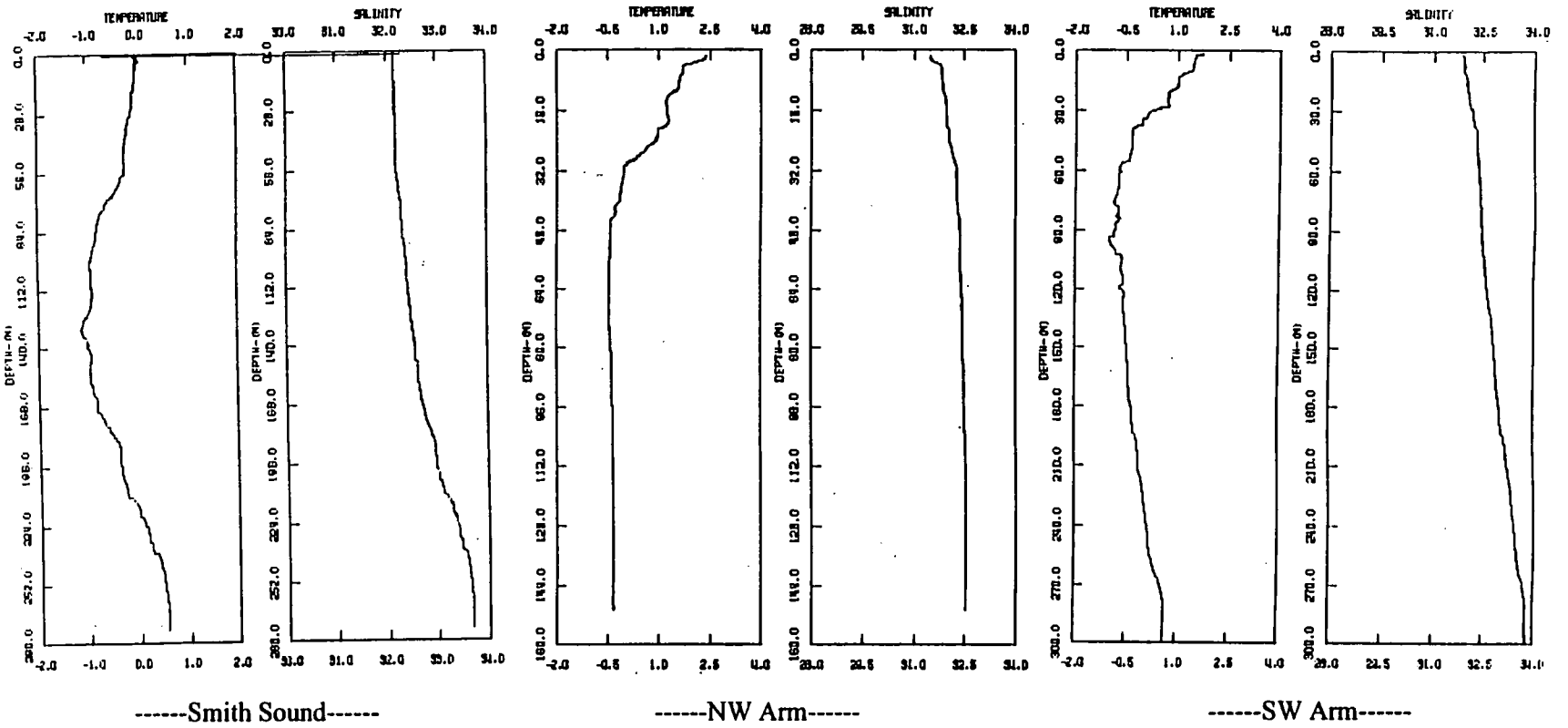

Fig. 3. Temperature and salinity profiles for Smith Sound, NW Arm, and SW Arm taken in mid-April 1996.

