Options for Improving Fuel Efficiency in the UK Fishing Fleet

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October 2006

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Executive summary

The financial performance of the UK fishing fleet has been directly affected by high prices for diesel fuel. As a result, the fishing industry has been faced with an urgent need to reduce their dependency on fuel oil.

The UK Sea Fish Industry Authority (Seafish) has led a project part-funded by Defra to identify possibilities and routes to more efficient fuel usage in the UK fishing fleet.

The study focuses on key segments of the UK fishing fleet, and covers fleet operations, gear type and fishing patterns. It includes an assessment of some of the current fuel efficiency measures, the degree of uptake and barriers to uptake of these measures.

To meet the aims of this project a combination of desk research and interviews were undertaken. Over 100 members of the fishing industry were interviewed and asked a range of questions relating to fuel efficiency. The survey data was analysed and individual case studies compiled where fishing businesses have successfully implemented fuel efficient measures. Given the small sample size industry experts were asked to comment on the preliminary results to ensure survey findings were realistically projected across the entire UK fleet.

The research findings show that over the past 18 months or so UK fishing vessel owners have changed their attitudes towards fuel oil. Most of the vessel owners surveyed reported making at least some small changes to their fishing methods and practices in an effort to reduce fuel use (per tonne of fish landed). The most common changes made were: changing trip planning practices, reducing towing and or steaming speeds, changing landing port, replacing the engine, changing fishing method, changing target species, stopping fishing temporarily, modifying gear, and undertaking preventative maintenance.

This report describes each of the fuel efficiency measures highlighted by the interviewees and examines the costs, benefits, and issues surrounding the measures.

Most fishermen interviewed noted that they have seen some clear benefits to their vessel businesses from taking steps to improve fuel efficiency. This report includes a summary of the estimated financial benefit per segment that might arise from further vessels adopting each fuel efficiency measure based on estimated scope for further uptake.

In improving fuel efficiency it is clear that no one solution will be the answer for all members of the fleet. However, vessel owners and fisheries administrations can both take action to further improve fuel efficiency among UK fishing vessels.

1. Introduction

1. Introduction

The financial performance and viability of the UK fishing fleet has been directly affected by recent high prices for diesel fuel. As a result, the fishing industry has been faced with an urgent need to react and reduce their dependency on fuel oil. In real terms the fishing industry has experienced fuel price increase of over 100% in less than 18 months (illustrated in figure 1).

Seafish estimates that the entire UK fleet consume around 300 million litres of fuel per year. At current price levels this costs the fleet around £100 million each year and a 1% reduction in fuel expenditure is worth £1 million to the fleet annually.

Most fuel analysts indicate that fuel prices will remain high for the foreseeable future, with some predicting an increase to US$100 a barrel in the next 12 months in the wake of OPEC's recent decision to limit supply (beginning November 2006). Fleet viability has been rescued to some extent by increased fish prices at the quayside in 2006, however, the price of fuel is still a major issue for the industry. There is an expectation that if the situation does not improve, then many vessel businesses may be forced to cease trading.

Seafish has led a project part-funded by Defra (FIFG funds) to identify possibilities and routes to more efficient fuel usage. Fuel efficiency can be considered as either the cost of fuel as a proportion of fish sales or the amount of fuel required to catch a certain volume of fish. The study is seen by the industry as part of an explicit commitment to adapting the UK

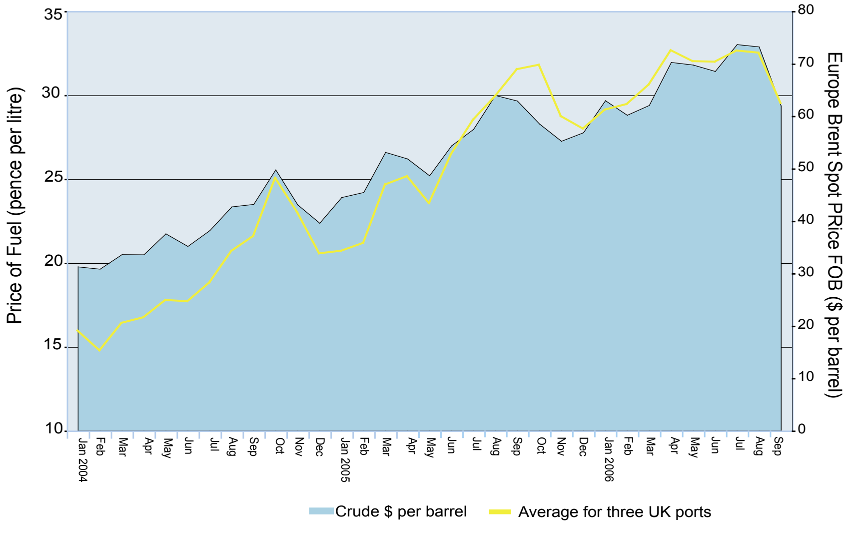

Figure 1. Average monthly fuel price (duty free) in three UK ports and average crude price

fishing fleet and its operations to the new era of relatively high fuel prices. The aims of the research are:

