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# A review of the status of the Georges Bank and Gulf of Maine haddock stocks for 1983

by

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# SUMMARY

Nominal catch (landings) in the Georges Bank haddock fishery declined to 17,300 (metric) tons in 1982, down 30% from the 1981 total of 24,800 tons. This constituted the second year of declining landings from the recent peak of 27,600 tons in 1980. The strong 1975 and 1978 year classes dominated Georges Bank landings in 1982, although both cohorts have been reduced considerably since recruiting to the fishery. Projected 1983 landings for Georges Bank will total approximately 12,600 tons or 75% of 1982 levels. A further decline is anticipated for 1984.

Gulf of Maine landings have remained relatively stable over the last several years and actually increased slightly from 6,200 tons in 1981 to 6,800 tons in 1982. Landings in 1982 were dominated by the 1979 year class, but the 1975, 1978, and 1980 cohorts were also well represented. Projected landings for 1983 will be about the same as in 1982 (6,600 tons).

Northeast Fisheries Center research vessel survey abundance and biomass indices for Georges Bank have declined continually since 1980. Index values for 1983 suggest that the Georges Bank stock has reached a level comparable to historic lows observed during the early to mid-1970's. In recent times (1966-1982), only two year classes, the 1975 and 1978 cohorts, have been reasonably strong on Georges Bank. The 1981 and 1982 year classes are poor, perhaps equal to the lowest on record, and there are preliminary indications that the 1983 year class is also weak. The 1980 cohort was also weak and contributed little to 1982 landings at age 2.

Northeast Fisheries Center autumn survey indices for the Gulf of Maine have also declined in recent years, while the spring index shows a more stable trend. The 1975 year class appears to have been reasonably strong, and in addition the 1979 and 1980 year classes were at least moderate in strength.

Estimates of total stock biomass (ages 2+) for Georges Bank derived from virtual population analysis (VPA) peaked at 427,000 tons in 1965 with recruitment of the outstanding 1963 year class. Subsequently, biomass declined to an apparent all time low of 16,000 tons in 1973. Recruitment from the 1975 and 1978 year classes resulted in an increase in stock biomass to 110,000 tons by 1980, but since that year biomass has declined steadily. Trends in spawning stock biomass (50% age 2 and 100% ages 3+) have paralleled those observed in total stock biomass. Current estimates of total spawning stock biomass were 28,000 tons and 27,000 tons, respectively, at the beginning of 1983.

Since 1979 fishing mortality has increased steadily and is now at or above $F_{max}$ ($F_{1982} = 0.52$). The Georges Bank stock will continue to decline in 1984 and 1985 because of poor recruitment, and landings are expected to fall to levels comparable to those of the early and middle 1970's.

Data for the Gulf of Maine are less consistent and therefore more difficult to interpret. Spring survey data suggest relatively constant levels of abundance and biomass in recent years, but autumn indices have declined substantially since the late 1970's. Modified DeLury analyses incorporating commercial landings (numbers) and NEFC autumn survey catch in numbers at age suggest a decline in abundance of over 60% since the late 1970's. This implies a recent increase in fishing mortality given the relative stability in commercial landings during this period. Prospects for the immediate future appear brighter than for Georges Bank in view of the relative strength of recent year classes although significant reductions in abundance and biomass could occur if mortality remains high or weak year classes appear.

A long-term (10-year) simulation of recruitment of the Georges Bank haddock stock suggests that if fishing mortality is maintained at current levels during 1983-1992, stock abundance and biomass will remain low. A reduction in fishing mortality to $F_{0.1}$ or less would result in an increased probability of recovery in terms of spawning stock biomass and population age structure. Average catch during the same period would only be slightly lower under the reduced fishing mortality option because of increases in biomass due to increased survival of recruiting fish.

Recruitment trends for the Georges Bank stock during the last two decades suggests that population age structure and spawning stock biomass are important factors controlling recruitment. If spawning stock remains low and population age structure remains unbalanced as in recent years, recruitment will continue to exhibit extreme variability and the potential for stock recovery and improved catches will remain low.

# INTRODUCTION

The Georges Bank haddock stock has declined steadily following a short-term recovery in the late 1970's. Following recruitment of the 1975 and 1978 year classes, nominal catch (live weight equivalent of landings excluding discards; subsequently referred to as landings) peaked at 27,600 (metric) tons in 1980 and has since dropped to 17,300 tons in 1982. The 1983 total should approximate 12,600 tons. Current declines appear attributable to poor recruitment and reduction of the 1975 and 1978 year classes by fishing. Landings from the Gulf of Maine also peaked in 1980 at 7,500 tons, but have since remained relatively stable, averaging 6,500 tons during 1981-1982. Recruitment prospects for this stock appear to be much better.

Patterns of recruitment for the two stocks vary considerably although both areas experienced an influx of recruits from the 1975 and 1978 year classes. On Georges Bank the 1979-1982 year classes appear to be poor while in the Gulf of Maine in 1979, 1980, and 1982 cohorts appear to be relatively more abundant.

Recent assessments (Clark et al., MS 1981; MS 1982) chronicled the recovery and subsequent decline of the Georges Bank fishery and its continued dependence on single incoming year classes. The Gulf of Maine fishery, in contrast, has several year classes that are contributing to the present fishery.

This report utilizes commercial and research vessel survey data bases to assess the current status of the Georges Bank and Gulf of Maine haddock stocks.

## MANAGEMENT

Haddock management by the New England Fishery Management Council (NEFMC) began initially in 1977 with the implementation of the Fishery Management Plan (FMP) for Atlantic groundfish (cod, haddock, and yellowtail flounder). This plan established a minimum mesh size of 130 mm (5-1/8 inches), seasonal spawning area closures, and optimum yields or OYS (quotas). Attempts to restrict harvests under this regime led to more restrictive measures, such as allocations by vessel class, quarterly quotas, and vessel trip limits, ultimately resulting in further management problems. The reliability of the commercial data base declined considerably because of misreporting, under-reporting, and discarding of catches.

As a result of these issues the NEFMC implemented the Interim Plan for Atlantic Groundfish on March 31, 1982. Management measures under this plan were limited to spawning area closures, minimum mesh size regulations (raised to 140 mm or 5½ inches on April 1, 1983), and voluntary reporting of data. Additionally, it included minimum sizes (total length) of 43 cm (17 inches) and 38 cm (15 inches) for commercial and recreational haddock landings, respectively. Atlantic cod, haddock, and yellowtail flounder are to be managed under this plan for a period of three years during which NEFMC will be developing the Atlantic Demersal Finfish plan (ADF). The ADF is scheduled for implementation in 1985.

## COMMERCIAL AND RECREATIONAL FISHERY

### Nominal Catch (Landings)

Nominal catch of Georges Bank haddock has fluctuated considerably since 1960. After averaging about 52,000 tons from 1960-1964, landings rose to 150,400 tons in 1965 and then dropped to 121,300 tons in 1966 (Table 1, Figure 1). This peak was followed by a period of historic low levels from 1969-1976. In 1977, landings began to increase and peaked at 27,600 tons in 1980, with the 1975 and 1978 cohorts comprising almost 85% of the catch in numbers. Since 1980, recruitment has been poor and landings have progressively declined (Table 1, Figure 1). The preliminary estimate for 1983 is about 12,600 tons or 75% of the 1982 total of 17,300 tons.

Landings for the USA fleet increased steadily from 1977 to 1981, but declined in 1982 to 12,600 tons or about 66% of the 1981 catch of 19,200 tons (Table 1, Figure 1). During 1977-1980, the commercial data base was compromised because of discarding and misreporting of landings of the 1975 and 1978 year classes. We have developed discard estimates for these year classes wherever possible in the present assessment in an attempt to improve estimates of abundance and biomass (Table 2).

Since 1977, Canadian landings have fluctuated considerably, exceeding 10,000 tons in 1978 and 1980 and dropping to a low of 4,800 tons in 1982 (Table 1, Figure 1).

Gulf of Maine haddock landings averaged 5,200 tons during 1960-1968, followed by a precipitous drop to only 600 tons in 1973 (Table 1, Figure 1). With improved recruitment, landings increased to a peak of 7,500 tons in

1980 and stabilized about an average of 6,500 tons during 1981-1982 (Table 1, Figure 1). This fishery has been prosecuted largely by USA vessels, with the Canadian catch amounting to about 10% of the total. Landings in 1983 will remain at about the 1981-1982 average of approximately 6,500 tons.

Recreational catches in both areas have been very small. Surveys of the recreational fishery indicate that 200-500 tons were taken annually over the 1974-1978 period (Clark et al., MS 1982). Most or all of the recreational landings are taken in the western Gulf of Maine.

Age Composition of Commercial Landings and Discard

The age composition of Georges Bank commercial landings during 1960-1982 has changed from a stable situation where several million fish were landed from each of several age groups (Table 2). The 1962 and 1963 year classes were the focus of an intense multinational fishery in 1965 and 1966, the outcome of which resulted in a dramatic decline in stock biomass and recruitment (Clark et al., 1982). The Georges Bank fishery was supported by the 1962 and 1963 year classes in the late 1960's and early 1970's, but became progressively more dependent on incoming recruitment (Table 2). In 1977 the large 1975 year class recruited to the fishery with landings and discard reaching nearly 20 million fish (Table 2). The fishery has been dependent on the 1975 and 1978 year classes since that year. These cohorts were heavily exploited to full recruitment and certainly before spawning (Table 2). Landings in 1982 were dominated by the 1975 and 1978 year classes which comprised 53% of the total. The 1980 year class at age 2 represented only 13.7% of the landings (Table 2). It appears that this year class is much smaller than first suspected (see Clark et al., MS 1981; MS 1982).

Discard of 1975 year class haddock at ages 2 (1977) and 3 (1978) was estimated using data provided by vessel captains during dockside interviews. Haddock discard for 1977 was estimated by applying the ratio of total trips with haddock landings to interviewed trips with haddock landings and discard to the reported discard for these trips. A second estimate was also obtained by applying the ratio of discard to landings for interviewed trips with discard to total landings. The average between these estimates (11,100 tons or 12.8 million fish) was approximately three times the reported USA landings in number, and USA landings were therefore adjusted by this factor to obtain a corrected catch at age estimate. An estimate of total catch for the 1972 year class at age 2 in 1974 and for the 1975 year class at age 3 in 1978 was obtained in the same manner.

