NAFO Sci. Coun. Studies, 8: 77-82

Seasonal and Age-specific Distribution of the 1975 and 1978 Year-classes of Haddock on Georges Bank

William J. Overholtz
National Marine Fisheries Service, Northeast Fisheries Center
Woods Hole, Massachusetts 02543, USA

Abstract

Seasonal and age specific distributions of haddock (*Melanogrammus aeglefinus*) of the 1975 and 1978 year-classes on Georges Bank were investigated from data collected during spring and autumn bottom-trawl surveys. Both year-classes at age 0 were widely dispersed in autumn with highest abundance in 41-60 m. As the fish matured at ages 2 and 3, they congregated along the northern edge and on the northeast peak in autumn to overwinter in deep water on the slopes of the bank. A general movement from deeper to shallower water occurred in late winter and early spring, with concentrations usually in 81-100 m. Implications of coincident distributions with other species are discussed.

Introduction

Information on spatial and temporal distribution of exploited fish populations is important for effective assessment and management. This is particularly true for the Georges Bank haddock (*Melanogrammus aeglefinus*) resource which has declined greatly over the last two decades due to intense exploitation and poor recruitment. Attempts to manage this stock have included catch quotas, prohibition of directed fishing coupled with by-catch regulations, seasonal spawning area closures, mesh regulations, and size limits (Clark *et al.*, 1982; Overholtz *et al.*, MS 1983). Despite these regulations, the strong 1975 and 1978 year-classes became vulnerable to commercial trawling gear in 1977 and 1980 respectively, which resulted in heavy discarding of these year-classes at age 2 (Overholtz *et al.*, MS 1983). The distribution of haddock of these year-classes overlapped that of cod (*Gadus morhua*) and yellowtail flounder (*Limanda ferruginea*) on Georges Bank (Murawski *et al.*, 1983), further complicating the situation.

Recent virtual population analyses of the Georges Bank haddock population (Overholtz *et al.*, MS 1983), indicated that the 1975 and 1978 year-classes provided approximately 83 million and 62 million recruits at age 2 respectively to the stock. Both of these cohorts were above the long-term average year-class size (Clark *et al.*, 1982). Because the spring and autumn bottom-trawl surveys by research vessels of the Northeast Fisheries Center consistently sample this species (Grosslein, 1969), the relatively large numbers of fish available made it possible to evaluate trends in seasonal distribution of the 1975 and 1978 year-classes by area and depth. The results should help to provide a basis for developing appropriate management actions for rebuilding the stock if additional strong year-classes occur in the future.

Materials and Methods

Bottom-trawl surveys of the Gulf of Maine, Georges Bank and southern New England areas (Fig. 1) have been conducted on a regular basis in autumn since 1963 and in spring since 1968. Additional winter and summer surveys have been carried out on an intermittant basis. These surveys were conducted according to a stratified-random design, with standardized gear, procedures and techniques (Grosslein, 1969; Azarovitz, 1981). Haddock were measured as fork length to the nearest centimeter.

A subset of the data from the spring and autumn surveys (Fig. 2, strata 13-25, 29, 30) was analyzed to determine seasonal distribution by age of the 1975 and 1978 year-classes of haddock on Georges Bank.

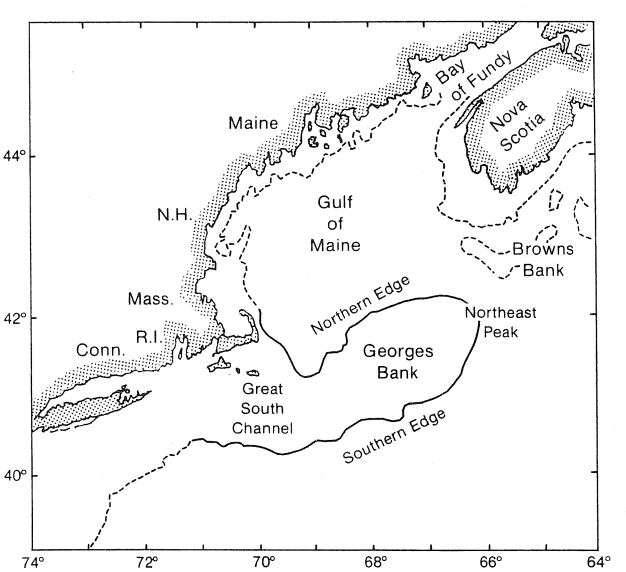

Fig. 1. Georges Bank and adjacent areas, with place names mentioned in the text.

