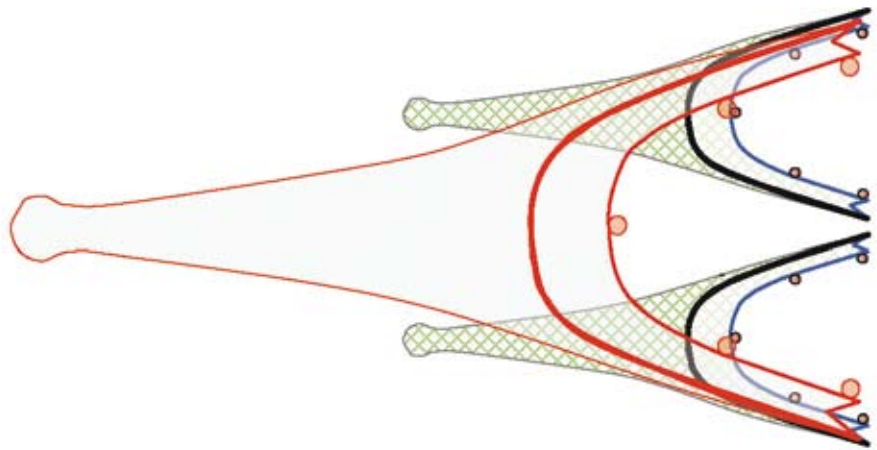


Economic
comparison of
single-rig and
twin-rig trawl for
nephrops



Economic comparison of single-rig and twin-rig trawl for nephrops



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December 2006

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Acknowledgements

The authors gratefully acknowledge assistance from the following people:

Robert Stevenson W.S.F.P.O
Alan McCulla A.N.I.F.P.O
Dick James N.I.F.P.O
Duncan McInnes W.I.F.A
John Hermse M.N.W.F.A
Dick Ferrow FRS, Marine Laboratory
J Masson Notus UK
S Sooter Seaforth Trawls
R Ritchie Pices, Peterhead
G Booth Pices, Peterhead
J Hamilton Net Supplier
T Cunningham Net Supplier
N Kelly Net Supplier

Skippers and owners of the sample vessels.



This project received part funding via the Financial Instrument For Fisheries Guidance.

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Summary

To improve catching performance and to mitigate the adverse effects of high fuel prices on fishing operations, some sectors of the UK fishing fleet have converted from single-rig trawling to twin-rig trawling.

There is very little independent technical guidance and financial information on the level of benefit of conversion from single-rig to twin-rig trawling.

This report illustrates the costs and benefits of twin-rig trawl compared with single-rig trawl based on financial data provided by nephrops vessels working west coast grounds in ICES areas VIIa and VIa.

Costs of investing in a twin-rig gear system may be around £20,000 for a two-wire system and around £40,000 for a three-wire system.

Twin-rig trawling for nephrops offers a technical efficiency advantage over single-rig trawling due to the improved relationship between catching opportunity (fishing circle) and main engine power in twin-rig vessels. Average fuel

cost as a percentage of earnings was slightly lower for twin-rig than for single-rig vessels. Average cost of repairs as a percentage of earnings was slightly higher for twin-rig vessels than for single-rig vessels in the study.

Overall, the twin-rig vessels in this sample did not translate their technical advantage into a financial advantage over the year. Further research may establish whether the technical advantage of twin-rig trawling could be realised to a greater extent in practice.

Owners should exercise care and attention to detail when considering switching from single-rig to twin-rig to ensure that they can translate the technical advantage into a financial advantage. Seafish and BIM are carrying out sea trials and advice to owners is available from Seafish.

Effective use of twin-rig trawl has the potential to improve profitability and sustainability, by reducing costs for catching the same volume of nephrops and by reducing fin-fish bycatch.

I. Introduction and scope

To improve catching performance and to mitigate the adverse effects of high fuel prices on the economics of fishing operations, some sectors of the UK fleet have converted from single-rig to twin-rig trawling, most notably in the Scottish east coast nephrops fishery. Elsewhere in Scotland and the UK, single-rig trawling still predominates.

