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A CRISIS IN THE HADDOCK FISHERY

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ABSTRACT

The recent development of a market for baby haddock has resulted in a catch of 3,000,000 pounds from the Georges Bank–South Channel fishing grounds during January–February 1941; average size 1 pound, age 2 years. Continuation and growth of this fishery will cause a 40 to 50 percent decline in the yield from this area within the next few years. The decline will result from taking the fish before they have completed their period of rapid growth, and from reducing the spawning stock. Supporting data are presented that show that except for the very high levels of abundance, which have not prevailed since 1928, the average production of young haddock is proportional to the abundance of spawners; and that at present the abundance of spawners is but half that of the most productive level. The baby haddock now being taken would double in weight if left on the banks another year. By application of adequate management practices, which would protect small haddock during their years of rapid growth and thus double the present spawning stock, the threatened decline can be prevented. Furthermore, the annual yield can be increased from the recent 100,000,000-pound average to at least 150,000,000 pounds. Several practical measures are proposed.

A CRISIS IN THE HADDOCK FISHERY[1]

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INTRODUCTION

The productivity of our most valuable North Atlantic fishery is seriously threatened by new developments in fishing practices and markets. This fishery is based on the great, but not unlimited, stocks of haddock found on the fishing grounds off the North Atlantic coast, which in 1940 yielded a catch of nearly 137,000,000 pounds and brought the fishermen an income of about $5,000,000. This income was spread throughout the range of the haddock fishery and ports of landing—from eastern Maine to Fulton Market, New York.

During the winter of 1940–41 there developed within the space of a few months a change in the haddock fishery and markets which, if continued, will reduce greatly the productivity of this resource and adversely affect the welfare of the fisherman, marketman, and consumer.

Informal marketing codes have existed in the fishing industry from the early days. One of these codes established two grades of haddock for the market: (1), Scrod haddock, consisting of 1½- to 2½-pound fish; and (2), large haddock, consisting of all sizes from 2½ pounds up. Since there was no market for small haddock below 1½ pounds (baby or snapper haddock) they were left in the water to benefit from further growth, except for those accidentally taken with the larger fish. On occasions when baby haddock made up a large part of the catch,

[1] A scientific report presenting the detailed data and analyses upon which this paper is based will be published in the near future.

the boats moved on to other localities where the small sizes were not so numerous. Thus, the fish below 1½ pounds received considerable voluntary protection from the fishery.

In the last few years there has been a limited trend toward the marketing of baby haddock, but until recently it did not develop far due to their low market value. During the winter of 1940–41, however, the price for baby haddock increased to a profitable level and some otter trawlers began fishing particularly for them. The marketed catch jumped from a few thousand pounds in November 1940 to nearly 340,000 pounds in December, 1,000,000 pounds in January,

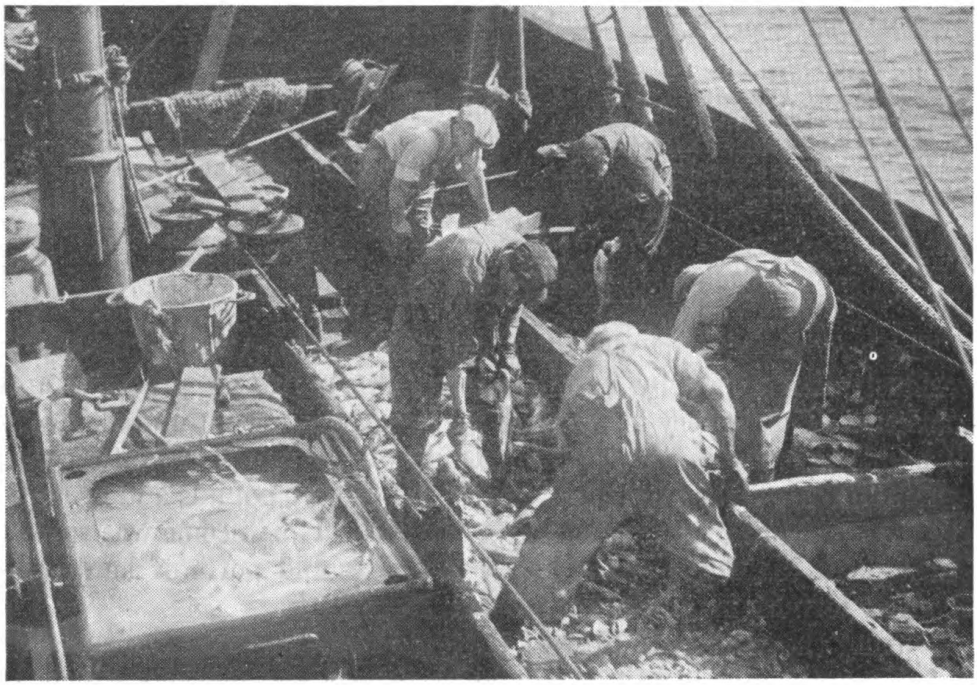

FIGURE 1.—Sorting fish aboard a trawler on Georges Bank is a laborious task, even in the best of weather. Excessive quantities of small haddock increase the labor involved and reduce the value of the catch.