Similar discard estimates were not developed for the 1978 year class at age 2 (1980) and age 3 (1981) because of a lack of interview data. However, data collected during sea sampling trips and industry reports indicated that large numbers of 1978 year class fish were discarded in 1980. An estimate of this discard was obtained by calculating an average instantaneous total mortality (Z) estimate from NEFC spring and autumn research vessel survey catch-at-age data (Z = .98) which was used with estimated stock size at age 3 from virtual population analysis or VPA to estimate stock size and total catch (31 million fish) at age 2. Discard was then estimated by subtraction. No reports of discarding of the 1978 year class in 1981 were received and accordingly it was assumed that little, if any, discard occurred.

The commercial catch in the Gulf of Maine was also dominated by the 1975 and 1978 year classes from 1977-1981, but in addition the 1979 and 1980 year classes contributed heavily to the landings at age 2 (Table 3). In general, recruitment in the Gulf of Maine appears to have been less variable than on Georges Bank, hence the commercial landings for the Gulf of Maine have been more stable with several age groups represented in the catch (Table 3). The 1979 year class comprised 33% of 1982 landings in the Gulf of Maine; the 1975 and 1978 year classes were also well represented. The 1980 year class provided 20% of the total (Table 3).

## RESEARCH VESSEL SURVEY INDICES

The Northeast Fisheries Center (NEFC) has conducted stratified random bottom trawl surveys in offshore areas (>27 m) on Georges Bank and in the Gulf of Maine since summer of 1963; inshore areas from Cape Cod northward have been sampled since 1977. A "36 Yankee" trawl has been used in all surveys except for spring 1973-1981, when a modified "41 Yankee" trawl was used. Indices of relative abundance and biomass (stratified mean catch per tow in numbers and weight in kg) have been developed using offshore spring and autumn bottom trawl survey data for both areas. Azarovitz (1981) provides detailed information on NEFC survey procedures.

### NEFC Surveys

Indices of relative abundance from NEFC offshore surveys have been extremely useful for monitoring trends in the Georges Bank haddock stock.

Spring index values for 1968-1972 and 1982-1983 indicate that current abundance has dropped to a level comparable to that in the 1970's, when stock size was minimal (Table 4). Fall survey indices peaked in the mid-1960's due to the presence of the strong 1962 and 1963 year classes (Tables 4 and 5, Figure 2). Survey index values declined in the late 1960's and early 1970's and dropped to extremely low levels in 1974 (Tables 4 and 5). An increase in both indices occurred in 1975 when age 0 fish from that year dominated the autumn catch (Table 5, Figure 2). Indices of both number and weight remained relatively high over the next several years and peaked at 42.7 fish (26.9 kg) in 1979 due to the presence of the strong 1975 and 1978 year class (Tables 4 and 5, Figure 2). Since that time survey abundance and biomass indices have declined steadily and are now back at levels observed in the historic low years of the late 1960's and early 1970's. On a relative basis it appears that the 1963 year class was by far the largest in recent times (1962-1982), followed by the 1962, 1975, and 1978 cohorts.

Survey data for the Gulf of Maine suggests that this stock is in slightly better condition than its Georges Bank counterpart (Table 6). Spring survey data show that stock abundance is above the level observed in the low years of 1970-1972. Autumn indices suggest that the stock has declined since the late 1970's. The 1975 and 1976 year classes appear to have been the strongest in the spring survey time series although the 1979 and 1980 year classes may also be relatively strong (Table 7). Autumn indices (1970-1982) show the same general trends in year-class strength. Therefore, although the total survey index has declined, at least in the autumn, the outlook for the Gulf of Maine is somewhat better.

State of Massachusetts Surveys

The State of Massachusetts has conducted research surveys in state waters since 1978. Information on catch per tow from both spring and autumn are available. The survey is similar to NEFC surveys in that stratified random sampling is utilized and similar biological and hydrographic data are collected (Howe et al., MS 1981).

The Massachusetts survey has been useful for evaluating trends in prerecruit (ages 0 and 1) haddock abundance in the southwestern Gulf of Maine. Fish from this inshore area appear to move further offshore after reaching age 2. The surveys indicate that the 1979, 1980, and 1983 year classes are reasonably abundant while the 1978 and 1981 year classes seem to be poor (Table 8). These data generally corroborate NEFC survey results and also indicate that recruitment patterns in the Gulf of Maine are different than those on Georges Bank.

## MORTALITY

Georges Bank

Virtual population analysis (VPA) was employed to estimate stock size (numbers) and fishing mortality (F) for 1960-1982. To estimate a starting F value for the VPA, a method described in detail in Clark et al. (1982) was used. Stock size in 1982 was estimated from a regression between stock size for age 3+ fish from a trial VPA and autumn survey catch in numbers for ages 2+ (lagged one year). Known catch at age was used with this estimate to generate an exploitation rate and F value that was used in a second VPA. The process was repeated several times until $F_{1982}$ stabilized at 0.52 ($r^2$ = .94). This estimate of F was used to run the final VPA, and for predictive purposes in the assessment.

Fishing mortality (age 3+) increased to a peak of 0.79 in 1966, and then averaged 0.50 until 1971 (Table 9). Redirection of effort resulted in a further drop to an average of 0.26 from 1972-1976. F increased in 1978 following the recruitment of the 1975 year class and remained between $F_{0.1}$ (F = 0.26) and $F_{max}$ (F = 0.55) for the next few years (1978-1980). In recent years an increasing trend has been evident with values approaching or exceeding $F_{max}$. Research vessel survey data also indicate an increasing trend since the mid-1970's and the average for age 3+ fish was also between $F_{0.1}$ and $F_{max}$ during 1977-1981 (Clark et al., MS 1982).

Gulf of Maine

Previous assessments have suggested increases in fishing mortality on the Gulf of Maine stock in recent years (Clark et al., MS 1982). Data were not judged adequate for additional analyses in the present assessment, although continued relatively high landings combined with decreases in survey abundance indices suggest a continued increase in fishing mortality in the Gulf of Maine. Estimates of Z for the 1975 year class ranged from 0.45 to 1.54 for ages 3-6 in the autumn survey, indicating high levels of fishing mortality on this cohort.

## STOCK ABUNDANCE AND BIOMASS

Georges Bank

The Georges Bank haddock stock (age 2+), after reaching historic high levels in abundance and biomass of 531 million fish and 427,000 tons, respectively, in 1965, declined to lows of nine million fish in 1972 and 16,000 tons in 1973 (Table 9, Figure 4). After several years of low

stock abundance in the mid-1970's, the stock recovered to 90,000 tons in 1977 with recruitment of the 1975 year class of 83 million fish at age 2. The following year this cohort peaked in terms of weight and stock biomass increased to 95,000 tons. After a decline in numbers and biomass in 1979 the stock rebounded in 1980 when the 1978 year class recruited at age 2 (Table 9). These two cohorts have supported the fishery since then, but due to poor recruitment the stock has continually declined to about 28,000 tons at the beginning of 1983.

Results from another sequential population estimation method, a modified DeLury analysis (Collie and Sissenwine, 1983), shows the same trends for the Georges Bank stock. For details of this method see Clark et al., MS 1982. Meager recruitment from the 1980, 1981, and 1982 year classes has hastened the decline of this stock. Based on NEFC survey indices, the 1980 year class was estimated at five million fish at age 2. The 1981 and 1982 year classes were even weaker in NEFC surveys and were assumed equal to the poorest observed (two million fish at age 2). Preliminary data for the 1983 year class suggest that it, too, is poor. Spawning stock biomass (50% age 2, 100% age 3 and older) for Georges Bank haddock peaked at 314,000 tons in 1965 and declined thereafter to a low of 13,000 tons in 1973 (Table 9). A rapid recovery occurred in the late 1970's when the two aforementioned year classes matured, but the spawning stock has since declined to only 27,000 tons at the beginning of 1983.

Gulf of Maine

Although no VPA is available for the Gulf of Maine haddock stock, the modified DeLury method previously mentioned was used to estimate age 2+ abundance from 1977-1983. Age 2+ abundance peaked in 1979 at 39 million

fish with recruitment from the 1975 year class and has declined since then to about 14 million fish at the beginning of 1983 (Figure 5). Recruitment indices from surveys conducted by the NEFC and the State of Massachusetts suggest that the 1979, 1980, and 1982 year classes are at least moderately strong, which suggests a greater degree of stability in 1984.

## DISCUSSION

### Short-term Outlook

The Georges Bank haddock stock will continue its downward trend for the next several years and will now show any recovery unless recruitment improves. Research vessel indices show that the 1981 and 1982 year classes are very poor. Recruitment from these two cohorts is not expected to be much more than two million fish at age 2 in 1983 and 1984, respectively. Preliminary indications are that the 1983 year class is poor as well.

If fishing mortality remains near $F_{max}$ (F = 0.55) in 1984, landings of about 6,500 tons would be expected and stock size would decline to perhaps 10,000 tons or so by the beginning of 1985. Given aforementioned poor recruitment prospects fishing at $F_{0.1}$ (F = 0.26) in 1984 and 1985 would not appreciably improve stock size by the end of 1985.

### Gulf of Maine

Age composition in the commercial catch and recruitment indices show that several year classes will support the fishery in 1984 and 1985. With these prospects the stock will probably stabilize at present levels of abundance in 1984, assuming the catch remains at about 6,500 tons. If effort is redirected from Georges Bank to the Gulf of Maine, this stock could decline further.

Long-term Perspective

The extreme variability in recruitment exhibited by Georges Bank haddock in recent years has made management of this stock particularly difficult. Although there is no firm empirical relationship between spawning stock size and subsequent recruitment (Clark et al., 1982), there do appear to be some stock-related influences. For example, when spawning stock biomass dropped to low levels in the late 1960's and mid-1970's, recruitment plummeted (Table 9, Figure 6). It appears that if spawning stock biomass drops below about 70,000 tons, recruitment will decline dramatically. In fact, the probability of producing a moderate to good sized year class at a spawning stock biomass below this approximate level is less than 10%. The 1975 year class resulted from a low spawning stock biomass, apparently because of an exceptional combination of biological and environmental factors that caused an increase in larval or post-larval survival.