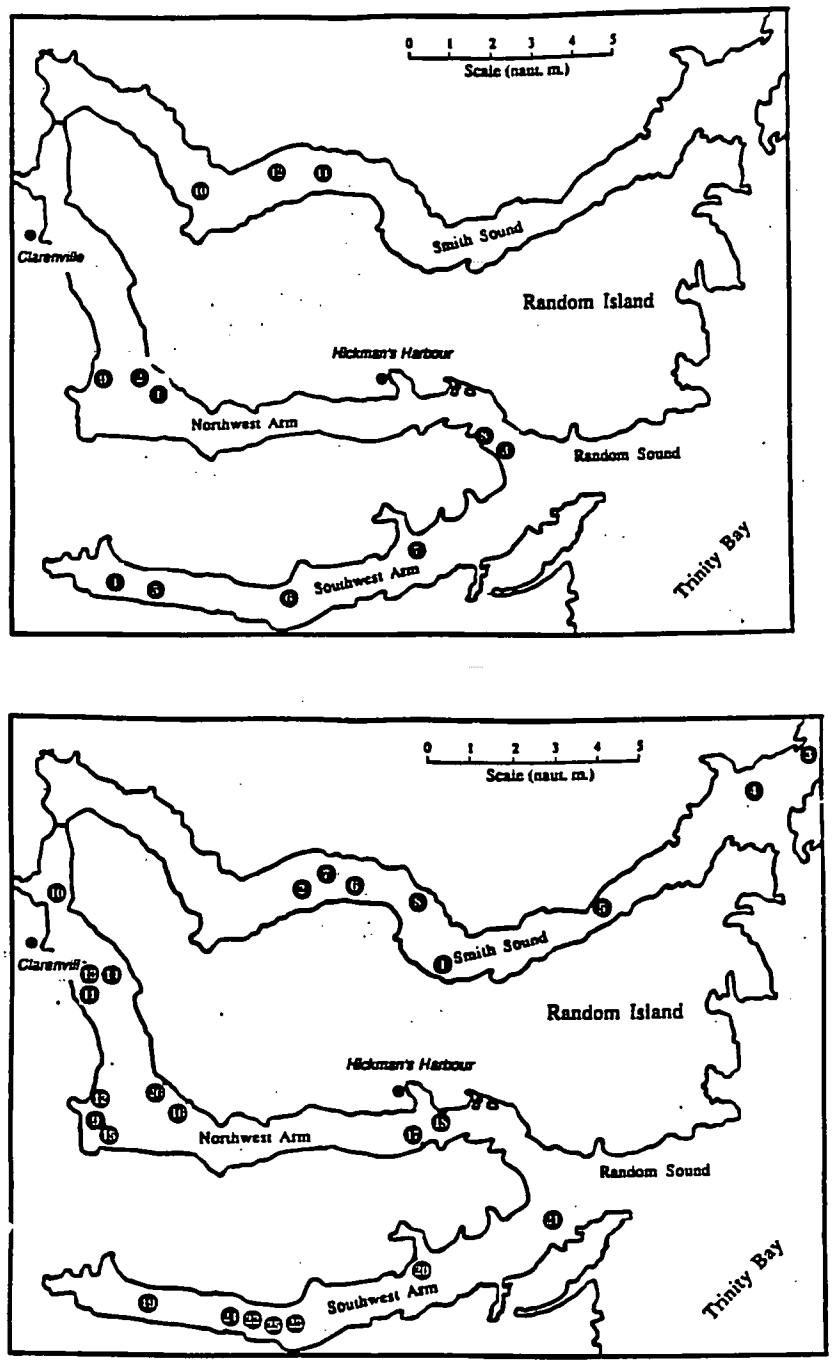

Fig. 4. Sampling (set) locations for the studies conducted during December 1995 (upper chart) and April 1996 (lower chart). See Tables 1 and 2 for further details.

