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Changes in biomass of finfish and squid in ICNAF Subarea 5 and Statistical Area 6 as evidenced by *Albatross IV* autumn survey data

by

Stephen H. Clark and Bradford E. Brown

National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

Introduction

The continental shelf of the Northwest Atlantic Region supports one of the world's most valuable fishery resources. Certain regions within this area, such as the Grand Banks off Newfoundland, have been heavily exploited for centuries; others have received comparatively little attention until recently. The latter situation appears to be true for ICNAF Subarea 5 and Statistical Area 6, which prior to 1960 were fished almost exclusively by a coastal fleet of small US vessels; landings for this region averaged less than 500 x 10^3 MT annually, a figure judged to be well below the MSY point for the fish stocks within this area (Brown, Brennan, Grosslein, Heyerdahl, and Hennemuth, 1975). During the 1960's, however, the distant water fleets of the Soviet Union, Japan, Poland, and other countries moved into the area, and as the decade progressed these fleets have been further modernized and expanded. The result has been a great increase in fishing effort and landings in SA 5 and 6 in recent years; analyses by Brown *et al.* (1975) indicate that between 1961 and 1972 a six-fold increase in standardized effort occurred, while landings more than tripled. Individual stock assessments indicate that all major stocks in these areas are now heavily exploited and some, notably the Georges Bank haddock and herring stock and the southern New England yellowtail flounder stock, have been demonstrably overfished (Hennemuth, 1969; Schumacher and Anthony, 1972; Brown and Hennemuth, 1971a).

The above surge in fishing activity in SA 5 and 6 has stimulated considerable interest in its potential effect on biomass levels. Edwards (1968) developed biomass estimates for Subarea 5 and adjoining regions (southern New England to southern Nova Scotia area) by adjusting 1963-1966 survey data to compensate for availability and vulnerability influences and estimated that the mean annual harvest (1.2 x 10^6 MT at that time) was approximately one-fourth of the standing crop. Grosslein (1972) examined 1963-1971 *Albatross IV* fall survey data for Div. 5Z finfish and found declines in stratified mean catch per tow (by weight) of 74% and 62% for southern New England and Georges Bank strata, respectively. Brown, Brennan, Heyerdahl, Grosslein, and Hennemuth (1973) presented additional analyses of Grosslein's (1972) data and documented declines ranging from 20-90% for nearly all groundfish species or species groups, while herring declined approximately 90%; overall, biomass of the principal finfish species under exploitation was found to have declined approximately 65% through 1971. Brown *et al.* (1975) updated these analyses by including 1972 data and found a biomass decline of 56%.

In response to accumulating evidence relative to biomass declines in SA 5 and 6, the ICNAF Standing Committee on Research and Statistics (STACRES) recommended an overall total allowable catch (TAC) for this area during the October, 1973, special meeting; this was adopted by the Commission. STACRES further recommended that the overall level of biomass as measured by bottom trawl surveys be used to monitor the effect of this regulation (ICNAF Proceedings, third special meeting, October, 1973).

The objective of the present study was to further investigate declines in finfish and squid biomass in SA 5 and 6 as evidenced by *Albatross IV* autumn bottom trawl survey data. As developed, the study expands on the previous work of Grosslein (1972) and Brown *et al.* (1975) so as to include data from all of the areas in SA 5 and 6 for the 1963-1974 period. In addition, a weighting procedure has been developed and used which appears to reflect total biomass decline more accurately than procedures used in earlier studies (Brown *et al.*, 1973, 1975).

Methods

Autumn bottom trawl survey data have been collected by the US National Marine Fisheries Service research vessel *Albatross IV* since 1963; the RV *Delaware II* has also participated infrequently. In all of these surveys, both vessels have used the standard "36 Yankee" trawl with a 1.25 cm stretched mesh cod end liner; this trawl measures 10-12 M along the footrope and 2 M in height at the center of the headrope, and is equipped with rollers to make it suitable for use on rough bottom (Edwards, 1968).

The area sampled in these cruises extends from Nova Scotia to Cape Hatteras. The basic sampling design used is the stratified random design as given by Cochran (1953); thus, the survey area has been apportioned into strata (Figure 1) with boundaries determined primarily on the basis of depth (Grosslein, 1968).

During the 1963-1966 period, only strata from the New Jersey coast northward (1-42, Figure 1) were sampled; in autumn, 1967, additional strata (61-76, Figure 1) were added to cover the mid-Atlantic region. An additional section covering part of the Scotian shelf was also added in 1968.

The field and laboratory procedures followed in the bottom trawl survey program, and the statistical principles involved, have been discussed in detail by Grosslein (1968, 1971) and will only be mentioned briefly here. It should be noted, however, that sampling stations are allocated to strata roughly in proportion to the area of each stratum and are assigned to specific locations within strata at random. In all cases, one 30-minute tow was taken at each station at an average speed of 3.5 knots. After each tow, numbers captured and total weight were recorded for each species. At the completion of each cruise, data were summarized, audited, and transferred to magnetic tape. Thus, a considerable volume of data relative to biomass levels (numbers and weight) is immediately available for evaluation of trends in biomass levels in recent years.

Following procedures given by Cochran (1953, p. 66), the stratified mean catch per tow in terms of numbers or weight is calculated by

$$\bar{y}_{st} = 1/N \sum_h N_h \bar{y}_h$$

where $\bar{y}_{st}$ = stratified mean catch per tow,

N = total area of all strata in the set,

N_h = area of the h^{th} stratum, and

$\bar{y}_h$ = mean catch per haul in the h^{th} stratum.

We used stratified mean weight per tow in preference to numbers as an index of biomass decline due to its convenience when working with different species groups and the high degree of variability in numbers associated with fluctuations in recruitment.

For detailed examination of trends in biomass levels, individual strata can be arranged in groups on the basis of stock structure, ecological factors, exploitation patterns and availability of survey data. In the present paper we have recognized four major areas in SA 5 and 6 based on the above factors (Figure 1) which were considered separately prior to examination of data for the total area. These are as follows:

a) Middle Atlantic area (strata 61-76, corresponding approximately to Divisions 6B and C);

b) Southern New England area (strata 1-12, corresponding approximately to Divisions 6A and 5Zw);

c) Georges Bank (strata 13-25, corresponding approximately to Division 5Ze); and

d) Gulf of Maine (strata 26-30 and 36-40, corresponding approximately to Division 5Y).

The rationale for this arrangement is based primarily on stock identification work and shifts in species diversity in response to ecological conditions, although exploitation patterns and data availability were also considered. A number of stock identification studies support such an arrangement (Wise, 1962; Grosslein, 1962; Anthony and Boyar, 1968; Ridgway, Lewis, and Sherburne, 1969; Anderson, 1974; and others). In addition, Grosslein's 1973 study indicates a relatively high diversity of species in the Southern New England-Middle Atlantic areas in contrast with the Gulf of Maine, with Georges Bank being a rather transitional area; further, the region around Nantucket Shoals appears to be an ecological barrier to certain species (Grosslein, personal communication). Exploitation patterns and reporting of commercial fishery statistics also dictate some form of division between Divisions 5Ze and 5Zw and other areas to the north or south. Finally, the fact that survey data is nonexistent for Middle Atlantic strata prior to 1967 indicates some sort of division between this area and the remainder of SA 5 and 6 for analytical purposes.

The term "species" as used in this paper for convenience refers to both species and species groups. Terms such as "other pelagics," "other fish," and "groundfish" refer to species as designated in the ICNAF Statistical Bulletin (ICNAF, 1974).

Results and Discussion

Trends for designated areas

Stratified mean catch per tow (by weight) is given for 16 selected species or species groups[1] of finfish and squid for the Middle Atlantic area (1967-1974) in Table 1; similar information is given for the Southern New England, Georges Bank, and Gulf of Maine areas in Tables 2-4 (1963-1974). It is at once apparent that finfish biomass in these areas has declined considerably since the initiation of the bottom trawl survey program. Almost all of the species and groups examined appear to have declined in abundance in recent years; this is particularly true for heavily-exploited species such as haddock, silver and red hake, yellowtail flounder, and certain other flounders, and ocean pout, although pronounced declines are also evident in other cases. Other species, such as redfish and pollock, have fluctuated in abundance to some degree without giving any clear-cut trends, while white hake and long-finned squid appear to show an increase (trends for squid, however, are believed partially anomalous due to inadequate recording of certain invertebrates during the early years of the program). Taken together, data indicate a pronounced decline in biomass since the inception of the bottom trawl survey program; the decline in mean weight per tow between averages computed for 1967 and 1968 and 1973-1974 for the Middle Atlantic area was found to be 77%, while the corresponding declines between averages computed for 1963-1965 and 1972-1974 were 52% for Southern New England, 36% for Georges Bank, and 41% for the Gulf of Maine (Tables 5 and 6). With squid (all species) excluded from the 1963-1974 data, declines were 59%, 39%, and 41% for the Southern New England, Georges Bank, and Gulf of Maine areas, respectively.

