INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 704
(B. Meet. f. 2&3)

Document No. 3

ANNUAL MEETING - MAY/JUNE 1960

Report of Regional Meeting of ICNAF Scientists, St. Andrews, N.B., December 8-12, 1959

Dr. Hart acted as Chairman. Drs. Martin and Graham served as reporters. A list of participants is presented in Appendix I.

SEA SCALLOPS

Bourne reported on Canadian investigations in the fishery, Medcof on the causes of scallop mortality, and Posgay on the activities of the U.S. fleet in 1959 and assessments of effect of delaying age of capture, based on the recent fishing distribution and earlier estimates of growth and mortality.

Canada made four sampling trips on two commercial scallop boats in the summer and fall of 1959 in six scallop unit areas on Georges Bank (Subdivision 5Z). The purpose of these trips was to obtain information on cull points and fishing mortality. The data have not yet been completely analyzed.

The culling practice has not changed. The cull point is still at about 95 mm. The fleet is fishing populations which are mostly recent recruits. About half the catch is less than 95 mm and is discarded while 15% of the catch is 110 mm in size or larger.

In accordance with recommendations of the last Annual Meeting, Canada carried out experiments with large-mesh drags. Observational studies with 3-inch and 4-inch rings were completed in November 1959. Canadian vessels attach additional links to the rings as the drags are used. It was suggested that experiments be conducted to obtain information on effects of multiple linkage on selection.

Scallops are very abundant on Georges Bank today. Canada's landings from this bank up to October 1959 have increased 56% over last year. Increased effort in the form of larger and more efficient crews, combined with high densities of scallops on the fished grounds, account for these increases. The effort is expected to increase further next year as two new 95-foot vessels are now under construction.

Canada reported that she now has log books on all offshore scallopers. She also reported on the initiation of experiments on early life-history studies and on the rate of separation of valves in dead animals. To date, natural mortality rates have been calculated from rate of separation of valves determined from a single tank experiment.

Medcof discussed the vicissitudes of scallops and enumerated the various kinds of natural mortality. He suggested a study of the importance of mortalities due to handling of the discards aboard commercial draggers.

The United States is continuing its studies of earlier tagging experiments designed to re-examine growth rates and to determine fishing mortality rates. Returns from these taggings are continuing. During the last few months the returns have

.../2

been mostly from Canadian vessels since Canadian vessels have fished more in the area of tagging than the U. S. fleet.

Recent U.S. studies of scallop beds confirm previous opinions that the beds, once established, are stable in location. There are differences in the relative strengths of recruited year-classes from bed to bed, but the degree of variation in natural mortality between beds is small and appears low. There are marked differences in fishing intensity among beds from month to month.

The U.S. fleet continues to fish intensively on newly-recruited sizes. This was vividly demonstrated this year when the fleet moved to a new bed on the southeast part of Georges Bank. This population had been sampled by a research vessel in May when a large year-class was found having a modal size of 88 mm. The fleet started fishing this population in July when the mode had advanced to 92 mm and fished it until October when the vessels shifted to other grounds. About 3.5 million pounds of scallop meats were landed from this bed during the period. Posgay's calculations indicate that if the distribution of fishing effort remained unaffected the yield from this bed would have been about 30% greater for the same amount of effort, if fishing had been delayed one year. This calculation is based on a growth rate which is well established and upon a natural mortality rate of 10% which may be an overestimate of the average annual natural mortality.

RECENT ADVANCES IN COD STUDIES

Subarea 5

Wise reported that cod landings by otter trawls from Subdivision 5Z increased from 14 million pounds in 1955 to about 19 million pounds in 1959. This has resulted from better recruitment, and perhaps from increased effort for cod because of lower landings of haddock. A possible slight, further increase in cod landings is anticipated in 1960 and 1961 because of the relatively high proportion of scrod cod in current landings.

As previously observed in Subarea 4, tagged cod move farther north and east than to the south and west. This movement may be related to the preference of cod for colder water as they grow to large size.

Subarea 4

Jean presented data on discards of cod from Canadian draggers fishing with 4 1/2-inch mesh codends during 1959 in Subdivision 4T. In June and July discards of small fish were 3% by number and 1% by weight. In August and September discards increased to 20% by number and 10% by weight, because of a change in culling practice as catches increased, and because of faster spoilage of small cod at this season.

