

Proper

RECOMMENDATIONS AS TO MINIMUM MARKET SIZE

FOR GEORGES BANK HADDOCK AND MINIMUM MESH SIZE

FOR OTTER TRAWLS CATCHING SUCH FISH

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In previous reports (Herrington 1935, 1936, 1941; Walford and Schuck 1947 at Atlantic States Marine Fisheries Commission meeting) it has been concluded that preventing the destruction of baby haddock on the New England banks would result in a substantial increase in the total poundage produced by any year class and would also increase the spawning stock of this fishery. It has also been concluded that a larger mesh size in otter trawls would, in large part, prevent the catching of baby haddock. Inasmuch as otter trawls of a certain size mesh are not perfectly selective, and inasmuch as any mesh size that is likely to be adopted is still capable of taking many baby haddock, at times in large numbers, it has been agreed that a minimum legal size of haddock to be landed be adopted in addition to a minimum mesh size. The minimum mesh size will prevent the catch of most small haddock and the minimum legal size of fish will discourage efforts and remove the incentive to concentrate in places and at times where some baby sared could still be caught in spite of the larger mesh.

The most feasible method of preventing the destruction of baby haddock thus would consist of a two-fold measure:

- a. A strictly enforced legal minimum market size of haddock
- b. The use of larger mesh in all offshore otter trawls, except those fishing for redfish, whiting, and red hake.

To determine a satisfactory combination of minimum mesh size and minimum legal fish size for haddock requires considerable study. The problem appears to be reduced logically to three parts:

- I. What sizes of Georges Bank haddock should be protected?
- II. What mesh size will normally result in a reasonable protection of these sizes?
- III. What sizes should the industry be allowed to land; i.e., what legal size and what amount of tolerance would be most satisfactory?

This subject will be considered according to these three problems.

PART I. WHAT SIZES OF GEORGES BANK HADDOCK SHOULD BE PROTECTED?

In regards to the size to which baby haddock on Georges Bank should be protected, it is possible to compute the benefits, in terms of poundages available and value in dollars to the fishery, of leaving 1-year-old baby scrod on the Bank to the ages of 2, 3, 4, 5, and 6 years. The figures shown in Table I are for revised growth-rate determinations. They assume an initial stock of 50,000,000 1-year-old haddock and a 10 percent natural mortality of haddock annually. The values in dollars are based on the 1945 values to the fishermen at the ports of Boston, Gloucester, Portland, and New Bedford of:

| | | | | | | | | |
|------|-------|---|-------|-------|-------|-------|---------|---------------------------|
| 3.14 | cents | a | pound | for | round | scrod | haddock | (1- and 2-year olds) |
| 7.55 | " | " | " | " | " | " | " | (3-year-olds) |
| 7.91 | " | " | " | large | " | " | " | (4-, 5-, and 6-year olds) |

Table 1.— Data showing the benefits of leaving one-year-old baby scrod haddock on Georges Bank to the ages of two, three, four, five and six years

| Age | Length | Average weight | Quantity of fish | | Value of fish | Annual increase in value |
|--------------|---------------|----------------|------------------|---------------|----------------|--------------------------|
| | | | By number | By weight | | |
| <u>years</u> | <u>inches</u> | <u>pounds</u> | | <u>pounds</u> | <u>dollars</u> | <u>percent</u> |
| 1 | 7.6 | 0.16 | 50,000,000 | 9,500,000 | 298,300 | - |
| 2 | 13.0 | 0.80 | 45,000,000 | 42,300,000 | 1,328,220 | 345 |
| 3 | 16.6 | 1.56 | 40,500,000 | 63,180,000 | 4,631,094 | 249 |
| 4 | 20.2 | 2.66 | 36,450,000 | 96,957,000 | 7,669,299 | 66 |
| 5 | 21.7 | 3.34 | 32,805,000 | 109,568,700 | 8,666,884 | 13 |
| 6 | 23.3 | 4.10 | 29,524,500 | 121,030,450 | 9,375,091 | 10 |

Considering the total and percent increase in value, it can be seen that the protection of baby sored from 1 to 2 years of age may result in an increase of 345 percent; protection from 2 to 3 years of age may result in an increase of 249 percent; and protection from 3 to 4 years of age may result in an increase of 66 percent. There appears to be good reason to protect baby haddock until the end of their third year, but relatively little advantage to protect them until the end of their fourth year.

