Experiments to assess the relative dredging performances of research and commercial vessels for estimating the abundance of scallops (*Pecten maximus*) in the western English Channel fishery

P.J. Dare, D.W. Palmer, M.L. Howell and C.D. Darby

MAFF

Fisheries Research Technical Report No. 96

Directorate of Fisheries Research, Lowestoft, 1994

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
DIRECTORATE OF FISHERIES RESEARCH

FISHERIES RESEARCH TECHNICAL REPORT
NUMBER 96

Experiments to assess the relative dredging performances of research and commercial vessels for estimating the abundance of scallops (*Pecten maximus*) in the western English Channel fishery

P.J. Dare, D.W. Palmer, M.L. Howell and C.D. Darby

LOWESTOFT
1994

The authors: P.J. Dare, BSc PhD is a Grade 7 Officer (Principal Scientific Officer), D. W. Palmer is a Scientific Officer, C. D. Darby BSc PhD is a Higher Scientific Officer, and they are all in the Fish Stock Management Division. M.L. Howell is a Scientific Officer in the Marketing and Information Group. All the authors are based at the Fisheries Laboratory, Lowestoft.

Fish. Res. Tech. Rep., MAFF Direct. Fish. Res., Lowestoft, (96): 9pp.

CONTENTS **Page**

1. INTRODUCTION

Dredge surveys to assess the spatial distribution and abundance of scallop stocks are routine in the management of many pectinid fisheries. In England and Wales, such surveys have been undertaken either from research vessels or from chartered commercial scallop dredgers. Although the efficiencies of various types of scallop dredge have been estimated in British waters (Chapman *et al.*, 1977; Dare *et al.*, 1993), no work on the catching ability of research vessels relative to commercial vessels has been reported.

In the western English Channel scallop fishery, commercial scallopers deploy from 6 to 20 or more spring-loaded and 0.75 m wide Newhaven dredges. By contrast, Directorate of Fisheries Research (DFR) research vessels have been capable of using only 3 (*RV CLIONE*), 6 (*RV CORELLA*) or 8 (*RV CORYSTES*) such dredges, which could not be fished according to commercial practices. It is not known, therefore, to what extent research catches can be regarded as reliable indicators of likely commercial catch rates, or of areas of commercially attractive stock density.

In 1990-91, comparative dredging trials were conducted in which the performance of *RV CORYSTES* (used for surveys since 1988) was compared directly with that of two regular scallop dredgers operating in the western English Channel fishery. This report presents the results from these field experiments or calibration trials.

2. METHODS AND MATERIALS

2.1 Operational procedures

Two trials, each of two days' duration, were conducted in July of 1990 and 1991 within a 20 x 8 km area on the Fowey-Eddystone scallop fishing ground some 4-12 km off the south coast of Cornwall (Figures 1 and 2).

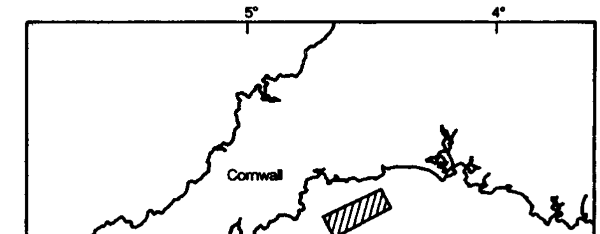

Figure 1. ***Western English Channel showing the location (hatched rectangle) of the experimental area off the south coast of Cornwall***

