International Council for the
Exploration of the Sea

C.M. 1954
Special Scientific Meeting
"Problems and Methods of
Sampling Fish Populations"
No.18

INFORMATIONS OF SAMPLING AND WORKING METHODS IN MARKET INVESTIGATIONS OF THE GERMAN DEEP SEA FISHERIES

J. Lundbeck

An important part of German sea fisheries are exercised in distant waters widely separated from each other. Therefore the observations and investigations on catching conditions must be done with the help of landings by commercial vessels. Only the methods in use to carry on such work are dealt with here.

I. Fisheries statistics under such circumstances are not only an indication of the amount of catches, but actually the base of the scientific work. Since about 1930 there has been undertaken a thorough analyse of the commercial landings as to species, market categories and size composition, place of capture, time of actual fishing and catch per unit of effort. In addition since 1935 current statistics of such a kind have been erected, which since 1939 and again 1949-54 by stages were combined with the official statistics.

The basic unit is the single trip.

Because of the lack of book-keeping on-board the trawlers, the informations are required in a mode of the greatest possible simplicity:

1. The places of capture are defined as rather large areas according to the usual fisherman's terms, as shown in the bystanding chart.

The limits have been defined in such a way that each place is of a rather uniform and distinct biological character. But the space is still so large as to include essential differences in feature and composition of the catches. So off Iceland on the same fishing places the fishery took previously place immediately outside the territorial limits, but now on the edge of the shelf where wholly another stock of commercial fishes are met with. Therefore, if the catches have altered by quantity or composition, there is no evidence at all of any change in the basic conditions.

Except for this the limits are of no importance anyway since the fishing fleet mostly gathers on rather restricted places and only little scatters to the outside. However, it has not in all cases been possible to maintain the limits set by ICES, due to the fact that in several cases important fishing places are lying on both sides of these limits, and the catches are therefore only registered as a whole.

2. The fishing days have been chosen as a time unit of fishing intensity and for calculation of comparable yields. Here, too, the skippers or mates will be able to give informations from immediate remembrance. There will no doubt be wider space for inaccuracy and faults than by fishing hours. But in principle the days fishing are as correct an expression of the time spent in fishing than the hours. In the average both can be connected together. A calculation from the log books of nearly 5000 German Trawler trips about 1930 averaged with

15,1 days or 366 hours for one whole trip

thereof

6,8	"	"	166	"	" running from and back to the harbour
1,4	"	"	32	"	" gales and other loss of time
6,9	"	"	168	"	" fishing

For every day therefore can be reckoned rather exactly 24 hours real fishing, i.e. towing the net over the bottom amounted to between 60 and 88% of the above fishing time. This depends from the duration of the haul and the time necessary for setting

out and heaving the trawl . But with the shorter hauls in deeper water this percentage recently has diminished, on the Norwegian coast to 26-60%. Also if trawling is only paying during day time or at night, or if heavily variable catches need longer intermittend seeking, that means reduction of productive time. In the exceptional case of very short and very prolific hauls on the west coast of Greenland, the net was only 50 hours really in action within 8 fishing days.

3. The catch per fishing day then serves as the comparable unit of yield. It should refer to as narrow as possible an area in a space of time. Practically the materials for the above mentioned catching places and every month are summed up. Only in special cases and as far as a sufficient amount of single date is available a subdivision after depth-Zones, 5 or 10 days etc. can be undertaken. This calculation does not need complete statistics of the whole landings; on the contrary every doubtful information and before all every landing, which originates from more than one place are left aside.

The fishing technique of the German deep sea trawler fleet is so uniform, that there are no difficulties in that direction. Only the differences in tonnage and engine power of the ships have an essential influence to the yield. Comparative calculations resulted in the following relations between average catch per day of the various size groups of vessels:

Gross tonnage cbm.	400-600	600-800	800-1100	1100-1400	1400-2000
In herring trawling	76	100	140	172	175
in northern waters	83	100	151	181	238

The correlation of the unit yield to the horse powers, which increase according to the tonnage of the ships, is a similar one, but is not further considered.