The trends described above represent generalizations, and closer examination of the data by area is useful. Accordingly, each of these areas is considered separately in the following sections.

Middle Atlantic

The magnitude of the observed decline for the Middle Atlantic area (Table 1) is surprising, but much of this appears attributable to a sharp reduction in catch of sea robins since 1968. The data of Table 5 do, however, indicate that nearly all finfish species did in fact decline, with the exception of "other pelagic" species and skates. In particular, data for silver and red hake, and summer flounder, winter flounder, and yellowtail flounder show pronounced decreases in abundance between 1967 and 1974.

Southern New England

The data of Table 2 are noteworthy in indicating the virtual disappearance of haddock and pronounced declines in other commercially important species. It should be noted that the 1972 data

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[1]Species were selected both on the basis of commercial importance and abundance in the survey data.

appear anomalous in that catches for many groundfish species increased sharply for no apparent reason; catch of yellowtail flounder, for instance, jumped considerably although no such pattern is evident in commercial catch or from stock abundance indices computed by Parrack (1974). Similarly, catches of angler, sea robins, skates, and red hake appear to have been unreasonably high considering overall trends in the survey data. The consistency of the 1972 data over a range of groundfish species is, therefore, judged to relate to some change in their catchability coefficient during that cruise, and from this we may infer that in reality the decline in biomass may have actually been somewhat greater than observed. A comparison between averaged total catch of finfish and squid for 1963 and 1964, and 1973 and 1974 reveals a decline of 64% for the Southern New England area contrasted with the 52% decline obtained for the 1963-1965 and 1972-1974 data reported in Table 5.

In summary, the data of Table 2 indicate declines in abundance for all commercially important groundfish species in the Southern New England area, with the exception of certain species which are typically incidental (scup and sea robins). The remaining elements of the biomass appear to fluctuate considerably in abundance throughout the 1963-1974 period, although the downward trend is clearly evident for skates and dogfish.

Georges Bank

On Georges Bank (Table 3) heavily exploited groundfish species such as cod and haddock, and species of lesser commercial importance such as pollock and redfish form a significant element of the fishable biomass, and the pattern of biomass reduction is modified somewhat. Among the groundfish, cod, redfish, and white hake show if anything an increase; the same is true for certain flounders. Declines, dramatic in certain cases, are evident for other groundfish and flounder species (Table 6). Most striking is the decline in haddock, which shows a reduction of over 90%; substantial declines are also evident for other commercially important species such as silver and red hake, winter flounder, American dab, yellowtail flounder, pollock, and ocean pout. On the other hand, pelagics and spiny dogfish appear to have increased, although considerable variation is apparent on an annual basis, probably in part due to seasonal migrational patterns. The declines observed for this area are even more striking when it is considered that Georges Bank had been heavily exploited for decades prior to 1963.

Gulf of Maine

The Gulf of Maine data (Tables 4 and 6) again indicate reductions in biomass for most of the species and groups examined. Angler, pollock, and "other groundfish" remained relatively stable, and white hake increased as on Georges Bank; the remaining species (including all species of commercial importance) show a decrease. Here, declines are particularly evident in the case of haddock, silver hake, and red hake, although cod, redfish, and all of the flounder species considered also appear to have been reduced. The overall trend is consistent in indicating a pronounced reduction in fishable biomass in these strata.

To summarize, the stratified mean catch per tow data of Tables 1-6 indicate declines for almost all of the species or species groups examined in one or more of the above areas. It is now of interest to examine trends for SA 5 and 6 as a whole, considering data for important pelagic species (*i.e.* herring and mackerel) more directly and using species and species groups treated in recent stock assessment work and formulation of quota allocations. For many species, *e.g.* dogfish, with pronounced movements between the regions discussed, anomalies observed above do not appear when the total region is considered.

Trends for Subarea 5 and Statistical Area 6 as a unit

Stratified mean catch per tow data for selected species of finfish and squid are given for all available strata in Tables 7 and 8. Again, the downward trend is evident in both sets of data. Examination of the data for the Middle Atlantic, Southern New England, Georges Bank, and Gulf of Maine areas (strata 61-76, 1-30, and 36-40) (Table 7) reveals that during the 1967-1974 period haddock, yellowtail flounder, "other flounders," herring, mackerel, and "other finfish" declined; the remaining species examined remained more stable although decreases become more evident when averages at the beginning and end of the period are compared. Comparison of simple averages computed for 1967-1968 and 1973-1974 for the data of Table 7 and for herring, mackerel, and squid (Table 9) reveals reductions in biomass for all groundfish with the exception of white hake, angler, and pollock, while data for "other finfish," skates, and squid indicate possible increases. Overall, a decline of 34% is indicated between these periods for "total finfish and squid." Data for

Southern New England, Georges Bank, and Gulf of Maine areas (strata 1-30 and 36-40) (Table 8) indicate reduced abundance for all finfish species and groups considered, with the possible exception of cod, redfish, and pollock. Comparisons of simple averages computed for 1963-1965 and 1972-1974 for these areas (Table 10) likewise reveal declines in almost all cases, with those for haddock, silver and red hake, and ocean pout being strongly evident. Overall, a biomass decline of 44% is indicated (Table 10); with squid excluded (considering that squid may not have been adequately recorded in the 1963-1965 period), the corresponding figure is 47%.

The data of Tables 7-10 are useful in indicating trends in fishable biomass and give preliminary indications of the magnitude of changes that have taken place in recent years. It will be noted, however, that projections based solely on total weight suffer from the limitation that "catchability" differs between species, and thus the various components of the biomass will not occur in the sample data in the proportions in which they actually occur on the fishing grounds. In the present data, this problem is particularly evident in the case of herring and mackerel, which on the average have comprised perhaps 50% of the fishable biomass during the 1963-1974 period, yet account for less than 1% of the samples collected by weight. To compensate for this deficiency, we computed "catchability coefficients" for the species and groups of Tables 7 and 8 for use as weighting factors. To compute these values, estimates of stock size were required; these have been calculated on an annual basis for herring and mackerel (*Redbook*, 1974), haddock (Hennemuth, 1969; Clark, 1975), and at least on a relative basis for Southern New England yellowtail flounder (Brown and Hennemuth, 1971b; Parrack, 1974). For other species, estimates of maximum sustainable yield (MSY) and accompanying instantaneous mortality rates were obtained from existing literature; where no MSY estimate was available, the total allowable catch (TAC) established by ICNAF for 1975 was used and a mortality rate assumed (see Table 11 for references). Using these data, stock sizes were calculated for each species or species group. We then divided catch per tow in weight in year i by stock size at MSY (or by calculated stock size at the beginning of year i+1) to obtain "catchability coefficients" by year for all species and groups in Table 11. These were averaged to obtain weighting factors (Tables 12 and 13). We used three averaging procedures, which were (1) $\frac{\bar{c}}{\bar{S}}$, average survey catch divided by average stock size over all years, (2) $\frac{\Sigma \frac{c}{s}}{n}$, the arithmetic mean of survey catches by year divided by the corresponding stock size, and (3) $\frac{\Sigma \log_{10} \frac{c}{s}}{n}$ (antilogged[1]), the geometric mean of survey catches by year divided by the corresponding stock size, n being equal to the number of years (Tables 12 and 13). We used values obtained by the latter procedure in preference to the others for weighting purposes in that the geometric mean is preferable as a measure of central tendency when using ratios with a wide range of values (Steel and Torrie, 1960); reciprocals of these values were used as weighting factors.

For each year, data for each species or group in Tables 7 and 8 were multiplied by the appropriate weighting factor and summed; values were thus obtained for mean weight per tow for all years with individual components weighted to account for differences in catchability. These values are given for all areas (1967-1974 data) in Table 14 and for Southern New England, Georges Bank, and the Gulf of Maine (1963-1974 data) in Table 15. For each of these groups of data, cumulative values were then computed, excluding data for herring and mackerel. The inclusion of herring and mackerel utilizing the aforementioned weighting coefficient appears to adjust adequately on the average for the expected biomass of these two species relative to the other species. The declining trend over the entire period of the survey is evident both with and without the inclusion of herring and mackerel data. However, when the latter are included, the variability of the yearly estimates of biomass increases. Accordingly, we transformed the data for herring and mackerel to logarithms (y+1) and antilogged the resulting means (Bliss, 1963). While this procedure reduced the variability of the resulting indices considerably, it did not provide appropriate weight to these species. Therefore, we are currently conducting similar analyses in which all of the mean values will be retransformed in this manner.