A comparison of sizes of Subdivision 4T cod caught by hook and line and otter trawl, from 1951 to 1959, shows that lines generally catch and land larger cod than otter trawls. In some years the larger cod appear to concentrate in shoaler water where they are available to longliners but not to draggers.

Observations on the abundance of cod in survey hauls in Subdivisions 4T, 4V, and 4W show that few cod were caught at depths greater than 100 fathoms, either in winter or summer.

/3

Greatest concentrations of cod were found at temperatures of 1° to 3°C. in 4W and 4V South in winter, of about 0° to 4°C. in 4V North in the spring, and of less than 0° to 5°C. in 4T in summer.

Marcotte reported for LaCroix that Chaleur Bay (4T) cod move off bottom with euphausiids, an important part of their food. Floating longlines, fished at 10 and 20 fathoms from the bottom, showed that euphausiids and 50- to 70-cm cod move vertically at night. They concentrate just below the thermocline, particularly when it is sharp.

Kohler described annual variation in growth of 4T dragger-caught cod. Larger sizes at each age in 1955 to 1957 are thought to be the result of more food per fish because of decreased density of cod and/or increased abundance of available food. Special collections of small cod are serving to clarify anomalies in otolith readings of 4T cod. The effects of varying amounts of food on cod growth were tested by controlled experimentation in tanks.

Dickie reviewed some problems raised by preliminary analysis of Subarea 4 data, particularly Subdivision 4T cod. Although available samples have indicated a variety of growth rates with area, gear, and time, it appears clear that all are taken from the same stock, and are representative of that part of it fished in various ways. The assessment analysis should be able to predict effects of fishing change on the different parts of the stock represented, provided that data on length and age compositions and age-length keys are supplied separately for the components.

Problems of assigning catch and effort to particular stocks may be clarified by tag results.

RECENT ADVANCES IN HADDOCK STUDIES

Subarea 5

Wise reported that landings of Subarea 5 haddock decreased from about 100 million pounds per year from 1951-1957 to 80 million pounds in 1958 and 1959 because of relatively weak year-classes in 1953, 1955, and 1956. There is no indication from survey catches of small haddock or from catch-per-unit-effort data that much change can be expected in 1960 landings.

Subarea 4

McCracken described the commercial fishery for haddock in Subarea 4 and its relation to the distribution of fish by area, depth, and temperature, as determined from research-vessel catches. The total annual landings are about 100 million pounds; about half is taken from the western Subdivision 4X and more than half the total landings are taken in winter (Feb.-April). Canada and the U.S. share the landings about equally. McCracken noted the limited area of commercial fishing in relation to total distribution, the differential distribution of different sizes of fish, the seasonal changes in the sizes of haddock available to the fishery in commercial concentrations, the apparent mixing of large haddock in Subdivisions 4T, 4V, and 4W, and differences in average size at each age between some survey results and commercial landings observations.

/4

Subarea 3

Hodder reported no current haddock fishery on St. Pierre Bank (3P), and no significant survival of year-classes in 3P since that of 1949. The fishery by Canadian otter trawlers is now mainly in 3O (deep) in winter and spring, and in 3N (shoal) during the latter part of the year. The 1949, 1952, and 1953 year-classes are being fished but these fish have been declining rapidly in numbers since 1956. It is expected that the 1955 year-class will contribute a major part of the 1960 landings. Research-vessel surveys have shown poor survival of year-classes since 1955. A sharp decline in Subarea 3 haddock landings is anticipated subsequent to 1961.

The sizes of fish in the 1952, 1953, and 1955 year-classes have progressively decreased from the slow growth observed for the 1949 year-class.

Research-vessel cruises have shown vertical movements of haddock, feeding on capelin, a deeper distribution of the large fish of a year-class, and reduced catches with 4 1/2-inch mesh manila codends as compared with smaller meshes.

REDFISH

Kelly gave a résumé of the highlights of the Redfish Symposium held in Copenhagen in October 1959, stating that growth rate was no longer a major issue in redfish biological discussions. The problem of systematics, however, is still in a confused state. Discussions at the Symposium pointed out lines of attack but did not lead to any agreement as to the status of such entities as "marinus" and "mentella".