If the spawning stock is maintained at low levels, we cannot assume that good year classes will occur with any regularity. In fact, there is no really reliable method of predicting when the next good year class may occur. Thus, maintaining the haddock spawning stock biomass at low levels will not only preclude future management options such as improving long-term yields, but may also jeopardize the total potential productivity of Georges Bank for many years to come since haddock are a major component of the demersal finfish biomass.

At present we can predict stock abundance about two years in advance with survey abundance indices. Since recruitment is highly variable and the stock is at low levels at present, a longer term perspective would

be useful for studying management options. Long-term stock projections are difficult because no empirical or mechanistic model is available for predictive purposes. Recently, however, a method which provides at least a technical solution to this problem was prepared and used to provide management advice for Pacific whiting (Merluccius productus) (Getz & Swartzman, 1981; Swartzman et al., 1983). Information on spawning stock size and subsequent recruitment can be transformed into a probability transition matrix and used to simulate recruitment in a Monte Carlo style experiment.

A modified version of the Getz-Swartzman approach was developed with the data in Figure 6 and used to simulate recruitment in the Georges Bank haddock stock. A series of 20 simulations over a 10-year span at a constant F level were performed resulting in average values for total and spawning stock biomass and catch. The simulations were started using the present status of the stock as determined from the modified DeLury method (Collie and Sissenwine, 1983).

Results from these experiments indicate that there is a distinct advantage in reducing fishing mortality from present levels which are at or above $F_{max}$. Long-term average catch would not be significantly different between high and low F options, but the probability of stock recovery would be much higher if lower F levels could be maintained (Table 10).

To determine the percent of time that spawning stock could be expected to recover to various levels under the three F options, the probability of recovering to 50,000 tons was calculated and additional 10,000 ton increments were also investigated (Table 10). The results suggest that fishing the stock at lower levels than at present would be advantageous.

Under the low F option (F = 0.10) there is a 90% chance that the spawning stock biomass (SSB) would reach 50,000 tons in 10 years and a 50% chance that the SSB would reach 80,000 tons or greater (Table 10). This level of SSB has consistently produced moderate to good recruitment in the past (Figure 6). Under the F option (F = 0.55) there is a very small chance for the spawning stock to rebuild (Table 10).

This series of projections suggests that if F is reduced, even to some mid-range such as $F_{0.1}$ (F = 0.26), the stock would be in a much better condition and long-term catch would not suffer. If F remains high because of directed effort on haddock or on other species resulting in haddock by-catch, the Georges Bank haddock stock can be expected to remain at the present low levels and catch potential will remain at about 10-20% of the 1935-1960 average.

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Table 1. Commercial landings[1] of haddock (metric tons, live) from Georges Bank and the Gulf of Maine, 1960-1982.

| | Georges Bank | | | | | Gulf of Maine | | | | | Total | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | USA | Canada | USSR | Other[2] | Total | USA | Canada | USSR | Other[2] | Total | USA | Canada | USSR | Other[2] | Total |
| 1960 | 40,800 | 77 | -- | -- | 40,877 | 4,541 | 383 | -- | -- | 4,924 | 45,341 | 460 | -- | -- | 45,801 |
| 1961 | 46,384 | 266 | -- | -- | 46,650 | 5,297 | 112 | -- | -- | 5,409 | 51,681 | 378 | -- | -- | 52,059 |
| 1962 | 49,409 | 3,461 | 1,134 | -- | 54,004 | 5,003 | 107 | -- | -- | 5,110 | 54,412 | 3,568 | 1,134 | -- | 59,114 |
| 1963 | 44,150 | 8,379 | 2,317 | -- | 54,846 | 4,742 | 3 | 44 | -- | 4,789 | 48,892 | 8,382 | 2,361 | -- | 59,635 |
| 1964 | 46,512 | 11,625 | 5,483 | 466 | 64,086 | 5,383 | 70 | -- | -- | 5,453 | 51,895 | 11,695 | 5,483 | 466 | 69,539 |
| 1965 | 52,823 | 14,889 | 81,882 | 768 | 150,362 | 4,204 | 159 | -- | -- | 4,363 | 57,027 | 15,048 | 81,882 | 768 | 154,725 |
| 1966 | 52,918 | 18,292 | 48,409 | 1,655 | 121,274 | 4,579 | 1,125 | -- | -- | 5,704 | 57,497 | 19,417 | 48,409 | 1,655 | 126,978 |
| 1967 | 34,728 | 13,040 | 2,316 | 1,385 | 51,469 | 4,907 | 589 | -- | -- | 5,496 | 39,635 | 13,629 | 2,316 | 1,385 | 56,965 |
| 1968 | 25,469 | 9,323 | 1,397 | 4,734 | 40,923 | 3,437 | 120 | -- | -- | 3,557 | 28,906 | 9,443 | 1,397 | 4,734 | 44,480 |
| 1969 | 16,456 | 3,990 | 65 | 1,741 | 22,252 | 2,423 | 59 | -- | 231 | 2,713 | 18,879 | 4,049 | 65 | 1,972 | 24,965 |
| 1970 | 8,415 | 1,978 | 103 | 804 | 11,300 | 1,457 | 38 | -- | 67 | 1,562 | 9,872 | 2,016 | 103 | 871 | 12,862 |
| 1971 | 7,306 | 1,630 | 374 | 1,552 | 10,862 | 1,194 | 85 | -- | 27 | 1,306 | 8,500 | 1,715 | 374 | 1,579 | 12,168 |
| 1972 | 3,869 | 609 | 137 | 1,118 | 5,733 | 909 | 23 | 4 | -- | 936 | 4,778 | 632 | 141 | 1,118 | 6,669 |
| 1973 | 2,777 | 1,563 | 602 | 389 | 5,331 | 509 | 49 | -- | -- | 558 | 3,286 | 1,612 | 602 | 389 | 5,889 |
| 1974 | 2,396 | 462 | 109 | 1,323 | 4,290 | 622 | 198 | -- | 9 | 829 | 3,018 | 660 | 109 | 1,332 | 5,119 |
| 1975 | 3,989 | 1,358 | 8 | 55 | 5,420 | 1,180 | 79 | -- | 4 | 1,263 | 5,169 | 1,437 | 8 | 69 | 6,683 |
| 1976 | 2,904 | 1,361 | 4 | -- | 4,324 | 1,865 | 91 | -- | -- | 1,956 | 4,769 | 1,452 | -- | 59 | 6,280 |
| 1977 | 7,934 | 2,909 | -- | -- | 10,843 | 3,296 | 26 | -- | -- | 3,322 | 11,230 | 2,935 | -- | -- | 14,165 |
| 1978 | 12,160 | 10,179 | -- | -- | 22,339 | 4,538 | 641 | -- | -- | 5,179 | 16,698 | 10,820 | -- | -- | 27,518 |
| 1979 | 14,279 | 5,182 | -- | -- | 19,461 | 4,622 | 257 | -- | -- | 4,879 | 18,901 | 5,439 | -- | -- | 24,340 |
| 1980 | 17,470 | 10,101 | -- | -- | 27,571 | 7,270 | 203 | -- | -- | 7,473 | 24,740 | 10,304 | -- | -- | 35,044 |
| 1981 | 19,176 | 5,659 | -- | 3 | 24,835 | 5,726 | 513 | -- | -- | 6,239 | 24,902 | 6,172 | -- | 3 | 31,077 |
| 1982[3] | 12,567 | 4,775 | | | 17,342 | 5,628 | 1,127 | | | 6,755 | 18,195 | 5,902 | | | 24,097 |
| 1983[4] | 8,847 | 3,756 | | | 12,603 | 5,562 | 1,000 | | | 6,562 | 14,409 | 4,756 | | | 19,165 |

[1]As reported to ICNAF/NAFO for Division 5Z and 5Y, respectively (5 NK landings have been assigned to Division 5Z).

[2]Primarily Spain, Poland, and Romania.

[3]Provisional (incomplete).

[4]Estimated.