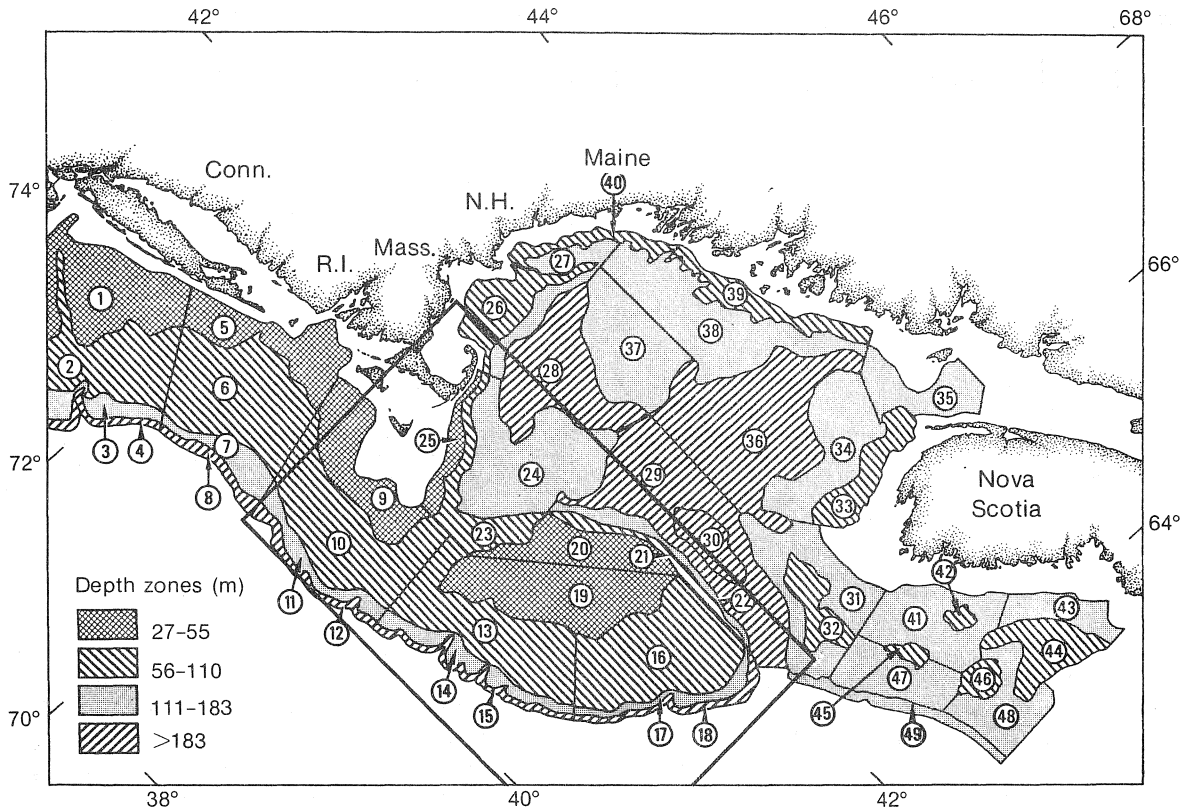

Fig. 2. Stratification scheme for bottom-trawl surveys of the Gulf of Maine, Georges Bank and southern New England areas.

Summer surveys of this area were generally incomplete, but coverage of the same strata in 1977 and 1980 was judged to be adequate for analysis. Catch rates (numbers per tow) of the 1975 and 1978 year-classes from the autumn surveys in 1975–81 and the spring surveys in 1976–81 were plotted to illustrate their spatial and seasonal distribution.

Abundance of the 1975 and 1978 year-classes was determined by modal analysis of the survey length frequencies. This was possible because these year-classes were dominant in the catches. Data for the survey stations were post-stratified into 20-m depth intervals to determine depth distribution of the two year-classes in each season.

Results and Discussion

Distributions of the 1975 and 1978 year-classes of haddock on Georges Bank varied by age, depth and season (Table 1). At age 0 in autumn, these year-classes occurred at depths less than 100 m, with peak abundance generally at 41–60 m. This is probably related to dispersal of eggs and larvae and eventual migration of juveniles upon completion of the pelagic phase of their life history, as both year-classes were widely dispersed over the bank in autumn (Fig. 3 and 4). Age 1 haddock tended to congregate along the eastern part of the bank in spring, particularly in the 81–100 m depth zone. In the following autumn, these fish were found on the northeast peak and along the northern edge of the bank, indicating a migration pattern opposite to the prevailing clockwise gyre on Georges Bank. Other studies have demonstrated that sizeable numbers of young haddock tend to mass along the eastern part of the bank (i.e. Walford, 1938).