Although the cull of haddock, as recognized by the New England Fish Exchange, lists sored (the smallest recognized category of haddock) as from 1-1/2 to 2-1/2 pounds (gutted weight), at the present time numbers of baby haddock as small as 1/2 pound are landed.

If 1/2-pound (round weight) baby sored were protected until they had reached a weight of 1.56 pounds (age 3 years), the result would be about 63,180,000 pounds of sored at the value of 7.33 cents a pound, rather than about 24 million pounds of low-priced (3.14 cents a pound) round sored, or an overall increase of about 39,180,000 pounds or about \$3,900,000, an increase of 515 percent in value.

It appears efficient to protect haddock until they have attained an average weight of 1.5 pounds, which corresponds to a length of about 16-1/2 inches or 42 centimeters (fork length). This size is usually attained by the average Georges Bank haddock at the completion of its third year of life, which occurs in the spring (March). Such protection would, in addition to producing a much greater poundage from any year class, result in many more of the year class spawning at least once (most Georges Bank haddock spawn at the end of their third year).

It should be realized that, although the average length of fish at the end of the third year of life is about 14-1/2 inches, many of the fastest growing fish will attain 14-1/2 inches before the completion of the third year, and thus be available. This partial availability of 3-year-olds will also vary between years, as there is some difference in the growth rate to the end of the third year in different years.

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By **HOWARD A. SCHOOK**

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**PART II. WHAT MESH SIZE WILL NORMALLY RESULT IN A REASONABLE
PROTECTION OF THESE SIZES?**

The second main problem is to decide what mesh size will best serve to protect the majority of haddock of 1-1/2 pounds (gutted weight) and under and still capture most of the haddock 1-1/2 pounds and larger.

If the selection of various sized fish by mesh of various sizes in otter trawls were sufficiently precise, then it would be possible to select the mesh size that would release 100 percent of all fish less than 1-1/2 pounds and retain 100 percent of all fish of 1-1/2 pounds and larger. Unfortunately, net selection is not as precise as this, i.e., the mesh size which will release 100 percent of all fish below 1-1/2 pounds will also release a considerable number of fish of 1-1/2 pounds and larger; and a mesh size that will retain 100 percent of all 1-1/2 pound fish will capture a considerable number of under-sized fish, also. (1-1/2 pound haddock average 42 centimeters or 16-1/2 inches in length).

There are some data available on the effect of various sizes of mesh in cod-ends of otter trawls upon the size of fish captured or released (Herrington 1935). The rest of this part consists of a study and summary of data presented in this publication.

The available data were confounded by several factors such as differences between measurements of new and used mesh, and between measurements representing inside knots and between knot centers. Corrections were made for these factors and all measurements of mesh size, where possible, were expressed in terms of inside knots after use. The effect of the various mesh sizes on the size of fish captured (of those entering the net) was expressed as follows:

X = stretched mesh inside knots after use, in inches

Q_1 = the size of fish in centimeters of which 25 percent of those entering the net are retained

M_{50} = " " " " 50 " "
 Q_3 = " " " " 75 " "

The tabulation of these original data is as follows:

| Mesh size | Q_1 | M_{50} | Q_3 |
|-----------|----------|----------|----------|
| 1.5 In. | 13.2 cm. | 14.7 cm. | 16.3 cm. |
| 2.0 | 15.3 | 15.3 | 16.8 |
| 2.3 | 17.3 | 19.1 | 20.4 |
| 2.8 | 18.7 | 20.8 | 22.3 |
| 2.5 | 21.5 | 23.7 | 26.0 |
| 2.0 | 23.1 | 25.0 | 26.7 |
| 3.0 | 25.0 | 26.9 | 29.0 |
| 3.8 | 33.7 | 38.4 | 41.6 |
| 4.1 | 38.8 | 42.6 | 46.6 |
| 4.1 | 39.0 | 41.6 | 44.1 |
| 4.7 | 39.0 | 43.0 | 48.0 |
| 4.1 | 38.7 | 42.3 | 45.8 |
| 3.9 | 38.7 | 42.0 | 46.0 |

For the purposes of estimating, for any mesh size, the sizes of fish that would be captured or released, regression lines for the relationship between

