This paper not to be cited without prior reference to the author

International Council for the Exploration of the Sea

C.M. 1963

Symposium on the Measurement of Abundance of Fish Stocks

No. 2

Significant Effects on Effort Units and Unit Yields as Experienced in an Exploration of the German Sea Fisheries Statistics

by

J. Lundbeck
Institut für Seefischerei
Hamburg

In 1929 the author was charged, among other research work on the fish markets, to develop the landing statistics as an aid for scientific investigations. The establishment of a fully comparable unit yield seemed one of the most outstanding tasks therein. The stepwise approach towards this aim has been reported mainly in the author's publication series "Biologisch-statistische Untersuchungen über die deutsche Hochsee-fischerei", I-IV, 1-7 (Ber.Dtsch.Wiss.Kom.f.Meeresforsch. since vol.VIII, 1936; after the concluding part, in press now, a German and English summary will follow). For international use short descriptions of methods and results have been given in English, mainly under the titles: "Information on sampling and working methods in market investigations of the German deep-sea fisheries" (Rapp.Proc.-Verb., 14o, I,1956); "Some examples of misleading possibilities in effort statistics" (ICES, C.M. 1956, Stat.Cttee., No.35); "Ways to a generally standardized effort unit in the German steam trawling fishery" (Joint Sci.Meeting ICNAF/ICES/FAO, Lisbon, 1957, Doc. No.E 4).

In referring to these papers, the present contribution will, in a more general manner, deal with the different aspects to be taken into account and the defects to be corrected, as they appeared in this special case but may also come forward in other similar investigations.

1. The time unit

It will be remembered that former unit catches have mainly been calculated per day at sea, though the total duration of a fishing trip, besides the time needed for fishing, strongly depends on the varying distances between the home ports and the fishing areas, and is furthermore influenced by travelling speed, weather and waves - strongly variable i.a. seasonally - or other loss of time. In proceeding to the fishing days the only purpose was to avoid these deficiencies by taking into account only that part of each trip actually devoted to the fishing operations, which, however, did not mean the time of fishing activity proper. About 193o there was no possibility in the German high-seas fishing fleet, nor in fact any necessity for a statistical utilization of fishing hours, because as a whole the days repeated rather exactly 24 hours (on average almost 5ooo fishing trips of 15,1days = 366 hours with a fishing time of 6.9 days = 168 hours). A 8o% agreement with the machinists' journals offered a satisfactory control, and a 64-65% agreement only as to the fishing time was easily explained by the engine being stopped during part of the fishing time. A similar degree of conformity with the daily catch records frankly inspired trust, because there were days with small catches but which did not count as fishing days, which had been defined as at least half having been spent in fishing. There are signs, however, that later on the number of fishing days were reported more according to the international consent of including all days with any fishing activity at all and even approaching the "time on the grounds".

Though this fishing time embraced that needed for shooting and hauling the trawl, smaller net repairs and all other business connected with the catching procedure proper, this latter one was supposed to keep in a rather uniform time ratio to it. Up to about 193o, especially in carrying out long hauls (usually 3 x 6 hours daily in former times), as a rule a 75-85% "net in action" part of the fishing time was stated. But later on, this relation decreased (down to about 25%) in consequence of a more complicated gear (but recently simplified in handling), exploitation of grounds with heavier working conditions, general passing over to shorter hauls and increasing time requirement for processing. Therefore that portion of the fishing time used here, during which the net was in action, has more recently become as well much smaller as also far more variable, and this is a severe objection against the fishing day as defined above, which may no longer be correctly converted to a "net in action" time. It should, therefore, be abandoned in favour of the fishing hours, which meanwhile are preferred internationally and are intended as indicating the duration of fishing proper.

In case of data concerning the fishing time lacking completely the author found the catch per trip more correct and better comparable than that per day at sea, because the variation of the time spent in fishing is much less than that of the total trips' duration. But a further progress towards comparability was obtained by estimating on the base of known fishing days per trip, those lacking, under assumption of a firm relation to the days at sea, which were generally available and may scarcely have been influenced by short-term changes in speed rates or other time factors.