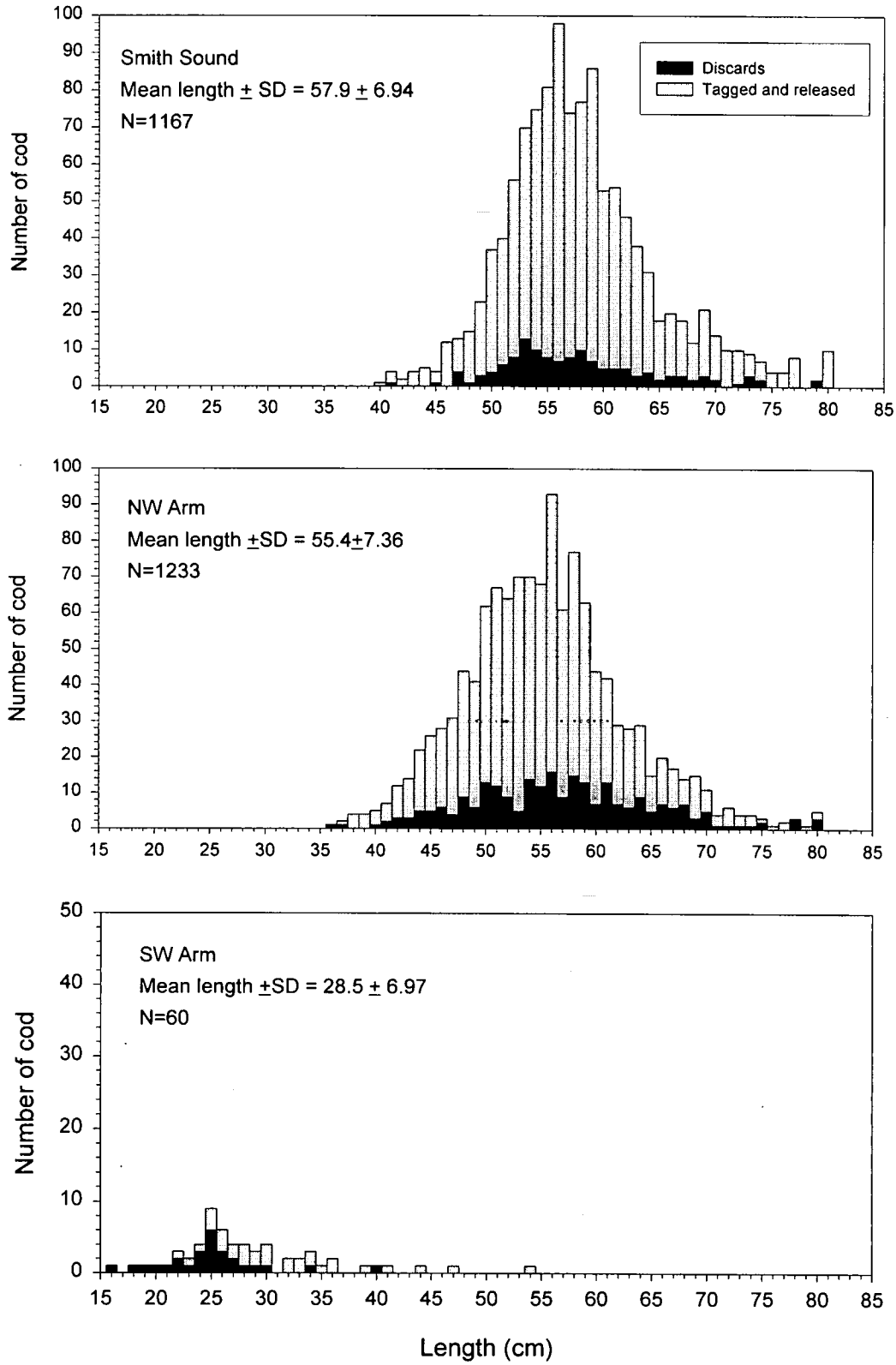

Fig. 5. Length frequencies of cod caught in three inshore areas of Trinity Bay during December 1995 (Smith Sound and NW Arm samples were caught with jigger and feathered hooks, SW Arm samples with Yankee 36 otter trawl).

