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The Influence of the Concentration of Fishing Effort and
Fishing Power on the Catch per Unit Effort



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Information on catch effort, position and fishing power has been collected from the fishing port Bagenkop, located at the Western Baltic. This port has been preferred for this investigation, because all the cutters there are using exactly the same type of gear, a combined cod/flatfish trawl, the groundrope 60-80 ft fitted with small bobbins, and because the number of species caught is small, only cod, plaice, dab and flounder being caught in considerable quantities. As by-catches brill, turbot, and whiting are landed in negligible amounts. It should be mentioned that no other types of trawls are used, further that no other fishermen, neither Danish nor German, fish in this area.

The size of the cutters is between 10-20 metric tons, most frequently 12-16 metric tons, and they are fitted with two-stroke engines which develop 35-100 H.P. The number of cutters is about 65 during winter - January-April - (the cod season), and during spring and summer about 40, because some of the largest vessels leave the western Baltic in order to catch sole in the North Sea or Norway lobster in the Kattegat.

All the cutters make one-day trips starting in the morning about 0300 and returning about 12 hours later.

Catch per unit effort and effort

The following refers only to catches of plaice and cod. The figures shown exemplify to which extent a comfortable fishing ground with a smooth bottom gets a high fishing effort accompanied by a lower catch per unit effort, in comparison with bordering, more uncomfortable, fishing grounds with a rough bottom or other obstacles leading to a low fishing effort and a higher catch per unit effort.

It appears from Figure 1 that fishing is carried out in six main areas. The dots representing 100 hours trawling refer to one week's trawling every month from October 1961 to September 1962, and thus they do not represent the total effort which is 3-4 times greater. It also appears from Figure 1 that the effort is very differently distributed among the six areas and that it is by far the greatest in area 3. In areas 2 and 4 the effort is four times less and in 1 and 5 about ten times less than in area 3.

The distribution is governed by the following factors:-

Area 1 has a rather shallow water and only the westernmost part of it serves as breeding place for cod and plaice. The fishing in this area is limited to rather short periods, i.e. autumn and spring, and in the westernmost parts January-March. Fishing in this area is carried out by the smallest cutters.

Area 2 is an important breeding place for cod and plaice but the lack of oxygen in the bottom layer during summer and autumn restricts the fishing to winter and early spring.

Area 3 offers good and smooth bottom conditions. It is an important breeding place for cod and plaice and fishing here is carried out throughout the year.

Area 4 is an important breeding place for cod and plaice, but the bottom is rough and difficult to trawling, and therefore only a limited number of "specialists" are fishing here. Fishing is carried out throughout the year.

Area 5 resembles Area 1 with regard to bottom conditions and depth. Fishing is carried out here from July to April but only by a smaller part of the fleet, fishing being prohibited here owing to the fact that the area is a mine field from the second World War.

Area 6 has rather smooth bottom conditions, apart from the fact that there are many wrecks. Due to the distance from Bagenkop only the biggest cutters are fishing here, especially in winter. During summer the lack of oxygen in the bottom layer is not seldom. In this area other Danish fishing crafts are fishing, together with numerous German ones. The true effort is thus very much more than 3-4 times the effort shown in Figure 1.

Summing-up the above description of the six areas:- the fishing effort in Area 3 is rather heavy due to the fact that fishing is comfortable and not limited by any troubling factors or to any season of the year.

Figure 2 shows the mean catch of plaice and cod per 1 hour's trawling in the period October 1960 - September 1962 and thus corresponding to the effort shown in Figure 1. It appears that the values for catch of plaice is highest in Area 4, followed by Areas 3, 5, 2, 6 and 1 in the order mentioned, but as fishing is only carried out throughout the year in Areas 3 and 4 only these two areas are comparable with regard to the mean catch per unit effort for the whole year.

By comparing Figures 1 and 2 it appears that the high effort in Area 3 corresponds to a lower catch per one hour's trawling than in Area 4, in which the effort is only 25% of the effort in Area 3. Or, in other words, in Area 4 the rough bottom has reduced the effort to 25% of the effort in Area 3 and this reduction has increased the catch per unit effort by about 36%.

With respect to cod it is seen that the values for catch per 1 hour's trawling in Areas 2, 4, 5 and 6 are very similar (76.0-82.8 kg) but in Area 3 it is considerably lower (57.6 kg) and is lowest in Area 1 (40.1 kg), the latter because most of the fishing hours have been used for catching flatfish.

A comparison between Areas 3 and 4 shows that the reduction of the effort to 25% as in Area 4 has increased the catch per 1 hour's trawling with about 44%.