2. The fishing power in relation to vessel size

The transition to bigger trawler types at the time when these investigations began, raised the problem how the increased investment and operation costs were met by the capture of more fish per time unit. Simple comparisons revealed marked differences in the average catch per fishing day between gross tonnage groups of trawlers. They were confirmed and completed as to the smaller vessels of the older times (19o3, 1913) and the further increased recent ones (1949-51). All cases agreed fairly well and could be combined to a series of yields per time unit increasing parallel to vessel size. This correlation, however, was not a simple linear one, but the rise in fishing power was steepest in medium-sized vessels. Furthermore, the degree of superiority of the bigger vessels was a lesser one in the North Sea than on the North Atlantic grounds, which may presumably be explained by the heavier nautical conditions there. From this reason, the relative power factor, used for conversion of the catches per fishing day, were - as far as depending on vessel size - lowered by 1o% for the near areas and raised by 2o% for the more distant ones. Moreover these factors have to be calculated for each fishing area separately, taking into account the size composition of the part of the whole trawler fleet which at any time is active in each area.

The superior performance of big vessels cannot be ascribed simply to larger trawls or higher towing speed, but will be due more or less to stronger resistance against wind, waves and currents, also obviously in a rather high degree to an unchecked choice of the most favourable operation field as to depth, bottom, etc. Off NW Norway, for example, the relation of the vessel-size groups as to fishing power may be compared a little more detailed:

cbm gross	6oo - 8oo	8oo - 11oo	11oo - 14oo
relative unit catches:			
unchanged averages from total landings	1oo	152	195
simple averages from depth zones	1oo	122	154

This difference may be interpreted as mainly due to the larger vessels fishing mainly in deeper zones with a higher density of commercial fish stock, but apart from that their superiority seems to be weaker than elsewhere, because the strong northward current offers a towing aid to all trawler sizes equally. Generally, however, the bigger vessels may be favoured additionally in propulsive strength, other technical, nautical and communication equipment, by the more experienced skipper, a more skilled crew etc. As a consequence of shortened passage times (saving roughly one day per 1ooo n.m.) the gain per day at sea or calculated as annually landed quantities increases further, for example among the size groups 6oo-8oo and over 11oo cbm gross ratio of 4 : 7 to that of 4 : 8 (1 : 2).

Similar to the steam trawlers a series of average catches per trip and per fishing day has been obtained for the offshore cutter fleet in 1949 and 1953.

Both series may be repeated here:-

A. Steam Trawlers: 2oo - 4oo - 6oo - 8oo - 11oo - 14oo - 2ooo cbm

fishing power relation	65	75	1oo	15o	175	2oo

B. Motor Cutters: 1o - 5o - 1oo - 15o - 3oo cbm

fishing power relation	9o	1oo	2oo	35o

Instead of the percentage per size group in future it may be advisable to rely as to fishing power directly on the average gross tonnage of each trawler fleet, which is uniformly characterised, or of the parts thereof active in the single fishing areas.

3. The fishing power in relation to propulsion strength

Originally the engine strength has been considered as corresponding to the gross tonnage and therefore needing no special consideration. But from 1928 to 1936 there was a marked increase in the horse powers beyond that of vessel size, and therefore 1935-38 the quantities caught per fishing day were compared both with vessel size and with propulsion power groups. The rise in a ratio of about 1:2 was quite similar in the one as in the other series. But these calculations as well as later additional ones made it clear that in case of disagreement between size and horsepowers the catches per time unit followed more narrowly the development of the vessel sizes. Especially in the motor cutters there was a rather confusing diversity of the unit yields, which tended well to increase parallel to vessel size, but in the contrary to decrease, if the bigger vessels disposed of no more horsepowers than smaller ones. That was not the case,however, in a similar survey of the steam trawlers. It may be a problem of naval architecture, whether this difference is due to the absolutely much bigger vessel hulls,or whether their propulsion is farther from a technical minimum than in the motor cutters. The catches per unit time in both vessel groups, strongly simplified and related to an average of 100, are shown below:-

A. Motor cutters 1949 + 1953

h.p. \ cbm	1o - 5o	- 1oo	- 15o	- 2oo	Average
2o-6o	87	72	-	-	82
- 1oo	1o4	73	1o4	88	91
- 15o	-	-	73	89	1oo
>15o	-	-	-	11o	127
average	122	97	-	91	1oo

