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Seasonal and age specific distribution of the 1975 and 1978 year classes of haddock on Georges Bank

by

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INTRODUCTION

Information concerning the distribution of exploited species in space and time is an important factor for effective assessment and management of marine fish stocks. This is particularly true for the Georges Bank haddock (*Melanogrammus aeglefinus*) resource which has declined dramatically over the last two decades. Recent attempts to manage the stock have included by-catch regulations, catch quotas, seasonal area closures, mesh regulations, and size limits (Clark et al., 1982; Overholtz et al., 1983). Large numbers of fish were discarded in 1977 and 1980 as the large 1975 and 1978 year classes became vulnerable to bottom trawl gear (Overholtz et al., 1983). The distribution of haddock from those year classes overlapped with the cod (*Gadus morhua*) and yellowtail flounder (*Limanda ferruginea*) fisheries on Georges Bank. Knowledge of spatial and temporal distributions at age for this stock could be very helpful in dealing with the management problems associated with this important commercial resource.

Haddock are sampled effectively during Northeast Fisheries Center (NEFC) spring and autumn bottom trawl surveys. In recent years, however, only the aforementioned 1975 and 1978 year classes were strong enough to be consistently sampled for determining spatial and temporal trends in distribution by age for Georges Bank haddock. Virtual population analysis or VPA indicates that the 1975 and 1978 year classes provided approximately 83 and 62 million age 2 recruits, respectively, to the Georges Bank stock (Overholtz, et al., 1983). Estimates of abundance at age 2 for both of these cohorts were at or above the long-term average (Clark et al., 1982). Since catchability by survey gear is relatively high for

this species, the large number of fish available made it possible to evaluate trends in seasonal distribution by area and depth for these two cohorts.

This report provides information based on NEFC spring and autumn survey results. Results should provide a basis for determining more appropriate spawning time-area closures, studying variations in year class strength, and developing contingency plans or appropriate management actions for rebuilding the stock should additional strong year classes occur in the future.

METHODS

The Northeast Fisheries Center has conducted annual bottom trawl surveys along the northeast coast of the USA since autumn of 1963. A spring cruise was added in 1968, and additional surveys have been scheduled during the winter and summer on an intermittent basis. A stratified random design has been employed in these surveys, and standardized gear, procedures, and techniques have been used. A more thorough justification for these surveys and more detailed reviews of survey procedures can be found in Grosslein (1969) and Azarovitz (1981).

A selected portion of the spring and autumn data base (stratas 13-25, 29, 30, see Figure 1) was used to determine seasonal distribution by age for the 1975 and 1978 haddock year classes on Georges Bank. Catch-per-tow-at-age (numbers) from autumn surveys for 1975-1981 and spring surveys for 1976-1981 were plotted to determine depth distribution of fish from these year classes. Summer survey coverage of this region was generally incomplete during this period, although coverage in 1977 and 1980 was judged adequate for analysis.

Length frequencies from the above surveys were analyzed on a per tow basis to determine catch per tow at age (number) for these year classes. This was possible since these year classes dominated the survey catch and were easily separated by length frequency mode from the other fish captured at each tow. Catch-at-age values were then plotted by year class using FISHMAP, a plotting package available at the Northeast Fisheries Center. This process was repeated for each cruise. Seasonal distribution in terms of depth was also examined for each age group; arbitrary depth ranges were selected and used with the above catch-per-tow data to determine depth distributions and modal depth range by age.

RESULTS AND DISCUSSION

Changes in distribution of Georges Bank haddock are related to age of the fish as well as season. Both the 1975 and 1978 year classes were widely dispersed as age 0 fish, occupying depths of less than 100 m (Figure 2). Abundance at age 0 was highest between 41-60 m for both year classes (Table 1). This is probably a function of dispersal of eggs and eventual migration of juveniles upon completion of the pelagic phase of their life history. Age 1 fish tended to congregate along the eastern part of Georges Bank in spring, particularly along the 100 m contour. Fish from both year classes tended to mass in this area and move toward the Northeast Peak and Northern Edge the following autumn at age 1. The distribution plots suggest a migration pattern opposite to the prevailing clockwise gyre that exists on Georges Bank. Other studies have demonstrated that sizable numbers of young haddock tend to gather in this area [see Walford (1938)].

Age 2 and older fish moved from deeper to shallower water in spring, apparently because of behavioral changes associated with spawning. Fish from both cohorts tended to disperse widely over the bank in waters less than 100 m (Figures 2,3, Table 1). The centers of distribution were along the Northern Edge, Northeast Peak, Great South Channel, and also the Southeast Part, at depths from 60-100 m.