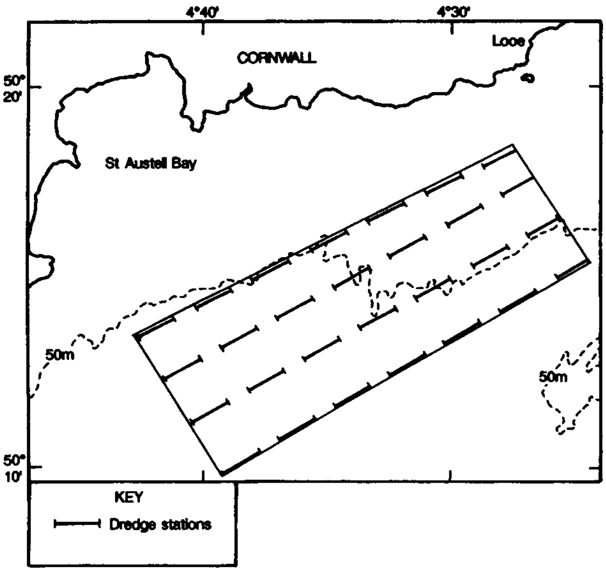

Figure 2. ***The experimental area enlarged to indicate approximate positions and tow lengths of the 28 dredge stations***

Within this 'box' 28 dredge stations, with start and end positions specified as Decca co-ordinates, were selected at regular intervals along four 'parallel' Decca lanes. At each station, dredges were towed by *RV CORYSTES* into the tidal stream at a ground speed of ~ 2.5 knots, which gave tow durations of ~ 15 minutes. Commercial vessel towing speeds were estimated to be generally 2.5-3 knots. All shooting and hauling positions were recorded so that actual distances towed could be calculated later. For *RV CORYSTES* mean distances were 0.96 nautical mile (± 0.17 s.d.) in 1990 and 0.70 nautical mile (± 0.11 s.d.) in 1991.

The seabed in the experimental area consisted of sand and finer gravels with some small stones and shell debris, at 48-62 m depth. It was typical of substrates found over a wide expanse of these inshore scallop grounds.

All three vessels used commercial mesh Newhaven dredges fitted with standard spring-loaded toothbars (9 teeth of 8 cm length and 7 cm spacing). Internal mesh diameters were 75 mm for both the metal belly rings and the rope back netting. In both years, *RV CORYSTES* (53 m overall length) operated 8 dredges in total from two beams. In 1990, the commercial scalloper *FV NELLIE* (23.7 m) from Portsmouth worked 20 dredges; in 1991, *FV NAURU* (15.0 m) from Plymouth used 14 dredges. The warp length:depth ratio employed on *RV CORYSTES* was 3:1, whilst on both commercial vessels it was between 2.5:1 and 3:1.

The experimental area formed part of the local scallop grounds fished regularly by the skipper of FV NAURU, while the skipper of *FV NELLIE* had also worked this ground, though only occasionally.

On each trial day the two vessels worked their way around the allocated stations using different start points from *RV CORYSTES* but always towing against the tidal stream (0.1-0.9 knot range).

All scallops caught by *RV CORYSTES* were counted and their shell heights were measured. On the fishing vessels, sampling was confined to 16 dredges on *FV NELLIE* and 8 on *FV NAURU* (Figure 3); selected groups of 4 dredges were taken for comparison with the two sets of 4 dredges worked by *RV CORYSTES*. All scallops caught by the selected FV dredges were counted, but it was possible to measure only subsamples at each station.

During the four trial days weather, sea and tidal conditions were recorded aboard *RV CORYSTES* during each tow (Table 1). Wind speeds ranged between 8-25 knots (mean of 16 knots) with 2-4 feet high waves and swells of 2-6 feet. Such conditions are experienced frequently by the two commercial vessels and did not hinder their dredging operations during the trials.

Table 1. Environmental conditions during the two calibration trials in 1990 and 1991

Date	Wind mean speed (knots) and range	Sea state		Tidal stream speed (knots)
		Wave height (ft)	Swell height (ft)	
1990, 7- 8 July	16.4 (12-22)	2-4	2-6	0.1-0.9
1991, 10-11 July	16.2 (8-25)	2-3	3-5	0.1-0.8