Age 2 and older haddock moved from deeper water in autumn to shallow areas in spring, apparently because of behavioral changes associated with spawning (Colton, 1955). Fish of both year-classes tended to be dispersed widely over the bank in areas less than 100 m (Fig. 3 and 4), with centers of distribution being generally along the northern edge, northeast peak, southeast slope and Great South Channel in 60–100 m.

As both year-classes matured, they moved progressively deeper in autumn until most fish were located at depths greater than 100 m. Age 2 fish tended to be distributed along the northern and northeastern slopes of the bank, whereas age 3 and older fish dispersed to deeper water in the Gulf of Maine (Fig. 3 and 4) indicating that haddock from Georges Bank may contribute to catches in the eastern Gulf of Maine fishery. Also, these older fish from the Georges Bank stock may, in autumn and winter, mix in this deepwater area with haddock from the western Gulf of Maine population (McCracken, 1960).

TABLE 1. Seasonal distribution (percent by number) by depth range for haddock age-groups of the 1975 and 1978 year-classes on Georges Bank. (Modal percentages are in **bold** type.

Depth range (m)	1975 year-class by age							1978 year-class by age			
	0	1	2	3	4	5	6	0	1	2	3
	Spring surveys, 1976-81							**Spring surveys, 1979-81**			
21-40	—	7.0	0.0	25.0	0.3	3.4	6.0	—	8.6	7.3	6.8
41-60	—	11.8	4.0	4.7	5.2	21.3	21.5	—	0.5	**41.3**	**29.3**
61-80	—	12.6	16.9	**51.4**	30.8	2.0	18.2	—	39.6	2.5	24.7
81-100	—	**66.7**	**60.5**	4.3	**54.2**	12.7	**30.8**	—	**49.9**	41.0	16.7
101-120	—	0.3	0.3	0.0	2.2	1.0	6.5	—	4.6	0.8	4.6
121-140	—	2.3	18.2	3.6	0.7	0.0	1.4	—	0.1	0.1	4.6
141-160	—	0.0	0.0	2.5	4.9	**58.5**	0.0	—	4.0	6.7	0.0
161-180	—	8.3	0.0	8.1	0.7	1.1	11.7	—	0.5	0.2	12.1
181-200	—	0.0	0.0	0.1	1.0	0.0	2.3	—	0.7	0.2	0.4
201-220	—	0.0	0.0	0.3	0.0	0.0	0.0	—	0.0	0.0	0.8
221-240	—	0.0	0.0	0.0	0.0	0.0	1.4	—	0.0	0.0	0.0
>240	—	0.0	0.0	0.0	0.0	0.0	0.0	—	0.0	0.0	0.0
No. caught	—	4,305	2,805	993	679	441	214	—	3,506	2,249	1,336
	Autumn surveys, 1975-81							**Autumn surveys, 1978-81**			
21-40	19.8	0.0	0.0	0.7	3.1	0.0	0.0	4.0	0.2	0.0	0.0
41-60	**28.6**	0.0	0.9	4.7	3.4	14.1	2.0	**53.6**	1.2	2.5	1.1
61-80	20.2	**89.3**	5.6	7.5	11.8	0.0	0.0	17.2	2.3	3.4	10.7
81-100	17.4	0.1	**76.9**	2.9	3.8	1.4	8.0	18.1	8.5	4.6	12.6
101-120	1.4	2.1	1.0	**30.2**	0.4	24.4	0.0	1.5	0.4	10.7	1.1
121-140	1.6	0.3	2.7	17.8	6.3	0.5	0.0	0.8	1.7	1.9	**22.8**
141-160	4.9	0.2	0.0	9.9	8.6	**26.3**	2.0	0.1	19.1	13.6	11.5
161-180	4.3	0.3	9.7	1.9	0.7	8.9	2.0	0.2	0.7	**36.4**	3.8
181-200	0.8	6.4	2.7	8.1	**22.3**	7.0	2.0	4.2	**58.7**	18.6	2.5
201-220	1.1	0.0	0.5	7.3	18.7	1.4	28.0	0.2	7.1	0.6	13.2
221-240	0.0	0.0	0.0	6.2	13.4	2.8	0.0	0.0	0.0	4.1	0.0
>240	0.0	1.3	0.0	2.6	7.4	4.0	**56.0**	0.0	0.0	3.5	20.6
No. caught	1,481	3,407	4,256	1,951	685	213	50	2,164	5,187	1,296	364

