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Results of the 1995 Fleming survey of demersal juvenile cod in the coastal zone of eastern Newfoundland

by

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Abstract

Research carried out under the Northern Cod Science Program (Methven, unpublished) showed that 0-group and 1-group cod currently (1992 onward) concentrate in coastal areas, with highest densities at depths of 4-7 m. 0-group cod are also concentrated in time, arriving in coastal nursery areas as distinct and predictable pulses in April-June, mid-August, mid-October, and possibly late December-January. Surveys were made during the October recruitment pulse at depths with maximum density by setting seines at 10-20 metres then hauling them shoreward. The primary objective during 1995 was to test for enhanced density of first year demersal juvenile cod resulting from a well documented spawning aggregation in Smith Sound in April and May of 1995. Enhanced density of juveniles settling to the bottom in suitable coastal habitats were expected circa 3-4 months later, in August and September. The second objective was to compare the abundance of identifiable length groups (corresponding to ages 0+ 1+ and 2+ fish) to the abundance of the same length groups in previous years. The survey revisited sites sampled in 1959-1964 and 1992-1994. The density of first year (0+) demersal juvenile fish (LG0 = length group 0) did not exceed the average for 1992-1994 for the entire survey area (St. Mary's Bay north to Notre Dame Bay). Within this area the density of LG0 demersal juveniles in Trinity and Conception Bay did not exceed that in previous years. The density of second year (1+) juveniles (LG1 = length group 1) fish was expected to be higher in 1995 than 1994, based on higher density of LGO fish in 1994 than in 1993. Instead, the number of LG1 fish in 1995 was the lowest in the 10 year record of comparable counts. Third year (2+) juveniles (LG2 = length group 2) were expected to be more abundant in 1995 than 1994, again based on strength of that cohort in previous years. Contrary to expectation the density of LG2 was lower in 1995 than 1994. The apparent increase in mortality on LG1 fish in the coastal zone was 258% relative to the expected density calculated from cohort strength the prior year. This calculation assumes no change in performance of gear, and no greater shift of LG1 into deep water than in previous years. Potential sources of mortality include incidental catch, predation by seals or large cod moving into shallow water.

Résumé

La recherche effectuée dans le cadre du programme scientifique « Morue du Nord » (Metven, données inédites) a montré que la morue des groupes 0 et 1 se rassemble (depuis 1992) dans les régions côtières, les densités maximales se trouvant aux profondeurs de 4 à 7 m. La concentration du groupe 0 est également un phénomène temporel, la morue arrivant dans les nourriceries côtières par vagues différenciées et prédictibles en avril-juin, à la mi-août, à la mi-octobre et, peut-être, à la fin décembre ou en janvier. Les relevés ont eu lieu au cours de la vague de recrutement d'octobre, aux profondeurs où la densité était maximale, à l'aide de seines mouillées à 10-20 m, puis tirées vers le rivage. En 1995, le principal objectif était de confirmer la densité accrue des morues juvéniles démersales de la première année issues d'une concentration de fraye bien connue dans la baie Smith, en avril et mai 1995. On s'attendait, trois ou quatre mois plus tard, en août et septembre, à observer une densité plus grande de jeunes morues s'établissant sur le fond dans des habitats côtiers favorables. Le deuxième objectif était de comparer l'abondance de groupes de longueur identifiables (correspondant aux âges 0+, 1+ et 2+) à l'abondance des mêmes groupes de longueur des années antérieures. Au cours de l'étude, on a revisité les lieux échantillonnés en 1959-1964 et en 1992-1994. La densité des poissons juvéniles démersaux de la première année (0+) (GL0 = groupe de longueur 0) n'a excédé la moyenne de 1992-1994 dans aucune partie de la région étudiée (baie Ste-Marie vers le nord jusqu'à la baie Notre-Dame). Dans cette zone, la densité des jeunes démersaux du GL0 dans les baies de la Trinité et de la Conception n'a pas excédé celle des années antérieures. On s'attendait à ce que la densité des juvéniles de la 2^{e} année (1+) (GL1 = groupe de longueur 1) soit supérieure en 1995 à la densité de 1994, vu la densité supérieure des poissons du GL0 en 1994, relativement à 1993. On a plutôt constaté que le nombre de poissons du GL1 était en 1995 le plus faible observé dans les dix années de relevés comparables. On s'attendait à ce que les juvéniles de la 3^{e} année (2+) (GL2 = groupe de longueur 2) soient plus abondants en 1995 qu'en 1994, de nouveau en raison de l'effectif de cette cohorte au cours des années antérieures. Contrairement aux attentes, la densité des poissons du GL2 était inférieure en 1995 à celle de 1994. L'augmentation apparente de la mortalité des poissons du GL1 dans la zone côtière était de 258 % relativement à la densité prévue à partir des calculs de l'effectif de la cohorte de l'année antérieure. Pour ces calculs, on a posé que les performances des engins de pêche n'avaient pas changé et que les poissons du GL1 n'étaient pas partis en plus grand nombre que par les années antérieures vers les eaux profondes. Les causes possibles de mortalité comprennent les prises accidentelles, la prédation par les phoques ou les départs des grosses morues vers les eaux peu profondes.

Objectives

The first objective of the 1995 survey was to test for enhanced abundance of first year demersal juveniles in coastal habitats, subsequent to spawning by a well documented aggregation of spawning fish in Smith Sound (Trinity Bay) several months earlier, in April and May. Spawning aggregations of this magnitude in deep sounds of coastal Newfoundland have not been reported previously in the scientific literature, although records kept by Eric Bailey (town of Petley) and Jack Marsh (Lance Cove) indicate that spawning aggregations do occur in Smith Sound in most years. The Smith Sound aggregation was the only one of its size reported in 1995, and hence it was of interest to test whether this aggregation, estimated at 10,000 tonnes or more (G. Rose, pers. comm.) would enhance the abundance of juvenile fish settling into suitable coastal habitats 3-4 months later.

