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Mackerel Research in the Newfoundland Area During 1975

by

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Introduction

During 1975 research continued into the biology of the Atlantic mackerel (Scomber scombrus) which occur seasonally in the Newfoundland area. Samples were taken from commercial landings, analysed and compared with results previously reported from the area (Moores et al 1975). As well as age and length composition, length-at-age, % mature at age, length at 50% maturity and sex ratio were re-examined for possible changes.

Preliminary investigations were also conducted into the utility of otolith measurements as a means of determining the relative proportions of 'northern' and 'southern contingent' mackerel present in the total population.

In 1974 and 1975 reports were received of 'winter kills' of mackerel from several areas of Newfoundland. These kills were similar to those reported by Templeman (1965) and studies were conducted into the influence of temperature in the deaths.

Methods and Materials

Mackerel samples were obtained from fishermen or from processing plants and were examined fresh or after being frozen for a period of several weeks. Data were obtained on total length, whole weight, sex, maturity and otoliths were removed for age determination.

The methods used for determination of length, weight, maturity stage and age were the same as those described by Moores et al (1975). A limited number of otoliths from various year classes were taken from the 1975 catches. Both the first year's and second year's growth were measured and examined for bimodality. Otolith measurements were made using a method similar to that described by Mackay (1967). Otoliths were measured with a steroscopic microscope equipped with a drawing tube which superimposed the image of the otolith on co-ordinate paper placed on a bench. Measurements were made from the centre of the otolith to the posterior end along the longest axis (Fig. 1). A year was composed of an opaque zone plus a hyaline zone. The magnified otolith image was measured in increments of 0.5 mm to the 0.5 mm below and then reconverted to actual width to the nearest 0.1 mm.

Results

Age-length distribution

Data from commercial catches by non-selective gears in Newfoundland waters indicate a large shift in the age distribution (Fig. 2) in 1975 from that observed in previous years. From 1971 to 1974 the 1967 year class has been dominant in the Newfoundland catches, whereas in 1975 it represented only 12%. Of the fish sampled in 1975 69% were from the 1971, 1972 and 1973 year classes. The 1972 year class was dominant at 25% while the 1971 and 1973 year classes each contributed 22%.

Since 1970 only two year classes (1971 and 1973) have shown up strongly in the Newfoundland area as two year olds suggesting that it is mainly the older mackerel which migrates as far north as Newfoundland. Indeed the 1972 year class which is dominant in 1975 represented only 1% of the catch at age two. In 1973 the 1971 year class represented 14% of the fish sampled. The 1973 year class represents 22% in 1975.

This may indicate that the 1973 year class is stronger than either the 1971 or 1972 year classes, or, that most of the older mackerel have been fished out leading to a dominance (though not necessarily stronger) of younger age-groups.

Corresponding to the shift in the age distribution the mode of the length distribution (Fig. 2) has moved to the left. In 1973 and 1974 the 1967 year-class showed its dominance with a mode at 40cm total length (36.6cm F.L.) while in 1975 the mode is spread from 34-38cm total length (31.1-34.8cm F.L.) due to the dominance input from the 1971-1973 year classes.

Length at age. Length at age was calculated for the period 1970 to 1975 for mackerel caught in June-July and August for all gears (Table 1). No significant differences could be observed for any of the years and all fluctuations appear to be of a random nature.

Otolith measurements. Mackerel of the 'southern contingent' spawn mainly in the Bight between New Jersey and Long Island from late April through May while 'northern contingent' mackerel spawn in the Gulf of St. Lawrence from mid-June to mid-July (Sette 1950). This separation of spawning in place and in time should give rise to growth differences which would be accentuated by the rapid growth rate of mackerel. It could be argued that the extra month of life would give the 'southern contingent' mackerel time to become proportionately larger than the 'northern contingent' during the 0-group stage. A comparison of length-at-age data of mackerel 3 years of age and older caught in Newfoundland and in New England (Moores et al 1975) does not demonstrate any significant difference between the two areas. If there is a difference in growth in the first year and if by age 3 both contingents show the same age-at-length then 'northern contingent' mackerel must grow more rapidly in the second year to compensate for the higher first year growth rate of the 'southern contingent'.