The data of Tables 14 and 15 again indicate considerable reductions in biomass. For the data of Table 14 (all areas), comparisons between simple averages for 1967-1968 and 1973-1974 indicate declines of 56% for Set 1 (all data), 41% for Set 2 (means for herring and mackerel estimated from transformed data), and 22% for Set 3 (data for herring and mackerel excluded). For the data of Table 15 (Southern New England, Georges Bank, and the Gulf of Maine), comparisons between averages for 1963-1965 and 1972-1974 gave corresponding values of 57%, 50%, and 47%.

As both sets of strata purport to measure abundance in the entire region of ICNAF SA 5 and 6 and the latter set samples the entire region, while the earlier surveys did not cover the southernmost

[1]Antilog ($\bar{y}$ + 1.1513s^2).

area, the combination of 1967-1973 data of Table 14 with the 1963-1966 data of Table 15 were examined. For this set of data comparisons between the 1963-1965 and 1972-1974 averages for each data set provide corresponding values of 53%, 48%, and 43%. (Figure 2).

To summarize, all of the above analyses demonstrate substantial declines in biomass during the period of study. It should be noted that despite a general leveling off of the rate of decline in the latter half of the period under study the 1974 values were the lowest observed and there has been a steady decline since 1972.

Literature cited

Anderson, E. D. 1973. Assessment of Atlantic mackerel in ICNAF Subarea 5 and Statistical Area 6. ICNAF Res. Doc. 73/14.

______. 1974. Comments on the delineation of red and silver hake stocks in ICNAF Subarea 5 and Statistical Area 6. ICNAF Res. Doc. 74/100.

Anthony, V. A., and H. C. Boyar. 1968. Comparison of meristic characters of adult herring from the Gulf of Maine and adjacent waters. ICNAF Spec. Publ. 5: 61-98.

Bliss, C. I. 1963. Statistics in biology. McGraw-Hill Book Co., New York. In 3 volumes.

Brown, B. E., and R. C. Hennemuth. 1971a. Assessment of the yellowtail flounder fishery in Subarea 5. ICNAF Res. Doc. 71/14.

______. 1971b. Prediction of yellowtail flounder population size from pre-recruit catches. ICNAF Res. Doc. 71/115.

______, and E. G. Heyerdahl. 1972. An assessment of the Georges Bank cod stock (Div. 5Z). ICNAF Res. Doc. 72/117.

______, J. A. Brennan, E. G. Heyerdahl, M. D. Grosslein, and R. C. Hennemuth. 1973. An evaluation of the effect of fishing on the total finfish biomass in ICNAF Subarea 5 and Statistical Area 6. ICNAF Res. Doc. 73/8.

______, J. A. Brennan, E. G. Heyerdahl, M. D. Grosslein, and R. C. Hennemuth. 1975. The effect of fishing on the marine finfish biomass in the Northwest Atlantic from the eastern edge of the Gulf of Maine to Cape Hatteras. ICNAF Res. Doc. 75/18.

Clark, S. H. 1975. Current status of the Georges Bank (5Ze) haddock stock. ICNAF Res. Doc. 75/48.

Cochran, W. G. 1953. Sampling techniques. John Wiley & Sons, Inc., New York.

Edwards, R. L. 1968. Fishery resources of the North Atlantic area. *In* The future of the fishing industry in the United States, Univ. Wash. Publ. Fisheries, New Series, Vol. IV.

Grosslein, M. D. 1962. Haddock stocks in the ICNAF convention area. ICNAF Res. Doc. 62/17.

______. 1968. Results of the joint USA-USSR groundfish studies. Part II. Groundfish survey from Cape Hatteras to Cape Cod. ICNAF Res. Doc. 68/87.

______. 1971. Some observations on accuracy of abundance indices derived from research vessel surveys. ICNAF *Redbook* 1971, Part III.

______. 1972. A preliminary evaluation of the effects of fishing on the total fish biomass, and first approximations of maximum sustainable yield for finfishes, in ICNAF Division 5Z and Subarea 6. Part I. Changes in relative biomass of groundfish in Division 5Z as indicated by research vessel surveys, and probable maximum yield of the total groundfish resource. ICNAF Res. Doc. 72/119.

______. 1973. Mixture of species in Subareas 5 and 6. ICNAF Res. Doc. 73/9..

Hennemuth, R. C. 1969. Status of the Georges Bank haddock fishery. ICNAF Res. Doc. 69/90.

ICNAF Proceedings of the Third Special Meeting, Ottawa, Canada, 15-19 October 1973. Publ. Intl. Comm. Northwest Atlant. Fish., Dartmouth, N.S., Can.

ICNAF *Redbook*, 1974, Part I. Publ. Intl. Comm. Northwest Atlant. Fish., Dartmouth, N.S., Can.

Ikeda, I., F. Nagasaki, and H. Imanaga. 1973. Stock assessment of common American squid in ICNAF Subarea 5 and Statistical Area 6. ICNAF Res. Doc. 73/62.

Parrack, M. 1974. Status review of ICNAF Subarea 5 and Statistical Area 6 yellowtail flounder stocks. ICNAF Res. Doc. 74/99.

Ridgway, G. J., R. D. Lewis, and S. Sherburne. 1969. Serological and biochemical studies of herring populations in the Gulf of Maine. ICES Committee Memorandum 24: 1-13.

Schumacher, A., and V. C. Anthony. 1972. Georges Bank (ICNAF Division 5Z and Subarea 6) herring assessment. ICNAF Res. Doc. 72/24.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill, Inc., New York.

Wise, J. 1962. Cod groups in the New England area. Fish. Bull. 63(1): 189-203.

Table 1. Stratified mean catch per tow (lb) for selected species of finfish and squid, *Albatross IV* fall survey data, 1967-1974, Middle Atlantic area (strata 61-76).

Species	1967	1968	1969	1970	1971	1972	1973	1974
Silver hake	1.9	2.0	0.3	0.5	0.6	1.1	0.8	0.0[1]
Red hake	0.3	1.8	1.0	0.4	0.8	0.5	0.2	0.0
Summer flounder	4.4	3.3	1.7	0.1	0.9	0.3	0.7	1.8
Winter flounder	3.8	2.8	1.4	0.1	0.4	0.3	0.3	0.0
Yellowtail	7.4	12.2	8.0	0.1	0.7	0.2	0.0[1]	0.0
Other flounders	1.6	4.4	1.3	0.9	1.8	2.1	3.6	1.0
Angler	1.6	1.3	0.6	0.0[1]	0.3	3.1	1.9	0.1
Scup	5.8	1.8	18.5	0.2	0.6	7.0	0.5	1.5
Sea robins	286.8	30.4	12.0	15.2	6.9	3.7	4.1	4.2
Other groundfish	1.2	0.7	0.7	0.0[1]	0.1	0.1	0.0[1]	0.0
Butterfish	7.9	40.0	8.5	11.8	11.0	9.3	24.2	8.2
Other pelagics[2]	0.7	0.2	3.0	0.0	1.2	0.0	2.3	1.4
Spiny dogfish	105.3	6.9	10.9	0.0	0.0	0.0	0.0[1]	0.0
Skates	0.8	0.5	0.7	0.7	0.5	2.2	2.2	0.5
Other fish[2]	25.7	12.0	13.9	16.0	7.0	18.4	30.3	3.2
Long-finned squid	23.3	20.5	20.2	10.5	5.5	27.8	24.6	24.4
Total finfish and squid	479.1	141.2	102.9	57.3	38.8	76.8	95.8	46.6

[1]Less than 0.05.

[2]"Other" categories do not include data for tunas, sharks, swordfish, American eel or white perch.

Table 2. Stratified mean catch per tow (lb) for selected species of finfish and squid, *Albatross IV* fall survey data, 1963-1974, Southern New England area (strata 1-12).