The second objective of the 1995 survey was to compare the abundance of fish in size classes identifiable as 0+ 1+ and 2+ fish to abundance of the same size classes (LG0 LG1 and LG2) in previous years. The abundance of LG1 fish in 1995 was expected to be 1.5 times that in 1994 (Schneider et al. 1995), based on detection of a recruitment signal in the 1959-64 and 1992-1994 surveys (Ings et al. in press). The abundance of LG2 fish in 1995 was expected to be 1.6 times that in 1994, based on LG1 abundances in 1993 (Schneider et al. 1995).

Gear, Methods, and Locations

In 1959 Allister Fleming, Tom Collier, and others from the present day Department of Fisheries and Oceans began a series of annual surveys along the coast of eastern Newfoundland to assess the abundance of small juvenile cod (Fig. 1). The objective was to determine if catches could be used as an index to assess year class strength (Lear et al. 1980). Surveys continued each year until 1964. Approximately 40-60 sites were sampled each year, except for 1959 and 1960 (the two start up years). These surveys were repeated in 1992-1994 (Table 1). To ensure that past and present surveys were as similar in execution as possible, special attention was given to each of the following.

i. locating sampling sites
ii. gear specifications, construction and deployment
iii. sampling design
iv. time of sampling

Fleming Sites were identified from charts and station records used during the 1959-1964 and 1992-1994 surveys. Black and white photographs taken in 1962 and colour photographs from 1992-1994 surveys were examined for characteristic features to ensure that the same site was resampled in 1995. Present day shoreline features, underwater algae and substrate were similar to 1959-1964 as determined by photographs and station records taken at that time. The survey party leader in 1995 was Peter Hennebury, who participated in the 1994 survey and thus was able to relocate sites quickly and accurately. He was assisted by Jason Howell and Stephen White, who are both student interns under the Enviromental Technology program within the Marine Institute of Memorial University. A fourth member of the survey party, Wade Bailey, conducted a habitat survey at each beach site, for the EIP program collaboration between DFO and Memorial University.

The fishing gear deployed in 1959-1964 and 1992-1995 was a 25 m bottom seine hauled by two people towards shore after being deployed from a small boat. Net deployment in 1992-1995 (Schneider et al. in review) was as similar as possible to that in 1959-1964 (Lear et al. 1980). During 1992 Tom Collier, who participated in the 1959-1964 surveys, made a trip into field to compare execution with the earlier survey. After viewing the sampling procedure, he suggested several changes, to arrive at a protocol as similar as possible to that used in the 1960s (Schneider et al. in review).

Three tows were conducted at each site in 1992-1995. Two consecutive sets were made at exactly the same location, with an additional set being conducted immediately adjacent to the first two sets. All sets were conducted during daylight with the first two consecutive sets being conducted usually within one hour of each other. Sampling was not confined to any particular time of the day or to a particular tide level. Present day sampling is very similar to the historical sampling in that the same beaches were sampled at the same time each year (Table 2).

Fish were measured for standard length (SL = mm) in the field. Standard length was used to divide the catch into three length groups defined by clear modes in the catch from several types of gear (Methven and Schneider in review). The length groups, which correspond to age groups 0+ 1+ and 2+ fish (Methven, 1995), were:

LG0 = 96 mm or less
LG1 = 97-192 mm
LG2 = 193 mm or greater

Birthdates of LG0 fish during the 1995 Fleming survey were backcalculated using daily otolith increments (Pinsent and Methven, in press).

Analysis of the 1959-1964 together with 1992-1994 data showed that the abundance of LG1 fish in any one year was related to LG0 abundance the previous year; LG2 fish was related to LG1 abundance the year before (Schneider et al. 1995). The equations for this relation were:

$$\mathrm{LG1} = \beta_{0->1}\,\mathrm{LG0}$$

$$\mathrm{LG2} = \beta_{1->2}\,\mathrm{LG1}$$

An iterative weighting algorithm was used to estimate parameters, which were as follows.

$$\beta_{0->1} = 0.7984 \qquad se = 0.1112$$

$$\beta_{1->2} = 0.02019 \qquad se = 0.00061$$

Based on these estimates and the observed mean catches of LG0 and LG1 fish in 1994, the predicted catch of LG1 fish for 1995 was 16 fish/haul, 1.5 times that of 1994. The predicted catch of LG2 cod for 1995 was 0.33 fish/haul, 1.6 times that of 1994 (Schneider et al. 1995).

Results

Age of LG0 Fish

The age of LG0 fish caught on 4 October 1995 at Little Mosquito Cove ranged from 93 to 123 days, depending on standard length (Table 3). The corresponding hatch dates range from 3 June to 3 July. Spawning dates will be one to two week earlier, given water temperatures near zero at this time of year. For LG0 fish greater than 70 mm in standard length, spawning occurred in mid-May or earlier, matching the time of spawning by fish in Smith Sound (G. Rose, unpublished observation).

Abundance and Distribution of LG0 Fish

Enhancement of LG0 fish density was tested at 3 different spatial scales. At the scale of the entire survey, from St. Mary's Bay to western Notre Dame, only a slight increase was expected, because the only reported spawning activity by any sizable aggregation was in Smith Sound. Contrary to expectation, no increase was observed. The average catch of LG0 fish in 1995 was 13.3 fish/haul, a value that did not exceed that of 1994 and was nearly the same as 1993 (Table 4). The 1995 catch of LG0 fish was similar to the average catch from 1992-1994 combined.

