

FORUM

Traffic Distribution and Collision Rate/Size Correlations Derived from Dover Straits Survey Data

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AFTER reading the first two reports on the surveys of marine traffic in the Dover Strait conducted by the National Physical Laboratory,^{1,2} it was decided to investigate the possibility of applying the results to two points raised in recent issues of the *Journal*.

The first question studied was one suggested by Beattie,³ in his article on the first of the above traffic surveys. It was noted that there was quite a variation in the number of ships per hour passing through a given area. This could have been caused by a systematic tendency for ships to come through in clusters or could be a perfectly random variation. If the variation was completely random then the frequency distribution of ships per hour should follow a standard statistical distribution known as the Poisson distribution. For each of six separate distributions obtained from the results of the surveys on 26 February to 1 March 1971 and 27 April to 29 April 1971, the appropriate theoretical Poisson distribution was fitted and tests made to assess how close the theoretical and observed distributions were. The results of the calculations are summarized below in the table.

The principle behind a statistical test such as the one used below is to compare the calculated test value with values from a theoretical statistical distribution of which the test value should be a member if the hypothesis being examined is true. Thus the 5 per cent values of the different theoretical χ^2 distributions used here are the values which only have 5 per cent of their particular distribution greater than them. Analogous definitions apply for the 1 per cent values. Hence if the calculated test value is less than the appropriate 5 per cent theoretical value it lies in the main 95 per cent of the theoretical distribution, but if it is only less than the appropriate 1 per cent theoretical value, its membership of the distribution is less conclusively shown, because in order for it to fit the distribution at all, 99 per cent of the values of the distribution have had to be considered.

It is interesting to note statistically that, using the ordinary χ^2 goodness of fit test, very good fits were obtained for all the above distributions, which illustrates the greater sensitivity of the variance test. Using the variance test, for one to conclude that there is a good fit between the two distributions the calculated statistic should have a value less than the 5 per cent critical value of the appropriate χ^2 statistic. Thus the results for the second survey are a little inconclusive as, with the exception of Zone 2, the calculated values are all near the critical values. However, none of the calculated values is greater than the 1 per cent

critical values, so in no case is the fit very bad. To illustrate the differences between the observed and theoretical distributions the results for Zones 1 and 2 of the second survey are shown in Figs. 1 and 2 respectively.

The results for the Dungeness survey which are based on more observations (69) do on the other hand suggest a good fit. From the tables on the second survey report of ships positively identified, a few such as naval and fishing ships were sometimes travelling in groups. When this occurred it would make the variance test statistic larger. Taking this into account therefore it would seem reasonable to conclude that in general most ships do pass through the Dover Strait at random and the large number of ships seen at one point at one time are there together purely by chance. It would, however, be useful now to repeat the analysis with a larger number of observations.

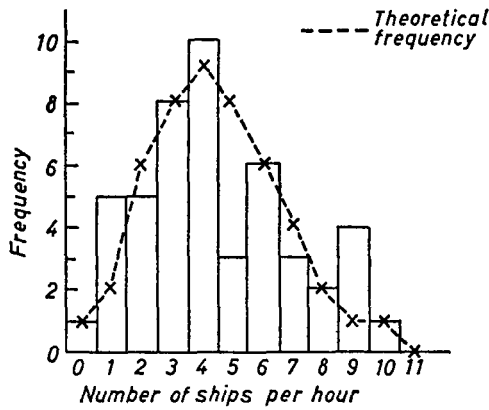


FIG. 1. Zone 1 Main SW. lane

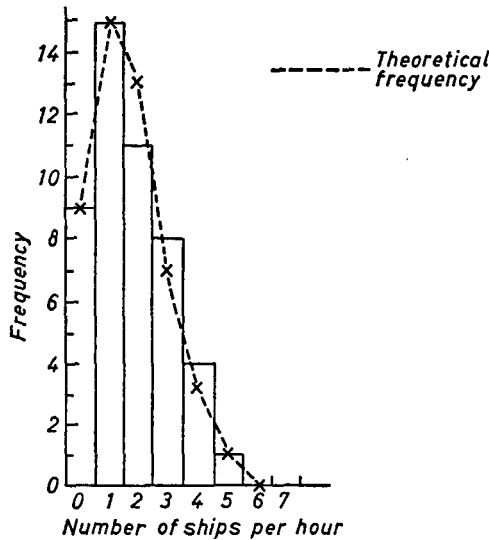


FIG. 2. Goodwin Sands to South Falls Buoy

If the above conclusions are in fact true, they will be in line with observations on ships passing through the Keihan Canal, connecting Yokohama and Tokyo and on ships in the straits between Helsingör and Hälsingborg both of which were found to fit the Poisson distribution quite well. It will also be possible to calculate the probability of any given number of ships simultaneously being in a certain area, which is relevant to questions of collision risk and traffic flow.

