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Report No.1 to ICNAF Committee on Research and Statistics regarding the use of propeller data for the evaluation of fishing power

by Jan-Olof Traung
Chief, FAO Fishing Boat Section

At the Joint Scientific Meeting of ICNAF, ICES and FAO in Lisbon, Portugal, from 27 May to 3 June, 1957, a paper was presented by the FAO Fisheries Division, Biology Branch, entitled The Measurement and Analysis of Fishing Operations a Review. I contributed an appendix to this paper discussing certain parameters which could be used for plotting the fishing power of trawlers mainly.

It was stated that trawlers from one port and of the same age often had a certain relation between length, beam, depth, power and even height of the mast. By this it was meant that when comparing trawlers from one port only in did not really matter much which parameter one used.

However, the problem was more difficult when comparing trawlers from different ports, different countries and of different age. The length of trawlers is measured several different ways and, with the introduction of transom sterns in modern British trawlers, the use of length could cause some confusion as to the real size of the vessel; gross register tonnage was considered to be most representative of the size of the vessel but it should perhaps have been made much clearer in the paper that trawlers of the same gross tonnage might have very different power of the propulsion plant.

An explanation was given of the different powers attributed to the propulsion plant which was intended to show how very careful one has to be with power ratings and how important it is always to consider the r.p.m. (revolutions per minute) of the propeller. It was also indicated that trawlers did not always utilise the full output of their engines while trawling; perhaps it should also have been emphasized that the percentage used is quite different in various size groups of trawlers. Many long distance trawlers have their engines mostly for steaming to and from far distant fishing grounds and only utilise a small part of them for trawling. The appendix finished off by suggesting various means of determining engine output and also proposing that the propeller could be used as an indicator of the thrust delivered by the engine.

In November 1959 I suggested that ICNAF should endeavour to include in future vessel lists information on the actual propellers used by the various trawlers together with a statement of the r.p.m. at which they work while trawling. This would make it possible to determine for individual vessels a kind of "trawling number". The "trawling number" was to be based on the thrust delivered by the propeller. The resistance of trawlers at three to four knots speed is very low and the difference in the resistance between trawlers of various designs is still less. Thus it is assumed that the "trawling number" can be based on the propeller thrust disregarding completely the vessel resistance, in fact the "trawling number" would be proportional to the resistance of the trawl and would perhaps give a better linear relation when plotting fishing power than length, horsepower or gross tonnage had given. It is also felt that such a "trawling number" would make possible comparisons between trawlers from one port and another and between those of one age and another.

It was realized that such a number should preferably be based on the actual trawling speed. Trawling speed is however, seldom measured, skippers' judgments vary and, further, because currents along the bottom sometimes differ from those on the surface, even a correct measurement of the trawling speed might contain errors. It was suggested that such a "trawling number" should be tried out in relation to a standard speed, say of three knots, and that one should then simply assume that if the net is smaller than the standard, the trawling speed is higher or, vice versa, the "screened water" would be approximately the same. It was admitted that this was a simplification because fish which were strong swimmers would naturally have greater difficulty escaping if the trawling speed were higher.

It was suggested that the information on the propeller and the propeller r.p.m. should be noted while trawling in a wind force less than Beaufort 3. In higher wind forces the r.p.m. of the engine would be increased in order to overcome the resistance of waves and wind. There would, however, be no more thrust delivered to the trawl and therefore its fishing power would not be influenced.

This proposal was considered by ICNAF at its meeting in Bergen in 1960 and it was decided to make a "pilot study of the possibility of using propeller specifications and their operating r.p.m. as an index of fishing power". It was suggested that a small number of trawlers (say ten) fishing in the ICNAF area should be selected for the study.

I recommended that we select the trawlers of different sizes and whose fishing powers had already been determind from statistic of catch and related to length gross tonnage or horsepower. One would then be able to determine whether their fishing powers were better related to the propeller index. It was suggested that it was most important to get a very honest statement from the skipper of the r.p.m. at which he lets his trawler run in a wind force below Beaufort 3.