Enhancement was expected to be more evident at the scale of individual bays, with greater abundances in Trinity (and perhaps Conception) Bays in 1995 than in preceeding years. Conception Bay is included in the prediction because the prevailing flow is with the coast to the right, and hence Conception Bay lies "downstream" of Trinity Bay. Contrary to expectation, no increase in LG0 fish was observed in Trinity Bay, relative to preceeding years (Figure 2, Table 5). During 1995 the density at Fleming sites in Trinity Bay was 15.96/21 = 76% of the mean density from 1992-1994 (Table 5). Outside Trinity Bay, density in 1995 was 11.53/14.5 = 80% of the density from 1992-1994. The hypothesis of an increase in density at Fleming sites in Trinity Bay in 1995 must be rejected.

It is interesting to note that current catches of LG0 cod in Trinity Bay are low, relative to the early 1960s (Figure 2). This difference is statistically significant, as indicated by 95% confidence limits that do not overlap (Figure 3).

Enhancement at the scale of sections of Trinity Bay was also expected, with greater catches in the inner part of Trinity Bay due to lower exchange rates and greater retention in the inner bay. Also, the prevailing drift on the western side of Trinity Bay runs toward the inner bay from the spawning site at Smith Sound. No enhancement within inner Trinity Bay was observed in 1995, relative to earlier years (Figure 4). Catches near Smith Sound (Random Island sites) were low in all years. During 1995 catches to the north and to the south were low, relative to previous years (Figure 4). The pattern of higher catches north and south of Smith Sound in recent years matches that observed in the 1960s (Figure 4). This pattern may be due to the presence of sites with good habitat to the north (Trinity) and south (Bull Arm) rather than any drift related patterns in transport of eggs and newly hatched fish.

Abundance and Distribution of LG1 and LG2 Fish

The expected catch of LG1 fish in 1995 was 16 fish/haul (1.5 times the 1994 catch), as computed from regression equations that project relative abundance at time scales of 1 year (Schneider et al. 1995). Contrary to expectation, the observed catch of LG1 fish in 1995 was less than 1994 (Table 4). The observed catch was the lowest on record in the ten year series (Table 4). The decrease in 1995 was statistically significant at $\alpha = 5\%$, as indicated by non-overlapping confidence limits around the 1994 and 1995 estimates of LG1 density (Figure 5). This shortfall in catch was not evenly distributed along the coast. It occurred primarily in Conception and Trinity Bay (Figure 2).

The expected catch of LG2 fish in 1995 was 0.33 fish/haul (1.6 times the 1994 catch) again based on regression equations that predict relative year class strength. Contrary to expectation, the observed catch in 1995 was less than 1994 (Table 4). This decrease was statistically significant ($\alpha = 5\%$) based on non-overlapping 95% confidence limits (Figure 5). This shortfall was due to Notre Dame and Bonavista Bays (Figure 2), which account for more than half of the survey sites.

Discussion

Neither of the two results were expected. Possible explanations are therefore listed and briefly discussed. Possible explanations for the failure of 10,000+ tonnes of spawning fish to produce detectable increases in the density of LG0 fish are:

1. Survey sites were too widely spaced to detect local enhancement.
2. The error rate of the survey was too high to detect an effect.
3. Spawning biomass in Trinity Bay or along entire coast was no higher than previous years.
4. The number of eggs produced by the Smith Sound was too small to bring about detectable increase.
5. The eggs were washed out to sea and never contributed to recruitment to demersal populations along the coast.
6. During 1995 juvenile cod settled at grater distances from the coast than in previous years.

The analysis was carried out at three scales of spatial resolution: the coast of eastern Newfoundland, individual bays, and sections of Trinity Bay. A finer scale of resolution was not possible because of the lack of prior measurements at more sites in Trinity Bay. Consequently, a more localized enhancement within Trinity Bay would have gone undetected. However, typical values of horizontal eddy diffusivity (500 $m^2 s^{-1}$) acting over a 90 day period will diffuse particles over an area of 3900 km^2, for which the diameter is 70 km. This is of the same order of magnitude as Trinity Bay. The sample spacing of this survey was sufficient to detect a density increase, unless eggs and larvae drifted in a more cohesive pattern than the surrounding water, leading to settlement in one highly restricted area.

The error rate for the Fleming survey, as measured by bootstrapped estimates of 95% confidence limits (Figure 3, Figure 5) is lower than other surveys but still substantial. The true value of LG0 abundance in 1995 lies between 7.1 and 19.4 fish/haul 95% of the time.

Given the uncertainly in the estimate, what change in density could have been detected ? The observed density of LG0 cod in Trinity Bay in 1995 relative to previous years was 15.96/21 = 76%, compared to 11.53/14.5 = 80% outside the Bay (Table 5). The minimum detectable increase inside Trinity Bay, at the 5% significance level, was 35.96/21 = 171%, based on analysis of the means in Table 5 (minimum increase to obtain significant interaction term in a two-way ANOVA). The survey could have detected, with a high degree of confidence, an increase of 171 − 100 = 71% in density in 1995, relative to previous years.

The number of eggs produced by the Smith Sound aggregation may have been too few to bring about detectable enhancement. An effort will be made to estimate the expected degree of enhancement by comparing the enhancement of egg density in Smith Sound relative to previous years (K. Smedbol). An effort will also be made to compute the number of eggs released by the spawning aggregation (G. Rose) and the subsequent dispersion of those eggs (B. deYoung).

A fourth possibility is that the eggs were washed out of Trinity Bay by sustained southwesterly winds in June. This can be tested with computations of wind-driven drift of the surface layer, which are being undertaken (F. Davidson, B. deYoung). Another source of information will be the results of the pelagic juvenile surveys undertaken by DFO in Trinity Bay in July and August (J. Anderson, E. Dalley).

Low numbers of LG1 and LG2 fish were even more unexpected than low numbers of LG0 fish. These low numbers were not due to a change in survey design. The execution and design were exactly the same as previous years, when regression equations for the survey successfully predicted increased LG1 and LG2 cod. High error rate is not a problem because a statistically significant decrease was observed. Several biological explanations for the decrease are possible.