Mackerel otoliths collected from Newfoundland catches were measured for both the first (O_1) and second (O_2) years growth. Neither of these measurements produced a bimodal distribution (Fig. 3) suggesting that either the 'northern contingent' mackerel were the only ones represented in the samples or that the 'southern contingent' mackerel do not form a significant proportion of the total mackerel population, if free-mixing is assumed. Other studies (Sette 1950 and Mackay 1967) on meristic and biochemical characteristics have failed to yield any means of separating the two contingents.

It is interesting to note both from the mean O_1 and O_2 widths (Table 2) and from the O_1 and O_2 width distributions (Fig. 3) that the 1969 and 1967 year classes show a wider O_1 band than 1971, 1972 and 1973 while in the O_2 annulus the 1971, 1972 and 1973 year classes show a wider band than 1967 and 1969. This suggests that growth compensation occurs in mackerel.

Age and Length at Maturity, Sex Ratio. Marked changes occurred in age-at-maturity and length at 50% maturity for 1975 from that reported by Moores et al (1975). The age of maturity was reduced for both males and females. In 1975 72.2% of the females were mature at age 2 while for 1970-73 only 31.4% were mature. Female mackerel were 100% mature by age 4 in 1975 while 100% maturity was not achieved until age 5 for 1970-73. The percentage of males mature at age 2 increased from 22.8% in 1970-73 to 63.0% in 1975. For males 100% maturity was effectively reached at age 4.

Thelength at 50% mature for 1975 was also reduced from 1970-73. The length at maturity represented by the maturity ogive (Fig. 4) was also analysed using Probit analysis which gave the 50% maturity length for females as 310 mm total length and for males as 313 mm total length. This compares to 339 mm for females and 347 mm for males reported for 1970-73.

The reduction in age at 100% maturity by 1 year and length at 50% maturity by 30 mm may be due to sampling error in 1970-73 rather than an actual increase in the maturation rate of mackerel.

Of the mackerel sampled in Newfoundland during 1975, 45.8% were females. This compares to 55.5% females in 1973 and 50.0% in 1974.

Winter Kills of Mackerel in Newfoundland

Mackerel are seasonal visitors to Newfoundland waters. They appear in mid June and depart during late October and November overwintering off New England (Moores et al 1975). Sette (1950) states that mackerel appear to undergo extensive longitudinal migrations which can be conclated with surface temperatures. The range of temperatures preferred by mackerel has not been determined but Sette (1950) states that no mackerel have been reported as occurring in water less than 4.5°C. Templeman (1965) reported mackerel washing ashore in December 1951 at Notre Dame Bay and at Cupids, Conception Bay. He attributed these deaths to the effects of low water temperature.

In 1974 and again in 1975 reports were received at the St. John's Biological Station that mackerel were washing ashore. The 1974 reports were for the 1st week of December in Notre Dame Bay (3L) and Bonne Bay (4R). In 1975 reports were again received in December from Notre Dame Bay and from Sweet Bay, Bonavista Bay.

When the 1974 kills were reported investigators went immediately to the Notre Dame Bay area.

Conversations with local Fisheries Officers and fishermen revealed that the occurrence of mackerel in the area during November and December was a common phenomen and that mackerel had been taken in gill nets as late as the first week of January. On December 4, 1974 mackerel were observed at Loon Bay (Fig. 5). These mackerel displayed atypical behaviour patterns. Individual mackerel were observed swimming in slow circles at the surface of the water. Other mackerel were seen swimming on their sides. As they accelerated the anterior half of their body would lift out of water then fall back to the surface in a slapping motion which was repeated for several minutes. Some mackerel were observed to swim rapidly towards shore and stop several inches from the beach where they could be picked up by hand even though the fish were still alive and upright in the water. In general the school appeared disoriented.

Surface temperatures were taken at Loon Bay and at several other beaches where dead mackerel were observed or reported. The temperatures (Fig. 5) ranged from 1.1°C to 2.6°C. In 1975 no temperature data were obtained but Fisheries Officers reported that at all beaches where mackerel has washed ashore slob ice was present (Ray Andrews pers. comm.).