and 2,000,000 pounds in February. Thus, this fishery appears to have initiated a practice which, if continued, must result in the capture of most of the young haddock before they have completed more than a fraction of their normal growth, and as a result the productivity of the fishing grounds will be reduced greatly. Such a practice corresponds to the cattle rancher marketing most of his stock as calves, or the hog farmer selling his stock as quarter-grown shoats. This does not pay the rancher or farmer, even though he must continue to feed his stock. Why, then, should it pay the fisherman, when nature provides the feed?

In order to comprehend fully the harmful effects of the trend toward the catching of smaller haddock, we must understand the prin-

cipal factors controlling the productivity of the haddock fishery. This is available from the extensive research program carried on by the former Bureau of Fisheries and the Fish and Wildlife Service, United States Department of the Interior, during the past 10 years. In this program the fishermen and the fishing industry have cooperated wholeheartedly. Without their help in obtaining the necessary observations and records, these results could not have been secured. The data have been collected and analyzed by the author, assisted at different times by John R. Webster, Henry M. Bearse, Mildred S. Moses, and others. W. P. A. workers assisted in part of the compilation and preliminary analysis. The calculation of the abundance index for years since 1937 was made by Dr. George A. Rounsefell, in conjunction with a general study of groundfish abundance.

CHANGES IN THE HADDOCK CATCH

Of all the haddock grounds, the most productive has been the South Channel-Georges Bank area. This area comprises about 20,000 square miles of fishing ground and has yielded an annual catch that reached a peak of nearly 230,000,000 pounds (gutted weight) in 1929, and then declined to approximately 105,000,000 pounds in 1939 and 93,000,000 pounds in 1940. A record of the annual haddock landings from this area over the past 27 years is shown in figure 2.

The fluctuations in catch shown in figure 2A have been due mainly to two factors: (1), Changes in the amount of fishing; and (2), changes in the abundance of haddock.

The amount of fishing in the South Channel-Georges Bank area has varied a great deal during the 27 years the records cover. From 1914–27 it was relatively low; then increased about five times to a peak in 1930; dropped rapidly to a low level in 1934; and finally increased once more to a relatively high level in 1938–39. In order to show these changes in amount of fishing in an understandable manner, the operations of all forms of gear, including line trawls, draggers, and large otter trawls, have been reduced to a common basis. Thus it is possible to determine the total number of days' fishing it would have taken boats of the *Notre Dame*, *Maine*, and *Ebb* size and type (length about 122 ft. and 500–550 hp.), with the same gear and methods used by these boats in 1932–37 to take the entire catch landed by all kinds and sizes of boats. This is shown in figure 2B as total theoretical number of fishing days. The rapid increase in the amount of fishing from 1928–30 was due to the recommissioning of trawlers built during the World War, construction of new boats, and the more continuous operation of old boats. The rapid decline from 1931–34 was caused by the tying up of many steamers and the diversion of most of the other large trawlers to the Nova Scotian banks. Partial

recovery since 1934 has resulted from the construction of new boats and the return of most of the large trawlers to the South Channel-Georges Bank area because of reduced catches on the Nova Scotian banks.