1. High rates of incidental catch of juvenile fish.
2. Shift of LG1 and LG2 away from coastal nursery areas in 1995 relative to earlier years.
3. High rates of loss of LG1 and LG2 fish to predators in 1994-1995.

Most sources of incidental catch were reduced or ended in 1992, due to the moratorium on groundfishing. The caplin fishery in 1994 and 1995 was small because of late arrivel of small fish. There is no evidence of increase in incidental catch of cod by this fishery in 1994-1995, relative to previous years.

A shift away from coastal nursery areas will normally occur in LG1 and LG2 relative to LG0 fish, based on winter surveys in 1992-1994 (Dalley and Anderson, in press). Preliminary results of the 1995 winter survey (E. Dalley, personal communication) suggest that density of LG1 fish declined substantially in 1995 within 30 nm of the coast. Decline in density of LG1 fish in 1995 relative to previous years was less evident away from the coast. This indicates that the decline observed in the Fleming survey was not confined to the coast, but rather was an indicator of a larger scale decline in density.

The third possibility, high rates of loss to predators, is consistent with observed patterns of size selectivity by seals (LG1 and LG2 cod) and with anecdotal observations of small cod found in stomachs of larger cod taken by the sentinel fishery. The estimate of increased mortality of LG1 in 1995, relative to previous years, was $\Delta M = -258\%$ per year. This was estimated from the ratio of LG1 in 1995 to LG0 in 1994 (0.06038) compared to the average ratio in the past ($\beta_{0->1} = 0.7984$) estimated by regression (Schneider et al. 1995). That is, $\Delta M = \ln(0.06038/.7984) = -258\ \%/yr$. This computation assumes that the performance of the Fleming seine did not change in 1995 (no change in catchability); it also assumes that shift offshore in 1995 was similar to previous years.

The cost to complete the survey in 1995 (14,500) came from the Canadian Centre for Fisheries Innovation (50%), with additional assistance from Department of Fisheries and Oceans, Human Resources Department, Natural Sciences and Engineering Research Council, and the Einvironmental Innovation Program.

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Table 1. Fleming sites samples with at least two successive sets of a bottom seine, St. Mary's Bay to Cape Bonavista.

Site\Yr	59	60	61	62	63	64	92	93	94	95	
01			X	X	X	X	X	X	X	X	Harricot Beach
02				X	X		X	X	X	X	Half Island
03							X	X		X	Mother Hicks Cove
04		X	X	X							Admirals Beach
05		X	X		X	X	X	X			Mosquito Cove
06			X	X		X	X	X	X	X	North Harbour (bottom)
10				X	X	X	X	X	X	X	Trepassey
12		X		X	X	X					Cape Broyle
16	X	X	X		X		X	X	X	X	Davies Head (N)
17	X	X	X	X			X	X	X	X	Davies Head (S)
18	X	X	X	X			X	X	X		Crockers Cove
19	X	X	X	X	X	X	X	X	X		Bryants Cove
20	X	X	X	X	X	X	X	X	X		Bristols Hope Cove
25			X	X	X	X					Rantem Cove
26							X	X	X	X	Masters Head
27			X	X	X		X	X	X	X	Little Mosquito Cove
28			X	X			X	X	X	X	Bald Point Beach
29		X				X	X	X	X	X	Long Beach (E)
30				X		X	X	X	X	X	Long Beach (W)
31			X	X	X	X					Lower Lance Cove
32				X		X	X	X	X	X	Middle Lance Cove
33					X	X	X	X	X	X	Burgoynes Cove
34	X	X	X	X	X		X	X	X	X	Lockston's Arm
35					X	X	X	X	X	X	Cap Cove
40		X	X	X	X	X	X	X	X	X	Cannings Cove
41		X		X		X	X	X	X	X	Man Point
42				X							Jamestown

Table 1. cont'd. Fleming sites from Cape Bonavista to western Notre Dame Bay.

Site\Yr	59	60	61	62	63	64	92	93	94	95	
43				X	X						Great Chance Hbr.(btm)
44				X	X	X					Great Chance Hbr.(rt.)
45			X	X		X					Eastport
46		X	X	X	X		X	X	X	X	Indian Bay
50				X	X	X	X	X	X		Rubens Cove
51			X		X		X	X	X	X	Grassy Island
52					X	X	X	X	X	X	Seal Island
53				X	X	X	X	X	X	X	Fox Island
57		X		X	X	X	X	X		X	Bridgeport
58		X	X	X	X		X	X		X	Luke's Arm
65		X			X		X	X	X	X	Fortune Hbr. (NW,btm)
66							X	X			Fortune Hbr. (Fox Cv.1)
67			X		X		X	X	X	X	Fortune Hbr. (Fox Cv.2)
68			X	X	X		X	X	X	X	Fortune Hbr. (SW btm)
69				X	X		X	X		X	Fortune Hbr. (SE btm)
70			X	X	X		X	X	X	X	Wild Bight
71				X	X	X	X	X	X	X	Julies Hbr.
72			X	X	X	X	X	X	X	X	Tommy's Arm
75			X	X	X	X	X	X	X		Woodfords Arm (outcrops)
76			X		X	X	X	X	X		Woodfords Arm (mid)
77			X		X		X	X	X		Woodfords Arm (btm)
78			X	X	X	X	X	X	X	X	Lower Wolfe Cove
79						X		X	X	X	Green Island
80			X	X	X	X	X	X	X	X	Halls Bay, Beachy Cv.
81			X	X	X	X	X		X		Shimmey Cove
82				X	X	X					Little Bay Arm
83					X						Middle Arm (btm)
84		X			X		X	X	X	X	Middle Arm (Green Bay)
85			X	X	X	X	X	X	X	X	King's Point (Green Bay)