The second question studied arose from the article by Fujii and Shiobara⁴ on the analysis of traffic accidents in which they stated that a linear correlation had been found between $\log R$ and $\log G$ where R is the ratio between the number of vessels in collision and the number of vessels registered, and G is the gross tonnage. A linear correlation between two variables x and y implies that there is a relationship between them of the form $y = a + bx$. This equation is known as a regression line and the value of the correlation coefficient is a measure of the amount of scatter of individual pairs of values of x and y about the calculated line.

In the above analysis a correlation coefficient of 0.95 was found and the slope of the regression line was 0.5. This implies that the relationship between R and G is of the form $R = KG^{0.5}$ where K is a constant.

DISTRIBUTION OF HOURLY TRAFFIC VOLUME

Traffic zone	Total number of ships	Average number of ships per hour	Variance test		
			Calculated value	χ^2 Critical values	
				5%	1%
<i>A. Survey from 12.00 G.M.T. on 26 February 1971 to 12.00 G.M.T. on 1 March 1971 of traffic from Dungeness (observations recorded for 69 hours)</i>					
1. English inshore	293	4.25	76.54	88.25	—
2. Main southbound	324	4.70	85.82	88.25	—
<i>B. Survey from 12.00 G.M.T. on 27 April 1971 to 12.00 G.M.T. on 29 April 1971 from St. Margaret's at Cliffe near Dover (observations recorded for 48 hours)</i>					
3. Zone 1 Main SW. lane S. Falls Buoy to Sandettie SW. Buoy	213	4.44	68.06	64.00	72.44
4. Zone 2 Goodwin Sands to S. Falls Buoy	82	1.71	46.83	64.00	72.44
5. Zone 3 Main NE. lane Sandettie SW. Buoy to Outer SW. Ruytingen Buoy	175	3.65	63.91	64.00	72.44
6. Zone 4. English inshore English coast—Goodwin Sands	101	2.10	68.66	64.00	72.44

The zones are as defined in the relevant reports.

The figures for the second survey are taken from the chart shown in the appendix to the report by Decca Radar Limited.

Although a Zone 5 (French inshore zone) was defined for the second survey there were insufficient observations on it to make further analysis meaningful.

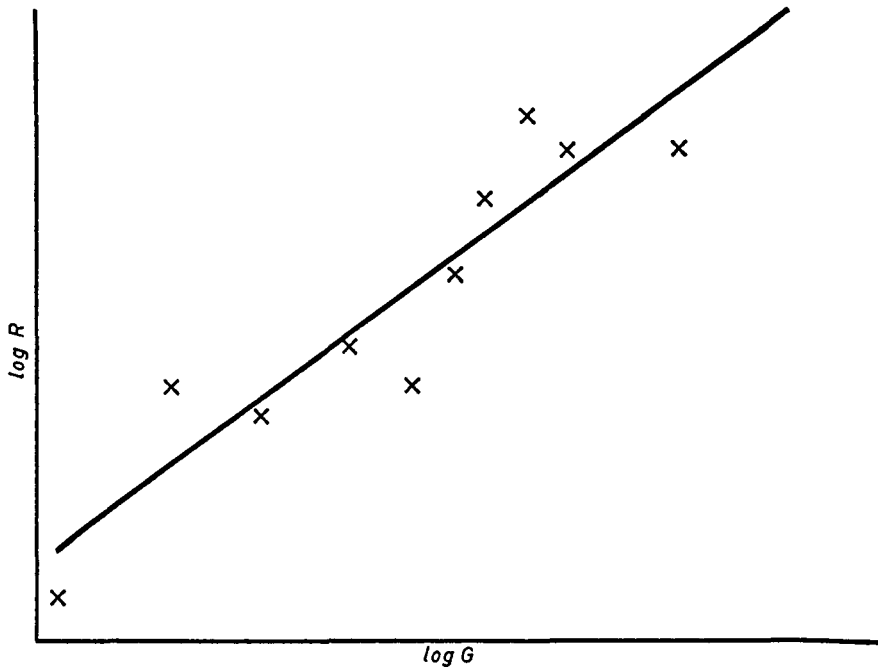


FIG. 3. Correlation coefficient $r = 0.92$. R calculated using the world-wide distribution of shipping

