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ANNUAL MEETING - JUNE 1958

Meeting of Scientific Advisers to Panels 4 and 5

Quebec City, Canada, December 3-5, 1957.

1. Introduction

Canadian and United States scientists held a meeting in Quebec, Canada, on December 3-5, 1957, to review results of research and to recommend future work in ICNAF Subareas 4 and 5. European scientists concerned with Subarea 4 were unable to attend. Marine scientists from the Province of Quebec were hosts and active participants in the meeting. The ICNAF Secretariat participated in the meeting. A list of the participants is attached as Appendix I. Dr. Hart was appointed Chairman, and Dr. Martin and Mr. Eckles were appointed as Rapporteurs.

Several informal papers were presented as bases for discussion. The substance of these is incorporated into the body of this report. Three committees were appointed to consider (1) effects of mesh regulation, (2) scallop research, and (3) trap and hook selection. The reports of these committees, as amended and approved by the meeting, are attached as Appendices II to IV.

2. Effects of Mesh Regulation

Studies of the effects of mesh regulation on important haddock and cod stocks in the two subareas showed that discards of fish at sea have been greatly reduced and that efficiency of gear has increased. Paloheimo introduced a different approach to the study of the size of year-classes in the Georges Bank haddock fishery (Appendix V). It was agreed that estimation of year-class strength, particularly in the early years, is vital to the assessment of the Georges Bank haddock regulation and that every approach possible should be used to measure this. This new study fails to demonstrate that landings increased as a direct result of the regulation. Since values for year-class strength derived from the new study are at variance with those derived from former studies, it was agreed that further analyses of existing data should be made by U.S. and Canadian scientists working together as closely as possible. The report of a committee appointed to study progress in this field was approved by the meeting (Appendix II).

3. Scallops

Posgay presented evidence demonstrating that gear now in use on Georges Bank to take sea scallops (the 3-inch ring bag) has a 50% selection point at 70 mm. Fifty per cent selection points for a 3½-inch ring and a 4-inch ring were demonstrated to be 82 mm. and 93 mm., respectively.

The growth rate of scallops in the eastern part of Subdivision 5Z, which account for about 70% of total U.S. landings, has been determined by reading rings on the shell and from recaptured tagged scallops. Samples collected in the same areas to show the relation of shell length to weight of meat indicate that a 70 mm. scallop doubles its meat weight if it is allowed to grow for one year beyond present age of capture, and more than triples in meat weight in two years.

Yield isopleths calculated according to the simple Beverton model were presented for assumed values of $m = .10$ and $m = .15$. These calculations show that, for values of F greater than .25, there would be an ultimate increase in yield per recruit if the age of first capture were postponed.

Insufficient data were available to determine the fishing and natural mortalities. There was some indication that the present total instantaneous mortality rate in stocks in the eastern part of Subdivision 5Z might be about .50. Posgay suggested that assuming the natural mortality to be .15, the introduction of a 3½-inch ring might increase the yield per recruit by 19%, a 4-inch ring by 38%.

Dickie reviewed his 1946 data on growth and mortalities of Georges Bank scallops.

The meeting concluded that more information is needed on definition of stocks, possible fluctuations in year-class strength, and estimates of mortality rates before management of the scallop fishery can be recommended. A committee was set up to propose a program of scallop research. Their report, as accepted by the Scientific Advisers, is attached as Appendix III. The importance of the proposed program was emphasized by noting that the landed value of the Georges Bank scallop fishery exceeds that of the haddock fishery from the same grounds.

4. Gear Selection

(a) Selection Review

McCracken presented a report on the progress made with a review of gear selection data pertinent to ICNAF problems.

The meeting endorsed the proposals that inconsistencies in some of the Newfoundland selection data should be studied, and that McCracken and Clark should distribute a written review of gear selection results at the next Annual Meeting of ICNAF.

(b) Trap and Hook Selection

Quebec scientists volunteered to study selection of cod by traps and hooks in the northern subdivisions of Subarea 4. The proposals of a committee appointed to consider a program of research are given in Appendix IV. The meeting approved this program and thanked Quebec scientists for their offer to participate in the ICNAF research program.