Seasonal changes in distribution are probably related to temperature influences, food preference and spawning activity. Colton (1955) suggested that a scarcity of suitable prey at 120–180 m in summer was one of the reasons why haddock were not found in this depth range. Studies in Passamaquoddy Bay, New Brunswick, indicated that haddock were distributed in relatively warm water, although their preferred food items were much more abundant a short distance away in shallower, cooler water (A. V. Tyler, Oregon State Univ., pers. comm., 1980). In the present study, adult haddock of the 1975 and 1978 year-classes showed similar patterns of distribution in spring to those observed in 1948-50 (Colton, 1955). However, age 0 haddock seemed to be more widely dispersed in 1975 and 1978, with highest concentrations on the eastern-central part of the bank, than was the case in 1948-50 when the southeast part of the bank was the primary area of concentration.

The distributions of age 2 haddock in spring overlapped those of yellowtail flounder on the eastern-central part of the bank and cod along the northern edge, northeast peak and Great South Channel (Murawski *et al.*, 1983; Overholtz and Tyler, 1985). Also, the summer distributions of age 2 haddock (Fig. 5) indicate overlapping with those of cod and yellowtail flounder, as well as showing a movement to deeper water relative to shallower depths generally occupied in spring. The coincidental distribution of these species creates the opportunity for significant catches of juvenile haddock to occur as by-catch in directed fisheries for cod and yellowtail flounder, whenever a strong year-class of haddock is present. This accounts, at least in part, for the large numbers of age 2 haddock that were discarded in 1977 and 1980. This undesirable phenomenon could be avoided to some degree in the future if age-specific distributional data are utilized for developing management strategies. Similarly, discarding of haddock in the directed haddock fishery might also be avoided or reduced.

The spring distributional data indicate that the stock is dispersed widely over Georges Bank. The northeast peak is certainly an important area of concentration, and other parts of the bank (southeast slope and Great South Channel areas shallower than 100 m) may also be significant, indicating that there may be several important spawning areas in depths less than 100 m on Georges Bank.