The ICNAF Vessel List for 1959 contains information, for some trawlers, on the propeller dimensions as well as the r.p.m. at which the propeller is working while trawling in calm weather. I have calculated the thrust developed by the propellers for the trawling speeds given and this has been listed in Table 1. When these figures are plotted in relation to the nominal rating in h.p. of the engines it is apparent that there is not a very good relation.

Thus it is clearly dangerous to use h.p. only, and it suggests that there may be a better relation between the thrust data and the fishing power than between the h.p, data. Without the fishing power data, this is naturally impossible to determine. A futher difficulty is that some of the r.p.m. particulars given might not be true.

When working with the data it was felt that much might be more desk data rather than actual information from skippers. For example, the six Canadian boats having 52" x 36" propellers are all said to be trawling at exactly 266 r.p.m.; this is hardly possible.

When working with the German data I was warned by Dr. J. Scharfe, FAO Gear Technologist, that the r.p.m. values given were probably higher than those used during actual operations. It seemed to him that the data given in the list were not obtained from the skippers themselves but rather consituted test data taken during the delivery trial. I therefore did not conclude my calculations on the German data but wrote to a personal contact in Germany to find out more, but I have not yet had an answer.

Something should perhaps be said about using propeller data to calculate the thrust. In so called model testing tanks, series of related propeller models have been tested and the results plotted in various ways. Propeller models with various number of blades, varying blade areas and varying relation between the pitch and the diameter have been tested. In order to calculate the thrust, we are interested in the curves for the thrust co-efficient K_T; Figure 1 shows such curves for three blade propellers having 50% blade area, and pitch-diameter ratios P/D from 0.5 to 1.4. If one wants to obtain the thrust co-efficient while trawling one has to calculate the speed co-efficient, λ, which is a non-dimensional number made up of the ship's speed minus the wake divided by the propeller revolutions and the diameter of the propeller. The propeller of the Canadian trawler GERARD DIANE, entry No.16 on the Canadian Sheet No.1, which is assumed to have a 50% propeller blade area, has three blades and its speed co-efficient during trawling is calculated as follows:-

$$\Lambda = \frac{V_e}{n.D}, \text{ where } V_e = \text{Propeller speed in ft/sec.} =$$

$$= 0.8 \text{ Trawling speed} =$$

$$= 0.8 . \ 4 \text{ knots} . \ 1.69 = 5.4$$

$$n = \text{revolutions per second} =$$

$$= \frac{266 \text{ r.p.m.}}{60} = 4.43 \text{ r.p.s.}$$

$$D = \text{Prop. diam. in ft.} = \frac{52''}{12} = 4.33 \text{ ft.}$$

$$\text{thus } \Lambda = \frac{5.4}{4.43 \ . \ 4.33} = 0.282$$

The pitch-diameter ratio, P/D, is $\frac{36''}{52''} = 0.693$, say 0.7

From Figure 1 then the thrust co-efficient, K_T, is read to be 0.2

The thrust is calculated from the following formula:-

$T = K_T \cdot \rho \cdot n^2 \cdot D^4$, where ρ = density factor for seawater = 1.988

thus $T = 0.2 \cdot 1.988 \cdot 4.43^2 \cdot 4.33^4$ = 2790 lb. = 1.265 ton (metric)

All the figures in Table 1 have been calculated similarly and using the declared trawling speed. Because this speed seems to be rather arbitrary, the question arises whether one could simplify determination of the trawling number by using simply 0 speed of advance. The K_T would then be read off at the speed co-efficient Λ = 0. This would make it possible to plot the thrust co-efficients for many different propellers on a simple diagram somewhat similar to Figure 2 instead of from a great number of diagrams. Interpolation for the exact P/D ratio would be simpler and more precise. It would further make it possible to design some kind of calculation form with the help of which even non-technical people could perhaps calculate the "trawling numbers."