From the size composition of the fishing fleet at work in the different areas there can be estimated, by which amount the yield should have been expected to increase in the course of several years. That has to be taken into consideration and to be compared with the yields actually obtained. This increase has been calculated for instance for the decennary 1925-1935 by about one third and almost equally for the years since 1946. In reality the augmentation often has been a higher one because of improvements other than the size of the ship and engine. But without any doubt in some cases, probably for the Norwegian Coast, an actual decrease in yields has been hidden by the increased technical catching power.

II. The commercial landings depend in quantity and composition from the place of origin, the species of fish occuring and the density of their stocks, the intensity of the fishery and its distribution as to localities and seasons, the selection for market purposes according to the prices and the wishes of the consumer and the subdivision into market categories. At any time the most favourable catching possibilities and the market conditions as decisive for which places and species should be preferred. The two first items are the object of the fisheries statistics treated above, whereas the last ones need further observations.

4. The catchable stock i.e. the fish of such size, that they are held back by the gear cannot be defined exactly because of the lack of information on the mesh selection. There may be given only the decrease in number of fish smaller than the size with maximal percentage or in other words the slope of the size distribution curve at left hand.

5. The marketable stock, containing all fishes above minimum commercial size, is a selection of the before mentioned catchable stock. It should be pointed out, that the market selection is of the most important relevance in fishery statistics for biological purposes. It does not/influence the quantity of landings absolutely, but not less the yield per unit of effort and the size composition of the landings. Unfortunately it is not easy, to get informations in that direction. In order to calculate the percentage retained and discarded in each size group, there must be reconstructed the catchable stock. That means, the total number of discarded fish has been added to those actually landed. Only observers on-board the trawlers can make estimations of the undersized fish for a single haul or a whole trip and measure sufficient samples of them. Informations therefore refer only to distinct cases, and surely there is very wide variation; often not more than an approximation can be reached.

/only

6. The market categories often are considered as a means of information about the size composition of the different commercial fishes landed. But experience has shown such an irregularity both from economic and from biological causes that it is impossible to define any category exactly. Of course, the composition of the whole catch as well as of each market category depends from the composition of the stock themselves and their alterations as to season and locality. Already on-board, a pre-sorting takes account of the sale conditions to be expected. On the market too, the definite sorting is not wholly uniform, in spite of several agreements on weight limits for each category. When compared with exact length compositions, the percentages of the market categories by far not always show similar variations and differences. For that reason the market investigations take no more account of them than is unavoidable.

In general the market categories correspond to the needs of the fishing industry. They originate from the beginning of fish auctions and have been augmented by number in the course of time, in some cases up to 5 or 6. The most exact sorting is done with high valued species for example sole. But it must not be forgotten that it is always judged only by the eyes.

In recent years there has not been undertaken a throughough survey of market categories and selection. But unmistakable signs make it sure that some of the most important commercial species are landed but from a considerably elevated minimum marketable size; and for cod, coalfish and redfish have been voluntarily agreed limits for landing of 750, 1500 and 750 g respectively. This development has its causes partly in the elevated requirements of the consumers, partly in the more expensive entertainment of the large trawlers and the high prices of to-day.

The bystanding table contains dates of the market categories in use containing average sizes in the grand total and the separating 50% selection points. The average sizes for the whole landings of each species and the 50% points of market selection are included. This summary gives a general impression, but it has to be born in mind that strong deviations are common. 7. Samples in principle shall be typical for the catches from a distinct region and season. Mixed catches therefore cannot be used.

Single catches of samples from un unimportant fishery can be of worth only to enable special comparisons. Generally from intensive fishing samples as numerous as possible will be the best means to represent large parts of the landings. Up to about 50 samples, including more than 10000 individual fishes, have been worked up toggther. But normally not more than 10 and only a few samples must often suffice. The material variation seems more important than the mathematical certainty of the single sample. Therefore it is thought more favourable to have a larger number of small samples than a small number of larger samples.

