On the Relative Fishing Power of Dutch Trawlers

By

J. J. Zijlstra and J. F. de Veen

Rijksinstituut voor Visserijonderzoek, IJmuiden

Introduction

In an attempt to standardize fishing effort, the relative fishing power of three types of Dutch trawlers have been studied in relation to some characteristics of the vessels. The relative fishing powers of the vessels have been estimated for separate species of fish, with a view to possible intraspecific differences. Besides, by considering the catches of single species only, some of the effects of specific adaptation in fishing gears have been eliminated. Estimates of fishing power were made with respect to three species, the herring, plaice and sole.

Herring are caught with special herring trawls and two types of vessels are involved in the fishery: steam trawlers and motor trawlers, whereas plaice and sole together form the main catch of a demersal fishery carried out by motor cutters.

Methods

The methods used in calculating the relative fishing powers were similar to those described by GULLAND (1956): after assessing the relative fishing powers estimated on a series of occasions for a number of standard ships, which all fished together, the fishing powers of other ships were obtained by reference to these standard ships.

The statistical material, used for herring, referred to the fishery in the years 1952–1957 and comprised data on 104 ships (20 steam trawlers, 84 motor trawlers).

The material on plaice and sole covered the period January–March 1960, and involved a total of 191 cutters.

The fishing powers obtained were compared with gross tonnage and engine power (steam trawlers Indicator Horse Power (IHP); motor ships Brake Horse Power (BHP)). Furthermore, in the case of motor trawlers and motor cutters a possible influence of the year of construction has been taken into consideration.

The following survey gives a general impression on the variation of the characteristics of the vessels:—

Type of vessel	Gross tonnage range	Gross tonnage average	Engine power range	Engine power average	Year of construction range
Steam trawler......	250–550	365	450–880 IHP	625 IHP	–
Motor trawler......	120–400	225	150–900 BHP	450 BHP	1901–1957
Motor cutter.......	31–230	85	100–480 BHP	210 BHP	1892–1959

The data on fishing power have been averaged per ship to calculate the regressions between fishing power and ships characteristics in the case of the herring fishery, whereas for the plaice and sole fishery the various individual estimates of fishing power per ship have been used.

Table 1

The characteristics of Dutch fishing vessels and their fishing power

	Steam trawler Herring	Motor trawler Herring	Motor cutter Plaice	Motor cutter Sole
r_{y1}............	0·729 (ss)	0·691 (ss)	0·453 (ss)	0·519 (ss)
r_{y2}............	0·884 (ss)	0·797 (ss)	0·562 (ss)	0·681 (ss)
r_{y3}............	–	0·691 (ss)	0·117 (s)	0·151 (ss)
$r_{y1.2}$...........	−0·027	−0·024	0·050	0·006
$r_{y2.1}$...........	0·752 (ss)	0·550 (ss)	0·376 (ss)	0·516 (ss)
$r_{y1.3}$...........	–	0·426 (ss)	0·482 (ss)	0·557 (ss)
$r_{y2.3}$...........	–	0·612 (ss)	0·565 (ss)	0·688 (ss)
$r_{y1.23}$..........	–	−0·107	0·089	0·060
$r_{y2.13}$..........	–	0·491 (ss)	0·348 (ss)	0·489 (ss)
$r_{y3.12}$..........	–	0·331 (ss)	0·155 (ss)	0·207 (ss)

(s) = significant ($p < 0{\cdot}05$)
(ss) = significant ($p < 0{\cdot}01$)

Results

The possibility of a relationship between fishing power and ship characteristics can be estimated from the ordinary and partial correlation coefficients given in Table 1, where fishing power is denoted by the suffix y, gross tonnage by the suffix 1, engine power by the suffix 2, and year of construction by the suffix 3.

From Table 1 the following features may be noticed.

1. Although the ordinary correlations between fishing power and gross tonnage are fairly good, the correlations disappear when the effect of engine power is eliminated.

2. Correlations between fishing power and engine power are the highest among the ordinary correlations, and remain high and significant after elimination of the effects of tonnage and year of construction.

3. Rather low but significant correlations are found between fishing power and year of construction, even when the influences of tonnage and engine power are eliminated.

4. The general pattern of correlations between fishing power and ship characteristics is similar for the various types of vessels and fish species.

Among the correlations between fishing power and the three ship characteristics studied only those for engine power and year of construction are significant. Since the validity of the regressions between fishing power and year of construction is probably restricted to the period under consideration, the regressions between fishing power and engine power are the only ones shown here.

The linear regressions are given below, in which P denotes fishing power and E engine power:—

$P_1 = 0{\cdot}0367\ E_1 - 9{\cdot}27$ (Steam trawler, herring) .... (1)
$P_2 = 0{\cdot}0351\ E_2 - 3{\cdot}71$ (Motor trawler, herring) .... (2)
$P_3 = 0{\cdot}0059\ E_3 + 0{\cdot}51$ (Motor cutter, plaice) .... (3)
$P_4 = 0{\cdot}0040\ E_4 + 0{\cdot}29$ (Motor cutter, sole) .... (4)

None of these regressions indicate a direct proportionality between P and E. The deviations from direct proportionality proved to be significant in all four regressions, on a probability level of $p < 0{\cdot}01$.