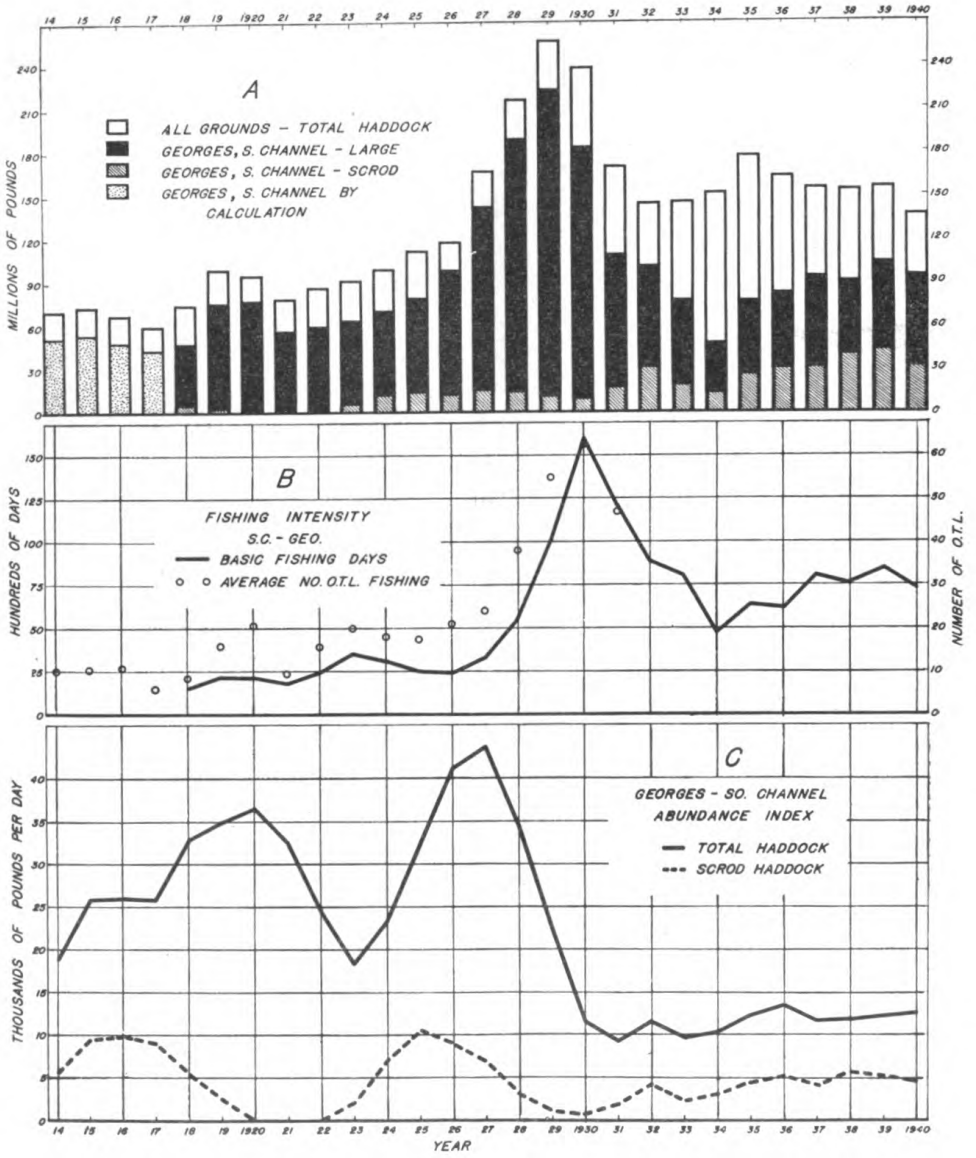

FIGURE 2.—A. The total haddock catch landed in the United States by all types of fishing gear and from all fishing grounds. The 1914–17 Georges Bank-South Channel catch is calculated from the total catch on the basis of the average percent coming from this area during 1918–22. B. The fishing intensity in the Georges Bank-South Channel area shown by basic units of effort and by the average number of large otter trawlers (O. T. L.) in operation, is calculated as described in the text. C. Abundance indices for total haddock and scrod haddock in the Georges Bank-South Channel area. This graph shows the average catch per day that would have been taken each year by boats of the *Notre Dame*, *Maine*, and *Ebb* type and size, using recent methods and equipment.

FLUCTUATIONS IN ABUNDANCE OF HADDOCK

Changes since 1914 in the abundance of haddock are shown as an "abundance index" in figure 2C. The curves represent the average catch per day's fishing by large otter trawlers, after adjusting the catches in the early years for differences between the catching capacity of the boats and gear used at that time and that for modern boats of the *Notre Dame*, *Maine*, and *Ebb* type. The curves are based upon actual performance records of most of the regularly operated large otter trawlers in the fleet, as shown by company records and radio reports for the Bay State and Portland Trawling Co. fleets, Bureau of Fisheries and Fish and Wildlife Service records, Boston Fish Exchange records, installation and operation records from the Radio Corporation of America, Vigneron Dahl Co., and Submarine Signal Co., and data obtained by personal interview from captains or mates for nearly all fishing trips since 1932. The effect of increases in the size and power of the boats, use of wireless, fathometer, Vigneron-Dahl gear, and increase in gear competition has been calculated and adjusted for in this curve. In short, the curve represents the very best measure that can be worked out at present for the relative abundance of haddock over the 27-year period.

From abundance records and data on growth rate and migrations, it is possible to calculate the approximate number of marketable-sized haddock in the South Channel-Georges Bank area. In 1927, the year of maximum abundance, the number was approximately 300,000,000 to 350,000,000 individuals, while in 1931, the year of minimum abundance, it was approximately 65,000,000. If these fish were distributed evenly over the 13,000,000 acres of the bank, they would have averaged about 25 fish per acre in 1927 and about 5 fish per acre in 1931.