(X) and Q_1 , between

" " Min, and between

" " Q_3

were computed by the method of least squares. The resultant equations are as follows:

$$Q_1 = -2.88 + 9.62X$$

$$\text{Min} = -2.69 + 10.55X$$

$$Q_3 = -3.22 + 11.55X$$

Solving for a wide range of mesh sizes (X), that appear to be usable from the viewpoint of conserving small haddock, i.e., meshes of 3-3/4, 3-7/8, 4, 4-1/8, 4-1/4, 4-5/8, 4-1/2, 4-5/8, 4-3/4, and 4-7/8 inches, the following values are obtained:

| Mesh size X | Q_1 | Min | Q_3 |
|-----------------|-------|------|-------|
| 3-3/4" or 3.75" | 33.9 | 36.9 | 40.1 |
| 3-7/8 " 3.88 | 35.2 | 38.2 | 41.6 |
| 4 " 4.00 | 36.3 | 39.5 | 43.0 |
| 4-1/8 " 4.13 | 37.5 | 40.9 | 44.5 |
| 4-1/4 " 4.25 | 38.7 | 42.2 | 45.9 |
| 4-5/8 " 4.38 | 39.9 | 43.5 | 47.4 |
| 4-1/2 " 4.50 | 41.2 | 44.8 | 48.8 |
| 4-5/8 " 4.63 | 42.3 | 46.2 | 50.3 |
| 4-3/4 " 4.75 | 43.5 | 47.4 | 51.6 |
| 4-7/8 " 4.88 | 44.8 | 48.8 | 53.2 |

With Q_1 , Mdn , and Q_3 , it is possible, knowing the general shape of the selection curves, to estimate the complete selection curve for any given mesh size, i.e., the percent of fish of any particular size entering the net that are captured. Thus, for the 4-5/8-inch mesh, in addition to the value of 25 percent capture for 42.3 cm. fish, 50 percent for fish of 46.2 cm., and 75 percent for fish of 50.3 cm., about 5 percent of fish of 36 cm., 10 percent of 39 cm. fish, and 15 percent of 40 cm. fish would be captured.

Considering only the meshes of 4-1/2, 4-5/8, and 4-3/4 inches, it is estimated that approximately the following sizes of fish would be captured (percent of fish of that size that enter the net).

| Percent caught | Mesh size | | |
|----------------|-----------|--------|--------|
| | 4-1/2" | 4-5/8" | 4-3/4" |
| 0 | 35 cm. | 36 cm. | 37 cm. |
| 5 | 37 | 38 | 39 |
| 10 | 38 | 39 | 40 |
| 15 | 39 | 40 | 42 |
| 20 | 40 | 42 | 43 |
| 25 | 41 | 42 | 44 |
| 30 | 42 | 43 | 44 |
| 40 | 43 | 45 | 46 |
| 50 | 45 | 46 | 47 |
| 60 | 47 | 48 | 49 |
| 70 | 48 | 50 | 51 |
| 80 | 49 | 51 | 52 |
| 90 | 51 | 52 | 53 |
| 100 | 54 | 55 | 57 |

In Part I it was concluded that most fish below 42 centimeters (age 3 years) should be protected. Although a good rate of growth to the end of the 4th year also exists, it does not seem desirable to protect them to this late age due to the fact that the fishing intensity is not high enough to ensure that all fish would be caught at that age. More accurate data on the effect of the Georges Bank fishery on the rate of removals of haddock will be available shortly, but at this time it appears unlikely that too many fish over 3 years old should be protected.

With the present state of knowledge, a minimum stretched mesh inside knots (after use rather than as purchased or constructed) of $4\text{-}\frac{5}{8}$ inches is thought to represent a reasonable compromise, although either $4\text{-}\frac{1}{2}$ or $4\text{-}\frac{3}{4}$ inches would also accomplish somewhat similar results. The great majority of fish under 42 cm. (85 percent of the 40 cm., 90 percent of the 39 cm., and 95 percent of the 38 cm. fish) should be released through a $4\text{-}\frac{5}{8}$ -inch mesh under average trawling conditions, and on the other hand not too excessive numbers of large fish should be released with this mesh. About 30 percent of the 43 cm. fish, 50 percent of the 46 cm. fish, 70 percent of the 50 cm. fish, and 90 percent of the 52 cm. fish that enter the net should on the average be retained. Thus, only occasionally will fish over 4 years be released.