(c) Chafing Gear

McCracken presented and interim report on a survey of the use of chafing gear on top of the codend in countries fishing the North Atlantic area. With one or two exceptions it is general practice to use such chafing gear on nets fished from large trawlers. Following recommendation of the 1957 Annual Meeting, more detailed information on the use of protective netting on top of codends will be reported to member countries through the Secretariat.

It was noted that topside chafing gear appears to be necessary on large trawlers. In the light of this information, United States scientists agreed to consider the possibility of conducting experiments on the effect of chafing gear, as it is normally used, on the selectivity of large-mesh codends.

(d) Film

Clark showed an impressive, revised, Woods Hole film on underwater TV observations of the escapement of fish from large-mesh otter trawls. Canadian scientists expressed interest in obtaining copies of the film and they were advised that this could be arranged.

5. Haddock

(a) Vertebrae

Martin and Clark reported the results of long-term studies of haddock vertebral counts in Subareas 3, 4 and 5. The importance of temperature during development in the determination of vertebral counts is demonstrated. The meeting expressed interest in early publication of these results.

(b) Subarea 3

Hodder reported that the large 1949 year-class, which contributed heavily to the commercial fishery on St. Pierre Bank since 1953, has decreased to a point where it no longer contributes much to the fishery. Survival of year-classes since 1949 has been poor, except for anticipated good survival of the 1956 year-class. On the Grand Banks, the 1949, 1952, 1955 and 1956 year-classes have shown good survival. He described recent research on the size of drumming muscles of mature male haddock. The muscles were nearly twice as large in May and June as in November. In the females the muscles are much smaller and do not exhibit any seasonal difference in size. These muscles can be used in sexing mature haddock landed in the gutted condition by commercial trawlers.

(c) Subarea 4

Martin and Clark reported on close liaison between St. Andrews and Woods Hole laboratories in the study of Subarea 4 haddock. Exchange of statistics and sampling, co-operative tagging programs in the Browns-LaHave and mouth of the Bay of Fundy areas, and adoption of the otolith method of age determination were satisfactorily carried out. Canadian scientists agreed to attempt more extensive sampling of haddock landings from Subdivision 4X.

McCracken reported that a large 1952 year-class was largely responsible for increased landings of haddock from Subdivision 4W in 1956. Growth of this year-class appears to be normal for the Western Bank region.

6. Cod

(a) Tagging

Subarea 5 cod tagging was reported by Wise. Returns from over 3,000 cod tagged in Subarea 5 indicate generally that the Subarea 5 fish are resident, although individuals move substantial distances within and outside the subarea. Returns are still coming in. No further tag releases are planned until data now available are analyzed.

Marcotte reported on returns from 2,000 cod tagged in 1954 along the north shore of the Gulf of St. Lawrence (Natashquan to Red Bay, Labrador). Returns to date total 354 or 17.7%. Recoveries by year were: 1954 - 93, 1955 - 158, 1956 - 79, 1957 - 24. Recoveries by area of recapture were: Quebec North Shore - 117, Labrador - 68, Newfoundland West - 40, Newfoundland South - 54, Newfoundland Northeast 57, elsewhere - 18. Many of the southern recaptures were

taken by European vessels during spring months. There is evidence of a seasonal movement from the Quebec North Shore in the hydrographic summer to the southwest coast of Newfoundland in the hydrographic winter.

McCracken reported on recaptures from about 9,500 cod tagged in inshore waters of Subarea 4, from the Lockeport area of Subdivision 4X to the Bay of Chaleur area of Subdivision 4T. Very high returns (up to 60%) were obtained from non-migratory, inshore, Nova Scotian stocks. In contrast, cod tagging in the Gulf of St. Lawrence has shown major seasonal migrations out of the Gulf in "winter", with "summer" recaptures mainly from the area of tagging. While the percentage of recaptured fish has been high for these more migratory cod, the recoveries have been lower than those from inshore Nova Scotia.

(b) Parasites

Wise reported that nearly 5,000 cod from Subarea 5 have been examined for incidence of Lernaeocera since the spring of 1957. About 30% were infected in the northern Gulf of Maine, and only about 1% on Georges and Browns Banks.