Kelly reported on his tagging experiments at Eastport, Maine. Tagged fish grow at a much slower rate than untagged fish. Holt pointed out that growth rates from tagged fish are still very useful for assessment purposes and can also be used for verifying growth rates determined from otolith examinations.

Magnusson briefly reviewed his studies of redfish biology which have to do with fertilization of eggs, sex ratios, migrations, and growth. He is currently working at Woods Hole with George Kelly under an arrangement between the Icelandic and U.S. governments. He also reported on trips to the ICNAF area on board Icelandic redfish trawlers.

Hodder described some studies of redfish in the Gulf of St. Lawrence in which they are able to observe the progression of length modes with time. Information on growth will be obtained from these studies.

FLOUNDER STUDIES

Yellowtail flounder

Annual yellowtail flounder landings from Subarea 5 have been as high as 70 million pounds and as low as 12 million pounds. The 1958 landings were about 32 million pounds. Lux reported on his studies of this species. It is fished on three principal grounds in the subarea: in southern New England, on Georges Bank, and off Cape Cod. Results of tagging experiments involving the tagging of about 1,500 fish indicate that the Cape Cod fish are separate from the other two stocks, and that the Georges Bank and southern New England stocks are either a single stock or two intermingling stocks.

/5

Age and growth studies indicate somewhat different growth rates for each of the areas.

American plaice

The American plaice is second to cod in the relative importance of Gulf of St. Lawrence (4T) commercial groundfish landings. Powles discussed plaice research in this area. Measurements of sizes of fish caught on research vessels and of those caught and landed by commercial draggers, with 4 1/2-inch mesh codends, showed commercial culling at about 34 cm and discards of 62%, 65%, and 73% by number in 1957, 1958, and 1959, respectively. Tagging, size-at-age, and maturity studies indicate two shallow-water stocks and a deep-water stock in the northern part of Subdivision 4T. About one quarter of the tagged fish are recaptured during 12 months following tagging. The growth of plaice taken in 1958 appears to be higher than that for samples taken in 1918 and in 1946 to 1949.

OTHER GROUNDFISH

Martin presented data on landings and sizes of groundfish other than cod, haddock, redfish, halibut, and plaice for Subarea 4. Pollock, hake, and witch flounder fisheries all yield annual catches of more than 10 million pounds. The sizes of these fish are large, and use of 4- to 6-inch manila meshes in codends would not affect landings.

LOBSTER SEMINAR

At a special session Wilder and Paloheimo described the calculated and observed effects of minimum size limits on a Canadian lobster fishery in Subarea 4. Attempts to observe effects of the size-limit regulations are obscured by the lack of data to take account of normal variations in recruitment and catchability. Models of the fishery show that benefits from reduced fishing effort are much greater than those to be expected from changes in size limits.

THE SUBAREA 5 HADDOCK REGULATION

Silliman reviewed the history of the Georges Bank haddock regulation. He pointed out that the large-mesh nets had been beneficial in various ways. Discards have been reduced to a negligible quantity, alleviating the necessity for culling at sea. The catches are cleaner and contain fewer unwanted fish such as hake, herring, etc.

He re-examined the strengths and yields of the 1948 and 1952 year-classes with a view towards evaluating effects of saving the small fish. On the basis of a length-frequency method, he concluded that the 1952 year-class was 1.07 times the size of the 1948 year-class. Taylor's method gives a figure of 0.9 and Paloheimo's 1.0. Silliman concluded that the two year-classes were of about equal initial size. He then pointed out that the 1952 year-class has now substantially passed through the fishery so that yield for ages 2-5 (nearly equivalent to total yield) figures are available for both the large pre-regulation 1948 year-class and the large post-regulation 1952 year-class. The comparison shows that the two year-classes produced about the same number of fish but the 1952 year-class produced about 20% greater weight of fish. Fewer fish were caught at age 3 but increased yields at ages 4 and 5 more than compensated for the lower catches at age 3. This is what had been predicted for the use of larger mesh gear.

/6

Silliman also reviewed the assessment of the regulation, that is, the expected benefit computed on the basis of growth rates, mortality rates, and availability of fish. He took into account the differential distribution. Biological knowledge of differential availability of the smaller sizes on the banks was not used in the original computation of expected yields. The original theory assumed an availability of 1.0 for all ages. It now appears that age 1 has an availability of about 0.4 and age 2 about 0.7. Using these figures, Silliman arrived at predicted benefits somewhat smaller than had the original computations.