Species	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Cod	6.5	1.1	3.9	1.6	6.3	1.7	3.4	1.3	0.3	4.6	0.0[1]	0.8
Haddock	6.0	15.6	2.6	0.3	1.1	0.0[1]	0.3	1.0	0.2	0.0	0.0[1]	0.0
Silver hake	11.5	12.5	16.8	7.9	9.7	10.5	5.1	5.7	10.1	8.8	7.1	2.8
Red hake	17.8	9.6	12.4	6.4	5.9	9.7	10.6	8.6	7.4	14.6	6.7	1.2
White hake	2.7	0.9	1.4	2.7	2.8	3.0	1.3	1.0	0.9	0.8	0.1	0.1
Winter flounder	5.2	6.9	6.9	4.6	3.3	2.2	2.9	5.2	2.2	6.6	1.2	0.9
Yellowtail	26.5	26.1	19.1	17.3	26.2	24.4	27.2	30.3	16.8	59.0	5.8	2.7
Other flounders	10.5	8.4	5.9	9.9	4.1	6.3	3.7	4.2	2.9	6.3	5.3	6.4
Angler	9.7	15.5	10.9	14.8	4.1	2.7	5.4	6.1	3.2	21.5	6.3	2.3
Ocean pout	1.5	0.9	0.7	2.4	1.4	1.2	0.6	0.6	0.1	0.3	0.5	0.0
Sculpins	0.6	2.2	3.7	5.6	3.5	2.2	3.0	2.4	0.6	4.9	0.3	0.2
Scup	2.9	5.4	1.5	1.0	1.3	0.8	3.5	0.8	0.5	4.1	3.5	3.0
Sea robins	2.1	1.7	1.1	1.6	1.8	0.6	1.0	0.4	0.6	10.3	0.7	0.2
Other groundfish	0.3	0.2	0.3	0.0[1]	0.7	0.0[1]	0.1	0.3	0.7	0.0[1]	0.0[1]	0.0
Butterfish	5.8	13.2	9.9	3.2	4.9	8.8	14.4	2.5	12.8	5.2	13.8	13.4
Other pelagics[2]	0.4	0.4	1.0	4.3	3.3	0.8	9.3	0.5	0.9	3.0	1.7	0.0[1]
Spiny dogfish	157.0	428.6	205.0	203.6	213.7	128.9	477.2	149.0	29.1	72.1	101.6	41.1
Skates	34.3	21.2	23.2	30.0	7.5	2.6	3.2	6.3	14.6	20.1	6.6	5.1
Other fish[2]	1.6	3.8	4.9	1.3	4.5	2.7	11.5	11.0	8.3	3.9	10.2	0.2
Long-finned squid	0.0	2.9	3.7	5.0	4.4	26.9	39.8	8.0	11.8	14.8	36.9	26.6
Total finfish and squid	302.9	577.1	334.9	323.5	311.6	237.6	623.7	245.8	124.7	262.7	208.5	107.4

[1]Less than 0.05.

[2]"Other" categories do not include data for tunas, sharks, swordfish, American eel or white perch.

Table 3. Stratified mean catch per tow (lb) for selected species of finfish and squid, *Albatross IV* fall survey data, 1963-1974, Georges Bank area (strata 13-25).

Species	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Cod	24.2	15.7	15.9	11.1	18.5	11.7	10.9	17.1	13.4	31.3	42.0	11.2
Haddock	112.8	165.7	123.7	47.2	45.1	20.5	12.7	23.4	8.0	11.3	15.8	6.1
Redfish	2.0	8.8	2.5	4.4	5.8	7.7	14.4	10.2	4.1	8.5	5.8	4.1
Silver hake	11.8	3.7	3.6	4.6	2.3	4.8	3.6	5.1	2.7	5.3	5.2	3.2
Red hake	16.4	4.9	4.0	2.7	1.7	2.5	3.3	2.0	4.1	2.6	6.1	3.1
White hake	3.0	1.0	1.7	0.0[1]	3.5	2.3	4.0	5.2	4.8	4.9	7.8	4.3
American dab	12.1	4.4	2.7	7.2	3.8	2.9	2.5	3.3	2.0	1.9	1.9	0.8
Winter flounder	4.0	4.6	4.3	7.9	2.9	3.4	3.7	10.3	2.2	3.4	3.5	3.2
Witch	2.1	1.1	1.2	3.4	1.4	2.0	1.1	3.4	1.2	2.2	3.3	0.9
Yellowtail	18.0	18.6	12.4	5.4	10.0	14.7	12.0	6.7	8.1	8.9	8.4	4.9
Other flounders	2.3	1.5	1.4	2.5	2.5	2.6	2.9	0.9	1.3	2.9	7.6	4.0
Angler	7.7	5.7	11.0	12.8	1.2	4.1	2.4	1.5	1.4	3.6	4.9	2.4
Ocean pout	3.7	2.2	1.9	2.0	0.5	0.3	0.1	0.2	0.1	0.8	0.5	0.1
Pollock	5.1	4.7	3.8	6.3	2.5	2.2	3.1	0.9	4.9	2.2	3.5	0.8
Sculpins	7.4	4.0	7.3	7.2	4.5	8.3	6.9	10.8	6.9	6.2	8.0	4.3
Other groundfish	1.2	1.1	1.3	2.1	1.5	2.2	0.4	1.2	0.3	0.8	1.5	0.7
Pelagics[2]	3.8	3.3	3.0	3.9	3.0	3.2	2.1	0.9	4.2	5.6	3.0	9.0
Spiny dogfish	6.4	6.5	7.6	4.0	5.5	12.4	5.2	7.8	7.3	21.3	79.7	4.9
Skates	69.1	33.1	47.8	39.0	33.4	27.1	19.1	34.7	19.6	33.9	62.8	33.8
Other fish[2]	1.0	0.8	1.0	1.2	1.2	0.9	0.8	0.4	0.1	0.2	0.3	0.3
Total finfish and squid	314.1	292.2	260.3	176.5	151.9	137.4	114.7	149.0	100.0	160.7	283.0	107.3

[1]Less than 0.05.

[2]"Pelagics" and "other fish" categories do not include data for tunas, sharks, swordfish, American eel or white perch.

Table 4. Stratified mean catch per tow (lb) for selected species of finfish and squid, *Albatross IV*, fall survey data, 1963-1974, Gulf of Maine area (strata 26-30 and 36-40).

Species	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Cod	24.4	31.0	16.3	17.6	12.5	26.5	20.9	22.4	22.5	17.7	11.9	12.2
Haddock	86.3	31.2	28.3	22.2	21.5	26.3	17.1	9.5	11.2	7.1	11.6	4.8
Redfish	59.2	130.2	30.8	70.0	56.7	95.3	47.0	74.5	56.0	55.0	38.2	58.2
Silver hake	62.3	10.5	19.2	9.2	5.8	4.5	5.7	5.3	6.5	13.9	8.8	8.5
Red hake	10.8	1.6	2.2	1.8	0.7	0.3	0.7	0.2	2.3	4.3	1.0	1.1
White hake	17.1	11.4	17.5	20.9	9.3	12.7	39.0	36.0	33.7	37.2	35.0	30.8
American dab	13.7	8.0	13.2	13.9	7.7	9.4	7.7	5.4	6.3	4.9	6.3	5.1
Witch	7.9	5.1	5.4	10.0	4.4	8.1	11.2	7.4	7.1	5.0	2.9	3.5
Other flounders	2.4	0.9	2.2	0.3	0.1	0.3	2.7	0.7	0.3	1.6	0.4	1.3
Angler	8.1	3.5	4.1	8.0	3.7	4.5	9.8	6.8	8.7	3.3	8.0	5.1
Cusk	4.9	2.7	2.8	8.4	2.5	3.9	3.7	4.3	3.9	6.5	2.8	1.1
Pollock	19.0	17.2	7.9	5.2	6.3	12.0	28.9	8.0	12.1	18.4	13.0	13.6
Other groundfish	0.7	0.9	1.3	2.2	0.4	1.2	0.3	1.3	0.6	1.8	0.8	0.6
Pelagics[1]	3.7	0.2	0.4	0.7	0.2	0.1	0.1	0.2	1.4	0.2	0.2	0.0[2]
Spiny dogfish	128.3	23.4	26.1	8.7	17.2	50.2	21.5	40.3	26.3	38.2	15.9	19.1
Skates	33.2	20.8	24.5	38.4	10.9	22.0	31.8	35.6	26.6	17.5	16.7	9.6
Other fish[1]	5.4	0.2	0.5	0.6	0.8	0.4	0.3	0.7	0.5	0.6	0.4	0.4
Total finfish and squid	487.4	298.8	203.2	239.1	161.1	277.9	248.7	259.3	227.1	233.6	175.4	177.7

[1] "Pelagics" and "other fish" categories do not include data for tunas, sharks, swordfish, American eel or white perch.

[2] Less than 0.05.

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Table 5. Stratified mean catch per tow (lb) for selected species, *Albatross IV* fall survey data, Middle Atlantic (1967-1968 and 1973-1974) and Southern New England (1963-1965 and 1972-1974) areas.[1] Mean catch per tow values represent simple averages of the values given in Tables 1 and 2 for these areas and years.