Jean reported that 2% of the cod examined in Subdivision 4T in 1957 were infected with Lernaeocera. Inshore cod of the 41 to 50 cm. size class showed the highest infections. About 40% of the cod were infected with Clavella.

Hodder reported heaviest infections of Lernaeocera among inshore cod in Newfoundland waters. In that area inshore lumpfish (Cyclopterus) act as intermediate hosts.

Martin reported that incidence of Porrocaecum in cod increased sharply in offshore waters of Subdivision 4W during the summer and fall of 1957.

In recognizing the value of these parasites as fish tags, biologists were encouraged to continue observations of parasite infections and exchange results.

(c) Census Studies in Subdivision 4T

Jean reported on a Canadian census of cod in Subdivision 4T during the period May to October, 1957. Cod from a shallow southern sector off Shippegan Gully were compared to those from a deeper northern sector off Bonaventure Island. The sizes of the southern cod were generally smaller than the northern cod. The number of cod over 60 cm. decreased in the south and increased in the north as the season progressed. Small cod appeared to move inshore in June. More detailed analysis will be reported following a study of otolith and hydrographic data.

Marcotte reported on a Quebec census of the Bay of Chaleur area during the same period. His observations show that surface temperatures were highest at the end of July and bottom temperatures in early November. By November temperatures were practically the same from surface to bottom. Young cod appeared to migrate into the shoal water of Chaleur Bay during the summer and then offshore in Subdivision 4T in the fall. Availability of cod to draggers appeared to be highest during the months of July to September in the Chaleur Bay area.

The value of these complementary census studies was recognized. The meeting recommended close co-ordination of these programs in 1958, and pointed out the need for extending the census to include shallow, inshore waters.

7. Redfish

Kelly gave a report on tagging and racial studies of redfish at Eastport, Maine, (Subdivision 5Y).

(a) Migration

Five thousand and sixty-two redfish have been tagged at Eastport, Maine, from August, 1956, through November, 1957. Eleven hundred and sixteen of these have been recaptured at the tagging site during that time. There is no evidence of migration. No returns of tags have been received from any areas outside of the immediate tagging area. Furthermore, there is little evidence that the fish normally move even distances of a fraction of a mile from the immediate point of release.

(b) Growth

The growth of the tagged fish appears to be so slow that the mechanical error of measurement masks the average growth over a period of 14 months. The stock of fish recaptured three or more times reveals an average growth of 2.6 mm. in 14 months. Tagging and recapture of tagged fish will continue on a monthly basis through the coming year.

(c) Racial Study

There is no evidence that the inshore stock of redfish at Eastport is different from the Gulf of Maine stock. A review of the available meristic study material indicates that these fish are not *Sebastes viviparus*. The data of Dr. Å. V. Tåning were used in this comparison. His suggestion that the American redfish are intermediate forms between *S. marinus* and *S. viviparus* appears to be valid. He refers to this group as *S. fasciatus*.

(d) Other Studies

Mid-water collections of post-larval redfish during August and September, 1957, yielded hundreds of small redfish in mid-depths between 10 metres and 100 metres, generally over depths of 90-120 fathoms. The mode of lengths of the young of the year pelagic redfish changed from 23.3 mm. on August 1 to 38.7 mm. on September 5. This growth of 15 mm. in about 5 weeks of pelagic life is in accord with the calculated growth rate previously derived from plankton tow catches and otter trawl catches of post-larval redfish. The growth of the redfish during the pelagic life in the first summer is several times as fast as the redfish growth in subsequent years.

8. Study Boats

Taylor reported on his studies of the value of small-mesh study boats in assessing the effects of the Subarea 5 mesh regulation. In comparing selection curves derived from length compositions of small-mesh and large-mesh vessels with selection curves obtained from covered-net experiments, he found departures which varied from season to season and year to year. There was considerable discussion and difference of opinion as to the seriousness of these departures.

Taylor also pointed out that abundance values for small fish obtained from small-mesh vessels after regulation cannot be compared directly with small-mesh values before regulation except at the instant the fish become available, since the small fish after regulation are receiving protection and thus are more abundant relatively.