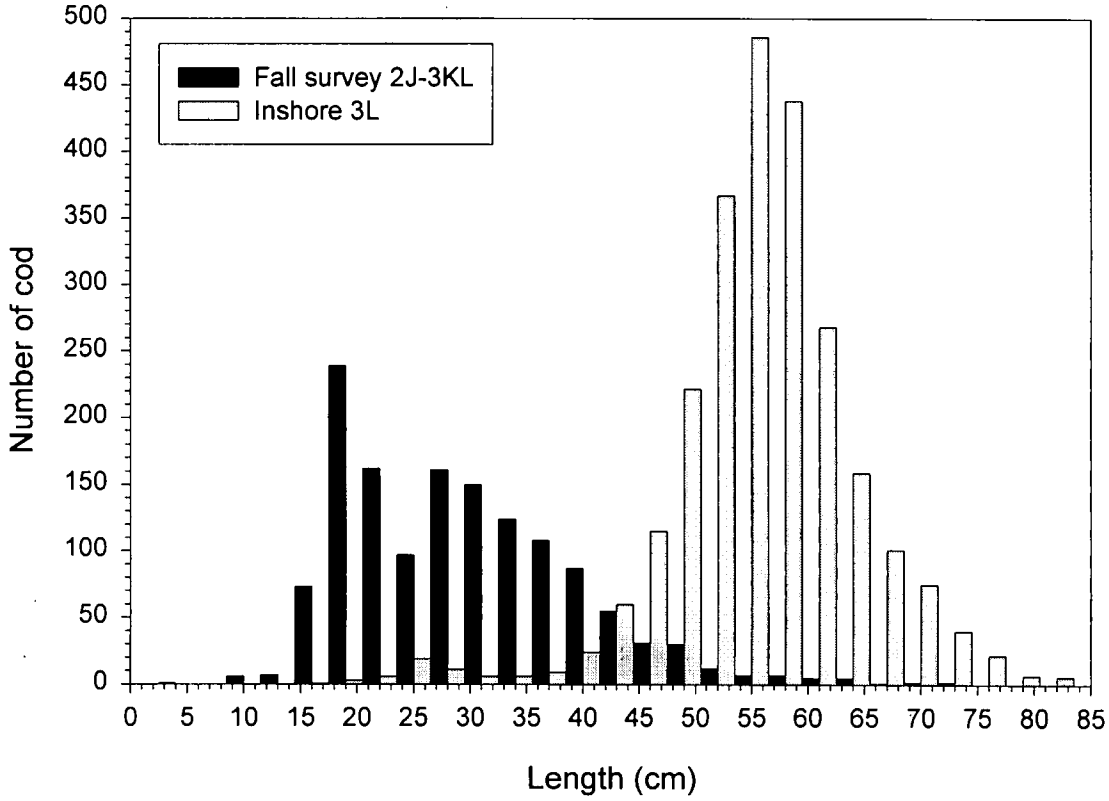

Fig. 6. Length frequency of cod (3 cm groups) from the 1995 fall survey of 2J-3KL compared with that from three inshore areas within Trinity Bay during December 1995.