This means that for the herring fishery, the ships with the larger engines are, horse power for horse power, more powerful than those with the smaller engines, whereas the reverse is true for the flatfish fishery. Since the fishing powers of motor trawlers and steam trawlers have been expressed in the same units (standard ships), they are directly comparable.

It can be calculated from equations (1) and (2) that within the entire observed range the regression line for motor trawlers lies above that for steam trawlers. Although those regression lines are converging, the fishing power of a motor trawler of n BHP can be said to be roughly equivalent with the fishing power of a steam trawler of about 1·3 n IHP.

Comparison of the regressions after combining the various scales of fishing power by making regression lines coincide in one point, leads to the conclusion that equations (3) and (4) could be identical, whereas all the other comparisons showed significant differences.

Discussion

In the case of Dutch trawling vessels, significant ordinary correlations were found between the fishing power of the ships and their gross tonnage, engine power, and year of construction. After elimination of the interrelations between the ship characteristics, only the correlations with engine power and year of construction remained significant, the ordinary correlations with gross tonnage being apparently due to the interrelation between gross tonnage and engine power.

The methods used cannot give any information about the causation of the relationships found, although the results strongly indicate an influence of engine power on fishing power.

We could assume that this influence operates through the propulsive power, which in its turn determines largely the speed of the gear and gear characteristics such as trawl size or distance between otter boards, which are probably more directly related with fishing power. In the case of Dutch trawling vessels this assumption may hold good, for generally the full engine power is utilized during fishing operations.

The relationship between fishing power and year of construction could at least partially be explained in terms of a selection of crews, the better crews working on the newer ships. GULLAND (1956) suggested this for British trawlers, but failed to find a significant effect of the factor. It is also possible, however, that changes in the shape of the hulls have played a role, and that a difference in propulsive power is hidden in the factor age of the vessels, which does not appear in the figure used for engine power, for instance because of the age and the efficient use of the engine.

None of the regressions between fishing power and engine power revealed direct proportionality, the intercepts being positive in the case of flatfish fisheries, but negative for the herring fisheries. GULLAND (1956) also found deviations from direct proportionality in the regression between fishing power and engine power, based on material of demersal fisheries, all intercepts being positive.

A possible explanation for the exceptional negative intercept, observed in the herring fishery, might be found in the fact that a fast towing speed is required in this fishery (speed between 3·5–4 knots), this in contrast to the requirements for the demersal fisheries. The absence of direct proportionality in the relationships makes it necessary to convert the effort into hours fishing of a standard ship of a given horse power.

GULLAND's (1956) results for British steam trawlers do not fully agree with our findings, because he obtained better correlations between fishing power and gross tonnage, the correlations with engine power after elimination of the effect of tonnage being very low.

An explanation for this disagreement might be offered by the different ways in measuring horse power, GULLAND using nominal horse power, whereas in this study indicator horse power has been used.

We were informed that indicator horse power is measured directly from the engines, but that nominal horse power depends less on the power of the engine than on the costs of surveying it. Calculations showed indeed that there is hardly any relation between IHP and nominal horse power. If nominal horse power is a poor measure of the power of the engine, GULLAND's partial correlations have little meaning. In the case of motor trawlers GULLAND used BHP and for this type of ship his calculations show a fairly good agreement with our results, though his partial correlation between fishing power and gross tonnage is still significant.

The difference in fishing power, observed in Dutch herring trawlers, motor vessels being 1·3 more powerful than steam vessels of the same horse power, is probably also related to the measurement of engine power, because BHP (motor trawlers) is measured nearer to the propeller than IHP (steam trawlers).

In this investigation both ordinary correlations of fishing power with engine power and with gross tonnage were found to be fairly high, the first one being somewhat higher than the second. It is therefore rather irrelevant, which of two possible regressions is used for standardizing the effect for the period to which the regressions refer. It has, however, been shown that engine power is closer connected with fishing power, and that the true agent in the relation fishing power/gross tonnage is the interrelation between gross tonnage and engine power. This means that any future or past change in this interrelation affects the regression between tonnage and fishing power and upsets an obtained standardization of effort, based on tonnage, unless the regression is constantly tested and adapted. It seems therefore preferable to use the regression fishing power/engine power for the standardization of fishing power.

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Summary

1. In an attempt to standardize fishing effort, the relative fishing power of three types of Dutch trawlers have been studied in relation to some characteristics of the vessels. The estimates of the fishing power of steam trawlers and large motor trawlers referred to the herring catches of these ships, whereas the estimates of the fishing power of smaller trawlers (cutters) were calculated separately from sole and plaice catches.

2. It could be shown that the fishing power for all types of ships and catches were significantly correlated with the engine power, tonnage and the year of construction of the vessel. However, after eliminating the interrelation between the three vessel characteristics, only the relationships between engine power/fishery power and year of construction/fishing power remained.

3. None of the (linear) regressions between fishing power and engine power indicated direct proportionality, the deviations being significant for all four regressions.

4. The intercepts were found to be positive in the case of the flatfish catches, but negative for the herring catches.

Reference

GULLAND, J. A., 1956. "On the fishing effort in English demersal fisheries". Fish. Invest. Lond., Ser. 2, **20**:(5) 41 pp.