It should be borne in mind that considerable variations from these values may be experienced due to various conditions.

This measurement represents a minimum mesh "as fished" and not "as constructed" or "as purchased". In general, the netting purchased will have to be larger than $4\text{-}\frac{5}{8}$ inches. The exact size "as purchased" is variable, due to variation in size of twine, type of twine, original tightness of the knots, etc.

More study would be desirable on the amount of shrinkage of variously constructed mesh and cod ends in order to advise the industry what should be bought in order to conform with the minimum of 4-5/8 inches, but from Harrington there are some data on shrinkage from new to used mesh. The average shrinkage for 4-5-inch mesh new 3-thread 1100 and 1200 twine double was 0.5 inches; that for 4-3/4-inch 4-thread 750 twine single was 0.3 inches; that for 5-inch 4-thread 750 and 900 twine double was over 0.6 inches.

The minimum mesh is also "inside knots" and not "between knot centers". Limited data on used nets indicate that "between knot centers" averaged larger than "inside knots" about the following amounts:

| | |
|--|-------------|
| For 3 and 4-thread, 1100 and 1200 twine double - | 0.57 inches |
| 4-thread 750 twine single | - 0.56 " |
| 4-thread 750 twine double | - 0.78 " |

The use of double or single twine would be permitted. The minimum mesh would be for the complete trawl with the exception of the lower belly, cod-end belly, and 3 feet of the rear end of the cod-end top, in which parts regular mesh as small as 3-1/4 inches could be used. The use of large mesh in these parts was found by Harrington to result in too many tear-ups. The large mesh on top of the cod end is adequate for the release of the fish.

PART III. WHAT SIZES OF HADDOCK SHOULD IT BE LEGAL TO LAND?

1. If a minimum mesh size of $4\frac{5}{8}$ inches were in use, some haddock smaller than $16\frac{1}{2}$ inches would still be taken, due to the fact that the size of mesh in trawls is not perfectly selective as to size of fish released.

2. The small percentage of small haddock that would be caught in normal operation could be greatly increased by definite efforts of fishermen to do so. Some of them probably would make such efforts, if a market was available for the sale of small haddock, as it is at present.

3. A minimum market size is thus necessary to remove the market for such sized fish, and the incentive to catch them.

4. It is felt that the market size should be such that almost all of the small haddock that would normally be caught with no special efforts in that direction should be utilized. All data at present indicate that fish brought onto the deck do not survive if released. Thus, to utilize any small normally caught haddock it should be legal to land them.

5. If the minimum market size were set at $16\frac{1}{2}$ inches, some tolerance would have to be allowed, i.e., it should be permissible to land a certain number of fish under $16\frac{1}{2}$ inches, probably a proportion of the total number in the catch.

6. Unfortunately, the abundance of young haddock fluctuates considerably. Thus, the proportion of these young fish to the total catch also varies. Assuming a legal length of $16\frac{1}{2}$ inches, Harrington's studies showed that in the large-meshed trawls he used, about 9.3 percent of the total catch by numbers were under this size. If we assume this is a normal average, then in a net of $4\frac{5}{8}$ inches inside knots in use (slightly larger than Harrington's nets), a reasonable tolerance for haddock below 42 centimeters would be about 5 percent of the total number of haddock caught.

Slightly different legal lengths and amounts of tolerance might be more suitable. Any regulations that are adopted concerning minimum market size, and also minimum mesh size, should however allow for modifications after observations are made as to how the regulations are working, to ensure that full advantage is taken of trends of the fishery, such as abundance or scarcity of young, varying growth rates; and changes in the mode of fishing, net construction, etc.

For actual recommendations it is probably more precise to specify the minimum legal length rather than the minimum legal weight, inasmuch as the gutted weight can be made to vary considerably through various degrees of gutting completeness. It is therefore recommended that at least 95 percent of the catches of haddock be over 16-1/2 inches fork length. Fork length is the length of the fish from the tip of the snout to the center of the fork of the tail.

General considerations

Although we have no data as to whether these regulations would be a conservation measure for Nova Scotian haddock or not, it might be necessary, in order to simplify enforcement, to include haddock caught on these banks, as well as on Georges, under the regulations.

Exactly how to regulate catches of small trawlers and trawlers fishing part time for redfish, whiting, and red hake, is a subject which also will require some study.