8. Length measurements as the simplest means of analysis are exercised in the first line. Partly by reading from a scale board, partly by marking the uttermost length point by an awl on a sheet of paper and tabulating afterwards. The lengths are grouped under full centimetres. In principle there must be measured so many fishes at a time, that the whole row becomes sufficiently reliable. The number therefore depends from that of the 1 cm-intervals in question. Whereas in the beginning several hundred fishes were taken, later on their number generally was reduced to about one hundred. The faults by chance no doubt are then larger, but as mentioned above the greater number of samples to be reached is more valuable. Except for extreme cases it has not been tried to measure a certain percentage of the fishes present.

Each market category has to be represented by a separate series of measurements. To reconstruct the whole catch, every series has to be converted to the total quantity of the respective market category on the base of known weights. Finally the calculated numbers of fishes within every single continuate group are summed up and result in the row of length composition of the whole catch. This one forms the basic unit material for further treatment and consideration.

It has not been undertaken to calculate deviations and errors; certainly the single sample does not correspond to the requirements of mathematical security. Only the sum of a whole group can be used, as far as average composition and the variability of the fishery in question are represented adequately.

The distribution to the single 1 cm-intervals shows best by decreasing irregularities the reliability. But smoothing almost in all cases is necessary, and mostly the sums for 5 cm of length are used.

9. The age composition is based on the length measurements, because the number of age determinations by far does not reach that of lengths. Generally some hundred or a few thousand data from one to about ten samples may be combined. In the first years only scales have been used, which can be taken from market fish without damaging them. But the difficulties for an exact determination of higher ages forced to find out possibilities to get otoliths. At present almost exclusively these are gained from the skelotons after filleting, from the heads cut or from whole fishes through the gill cavity.

Usually the number of year-classes within a space of 5 cm (without respect to market categories) are converted to the percentage of the corresponding length group by measurements. In that manner immediately the percentage composition of the landings will be attained. Also the absolute number of fish of each age group or the average per fishing day are calculated for a fishery of a distinct season or region as well as for the whole year and area in order to know the practical importance of the year-classes.

Considering the taking of equal samples from several market categories, of which very different quantities are contained in a landing, it is not deemed practicable to calculate average lengths of the year-classes. No growth investigations therefore can be made on the base of market investigations alone (except special cases when sorting seems not to disturb the natural size composition of the stock fished). For the conversion of age groups from numbers as well as generally from lengths to weights is exercised by some 6000 statements of individual weights of all sizes of commercial species.

IV. In further treatment and utilization of the market investigations because of several shortcomings in the material only the fishery and the landings can be taken as a base of consideration. Unto which degree they give informations over the natural stocks of fish may be a question of further examination.

10. The total landings represent the final commercial effect as well as the fishing mortality absolutely. In this latter respect, however, the discarded quantities of non-marketable fishes should be included. Samples of them are available only by work at sea and therefore not more than in single cases as said before in respect to the market selection.

The total fishing intensity corresponding to the quantities caught is expressed adequately by the number of fishing days, which if desired could be connected internationally with the fishing hours of other countries. Whereas fishing intensity is senseful only in respect to the whole distribution area of a species or stock, the importance of distinct parts of this area to the fishery according to total landings may be of immediate interest.

11. The catch per unit of time demands more /thorough/ critics. The large number of commercial vessels at work secure a rather exact average calculation. But it has been experienced that in an unfavourable fishery a shortening of the season or a restriction to a narrow area of good catches with participation of only a small part of the fleet may result in much higher average unit yields than would have been calculated for a full fishery during the whole season. Especially in the Barents Sea near the outer limits of distribution and migration of cod and haddock there may occur a real reversal: With the rising temperature in the hydrographical spring the first shools arriving remain concentrated for some time and may give single high yields; later on in hydrographical summer the warm water allows a scattering of large quantities of immigrants with only smaller catches over the whole area; finally the decreasing temperature in the beginning winter again sweeps the fishes together with the result of increased catches at distinct points. For this reason also years of unsufficient heating in spite of week immigration show a higher average unit yields than warmer years.