B. Steam trawlers 1953 + 1954

h.p. \ gross tons	2oo - 3oo	- 5oo	- 7oo	Average
4oo-6oo	47	77	-	73
-8oo	45	115	143	1o1
-1ooo	-	119	153	1o6
>1ooo	-	-	169	117
average	48	111	14o	1oo

The averages have to be understood as not being calculated only from the figures given here, but after filling in the gaps by extrapolation, so that the series for tonnage are independent of horsepowers and vice versa. It can be seen that in the small vessels the propulsion power has rather strong influence: at equal vessel size the catch rises with the horsepowers, whereas unchanged horsepowers yield less with increasing vessel size. In the contrary the steam trawlers show a yield increase in both directions, but a stronger one of the ratio 1:3 according to size and a much weaker one of 2:3 according to horsepowers.

This experience led to the conclusion that in the first line a fishing power unit should remain based on vessel sizes, but for the future the inclusion of the propulsion strength should be considered. This has been already an unavoidable amendment for unit catch comparisons in time. During the almost 7o years elapsed up to the present time the average horsepowers of the steam trawlers increased by 32% more than the average gross tonnage.

Until 1955 there was no need to take motor vessels into special account within the high-seas trawler fleet, because a final percentage of 1o-12% might result in a unit catch increase of not more than about 1% and maximally 2.5%. Available data show that motor-driven vessels had on an average 35% more horsepowers than equally sized steamers. In 1955 they caught 18% and in northern waters up to 26% more fish during unit time. But after removal of the size differences this superiority fell to 1o% (6% in herring trawling, 24% in northern waters alone). In comparing, on the other hand, vessels of equal propulsion strength, the motor vessels got 7% more fish in unit time; in herring trawling they were superior by 13% - in the more protected North Sea the motor, driving on a relatively small hull while pursuing a highly movable fish, seems to develop strongest effects - but in northern bottom trawling by 4% only - here the perseverance of a bigger ships body seems to be more important.

4. The fishing power in relation to gear efficiency

Lack of information on the comparative catch efficiency of the trawl types used is in fact the weakest part of this calculation system. Up to the present time the gear and its operation have remained quite unchanged in principle, and it might seem easy to relate the bottom area swept per haul or per unit fishing time - resulting from the opening width of the net times towing speed - to the catch per time unit which, however, may be supposed to grow in fact stronger than the area covered. Moreover, mere enlargement of the trawl net seems to account only to a limited extent for the increased yields. In replacing the beam trawl by the otter trawl in 1895 there was (after Henking) a 64% larger-fished area per haul. Subsequently the trawl was somewhat enlarged further, but a ground-rope up to 2oo (-22o)' was a maximum, which was used for special purposes only, small-meshed and towed slowly, during a short span of time just before and after the first World War. Then followed the period, in which the trawl net proper tended to diminish and to apply instead a system of ropes between the network and the otterboards. Since the late twenties the VD-trawl came into use, and further progress led to still more complicated constructions recently. It has been tried to fit this gear development approximatively into the power unit system. The predominant features are an assumed 33% and 4o% improvement by the introduction of the otter trawl and the VD-trawl respectively (after English data). The addition thrice of another 1o% increase may roughly correspond to the intermittent minor improvements. In this way there results a gear-dependant rise in fishing power to $2\frac{1}{2}$ times the initial value as compared with that of 1:3 by vessel size. In the case of the herring trawling, which for a long period at least was suspicious of overfishing, an application of the fishing power factors as to gear resulted in rather constant unit catches, by which the accuracy of this procedure may be confirmed.

For the cutters the only comparison available was that the otter trawl, introduced in 19o4, had a 16% wider opening, but caught almost twice as many fish as the beam trawl; there was a further duplication as a consequence of replacing the sail by a (weak) motor for towing.

5. The progress of the fishing power in time

The simultaneous yield comparisons mentioned above could not of course be repeated in temporary sequence because of possibly changed stock densities. Therefore, a relative power system had to be guessed with any empirical foundation. Preserving the vessel size groups as a basis, the catching power changes in the course of time were related further to the development of the propulsion and of the gear, taking into account some minor improvements in hull shape and towing force as far as their effects could be computed numerically. In fact, the rise in fishing power calculated in this way is a minimum, because several other influences were not accessible quantitatively at all. Intelligence factors appear in observations such as, for example,trawlers belonging to shipowner firms with more than 1o vessels catching 1o% in excess of singly owned ones, or the shorter trips and better unit yields of vessel from ports especially experienced in the fishery of certain areas. Echo-sounding and similar searching devices, which, towards the end of the period considered here, developed to an extremely important effect on the catching ability, could not in any way be assessed quantitatively.