July 8, 1947

BIOMETRICS OF NEW ENGLAND HADDOCK, 1931-1946

PART I. Size composition of the total catch

1. Introduction. Values and general characteristics of the population; need for study.
2. The total poundage and numbers of haddock caught in each of four seasons of each of the sixteen years.
3. Trend of the average size through the seasons and years.
4. Size composition of the total catch.

PART II. Age composition of the total catch

Age reading from scales.

Total catch reduced to ages.

Contribution of each age group by seasons, years, to the catch.

Growth rates, seasonal and yearly.

Abundance of each age group in terms of catch-per-day.

Total mortality rates.

PART III. Recruitment of New England Haddock

Indices of the relative strength and recruitment of all year classes.

Evaluation of the effect of various factors on recruitment of young.

Possibilities of controlling certain factors to obtain maximum recruitments in the future.

Necessary or desirable management measures.

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A SUMMARY OF SOME BIOLOGICAL DATA ON
MAJOR SPECIES OF FISH OTHER THAN HADDOCK
CAUGHT IN OTTER TRAWLS ON GEORGES BANK

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Of the species other than haddock that are taken in otter trawls on Georges Bank, there are several that may be considered as of major importance and others of lesser importance. The total 4-port (Boston, Gloucester, New Bedford, Portland) landings in 1945 for various species, taken in large and medium sized otter trawlers on Georges Bank were as follows:

| Species | Landings in pounds | Percent of total of all species |
|-----------|--------------------|---------------------------------|
| Haddock | 62,794,693 | 55.4 |
| Cod | 17,123,881 | 15.1 |
| Rosefish | 13,435,593 | 11.8 |
| Flounders | 11,547,098 | 10.2 |
| Pollock | 4,786,331 | 4.2 |
| Hake | 1,999,898 | 1.8 |
| Whiting | 639,926 | 0.6 |

In regard to possible recommendations of desirable minimum legal sizes for species other than haddock of fish caught in numbers in large-meshed otter trawlers on Georges Bank, the important species are principally cod, pollock, and hake, and possibly yellowtail flounder.

Published biological data on these species are limited. Following the meeting of the Atlantic States Marine Fisheries Commission on May 2, 1947, we began to assemble what little published or unpublished data were available and to obtain original observations on growth rate and length-weight where it was lacking, and where it was feasible.

Growth

In regard to growth, published material that was found consisted of some data by Newfoundland, Canadian, and American workers on cod, hake, and pollock in North American waters. Growth rate of the yellowtail flounder on Georges Bank was furnished by the Flounder Investigation of the U.S. Fish and Wildlife Service (Royce and Buller). Data supplementing the published data on cod and pollock were obtained by the Haddock Investigation and Mr. Arnold, by the collection of scales of these species at the Boston Fish Pier and their reading. Due to the difficulties of reading hake scales, no time was spent on the growth of this species at this time.

Length weight

Yellowtail data were supplied by the Flounder Investigation, and data for cod, pollock, hake, were obtained by the Haddock Investigation at the Boston Fish Pier.

Abundance

At present there are some data on the catch per day of cod and hake for Boston trawlers, which fish principally for haddock. The limitations of these data as indicative of abundance of secondary species such as cod and hake must thus be realized. The average yearly figures on catch per day in pounds in these species for the years 1932 to 1946 for Georges Bank medium depth have been computed to be as follows:

| Year | Cod | Hake |
|------|------|------|
| 1932 | 5399 | 118 |
| 1933 | 5433 | 130 |
| 1934 | 4612 | 128 |
| 1935 | 5158 | 94 |
| 1936 | 6670 | 159 |
| 1937 | 6629 | 203 |
| 1938 | 3008 | 146 |
| 1939 | 3702 | 156 |
| 1940 | 5236 | 80 |
| 1941 | 4959 | 92 |
| 1942 | 4976 | 122 |
| 1943 | 3770 | 150 |
| 1944 | 5732 | 117 |
| 1945 | 6360 | 141 |
| 1946 | 4921 | 158 |

The information for determining the size to which each of these species should be protected by the establishment of minimum size limits might be considered to be data on growth rate and the age at maturity. Utilizing what limited data were available at the time of writing, the analysis consisted of a similar system as with the haddock, i.e., the tabulation of the average size and average weight at various ages and, assuming a 10 percent natural mortality, the calculation of the poundages and value resulting. The 10 percent natural mortality was used for the lack of a better figure, but is probably too high in the case of cod, possibly too high for pollock. Values of the stock were computed in terms of the prices paid to fishermen in 1945 at Boston, Gloucester, New Bedford, and Portland. These data are shown in the following tables:

- | | | | | |
|---------------|---|------------------|---|-----------|
| 1. Pollock | - | Bay of Fundy | - | Canadians |
| 2. Pollock | - | Georges Bank | - | USFWS |
| 3. Cod | - | Bay of Fundy | - | Canadians |
| 4. Cod | - | Georges Area | - | Schroeder |
| 5. Cod | - | Georges & Browns | - | USFWS |
| 5a. Cod | - | Newfoundland | - | Thompson |
| 6. Hake | - | Bay of Fundy | - | Canadians |
| 7. Yellowtail | - | Georges | - | USFWS |

FullockTable 1. Fullock (Centr. Can. Biol.), 1927-1928Bay of Fundy

| Age | Average length in inches | Average weight in pounds | Stock on hand in numbers | Total weight in pounds | Average value in cents | Total value in dollars | Value increase in dollars | Percent yearly increase |
|-----|--------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|---------------------------|-------------------------|
| 1 | 5.9 | .11 | 50,000,000 | 5,500,000 | 5.58 | 306,900 | - | - |
| 2 | 12.4 | .76 | 45,000,000 | 34,200,000 | 5.58 | 1,908,360 | 1,601,460 | 521.8 |
| 3 | - | - | - | - | - | - | - | - |
| 4 | 22.6 | 3.7 | 36,450,000 | 134,865,000 | 5.58 | 7,525,467 | 5,627,207 | 294.3 |
| 5 | 24.9 | 4.8 | 32,805,000 | 157,464,000 | 5.58 | 8,786,491 | 1,261,024 | 16.8 |
| 6 | 26.8 | 5.9 | 29,524,500 | 174,134,550 | 5.58 | 9,720,056 | 933,565 | 10.6 |

Table 2. Fullock - U. S. F. W. B. Age AnalysisGeorges Bank

| Age | No. aged | Average length in inches | Average weight in pounds | Stock on hand in numbers | Total weight in pounds | Average value in cents | Total value in dollars | Value increase in dollars | Percent yearly increase |
|-----|----------|--------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|---------------------------|-------------------------|
| 1 | 102 | 6.7 | .15 | 50,000,000 | 7,500,000 | 5.58 | 418,900 | - | - |
| 2 | 83 | 12.2 | .72 | 45,000,000 | 32,400,000 | 5.58 | 1,807,920 | 1,389,420 | 332.0 |
| 3 | 83 | 17.0 | 1.7 | 40,500,000 | 68,850,000 | 5.58 | 3,841,830 | 2,033,910 | 112.5 |
| 4 | 68 | 21.2 | 3.2 | 36,450,000 | 116,640,000 | 5.58 | 6,508,512 | 2,666,682 | 69.4 |
| 5 | 53 | 24.7 | 4.8 | 32,805,000 | 157,464,000 | 5.58 | 8,786,491 | 2,277,979 | 35.0 |
| 6 | 34 | 27.9 | 6.7 | 29,524,500 | 177,814,150 | 5.58 | 11,038,030 | 2,251,539 | 25.6 |
| 7 | 14 | 30.3 | 8.3 | 26,972,050 | 220,548,015 | 5.58 | 12,306,979 | 1,268,549 | 11.5 |
| | 439 | | | | | | | | |

Growth rate

The growth of the Georges Bank pollock, table 2, while not more rapid than haddock during the early years of life, maintains itself longer than does haddock with the result that the total poundage and total value of the resource does not fall off as much as haddock in the later years of life. On this basis, it would appear possible that pollock should be protected to a somewhat larger average size and older age than haddock.

No information was found on the age at maturity.

Present market size (N.E. Fish Exchange)

Based 1-1/2 to 4 pounds. Very few fish less than 1-1/2 pounds are marketed.