As both year classes matured they moved progressively deeper in autumn until most were located at depths greater than 100 m (Figures 2,3, Table 1). Age 2 fish tended to be distributed along the Northern Edge and Northeast Peak. Age 3 and older fish dispersed to deeper water in autumn, indicating that Georges Bank fish may contribute to haddock landings from the eastern Gulf of Maine region (Figures 2,3, Table 1). These older fish may also mix in this region with fish produced in the western Gulf of Maine during the autumn and winter months (McCracken, 1960).

The distribution of haddock from the 1975 and 1978 year classes was highly dependent on life history stage and season. Most of the change in distribution could probably be related to variation in temperature, food preference, habitat preference, or spawning activity. Colton (1955) suggested that a scarcity of suitable prey items between 120 and 180 meters in summer was one of the reasons why haddock were not found in this depth range. Distribution studies in Passamaquoddy Bay, New Brunswick, showed that haddock distributed themselves along warmer temperature isotherms, even though their preferred food items were much more abundant a short distance away in shallower cooler water (Tyler 1980)[1]. In the present study, adult fish from these two cohorts exhibited similar movements during spring

[1]Tyler, A. V. 1980. Personal communication. Department of Fisheries and Wildlife, Oregon State University.

and late summer as were observed by Colton (1955) during 1948-1950. Age 0 fish, however, seemed to be more widely dispersed in 1975 and 1978 with highest concentrations being observed along the east-central part of Georges Bank, in contrast to the observed tendency for the Southeast Part to be the primary area of concentration during 1948-1950.

The distribution data presented in this document reflect the behavior and movements of the 1975 and 1978 year classes. To the extent that this behavior is indicative of trends in the Georges Bank haddock stock, this information provides the following insights:

1) The age specific distribution of haddock from these two year classes appears to have important management implications. Spring survey distributions of age 2 fish overlap with those of yellowtail flounder in the east central part of the Bank and cod on the Northern Edge, Northeast Peak, and South Channel. Distribution plots from summer surveys confirm this and also show the gradual movement of haddock to deeper water as the year progresses (Figure 4). The coincidental distribution of these species creates the opportunity for significant catches of juvenile haddock to occur whenever a strong year class is present. These distribution trends account at least in part for the large numbers of age 2 haddock that were discarded in 1977 and 1980, a phenomenon that might be avoided to some degree in the future if age specific distribution is used in the management decision making process. Additionally, large numbers of juveniles were discarded in 1977 and 1980 in the directed haddock fishery.

2) The spawning area closure presently in effect from March to May coincides reasonably well in time with haddock spawning activity on Georges Bank (Walford 1938, Colton 1962, Marak and Livingstone 1970,

Morse 1983)[2] but does not appear to provide complete spatial protection. The spring distribution data suggest that the spawning stock is dispersed widely over the Bank. Although the Northeast Peak is a concentration area, the Southeast Part, areas of the Great South Channel shallower than 100 m, and areas west of the present closed area on the Northeast Peak also appear to be important according to the survey data base. The area presently closed in the Great South Channel does not appear to be a particularly important spawning site. Based on depth distributions from spring survey catches, it appears that the most important spawning areas are all less than 100 meters. Walford (1938) noted that the South Channel was an important spawning area, but not as important as the Northeast Peak and not every year.

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[2]Morse, W. 1983. Personal communication. Northeast Fisheries Center, Sandy Hook Laboratory, Sandy Hook, New Jersey.

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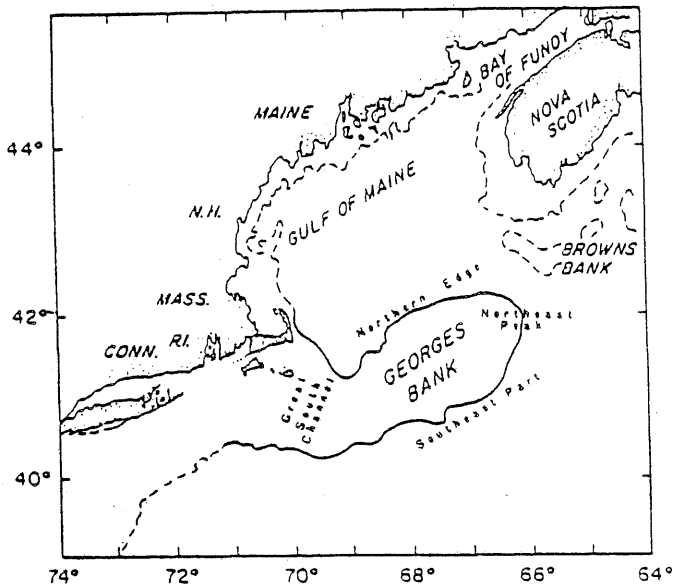
Table 1. Seasonal depth distribution by age group for the 1975 and 1978 haddock year classes on Georges Bank.