The question of study boats was referred to the appropriate experts from the St. Andrews and Woods Hole laboratories for further study and reporting at the June meeting.

9. Sampling Yearbook

Keir reported on progress with preparation of the first ICNAF Sampling Yearbook. The meeting endorsed the standardization for reporting adopted by the Secretariat, and noted a preference for use of fork length in the yearbook. The Secretariat expressed a need for compilation of samples along the standard ICNAF lines at laboratories, and a need for conversion factor data wherever the data submitted do not conform with the standards which have been accepted for reporting by the Secretariat. The four laboratories represented at the meeting agreed to submit sampling data to ICNAF in the form adopted in the first yearbook. Keir pointed out the problem of weighting samples and the need for consideration of this matter at the June meeting.

10. Plans for June Meeting

It was agreed that the following topics should be considered at the June meeting of Scientific Advisers to Panels 4 and 5:

(1) Effects of present mesh regulation on cod and haddock in Subareas 4 and 5.

(2) Possible effects of adoption of 5½-inch mesh for cod and haddock fishing in Subareas 4 and 5.

(3) Review of research program on need for scallop regulation in Subarea 5.

(4) Review of research on cod in Subareas 4 and 5.

(5) Review of trap and hook selection data for Subarea 4 cod.

The meeting proposed that the following topics be considered for the agenda of the next meeting of the Committee on Research and Statistics:

(1) Review of gear selection data (Clark and McCracken).

(2) Review use of topside chafing gear.

(3) Need for study boats in Subarea 5 haddock fishery.

(4) Consideration of the need for a meeting on tagging.

(5) ICNAF statistics and sampling publications.

(6) Plans for redfish symposium.

The meeting endorsed the proposal of the Chairman of the Research and Statistics Committee that a special lecture on a topic of interest to the Commission is desirable. As a specific proposal, it was suggested that Professor Evelyn Hutchinson might speak on basic productivity.

11. The Chairman and Dr. Graham expressed the thanks of visiting scientists to the Quebec Department of Fisheries for their assistance and hospitality in conducting a very satisfactory meeting. A visit to the Biological Centre was greatly appreciated. The hope was expressed that Quebec scientists will continue to participate in the Commission's program.

APPENDIX I

List of Participants

U.S. Fish and Wildlife Service

Washington:

Dr. L.A. Walford
Mr. H.H. Eckles

Woods Hole:

Dr. H.W. Graham
Mr. C.C. Taylor
Mr. J.R. Clark
Mr. J.P. Wise
Mr. J.A. Posgay
Mr. G.F. Kelly

Fisheries Research Board of Canada

St. Andrews:

Dr. J.L. Hart
Dr. W.R. Martin
Dr. F.D. McCracken
Dr. L.M. Dickie
Mr. J.E. Paloheimo
Dr. Y. Jean

St. John's:

Mr. V.M. Hodder
Mr. T.K. Pitt

Dept. of Fisheries Quebec

Dr. H.E. Corbeil
Dr. A. Marcotte
Dr. V.D. Vladykov
Mr. J-M. Boulanger

ICNAF Headquarters

Dr. E.M. Poulsen
Mr. R.S. Keir

APPENDIX II

Report of Committee on Effects of Mesh Regulation

Membership: Graham (Chairman), Martin (Rapporteur), Taylor, Dickie, Paloheimo, Hodder, Posgay, Walford.

The committee considered papers by Paloheimo and Taylor on the effects of mesh regulation on Georges Bank haddock.

Paloheimo used a modified virtual population approach, involving summation of total catch for each year-class corrected for fishing effort to give an estimate of actual population at recruitment to the fishery. Both landings and discards were considered. He concluded that the 1952 year-class was about the same size as the 1948 year-class and substantially larger than the 1950 year-class.

Taylor's analysis used the average relationship between landings of 2-year-olds per day fished and total lifetime yield (in numbers), to give relative year-class strength for the same year-classes.

The results obtained by the two methods were not in agreement. An assessment of differences in methods suggested consideration of the following points in further studies of the effect of mesh regulation on Georges Bank haddock:

(1) improved estimates of the proportion of the population taken by a unit effort;

(2) interpretation of abundance of 2-year-olds might include a study of the effect of discards, of the nature of schooling, and of recent changes in the commercial cull of haddock;

(3) expansion of study to include several more year-classes;

(4) analysis of recent changes in total and natural mortalities.