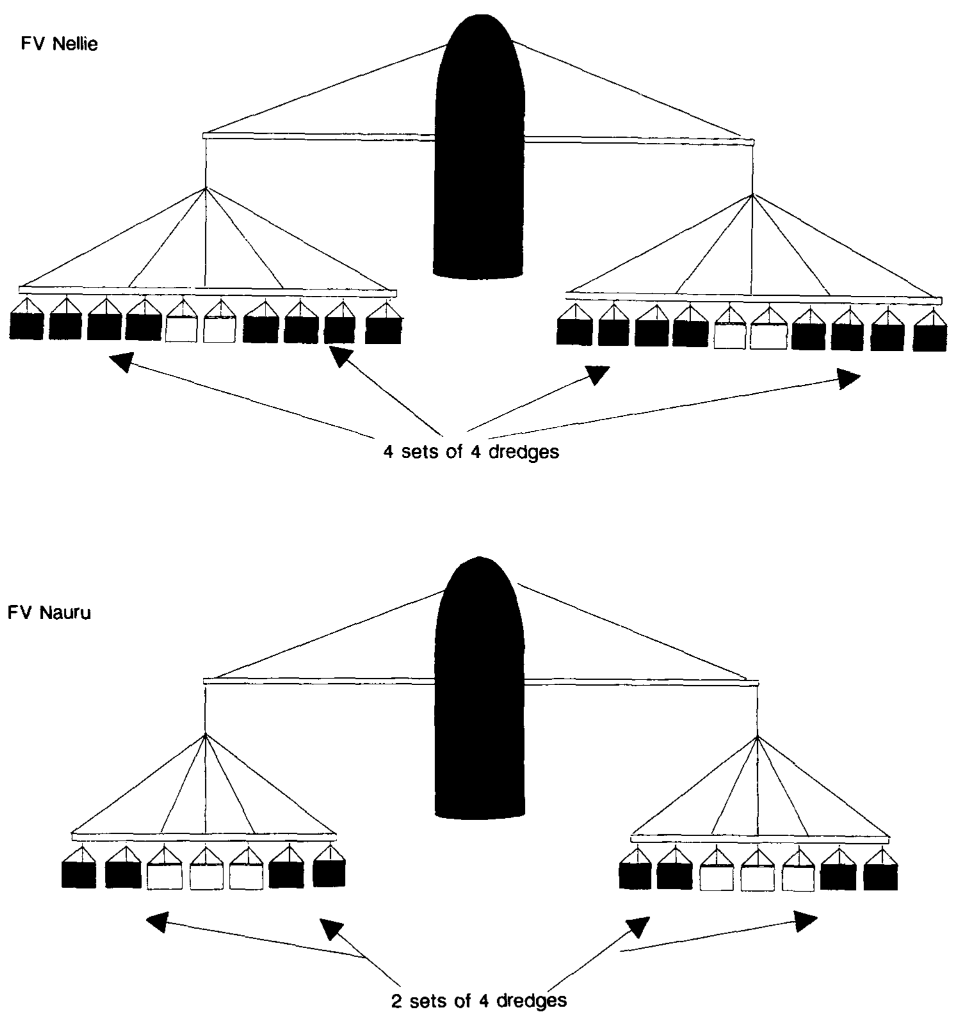

Figure 3. Schematic diagram showing the dredge arrays deployed by the two commercial fishing vessels; only catches in the shaded dredges were sampled during the trials

2.2 Statistical analyses

At each sampling station, catches were converted first to a standard catch per unit of effort (CPUE) expressed as the mean number of scallops caught per metre width of dredge per kilometre towed along the seabed by each vessel.

The model fitted is

$$\ln(catch_{ysv}) = V_v + Y_y + S_s + (YS)_{ys} + error_{ysv}$$

where

V_v is the vessel effect for the v'th vessel, v = 1, 2, 3
Y_y is the year effect for the y'th year, y = 1990, 1991
S_s is the station effect for the s'th station, s = 1-28
$(YS)_{ys}$ is the interaction effect between the s'th station and y'th year.

This implies that

$$E[catch_{ysv}] = e^{V_v + Y_y + S_s + (YS)_{ys}}$$

$$= e^{V_v} \times e^{Y_y + S_s + (YS)_{ys}}$$

The model is scaled so that $e^{V_{corystes}} = 1$; that is, $V_{corystes} = 0$.

V_v for the two commercial vessels was estimated from the fitted model.