The most striking features of the abundance curves shown in figure 2C are the cycles during the 1914–31 period and the continued low level since the latter year. The increases and declines in total haddock are due to changes in scrod abundance, for in each instance increases in total haddock occur in the years following big catches of scrod, while declines in total haddock follow years of small scrod catches. This fact indicates simply that increases in abundance can occur only following years in which large numbers of young were produced, and that following years of poor production of young the total abundance must decline as the result of losses due to natural mortality and the commercial fishery. It should be noted, however, that following 1931 total haddock abundance did not increase materially in spite of the fact that there was a considerable abundance of scrod. The reasons for this failure to respond as in previous instances will be discussed later.

CAUSES OF FLUCTUATIONS IN ABUNDANCE

Since it is evident that the principal fluctuations in the abundance of marketable haddock are due directly to changes in scrod abundance, the problem now resolves into a determination of the factors responsible for variations in the abundance of scrod. The most probable factors have been studied carefully, and it has been found that the most important are the size of the spawning stock and competition between adults and young—presumably competition for food, since haddock are not known to be cannibals. The controlling influence of these factors is shown clearly by the following data.

From extensive biological studies we know that most South Channel-Georges Bank scrod are 3 years old; that is, from 3 up to, but not including, 4 years old. In the fall and winter the scrod catches include considerable numbers of younger haddock which will be 3 years old the following spring, but during the spring and early summer the main part of the scrod catch, except for baby scrod, is made up of 3-year-old haddock; for at that time most 4-year-old fish are included with large haddock, while 2-year-old fish average about 1 pound and until 1941 were not landed in appreciable quantities. Consequently, the abundance of scrod during the spring and early summer constitutes a good measure of the relative numbers of haddock reaching marketable size from the spawning season 3 years earlier.

Studies of the quantities of eggs produced by fish of different sizes have shown that the number is roughly proportional to the weight of the fish. Furthermore, examination of thousands of haddock during the spawning season has shown that most of those of scrod size or larger are mature. Consequently the total number of eggs spawned during any season is approximately proportional to the abundance of marketable haddock during the winter and spring of that year.

The size of the spawning stock and number of young produced from it, measured as described above, has been compared for each of the years covered by the data for 1914–40. The results demonstrate that as the spawning stock increased, the number of young produced also increased until the spawning abundance reached a level corresponding to a yearly average catch per day of 20,000 to 25,000 pounds. With further increases above that abundance level, the production of young declined irregularly. Since this decline in production of young must have been due to competition with the adults as they became very numerous, a second comparison has been made between the abundance of adults during the winter months and the number of young which survived through that winter from the previous spawning season. This comparison disclosed a high

negative relationship, showing that during winters when the adults were most numerous few young haddock survived.

The combined influence of the two factors just mentioned is illustrated by the composite graph in figure 3. The relationship, at medium and low levels of abundance, between the adult haddock during the spawning season and the numbers of young produced from that spawning is shown in the left-hand section of the graph. This