The most important season for cod fishing in the western Baltic is January, February and March. In order to omit the fishing hours which have been used for fishing flatfish, the mean catch of cod per 1 hour's fishing for the months concerned has been calculated as shown in Table 1.

Table 1

Area	Catch per 1 hour's fishing (kg)	Fishing effort (100 hours)	Kg per 1 hour's trawling corrected to 59 H.P.	Weighted mean fishing power
1	89.4	0.9	93.5	54.61
2	103.6	3.1	97.9	65.24
3	74.1	19.4	74.1	59.05
4	168.8	3.2	161.4	62.71
5	188.5	0.8	176.1	72.54
6	119.7	0.2	105.0	75.00

It appears that Area 3 now yields the lowest catch per unit effort, corresponding to the high effort in this area. By comparing Areas 3 and 4 it is seen that the effort in Area 4 is only about 17% of the effort in Area 3 and that the catch per 1 hour's trawling in Area 4 is about 122% greater.

Catch per unit effort and fishing power

The catch per unit effort of cod and plaice has been calculated for each of the cutters which has been fishing in Area 3 in January, February and March 1962. The cutters have been grouped with respect to horse power, and the mean catch per 1 hour's trawling has been calculated for the different horse power groups (35-100 H.P.) and plotted against the horse power. The ordinary regression line has been calculated.

In Figures 3 and 4 the results with respect to catch of plaice (Figure 3) and cod (Figure 4) are shown.

It appears that the regression line in Figure 3 is almost horizontal ((the slope is 0.002) $y = 7.75 + 0.002 x$). There does not seem to be any relation between H.P. and catch per unit effort of plaice when plaice is caught as by-catch to cod fishing.

From Figure 4 it appears that there is a positive relation between H.P. and catch of cod per 1 hour's trawling. The slope of the line is 0.920 corresponding to 9.2 kg per 1 hour's trawling per 10 H.P. ($y = 58.29 + 0.92 x$).

In order to estimate if the fishing power is related to catch per unit effort of plaice during the time in which this species is the most important fishing object similar calculations as mentioned above have been made for the months October, December 1961 and July 1962. The result is shown in Figure 5. It appears that the positive slope of the regression line is so slight (0.130) ($y = 42.39 + 0.13 x$) that there seems to be no relation between H.P. and catch per unit effort.

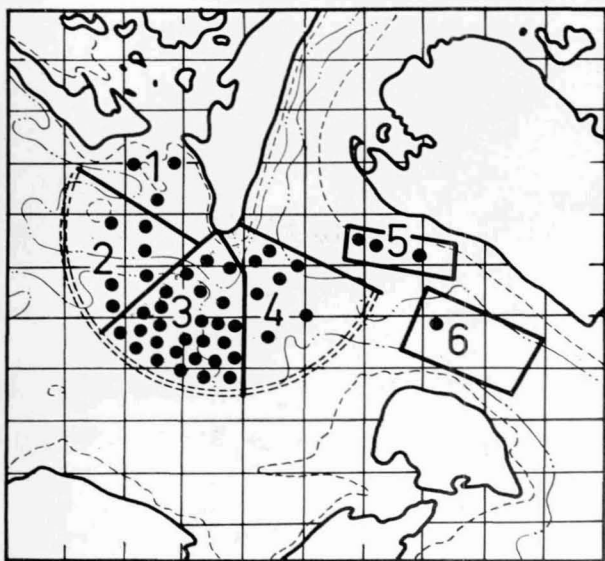
Unfortunately, the number of landings is rather small, especially within the interval 80-100 H.P. And the values are suspiciously low. In order to eliminate this probable error these values have been omitted in Figure 6. Now the slope of the line has increased positively (0.453) ($y = 25.12 + 0.453 x$).

In other words, it seems that within the interval 35-75 H.P. the catch per 1 hour's fishing of plaice increases 4.53 kg when the fishing power increases 10 H.P.

The influence of the fishing power on the catch per unit effort of plaice and cod is thus varying, depending on which of the species is the main subject for fishing, but within the interval 35-100 H.P. catch per unit effort of plaice seems in all events to be influenced by the fishing power to a lesser degree than the catch per unit effort of cod.

In Table 1 the weighted mean fishing power used in the six areas for cod fishing during the months January, February and March 1962 and the corrected values for catch per 1 hour's fishing are shown. The values are corrected to 59 H.P. by means of the regression line in Figure 4.

It appears that the correction is not without effect. The catch per 1 hour's fishing in Areas 1 and 2 is now almost the same.