There is very little independent technical guidance and financial information on the benefits of conversion or constraints to the use of twin-rigs. The purpose of this report is to identify and quantify the costs and benefits of twin-rigging compared to single-rigging within the framework of a sustainable fishery. The study includes vessels catching nephrops, based in the west coast of Scotland and Northern Ireland.

2. Background and theory of twin-rig trawling

2.1 Background

Although the use of two trawl nets by a single vessel is well-established in the beam-trawl sector, interest in twin-rig otter trawling is relatively new, and was introduced into Europe by the Danes in the early 1980s. Uptake of the technique that used three warps however was initially limited by the costs of conversion, including the requirement for a three-barrelled winch to handle the extra warp.

Reports that twin-rig catches could be double those of comparable single-rig operators stimulated interest in the UK and Seafish gear technologists helped to pioneer the development of a successful low cost two-wire system targeted at smaller vessels of up to 300 horse-power (221kW).

Vessel owners expected that this class of vessel, being more constrained by weather conditions, would be more economically efficient by adopting the system. The systems were designed such that conversion from single to twin-rig could be accomplished with minimal alteration to existing deck layouts and operating procedures.

Fishermen who had reservations about the method, but wanted to try twin-rig trawling before committing themselves to major change and investment found this flexibility attractive.

As benefits of the new technology were realised and more interest developed, owners began to invest in twin-rigs in the nephrops and whitefish sectors, particularly on the east coast of Scotland. Some invested in new purpose-designed twin-rig vessels. On the west coast of Scotland and in Northern Ireland, owners have been slower to adopt twin-rigging. Here the development has been constrained by lack of technical guidance and concern for its impact on the sustainability of stocks.

2.2 Theory of twin-rig trawling

The principle attraction of twin-rig trawling is that, for a given vessel horsepower, it is possible to tow two smaller trawls with greater potential catching power than one larger trawl due to the reduced drag of the area of net mesh. Alternatively, two smaller nets could be used to produce the same catch volume but at lower cost (by reduced effort or by use of still smaller nets).