Generally spoken the yield per time unit depends not only from the total amount of stocks present but also and often in the first line from ecologial influences by their effect on the strength and regularity of the accumulations of commercial fishes as well as from the experience and ability of the fisherman to discover the most favourable catching possibilities at any time.

12. As to length and age composition it may be repeated that the market selection should be considered as far more relevant than the market categories, and to take account of the material differences to be more important than to the deviations by mathematical chance. It has been tried to calculate instead of percentages the absolute amounts of the fishes for the single length and age groups, but mostly strong and irregular differences seem to make that unpracticable for instance in the NE-Area. Only taken in the grand total the length and age composition becomes more regular in spite of the dependance from the distribution of the fishery in space and time. For the same reasons no mortality and similar rates have been calculated.

13. Finally the relations to populations studies may be touched. From the foregoing such relations cannot be thought to be very simple or immidiate. But in most cases no other and better informations for the natural population of commercial fish are available, and especially not in such extent as the market investigations give opportunity to.

A certain independence from the commercial fishery can be obtained by using the catch per unit of time calculated not from the bulk of landings, but for single groups equally distributed over the area or the season in question and summarized as a simple mean value. That would often be a way to approach at least some conceptions on the populations or make possible comparisons without respect to intensity, location and course in time of the fishery. But here the final limits of evaluation from market investigations without additions by further research work begin to be felt.

In considering the success of the commercial fishery generally we have to deal with two causes: Firstly the absolute number of fishes present as depending from fluctuations in year-classes. Secondly their distribution and movements. Only the first item can be fully taken into consideration. The second one at present leaves still too many open questions of a general biological kind. In future work perhaps two points could more be taken into consideration: Availability and behaviour. Because of the restriction of the fishery to such regions and times as expected to give paying catches practically the availability is limited from economic regards. Behaviour not only should be understand in the sense of extended migrations in vertical and horizontal direction, but also in single feature to be read from echosounding etc. Thus availability, arising as well from economic and technical as from physiological and ecological factors would have to be taken into account for its immediate practical effect and as a biological factor for stock maintenance.

Fig. 1 Division of fishing areas used in the German deep sea fisheries statistics (some division lines discontimued for simplification or because of changes in the distribution of the fishes fleet are marked by hatched lines).

Fig. 2 Two exemples of market selection and sorting into market categories: The North Sea haddock and the cod from the Barents-Sea. Curves of the size composition of the catch and the market landing, divided into market categories (above), the curves of the percentage distribution between the unmarketable and marketable fishes as well as between the market categories (below).