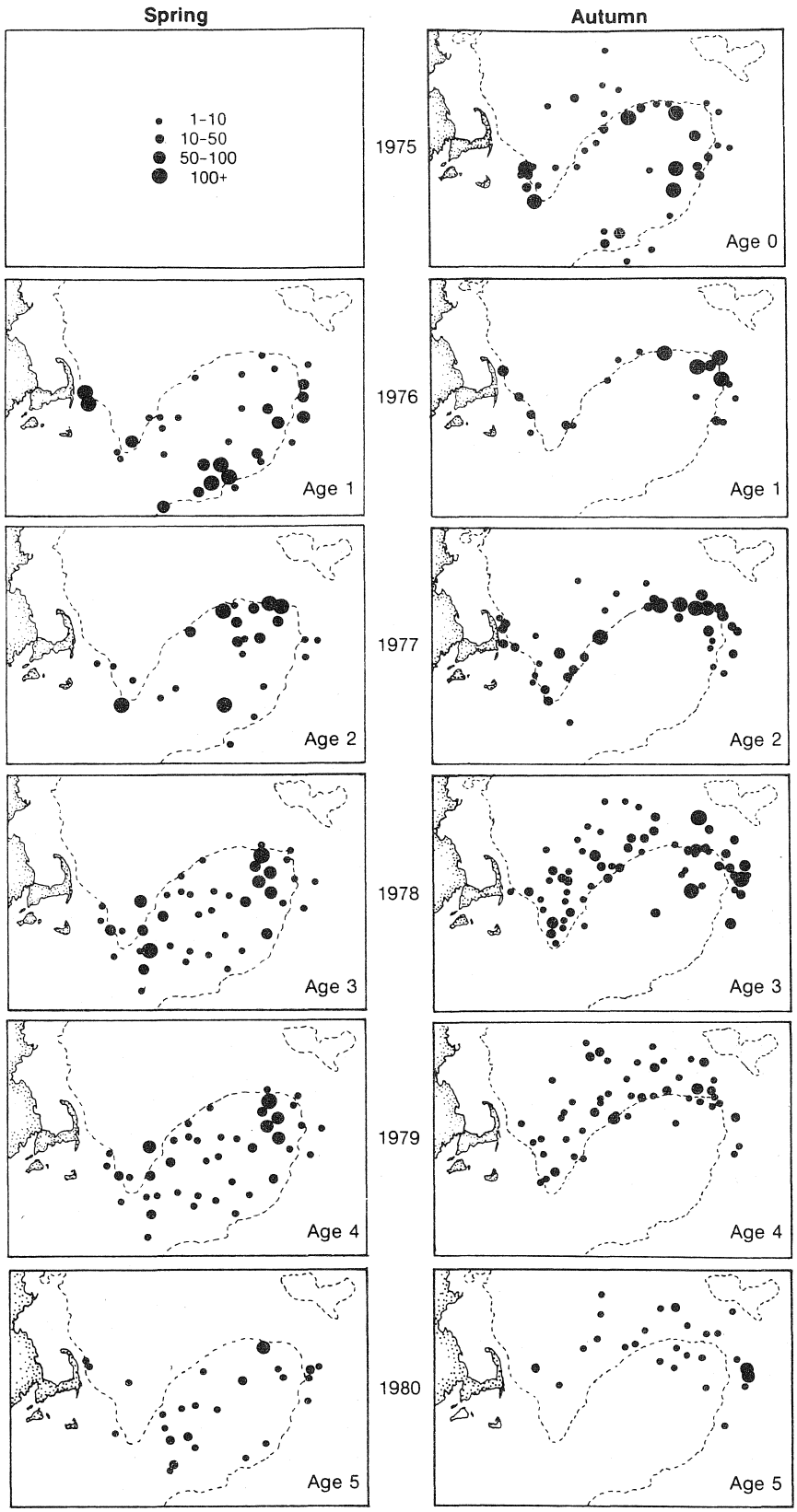

Fig. 3. Spring and autumn distributions of the 1975 year-class of haddock (ages 0-5) on Georges Bank from bottom-trawl surveys in 1975-80. (Dotted line represents the 100-m isobath.)