Species	Middle Atlantic			Southern New England		
	1967-68 mean	1973-74 mean	% change	1963-65 mean	1972-74 mean	% change
Cod	-[2]	-	-	3.8	1.8	- 53
Haddock	-	-	-	8.1	0.0[3]	-100
Silver hake	2.0	0.4	- 80	13.6	6.2	- 54
Red hake	1.1	0.1	- 91	13.3	7.5	- 44
White hake	-	-	-	1.7	0.3	- 80
Winter flounder	3.3	0.2	- 96	6.3	2.9	- 54
Yellowtail	9.8	0.0[3]	-100	23.9	22.5	- 6
Other flounders	6.9	3.6	- 48	8.3	6.0	- 27
Angler	1.5	1.0	- 31	12.0	10.0	- 17
Ocean pout	-	-	-	1.0	0.3	- 74
Sculpins	-	-	-	2.2	1.8	- 17
Scup	3.8	1.0	- 74	3.3	3.5	+ 8
Sea robins	158.6	4.2	- 97	1.6	3.7	+131
Other groundfish	1.0	0.0[3]	-100	0.3	0.0[3]	-100
Butterfish	24.0	16.2	- 33	9.6	10.8	+ 13
Other pelagics	0.5	1.9	+280	0.6	1.6	+167
Spiny dogfish	56.1	0.0[3]	-100	263.3	71.6	- 73
Skates	0.6	1.4	+233	26.2	10.6	- 60
Other fish	18.9	16.8	- 10	3.4	4.8	+ 41
Long-finned squid	21.9	24.5	+ 12	2.2	26.1	+1086
Total finfish and squid	310.2	71.2	- 77	405.0	192.9	- 52

[1] Middle Atlantic and Southern New England areas represented by strata sets 61-76 and 1-12, respectively.

[2] Dashes indicate inadequate data (included in "other" categories).

[3] Less than .05.

Table 6. Stratified mean catch per tow (lb) for selected species, *Albatross IV* fall survey data, Georges Bank and Gulf of Maine areas[1], 1963-1965 and 1972-1974. Mean catch per tow values represent simple averages of the values given in Tables 3 and 4 for these areas and years.

Species	Georges Bank			Gulf of Maine		
	1963-65 mean	1972-74 mean	% change	1963-65 mean	1972-74 mean	% change
Cod	18.6	28.2	+ 51	23.9	13.9	- 42
Haddock	134.1	11.1	- 92	48.6	7.8	- 84
Redfish	4.4	6.1	+ 39	73.4	50.5	- 31
Silver hake	6.4	4.6	- 28	30.7	10.4	- 66
Red hake	8.4	3.9	- 54	4.9	2.1	- 56
White hake	1.9	5.7	+198	15.3	34.3	+124
American dab	6.4	1.5	- 76	11.6	5.4	- 53
Winter flounder	4.3	3.4	- 21	-[2]	-	-
Witch	1.5	2.1	+ 44	6.1	3.8	- 38
Yellowtail	16.3	7.4	- 55	-	-	-
Other flounders	1.7	4.8	+182	1.8	1.1	- 41
Angler	8.1	3.6	- 55	5.2	5.5	+ 4
Cusk	-	-	-	3.5	3.5	0
Ocean pout	2.6	0.5	- 82	-	-	-
Pollock	4.5	2.2	- 53	14.7	15.0	+ 2
Sculpins	6.2	6.1	- 6	-	-	-
Other groundfish	1.2	1.0	- 17	1.0	1.1	+ 10
Pelagics	3.4	5.9	+ 74	1.4	0.1	- 93
Spiny dogfish	6.8	35.3	+419	59.3	24.4	- 59
Skates	50.0	43.5	- 13	26.2	14.6	- 44
Other fish	0.9	0.3	- 72	2.0	0.5	- 75
Total finfish and squid	288.9	183.7	- 36	329.8	195.6	- 41

[1] Georges Bank and Gulf of Maine areas represented by strata sets 13-25 and 26-30 and 36-40, respectively.

[2] Dashes indicate inadequate data (included in "other" categories).

Table 7. Stratified mean catch per tow (lb) for selected species of finfish and squid, *Albatross IV* fall survey data, Middle Atlantic, Southern New England, Georges Bank and Gulf of Maine areas[1] (strata 61-76, 1-30 and 36-40), 1967-1974.

Species	1967	1968	1969	1970	1971	1972	1973	1974
Cod	9.8	11.0	9.6	11.1	10.0	14.1	14.0	6.5
Haddock	17.8	12.8	8.2	8.9	5.3	4.9	7.3	2.9
Redfish	17.9	29.6	17.2	24.2	17.3	18.1	12.5	17.9
Silver hake	5.1	5.6	3.9	4.3	5.2	7.8	5.8	4.0
Red hake	2.2	3.5	3.9	2.8	3.7	5.7	3.5	1.4
Yellowtail	10.6	12.3	11.6	9.3	6.4	17.3	3.6	1.9
Other flounders	10.2	12.2	11.3	10.9	7.5	9.5	9.4	7.5
Pollock	2.6	4.0	9.2	2.5	4.7	5.9	4.6	4.1
Herring	0.6	0.2	0.1	0.1	0.6	0.1	0.0[2]	0.0[2]
Mackerel	0.7	0.3	2.4	0.1	0.1	0.3	0.1	0.2
Other finfish	179.1	100.4	185.1	106.7	63.9	95.3	115.3	54.6
Squid	6.8	12.0	15.2	5.5	5.5	10.9	17.7	14.0
Total finfish and squid	263.4	203.9	277.7	186.4	130.2	189.9	193.9	115.1

[1]Weighting coefficients used were 12692, 15163, 15300, and 17892 nautical miles, respectively.

[2]Less than 0.05.

Table 8. Stratified mean catch per tow (lb) for selected species of finfish and squid, *Albatross IV* fall survey data, Southern New England, Georges Bank and Gulf of Maine areas[1] (strata 61-76, 1-30 and 36-40), 1963-1974.

Species	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Cod	18.8	16.8	12.3	10.6	12.5	14.1	12.3	14.1	12.7	18.0	17.8	8.3
Haddock	69.9	69.4	50.9	23.4	22.7	16.3	10.5	11.3	6.8	6.2	9.3	3.7
Redfish	22.5	51.0	12.2	27.3	22.8	37.6	22.0	30.8	22.0	23.1	16.0	22.8
Silver hake	30.4	9.0	13.5	7.3	5.9	6.5	4.8	5.4	6.4	9.6	7.1	5.0
Red hake	14.8	5.2	5.9	3.5	2.6	3.9	4.6	3.4	4.5	6.9	4.4	1.8
Yellowtail	14.6	14.3	9.9	7.1	11.3	12.3	12.4	11.6	7.9	21.5	4.5	2.4
Other flounders	19.7	13.4	14.7	20.2	10.2	12.7	13.2	13.6	8.8	11.2	10.7	8.8
Pollock	7.6	7.9	4.2	3.9	4.0	5.1	11.7	3.3	6.0	7.5	5.9	5.3
Herring	2.2	0.2	1.0	2.6	0.8	0.2	0.2	0.1	0.7	0.1	0.0[2]	0.0[2]
Mackerel	0.1	0.0[2]	0.1	0.1	0.8	0.3	3.0	0.1	0.1	0.3	0.1	0.2
Other finfish	173.2	196.3	135.5	137.0	109.6	102.4	215.6	122.7	73.5	108.8	128.3	63.9
Squid	0.0	1.2	2.0	2.4	2.2	9.4	13.6	3.9	5.3	5.9	15.7	11.0
Total finfish and squid	373.8	384.7	262.2	245.4	205.4	220.8	323.9	220.3	154.7	219.1	219.8	133.3

[1]Weighting coefficients used were 15163, 15300 and 17892 nautical miles, respectively.

[2]Less than 0.05.

Table 9. Stratified mean catch per tow (lb) for selected species, 1967-68 and 1973-74, *Albatross IV* fall survey data, Middle Atlantic, Southern New England, Georges Bank and Gulf of Maine areas[1] (strata 61-76, 1-30 and 36-40).

