INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

RESTRICTED

Serial No. 2080
(D.c.3)

ICNAF Res. Doc. 68/92

ANNUAL MEETING - JUNE 1968

Status of the Georges Bank Haddock Stock and Effects of Recent High Levels of Fishing Effort

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The long term trends and dynamics of this stock are reviewed in the Report of the Working Group on Fishery Assessment (Supplement to ICNAF annual proceedings, Vol. 11, 1962) and in the Report of the Working Group on Joint Biological and Economic Assessment of Conservation Actions (Appendix I, ICNAF Ann. Proc., Vol. 17, 1968). It is reasonably established that the maximum sustainable yield of about 50,000 tons is obtained at a level of 7,000 standard (U.S. otter trawl) days fished. This level of fishing had, more or less, been maintained solely by the U.S. fishery for many years. In the early 1960's other countries began to enter the fishery, and in 1965 and 1966 the landings increased markedly, primarily because of the Soviet fishery.

Table 1. Recent statistics from the Georges Bank Haddock Fishery.

	Year									
	58	59	60	61	62	63	64	65	66	67
Weight of Landings:										
U.S.	35.5	35.9	41.1	46.2	49.4	44.1	46.5	52.8	52.9	34.7
Other	-	-		.1	4.6	10.7	17.6	96.8	38.2	?
Total	35.5	35.9	41.2	46.3	54.0	54.8	64.1	149.6	91.1	?
Total Days* Fished	7.8	9.4	7.7	7.2	8.6	12.4	12.1	26.7	20.2	?
Landings* Per D.F.	4.6	3.8	5.4	6.5	6.3	4.4	5.3	5.6	4.5	3.7

*U.S. otter trawl fleet units. Landings and effort in tons $X10^3$, landings per day in tons.

Analysis of fishery data is limited to that collected by the U. S. and Canada. Suitable data on age-length composition of the Soviet landings are not available. As will be pointed out below, this leads to a certain degree of provisionality because the Soviet catches in all probability had a different age composition from that of the U. S. -Canadian catches.

In addition to the fishery data, we have examined the results of the seasonal groundfish surveys conducted by the U. S. with the Albatross IV. These provide a random sampling of the population independent of the fishery statistics, and, in fact, probably provide a more accurate picture of stock abundance and age composition than does the latter.

MORTALITY RATES

Using the results of the fall and winter research vessel surveys from 1963 to 1966 (completed in November and February, generally), the estimates in Table 2 of total annual instantaneous mortality have been obtained.

Table 2. Total mortality coeficient for Georges Bank haddock estimated from surveys by research vessel (1957-61 year classes).

Age Groups	1964	1965	Factor 65/64
III	0. 40	1. 98	4. 9
IV	0. 90	1. 46	1. 6
V	0. 66	0. 75	1. 1
VI	0. 86	1. 06	1. 2
VII	0. 90	1. 08	1. 2
VIII	0. 48	0. 94	2. 0
Total	0. 70	1. 08	1. 5

Thus, there was an apparent overall increase in total mortality by a factor 1. 54, but the increase for age group III was considerably higher. The two year old fish are still, to some extent being recruited even to the small meshed survey trawl, and, hence do not provide a measure of total mortality. However, the two year olds in 1964 increased in abundance by a factor of 1. 5 during the year, while the two year olds in 1965 decreased

by a factor of 0.82 during the year. Assuming the same recruitment rate for the two years, this provides some indication that the two year old fish may also have been more heavily fished in 1965 than in 1964. The data suggest that a higher proportion of two and three year old fish were taken in the catch in 1965 than is normally taken by a 4 1/2 inch mesh. The proportions of the U.S. landings for the two periods were in fact the same. Unfortunately, the age compositions for a large part of the catch, that of the Soviet Union, is not known.

The data above were based on the 1957 to 1961 year classes. We have also estimated annual mortality coefficients from age frequencies in the U.S. landings for the periods 1958-1964 and 1965-1967 (1952 to 1963 year classes). These estimates were based on estimated numbers of fish landed per days fished by the U.S. otter trawl fleet.