Cod

Table 3. Cod - Woodhouse (Centr. Can. Biol.), 1914-1915

Bay of Fundy

| Age | Average length in inches | Average weight in pounds | Stock on hand in numbers | Total weight in pounds | Average value in cents | Total value in dollars | Value increase in dollars | Percent yearly increase |
|-----|--------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|---------------------------|-------------------------|
| 1 | 5.7 | .06 | 50,000,000 | 3,000,000 | 6.10 | 183,000 | - | - |
| 2 | 14.1 | .90 | 45,000,000 | 40,500,000 | 6.10 | 2,470,500 | 2,287,500 | 1250.0 |
| 3 | 19.6 | 2.3 | 40,500,000 | 93,150,000 | 6.10 | 5,682,150 | 3,211,650 | 130.0 |
| 4 | 25.6 | 5.0 | 36,450,000 | 182,250,000 | 6.93 | 12,629,925 | 6,947,775 | 122.3 |
| 5 | 32.3 | 9.8 | 32,805,000 | 321,489,000 | 6.93 | 22,879,188 | 9,649,263 | 76.4 |
| 6 | 35.4 | 13.0 | 29,524,500 | 383,818,500 | 7.44 | 28,536,096 | 6,276,908 | 28.2 |
| 7 | 39.0 | 17.7 | 26,372,050 | 470,323,285 | 7.44 | 34,992,202 | 6,436,105 | 22.5 |

Table 4. Cod - Selroeder

Georges Area

| Age | Average length in inches | Average weight in pounds | Stock on hand in numbers | Total weight in pounds | Average value in cents | Total value in dollars | Value increase in dollars | Percent yearly increase |
|-----|--------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|---------------------------|-------------------------|
| 1 | 6.7 | .10 | 90,000,000 | 5,000,000 | 6.10 | 305,000 | - | - |
| 2 | 13.1 | 1.06 | 45,000,000 | 47,700,000 | 6.10 | 2,909,700 | 2,604,700 | 834.0 |
| 3 | 20.8 | 2.66 | 40,300,000 | 107,730,000 | 6.10 | 6,971,530 | 3,661,830 | 125.8 |
| 4 | 24.8 | 4.6 | 36,450,000 | 167,670,000 | 6.93 | 11,619,531 | 5,048,001 | 76.8 |
| 5 | 27.7 | 6.3 | 32,805,000 | 206,671,500 | 6.93 | 14,322,335 | 2,702,804 | 23.3 |
| 6 | 31.1 | 9.0 | 29,324,500 | 265,720,500 | 6.93 | 18,414,431 | 4,092,096 | 28.6 |
| 7 | 33.6 | 10.9 | 26,972,030 | 289,635,345 | 7.44 | 21,948,870 | 3,134,439 | 17.0 |
| 8 | 36.1 | 13.5 | 23,914,836 | 321,830,286 | 7.44 | 24,020,061 | 2,471,191 | 11.5 |

Table 5. Cod - U. S. Y. W. B. Age Analysis, 1935

Brown and Georges

| Age | No. aged | Average length in inches | Average weight in pounds | Stock on hand in numbers | Total weight in pounds | Average value in cents | Total value in dollars | Value increase in dollars | Percent yearly increase |
|-----|----------|--------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|---------------------------|-------------------------|
| 1 | 259 | 5.4 | .05 | 90,000,000 | 2,500,000 | 6.10 | 152,500 | - | - |
| 2 | 132 | 13.5 | .72 | 45,000,000 | 32,400,000 | 6.10 | 1,976,400 | 1,823,900 | 1196.0 |
| 3 | 94 | 18.9 | 2.10 | 40,300,000 | 85,030,000 | 6.10 | 5,188,030 | 3,211,630 | 162.5 |
| 4 | 24 | 23.1 | 3.75 | 36,450,000 | 136,687,500 | 6.93 | 9,472,444 | 4,284,394 | 82.6 |
| 5 | 7 | 27.8 | 6.50 | 32,805,000 | 213,232,500 | 6.93 | 14,777,012 | 5,304,568 | 56.0 |
| | 479 | | | | | | | | |

Growth rate

Studies made in the Cambridge office showed the growth rate of Browns and Georges Bank to be very similar. It seems to indicate a more complete mixing of the fish between Georges and the Nova Scotian Banks than is the case for haddock, which show a definite difference in growth rate between Georges and the Nova Scotian banks. The data for these two banks were thus combined. These data, up to the age of 5 years, show no signs of a diminished growth rate in older fish and the data in table 4 (Schroeder- Georges Area) and table 5a (Newfoundland) bears up the conclusion that the cod is a relatively long-lived and steadily growing fish.