Species	67-68 mean catch/tow	73-74 mean catch/tow	% change
Haddock	15.3	5.1	- 67
Cod	10.4	10.3	- 1
Redfish	23.8	15.2	- 36
Silver hake	5.4	4.9	- 9
Red hake	2.9	2.5	- 14
White hake	4.7	11.2	+136
Pollock	3.3	4.8	+ 45
Yellowtail flounder	11.5	2.8	- 76
Winter flounder	2.2	1.4	- 38
Other flounder	8.9	7.1	- 20
Sculpin	2.4	1.7	- 29
Ocean pout	0.5	0.2	- 66
Angler	3.0	4.1	+ 37
All other groundfish	35.9	3.0	- 92
Skates	13.8	17.7	+ 28
Dogfish	66.9	33.5	- 49
Total groundfish, dogfish, skates and flounders	210.8	125.5	- 40
Sea herring	0.4	0.0[2]	-100
Mackerel	0.5	0.1	- 80
Other finfish	12.6	13.2	+ 5
Squid	9.4	15.8	+ 70
Total finfish and squid	233.7	154.5	- 34

[1]Weighting coefficients used were 12692, 15163, 15300 and 17892 square nautical miles, respectively.
[2]Less than 0.05.

Table 10. Stratified mean catch per tow (lb) for selected species, 1963-1965 and 1972-1974, *Albatross IV* fall survey data, Southern New England, Georges Bank and Gulf of Maine areas[1] (strata 1-30 and 36-40).

Species	63-65 mean catch/tow	72-74 mean catch/tow	% change
Haddock	63.4	6.4	- 90
Cod	16.0	14.7	- 8
Redfish	28.6	20.6	- 28
Silver hake	17.6	7.2	- 59
Red hake	8.6	4.4	- 49
White hake	6.8	14.6	+115
Pollock	6.9	6.2	- 10
Yellowtail flounder	12.9	9.5	- 26
Winter flounder	3.7	2.2	- 41
Other flounder	12.2	8.0	- 34
Sculpins	2.8	2.8	0
Ocean pout	1.2	0.3	- 75
Angler	8.3	6.3	- 24
All other groundfish	3.5	4.1	+ 16
Skates	33.7	22.5	- 33
Dogfish	106.6	39.0	- 64
Total groundfish, dogfish, skates and flounders	332.8	168.8	- 49
Sea herring	1.3	0.0[2]	- 98
Mackerel	0.1	0.2	100
Other finfish	5.3	10.7	+101
Squid	1.1	11.0	+928
Total finfish and squid	340.6	190.7	- 44

[1]Weighting coefficients used were 15163, 15300 and 17892 square nautical miles, respectively.
[2]Less than 0.05.

Table 11. Estimated average stock sizes for 1964-1975 for selected species in Subarea 5 and Statistical Area 6 based on previous assessment studies.

Species	Estimated MSY (000 MT)	F at MSY	Exploitation Rate[1]	Stock Size (000 MT)	Reference
Cod	45	0.35	0.269	167	Res. Doc. 72/117
Haddock	50	0.50	0.359	140	Res. Doc. 69/90
Redfish	30	0.40	0.301	100	Redbook 1974
Silver hake	185	0.60	0.379[2]	490	Redbook 1974
Red hake	70	0.60	0.379[2]	185	Res. Doc. 74/19
Yellowtail	37	0.80	0.506	73	Res. Doc. 71/14
Other flounders	25	0.80	0.506	50	Redbook 1974
Pollock	18[3]	0.40	0.301	60	Redbook 1974
Herring	335	0.45	0.331	1010	Res. Doc. 72/24
Mackerel	310	0.45	0.317[4]	980	Res. Doc. 73/14
Other finfish	150	0.50	0.359	420	Redbook 1974
Squid	80	2.00	0.808	100	Res. Doc. 73/62
Sum of individual MSY and stock estimates	1335			3775	

[1]Computed as $F_1/Z_1\ (1-e^{-Z_1})$. M assumed equal to 0.2 unless otherwise stated.

[2]M = 0.4.

[3]Prorated on the basis of commercial catch to include the Subarea 5 portion of the 4VWX - 5 stock.

[4]M = 0.3.

Table 12. Catchability coefficients for selected species, Middle Atlantic, Southern New England, Georges Bank and Gulf of Maine areas 1967-1974, computed using *Albatross IV* fall survey data and estimated stock sizes from previous assessments. All values x 10 [8].

Species	1967	1968	1969	1970	1971	1972	1973	1974	$\frac{\overline{C}}{\overline{S}}$ [1]	$\frac{\Sigma \frac{C}{S}}{n}$ [2]	CV[3]	Antilog[4] $\frac{\Sigma \log \frac{C}{S}}{n}$	CV[5]
Cod	2.66	2.99	2.61	3.01	2.72	3.83	3.80	1.77	2.92	2.92	0.23	2.94	0.23
Haddock	7.21	8.06	6.41	7.62	7.51	6.95	4.94	1.71	6.14	6.30	0.30	6.62	0.30
Redfish	8.12	13.43	7.80	10.98	7.85	8.21	5.67	8.12	8.77	8.77	0.27	8.78	0.12
Silver hake	0.46	0.51	0.35	0.39	0.47	0.71	0.53	0.36	0.47	0.47	0.25	0.47	0.30
Red hake	0.54	0.86	0.96	0.69	0.91	1.40	0.86	0.34	0.82	0.82	0.38	0.83	-1.00
Yellowtail	5.28	6.97	7.30	6.59	4.92	14.27	3.20	1.80	5.55	5.15	0.40	5.32	0.32
Other flounders	9.25	11.07	10.25	9.89	6.80	8.62	8.53	6.80	8.90	8.90	0.17	8.94	0.08
Pollock	1.97	3.02	6.96	1.89	3.55	4.46	3.48	3.10	3.55	3.55	0.45	3.58	0.35
Herring	0.02	0.01	0.05	0.01	0.06	0.01	0.01	0.00[6]	0.01	0.02	-1.00	0.02	0.23
Mackerel	0.03	0.01	0.06	0.00[6]	0.00[6]	0.01	0.00[6]	0.01	0.02	0.02	-1.00	0.02	0.23
Other finfish	19.34	10.84	19.99	11.52	6.90	10.29	12.45	5.89	12.16	12.15	0.43	12.13	0.18
Squid	3.08	5.44	6.89	2.49	2.49	4.94	8.03	6.35	4.96	4.96	0.42	5.08	0.29

[1] $\overline{C}$ = mean catch per tow over all years, *Albatross IV* survey data (MT); $\overline{S}$ = mean stock size (MT) over all years.
[2] All values represent catch/tow (MT), *Albatross IV* fall survey data in year i/stock size (MT) at the beginning of year i + 1.

Stock size for haddock, herring and mackerel calculated for each year from $C_1 = N_1 \frac{F_1}{Z_1} (1-e^{-Z_1})$ and weight at age data; stock size for yellowtail was further adjusted by the index developed by Brown and Hennemuth (Res. Doc. 71/115) to compensate for variation in stock size of the Southern New England component. Estimated stock size at MSY (Table 11) used in all other cases.

[3] Coefficient of variation (linear scale).
[4] Estimates of the untransformed mean computed by $E\overline{y}$ = antilog $(\overline{y} + 1.1513\ s^2)$.
[5] Coefficient of variation (logarithmic scale).
[6] Less than 0.05.

able 13. Catchability coefficients for selected species, Southern New England, Georges Bank, and Gulf of Maine areas, 1963-1974, computed using *Albatross IV* fall survey data and estimated stock sizes from previous assessments. All values x 10 [8].

pecies	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	$\frac{\bar{C}}{\bar{S}}$ [1]	$\frac{\Sigma \frac{C}{S}}{n}$ [2]	CV[3]	Antilog $\frac{\Sigma \log \frac{C}{S}}{n}$ [4]	CV[5]
od	5.11	4.55	3.34	2.88	3.40	3.83	3.34	3.83	3.45	4.89	4.83	2.25	3.81	3.81	0.25	3.81	0.19
addock	16.34	11.83	10.59	6.72	9.19	10.27	8.21	9.67	9.64	8.79	6.30	2.18	10.17	9.14	0.37	9.38	0.23
edfish	10.21	23.13	5.53	12.38	10.34	17.05	9.98	13.97	9.98	10.48	7.25	10.34	11.72	11.72	0.40	11.67	0.15
ilver hake	2.76	0.82	1.22	0.66	0.54	0.59	0.44	0.49	0.58	0.87	0.64	0.45	0.66	0.72	0.89	0.67	0.68
ed hake	3.62	1.27	1.45	0.86	0.64	0.96	1.13	0.83	1.10	1.69	1.08	0.44	1.04	1.04	0.34	1.05	-1.00
ellowtail	8.83	8.65	5.99	3.83	5.63	6.97	7.81	8.22	6.07	17.73	4.00	2.27	6.47	6.21	0.35	6.31	0.24
ther flounder	17.87	12.16	13.34	18.33	9.25	11.52	11.97	12.34	7.98	10.16	9.71	7.98	13.10	11.88	0.28	11.85	0.11
ollock	5.75	5.97	3.18	2.95	3.02	3.86	8.85	2.49	4.54	5.67	4.46	4.00	4.56	4.56	0.44	4.59	0.25
erring	0.07	0.06	0.03	0.08	0.03	0.08	0.01	0.01	0.07	0.01	0.07	0.00[6]	0.03	0.03	-1.00	0.03	0.38
ackerel	0.02	0.01	0.01	0.01	0.03	0.01	0.08	0.00[6]	0.00[6]	0.01	0.00[6]	0.01	0.02	0.02	-1.00	0.02	0.32
ther finfish	187.0	21.20	14.63	14.79	11.84	11.06	23.28	13.25	7.93	11.73	13.85	6.89	14.10	14.10	0.35	14.21	0.35
quid	0.00	0.54	0.90	1.09	1.00	4.26	6.16	1.77	2.40	2.68	7.12	4.99	4.20	4.20	0.56	4.31	0.83