●: 100 trawling hours

Figure 1. Fishing effort. Each dot represents 100 fishing hours employed for plaice and cod by fishing one week every month from October 1961–September 1962.

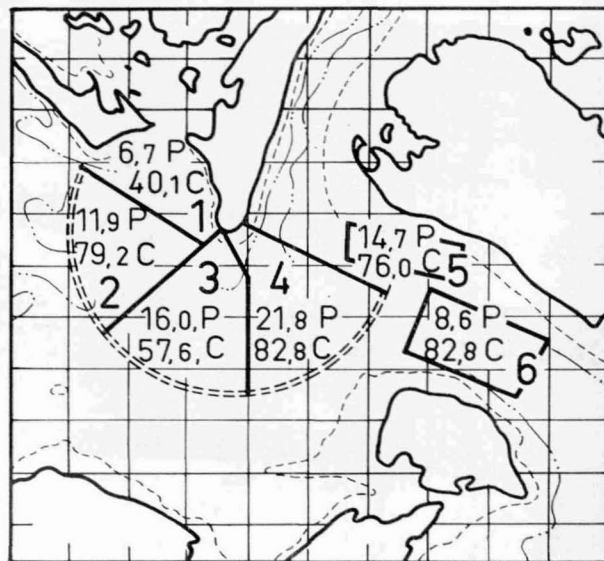


Figure 2. Catch per 1 hour's fishing of plaice (P) and cod (C) one week every month from October 1961–September 1962.

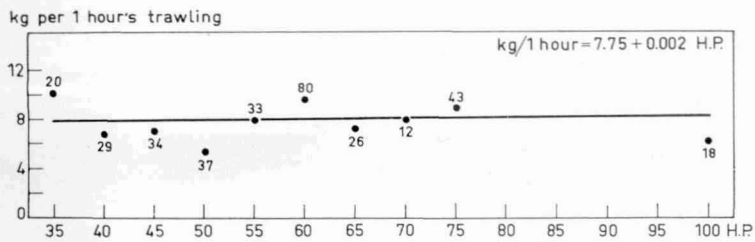


Figure 3. The relation between catch per 1 hour's fishing of plaice in area 3 (January, February and March 1962) and fishing power.

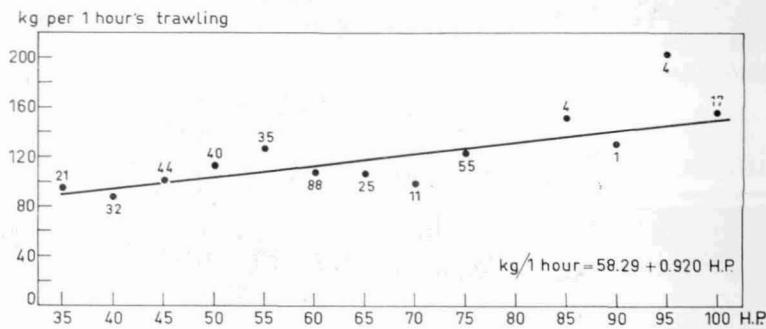


Figure 4. The relation between catch per 1 hour's fishing of cod in area 3 (January, February and March 1962) and fishing power.

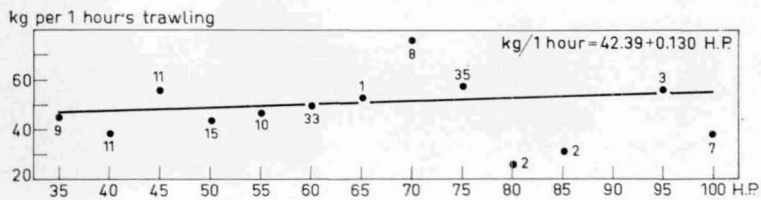


Figure 5. The relation between catch per 1 hour's fishing of plaice in area 3 (October, December 1961 and July 1962) and fishing power.

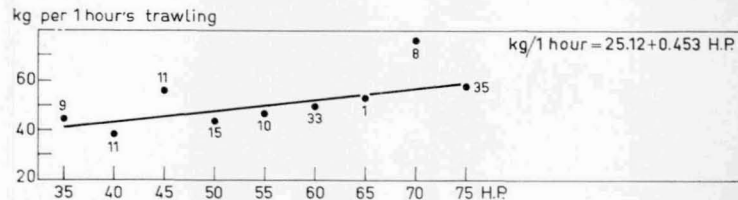


Figure 6. The same as Figure 5 but 80–100 H.P. omitted.