It was concluded that: (1) Commission scientists should be cautious in their claims for benefits of mesh regulation until they have an assessment based on more years of data; (2) there should be a more frequent exchange of visits for personnel involved in population dynamics studies.

Analysis of length frequencies of Subarea 5 cod caught during 1956 and 1957 has shown that the 4½-inch mesh has had little or no effect in releasing any of the cod taken by the fishery. In fact, the sizes caught are so large that a 5½-inch mesh would have little effect.

Consideration of Canadian observations of effect of mesh regulation on cod in Subdivision 4T showed: (1) that introduction of large-mesh nets in 1957 released large numbers of cod previously discarded at sea; (2) that the selection i still well below the sizes culled for landing; and (3) that the efficiency of gear appeared to increase. This led to the conclusion that Canadians explore the feasibility of carrying out a 5½ inch mesh study-boat program and report their proposals at the next meeting of Scientific Advisers.

It was noted that there is a great need for sampling of cod taken by European vessels from Subarea 4. Preliminary analysis of Canadian landings and effort statistics demonstrated the complexity of the data, and pointed out the need for extensive analysis and refinement of the assessment of effort. This involves a consideration of economical factors and may also necessitate experimental fishing.

APPENDIX III

Report of Committee on Subarea 5 Scallop Research

Membership: Walford (Chairman), Dickie (Rapporteur), Paloheimo, Posgay, Taylor, Keir.

The committee was appointed to review knowledge relating to possible regulation of the scallop fishery, and to outline a program designed to provide the information necessary to determine the advisability of increasing the size of rings in scallop dredges

In order to predict and subsequently to test the benefits of any future regulation, it is necessary to establish an applicable model of the scallop fishery; this, in turn, necessitates that mortality from age to age be measured for different areas separately. The following new research is necessary:

(1) more tagging experiments; scientists of Canada and the United States should collaborate in the design and execution of these experiments;

(2) assessment of the stocks by photography;

(3) collection of more accurate catch and effort statistics for Canadian as well as United States vessels.

(4) studies of the way the fishing fleets operate;

(5) experimental fishing in association with photographic surveys to compare various sizes of rings as to sizes of scallops caught, efficiency of gear, and relative measures of year-class strength.

Knowledge of age composition of the populations in the various areas fished, over a series of years, is essential for determining mortality rates, constructing appropriate models, measuring year-class strength, and studying fluctuations and their causes

The methods of age analysis are probably sufficiently accurate, but a check on growth by different methods of analysis is needed for at least two more years.

The age reading program is now deficient, it needs to be systematized, the number of readings should be very substantially increased; age readings should be kept up-to-date; the process of age determination should be mechanized wherever practical; the scientists engaged in scallop research should be given assistants to carry on the routine parts of their work.

It is necessary to conduct fundamental research on biology of the scallop and on its environment in order to determine the elements influencing its occurrence, behavious and survival. It is particularly important for assessing benefits of a regulation to distinguish between natural and artefactual causes of changes in abundance.

All material bearing on proposed regulation of the scallop fishery, to be considered by the scientific advisers to the panels or by the Committee on Research and Statistics, should be submitted in written form along with the supporting numerical data

Report of Committee on Collection of Data on Cod Traps and Hook Fishing (and Redfish Selection)

Membership: Corbeil (Chairman), Marcotte, Boulanger, Clark, McCracken.

The Quebec biologists surveyed the 92 cod traps operated on the north shore of the St. Lawrence River in 1956. Five traps were surveyed throughout the fishing season. The data will be analysed to determine whether any fish escape from the traps. If there is escapement, the relation of size of fish caught to size of mesh in traps must be determined.

Quebec biologists will remain in contact with other ICNAF biologists and will report the results of their findings to the Commission.

Some hook selection data have already been published by Station de Biologie Marine, but there are more data available. These data will be analysed before planning further work. The analysis will be made by the appropriate biologists, this to be decided after further consultation.