Table 2. Duration of sampling for juvenile cod by year and bay in eastern Newfoundland in 1959-1964 and in 1992-1995. SMB=Saint Mary's Bay, SS=Southern Shore, CB=Conception Bay, TB=Trinity Bay, BB=Bonavista Bay, NDB=Notre Dame Bay (located in Figure 1).

area	1959	1960	1961	1962	1963	1964	1992	1993	1994	1995
SMB	----	12 Sep-20 Sep	8 Sep-14 Sep	17 Sep-21 Sep	19 Sep-25 Sep	19 Sep-25 Sep	22 Sep-23 Sep	22 Sep-23 Sep	23 Sep	21 Sep-27 Sep
SS	23 Sep-24 Sep	----	15 Sep	22 Sep	26 Sep	18 Sep	21 Sep	21 Sep	21 Sep	20 Sep
CB	2 Oct-8 Oct	28 Sep-29 Sep	21 Sep-23 Sep	26 Sep-27 Sep	5 Oct-7 Oct	24 Sep-25 Sep	28 Sep-29 Sep	28 Sep-29 Sep	29 Sep, 4 Oct	28 Sep
TB	10 Oct-12 Oct	3 Oct-4 Oct	25 Sep-30 Sep	1 Oct-14 Oct	10 Oct-12 Oct	29 Sep-3 Oct	20 Sep-6 Oct	30 Sep-6 Oct	30 Sep-6 Oct	30 Sep-7 Oct
BB	16 Oct	6 Oct-10 Oct	3 Oct-7 Oct	11 Oct-16 Oct	17 Oct-19 Oct	6 Oct-8 Oct	8 Oct-9 Oct	8 Oct-9 Oct	7 Oct-8 Oct	8 Oct-9 Oct
NDB	23, 26 Oct	17 Oct-27 Oct	9 Oct-24 Oct	17 Oct-26 Oct	21 Oct-31 Oct	12 Oct-22 Oct	14 Oct-21 Oct	14 Oct-21 Oct	14 Oct-22 Oct	14 Oct-20 Oct

Table 3. Ages (days) of LG0 fish caught at Little Mosquito Cove on 4 October 1995. Standard length (SL) in mm. Data from David Pinsent. Estimated hatch date = 277 − mean age

Specimen	SL	Count 1	Count 2	Count 3	Age	Hatch Date
1 left	56	97	93	90	93	3 July
right		95	91			
2	53	89	95	96	93	3 July
3	57	101	96	100	99	27 June
4	59	103	99	93	98	28 June
5	71	115	124	130	123	3 June

Table 4. Summary of the number of number of hauls (NHAUL) and mean catch (fish/haul) by year for LG0 LG1 and LG2 juvenile cod collected at Fleming Sites along the northeast coast of Newfoundland. This table summarizes all data where two consecutive sets were conducted at each beach. N_{sites} = Number of sites.

YEAR	NHAUL		LG0	LG1	LG2
59	12	6	177.833	5.167	1.500
60	34	17	31.353	133.941	0.588
61	60	30	10.967	27.683	2.067
62	80	40	29.513	6.963	0.813
63	82	41	17.841	30.732	0.439
64	64	32	9.531	50.797	2.063
92	92	46	9.598	3.946	0.391
93	88	45	13.250	10.216	0.233
94	80	40	19.775	16.450	0.937
95	72		13.264	1.194	0.264

Table 5. Mean catch (LG0 fish per haul) in 1995 in Trinity Bay, compared to recent (1992-94) catches outside Trinity Bay. Std = standard deviation. Note that means are based on differing sample sizes, and hence cannot be added together directly.

	1992-1994			1995		
	Mean	Std	N	Mean	Std	N
inside	21.00	3.964	81	15.96	6.865	27
outside	14.5	2.004	317	11.53	3.964	81
both	17.76	2.221	398	23.75	3.964	108

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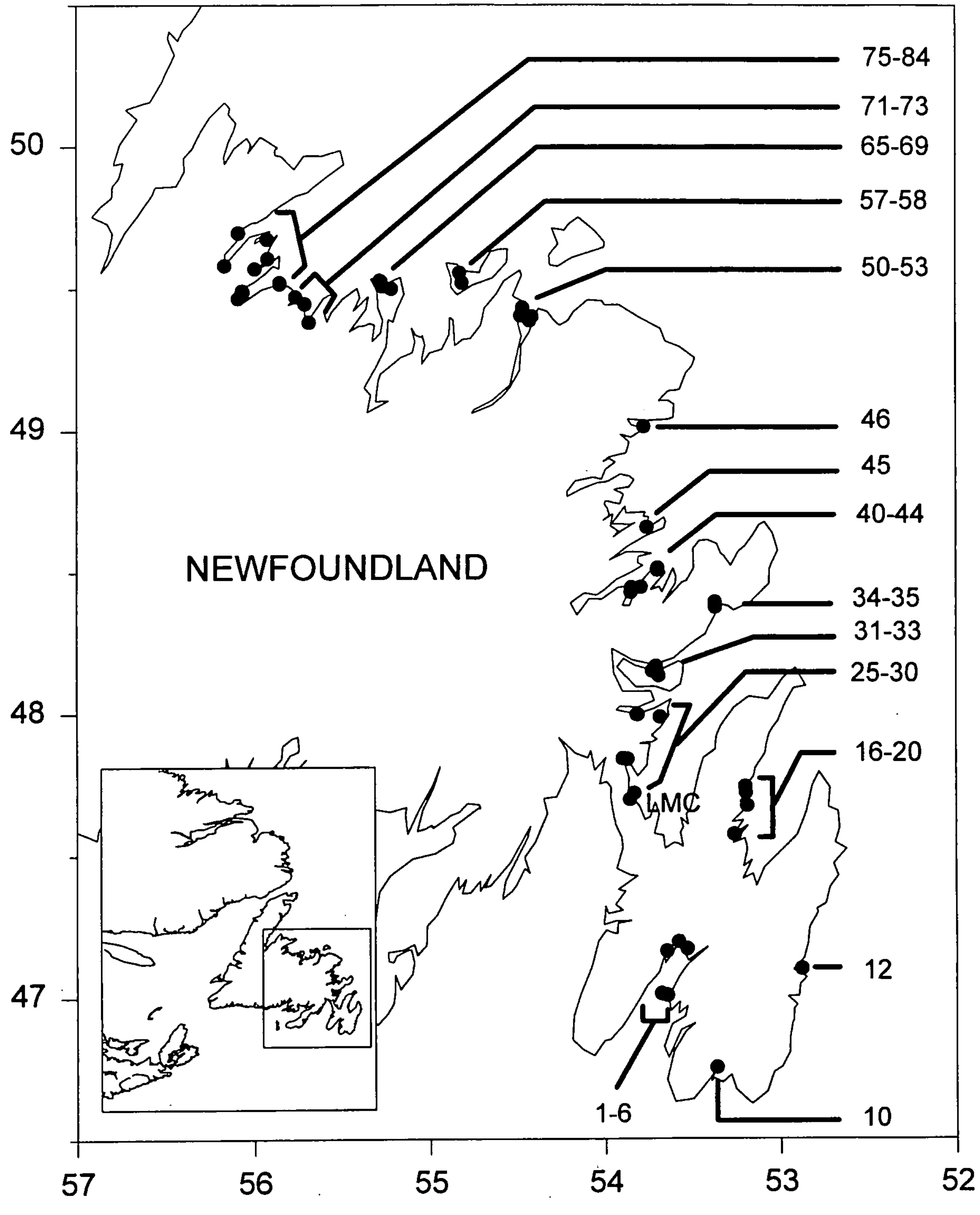