The closest hydrographic station to the Notre Dame Bay area for which we have temperature data available for this period is Station 27 (47°31'50"N, 52°35'10"W). For 1974 and 1975 (Table 4) there is a drop in surface temperature of 9°C from October to December. Surface temperatures reported at Station 27 for November are at the lower limit set by Sette yet mackerel are still readily available to fishermen.

Samples of dead mackerel and mackerel taken in gill nets were collected. These samples displayed no obvious differences from mackerel samples collected from the area during the year.

It would appear that winter kills of mackerel are not an uncommon occurrence in Newfoundland waters. Mackerel waiting too long to begin their southward migration become trapped in pockets of warm water in sheltered bays. As these pockets of water cool the mackerel undergo thermal stress resulting in death. The presence of mackerel in Newfoundland during November and December indicates that they may be able to tolerate water temperatures 2-3°C below those cited by Sette (1950).

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References

Mackay, K.T. 1967. An ecological study of mackerel Scomber scombrus in the coastal waters of Canada. Fish. Res. Bd. Canada Tech. Rep. 31, 127p.

Moores, J.A., G.H. Winters and L.S. Parsons. 1975. Migrations and biological characteristics of Atlantic mackerel (Scomber scombrus)occurring in Newfoundland waters. J. Fish. Res. Bd. Canada 32(8): 1347-1357.

Sette, O.E. 1950. Biology of the Atlantic mackerel (Scomber scombrus) of North America. Part II Migrations and habits. U.S. Fish. Wildl.Serv. Fish. Bull. 51(49):251-358.

Templeman, W. 1965. Mass mortalities of marine fish in the Newfoundland area presumably due to low temperature. ICNAF Spec. Pub. No. 6: 137-145.

Table 1. Mean length at age of mackerel from the Newfoundland area for the period June-July (A) and August (B) 1970-1975. No. of fish examined in brackets.

Year	2	3	4	5	6	7	8	9	10	11	Total
A. 1970	-	35.4(18)	37.8(93)	39.0(104)	41.2(24)	43.6(16)	43.3(27)	44.0(21)	43.7(21)	45.6(14)	338
1971	30.1(8)	35.5(8)	36.1(218)	38.5(121)	39.4(71)	41.4(7)	44.5(2)	43.7(6)	43.0(2)	43.7(10)	452
1972	-	34.8(30)	38.1(45)	38.9(197)	40.8(84)	41.7(51)	43.3(13)	43.8(21)	44.9(10)	44.7(34)	485
1973	31.3(226)	33.9(51)	36.9(81)	39.1(92)	40.1(238)	40.9(109)	41.7(49)	42.9(17)	43.3(14)	44.0(20)	897
1974	33.2(5)	34.9(135)	36.2(34)	37.8(43)	39.0(41)	40.1(101)	41.5(33)	42.0(12)	43.7(3)	44.9(8)	415
1975	30.9(157)	34.7(116)	36.7(140)	38.5(25)	39.5(31)	40.7(20)	41.1(46)	41.9(7)	43.8(3)	45.8(5)	550
B. 1970	33.0(4)	34.1(174)	37.1(147)	38.5(116)	40.8(39)	41.7(9)	43.1(12)	43.6(14)	43.6(7)	44.7(15)	537
1971	-	36.2(6)	36.2(66)	37.1(16)	43.8(4)	41.0(2)	42.0(1)	44.5(2)	42.0(1)	43.0(2)	100
1972	31.0(1)	35.5(23)	37.2(61)	38.0(210)	39.1(96)	39.8(26)	43.5(9)	44.0(9)	41.5(2)	43.9(8)	445
1973	32.3(63)	34.5(25)	38.0(24)	39.3(72)	39.5(132)	40.6(44)	41.3(12)	43.0(2)	-	-	374
1974	32.6(13)	34.7(253)	36.3(77)	37.9(104)	39.2(145)	40.4(480)	41.6(219)	42.2(72)	43.6(15)	45.0(22)	1400
1975	33.0(63)	35.1(123)	37.2(110)	38.4(35)	39.9(54)	40.4(46)	41.4(103)	42.5(21)	42.4(10)	44.8(5)	570

Table 2. Range and mean of O_1 and O_2 otolith measurements of mackerel caught in Newfoundland during 1975.