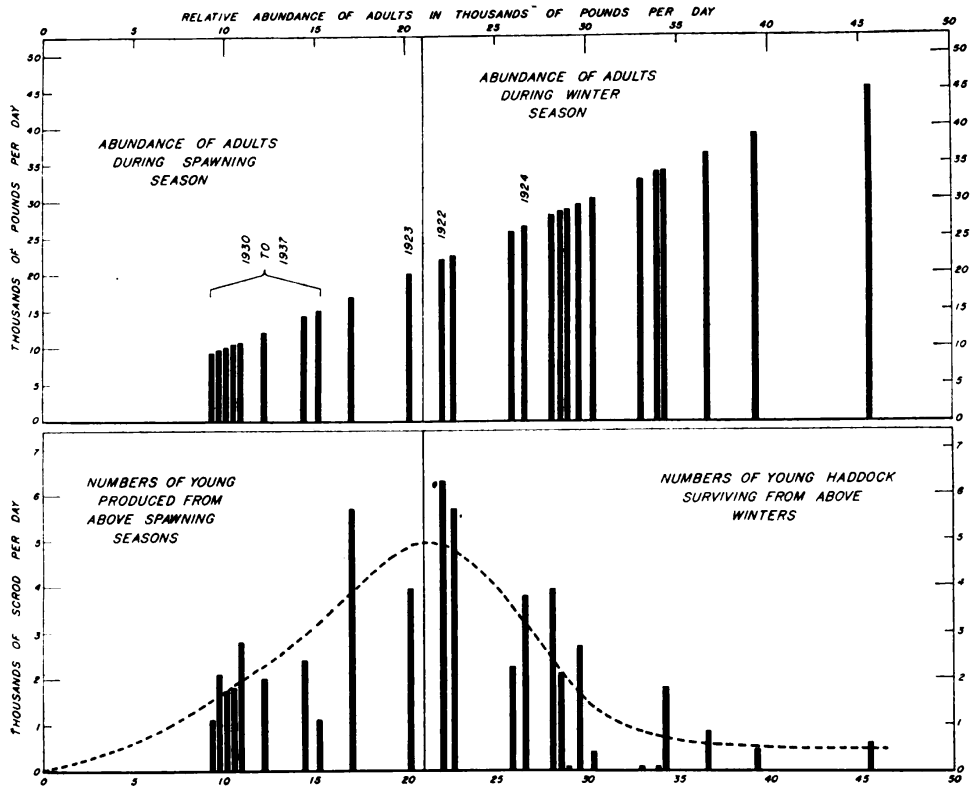

FIGURE 3.—Relationship between the adult stock and the number of young produced. The left-hand portion of the upper graph shows the relative abundance of haddock, in order of magnitude, in different spawning seasons. Directly below each is shown the relative number of young from that spawning. The abundance of adults is given in pounds, since the number of eggs produced is proportional to the weight of the fish. The right-hand portion of the upper graph shows the relative abundance of adult haddock during the winter months. Directly below each is the relative number of young from the preceding spawning season that survived through that winter.

demonstrates that the production of young increases as the spawning stock becomes larger, until an abundance level is reached corresponding to average catches of 20,000 to 25,000 pounds a day.

The relationship at high levels of abundance between the adults during the winter and the numbers of young surviving is shown in the right-hand section of figure 3. When adult haddock were extremely abundant the survival of young was reduced to practically

nothing, apparently due to the fact that when the adults become sufficiently numerous the young cannot compete successfully with them for food.

The degree of competition between adults and young of different ages was studied and was found to be most severe when the young are in their first winter, during which season the adults are most widely dispersed over the fishing grounds. Studies of the distribution of haddock over the bank during the year, based on extensive data from the fishing fleet and research-vessel surveys, show that during years of high abundance the adults overrun the nursery grounds during the winter and spring months, while in years of low abundance they do so only to a limited extent.

On the basis of the above evidence, it is apparent that at low and medium levels of abundance the production of young is controlled principally by the size of the spawning stock; that is, the more spawners, the more young fish. From medium to very high levels of abundance the production of young is controlled principally by the abundance of adults during the winter months; that is, the greater the numbers of adults, the smaller the number of young that survive. Other environmental factors, such as temperature, probably affect spawning success to some extent and undoubtedly account for some of the deviations of the observed values from the smoothed line in figure 3, lower graph.

CAUSES OF LOW ABUNDANCE IN RECENT YEARS

With an understanding of the major factors that control the production and survival of young haddock, the catch records again may be examined to determine the reasons for the continued low abundance and low catch in recent years. This can best be done by reference to specific examples.

In 1925–26 the annual haddock catch from the South Channel-Georges Bank area averaged about 95,000,000 pounds; but, in spite of this heavy drain on the supply, the abundance of haddock on the banks continued to increase rapidly. Since 1931 the total catch in the same area has averaged well below the 1925–26 figure, but notwithstanding this apparently smaller drain on the supply, the haddock stock has not increased in abundance as it did in 1925–26. There are two important reasons for this failure to increase.

First of all, the spawning stock since 1929 has been far below its most productive level (fig. 3). According to the data, the relative abundance of adults during these years has averaged but 12,000 pounds per day. The number of young produced at this low level of abundance has been limited and corresponds to an average catch of less than 1,900 scrod per day. In 1922–24, the years during which

the great numbers of young haddock were spawned which were responsible for the rapidly increasing catches in 1925–26, the abundance of adults averaged over 23,000 pounds per day. This doubling of the spawning stock increased the numbers of young produced to an average of nearly 4,500 scrod per day. Thus, the evidence indicates that the abundance of young in recent years would have been more than doubled if the spawning stock had been built up to a level corresponding to that in 1922–24. That by itself would have greatly increased the annual yield.

The second reason for the continued low abundance is that the fishery now is taking haddock at a much smaller size than in former years. During 1925–28 the fleet landed only 12 percent as much scrod as large haddock, while in 1937–40 it landed nearly 60 percent as much scrod as large. This increase in the proportion of scrod represents the general trend toward capture of smaller haddock. We have no detailed data for 1925–27, but a large series of measurements made in 1928 showed that the average size of haddock landed in that year was about 3.4 pounds. Ten years later, in 1938, the average size was 2.4 pounds.