In the discussion of this paper, it was pointed out that we should continue to evaluate the regulation from all possible angles, and that such factors as increased efficiency of the larger meshes, change in cull size, change in catchability, and increased size-at-age should be examined in relation to the increased yields per recruit obtained since regulation.

ASSESSMENT OF MESH REQUIREMENTS

The group discussed procedures to be followed in assisting the assessment task force in their assignment for the year. It was decided that the members of the task force present should meet together during these sessions to plan and schedule the data compilation and analyses required for their studies. A general partitioning of work among laboratories in the region was agreed upon and is tabulated below:

Woods Hole	- All species in Subarea 5; haddock in Subdivision 4X; redfish in Subdivisions 4V, 4W, 4X.
St. Andrews	- Cod in Subdivisions 4S, 4T, 4V, 4W, 4X; haddock in Subdivisions 4T, 4V, 4W; other groundfish (excl. redfish) in Subarea 4.
St. John's	- All species in Subarea 3; cod and haddock in Subdivision 4R; redfish in Subdivisions 4R, 4S, 4T.

The report of the assessment task force is attached as Appendix II.

The meeting expressed their appreciation for the participation in their discussions of Mr. Holt of FAO.

12/1/60

APPENDIX I

List of Participants

CANADA

St. Andrews

John Hart, Chairman
Neil Bourne
Neil Campbell
Lloyd Dickie
Fabian Forgeron
Yves Jean
Carl Kohler
Louis Lauzier
Stuart MacPhail
Robert Martin
Frank McCracken
Donald McLeese
Carl Medcof
Jyri Paloheimo
Percival Powles
Donald Wilder

St. John's

Vincent Hodder

Dept. of Fisheries, Quebec

Alexandre Marcotte

UNITED STATES

USFWS, Washington, D. C.

Joseph King
Ralph Silliman

Woods Hole

Herbert Graham
Allan Barker
George Kelly
Fred Lux
Arthur Posgay
Roland Wigley
John Wise

ICNAF HEADQUARTERS

Erik Poulsen
Ronald Keir

FAO

Sidney Holt

ICELAND

Observer

Jakob Magnusson

REPORT OF MESH-ASSESSMENT COMMITTEE AT REGIONAL MEETING OF ICNAF SCIENTISTS, ST. ANDREWS, N. B.

Afternoon, Thursday, 10 December to
Morning, Saturday, 12 December, 1959

Present: S. Holt (FAO, Convener)
V. Hodder (Canada)
J. Wise (U.S.)
R. Silliman (U.S.)
L. Dickie (Canada)
J. Paloheimo (Canada)
R. Keir (ICNAF)

The following plans were made for preparatory work for the meeting of the Assessment Group at Lowestoft in March 1960:

1. Subdivision of task by species, time, and place.

Responsibility is assigned as follows:

Woods Hole:	All species SA 5; haddock SD 4X; redfish SD 4V, W, X.
St. Andrews:	Cod SA 4 (except 4R); haddock SA 4 (except 4X); other species SA 4 (except redfish).
St. John's:	All species SA 3; cod and haddock SD 4R; redfish 4R, S, T.

Data will in general be worked up by years, countries, major gears and subareas. Where necessary, geographical breakdown will be taken to subdivision level, and notes on differential effects of possible mesh changes on fisheries by seasons (quarters) and more localized changes in particular fisheries will be appended to the general predictions.

2. Choice of mesh sizes for calculations.

Assessments will be made at least for mesh sizes of 4, 4½, 5, 5½, and 6 inches (manila codends or equivalent measures for other fibres) as follows:

a) 4-inch mesh for cod, haddock, redfish, and other species in all areas. This involves an increase in mesh at present used for redfish and a half-inch decrease in mesh used for cod and haddock in Subareas 4 and 5. In fact, the cod and haddock 4½-inch mesh might continue to be used voluntarily even with a decrease in the legal minimum. Additional calculations using this assumption should be made for all cases where a mesh greater than 4 inches is at present used.

b) Meshes for all species in all subareas raised successively to 4½, 5, 5½, and 6 inches. Calculations will refer to the nets used by all types of otter trawlers and other bag-nets (e.g., Danish seines, pair trawls, etc.).

c) Smaller mesh sizes, approximating say the old $2^{7/8}$-inch mesh size, especially for those areas where the additional accumulation of data gives opportunity to review the previous calculations leading to mesh regulations or where the yield calculations indicate that the present mesh sizes may be above those mesh sizes which give maximum yield per recruit.