Table 2. Age composition (000's) of commercial haddock landings (all countries) from Georges Bank, 1960-1982 corrected for discards in the USA fishery.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | Total | Observed (Tons) | Calculated[1] (Tons) | Ratio Obs/Calc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 258 | 16010 | 6122 | 4562 | 3067 | 1792 | 787 | 406 | 348 | 33352 | 40877 | 42776 | 0.96 |
| 1961 | 62 | 10698 | 14927 | 4198 | 2917 | 1856 | 1266 | 496 | 674 | 37094 | 46650 | 48497 | 0.96 |
| 1962 | 74 | 4455 | 16245 | 10440 | 3448 | 2089 | 1566 | 1185 | 898 | 40491 | 54004 | 56390 | 0.96 |
| 1963 | 2910 | 4047 | 7418 | 11152 | 8198 | 2205 | 1405 | 721 | 1096 | 39152 | 54846 | 56072 | 0.98 |
| 1964 | 10101 | 15935 | 4554 | 4776 | 8722 | 5794 | 2082 | 1028 | 1332 | 54324 | 64086 | 62773 | 1.02 |
| 1965 | 9601 | 125818 | 44496 | 5356 | 4391 | 6690 | 3772 | 1094 | 1366 | 202584 | 150362 | 176204 | 0.85 |
| 1966 | 114 | 6843 | 100810 | 19167 | 2768 | 2591 | 2332 | 1268 | 867 | 136760 | 121274 | 140649 | 0.86 |
| 1967 | 1150 | 168 | 2891 | 20667 | 10338 | 1209 | 993 | 917 | 698 | 39031 | 51469 | 51306 | 1.00 |
| 1968 | 8 | 2994 | 709 | 1921 | 14519 | 3499 | 667 | 453 | 842 | 25612 | 40923 | 40990 | 1.00 |
| 1969 | 2 | 11 | 1698 | 448 | 654 | 5954 | 1574 | 225 | 570 | 11136 | 22252 | 22335 | 1.00 |
| 1970 | 46 | 158 | 16 | 570 | 186 | 214 | 2308 | 746 | 464 | 4708 | 11300 | 12343 | 0.92 |
| 1971 | 1 | 1375 | 223 | 40 | 289 | 246 | 285 | 1469 | 928 | 4856 | 10862 | 11998 | 0.91 |
| 1972 | 156 | 2 | 450 | 81 | 32 | 120 | 78 | 66 | 1236 | 2221 | 5733 | 6368 | 0.90 |
| 1973 | 2560 | 2075 | 3 | 386 | 53 | 30 | 77 | 15 | 447 | 5646 | 5331 | 5254 | 1.01 |
| 1974 | 46 | (4320)[3] | 657 | 2 | 70 | 2 | 2 | 53 | 249 | (5401)[5] | (6190)[5] | (6512)[5] | 0.93 |
| 1975 | 192 | 1034 | 1864 | 375 | 4 | 42 | 4 | 4 | 88 | 3607 | 5420 | 5426 | 1.00 |
| 1976 | 144 | 473 | 550 | 880 | 216 | - | 23 | 4 | 112 | 2402 | 4324 | 4215 | 1.03 |
| 1977 | 1 | (19585)[3] | 187 | 680 | 515 | 357 | 4 | 39 | 111 | (21497)[5] | (20531)[5] | (21270)[5] | 0.94 |
| 1978 | 1 | 761 | (14395)[3] | 305 | 567 | 517 | 139 | 14 | 67 | (16766)[5] | (26281)[5] | (26345)[5] | 1.00 |
| 1979 | 1 | 26 | 1726 | 7169 | 525 | 410 | 315 | 96 | 46 | 10314 | 19461 | 21100 | 0.92 |
| 1980 | 8 | (31000)[4] | 347 | 975 | 6054 | 594 | 546 | 153 | 81 | (39758)[5] | (51084)[5] | (48984)[5] | 1.04 |
| 1981 | 1 | 1743 | 10998 | 831 | 937 | 2572 | 331 | 158 | 94 | 17665 | 24835 | 26304 | .94 |
| 1982 | 78 | 1356 | 1762 | 3472 | 350 | 785 | 1709 | 156 | 185 | 9853 | 17342 | 17320 | 1.00 |

[1]Obtained by multiplying mean weight at age by numbers caught at age.

[2]Trip interviews and published reports indicate that discards of age 2 and older fish for 1960-1973, 1975-1976, 1979, and 1981 were negligible.

[3]Includes discard estimate based on trip interviews (see text).

[4]Includes discard estimate based on total mortality (Z) at age 2 from NEFC research surveys (see text).

[5]Includes nominal catch and discard estimates.

Table 3. Percent age composition of haddock in commercial landings (all countries) from the Gulf of Maine, 1977-1982.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ |
|---|---|---|---|---|---|---|---|---|---|
| 1976 | 79.0 | 1.3 | 5.2 | 5.5 | 7.0 | - | 0.3 | - | 1.8 |
| 1977 | - | 87.1 | 2.2 | 7.0 | 3.7 | 2.9 | - | 0.0 | 0.1 |
| 1978 | - | 14.4 | 67.0 | 7.1 | 8.5 | 3.0 | 0.0 | - | - |
| 1979 | - | 0.5 | 17.3 | 68.3 | 8.3 | 3.4 | 1.6 | 0.6 | - |
| 1980 | - | 38.5 | 4.3 | 27.2 | 24.8 | 2.8 | 1.3 | 0.1 | 1.1 |
| 1981 | - | 40.2 | 27.3 | - | 2.6 | 22.0 | 3.3 | 4.6 | - |
| 1982 | - | 19.8 | 33.0 | 17.9 | 5.2 | 5.3 | 14.2 | 2.6 | 2.1 |

Table 4. Stratified mean catch per tow in numbers and weight (kg) for haddock in NEFC offshore spring and autumn bottom trawl surveys on Georges Bank[1], 1963-1983.

| | Spring[2] | | Autumn | |
|---|---|---|---|---|
| | Nos. | Wt. (kg) | Nos. | Wt. (kg) |
| 1963 | -- | -- | 97.34 | 52.83 |
| 1964 | -- | -- | 129.70 | 64.07 |
| 1965 | -- | -- | 68.26 | 48.20 |
| 1966 | -- | -- | 22.32 | 19.78 |
| 1967 | -- | | 11.88 | 16.87 |
| 1968 | 9.15 | 13.61 | 5.06 | 10.20 |
| 1969 | 4.86 | 11.21 | 2.28 | 5.59 |
| 1970 | 4.02 | 11.34 | 5.17 | 8.94 |
| 1971 | 1.87 | 3.31 | 2.83 | 3.70 |
| 1972 | 4.27 | 4.88 | 7.62 | 5.61 |
| 1973 | 25.23 | 10.18 | 9.98 | 6.48 |
| 1974 | 12.77 | 11.72 | 2.71 | 2.64 |
| 1975 | 4.18 | 5.44 | 20.78 | 10.00 |
| 1976 | 55.83 | 10.41 | 47.68 | 23.68 |
| 1977 | 24.74 | 17.60 | 19.02 | 23.13 |
| 1978 | 13.03 | 20.71 | 20.70 | 15.18 |
| 1979 | 30.53 | 13.09 | 42.74 | 26.87 |
| 1980 | 40.32 | 35.71 | 24.98 | 18.47 |
| 1981 | 25.53 | 31.95 | 11.01 | 11.77 |
| 1982[3] | 7.10 | 11.00 | 3.47 | 4.17 |
| 1983[3] | 3.66 | 8.56 | 5.20 | 3.97 |

[1]Strata 13-25, 29, and 30.

[2]Data for 1968-1972, 1982, and 1983 were collected with a "36 Yankee" trawl, and the remaining years (1973-1981) with a "41 Yankee" trawl. No adjustments for trawl size differences were attempted. A conversion factor of 1.70, representing the surface ratio of the "41 Yankee" to the "36 Yankee", was used in previous assessments.

[3]Preliminary.

Table 5. Stratified mean catch per tow at age (numbers) for haddock in NEFC offshore spring and autumn bottom trawl surveys on Georges Bank[1], 1963-1982.

| | Age | | | | | | | | | | Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | 0+[2] | 1+[2] | 2+ |
| 1968[3] | - | 0.27 | 1.90 | 0.31 | 0.47 | 4.51 | 1.13 | 0.17 | 0.30 | 0.23 | - | 9.29 | 9.02 |
| 1969 | - | 0.00 | 0.05 | 0.39 | 0.10 | 0.28 | 2.84 | 0.69 | 0.19 | 0.31 | - | 4.85 | 4.85 |
| 1970 | - | 0.45 | 0.17 | 0.00 | 0.22 | 0.31 | 0.31 | 1.34 | 0.66 | 0.57 | - | 4.03 | 3.58 |
| 1971 | - | 0.00 | 0.78 | 0.17 | 0.00 | 0.08 | 0.08 | 0.06 | 0.55 | 0.15 | - | 1.87 | 1.87 |
| 1972 | - | 2.70 | 0.06 | 0.41 | 0.08 | 0.02 | 0.03 | 0.09 | 0.02 | 0.87 | - | 4.28 | 1.58 |
| 1973 | - | 20.59 | 3.25 | 0.00 | 0.36 | 0.06 | 0.00 | 0.12 | 0.01 | 0.86 | - | 25.25 | 4.66 |
| 1974 | - | 1.43 | 8.92 | 1.92 | 0.00 | 0.16 | 0.00 | 0.01 | 0.07 | 0.25 | - | 12.76 | 11.33 |
| 1975 | - | 0.63 | 0.65 | 2.23 | 0.42 | 0.00 | 0.09 | 0.06 | 0.01 | 0.10 | - | 4.19 | 3.56 |
| 1976 | - | 54.22 | 0.20 | 0.40 | 0.62 | 0.29 | 0.00 | 0.03 | 0.00 | 0.07 | - | 55.83 | 1.61 |
| 1977 | - | 0.41 | 22.42 | 0.28 | 0.82 | 0.40 | 0.30 | 0.00 | 0.03 | 0.08 | - | 24.74 | 24.33 |
| 1978 | - | 0.05 | 0.65 | 10.69 | 0.24 | 0.63 | 0.55 | 0.11 | 0.04 | 0.07 | - | 13.03 | 12.98 |
| 1979 | - | 24.24 | 1.06 | 0.76 | 3.83 | 0.22 | 0.11 | 0.25 | 0.04 | 0.03 | - | 30.54 | 6.30 |
| 1980 | - | 3.49 | 31.34 | 0.34 | 0.70 | 3.27 | 0.45 | 0.25 | 0.31 | 0.16 | - | 40.31 | 36.82 |
| 1981 | - | 2.70 | 2.69 | 15.95 | 1.79 | 0.62 | 1.46 | 0.20 | 0.09 | 0.04 | - | 25.53 | 22.83 |
| 1982[4] | - | 0.62 | 1.25 | 0.77 | 3.33 | 0.34 | 0.23 | 0.50 | 0.00 | 0.00 | - | 7.04 | 6.42 |
| Autumn | | | | | | | | | | | | | |
| 1963 | 56.33 | 17.04 | 6.19 | 4.57 | 5.60 | 3.99 | 1.37 | 1.13 | 0.79 | 0.31 | 97.32 | 40.99 | 23.95 |
| 1964 | 1.59 | 75.75 | 42.78 | 3.91 | 1.20 | 2.56 | 1.05 | 0.46 | 0.17 | 0.22 | 129.69 | 128.10 | 52.35 |
| 1965 | 0.22 | 6.82 | 51.94 | 6.51 | 0.72 | 0.54 | 0.61 | 0.54 | 0.17 | 0.18 | 68.25 | 68.03 | 61.21 |
| 1966 | 4.12 | 0.64 | 1.94 | 12.34 | 2.25 | 0.35 | 0.33 | 0.22 | 0.08 | 0.05 | 22.32 | 18.20 | 17.56 |
| 1967 | 0.02 | 4.51 | 0.24 | 0.67 | 4.54 | 1.09 | 0.33 | 0.14 | 0.22 | 0.12 | 11.88 | 11.86 | 7.35 |
| 1968 | 0.06 | 0.04 | 0.64 | 0.09 | 0.22 | 2.59 | 0.85 | 0.18 | 0.11 | 0.26 | 5.04 | 4.98 | 4.94 |
| 1969 | 0.26 | 0.02 | 0.00 | 0.19 | 0.09 | 0.11 | 1.02 | 0.34 | 0.06 | 0.18 | 2.27 | 2.01 | 1.99 |
| 1970 | 0.03 | 2.77 | 0.14 | 0.01 | 0.19 | 0.18 | 0.34 | 0.92 | 0.32 | 0.27 | 5.17 | 5.14 | 2.37 |
| 1971 | 1.63 | 0.00 | 0.21 | 0.05 | 0.01 | 0.15 | 0.02 | 0.06 | 0.50 | 0.19 | 2.82 | 1.19 | 1.19 |
| 1972 | 4.53 | 1.69 | 0.00 | 0.35 | 0.06 | 0.00 | 0.06 | 0.04 | 0.02 | 0.87 | 7.62 | 3.09 | 1.40 |
| 1973 | 2.17 | 6.04 | 1.08 | 0.00 | 0.13 | 0.03 | 0.00 | 0.05 | 0.01 | 0.48 | 9.99 | 7.82 | 1.78 |
| 1974 | 0.50 | 1.19 | 0.66 | 0.21 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.15 | 2.72 | 2.22 | 1.03 |
| 1975 | 15.76 | 0.42 | 0.48 | 3.26 | 0.62 | 0.00 | 0.02 | 0.00 | 0.01 | 0.20 | 20.77 | 5.01 | 4.59 |
| 1976 | 2.90 | 43.07 | 0.35 | 0.36 | 0.55 | 0.20 | 0.00 | 0.03 | 0.07 | 0.17 | 47.70 | 44.80 | 1.73 |
| 1977 | 0.11 | 1.75 | 15.33 | 0.46 | 0.47 | 0.52 | 0.28 | 0.03 | 0.01 | 0.07 | 19.03 | 18.92 | 17.17 |
| 1978 | 10.82 | 0.69 | 0.85 | 7.59 | 0.15 | 0.21 | 0.37 | 0.01 | 0.00 | 0.01 | 20.70 | 9.88 | 9.19 |
| 1979 | 1.08 | 37.29 | 0.03 | 0.74 | 3.12 | 0.21 | 0.23 | 0.04 | 0.01 | 0.00 | 42.75 | 41.67 | 4.38 |
| 1980 | 9.56 | 2.22 | 10.41 | 0.37 | 0.15 | 1.39 | 0.39 | 0.38 | 0.07 | 0.05 | 24.99 | 15.43 | 13.21 |
| 1981 | 0.31 | 5.02 | 1.70 | 3.03 | 0.17 | 0.34 | 0.43 | 0.00 | 0.00 | 0.01 | 11.01 | 10.70 | 5.68 |
| 1982[4] | 0.91 | 0.00 | 0.89 | 0.23 | 0.94 | 0.09 | 0.05 | 0.14 | 0.01 | 0.07 | 3.32 | 2.41 | 1.53 |