Depth zone	Range (m)	Age	% at Depth										
			1975 Year Class							1978 Year Class			
			0	1	2	3	4	5	6	0	1	2	3
								FALL					
1	1- 20		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	21- 40		19.8	0.0	0.0	0.7	3.3	0.0	0.0	4.0	0.2	0.0	0.0
3	41- 60		28.6	0.0	0.9	4.8	3.6	15.5	3.6	52.6	1.2	2.6	1.2
4	61- 80		20.2	90.5	5.6	7.7	12.6	0.0	0.0	17.2	2.3	3.5	11.9
5	81-100		17.4	0.1	76.9	3.0	4.0	1.6	14.3	18.1	8.5	4.7	14.1
6	101-120		1.4	2.1	1.0	31.0	0.5	26.9	0.0	1.5	0.4	11.1	1.2
7	121-140		1.6	0.3	2.7	18.3	6.7	0.5	0.0	0.8	1.7	2.0	25.4
8	141-160		4.9	0.2	0.0	10.2	9.2	29.0	3.6	0.1	19.1	14.1	12.8
9	161-180		4.3	0.3	9.7	2.0	0.8	9.8	3.6	0.2	0.7	37.8	4.3
10	181-200		0.8	6.5	2.7	8.4	23.8	7.8	3.6	4.2	58.7	19.3	2.8
11	201-220		1.1	0.0	0.5	7.5	19.9	1.6	50.0	0.2	7.1	0.6	14.7
12	221-240		0.0	0.0	0.0	6.4	14.3	7.3	0.0	0.0	0.0	4.2	0.0
13	241-260		0.0	0.0	0.0	0.0	1.2	0.0	21.4	0.0	0.0	0.0	11.6
MODAL DEPTH			41-60	61-80	81-100	101-121	181-200	141-160	201-220	41-60	181-200	161-180	121-140
N			1481	3363	4255	1900	642	193	28	2164	5187	1250	327
$\overline{X}$ DEPTH ZONE			4.1	4.6	5.5	7.2	8.6	7.2	10.0	3.9	9.0	8.3	7.9
								SPRING					
1	1- 20		-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
2	21- 40		-	7.0	0.0	25.0	0.3	10.0	6.1	-	8.6	7.3	6.8
3	41- 60		-	11.8	4.0	4.7	5.2	14.9	21.5	-	0.5	41.3	29.3
4	61- 80		-	12.6	16.9	51.4	30.8	2.0	18.2	-	39.6	2.5	24.7
5	81-100		-	66.7	60.5	4.3	54.2	12.7	30.8	-	49.9	41.0	16.7
6	101-120		-	0.3	0.3	0.0	2.2	0.9	6.5	-	4.6	0.8	4.6
7	121-140		-	2.3	18.2	3.6	0.7	0.0	1.4	-	0.1	0.1	4.6
8	141-160		-	0.0	0.0	2.5	4.9	58.4	0.0	-	4.0	6.7	0.0
9	161-180		-	8.3	7.1	8.1	0.7	1.1	11.7	-	0.5	0.2	12.1
10	181-200		-	4.6	0.0	0.1	1.0	0.0	2.3	-	0.7	0.2	0.4
11	201-220		-	0.0	0.0	0.3	0.0	0.0	0.0	-	0.0	0.0	0.8
12	221-240		-	0.0	0.0	0.0	0.0	0.0	1.4	-	0.0	0.0	0.0
13	241-260		-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
MODAL DEPTH				81-100	81-100	61-80	81-100	141-160	81-100		81-100	81-100	41-60
N				4305	2805	993	679	442	214		3506	2249	1336
$\overline{X}$ DEPTH ZONE				5.0	5.1	4.1	4.8	6.1	4.9		4.8	4.2	4.7