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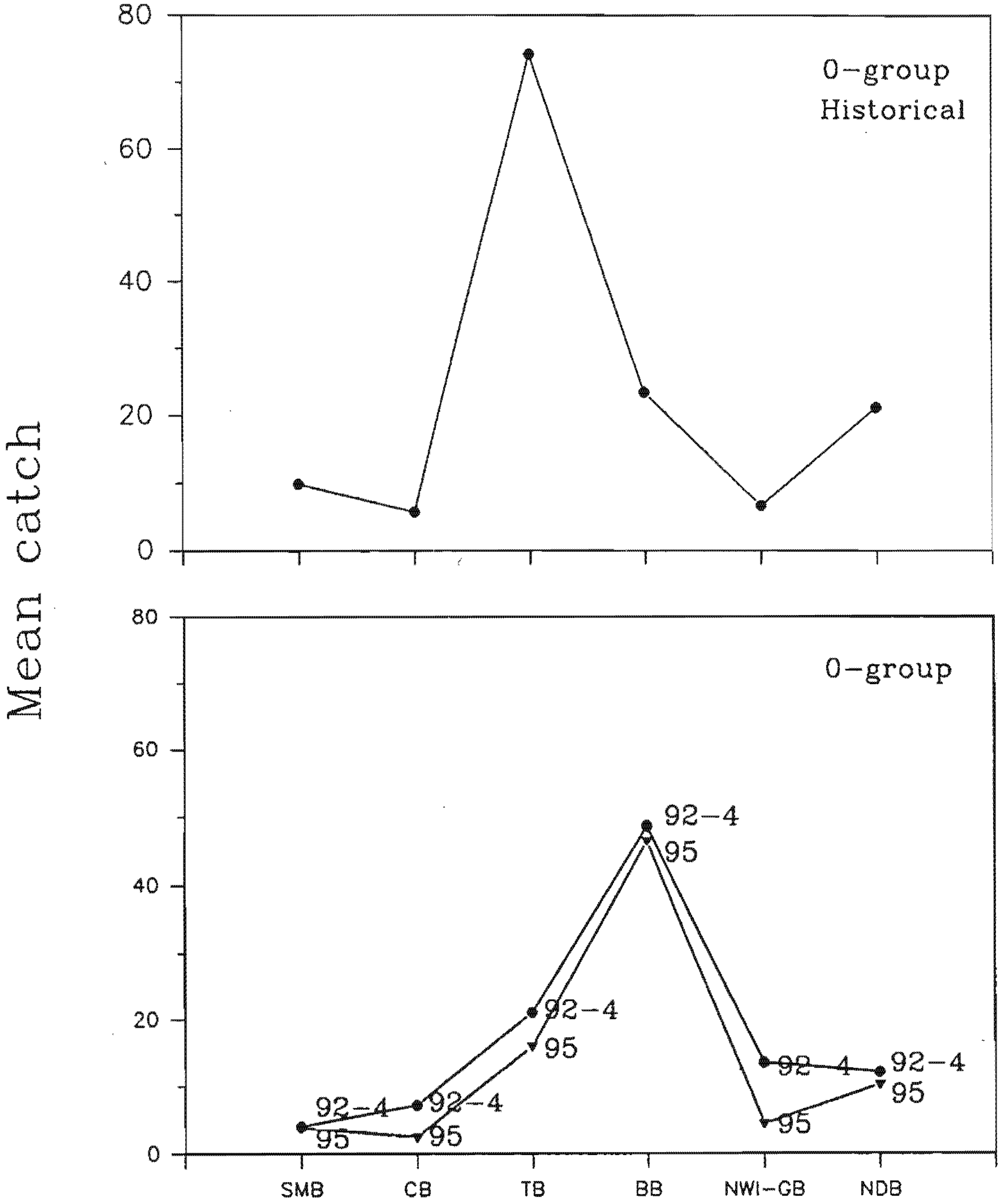