The author tried repeatedly to get an empirical insight into the real development, but that was unsatisfactory in all cases and may be mentioned only shortly here:- 1926-35 the bottom trawling yields (as plain average of the areas) increased by 34% per time unit, 19% of which only were covered by increased vessel sizes. In 1935-38 there was a 26% rise in fishing power by the addition of bigger vessel to the fishing fleet, but a 46% higher yield per time unit; in this case the explanation can be seen largely in a stronger preference of more paying fishing grounds, because the rise in catching power calculated as simple average from the areas amounted to 8% only. Whereas up to the late thirties the unit yields grew actually more than might be expected from increased average vessel sizes, since then on the contrary the 43% fishing power increase 1938-195o/51 was accompanied by not more than 14% higher catches per unit time, thus pointing to the meanwhile worsened fishing conditions.

In comparing vessels of different age the actual catch increase of a certain size group per time unit amounted to roughly 5o% in favour of those built more recently. A large part of this superior fishing power appears to be due to strengthened propulsion. But in no case is there a conclusive answer as to whether the older ships themselves and their equipment originally were less effective or whether they weared out during the almost 2o years' of use. There are signs,however, that the oldest vessels still active are the very best of their group and do not represent adequately the general catching power of vessels of this size. On the other hand, the newly built vessels seem to develop their full efficiency not before having been in use some time, so that occasionally the largest size group fails to show its superiority at once. For both reasons the fishing power of the smallest and the largest vessels had to be judged cautiously and sometimes to be rectified.

On the whole, the development of the average relative fishing power per steam trawler was calculated in the following series:-

1885	88	93	98	19o3	o8	13	18	23	28	33	38	44	48	53	56
34	36	43	51	59	64	64	75	88	1o8	154	154	217	256	3o3	

In a similar way the offshore Ewers and Cutters were compared:-

187o	1886	185o	19o5	193o	1946
1	2	2	4	8	1o

6. The calculation of the catch per effort unit

Since the numbers of fishing days became available about 193o the author used the catch per fishing day for purely spatial comparisons - though even that was not quite correct - or for surveys of not more than some few years as well as, up to the present time, annual reports. But, although the mistake so far might be tolerable, the establishment of an effort unit, based besides the fishing time on the fishing power as well, became quite unavoidable for the approach to the historical development of the sea fisheries as to catching techniques and commercial fish stocks (Pt. IV of "Biol.-Stat.Untersuch.ü.dtsch.Seefischerei", since 1954 and Ber.Dtsch.Wiss.Komm.f.Meeresforsch., Bd. XIII). Henceforth the catches per fishing trip were converted to a standard of 1o fishing days and the fishing power of the steam trawler size group 6oo-8oo cbm gross about 193o. Combined conversion factors for power and time have been calculated for 5 years' periods and interpolated for the single years. Each fishing area was dealt with separately on the base of the special size distribution of the trawlers active in each one. The power factor relating to the gear was used unchanged for all areas.

It has been calculated that storms increasing up to 75o hours per fishing trip cause a 29% catch reduction. In 1935 storms were divided into almost equal times for those interrupting the fishing operations completely or partly or not at all with a catch depreciation to 18%, 62% and 98%, respectively. Taking log book records for the second group, the only one of interest here, 8% such storm days and 38% loss in yield, the mistake would amount to 3% only. Since the complete interruption of the fishery by bad weather is expressed in the number of fishing days, further weather influences appear therefore unimportant.

The fish weights used are those landed, mostly gutted on ice, and adjusted only in case of processing at sea. For each trip one unit could be stated only referring to the main fishing place (mixed trips directed to more than one fishing place, each exceeding 25% of the landed catch, were omitted). Because times of unsuccessful fishing were included, the real yields as to peaks and variations are rarely shown correctly.