In this light it appears desirable that cod should, in order to obtain a nearly maximum poundage and value, be protected for a considerably longer span of years than haddock.

Table 5a. Cod - Browns

Newfoundland

| Age | Average length in inches | Average weight in pounds |
|-----|--------------------------|--------------------------|
| 3 | 10.2 | .33 |
| 4 | 14.5 | .92 |
| 5 | 17.5 | 1.62 |
| 6 | 20.5 | 2.4 |
| 7 | 23.6 | 3.9 |
| 8 | 26.2 | 5.6 |
| 9 | 28.5 | 6.7 |
| 10 | 31.5 | 9.0 |
| 11 | 34.6 | 12.2 |
| 12 | 38.1 | 15.9 |
| 13 | 40.6 | 19.0 |
| 14 | 42.9 | 22.9 |

The only data that was found on the age of maturity of North American cod is that for the Newfoundland Banks (Thompson) and is as follows:

| <u>Age</u> | <u>Percent mature</u> |
|------------|-----------------------|
| 4 | 2 |
| 5 | 8 |
| 6 | 30 |
| 7 | 52 |
| 8 | 74 |
| 9 | 77 |
| 10 | 99 |
| 11 | 100 |

In contrast to haddock, most of which are mature on Georges at the end of 3 years, it is apparent that cod are much later maturing.

Present market size (N.E. Fish Exchange)

Sized 1-1/2 to 2-1/2 pounds. Very few fish less than 1-1/2 pounds are marketed.

Hake

Table 6. Hake-Squirrel - Greig, 1916

(3-year olds)

| <u>Age</u> | <u>No. aged</u> | <u>Average length in inches</u> | <u>Average weight in pounds</u> | <u>Stock on hand in numbers</u> | <u>Total weight in pounds</u> | <u>Average value in cents</u> | <u>Total value in dollars</u> | <u>Value increase in dollars</u> | <u>Percent yearly increase</u> |
|------------|-----------------|---------------------------------|---------------------------------|---------------------------------|-------------------------------|-------------------------------|-------------------------------|----------------------------------|--------------------------------|
| 1 | 7 | 8.1 | .21 | 50,000,000 | 10,500,000 | 5.37 | 563,850 | - | - |
| 2 | 7 | 13.5 | .90 | 45,000,000 | 40,500,000 | 5.37 | 2,174,850 | 1,611,000 | 285.7 |
| 3 | 7 | 17.2 | 1.80 | 40,500,000 | 72,900,000 | 5.37 | 3,914,730 | 1,739,880 | 80.0 |
| <u>Σ</u> | | | | | | | | | |

The very limited data available on growth rate do not indicate a diminishing growth rate up to the completion of the 3rd year.

No data on age at maturity found.

Present market size (N. E. Fish Exchange)

Snappers 1-1/2 pounds.

Yellowtail

Table 7. Yellowtail - U. S. E. N.S. Age Analysis

XIII 9

| AGE | No. aged | Average length in inches | Average weight in pounds | Stock on hand in numbers | Total weight in weight | Average value in cents | Total value in dollars | Value increase in dollars | Percent yearly increase |
|-----|----------|--------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|---------------------------|-------------------------|
| 1 | ? | 1.29 | .0002 | 50,000,000 | 10,000 | 5.69 | 569 | - | - |
| 2 | ? | 11.74 | .50 | 45,000,000 | 22,500,000 | 5.69 | 1,280,250 | 1,279,681 | 2150.0 |
| 3 | ? | 13.39 | .80 | 40,500,000 | 32,400,000 | 5.69 | 1,843,560 | 563,310 | 44.0 |
| 4 | ? | 14.79 | 1.10 | 36,450,000 | 40,095,000 | 5.69 | 2,281,405 | 437,845 | 23.7 |
| 5 | ? | 16.08 | 1.45 | 32,805,000 | 47,567,250 | 5.69 | 2,706,377 | 425,172 | 18.6 |
| 6 | ? | 19.67 | 2.00 | 29,524,500 | 59,049,000 | 5.69 | 3,359,880 | 653,511 | 24.1 |
| 715 | | | | | | | | | |

Growth data indicate an extremely low size at the age of 1 year followed by rather uniform increments in the following years.

Present market size (N.E. Fish Exchange)

1 pound. At present many fish as small as 1/2 pound are landed.