Unfortunately it has not been possible to devote as much time to this important matter as would have been desirable. If, however, the fishing power could be given for a number of trawlers for which we know the propeller data and the true r.p.m. (which perhaps could be obtained by conversation with the skippers). I would be glad to investigate whether or not one could base the "trawling number" estimates on a diagram like Figure 2 and to design a suitable form.

To sumraize, it is suggested that the ICNAF R + S Committee might arange to

1. Check the r.p.m. particulars.

2. Obtain fishing power estimates for selected vessels for which propeller data are available.

3. investigate the exactness of the suggested simplified method for calculating the "trawling number."

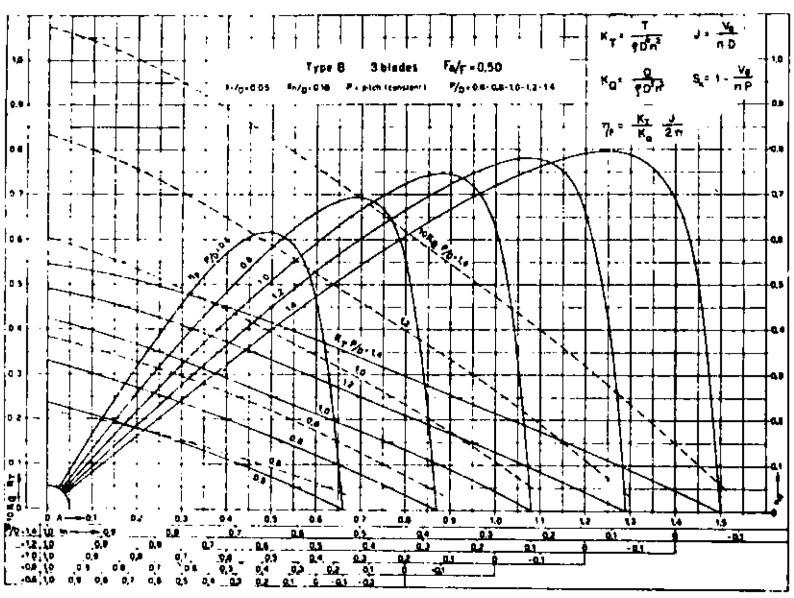
TABLE I

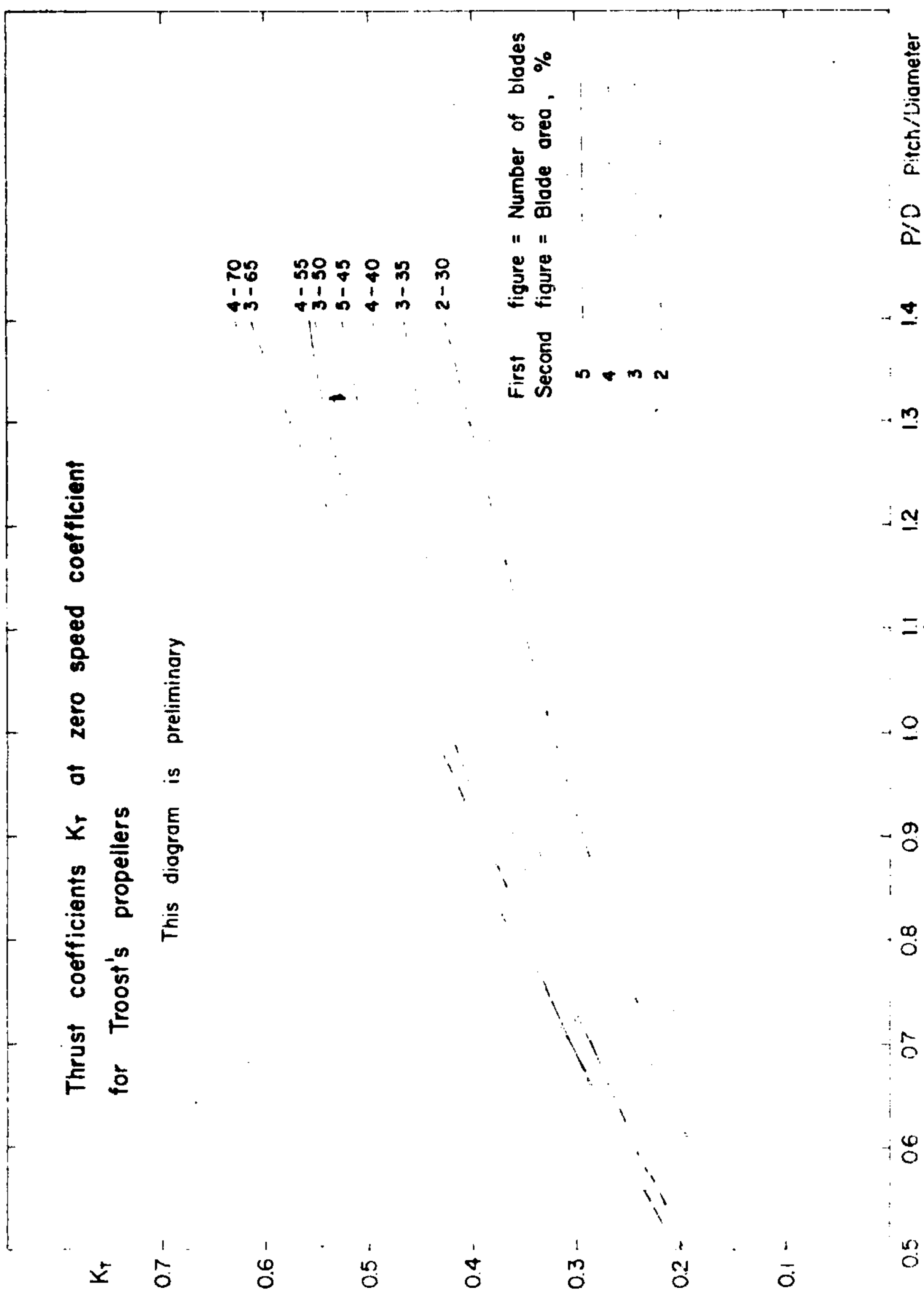
Trawling thrust in metric tons calculated from data given in ICNAF 1959 Vessel List

Country	Sheet No.	Row No.	Nominal Brake h.p.	Trawling Thrust Ton