Originally the calculated unit yields refer to as small as possible time spans and spaces, i.e., months and fishing places, the latter ones being established expressly for this purpose since the late twenties. Simple averages per year or for longer periods of year and for the more extended fishing areas seemed to express best the general abundance of commercial fishes and the densities of fishable stocks as a whole. But in case of data not being available in such detail, and especially in the more historical surveys the unit yields needs must be based mostly on the total landings per year and area. In that case it has to be borne in mind that this more direct procedure implies some alterations and insecurities; as compared with the average unit yields those based on the total fishery will most often be higher, because the commercial fishery tends to concentrate at those places and within those seasons, where and when the fishes are present in the greatest quantities; only in cases of more single peak catches - typical especially in the north-eastern waters - this relation is reversed. Furthermore, there is a minimum yield economically, and in approaching it there will be a stop or a shift in the fishery itself instead of a further unit catch decrease. Thus the reduction of a fishery to a small number of the most successful fishing trips during a bad season may erroneously result in just the same good unit yields as in a fully and amply accomplished normal season. This is to say, the annual average yield per unit effort gives no satisfactory information on the real conditions as determined by the abundance of fishes and the external circumstances influencing their behaviour, distribution, migration, concentration and availability.

7. Special fisheries for different species

The first step toward a unit catch had to deal with a mixed fishery, which was uniform and therefore fully comparable. More recently, however, the composition of the single landings from certain areas began to differ more and more as to species percentage. Quite generally, but most obviously off Iceland, the fishery since about 193o shifted partly from the shelf region, inhabited mainly by cod and haddock, to deeper waters, where coalfish and redfish prevailed. Of course the unit catch of a certain fish species will strongly decrease, when the fishery turns away from the area of its main distribution and greatest density, and instead the species inhabiting the newly fished grounds will increase. In the case mentioned above, downward trends of the cod and haddock yield, and upward ones in coalfish and redfish must not at all be misunderstood as stock changes or the like, but had to be taken as purely secondary effects of a changed fishery, and of course such influences on the unit catches should be removed. It was quite clear, therefore, that a sub-division according to the prevailaing commercial fish species appeared to become a highly necessary further step in order to obtain comparable series of yields per unit effort for the different fish species. As an example the landings from Iceland 1936-38 have been grouped after that species, which predominated by more than (or at least almost) 5o%:

	Total fishery	Special fishery for: haddock	cod	coalfish	redfish
Percentage of trips	1oo 1)	o	26	18	25
Fishing days per trip	6,7	7,6	7,1	6,4	6,2
Tons per fishing days:					
Haddock	o,5	2,4	o,8	o,3	o,1
Cod	2,7	o,9	6,9	1,5	1,7
Coalfish	2,8	o,8	1,4	8,4	1,7
Redfish	3,2	o,3	o,8	1,9	9,o
Others	o,8	o,5	o,5	o,6	o,9
Total	1o,o	4,9	1o,4	12,7	13,4

1) including 31% mixed trips

It may be presumed that a fishery explicitly for one species will always be carried out under the most favourable conditions possible; therefore, the unit yields drawn from the special fisheries will be comparable (although it is not certain, that during such trips the fishery was not directed partly also to other species).

On the other hand, the unit yields of the single species, as calculated from the total fishery, depend to a decisive degree on which percentages of the total fishery was directed to the species in question or to other species. These percentages change from year to year or follow a certain trend during longer periods of years. Therefore the unit yields drawn from the total fishery so far were no longer apt for comparison. As far as necessary and possible, the overall unit catches per species have been raised to those of the special fishery in question. The conversion factors, found fully empirically for single years or groups of years and interpolated for the intervals, varied currently between near to 1 and up to about 3, quite exceptionally approaching 1o. In other cases such influences have at least been taken into account in one form or the other inter alia in the North Sea between haddock and coalfish. As far as separate statistics for any special fishery were available, their investigation revealed characteristic features as to spatial and seasonal distribution, concentrations and fluctuations in abundance of stocks etc., which could not be discerned in the statistics of the total fishery.

8. The effects of changes in market selection and mortality

As calculated from that part of the catch only, which is landed as human food, the unit yield is influenced essentially by the market selection (instead by the net selection only in case of complete utilization of catch). Certain species caught may be absent at all, while the commercial fishes are landed in a percentage of the quantities caught, which increases parallel to their market value. The market selection becomes more rigorous with increasing distance of the fishing area from the home ports, so that the unit yields in northern waters are calculated too low as compared with those of the North Sea.