Table 3. Total mortality coefficients for Georges Bank haddock estimated from U.S. fishery statistics.

Age Groups	1958-1964	1965-1967	Factor 65-67/58-64
III-IV	0.51	0.78	1.53
IV-V	0.48	0.99	2.06
V-VI	0.60	0.63	1.05
VI-VII	0.54	1.08	2.00
VII-VIII	0.67	0.99	1.48
Total	0.56	0.89	1.59

Estimated total mortality increased by a factor of 1.59, very nearly the same as obtained above. However, the increase is similiar for all ages, and the mortality coefficients are somewhat less than those obtained from the survey data. A more detailed analysis is underway to elucidate the reasons for the differences. An increase in the efficiency of the U.S. otter trawl fleet because of a reduction in size of the fleet (the best boats surviving) and use of better nets may have taken place over the last few years.

On the basis of the data above, the following mortality rates and fishing rates are probably close to reality for the two periods:

	Pre 1965	1965-66
Z	0.6	1.0
M	0.2	0.2
F	0.4	0.8
$E(\frac{F}{F+M})$	0.67	0.80

The landings increased from 1964 to 1965 by a factor of 2.35, and the days fished by a factor of 2.21.

In terms of equilibrium yield per recruit, this increase in fishing mortality would cause a decrease of 4% if the mean age of first capture (2.5 years) remained the same as before and a decrease of 10% if the average age of first capture was reduced from 2.5 to 2.0 years for half of the catch. In view of the probable heavy fishing on two year olds and possible adverse effects on recruitment, the above is a somewhat conservative statement of possible losses. In any case, the effect on catch per unit effort is quite severe. The current catch rate for the U.S. fleet is the lowest on record, in spite of the recruitment of the best year class on record.

YEAR CLASS ABUNDANCE ESTIMATES

The sudden increase in fishing was stimulated primarily by the recruitment of a larger than normal 1963 year class. Because of the probable heavy fishing on this year class before it became available to the U.S. trawlers, the indices of relative abundance derived from U.S. fishing statistics of landings and effort are somewhat biased. We have, therefore, derived an index of relative abundance of year classes from the Albatross IV survey catches.

Briefly this is the average mean abundance of the given year class in the nine cruises from 1963 to 1966, linearly adjusted to age 1 along a common slope fitted to the abundance at age data. Its main drawback is that different year classes are represented by different age groups. If the decrease in abundance over the years has not been exponential with a common parameter, then some bias would result. The data, however, do not indicate that this has been the case, i.e. the linear fits were good.

The abundance scale-factors relative to that of the 1958-59 year classes are given in Table 4.

Table 4. Relative abundance of recent year classes of Georges Bank haddock (in terms of numbers of fish).

Year Class	Scale Factor
1963	6.2
1962	1.9
1958	1.0
1959	1.0
1956	0.8
1957	0.5
1964	0.4
1960	0.4
1961	0.4

The relationship of this index (which is in $\log_e$ units) to the numbers of fish in age group II and III landed per day of fishing by the U.S. fleet is presented in Figure 1. The straight line was drawn by eye through the points for the 1956 through 1961 year classes, for which there is a satisfactory correlation. The points for the 1962, 1963 and 1964 year classes, particularly the latter two, are strong deviates.

The relationship holds only if the mortality has in fact remained constant, as mentioned above. Thus, the deviations of the 1963 and 1964 points might be expected on the basis of increased mortality demonstrated above. The vertical deviation from the line is one estimate of what the landings per day might have been had not the fishing increased. Thus for the 1963 year class, there might have been landed upwards of 20,000 fish of age group II and III per day of fishing, compared to the 5,000 actually obtained.

FUTURE RECRUITMENT AND MANAGEMENT

Year classes since 1963 have been very small. The 1962 and 1963 year classes, now in their 5th and 6th year of life, respectively have been considerably fished down, and the fishery is totally dependent on them at least until 1971, which is the year the 1968 year class will enter the fishery fully; the earliest hope now for a good year class. The already low catch per unit effort will probably continue downward. In terms of future recruitment to the haddock fishery, we can only hypothesize that the lowered adult densities may, in fact, limit the production for some years to come. A firm relationship between stock density and recruitment has not yet been demonstrated, but it is a question of some import when considering future yields from the fishery.