$\bar{C}$ = mean catch per tow over all years, *Albatross IV* survey data (MT); $\bar{S}$ = mean stock size (MT) over all years.
All values represent catch/tow (MT), *Albatross IV* fall survey data in year i/stock size (MT) at the beginning of year i + 1.

Stock size for haddock, herring and mackerel calculated for each year from $C_1 = N_1 \frac{F_1}{Z_1} (1-e^{-Z_1})$ and weight at age data;

stock size for yellowtail was further adjusted by the index developed by Brown and Hennemuth (Res. Doc. 71/115) to compensate for variation in stock size of the Southern New England component. Estimated stock size at MSY (Table 11) used in all other cases.
Coefficient of variation (linear scale).
Estimates of the untransformed mean computed by $E\bar{y}$ = antilog ($\bar{y}$ + 1.1513 s^2).
Coefficient of variation (logarithmic scale).
ess than 0.05.

Table 14. Stratified mean catch per tow for selected species, Middle Atlantic, Southern New England, Georges Bank, and Gulf of Maine areas (strata 61-76, 1-30, and 36-40), 1963-1974 *ALBATROSS IV* fall survey data. Each observation represents the sum of all catches for species in Table 7 weighted by their respective catchability coefficients in Table 12.

Year	All data	Data for herring and mackerel transformed to $\log_{10}X+1$ 1/	Data for herring and mackerel excluded
1967	111.3	60.50	41.5
1968	67.8	56.60	40.6
1969	189.7	51.20	43.7
1970	45.5	38.90	33.9
1971	66.4	36.40	31.4
1972	69.0	53.0	47.0
1973	44.9	42.40	39.9
1974	34.5	27.0	24.5

1/ Untransformed means estimated according to $E\bar{y}$ = antilog $(\bar{y} + 1.1513s^2)$

Table 15. Stratified mean catch per tow for selected species, Southern New England, Georges Bank and Gulf of Maine areas (strata 1-30 and 36-40), 1963-1974 *ALBATROSS IV* fall survey data. Each observation represents the sum of all catches for species in Table 8 weighted by their respective catchability coefficients in Table 13.

Year	All data	Data for herring and mackerel transformed to $\log_{10}X+1$ 1/	Data for herring and mackerel excluded
1963	170.1	113.8	91.8
1964	60.4	57.1	53.8
1965	87.5	64.4	49.2
1966	127.4	62.9	35.7
1967	97.4	49.4	30.7
1968	57.3	45.6	35.6
1969	198.4	50.0	41.7
1970	40.4	37.3	32.1
1971	57.8	34.3	29.5
1972	61.5	49.9	43.2
1973	42.4	40 9	37.4
1974	33.0	26 5	23.0

1/ Untransformed means estimated according to $E\bar{y}$ = antilog $(\bar{y} + 1.1513s^2)$

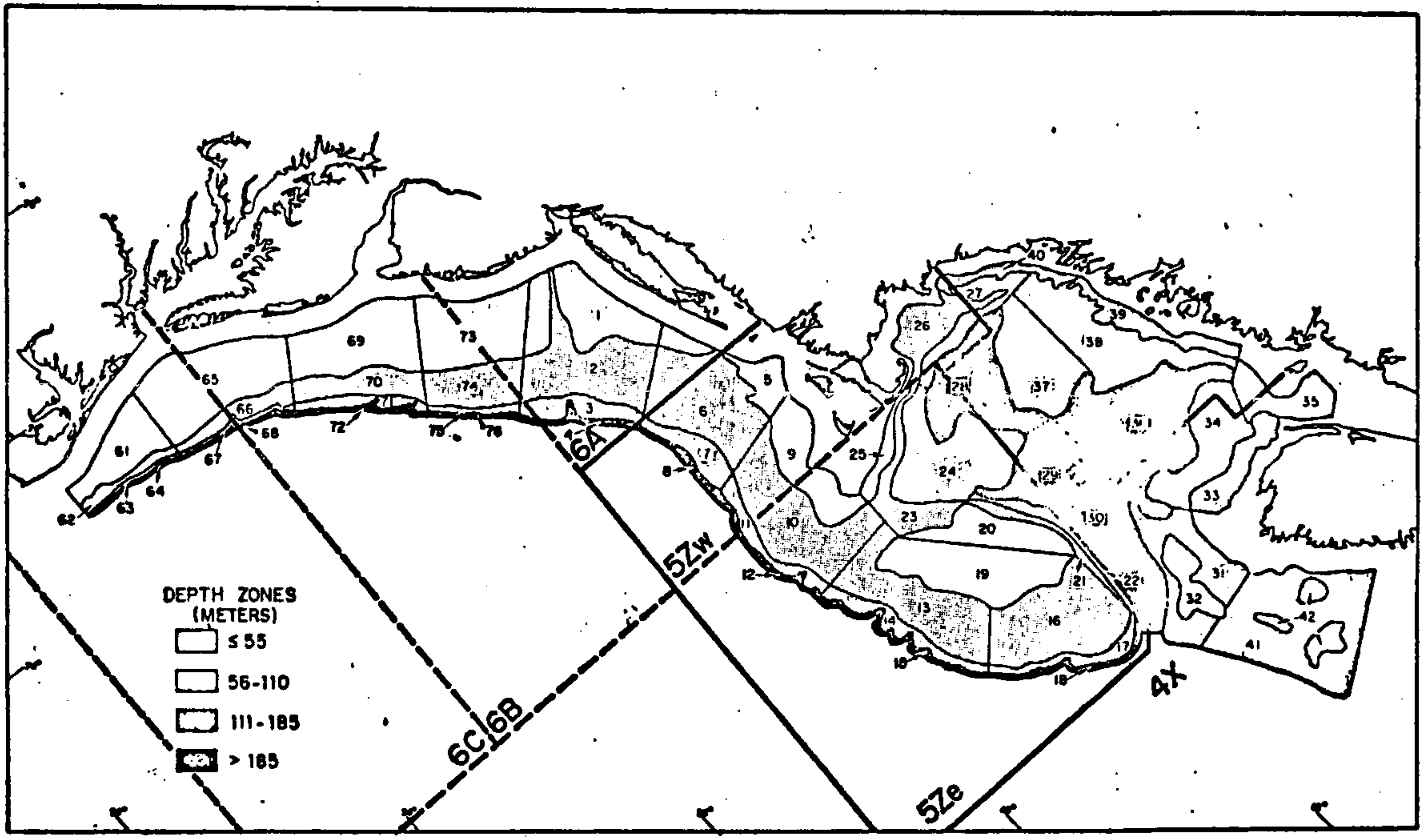

Figure 1. Northwest Atlantic area delineated into strata (by depth zones) with ICNAF division boundaries superimposed.