In order to compute numerically this effect for any fish species its size composition in the landing is required. Completed by that of the non-marketable catch and the curves of the market selection as such, it was possible, for example, to explain a decrease in the unit catch of plaices by the German offshore cutters from 1931 to 1932 quantitatively from two causes, a density loss of the stock itself and a sharper market selection due to the economic depression of that year. For the most frequent case of only the size composition of the market landing being available, another solution for a quantitative calculation of selection changes was found later on. Supposing an unchanged fish stock, the right branches of two size composition curves are brought to cover each other; then the interval between the left branches, as depending on different market selection, may be counted out. In case of a length composition curve the cubics can indicate the respective weights.

If, however, the right branches do not have the same slope, that may be taken as a sign of different mortality rates. A steeper slope will probably reveal an additional fishing mortality, beginning with the fish size at which the net selection comes into action. In arranging both curves in a reasonable manner - i.e. the steeper the right branch the more to the left - again the interval can be counted out as expressing the loss by fishing mortality. This may, however, be hampered by 1) an abbreviation of the life cycle caused by rising temperatures and connected with an acceleration in growth, maturation and mortality; or (often in connection with such a natural changement) 2) a more pronounced orientation of the fishery to catch smaller fishes than before.

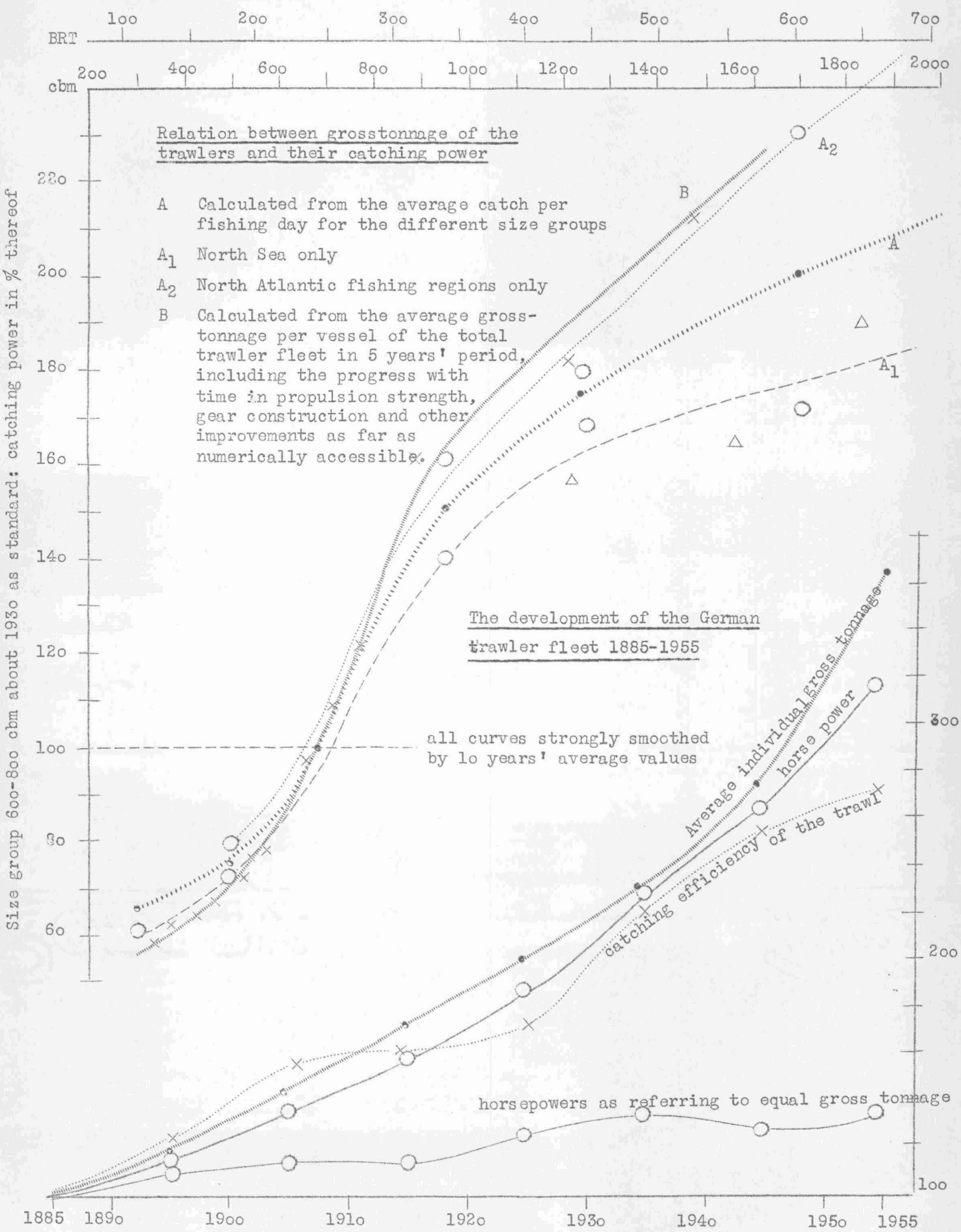
It seems that the market selection has tended to be sharpened in the course of time in connection with consumer claims, but that, in the contrary, it has often been weakened in order to compensate the yield decreases caused as well by fishing mortality as by environmental conditions. In any case, the procedure described may open a way to discriminate between the "artificial" changes by fishing mortality and market selection on the one side and those by natural causes on the other. As an example the calculation relating to the North Sea haddock may be given:

	Maximum (1894-97)	Minimum (1934-37)
Tons per unit effort	318	48
plus fishing mortality	-	55 (115%)
	318	1o3
minus gain by market selection	-	51 (5o%)
	318	52

The unit yields when amended in this way may be considered as indicating a natural stock changement, in this case a strong and continuous decrease. Generally speaking, however, the development in the stocks of commercial fish species was more complicated and manifold. In an obvious agreement with the "heating of the North" southern species reached a minimum about 191o, but increased thereafter in the North Sea; boreal species, on the contrary, became more abundant in the North Sea about 191o, and thereafter in the North Atlantic 192o-5o. Since then a decrease of the herring in the southern North Sea and of northern species in the North Atlantic - except Greenland - occurred. Within these natural changements in many cases the saving effects of the two World Wars can unmistakably be seen, but in the more distant fishing areas they are too weak to be percebtible immediately and for some shallow water species to some degree they are feigned by a transitory return of the steam trawl fishery to abandoned fishing grounds. The counter part of fish densities and yields decreasing because of highly intensive fishing, though very clearly visible in some cases, mostly reveals itself in a more diffuse manner by a predominance of declining trends in the unit yield curves. Such slopes can, however, as well be produced as also be avoided and hidden by changes in the fishery.

Summary

1. The "fishing day", since about 193o replacing the "day at sea" as a time unit, included a 75-85% "net in action" time.
2. The relative fishing power of trawlers was found empirically by comparisons between size groups of vessels fishing together within one month on the same fishing place.
3. The propulsion strength was not taken into consideration separately, but becomes important in case of changes independant of vessel size.
4. The gain in fishing power by gear improvement was estimated from existing information.
5. Relative fishing power comparisons in time were calculated from vessel size, propulsion strength and gear efficiency.
6. The catch per fishing day was recently converted to the power unit of the 6oo-8oo cbm trawler size group of 193o.
7. Since about 193o a sub-division as to the prevailing fish species led to relevant further corrections of the unit yields.
8. By comparing the length composition of market samples it was tried to estimate unit yield changes due to market selection and fishing mortality.


BRT
100
200
300
400
500
600
700
cbm
200
400
600
800
1000
1200
1400
1600
1800
2000
Relation between grosstonnage of the trawlers and their catching power
A Calculated from the average catch per fishing day for the different size groups
A1 North Sea only
A2 North Atlantic fishing regions only
B Calculated from the average gross-tonnage per vessel of the total trawler fleet in 5 years' period, including the progress with time in propulsion strength, gear construction and other improvements as far as numerically accessible.
Size group 600-800 cbm about 1930 as standard: catching power in % thereof
220
200
180
160
140
120
100
80
60
A2
B
A
A1
The development of the German trawler fleet 1885-1955
all curves strongly smoothed by 10 years' average values
Average individual gross tonnage
horse power
catching efficiency of the trawl
horsepowers as referring to equal gross tonnage
300
200
100
1885
1890
1900
1910
1920
1930
1940
1950
1955

The development between 189o and 1955 of the average total market catches per trip (calculated in 5 year-periods for the most important fishing areas).