[1]Strata 13-25, 29-30.

[2]May not agree with data in Table 2 because of rounding differences.

[3]Data for 1968-1972 and 1982 were collected with a "36 Yankee" trawl and the remaining years (1973-1981) with a "41 Yankee" trawl. No adjustments for trawl size differences were attempted. A conversion factor of 1.70, representing the surface area ratio of the "41 Yankee" to the "36 Yankee", was used in previous assessments.

[4]Preliminary.

Table 6. Stratified mean catch per tow in numbers and weight (kg) for haddock in NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine[1], 1963-1983.

| | Spring[2] | | Autumn | |
|---|---|---|---|---|
| | Nos. | Wt. (kg) | Nos. | Wt. (kg) |
| 1963 | - | - | 46.68 | 33.57 |
| 1964 | - | - | 9.51 | 12.47 |
| 1965 | - | - | 11.70 | 11.72 |
| 1966 | - | - | 7.82 | 9.18 |
| 1967 | - | - | 8.18 | 11.16 |
| 1968 | 4.11 | 5.39 | 5.75 | 11.42 |
| 1969 | 2.54 | 4.88 | 3.66 | 8.51 |
| 1970 | 0.61 | 1.14 | 1.96 | 4.87 |
| 1971 | 0.59 | 1.67 | 1.93 | 5.39 |
| 1972 | 0.58 | 0.58 | 1.33 | 2.01 |
| 1973 | 0.88 | 1.06 | 2.80 | 5.68 |
| 1974 | 0.96 | 0.70 | 1.80 | 2.21 |
| 1975 | 1.86 | 2.30 | 3.71 | 5.71 |
| 1976 | 5.59 | 4.21 | 4.05 | 5.32 |
| 1977 | 4.56 | 4.45 | 6.79 | 7.34 |
| 1978 | 0.91 | 0.95 | 8.00 | 18.16 |
| 1979 | 2.32 | 3.17 | 4.52 | 11.50 |
| 1980 | 1.81 | 2.24 | 5.85 | 8.24 |
| 1981 | 2.96 | 3.00 | 3.17 | 7.83 |
| 1982[3] | 1.84 | 2.40 | 1.69 | 2.74 |
| 1983[3] | 2.50 | 2.34 | 1.47 | 3.74 |

[1]Strata 26-28 and 36-40.

[2]Data for 1968-1972 and 1982-1983 were collected with a "36 Yankee" trawl, and the remaining years (1973-1981) with a "41 Yankee" trawl. No adjustments for trawl size differences were attempted. A conversion factor of 1.70, representing the surface area ratio of the "41 Yankee" to the "36 Yankee", was used in previous assessments.

[3]Preliminary.

Table 7. Stratified mean catch per tow at age (numbers) for haddock in NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine[1], 1963-1982.

| | AGE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | 0+[2] | 1+[2] | 2+ |
| 1968[3] | - | 0.00 | 0.00 | 0.00 | 0.22 | 3.04 | .64 | 0.05 | 0.00 | 0.13 | - | 4.08 | 4.08 |
| 1969 | - | 0.00 | 0.00 | 0.05 | 0.01 | 0.13 | 1.79 | 0.47 | 0.00 | 0.05 | - | 2.50 | 2.50 |
| 1970 | - | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.41 | 0.06 | 0.04 | - | 0.61 | 0.61 |
| 1971 | - | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.40 | 0.12 | - | 0.56 | 0.56 |
| 1972 | - | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | - | 0.56 | 0.17 |
| 1973 | - | 0.09 | 0.53 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.23 | - | 0.89 | 0.80 |
| 1974 | - | 0.60 | 0.06 | 0.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | - | 0.97 | 0.37 |
| 1975 | - | 0.01 | 1.32 | 0.10 | 0.25 | 0.00 | 0.01 | 0.00 | 0.00 | 0.17 | - | 1.86 | 1.85 |
| 1976 | - | 3.46 | 0.05 | 1.24 | 0.12 | 0.61 | 0.00 | 0.02 | 0.00 | 0.09 | - | 5.59 | 2.13 |
| 1977 | - | 0.59 | 2.39 | 0.02 | 0.90 | 0.27 | 0.39 | 0.00 | 0.00 | 0.00 | - | 4.56 | 3.97 |
| 1978 | - | 0.06 | 0.47 | 0.21 | 0.04 | 0.10 | 0.03 | 0.00 | 0.00 | 0.00 | - | 0.91 | 0.85 |
| 1979 | - | 0.25 | 0.00 | 1.08 | 0.80 | 0.06 | 0.08 | 0.06 | 0.00 | 0.00 | - | 2.33 | 2.08 |
| 1980 | - | 0.87 | 0.12 | 0.14 | 0.36 | 0.28 | 0.02 | 0.00 | 0.00 | 0.03 | - | 1.82 | 0.95 |
| 1981 | - | 0.89 | 1.07 | 0.40 | 0.13 | 0.26 | 0.07 | 0.05 | 0.02 | 0.08 | - | 2.97 | 2.08 |
| 1982[4] | - | 0.04 | 0.34 | 0.79 | 0.37 | 0.14 | 0.05 | 0.01 | 0.00 | 0.00 | - | 1.74 | 1.70 |
| Autumn | | | | | | | | | | | | | |
| 1963 | 23.90 | 8.18 | 1.14 | 2.02 | 4.66 | 3.31 | 1.12 | 0.88 | 0.70 | 0.74 | 46.65 | 22.75 | 14.57 |
| 1964 | 0.02 | 2.99 | 1.87 | 0.48 | 0.82 | 1.62 | 0.96 | 0.32 | 0.22 | 0.21 | 9.51 | 9.49 | 6.50 |
| 1965 | 0.04 | 0.25 | 5.39 | 3.40 | 0.17 | 0.98 | 0.77 | 0.44 | 0.21 | 0.04 | 11.69 | 11.65 | 11.40 |
| 1966 | 0.01 | 0.03 | 0.37 | 4.86 | 1.60 | 0.18 | 0.41 | 0.29 | 0.04 | 0.02 | 7.81 | 7.80 | 7.77 |
| 1967 | 0.00 | 0.00 | 0.20 | 0.83 | 5.37 | 1.21 | 0.33 | 0.08 | 0.12 | 0.03 | 8.17 | 8.17 | 8.17 |
| 1968 | 0.00 | 0.00 | 0.00 | 0.06 | 0.13 | 4.13 | 0.95 | 0.17 | 0.22 | 0.09 | 5.75 | 5.75 | 5.75 |
| 1969 | 0.00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.02 | 2.78 | 0.57 | 0.09 | 0.14 | 3.64 | 3.64 | 3.64 |
| 1970 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.03 | 0.06 | 1.41 | 0.41 | 0.03 | 1.97 | 1.97 | 1.94 |
| 1971 | 0.18 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.07 | 0.11 | 1.34 | 0.19 | 1.94 | 1.76 | 1.76 |
| 1972 | 0.00 | 0.80 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.52 | 1.34 | 1.34 | 0.54 |
| 1973 | 0.76 | 0.01 | 0.64 | 0.00 | 0.24 | 0.02 | 0.01 | 0.03 | 0.01 | 1.08 | 2.80 | 2.04 | 2.03 |
| 1974 | 0.01 | 1.13 | 0.13 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.23 | 1.80 | 1.79 | 0.66 |
| 1975 | 0.60 | 0.15 | 1.29 | 0.37 | 0.93 | 0.00 | 0.03 | 0.03 | 0.00 | 0.32 | 3.72 | 3.12 | 2.97 |
| 1976 | 1.10 | 1.13 | 0.05 | 0.86 | 0.11 | 0.52 | 0.00 | 0.10 | 0.00 | 0.12 | 4.04 | 2.94 | 1.76 |
| 1977 | 0.03 | 2.74 | 2.65 | 0.10 | 0.85 | 0.13 | 0.21 | 0.00 | 0.00 | 0.07 | 6.78 | 6.75 | 4.01 |
| 1978 | 0.14 | 0.01 | 1.65 | 3.78 | 0.38 | 0.94 | 0.77 | 0.12 | 0.00 | 0.21 | 8.00 | 7.86 | 7.85 |
| 1979 | 0.59 | 0.30 | 0.01 | 0.79 | 1.97 | 0.41 | 0.30 | 0.09 | 0.05 | 0.02 | 4.53 | 3.94 | 3.64 |
| 1980 | 3.25 | 0.41 | 0.26 | 0.00 | 0.24 | 0.88 | 0.55 | 0.11 | 0.08 | 0.08 | 5.86 | 2.61 | 2.20 |
| 1981 | 0.00 | 0.41 | 0.45 | 0.60 | 0.33 | 0.69 | 0.56 | 0.02 | 0.06 | 0.05 | 3.17 | 3.17 | 2.76 |
| 1982[4] | 0.26 | 0.03 | 0.38 | 0.54 | 0.23 | 0.03 | 0.02 | 0.12 | 0.02 | 0.09 | 1.71 | 1.45 | 1.42 |