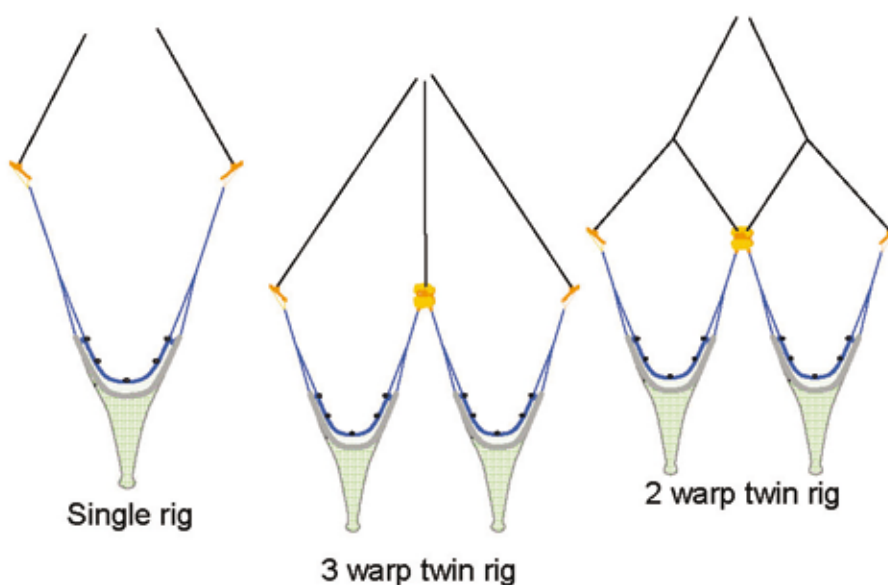


Figure 1. Single-rig and twin-rig gears

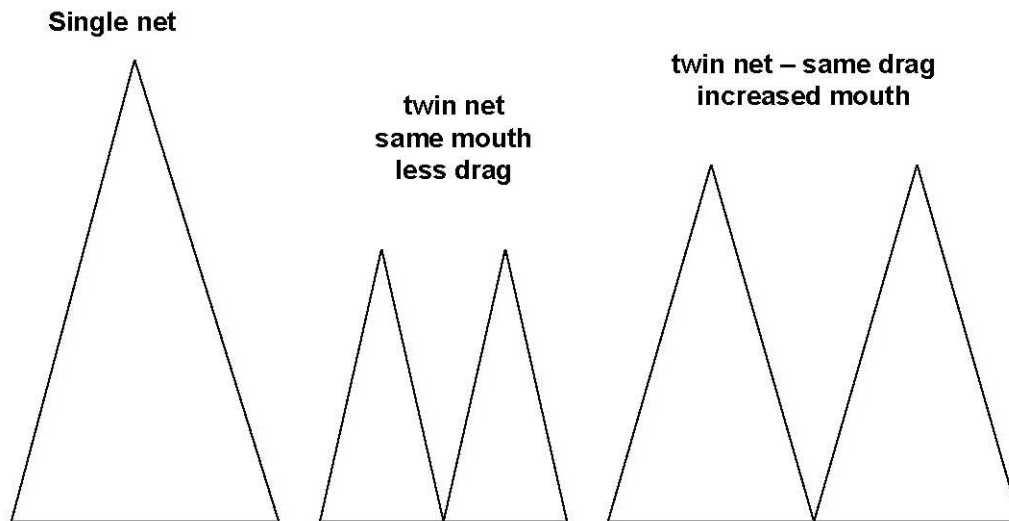


Figure 2. Theory of twin-rig gear – ratio of catching capacity to drag

To explain the principle of twin-rig trawling, it is useful to compare to single-rig gear. The main areas of comparison are the:

- shape and area swept by the body of the net
- drag of the net
- area of the seabed swept by the net
- length of footrope in contact with the seabed
- length of the bosom of the net
- net opening
- length and angle of the bridles

Twin-rig trawls present a wider, lower frontal net shape ideally suited for targeting bottom-living species such as nephrops (Figure 3).

The two smaller twin-rig trawls have a much lower headline height than the similarly shaped single trawl and

that the total frontal area of the two smaller nets is less than the one large one. This increases the length of the footrope in contact with the seabed and the effective bosom length of the net and decreases the drag.

The enhanced performance of twin-rig trawls however is not simply explained by the geometry of the gear. In catch comparison trials between single and twin-rig gear conducted by FRS Marine Laboratory, an increase in catch of nephrops of 340% was observed in commercial trials with nets operating over the same swept area of seabed. In the report of the trials it is suggested that differences in ground gear shape for the two gears could imply different ground gear contact and significantly higher fishing efficiencies for species such as nephrops.

Increased interest in twin-rig gear has also stimulated technical development by the larger electronic and engineering manufacturers. New systems incorporating gear-mounted monitoring equipment and automatic winch controls, designed to ensure that twin-rig trawls are

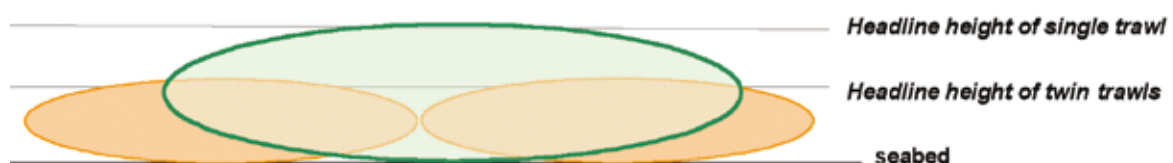


Figure 3. Shape of the net looking into the mouth of two twin-rig trawls and a single-rig trawl

towed evenly, are now commercially available. At present the use of this technology is more by the larger class of vessels rather than smaller inshore nephrops twin-riggers. These operators need to rely on their knowledge and understanding of the geometry and forces involved to set up and optimise the performance of their twin-rig system.