3. All calculations will be made in terms of weights of catches. Where absolute values are required they will be given in metric units (tons). Body weights of fish will be given in grams (to nearest gram).

Approximate relative values of the various species will be compiled where there are substantial differences, so that their effect on relative total value may be appraised at a later stage.

4. Calculations of immediate effects of mesh changes.

It was agreed that the present selectivity of many types of gear is insufficiently known to permit appraisal of the immediate effects of changes in them (trap mesh, hook size, etc.) which would cause their selectivity to be equivalent to that of 4 to 6 inch manila codend meshes. Calculation of immediate effects would therefore be confined to trawls and other towed bag-nets.

The work sheet drawn up by the St. Andrews laboratory is appended. With minor modifications it can be used for all these calculations.

Length frequencies of catches and landings are entered on a per-mille basis. Size groupings follow ICNAF Sampling Yearbook standards except that flounders are treated in 2-cm instead of 1-cm groups.

It is thought that average length frequencies for about 3 recent years will be suitable in many cases for calculation of average percentage loss of landings in the first year after introduction of new mesh size. Where length-frequency composition varies greatly from year to year, an appraisal, by calculation for separate years, would need to be made of the expected range of per cent loss or its probability distribution. Changes in quantities which would be discarded will also be computed.

Calculation of immediate effects of introducing a certain mesh size depends on knowledge of the effective selectivity of currently used meshes. This is often not known, and in such cases the best estimate should be made, based on whatever mesh measurements are available, and appraisal made, by trial calculations, of the extent to which the first results are affected by erroneous choice of this. The extreme case is an assumption that the present gears are unselective; their catches would then represent the size composition of the accessible population, and calculation on this basis gives an estimate of maximum possible initial loss.

The effective mesh size of a fleet for which measurements are not available might in some cases be deduced by comparing the frequency distribution of its catches with that of another fleet fishing in the same area, and for which mesh measurements are available.

Selection curves used will be based on information summarized in ICNAF Ann. Proc. (8). By plotting quartiles on arith-probability paper, selection curves having form of normal ogives can be derived; these are considered to be satisfactory for the present purpose. Where selection experiments have not been carried out for the largest or smallest meshes, the 50% point for these will be estimated by linear extrapolation of the graph of each 50% point against mesh size (thus not assuming invariability of "selection factor" with mesh size).

To facilitate uniformity, St. Andrews (McCracken via Dickie) will draw up a table of curves for the 4- to 6-inch meshes (all species except redfish) and send copies directly to other members of the group, and two to the ICNAF Secretariat, one of which to be sent to Beverton for his information. St. John's (Templeman via Hodder) will be asked to prepare and distribute a similar set of curves for redfish. These tables should be accompanied by the graph of quartiles against mesh size so that each participant can derive selection curves for the various estimates of meshes at present in use.

For species for which no selection curves are available the 50% selection points will be estimated as well as possible from consideration of:

a) Measurements of maximum girth;

b) Body weight/length ratios, compared with fish fairly similar in shape for which these ratios are known and also either girth or the measured selection point;

c) Selection curves of other species having body form nearest to that of the unknown one.

Upper and lower quartiles (25-75% points) should be estimated roughly from shapes of selection curves for similar species. On each work sheet should be indicated the way in which the selection curve has been derived including the values of the ratios, etc., used. For industrial fisheries the immediate effect of mesh change will be calculated separately for each species in the catches and the results summed.

Other groups of work sheets for species caught together should be identified as such.

Each participant will use the best available data for the relation of body weight (round, fresh) to length for each species in each area. Where measurements are not available for, say, a particular area for trawler-caught fish, it will be necessary to use data for an adjacent area, or catches by another gear or fleet of another country.

In the case of fast developing fisheries, it is recognized that the relative contribution of large fish to the catch is likely to decrease, then the relative immediate losses from increase in mesh size would be greater.

5. Long-term effects of mesh changes.

Estimation of these is a research problem for which general rules cannot be laid down since the necessary parameters of mortality (due to fishing and to natural sources) and growth, or particular combined functions of them will be estimated in different ways in different situations. It was agreed, however, that in making the initial step in appraisal, calculations would be made along the following lines, and participants would, if possible in time available, begin investigation of the errors likely to be introduced by making the approximations noted.