A preliminary analysis of the data showed that, on a log scale, the errors were distributed normally and the variance was constant.

3. RESULTS

3.1 Catch size compositions

The size frequency distributions of scallops captured by each vessel are shown in Figures 4 and 5 for the years 1990 and 1991 respectively. It is readily apparent that the catch compositions of *RV CORYSTES* were virtually identical to those of the commercial vessels, and that there were no significant inter-year differences. In all cases, scallop sizes were distributed almost symmetrically about the minimum legal size (MLS) of 88 mm shell height (corresponding to 100 mm length), this being partly a function of size-specific dredge efficiency (Dare *et al.*, 1993).

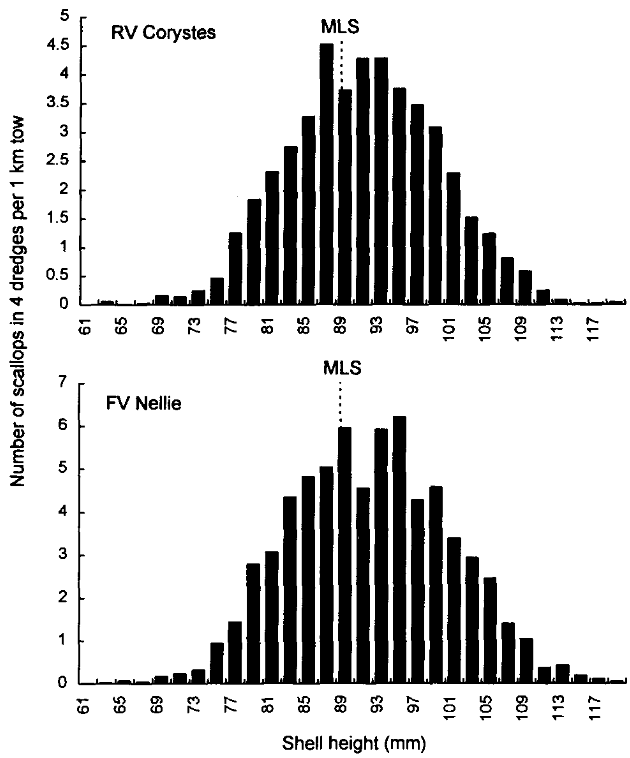

Figure 4. The size frequency distributions of scallops caught in the 1990 trial, RV CORYSTES : FV NELLIE

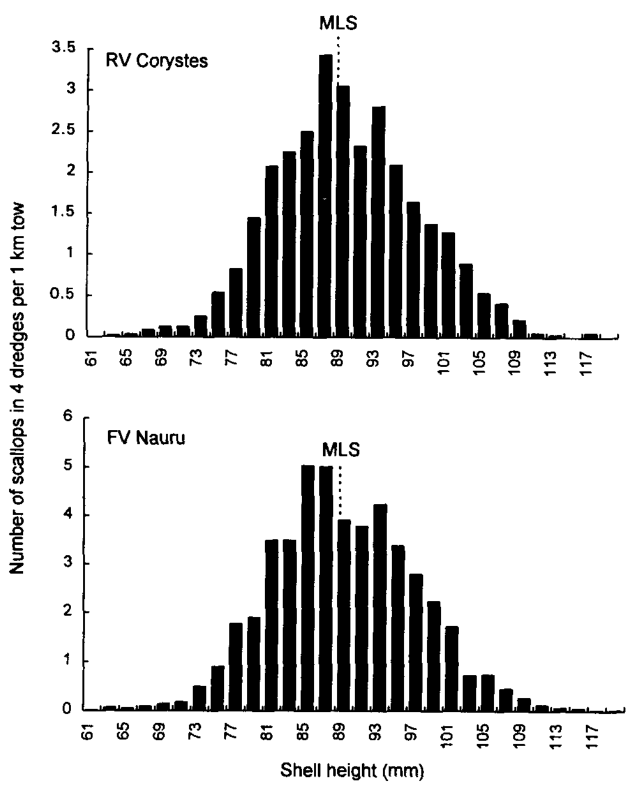

Figure 5. The size frequency distributions of scallops caught in the 1991 trial, RV CORYSTES : FV NAURU

3.2 Catch rates

The mean catch rates (CPUE) for *RV CORYSTES* are plotted against those of each of the two commercial vessels (Figure 6). The fitted lines have been taken from equations 2(a) and 2(b) below. Figure 7 gives the same plot, on a log scale, with the fitted lines taken from equations 1(a) and 1(b). Catches were generally lower in the second year, probably as a result of intervening fishing as well as natural mortality.