Inappropriate design and use of twin-rig systems can however lead to reduced financial returns, when catch rates do not justify the increased costs of gear, fuel and vessel maintenance. In such circumstances it may be that owners could achieve better results by down-sizing of gear or even reverting to a more suitable single net arrangement.

2.3 Regulation of twin-rig trawling

Because twin-rig systems may be used to increase catch rates, concern has been raised as to the impact of twin-rigging on sustainability of the target species (nephrops) and the increased level of by-catch discards. If, however, the twin-rig system is designed to achieve the same catching performance as a single-rig (but at lower operating cost) then a case can be made in favour of the

twin-rig system on the grounds of conservation. This may be achieved because the lower headline height of the twin-rig nets reduces whitefish by-catch species. There is no legal constraint on the use of twin-rigs but there are restrictions on the mesh sizes used. Twin-rig mesh sizes are restricted to 95mm diamond mesh, although a minimum of 80mm may be used when working:

- on the Fladen grounds (North Sea north of 57° 30'N);
- in ICES VI south of 56°N;
- in ICES VII; and
- in ICES IV south of 53°N.

Depending on whether covers are used or not, the by-catch of nephrops trawlers must be no more than 65% or 70% of the catch.

With regard to catch rates, the larger mesh-size restrictions imposed upon twin-rig vessels are reported to be of minimal significance in summer (in good weather) but of some effect in winter (in poor weather) due to the increased motion of the nets on the seabed.

3. Practice and cost of converting from single-rig to twin-rig

The simplest and cheapest conversion from single-rig to twin-rig is by the use of warp-end splits that are attached to the otter-doors on the outer bridles and the clump weight that connects the two centre bridles (see Figure 1). This avoids the need and cost of replacing the two-barrel winch with a three-barrel winch. The disadvantage however is that change of alignment of the nets cannot be achieved while the gear is in the water. Alignment is required to ensure that the two nets fish 'square' and tow evenly as door spread increases. As can be seen from Figure 4, when the doors spread, they move out of alignment with the centre clump weight causing the trawl nets to distort.

In order to restore alignment, the centre warp (3 wire) or split warps (2 wire) must be shortened relative to the two outer warps. With a three-wire/three-barrel winch system the centre warp can be shortened with the gear in the water to ensure alignment of the doors and clump weight for maximum fishing efficiency. The length of shortening can be calculated from the geometry of the gear or by use of electronic sensors on the doors and clump weight that relay information wirelessly to bridge equipment.

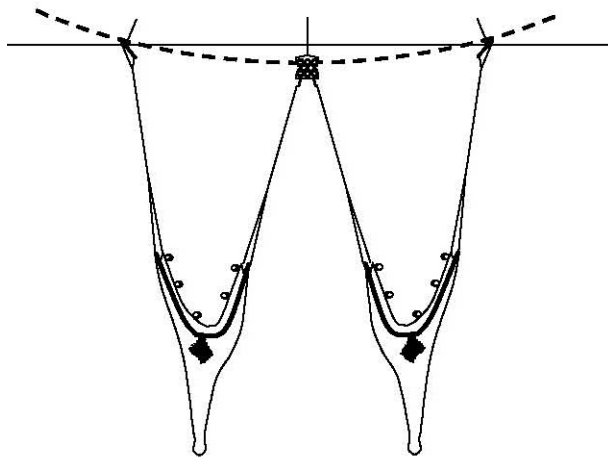


Figure 4. Three-wire twin-rig: centre warp not shortened showing slack netting in trawls

The figures in Tables 1 and 2 are indicative costs of buying twin-rig two-wire and three-wire systems when switching from a single-rig system. These figures would be typical for a 20 metre x 300 kW vessel.