Quebec has intiated studies of selection for redfish in otter trawls. The net used will be modified to give results more comparable to ICNAF data and the work will continue.

APPENDIX V

Estimation of the year-class strengths of the 1948, 1950, and 1952 year-classes of Georges Bank haddock.

J.E. Paloheimo

A simple method will be described to estimate the strength of a year-class when it is subjected to known fishing and natural mortalities. This method is then applied to establish the strength of 1948, 1950, and 1952 year-classes of Georges Bank haddock.

We adopt the international notation, and let the subscript t stand for year, N_t for strength of a year-class at the beginning of the year t, and C_t for catch from that year-class in the year t. We may then write

$$C_t = \frac{cf_t}{cf_t + M}(N_t - N_{t+1})$$

or

$$a_t C_t = N_t - N_{t+1}$$

where

$$a_t = \frac{cf_t + M}{cf_t}$$

Let t = 1 be the year when the year-class is two or three years old and t = n be the last year for which we have statistics. Thus, we have

$$\sum_{t=1}^{n} a_t C_t = N_1 - N_{n+1}$$

$$= N_1 \left[1 - \exp. - \sum_{t=1}^{n} (cf_t + M)\right]$$

i.e., the weighted sum of catches (in numbers) divided by the expression in the square brackets gives an estimate of N_1.

To calculate the year-class strengths of 1948, 1950, and 1952 year-classes at the age of two and three, we have to know the total catches (by small- and large-mesh vessels) from those year-classes over as many years as possible, and the effective efforts expended to obtain them. The value c = .09 (the effort is expressed in thousands of days fished) and M = .10 are obtained from Clyde C. Taylor (4).

The total effort for fish older than two years can also be directly obtained from (4) for 1950-1954. The final corrected figures of the total landings and total efforts for 1955, and all the figures for 1956 were obtained from Mr. Taylor by personal communication.

The relationship between the average catch per day at given age and the subsequent lifetime yield are expected to follow a linear relationship. Prior to mesh regulation, this was not so for 2-year-olds, but the total yield from abundant year-classes fell below the expected. Mr. Taylor has indicated that this may be due to the tendency of 2-year-olds to school apart from older fish and that the catch-per-effort figures reflect the school density rather than the abundance. A similar curved relationship would also result if the natural mortality is density dependent for fish at age two.

If the schooling behaviour of 2-year-olds is responsible for the distorted relationship between the catch per effort and the abundance, the total effort is not the same as the effective effort, i.e., the effort which is linearly related to the fishing mortality.

The straightforward total effort can be considered as minimum effective effort because the year-classes in question are all above average strength. Quite arbitrarily we have assumed that an effort figure, which is 10% greater than the total effort, gives the upper limit for the true effective effort.

For the 1952 year-class the total effort by large-mesh boats in 1954 has been multiplied by .714 to take account of the selection by 4½-inch mesh (see below)1). This figure is derived by calculating the catch per days fished by the large-mesh boats and dividing the obtained figure by the catch per days fished by the small-mesh boats. This gives the total effort .714 x 5181 + 626 = 4325. This figure is considered as minimum. The lower and upper limits of the effective efforts for 2-year-olds for all the year-classes in question are tabulated in Table I.

The figures on the total effective effort determine the corresponding instantaneous fishing mortality rates ($F = cf$). However, as the estimate of c is based on the pre-mesh-regulation data, we have calculated F from $F = 1.05\ cf$ for 1954, 1955 and 1956, to take account of the 5% increase in the efficiency of large-mesh nets (excluding, of course, 2-year-olds of the 1952 year-class in 1954). The correction does not, however, affect the results appreciably.

Table I, Taylor (1957), gives the total landings from Georges Bank by year-classes from 1949-1955. To the landings of (1-), 2-, and 3-year-olds we have to add the quantities discarded at sea. The discards of 3-year-olds have been so small for the year-classes in question that we have completely ignored them. Using the figures on the percentage discards obtained from Premetz (1953, 1954), and the figures on the total landings obtained from Taylor, we arrive at the estimated discards of 7.1 million fish in 1950 and at that of 4.7 million in 1952. These figures have then been multiplied by .95 (cfr. Premetz (1954)) to get the approximate numbers of 6.7 and 4.5 million fish discarded at age two from the 1948 and 1950 year-classes, respectively.