Extensive age and growth studies made during this investigation show that on Georges Bank 2-year-old haddock, if left on the bank another year, will about double in weight; and similarly, 3-year-old fish will increase in weight by 30 to 40 percent. Since this weight increase is a great deal more than the decrease in numbers through natural death (our data indicate that natural mortality probably is about 10 percent), it follows that when haddock are caught young the number of pounds available to the fishermen is considerably reduced. Taking a specific instance: In 1938, if the approximately 18,000,000 haddock weighing less than 2 pounds had been left in the water until they reached the average size of haddock landed in 1928 they would have provided an additional 15,000,000 to 25,000,000 pounds for the fishermen, and in addition they would have increased the spawning stock in 1939, 1940, and 1941 so that more young would have been produced for future years.

From this evidence it is clear that the failure of the haddock population in the South Channel-Georges Bank area to build up to a more productive level since 1931 is due principally to the following two causes: (1), The fishery is taking smaller fish than formerly, with the result that although the annual catch in pounds of fish since 1931 averaged considerably smaller than the average for 1925–26, the catch in number of fish averaged nearly 35 percent greater than for 1925–26. If the fishery in recent years had been restricted to the larger haddock, a considerably larger poundage would have been available from the same number of fish; and (2), the very intensive fishery in 1929–31 re-

duced the spawning stock to less than one-half of its most productive level. Consequently, even though the fishing intensity on Georges Bank since 1931 has averaged little more than half that in 1929–31, the number of haddock has not increased materially because of the reduced supply of young.

EFFECT OF THE NEW FISHERY FOR BABY HADDOCK

In view of the above evidence, it is clear that the rapidly growing fishery for baby haddock threatens the future productivity of the haddock industry. The increase in landings of baby haddock is illustrated by figure 4, which shows the approximate numbers of haddock of each size landed from the South Channel-Georges Bank area during January and February in 1928, 1938, and 1941. A trend toward smaller fish is shown from 1928–38, but the big change occurs in 1941 when well over 2,000,000 haddock weighing less than 1½ pounds were landed. These fish were but 2 years old, and if left on the fishing grounds they would have doubled in weight in another year.

If this practice is continued it will further reduce the size of haddock from the average of 2.4 pounds in 1938 to perhaps 1.7 pounds or less within the next few years. With the same average number of young produced as during 1932–40, the total annual catch that could be obtained regularly from this area would drop from the present 90,000,000- to 100,000,000-pound level to about 60,000,000 to 70,000,000 pounds, representing a loss to the fishermen of more than $1,000,000 (based on 1940 prices). Furthermore, the data show that the production of young will decrease proportionately if the spawning stock is reduced further by the capture of small, immature haddock. This trend, combined with the lower average size of market fish, must cause the total yield from the South Channel-Georges Bank area to drop considerably below the 60,000,000- to 70,000,000-pound level. The result will be smaller trips, much higher production costs, greatly reduced supplies for the market, fewer and smaller fish for filleting, and fewer jobs for fishermen and shore crews. In addition, the decreased supplies and higher costs will result in loss of markets to other kinds of fish and other foodstuffs.

MEASURES NECESSARY TO MAINTAIN AND IMPROVE FISHING

On the basis of the evidence thus far presented, it is possible to state definitely that under adequate and practical management measures which would protect young haddock until their rapid growth is completed, and which would build up the spawning stock to the most productive level, annual production from the South Channel-Georges Bank area not only can be maintained but can be increased greatly—