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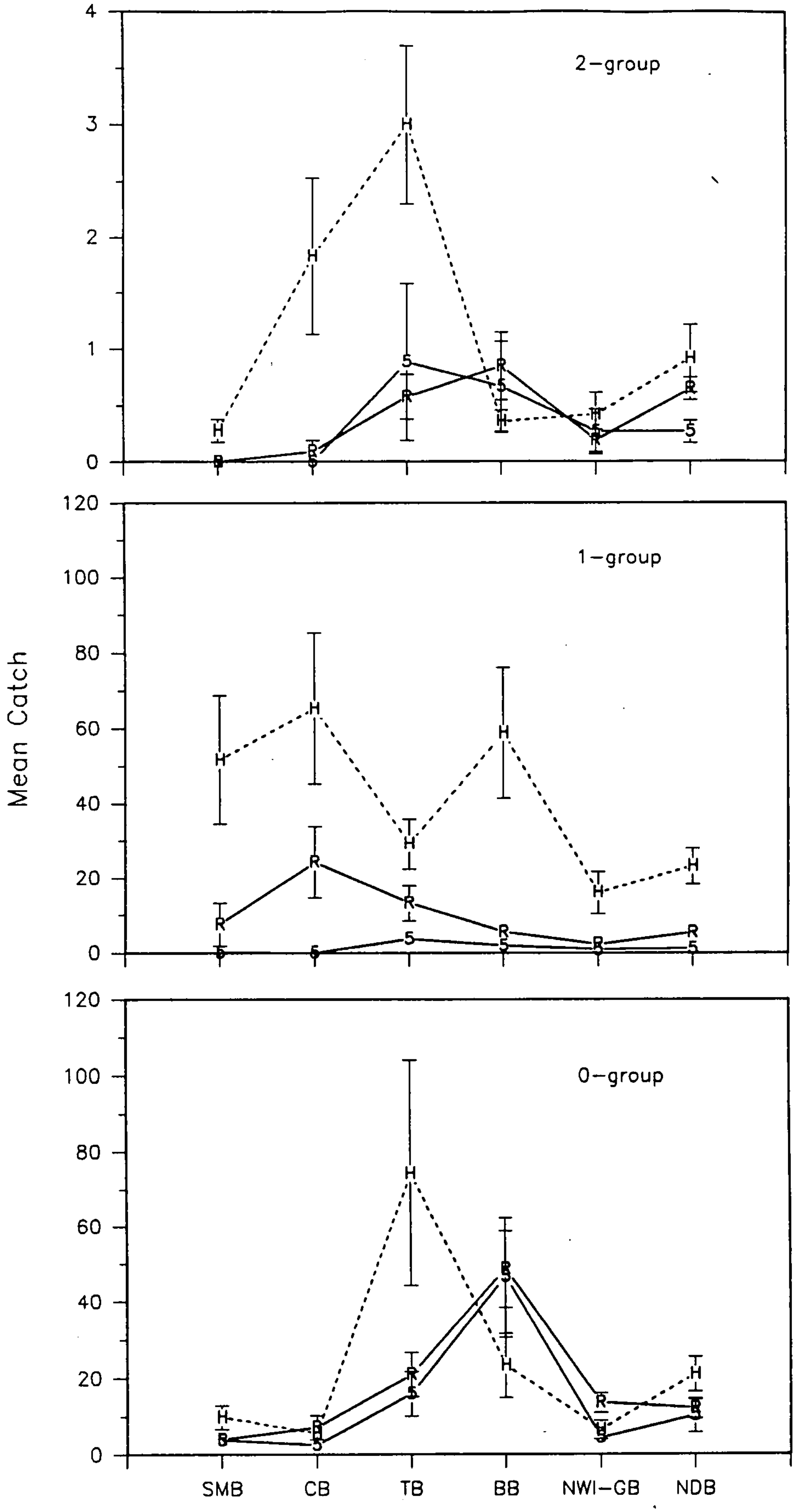

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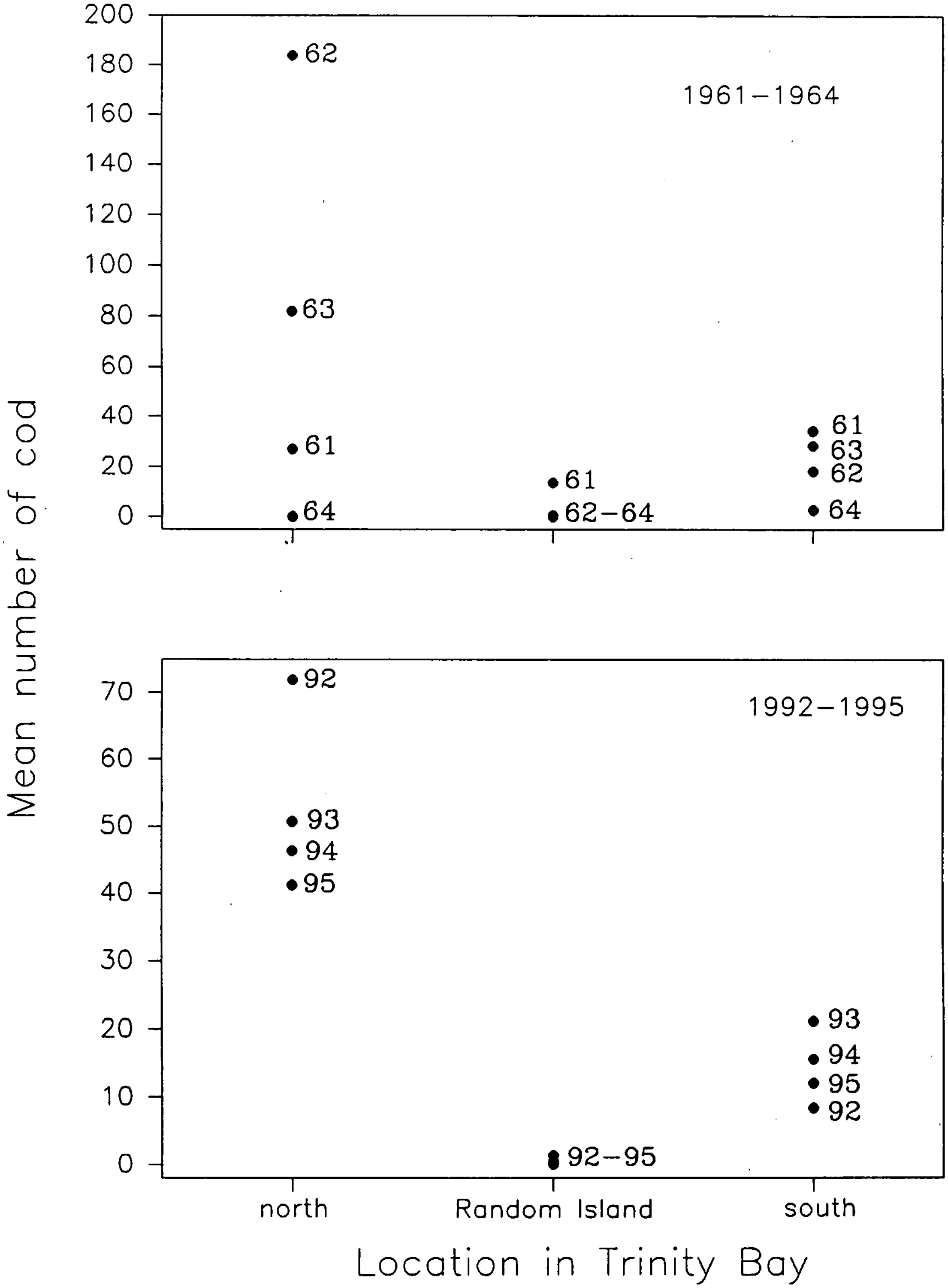