With the year and station effects removed, the results showed the following vessel effects, with associated standard errors:

$$V_{nauru} = 0.43 \pm 0.13$$

$$V_{nellie} = 0.27 \pm 0.13$$

which implies that on a log scale the relative performances of the three vessels are expressed by the following equations:

$$\ln(catch_{nauru}) = \ln(catch_{corystes}) + 0.43 \quad (1(a))$$

$$\ln(catch_{nellie}) = \ln(catch_{corystes}) + 0.27 \quad (1(b))$$

or, by taking anti logs,

$$catch_{nauru} = e^{0.43} \times catch_{corystes}$$

$$= 1.54 \times catch_{corystes} \quad (2(a))$$

$$catch_{nellie} = e^{0.27} \times catch_{corystes}$$

$$= 1.31 \times catch_{corystes} \quad (2(b))$$

Both commercial vessels achieved significantly higher catch rates than *RV CORYSTES*; equivalent to factors of 1.3 and 1.5 for *FV NELLIE* and *FV NAURU* respectively.

To test whether the commercial vessels were significantly different from each other, the data from *FV NELLIE* and *FV NAURU* were combined to form one group. The data were then fitted to this reduced model. An F-test showed that the reduced model adequately explained the variation in catches and one scaling factor for the commercial vessels was sufficient.

So now:

$$V_{commercial} = 0.35 \pm 0.09$$

and

$$catch_{commercial} = e^{0.35} \times catch_{corystes}$$

$$= 1.42 \times catch_{corystes}$$

where *commercial* is the catch from either *FV NELLIE* or *FV NAURU*.

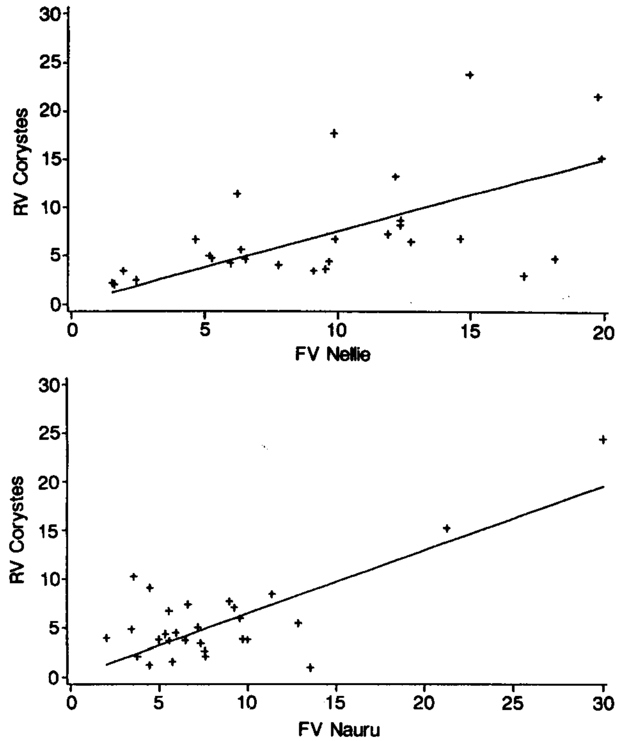

Figure 6. ***Relationships between the catches (mean numbers of scallops per dredge per kilometre towed) of RV CORYSTES and (upper) FV NELLIE in 1990, (lower) FV NAURU in 1991. The data are plotted on linear scales with regression lines fitted***