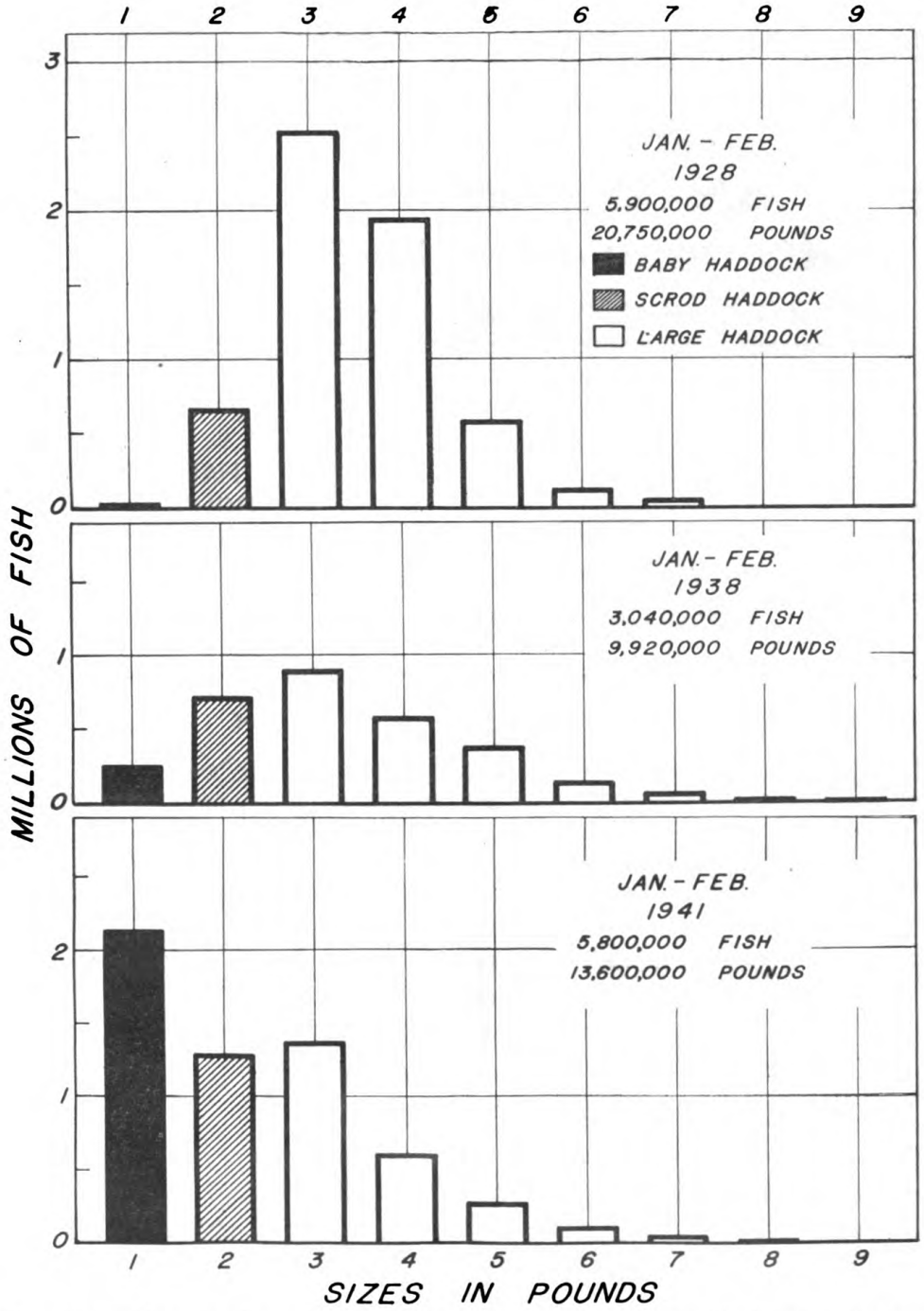

FIGURE 4.—Changes from 1928 to 1941 in the numbers of haddock of each size landed by the fleet during the first 2 months of the year.