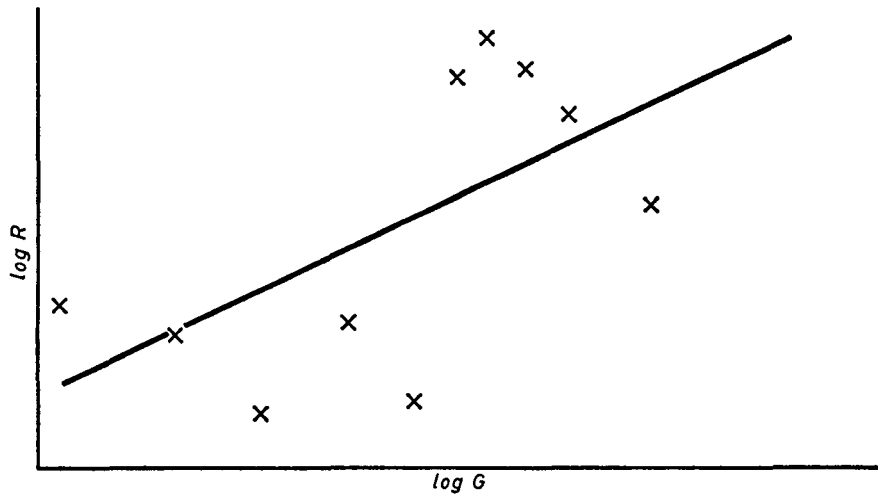


FIG. 4. Correlation coefficient $r = 0.62$. R calculated using data from National Physical Laboratory Dover Strait Survey

To discover whether there is a similar relationship for collisions in the Dover Strait, the 40 collisions there from 1 June 1967, when the present recommended traffic routing system was introduced, until 28 February 1971 were analysed. The number of vessels registered was taken from the world-wide distribution of ships published in Lloyd's Register of Shipping Statistical Tables.

A linear correlation coefficient r of 0.92 was found and the slope of the regression line was calculated to be 0.4. These results are very much in agreement with the Japanese results, but there are some worrying features about the analysis. Firstly the collisions relate to a period from 1967 to 1971 whereas the Lloyd's data relate to 1 July 1971 only. Over the collision period the distribution of ships is likely to have changed with the increasing numbers of very large ships being built. However, the numbers of all ships are so large compared to the number of collisions that this will probably not affect the situation very much. Also the total number of collisions per year is very small, 14 was the maximum over the period considered so that a year by year analysis would in any case be of little value. Secondly it is questionable whether the world-wide distribution of ships is the correct one to use for the collision rate in a local area, or whether it would not be more sensible to use a measure of the actual number of ships at risk in that area. It is not clear what Shiobara used in his analysis. The report on the Dover Strait survey of 27 to 29 April 1971 gave details of ships positively identified, so from this a distribution by gross tonnage of ships at risk in that area can be prepared. Comparing this to the world-wide distribution there are considerable dissimilarities, the main one being in the far fewer smaller ships (100–499 tons) in the Dover Strait distribution compared to the world-wide distribution. To draw too many conclusions from this is difficult as the results for the Dover Strait are based on a small sample which may not be representative.

Repeating the regression analysis, however, and using this data, the linear correlation coefficient r is about 0.62 with a regression line slope of 0.2. It would therefore be useful to repeat this analysis if more extensive data were available. As a further illustration of the difference between the two analyses, graphical illustrations of each are given in Figs. 3 and 4 respectively.

REFERENCES

- 1 Marine Traffic in the Dover Strait. An exploratory survey and analysis of collisions. Preliminary Report. *N.P.L. Eng. Sci. Report 1-71*, March 1971.
- 2 Marine Traffic in the Dover Strait. A survey of traffic: 27 April 1971 to 29 April 1971. *N.P.L. Mar. Sci. Report 2-71*, July 1971.
- 3 Beattie, J. H. (1971). Traffic flow measurements in the Dover Strait. *This Journal*, **24**, 325.
- 4 Fujii, Y. and Shiobara, R. (1971). The analysis of traffic accidents. *This Journal*, **24**, 534.

'By the Mark'

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YACHTSMEN, like other mariners, are being encouraged to 'think metric'—to become accustomed to metres in Tide Tables, Pilots and Light Lists, and to make