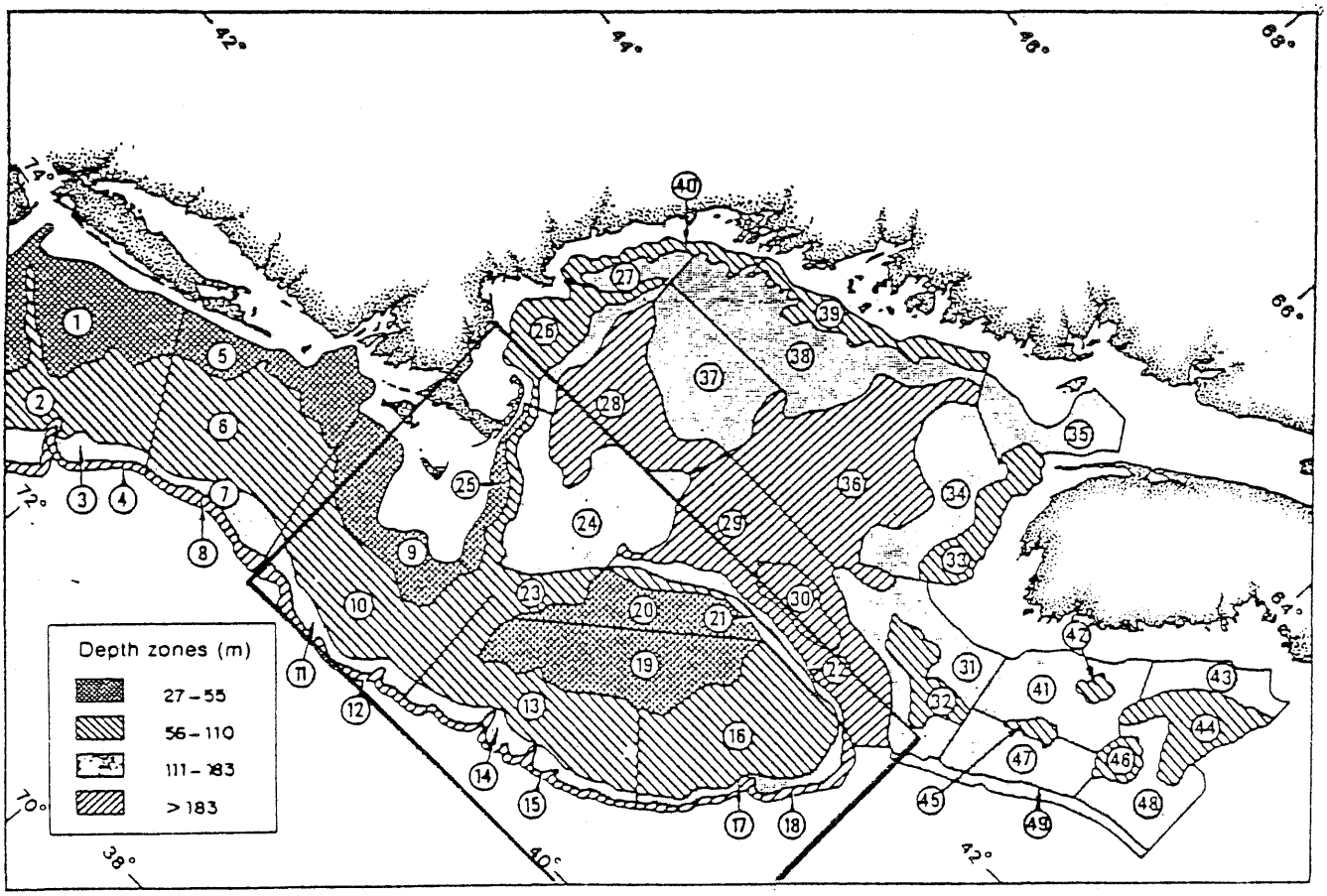


Figure 1. Location of Georges Bank in the Atlantic Ocean with associated land masses and Northeast Fisheries Center stratification scheme for spring and autumn bottom-trawl surveys.