[1]Strata 26-28, and 36-40.

[2]May not agree exactly with data in Table 3 because of rounding differences.

[3]Data for 1968-1972, and 1982 were collected with a "36 Yankee" trawl and the remaining years (1973-1981) with a "41 Yankee" trawl. No adjustments for trawl size differences were attempted. A conversion factor of 1.70, representing the surface area ratio of the "41 Yankee" to the "36 Yankee", was used in previous assessments.

[4]Preliminary.

Table 8. Stratified mean catch per tow in numbers and weight (kg) for haddock in Massachusetts spring and autumn inshore surveys in the Gulf of Maine.

| Year | Stratified mean catch per tow at age[1] (numbers) 0 | 1 | 2 | 3 | 4 | 5 | 6+ | Total | Stratified mean catch per tow in weight (kg) |
|---|---|---|---|---|---|---|---|---|---|
| Massachusetts (Spring) | | | | | | | | | |
| 1978 | 0.00 | 0.00 | 0.90 | 0.09 | 0.00 | 0.00 | 0.00 | 0.99 | 0.62 |
| 1979 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.03 | 0.03 |
| 1980 | 0.34 | 3.00 | 0.03 | 0.00 | 0.03 | 0.05 | 0.00 | 3.45 | 0.46 |
| 1981 | 0.00 | 4.00 | 0.12 | 0.04 | 0.02 | 0.00 | 0.00 | 4.18 | 0.55 |
| 1982 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.03 |
| Massachusetts (Autumn) | | | | | | | | | |
| 1978 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1979 | 15.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 15.32 | 0.11 |
| 1980 | 15.64 | 0.78 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 16.42 | 0.35 |
| 1981 | 0.13 | 0.97 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 0.31 |
| 1982 | 28.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 28.54 | 0.22 |

[1]Obtained by applying combined NEFC age-length keys from offshore and inshore strata.

Table 9. Instantaneous fishing mortality (F) and stock size (millions) by age group from virtual population analysis with M = 0.20 for Georges Bank haddock, 1960-1982.

HADDOCK 1982 VPA WITH DISCARDS

| YEAR | AGE 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | MEAN F[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FISHING MORTALITY | | | | | | |
| 1960 | 0.002 | 0.184 | 0.216 | 0.246 | 0.285 | 0.190 | 0.253 | 0.233 | 0.233 | 0.233 |
| 1961 | 0.001 | 0.124 | 0.261 | 0.225 | 0.246 | 0.279 | 0.199 | 0.250 | 0.250 | 0.250 |
| 1962 | 0.002 | 0.117 | 0.280 | 0.294 | 0.292 | 0.279 | 0.402 | 0.290 | 0.290 | 0.290 |
| 1963 | 0.017 | 0.151 | 0.290 | 0.316 | 0.396 | 0.308 | 0.307 | 0.326 | 0.326 | 0.326 |
| 1964 | 0.024 | 0.124 | 0.253 | 0.307 | 0.437 | 0.543 | 0.534 | 0.386 | 0.386 | 0.386 |
| 1965 | 0.390 | 0.468 | 0.591 | 0.531 | 0.516 | 0.716 | 0.844 | 0.603 | 0.603 | 0.603 |
| 1966 | 0.031 | 0.535 | 0.866 | 0.553 | 0.584 | 0.664 | 0.591 | 0.788 | 0.788 | 0.788 |
| 1967 | 0.113 | 0.059 | 0.455 | 0.427 | 0.664 | 0.550 | 0.582 | 0.491 | 0.491 | 0.491 |
| 1968 | 0.024 | 0.474 | 0.371 | 0.627 | 0.609 | 0.496 | 0.679 | 0.580 | 0.580 | 0.580 |
| 1969 | 0.002 | 0.041 | 0.545 | 0.426 | 0.452 | 0.545 | 0.436 | 0.514 | 0.514 | 0.514 |
| 1970 | 0.010 | 0.238 | 0.077 | 0.353 | 0.314 | 0.261 | 0.421 | 0.380 | 0.380 | 0.380 |
| 1971 | 0.000 | 0.479 | 0.617 | 0.281 | 0.305 | 0.893 | 0.656 | 0.522 | 0.522 | 0.522 |
| 1972 | 0.020 | 0.011 | 0.282 | 0.477 | 0.381 | 0.200 | 0.818 | 0.306 | 0.306 | 0.306 |
| 1973 | 0.157 | 0.402 | 0.021 | 0.416 | 0.668 | 0.750 | 0.190 | 0.356 | 0.356 | 0.356 |
| 1974 | 0.005 | 0.430 | 0.216 | 0.017 | 0.122 | 0.045 | 0.096 | 0.194 | 0.194 | 0.194 |
| 1975 | 0.028 | 0.153 | 0.334 | 0.184 | 0.043 | 0.100 | 0.120 | 0.283 | 0.283 | 0.283 |
| 1976 | 0.002 | 0.088 | 0.114 | 0.260 | 0.153 | 0.001 | 0.073 | 0.169 | 0.169 | 0.169 |
| 1977 | 0.000 | 0.298 | 0.046 | 0.201 | 0.238 | 0.404 | 0.067 | 0.170 | 0.170 | 0.170 |
| 1978 | 0.000 | 0.077 | 0.373 | 0.098 | 0.256 | 0.399 | 0.271 | 0.351 | 0.351 | 0.351 |
| 1979 | 0.000 | 0.008 | 0.249 | 0.322 | 0.243 | 0.298 | 0.453 | 0.304 | 0.304 | 0.304 |
| 1980 | 0.001 | 0.779 | 0.141 | 0.217 | 0.496 | 0.475 | 0.821 | 0.416 | 0.416 | 0.416 |
| 1981 | 0.000 | 0.285 | 0.717 | 0.581 | 0.335 | 0.406 | 0.533 | 0.601 | 0.601 | 0.601 |
| 1982 | 0.000[2] | 0.307 | 0.520 | 0.520 | 0.520 | 0.520 | 0.520 | 0.520 | 0.520 | 0.520 |
| | | | | STOCK SIZE | | | | | | |
| 1960 | 123366 | 104773 | 34662 | 22984 | 13595 | 11387 | 3872 | 2147 | 1840[6] | |
| 1961 | 53896 | 100981 | 71364 | 22869 | 14714 | 8373 | 7710 | 2462 | 3348 | |
| 1962 | 38734 | 44401 | 73035 | 45004 | 14946 | 9422 | 5187 | 5172 | 3917 | |
| 1963 | 187038 | 31767 | 32337 | 45191 | 27462 | 9137 | 5836 | 2841 | 4323 | |
| 1964 | 461598 | 150528 | 22364 | 19807 | 26979 | 15127 | 5499 | 3515 | 4550 | |
| 1965 | 32589 | 368839 | 108884 | 14214 | 11925 | 14267 | 7198 | 2638 | 3295 | |
| 1966 | 4091 | 18065 | 189206 | 49342 | 6841 | 5830 | 5708 | 2532 | 1732 | |
| 1967 | 11865 | 3247 | 8663 | 65127 | 23242 | 3125 | 2458 | 2587 | 1969 | |
| 1968 | 376 | 8678 | 2507 | 4501 | 34784 | 9792 | 1476 | 1124 | 2088 | |
| 1969 | 999 | 301 | 4421 | 1416 | 1968 | 15495 | 4882 | 612 | 1549 | |
| 1970 | 4886 | 819 | 236 | 2100 | 757 | 1024 | 7356 | 2585 | 1602 | |
| 1971 | 245 | 3961 | 529 | 179 | 1207 | 453 | 646 | 3952 | 2485 | |
| 1972 | 8483 | 200 | 2011 | 233 | 110 | 728 | 151 | 274 | 5104 | |
| 1973 | 19352 | 6803 | 162 | 1242 | 118 | 62 | 488 | 54 | 1637 | |
| 1974 | 9822 | 13538 | 3724 | 130 | 670 | 49 | 24 | 330 | 1553 | |
| 1975 | 7725 | 8013 | 7209 | 2468 | 105 | 486 | 39 | 17 | 392 | |
| 1976 | 101922 | 6153 | 5629 | 4228 | 1675 | 82 | 360 | 28 | 792 | |
| 1977 | 13849 | 83392 | 4611 | 4113 | 2670 | 1176 | 67 | 274 | 781 | |
| 1978 | 4358 | 11339 | 50672 | 3606 | 2755 | 1723 | 643 | 51 | 248 | |
| 1979 | 76200 | 3568 | 8598 | 28564 | 2678 | 1746 | 946 | 401 | 193 | |
| 1980 | 9394 | 62388 | 2899 | 5486 | 16945 | 1720 | 1061 | 492 | 260 | |
| 1981 | 6107[4] | 7719 | 23432 | 2061 | 3614 | 8449 | 876 | 382 | 227 | |
| 1982 | 2442[4] | 5000[5] | 4753 | 9366 | 944 | 2117 | 4610 | 420 | 499 | |
| 1983 | 2442[4] | 2000[5] | 2772[7] | 2314[7] | 4559[7] | 459[7] | 1030[7] | 2444[7] | 204[7] | |