To arrive at the corresponding figure for the 1952 year-class we have obtained the average numbers of discards per days fished for both small-mesh and large-mesh boats by weighting the corresponding figures by seasons (from Taylor, Table VI) with the total landings by seasons (from ICNAF Statistical Bulletins). When these figures were multiplied by the total days fished by small- and large-mesh boats, respectively, an estimated discard of 1.1 million 2-year-olds was obtained.

The average discards per days fished were 1149 and 74 fish for small- and large-mesh boats, respectively, in 1954. This brings the catch of 2-year-olds of the 1952 year-class (not landed catch as in Taylor's Table VIII) per day fished to 7616 for small-mesh boats and to 5441 for large-mesh boats. These two figures had been used above to obtain the effective selection of large-mesh boats relative to small-mesh boats.

1) If we assume a lower minimum effective effort corresponding to a smaller value than .714, we get an estimate of the 1952 year-class strength far greater than in Table III.

In Table II the total catches, corrected for the discards, the instantaneous fishing mortality rates ($F = cf_t$ or $F = 1.05\ cf$), the values for a_t, the values for the summation $\sum a_t C_t$ (corresponding to the estimates at the beginning of the second year), and for $[1 - \exp. - \sum (c_t f_t + M)]$ are tabulated. The corresponding estimates of the year-class strengths at age two and at age three are given in Table III.

Table III. Estimates of the 1948, 1950, and 1952 year-class strengths.

At the second birthday			
Year-class:	1948	1950	1952
N (000,000)	Max. = 93.1	Max. = 70.6	Max. = [illegible]
	Min. = 93.9	Min. = 71.8	Min. = [illegible]
At the third birthday			
Year-class:	1948	1950	1952
	N = 50.8	N = 36.5	N = 49.5

According to our estimates, the 1952 year-class is about equal to the 1948 and far greater than the 1950 year-class. It appears to be 28-30% larger than the 1950 year-class and about 1-3% smaller than the 1948 year-class at the age of two. At the third birthday the 1952 year-class is also almost equal to that of 1948 and 36% larger than the 1950 year-class.

These estimates are subject to revision pending better estimates of the discards and effective effort for the 2-year-olds.

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Table I. Total effective effort for 1948, 1950, and 1952 year-classes of haddock on Georges Bank.

Year-class		2-	3-	4-	5-	6-	7-	8 yr. old
1948	max.	6473	6490	5933	6511	5807	5065	6569
	min.	5486						
1950	max.	7000	6511	5807	5065	6569		
	min.	5933						
1952	max.	5104	5065	6569				
	min.	4325						

Table II. Data for estimation of the 1948, 1950, and 1952 year-class strengths.

Year-class	1948					1950					1952				
		F		a_t			F		a_t			F		a_t	
Age	C_t '000,000	Min.	Max.	Min.	Max.	C_t '000,000	Min.	Max.	Min.	Max.	C_t '000,000	Min.	Max.	Min.	Max.
2	35.7	.49	.54	1.204	1.185	29.6	.53	.63	1.189	1.159	33.0[a]	.39	.46	1.256	1.217
3	26.7	.58		1.172		17.6	.59		1.169		18.2	.46		1.217	
4	8.5	.53		1.89		5.6	.52		1.192		11.3	.59		1.169	
5	3.8	.59		1.169		2.7	.46		1.217						
6	2.1	.52		1.192		2.7	.59		1.169						
7	.8	.46		1.217											
8	.4	.59		1.169											

		1948	1950	1952
$\sum_{t=n}^{n-1} a_t C_t =$	min.	92.7	68.9	76.8
	max.	92.1	68.0	75.5
$\exp. -\sum_{t=1}^{n-1} (cf_t + M) =$	min.	.9884	.9589	.8245
	max.	.9890	.9627	.8363

[a] The corresponding figure, Table 1 of Taylor, is 31,587,000. By multiplying the days fished by the catch per day we obtain, however, 31,857,000. This also checks with the marginal total given. The figure 31.9 has therefore been used to get 33.0 (=31.9 + 1.1).