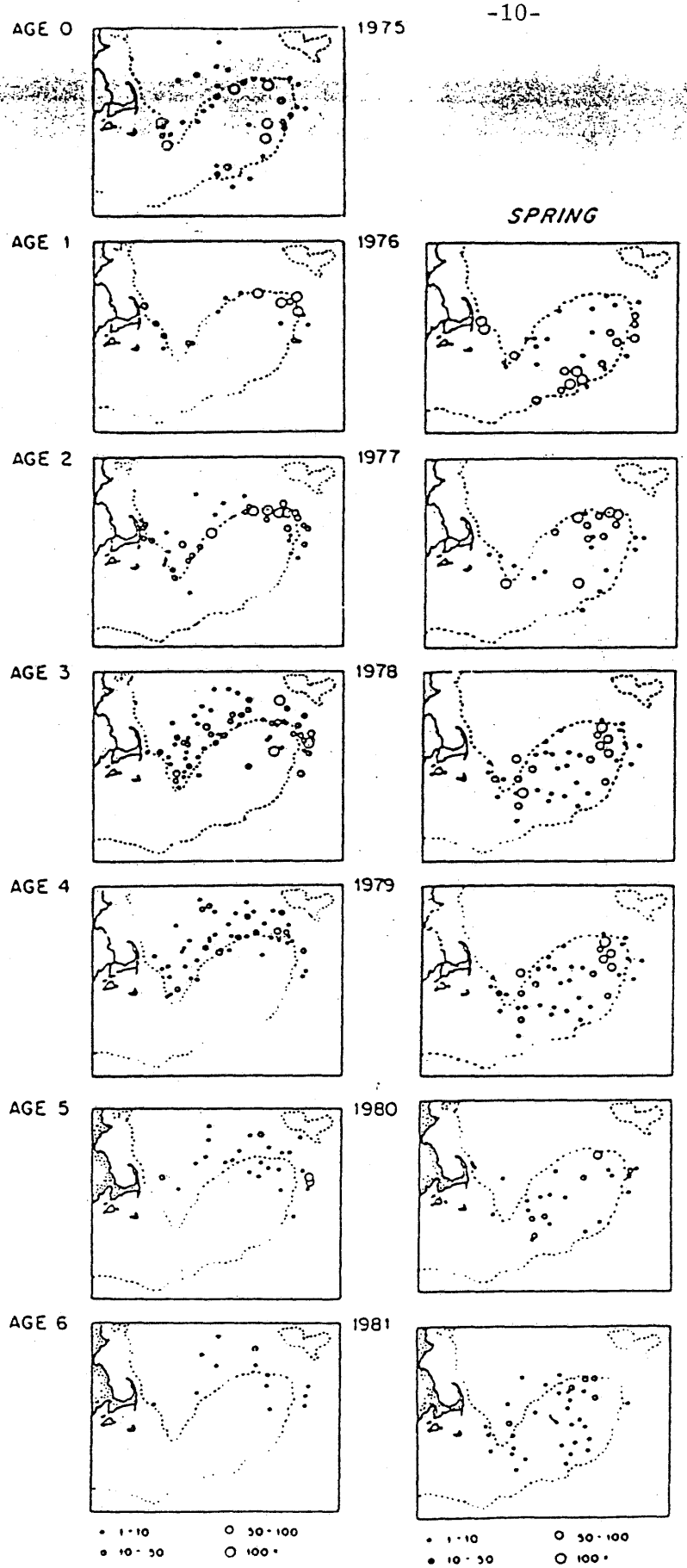


Figure 2. Fall and spring distribution of the 1975 haddock year class (ages 0-6) on Georges Bank for 1975-1981 observed during NEFC bottom trawl surveys. The dotted line is a 100 meter contour.