| Total stock Age 2+ Number (000's) | Total stock Age 2+ Weight (tons) | Spawning stock[3] Number (000's) | Spawning stock[3] Weight (tons) |
|---|---|---|---|
| 195263 | 232426 | 142877 | 187376 |
| 231822 | 269720 | 181332 | 226803 |
| 201085 | 233634 | 17884 | 218095 |
| 158896 | 205205 | 143013 | 194723 |
| 248358 | 252670 | 173100 | 203007 |
| 531221 | 427401 | 346814 | 314926 |
| 279224 | 271992 | 270193 | 267929 |
| 110390 | 144110 | 108767 | 142358 |
| 64923 | 94078 | 60687 | 90354 |
| 30621 | 57332 | 30471 | 57199 |
| 16462 | 40299 | 16053 | 39923 |
| 13391 | 29298 | 11415 | 27742 |
| 8803 | 24968 | 8704 | 24889 |
| 10566 | 16486 | 7300 | 13697 |
| 18465 | 25658 | 11696 | 20514 |
| 18327 | 27244 | 14321 | 23838 |
| 18947 | 33239 | 15871 | 30224 |
| 97084 | 90617 | 55388 | 60596 |
| 71037 | 95035 | 65368 | 90896 |
| 46694 | 80128 | 44910 | 78826 |
| 91251 | 109907 | 60005 | 87465 |
| 46533 | 72165 | 42674 | 55448 |
| 27709 | 42351 | 25209 | 40701 |
| 15782 | 27942 | 14782 | 26622 |

[1] Weighted by stock size in numbers, ages 3+.

[2] Not estimated.

[3] Fifty percent age 2 and 100 percent of age 3+

[4] Backcalculated using M = 0.20.

[5] Estimated.

[6] Calculated from $C_t = N\ {}^{F}/_{Z}\ (1-e^{-Z})$.

[7] Calculated from $N_t = N_o e^{-Z}$.

Table 10. Projections for Georges Bank haddock with 1983 stock conditions as a starting point. Values are expressed as average expected catch and biomass after 10 years under constant fishing mortalities with conditional probabilities for recovery of spawning stock biomass to 50,000 tons and above.

| F | Total stock biomass (2+) | Mean[1] spawning stock biomass | Mean total catch | Spawning stock to or above projected level after 10 years. 50,000 tons | 60,000 tons | 70,000 tons | ≥80,000 tons |
|---|---|---|---|---|---|---|---|
| 0.10 | 60,642 (31-136)[2] | 54,280 (29-119) | 5,957 (3-13) | 90.0 | 90.0 | 70.0 | 50.0 |
| 0.26[3] | 29,971 (16-51) | 26,588 (15-44) | 7,198 (4-12) | 35.0 | 35.0 | 10.0 | 0.0 |
| 0.55[4] | 14,192 (9-21) | 11,759 (8-17) | 9,616 (6-14) | 5.0 | 0.0 | 0.0 | 0.0 |

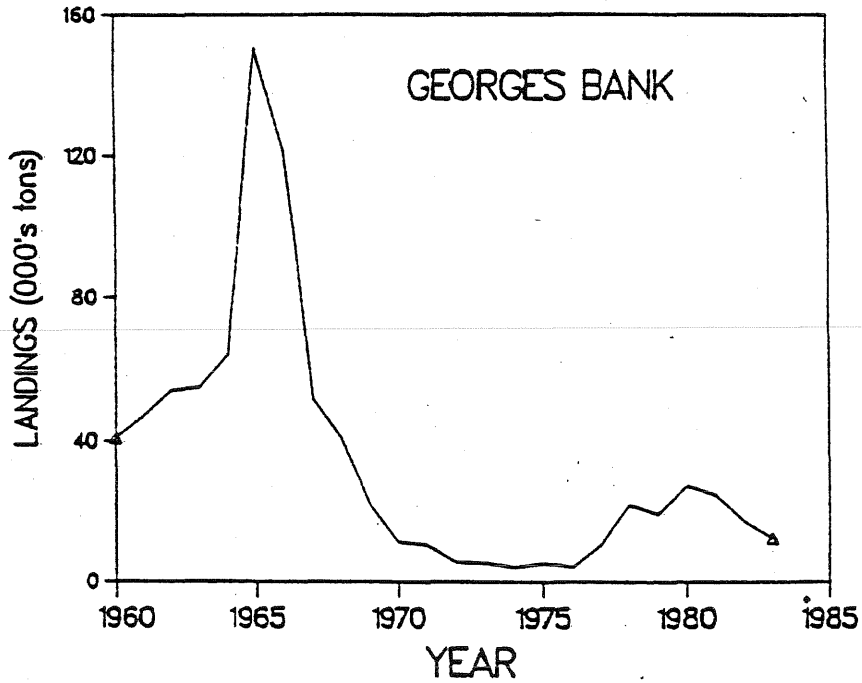
[1] 50% of age 2 and 100% of 3 and older.

[2] Range of averages for 10-year runs (thousands of tons).

[3] $F_{0.1}$

[4] $F_{max}$

Figure 1. Commercial landings of haddock (metric tons, live) from Georges Bank and the Gulf of Maine, 1960-1982.



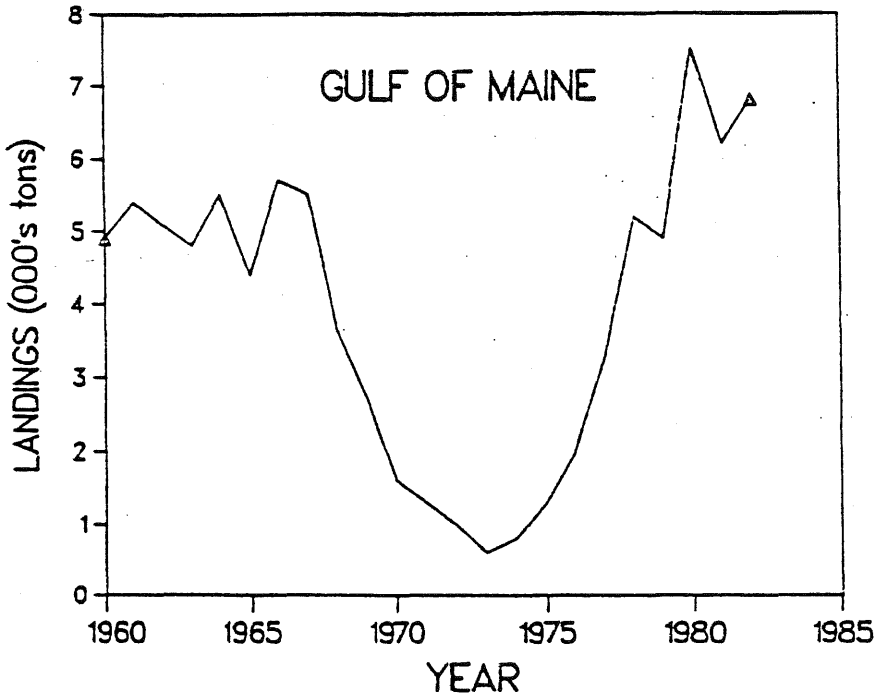
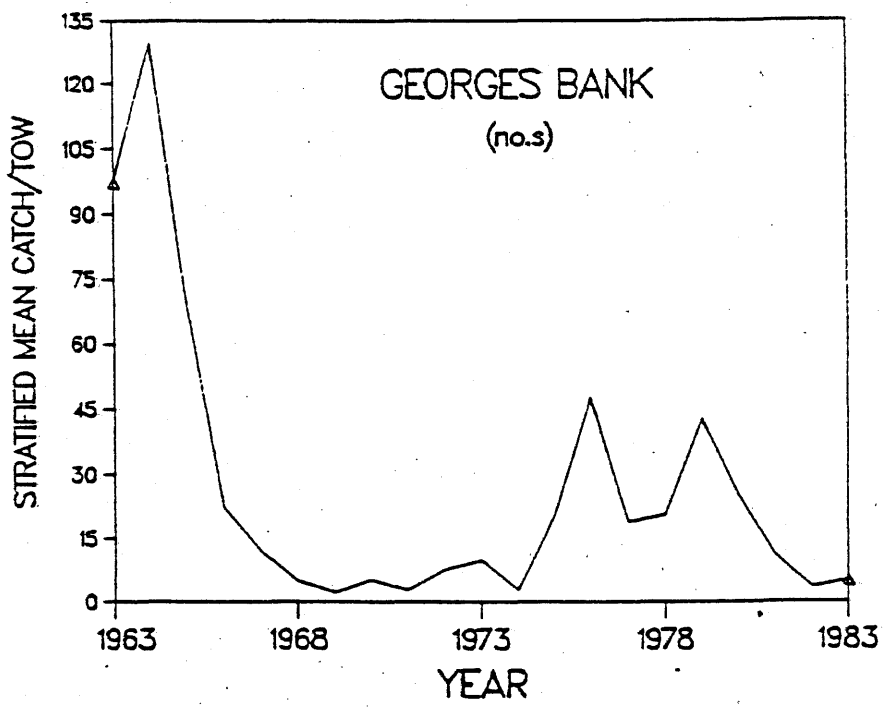



Figure 2. Stratified mean catch/tow in numbers and weight for haddock in NEFC autumn bottom trawl surveys on Georges Bank, 1963-1983.