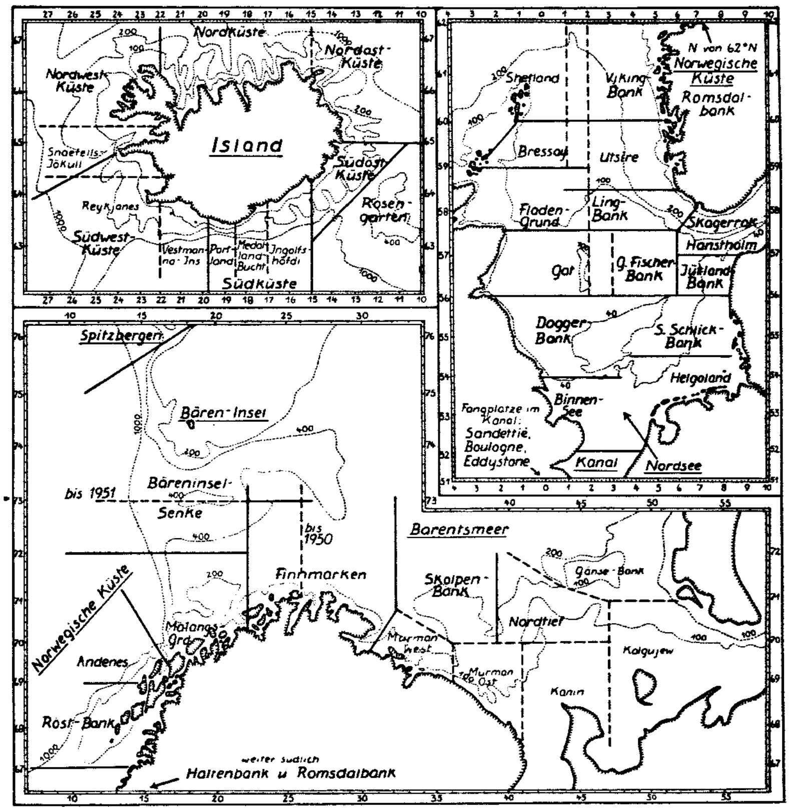
Island
Nordküste
Nordost-Küste
Nordwest-Küste
Snaefells-Jökull
Reykjanes
Südwest-Küste
Südost-Küste
Rosengarten
Südküste
Shetland
Viking-Bank
Norwegische Küste
Romsdalbank
N von 62°N
Bressay
Utsire
Fladen-Grund
Ling-Bank
Skagerrak
Hanstholm
Gat
g. Fischer-Bank
Jütland-Bank
Dogger-Bank
S. Schlick-Bank
Helgoland
Binnen-See
Kanal
Nordsee
Fangplätze im Kanal: Sandettié, Boulogne, Eddystone
Spitzbergen
Bären-Insel
Bäreninsel-Senke
bis 1951
bis 1950
Barentsmeer
Finnmarken
Skolpen-Bank
Gänse-Bank
Nordtief
Kolgujew
Kanin
Norwegische Küste
Andenes
Malangsgrund
Röst-Bank
weiter südlich Haltenbank u. Romsdalbank

Fig. 1.

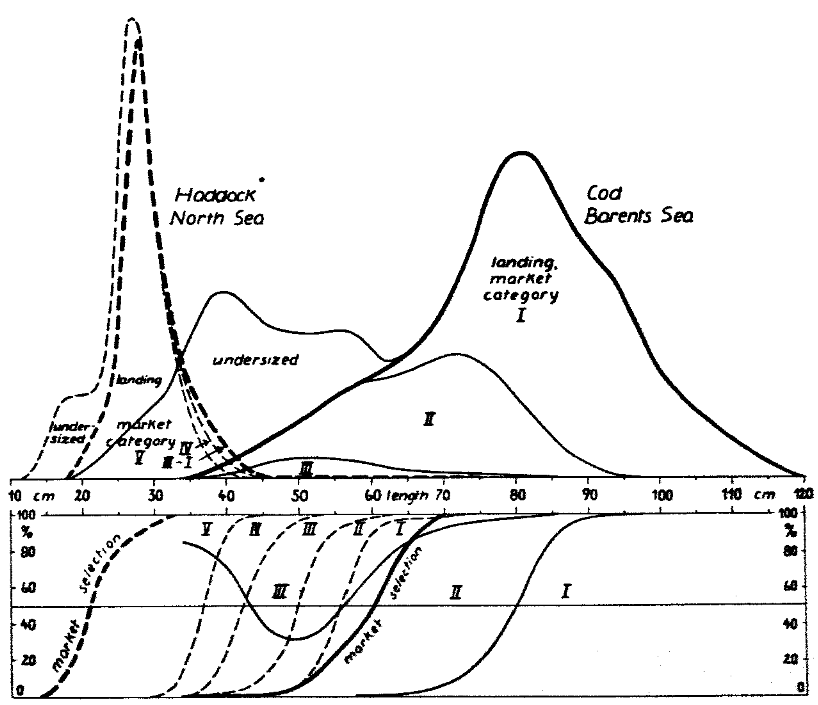
Haddock
North Sea
Cod
Barents Sea
landing, market category
I
undersized
landing
market category
under-sized
II
III
10 cm
20
30
40
50
60 length 70
80
90
100
110 cm
120
market selection
%

Fig. 2.