From the current mesh selection curve the length frequency of the accessible stock can be computed. From the shape of the left-hand (ascending) part of this distribution, an approximate curve of recruitment as a function of fish length can be deduced. Thus, for each mesh size a mean length at entry to the exploited phase can be computed as the mean of the derivative of the ogive obtained by multiplying the recruitment curve by the mesh selection curve. For purposes of further calculation it is assumed that entry to the exploited phase is of "knife-edge" type at these mean lengths. The curve of average weight against age of fish is used to estimate the mean time-delay (Δt) of entry to the exploited phase caused by a particular increase in mesh size, corresponding with the calculated increase in mean length at entry. Fish of all sizes greater than the new entry length will be increased in number by the fraction $e^{+F\Delta t}$ where F is the average fishing mortality exacted by trawlers using the smaller mesh of fish between the current mean length at entry and the mean length at entry which would result from use of the larger mesh. The catch in weight of fish of these sizes will be increased in weight by the same fraction.

The value of F for which this weight increase equals the initial loss can be calculated to show the minimum value of F which would have to be observed before the particular increase in mesh would have a long-term beneficial effect.

In cases where F has been measured, or its order of magnitude can be estimated, the per cent benefit can be similarly calculated. Where F is not known but total mortality can be estimated, the maximum possible long-term benefit is calculated by assuming that there is no natural mortality.

If possible, an appraisal will be made of errors in the predictions caused by the use of:

a) curves of weight at age in catches, instead of true growth curves unbiased by gear selection or differential availability by size to different gears;

b) curves of average length at age which ignore the real variation or spread of length (and weight) at age;

c) the assumption of "knife-edge" entry to the exploited phase. If time permits the errors due to this approximation and to the use of average and observed growth curves in place of the true growth may be investigated in detail.

Calculations can be made in the above manner for the assumption that fishing effort does not change. Parts of yield curves sufficient to show their general shape will also be calculated, especially near to the present situation (if this can be estimated), to indicate changes to be expected from both increases and decreases in effort. These curves will also permit appraisal of effects of possible changes in the efficiency of gear resulting from the mesh changes.

Attention of the responsible administrators will be drawn to the need to make available their prognostications of changes in sizes of fleets in coming years, if the results of such calculations are ever to be realistically applied to the fisheries.

The calculations outlined above relate to the trawler-caught fish. Their results therefore give estimates of minimum benefits (or maximum losses) to the entire fisheries. Estimates of maximum benefits (or minimum losses) might be obtained by calculations based on the assumption that the fish in catches by other gears, of sizes above the mean size of entry to trawler catches, will be increased or decreased in the same proportions as in the trawler catches. This is in effect based on an assumption that the trawler catches and catches by other gears all come from the same completely mixed stock, at least as far as the fish above the mean size at entry to trawler catches are concerned.

Calculations of long-term effects can be made for a range of values of mortality rates. It is then necessary to locate the point representing the present situation on these curves. Limits can be set by estimation of the total mortality from catch per unit effort at successive ages, and assuming alternatively that F is nearly zero or M is zero. These mortality estimates will be supplemented where possible by estimates from tagging experiments. Where survey data are available, catches per unit effort should be used to supplement estimates of apparent mortality from catches per unit effort by the commercial vessels.

Where data for discards are inadequate, assumption that there is in fact no discarding at present results in estimates of minimum long-term benefits.

Growth data present few problems in these fisheries. The redfish growth will be taken as the "slow" rate recommended by the Redfish Symposium to be provisionally accepted. It is pointed out, however, that even if this is in fact wrong it is not likely to lead to any considerable errors in the prediction of the effects of mesh change made by the methods described.

6. Other conservation measures

Changes in fishing effort are covered by the calculations outlined above, and their results will therefore indicate the possible benefits of regulation of fishing effort. Calculations cannot be made at present of the effects of closed seasons or areas.

Effects of minimum legal size limits, associated with minimum mesh sizes, can easily be calculated. As a first step, the losses (by discard) to be expected by setting size limits equal to the 50 per cent mesh selection lengths will be calculated.

St. Andrews, N.B.,
December 16, 1959.