	£
2 nets	6,000
Spare net	3,000
New trawl doors	2,250
Warp end splits etc.	400
Clump weight	800
New net drums	8,000
Total	£20,450

Table 1. Costs of converting from single to a twin-rig two-wire system

	£
New three barrel winch	20,000
2 nets	6,000
Spare net	3,000
New trawl doors	2,250
3 x 250 fathom wires	2,250
Bridles and sweeps	520
4 x 25 fathoms combination	560
Clump weight	1,000
New net drums	8,000
Total	£43,580

Table 2. Costs of converting from single to a twin-rig three-wire system

If it were possible to split the existing net drum a saving could be made on the cost of the new net drum.

The cost of optional gear monitoring equipment including sensors on the doors and clump, wheelhouse display and computer would be in the region of £15,800.

The investment cost of new equipment and gear to switch to twin-rig would also incur a capital cost, either in terms of interest on a loan, or increased requirement for return on investment to the shareholder.

4. Economic implications

4.1 Methods

To enable a valid comparison of the economic benefits of twin-rig trawling compared with single-rig trawling, the analysis was based on vessels working west coast grounds in ICES VIIa and VIa areas over the same fishing year (2004). All the vessels were dedicated nephrops trawlers. Seafish used costs and earnings data and technical data relating to the vessel or gear which they collected via face-to-face interviews with the owner or skipper or by the supplier of the gear.

The sample size for the study was 24 vessels, of which ten were single-rig, twelve were twin-rig and two worked both single-rig and twin-rig in the same year. Commercial companies provided the typical costs of converting from single-rig to twin-rig and the cost of installing electronic gear monitoring equipment.

4.2 Analysis

Table 3 shows that twin-rig vessels in this sample were on average larger and more powerful than single-rig vessels. Installed power of twin-rig vessels was on average 37.5% more than that of single-rig vessels and fishing circle of the gear was 66% more for twin-rig vessels. On average the twin-rig vessels also carried one extra crewman.

	Single-Rig	Twin-Rig
GT	64	106
Main engine power kW	213	293
Fishing circle m	42.1	70
Days per year	180	183
Crew	3.8	4.5
Gross earnings £	133,151	202,377
Fuel/oil cost £	19,062	29,405
Repair & gear cost £	17,572	35,096
Profit £	27,068	40,422
Fuel as % of earnings	15.0	14.4
Repairs as % of earnings	14.2	17.8
Profit as % of earnings	23.2	16.9

Table 3. Average vessel characteristics and performance during 2004 of sample vessels

The average catch value achieved by the twin-rig vessels is 52% higher than single-rig but average profit is only 49% higher; for approximately the same number of days on the same fishing grounds.

Catch value seems to be approximately related to the size of the fishing circle, which is 66% higher on average for the twin-rig vessels in the sample. This relationship is in line with previous studies into the behaviour of nephrops that established that they are not herded by the sweeps but are caught only when entering the mouth of the trawl. Large sweep angles therefore are of no advantage when targeting nephrops.

Because of the size difference between the single-rig and twin-rig vessels in the sample, analyses are based on relationships rather than on absolute values for single-rig and twin-rig.

Figure 5 shows the relationships between installed power (kW) and catch value for single-rig and twin-rig vessels in the survey sample. The best fit lines indicate the expected catch value for any given level of engine power. Catch value (annual gross earnings) per kW is significantly higher for twin-rig vessels than for single-rig vessels.

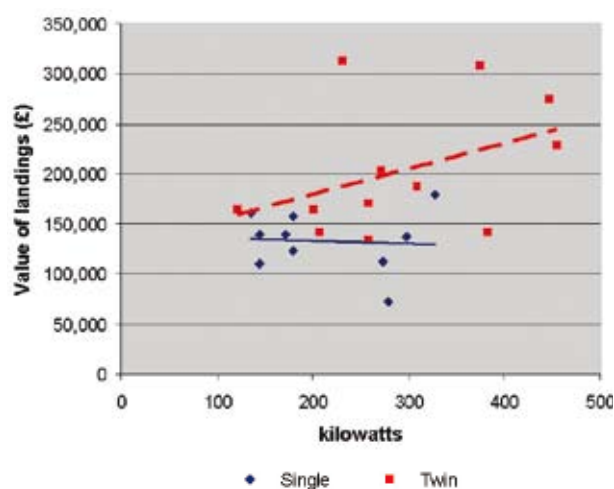


Figure 5. Value of landings as a function of main engine power (kW) for single-rig and twin-rig trawlers.