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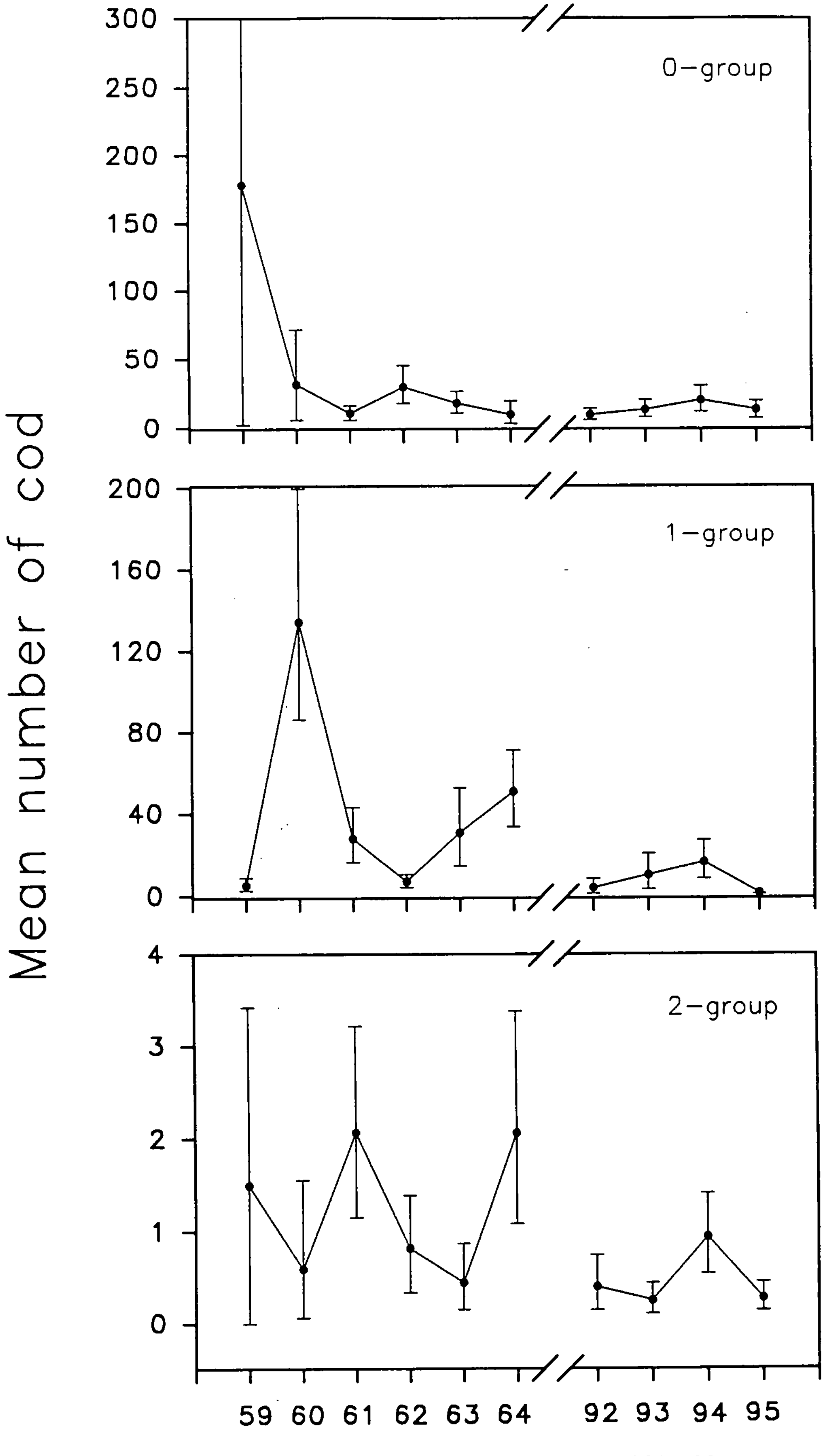

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