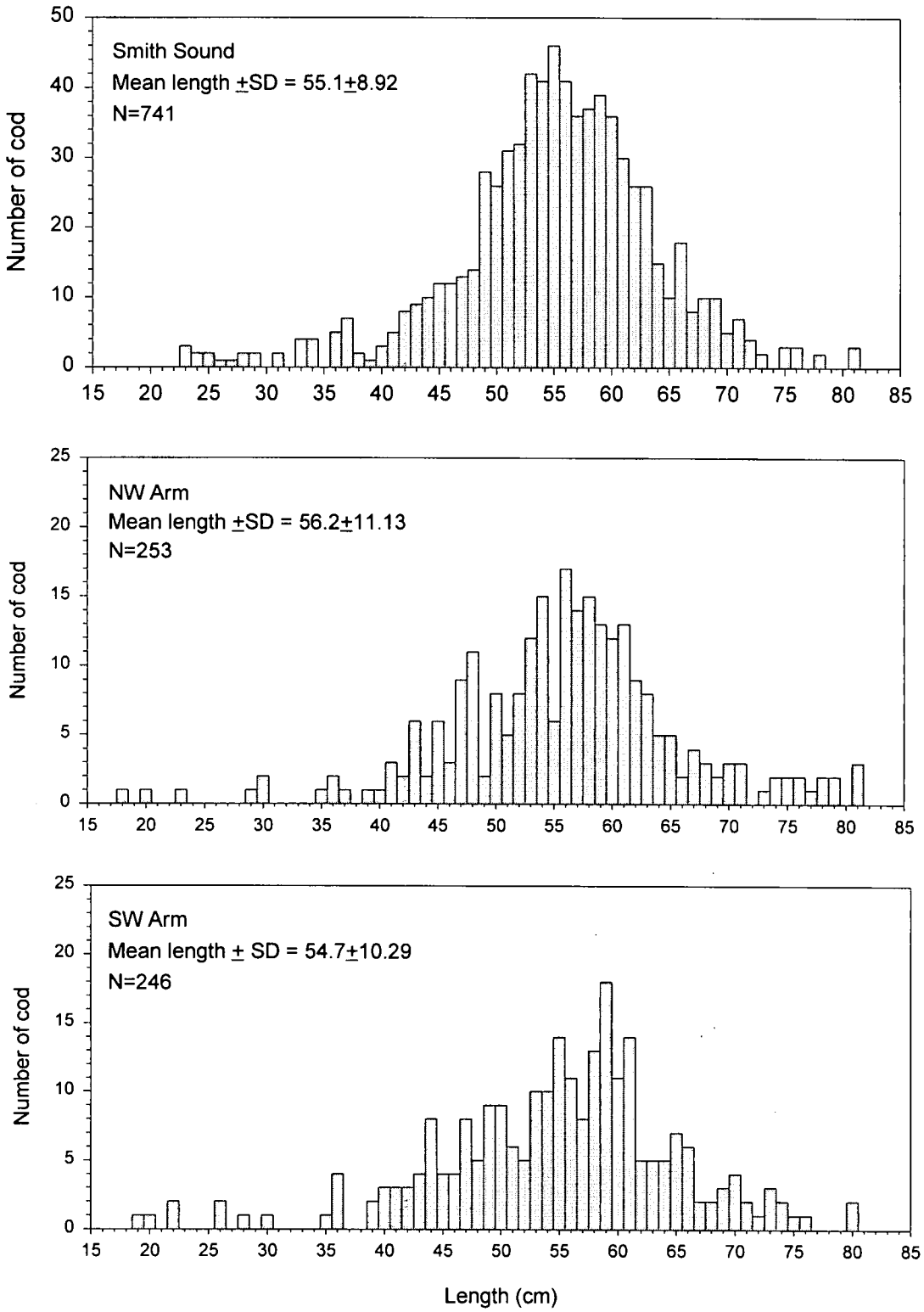

Fig. 7. Length frequencies of cod caught in three inshore areas of Trinity Bay during April 1996 (combined catches from Yankee 36 otter trawl, jigger and feathered hooks, and 5.25" gill nets)