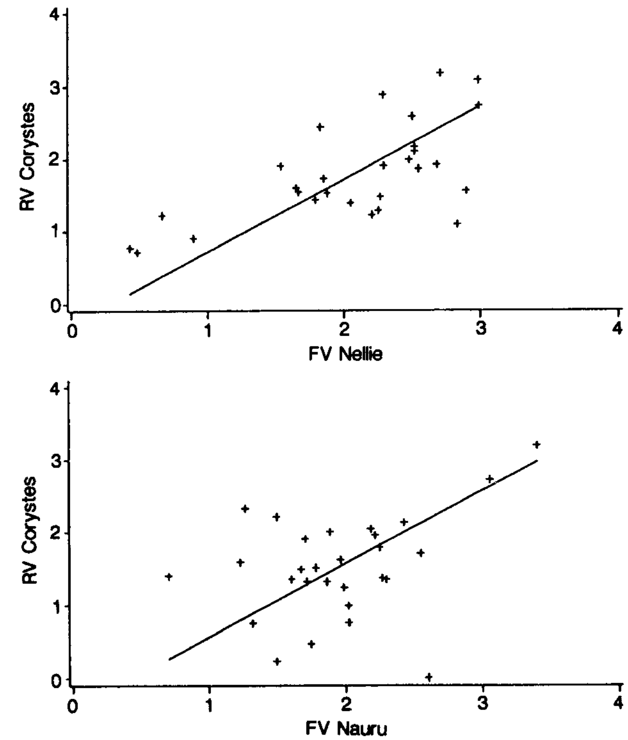

Figure 7. ***Relationships between the catches (as logs of mean numbers of scallops per kilometre towed) of RV CORYSTES and (upper) FV NELLIE in 1990, (lower) FV NAURU in 1991. The fitted regression lines are shown***

4. DISCUSSION AND CONCLUSIONS

These comparative dredging trials were conducted on a regular scallop fishing ground, and under weather and sea conditions often worked by dredgers in the Cornish fishery. The commercial vessels also used their own standard gear and warp settings. Consequently, in this sense, the results may be considered realistic even though the experimental protocol necessarily differed in other regards from their normal *modus operandi*. Thus, commercial scallopers normally would tow to and fro across a productive area, or weave around it in irregular patterns, for longer towing periods (often 30-60 minutes) and at somewhat different ground speeds.

Observed performance differences between the two commercial dredgers were not statistically significant. Minor individual variations are to be expected, reflecting differences in gear setting, vessel, and human characteristics. Of primary importance, however, is the demonstration that the catching performance of *RV CORYSTES*, as a sampling platform for scallop assessment work, can be considered acceptable. The difference between the research and commercial vessels was much less than might have been expected, given the relative inexperience of DFR personnel at scallop dredging coupled with the operational and design features of a large multi-purpose research vessel.

In the past, it has not been possible to interpret research vessel catches in commercial fishing terms, nor to use observed spatial abundance patterns to predict or explain fishing exploitation. Now, however, it is concluded that research catches by *RV CORYSTES* will provide satisfactory indicators of spatial abundance which can then be adjusted (using a raising factor of 1.4) to estimate the abundances which a commercial scalloper would record on the Fowey-Eddystone, or similar, grounds. In discussion with industry, it should then be possible to identify stations where research vessel catch rates attain or exceed minimum levels for commercial exploitation. From this, future broad-scale stock surveys should then be able to estimate the proportion of total stock biomass which occurs at exploitable densities together with the distribution of such 'patches'.

5. REFERENCES

CHAPMAN, C. J., MASON, J. AND KINNEAR, J. A. M., 1977. Diving observations on the efficiency of dredges used in the Scottish fishery for the scallop, *Pecten maximus* (L.). Scott. Fish. Res. Rep., No. 10, 16 pp.

DARE, P. J., KEY, D. AND CONNOR, P. M., 1993. The efficiency of spring-loaded dredges used in the western English Channel fishery for scallops, *Pecten maximus* (L.). ICES C.M. 1993/B:15, 8 pp. (mimeo).