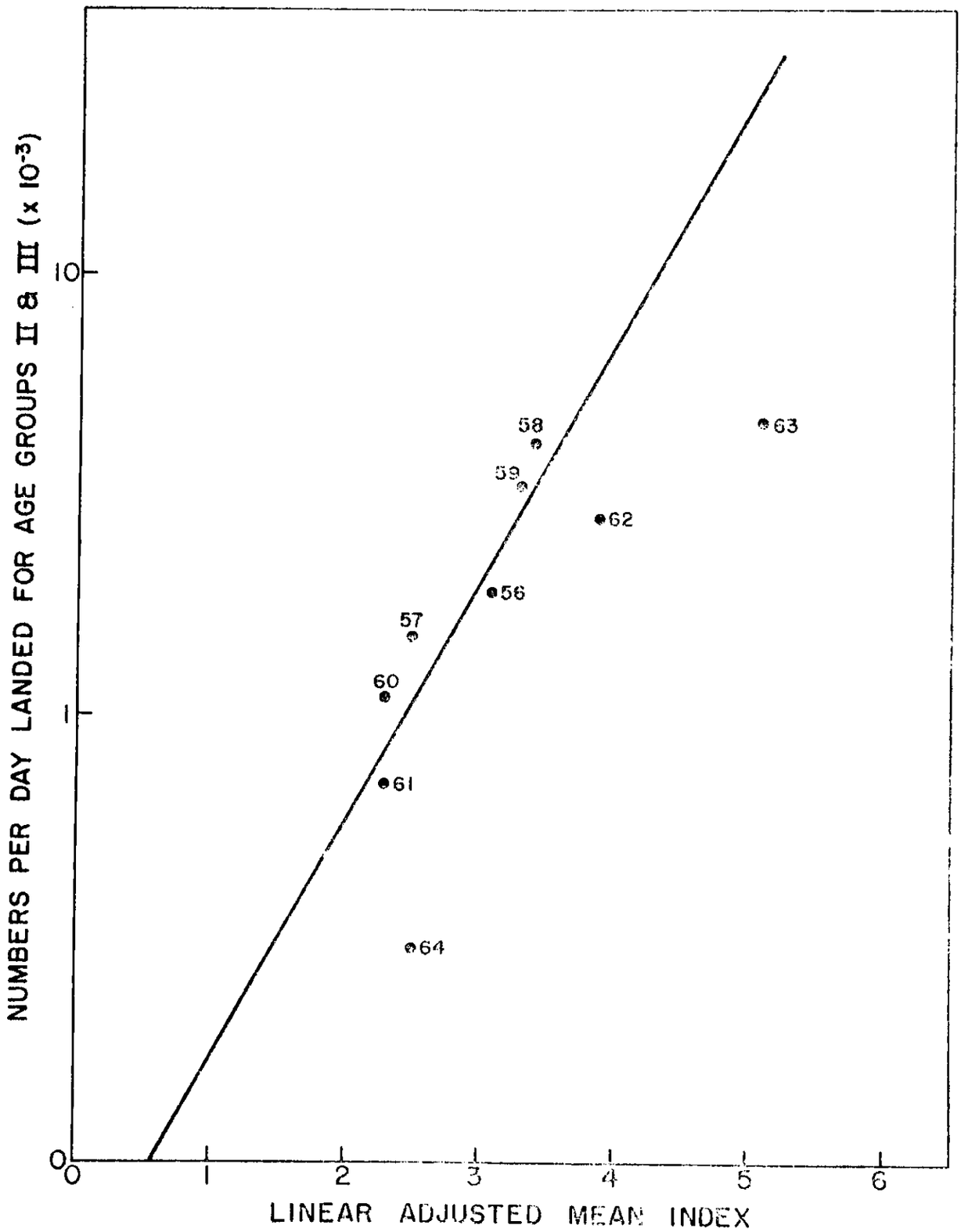

Figure 1. Relationship of year class abundance index (derived from research vessel surveys) to numbers landed per day fished by US otter trawl fleet.