Year Class	No. Examined	O_1		O_2	
		Range	Mean	Range	Mean
1973	100	0.92mm - 1.58mm	1.18mm	0.06mm - 0.78mm	0.49mm
1972	100	0.90mm - 1.64mm	1.16mm	0.16mm - 0.72mm	0.46mm
1971	100	0.88mm - 1.64mm	1.17mm	0.20mm - 0.62mm	0.41mm
1969	50	0.98mm - 1.50mm	1.26mm	0.18mm - 0.66mm	0.37mm
1967	50	1.02mm - 1.52mm	1.24mm	0.22mm - 0.64mm	0.36mm

Table 3. Number of mackerel examined and percentage mature by age from Newfoundland waters during 1975.

Age	Females		Males		Combined	
	No.	%mat	No.	%mat	No.	% mat
2	126	72.2	227	63.0	353	66.3
3	193	97.9	260	95.8	453	96.7
4	221	100.0	249	99.6	470	99.8
5	62	100.0	71	100.0	133	100.0

Table 4. Temperatures recorded at Station 27(47°31'50"N, 52°35'10"W). Newfoundland selected months in 1974 and 1975.

Depth(m)	Oct.2 1974	Oct.30 1974	Nov.18 1974	Nov.25 1974	Oct.1 1975	Oct.30 1975	Nov.18 1975	Nov.27 1975	Dec.10 1975
0	11.4	6.3	4.5	3.8	11.2	6.1	4.2	3.4	2.1
10	11.1	6.2	4.6	3.7	11.2	6.1	4.4	3.3	2.0
20	10.6	6.2	4.6	3.3	11.3	5.7	4.0	3.3	2.0
30	7.8	6.2	4.3	3.2	5.7	5.6	3.9	3.3	1.9
50	-0.1	5.4	4.1	3.1	0.2	4.6	3.6	2.5	1.5
75	-0.3	-0.2	0.2	1.6	-0.6	3.2	2.3	1.7	1.5
100	-1.2	-1.1	-0.6	-0.7	-1.2	2.6	1.2	1.7	1.3
125	-1.6	-1.4	-1.2	-1.2	-1.3	-0.1	-0.3	0.6	1.0
150	-1.6	-1.5	-1.4	-1.5	-1.2	-0.9	-0.9	-0.9	-0.1
174	-1.4	-1.5	-1.5	-1.4	-1.1	-0.7	-0.7	-0.8	-0.4

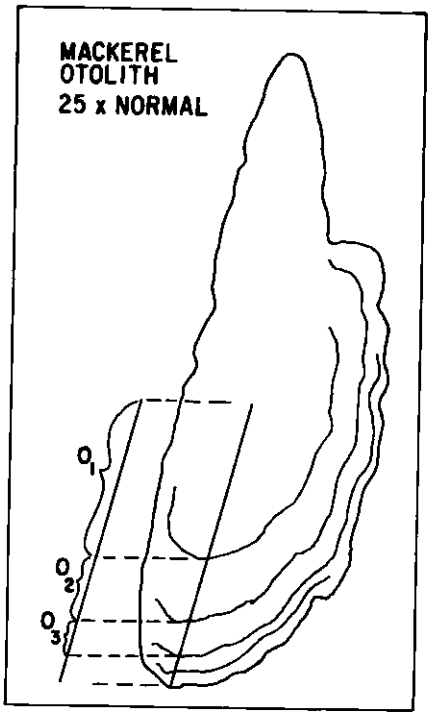

Fig 1. Measurements performed on mackerel otoliths.