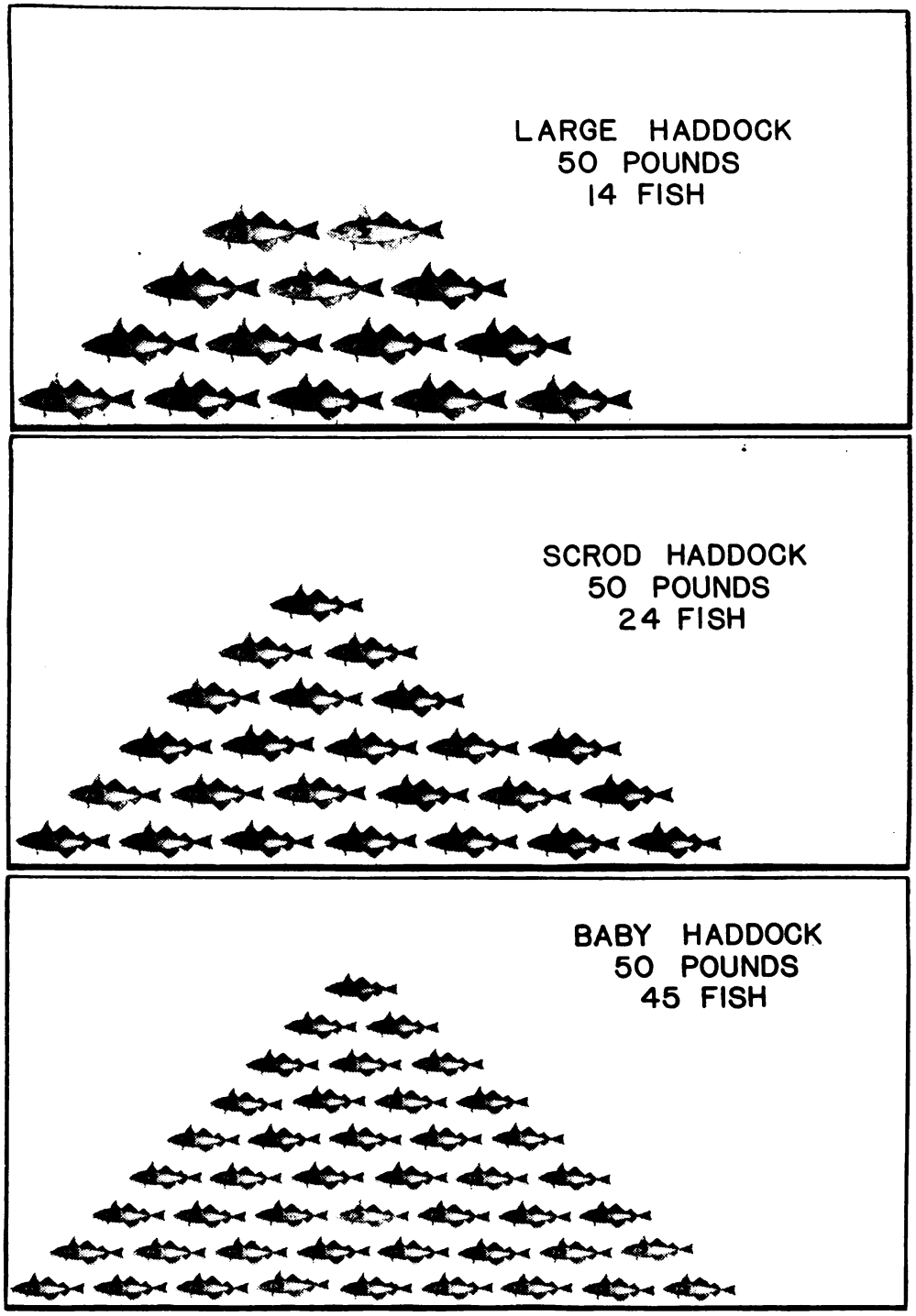

FIGURE 5.—The relative sizes of the haddock shown in the above charts are based on the average sizes of large, scrod, and baby haddock landed on the Boston Fish Pier in January–February 1941. To make up a 100,000-pound trip required 28,000 large, 48,000 scrod, or 90,000 baby haddock. It is easy to see that a catch of small haddock not only reduces the population left in the sea to grow and spawn, but it also requires several times as much labor to handle.

possibly to double its recent level; that is, to nearly 200,000,000 pounds. Certainly it can be increased to 150,000,000 pounds. With such an incentive, the various groups of producers and marketers should find it well worth while to assist in developing and applying practical management measures which will make this goal possible.

Measures which will be of material help in producing the desired results, and are practical to apply, are limited in number. The most promising appear to be: (1) Require all boats fishing for haddock to use a mesh of such size that most of the haddock below 2 pounds will escape.[2] (2) Establish closed areas to protect the principal nursery grounds. (3) Prohibit the sale of haddock below 2 pounds in weight.

On the basis of past experience with measures of this kind, it appears certain that to make them effective they must be backed by Federal legislation or international treaty. For Georges Bank, which during the last 10 or 15 years has been fished only by United States boats, probably Federal legislation would be sufficient. To extend the regulations to the Nova Scotian banks, however, international action might prove desirable; although at the present time the Canadian fleet includes no otter trawlers. The effect of the line-trawl fishery is not important, for as a general rule these boats catch few haddock below 2 pounds.

ALTERNATIVES FACING THE INDUSTRY

The above measures may appear drastic to those accustomed to thinking of the fishing industry in terms of wholly unrestricted operations. When the alternatives are considered, however, it should be obvious that some definite action of the kind suggested must be taken. If the fishery continues its present course without hindrance, and the taking of small haddock continues and increases, the tremendous production of the haddock fishery in the South Channel-Georges Bank area will decrease in both quantity and quality until the annual catch is reduced to less than 50,000,000 to 60,000,000 pounds and is made up principally of scrod haddock and baby haddock—fish weighing less than 2½ pounds each. Such a decrease will occur within the next few years, not 15 or 20 years from now. On the other hand, if adequate remedial measures are adopted in the near future, not only will a drastic decline in the catch be prevented but actually an increase of at least 50 percent will result. This increase represents a difference in yield of 100,000,000 pounds or more, which at 1940 prices would bring the fishermen about $4,000,000. The proposed measures will be of major assistance in achieving this result.

[2] This suggestion will require a mesh with an inside stretched diameter of about 4 inches, after shrinkage; or a diameter of about 5¼ inches between knot centers, new netting.

The entire haddock problem here presented is important primarily to fishermen, fish dealers, processors, and to all boat owners; particularly those with boats whose cruising radius prevents their fishing distant grounds such as Quereau and the Newfoundland Banks. Moreover, in view of the approaching production emergency due to requirements for national defense, any action that will prevent an increase in cost and a decrease in supply of food is bound to be of importance to all consumers of fish.