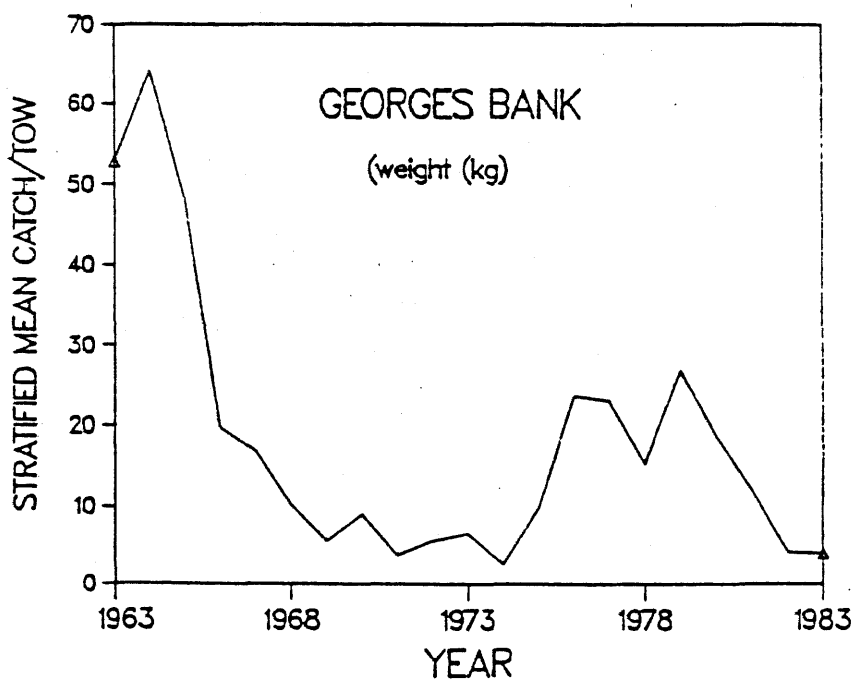



Figure 5. Stock size (millions, age 2+) for Gulf of Maine haddock calculated from the modified DeLury method, 1977-1982.

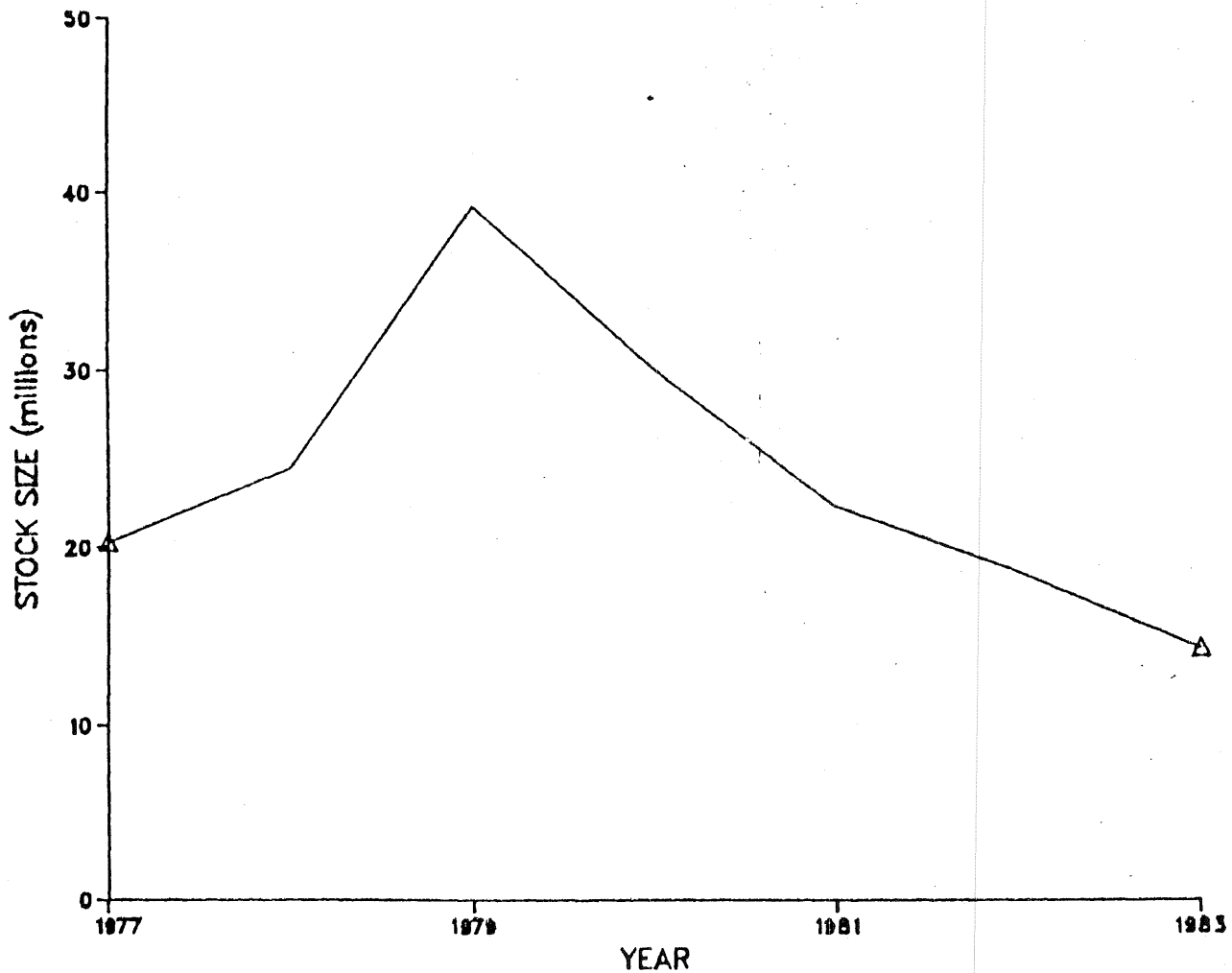
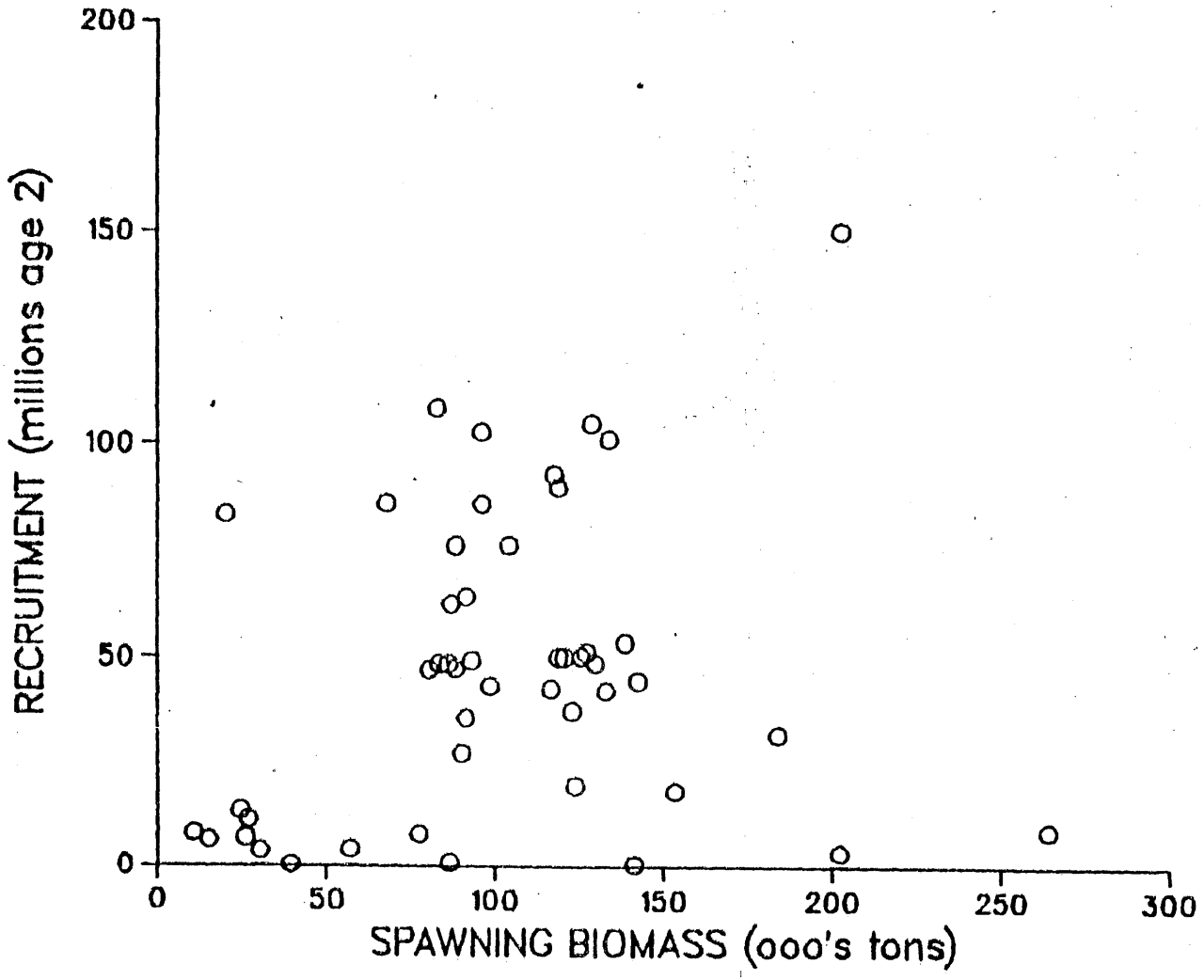



Figure 6. Spawning stock biomass (000's tons) and subsequent recruitment (millions, age 2) for Georges Bank haddock, 1931-1979. The 1963 point (194,700 tons, 368.8 million recruits) has been omitted.