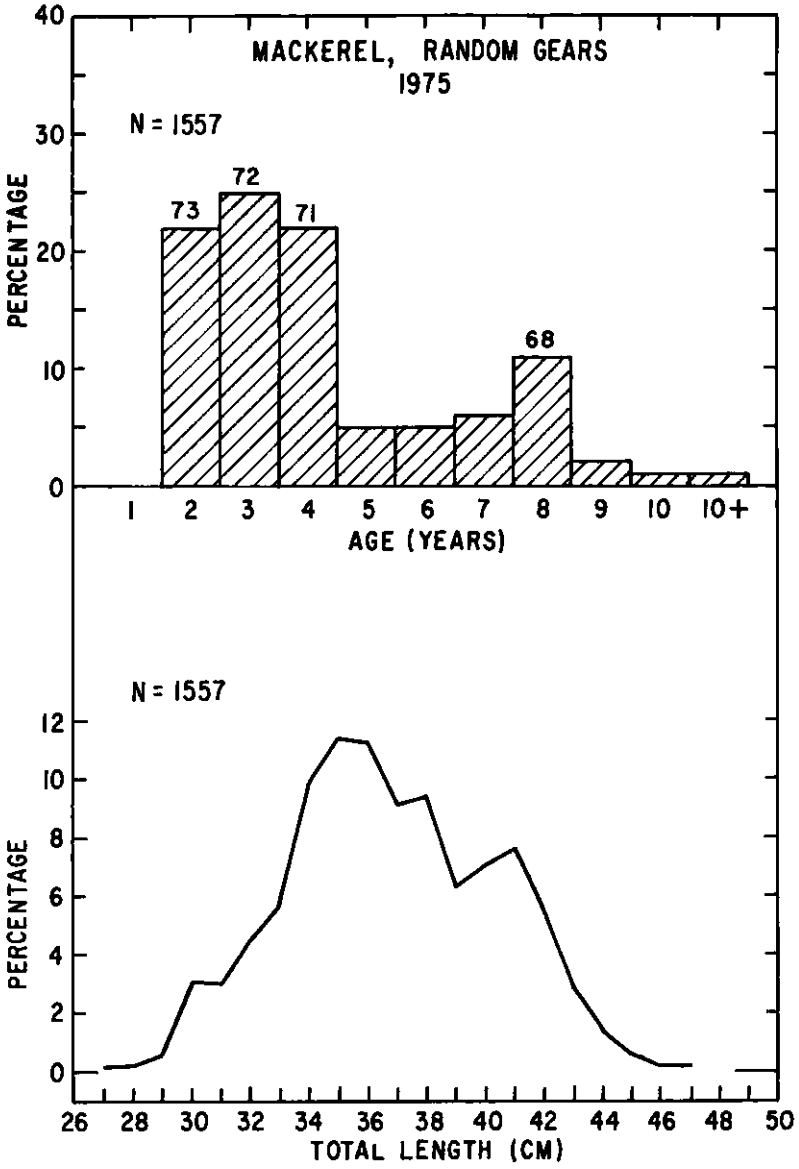

Fig 2. Length and age composition of Mackerel caught in Newfoundland by random gears during 1975.