For any given fishing circle, the cost of fuel and oil is lower for twin-rig vessels, as shown in Figure 6. This relationship demonstrates the theoretical efficiency advantage and suggests that fuel costs as a percentage of catch value could be expected to be lower for twin-rig vessels than for single-rig. In fact the average cost of fuel as a percentage of catch value was slightly lower for twin-rig vessels, at 14.4% than for single-rig vessels, at 15.0%. Further research may establish whether the theoretical advantage could be realised to a greater extent in practice.

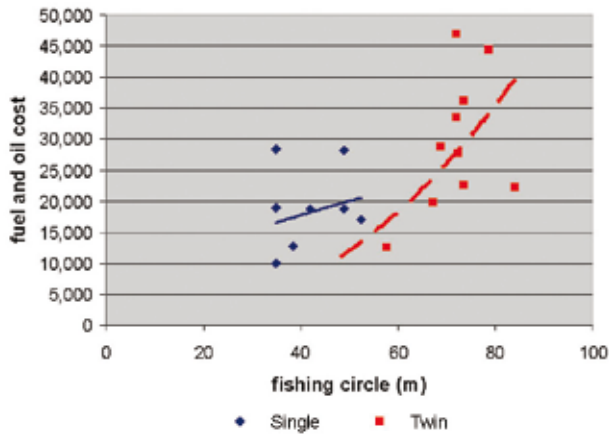


Figure 6. Fuel and oil cost as a function of fishing circle for twin and single-rig trawlers
Best fit lines are not linear for these relationships

Twin-rig vessels' average repair costs as a percentage of sales were slightly higher at 17.8%, compared to 14.2% for single-rig. Skippers and owners attributed the higher costs of repair and maintenance of twin-rig vessels to the extra strain put on the propulsion and hydraulic systems when operating closer to maximum power for longer periods. This may suggest that to fully benefit from the theoretical advantage of a twin-rig system, it is important to ensure that all elements of the system are designed together.

When fuel and repair costs for the sample vessels are combined, the twin-rig vessels no longer appear to have an overall advantage (see Figure 7). Average combined costs as percent of earnings are 32.2% for twin-rig and 29.2% for single-rig.

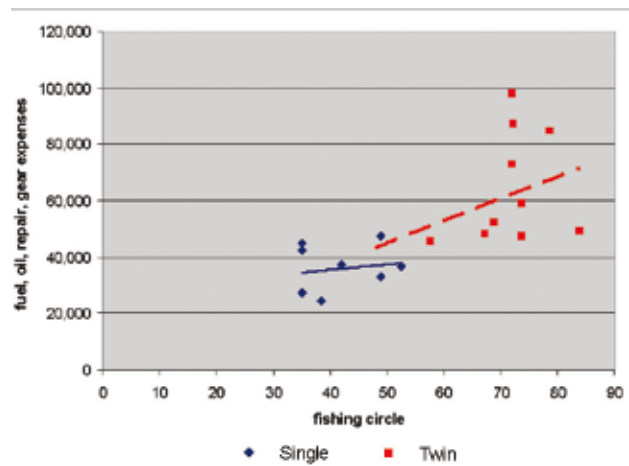


Figure 7. Fuel, oil, gear and vessel repair expenses as a function of fishing circle

The difference in catch volume between single-rig and twin-rig vessels in our sample, taking into account the greater power of the twin-rig vessels, is nowhere near that achieved in the trials by FRS Aberdeen (340%) or that reported by east coast twin-rig vessels. It would also appear that most twin-rig operators in the survey sample had opted to improve their profitability by increasing their catching performance (by increasing the catching circle of their gear) rather than maintaining the same level of catching performance at reduced operating cost.