Canada	1	16) 19) 20) 24)	225	1.265
	2	16) 18)		
	1	30	225	1.35
	2	28)	650	6.57
	3	1) 13) 27)		
	2	33	625	7.7
France	1	3	1000	4.46
		6	1500	11.60
		7	1300	12.35
		8	2100	14.95
		14	1500	10.20
		17	1250	11.90
		20	1900	16.6 to 18.3
		22	1200	12.75
		23	1200	10.25
		24	1000	6.9
		26	1200	8.75
		27	1500/1175	18.4
		28	1100	6.5
		30	1100	2.11 to 2.66
Germany	1	1	1000	11.8
		2	875	12.8
		3	880	14.15
		4	1000	15.95
		12	1500	28.1
Italy	1	1) 2)	1200	9.85
Poland	1	2) 3)	800	0.25 (Prop. data must be wrong. Radius given instead diam.?)

FIGURE 1

Thrust coefficient, KT; Torque coefficient, KQ; and efficiency, η, curves for Troost 3-bladed propellers with 50% blade area and pitch/diameter ratios, P/D, 0.5 to 1.4.





Thrust coefficients K_T at zero speed coefficient
for Troost's propellers
This diagram is preliminary
4-70
3-65
4-55
3-50
5-45
4-40
3-35
2-30
First figure = Number of blades
Second figure = Blade area, %
5
4
3
2
K_T
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
P/D Pitch/Diameter

Figure 2.