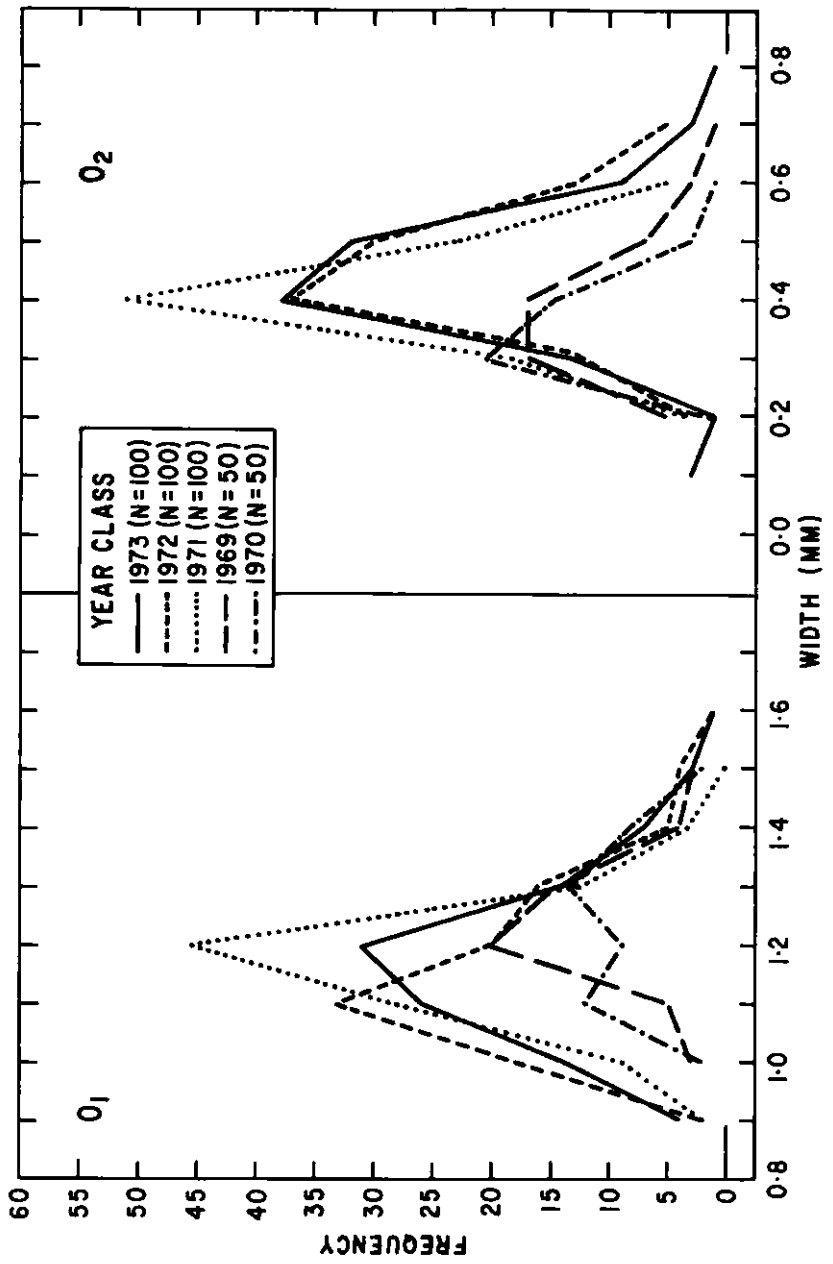

Fig. 3. Distribution of 1st (O_1) and second (O_2) year measurements of mackerel otoliths from Newfoundland catches.

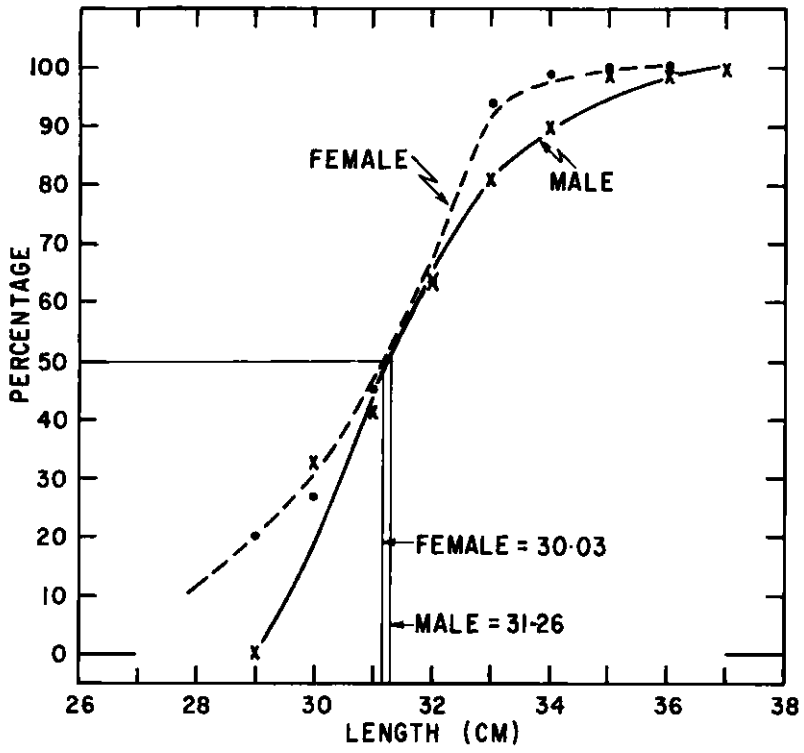

Fig 4. Maturity ogive for mackerel sampled in Newfoundland during 1975.