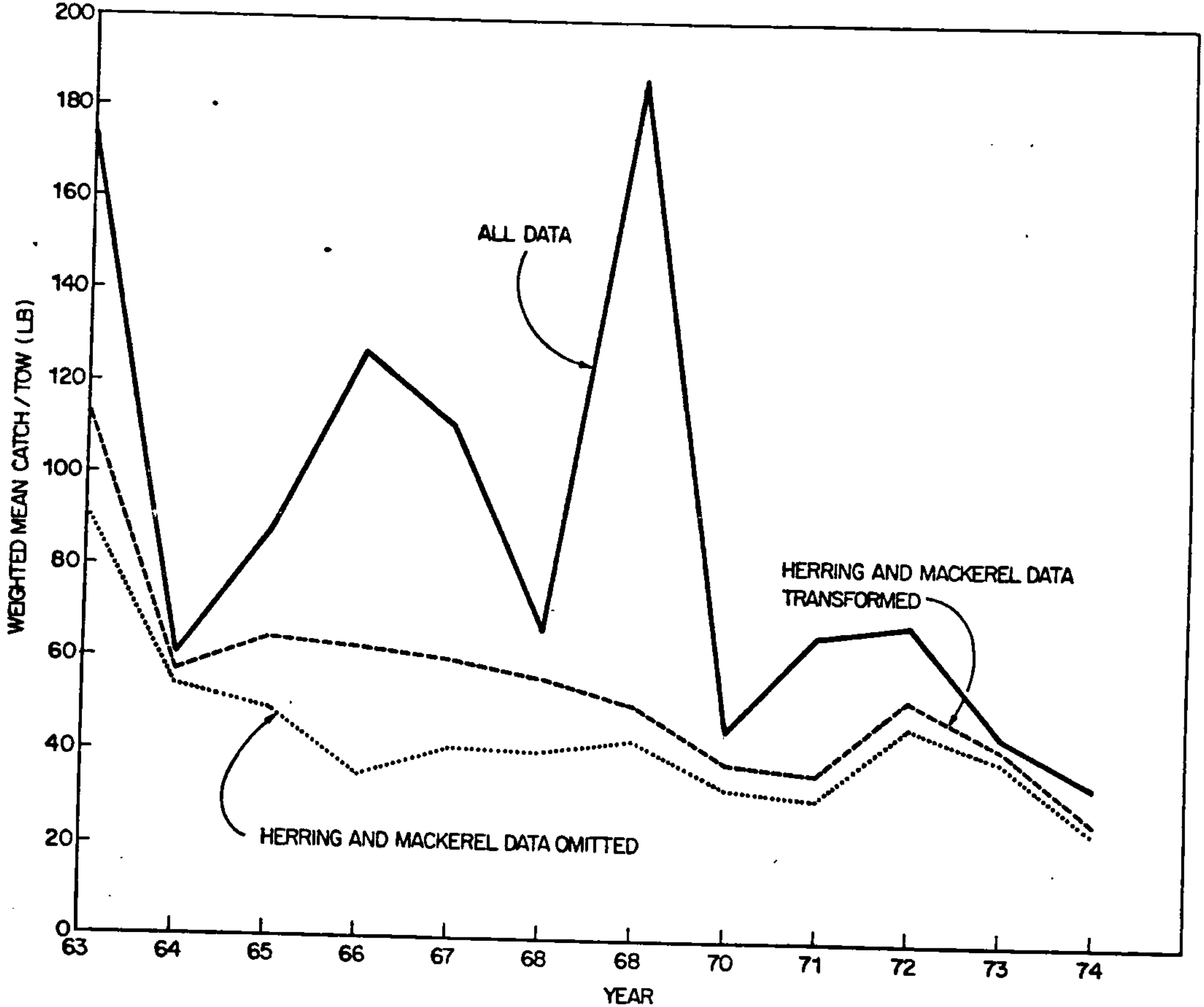

Figure 2. Weighted mean catch per tow (lb), *ALBATROSS IV* fall survey data, 1963-1974. Data sets include 1963-1966 data for southern New England, Georges Bank and Gulf of Maine and 1967-1974 data for all areas.

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Addendum 1

ANNUAL MEETING - JUNE 1975

Changes in biomass of finfish and squid in ICNAF Subarea 5 and Statistical Area 6 as evidenced by *Albatross IV* autumn survey data

by

Stephen H. Clark and Bradford E. Brown
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

Yearly rates of change in finfish and squid biomass.

Year at Midpoint	Predicted stock size from rate of decline	Slope of decline	% decline from predicted stock size
1964	106.0	- 41.3	- 39
5	64.7	33.5	+ 52
6	98.2	11.9	+ 12
7	110.1	- 29.8	- 27
8	80.3	39.2	+ 48
9	119.5	- 11.5	- 10
1970	108.0	- 61.5	- 57
1	46.5	11.8	+ 25
2	58.3	- 10.8	- 18
3	47.5	- 17.5	- 37
4	30.0 (33.0)[1]	avg.= 3.3	avg = 5.1%

	Groundfish only			All fish with herring and mackerel based on 1m (M + 1) indices		
1964	64.9	- 21.3	- 33	78.4	- 24.7	- 32
5	43.6	- 9.0	- 21	53.7	18.2	+ 34
6	34.6	- 3.8	- 11	71.9	- 2.0	- 3
7	30.8	+ 2.4	+ 8	69.9	- 3.2	- 5
8	33.2	- 1.8	- 5	66.7	- 4.6	- 7
9	31.4	- 3.3	- 10	62.1	- 10.0	- 16
70	28.2	- 6.2	- 22	52.1	- 7.4	- 14
1	22.0	+ 6.5	+ 29	44.7	7.0	+ 16
2	28.4	+ 4.2	+ 15	51.7	3.0	+ 6
3	32.6	- 11.2	-.34	54.7	- 13.0	- 24
4	21.4(23.0)[1]	avg. = 4.4	avg = 8.4	41.7(28.4)[1]	avg. = 3.7	avg. = 4

1) observed values

RESTRICTED

International Commission for the Northwest Atlantic Fisheries

Serial No. 3549
(D.c.3)

ICNAF Res.Doc. 75/65
Corrigendum

ANNUAL MEETING - JUNE 1975

Changes in biomass of finfish and squid in ICNAF Subarea 5 and Statistical Area 6 as evidenced by *Albatross IV* autumn survey data

by

S.H. Clark and B.E. Brown
Northeast Fisheries Center
National Marine Fisheries Service
Woods Hole, Massachusetts, USA

Please substitute the following tables 9 and 10 for those originally submitted:

Table 9. Stratified mean catch per tow (lb) for selected species, 1967-68 and 1973-74, *Albatross IV* fall survey data, middle Atlantic, southern New England, Georges Bank and Gulf of Maine area (strata 61-76, 1-30 and 36-40).

Species	67-68 mean catch/tow	73-74 mean catch/tow	% change
Haddock	15.3	5.1	- 67
Cod	10.4	10.3	- 1
Redfish	23.8	15.2	- 36
Silver hake	5.4	4.9	- 9
Red hake	2.9	2.5	- 14
White hake	4.7	11.2	+136
Pollock	3.3	4.8	+ 45
Yellowtail flounder	11.5	2.8	- 76
Winter flounder	2.2	1.4	- 38
Other flounder	8.9	7.1	- 20
Sculpin	2.4	1.7	- 29
Ocean pout	0.5	0.2	- 66
Angler	3.0	4.1	+ 37
All other groundfish	35.9	3.0	- 92
Skates	13.8	17.7	+ 28
Dogfish	66.9	33.5	- 49
Total groundfish, dogfish, skates and flounders	210.8	125.5	- 40
Sea herring	0.4	0.0[2]	-100
Mackerel	0.5	0.1	- 80
Other finfish	12.6	13.2	+ 5
Squid	9.4	15.8	+ 70
Total finfish and squid	233.7	154.5	- 34

[1]Weighted coefficients used were 12692, 15163, 15300 and 17892 square nautical miles, respectively.
[2]Less than 0.05.

Table 10. Stratified mean catch per tow (lb) for selected species, 1963-1965 and 1972-1974, *Albatross IV* fall survey data, southern New England, Georges Bank and Gulf of Maine areas[1] (strata 1-30 and 36-40).

Species	63-65 mean catch/tow	72-74 mean catch/tow	% change
Haddock	63.4	6.4	- 90
Cod	16.0	14.7	- 8
Redfish	28.6	20.6	- 28
Silver hake	17.6	7.2	- 59
Red hake	8.6	4.4	- 49
White hake	6.8	14.6	+115
Pollock	6.9	6.2	- 10
Yellowtail flounder	12.9	9.5	- 26
Winter flounder	3.7	2.2	- 41
Other flounder	12.2	8.0	- 34
Sculpins	2.8	2.8	0
Ocean pout	1.2	0.3	- 75
Angler	8.3	6.3	- 24
All other groundfish	3.5	4.1	+ 16
Skates	33.7	22.5	- 33
Dogfish	106.6	39.0	- 64
Total groundfish, dogfish, skates and flounders	332.8	168.8	- 49
Sea herring	1.3	0.0[2]	- 98
Mackerel	0.1	0.2	+233
Other finfish	5.3	10.7	+101
Squid	1.1	11.0	+928
Total finfish and squid	340.6	190.7	- 44

[1]Weighted coefficients used were 16163, 15300 and 17892 square nautical miles, respectively.
[2]Less than 0.05.