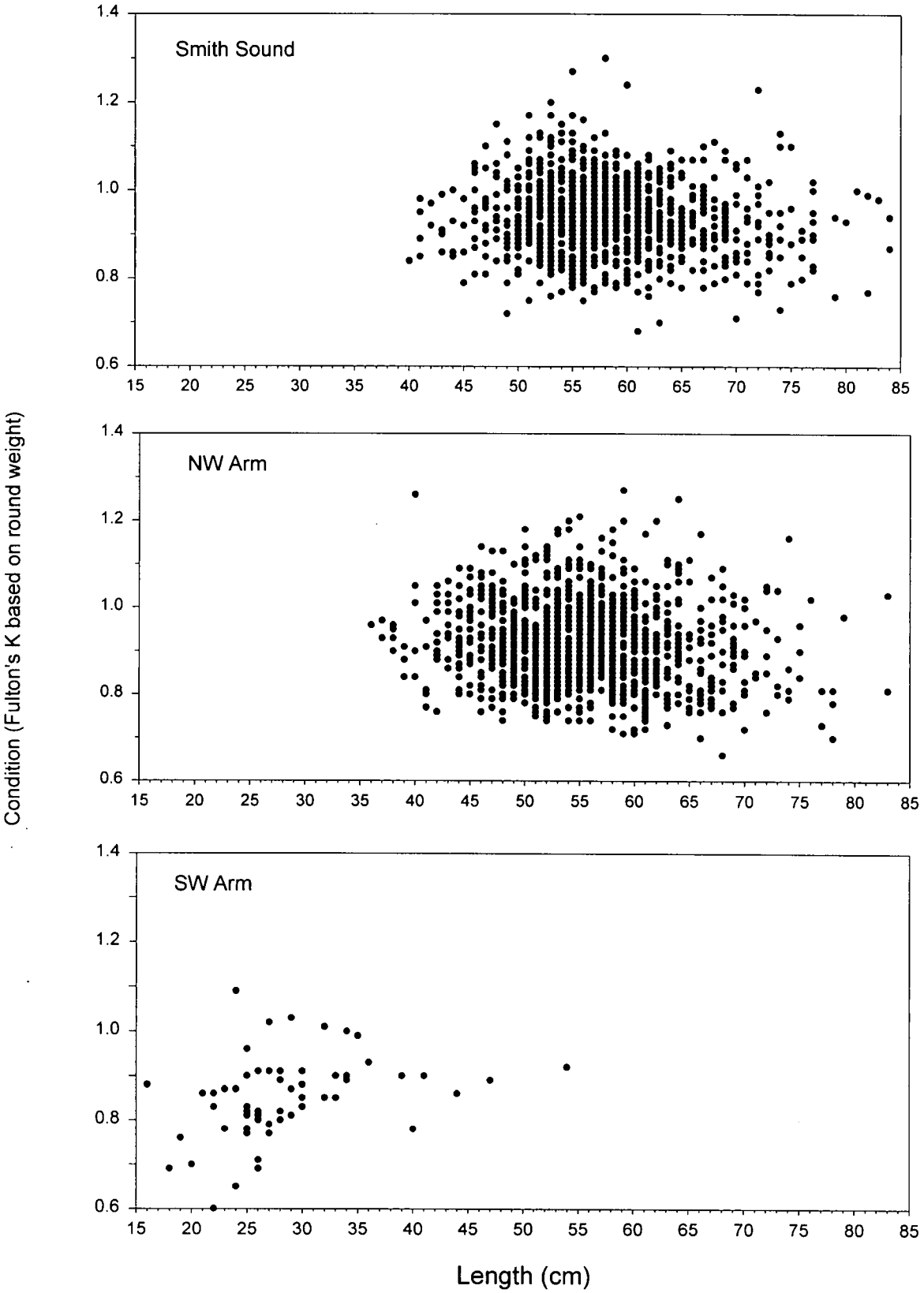

Fig. 8. Scatter plot of condition indices ((round weight x 100)/Length^3) for cod sampled in three inshore areas of Trinity Bay during December 1995.