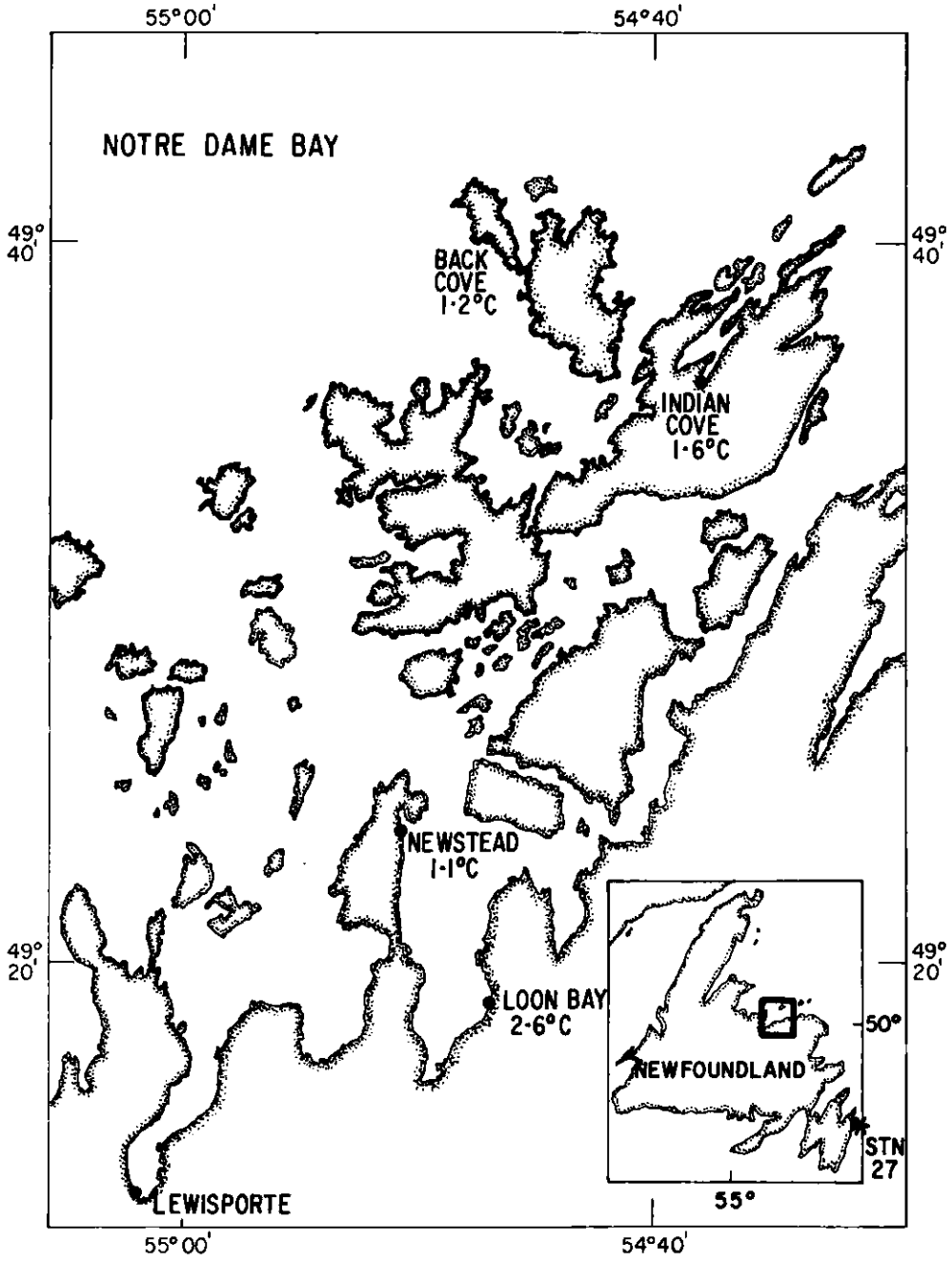

Fig 5. Area of mackerel winter kills and surface water temperatures as recorded on Dec. 4 , 1974.