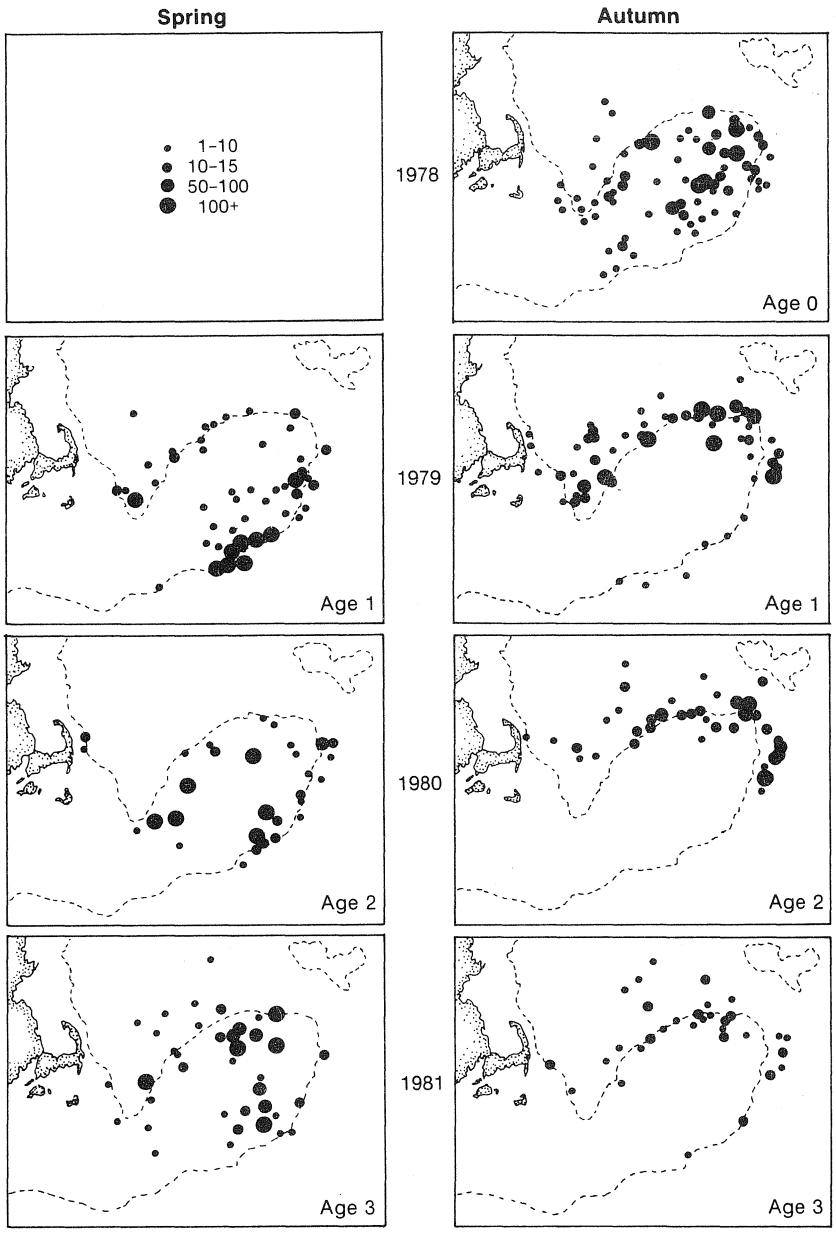

Fig. 4. Spring and autumn distribution of the 1978 year-class of haddock (ages 0-3) on Georges Bank from bottom-trawl surveys in 1978-81. (Dotted line represents the 100-m isobath.)

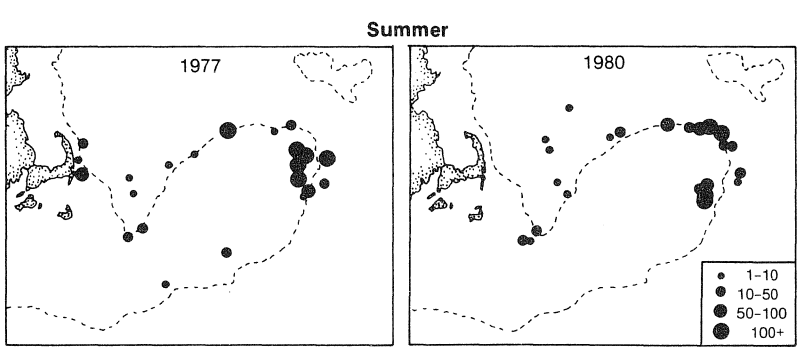

Fig. 5. Summer distribution of age 2 haddock of the 1975 and 1978 year-classes on Georges Bank from bottom-trawl surveys in 1977 and 1980. (Dotted line represents the 100-m isobath.)

Acknowledgements

I appreciate the assistance of my colleagues at the Northeast Fisheries Center during the preparation of this paper. I am especially grateful to Frank P. Almeida who helped with the computer algorithms and gave useful suggestions, and I appreciate the thorough reviews of the manuscript by Stephen H. Clark, Fredric M. Serchuk and Steven A. Murawski.

References

AZAROVITZ, T. R. 1981. A brief historical review of the Woods Hole laboratory trawl survey time series. *Can. Spec. Publ. Fish. Aquat. Sci.*, **58**: 62-67.

CLARK, S. H., W. J. OVERHOLTZ, and R. C. HENNEMUTH. 1982. Review and assessment of the Georges Bank and Gulf of Maine haddock fishery. *J. Northw. Atl. Fish. Sci.*, **3**: 1-27.

COLTON, J. B. 1955. Spring and summer distribution of haddock on Georges Bank. *NOAA Tech. Rep. NMFS (Spec. Sci. Rep Fish.)*, **156**, 65 p.

GROSSLEIN, M. D. 1969. Groundfish survey program of BCF Woods Hole. *Comm. Fish. Rev.*, **31**(8-9): 22-35.

McCRACKEN, F. D. 1960. Studies on haddock in the Passamaquoddy Bay region. *J. Fish. Res. Board Can.*, **17**: 175-180.

MURAWSKI, S. A., A. M. LANGE, M. P. SISSENWINE, and R. K. MAYO. 1983. Definition and analysis of multispecies otter-trawl fisheries off the northeast coast of the United States. *ICES J. Cons.*, **41**: 13-27.

OVERHOLTZ, W. J., and A. V. TYLER. 1985. Long-term responses of the demersal fish assemblages of Georges Bank. *Fish. Bull. U.S.*, **83**(4): (in press).

OVERHOLTZ, W. J., S. H. CLARK, and D. Y. WHITE. MS 1983. A review of the status of the Georges Bank and Gulf of Maine haddock stocks for 1983. Nat. Mar. Fish. Serv., Woods Hole Lab. Ref. Doc., No. 83-23, 31 p.

WALFORD, L. A. 1938. Effect of currents on distribution and survival of the eggs and larvae of haddock (*Melanogrammus aeglefinus*) on Georges Bank. *Bull. U.S. Bur. Fish.*, **49**: 1-73.