An important point however, is that one of the twin-rig skippers, working day trips, had opted for a shorter working day than most single-rig boats in the same port. He claimed to achieve the same catch volume but with reduced costs together with life-style benefits for himself and his crew. Shorter trip lengths also improved catch quality and helped with crew retention.

The data in this study does not enable a calculation to show what profit advantage could be expected for a given vessel if it converted from single-rig to twin-rig gear. Rather, it suggests that owners who are considering switching from single-rig gear to twin-rig gear should take care and ensure that they have all the detailed information to hand regarding the design of their whole system of main engine power, hydraulics, total gear size and fishing circle. It appears that it is not uncommon for the technical efficiency advantage to be lost to higher repair costs.

Seafish and BIM are now running trials to compare the performance and costs of using a single nephrops trawl with that of a twin-rig trawl having two nets each of half the size of the single (and having reduced overall drag).

5. Conclusions

Results of the analysis suggest that twin-rig trawling for nephrops offers a technical efficiency advantage over single-rig trawling due to the improved relationship between catching opportunity (fishing circle) and drag in twin-rig gear.

Most skippers and owners in this study appear to use the technical efficiency (of reduced drag) of the twin-rig to increase their catching performance (by increasing the fishing circle/footrope ground contact) accepting increased costs of crew labour; fuel/oil and vessel/gear repairs etc. The level of increased catch in the sample however, was not as great as that demonstrated in trials by FRS Aberdeen or reported by east coast vessels. The limiting factors may possibly be differences in efficiencies over different ground conditions, use of different gear; skill levels in working twin trawls or investment in gear monitoring equipment.

Costs of converting from single-rig to twin-rig start at around £15,000 for a two-wire system, increasing to £59,000 for a three-wire system with gear monitoring equipment.

Twin-rig trawling for nephrops offers a technical efficiency advantage over single-rig trawling due to the improved relationship between catching opportunity (fishing circle) and drag in twin-rig gear. Average cost of fuel as a percentage of catch value were slightly lower for twin-rig vessels, at 14.4% than for single-rig vessels, at 15.0%. Average cost of repairs as a percentage of gross earnings was higher for twin-rig vessels than for single-rig vessels in the study. Overall, the twin-rig vessels in this sample did not translate their technical advantage into a financial advantage over the year. Further research may establish whether the theoretical advantage could be realised to a greater extent in practice.

Maximum profitability is achieved by optimising the increased levels of catching performance and costs. On average the ratio of fishing circle (m) to installed power (kW) in the sample was 0.20 for single-rig vessels and 0.24 for twin-rig vessels - 20% higher for twin-rig vessels.

Owners who are considering switching from single-rig gear to twin-rig gear should take care and ensure that they have all the detailed information to hand regarding the design of their whole system of main engine power; hydraulics, total gear size and fishing circle.

It would appear that more guidance and research may be required on the specification (size) of twin-rig gear appropriate to vessel engine power. It may also be that some fishermen might benefit from training in the use of twin-rig gear to ensure that the gear is properly aligned and fishing square.

Where the level of increased catch per vessel is acceptable under the constraints of fishery management controls then use of twin-rigs is perfectly acceptable. Some people have expressed concern that the increased technical efficiency of twin-rig gear could threaten the sustainability of a fishery, particularly where effort-based management controls are used. The concern is misplaced however where there is effective restriction on output by well-enforced quota regulations. There should be a positive impact on sustainability if owners and skippers adopt a strategy of improving profitability by using twin-rig gear to operate at a similar level of catch as a single-rig trawl, but at lower operating costs. The lower headline height of twin-rig gear could also have a positive effect on sustainability by reduction of by-catch of non-target fin-fish.

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