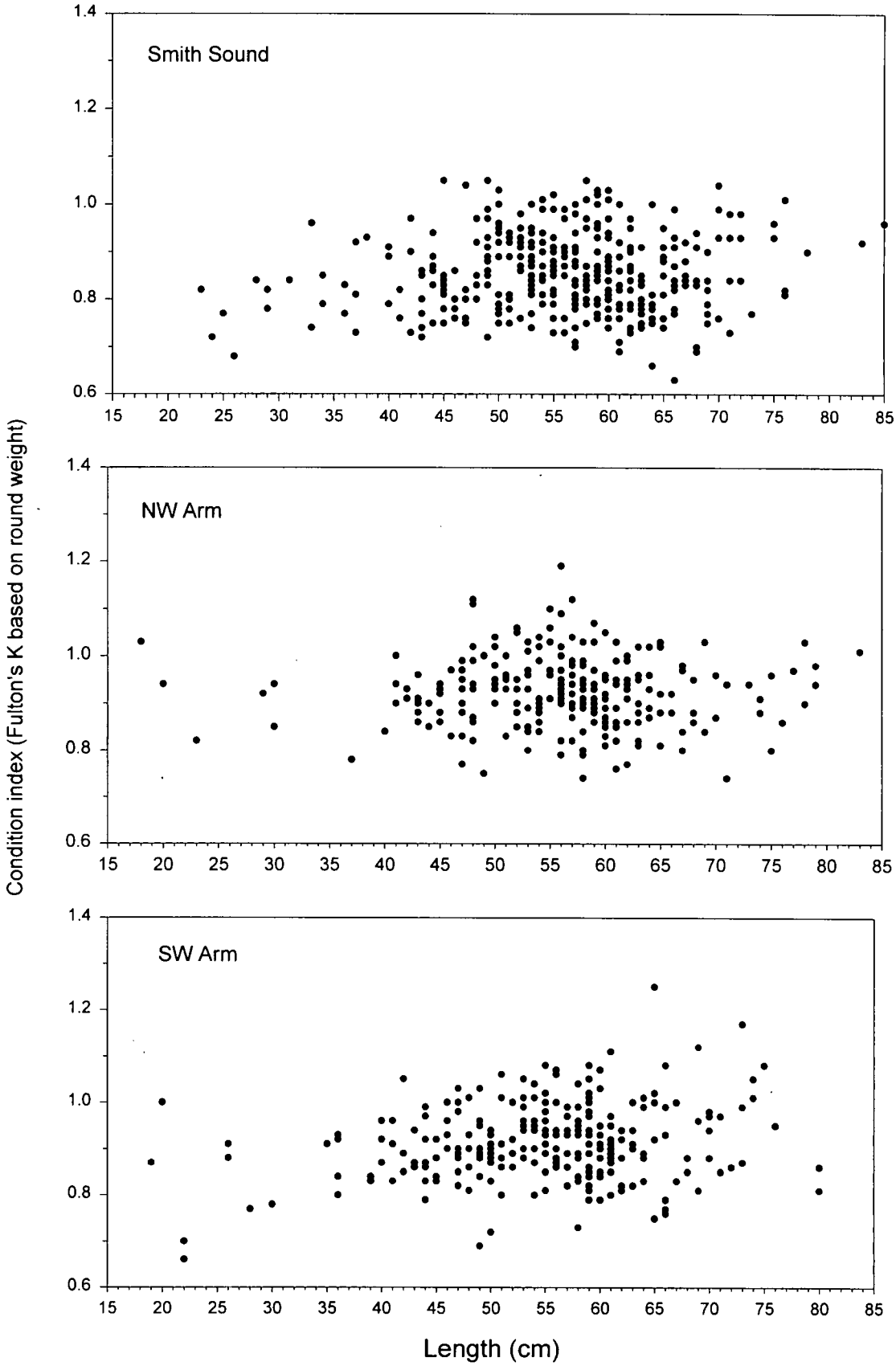

Fig 9. Scatter plots of condition indices ((round weight x 100)/Length^3) for cod sampled in three inshore areas of Trinity Bay during April 1996.