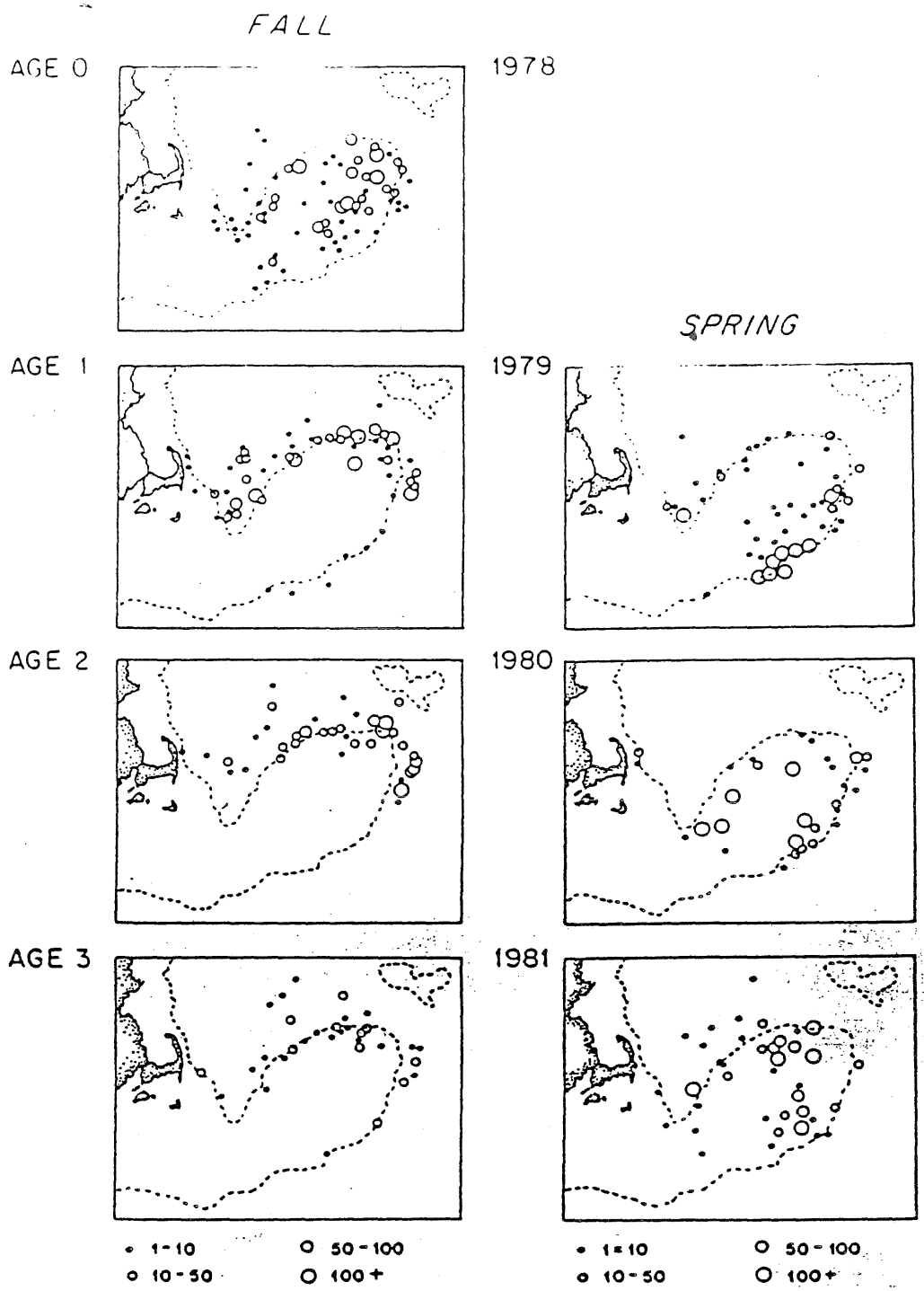


Figure 3. Fall and spring distribution of the 1978 haddock year class (ages 0-3) on Georges Bank for 1978-1981 during NEFC bottom trawl surveys.

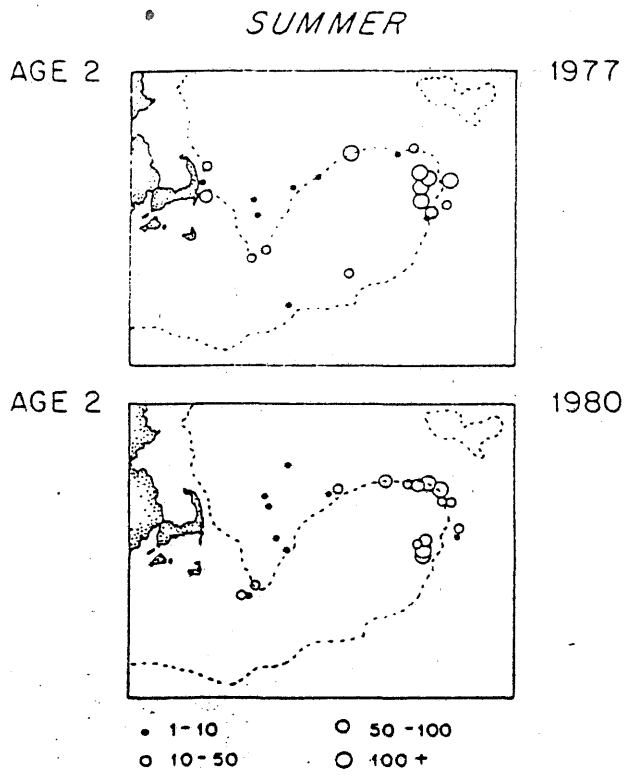


Figure 4. Summer distribution of the 1975 year class (Age 2) and 1978 year class (Age 2) of haddock on Georges Bank in 1977 and 1980, respectively, from NEFC surveys.