- To identify current practices aimed at improving fuel efficiency;
- To identify the potential scope and benefits of further uptake of fuel efficiency measures, so vessel owners and government can take action to further improve fuel efficiency among UK fishing vessels.

This work is seen as an initial study which may be supplemented later by more detailed work on particular fleet sectors or efficiency measures.

Note: This project was requested in August 2005, the survey took place between December 2005 and February 2006, data analysis between April and June 2006 and report write up between July and September 2006. The average fuel price has fluctuated over this period but remains high compared to the last three year period.

1.1 Project objective

The objectives of this research project are to:

- Identify options to improve fuel efficiency and evaluate costs, benefits and other impacts;
- Publish a report which can be used by the fishing industry to inform their decisions regarding adopting new practices, and potentially guide investment in new equipment needed to adopt new practices; and
- Inform government about the scope (or otherwise) to further improve fuel efficiency, and highlight some of the policies and regulations in fisheries management which prevent the fleet from becoming more fuel efficient.

1.2 Scope

The study focuses on key segments of the UK fishing fleet, and covers fleet operations, gear types and fishing patterns. It includes an assessment of some of the current fuel efficiency measures, the degree of uptake and barriers to uptake of these measures.

The main fleet segments which are covered in this report are the beam trawl, whitefish trawl, nephrops trawl and scallop dredge sectors.

Other fleet segments including lines and nets, creeling, purse seine and pelagic trawl were also included in the survey. The results from these sectors have also been incorporated into this report. A breakdown of the sample is given in section 2.2.

1.3 Background information – UK fleet segments

The UK fishing fleet in 2005[1] consisted of around 6,700 vessels with a total registered tonnage (RT) of around 220,000 tonnes and total fleet power of around 880,000 kW. Latest figures suggest the average age of vessels in the UK fleet is increasing, with average (approximate) vessel age in 2005 of 22 years compared to 20 years in 2003.

Segment	Estimated fuel cost per day at sea
Beam trawl	c.£1,000 - £2,500
Whitefish trawl > 24m	c.£1,000 - £1,500
Whitefish trawl <24m	c.£500 - £1,000
Twin-rig nephrops trawl	c.£500 - £1,000
Scallop dredgers	c.£500 - £1,500
Seine netters	c.£200 - £400
Under 10m mobile gear	c.£50 - £200
Under 10m static gear	c.£5 - £100

Table 1. Average fuel cost per day at sea [2]

[1] Marine Fisheries Agency, United Kingdom Sea Fisheries Statistics, 2005.
[2] Estimated using knowledge of Seafish technical staff and average fuel costs for 2005 from the 2005 economic survey of the UK fishing fleet, Seafish, not yet published.

Some sectors of the UK fishing fleet (such as beam trawlers and over 24m whitefish trawlers) have a higher dependency on fuel than others (especially static gear). Presently, fuel costs range from around 5% of sales for small boats, inshore fisheries, and static gear to around 60% of total sales for beam trawlers.

1.3.1 Beam trawl

There are up to 120 active beam trawlers in the UK fleet, with the majority based in South West England and North East England. The South West beam trawl fleet mostly fish areas VIId/e and IV (see figure 1). On average vessels are 27m long, 26 years old, with engine power of 675 kW. These vessels target high value flatfish with other species such as monk fish contributing to vessel earnings.

The South West beam trawl fleet has undergone significant structural change in recent years, with a process of consolidation leaving fewer vessels, mostly operated by larger fishing companies.

The North Sea beam trawlers are larger, younger and more powerful than the south west vessels. They fish in the North Sea areas IVb and IVc on five day trips catching mainly plaice, dabs and high value flatfish with a target fishery on dover sole in the winter months.

Continuing high running costs, driven by the high cost of fuel, and lower volumes of landings have affected the recent economic performance of this sector. These have been offset to some extent recently by increasing fish prices, however some vessel owners still have to consider tying up for part of the year. Vessel owners have cut back on vessel repairs where possible to remain viable. Crew retention and recruitment remains a problem.

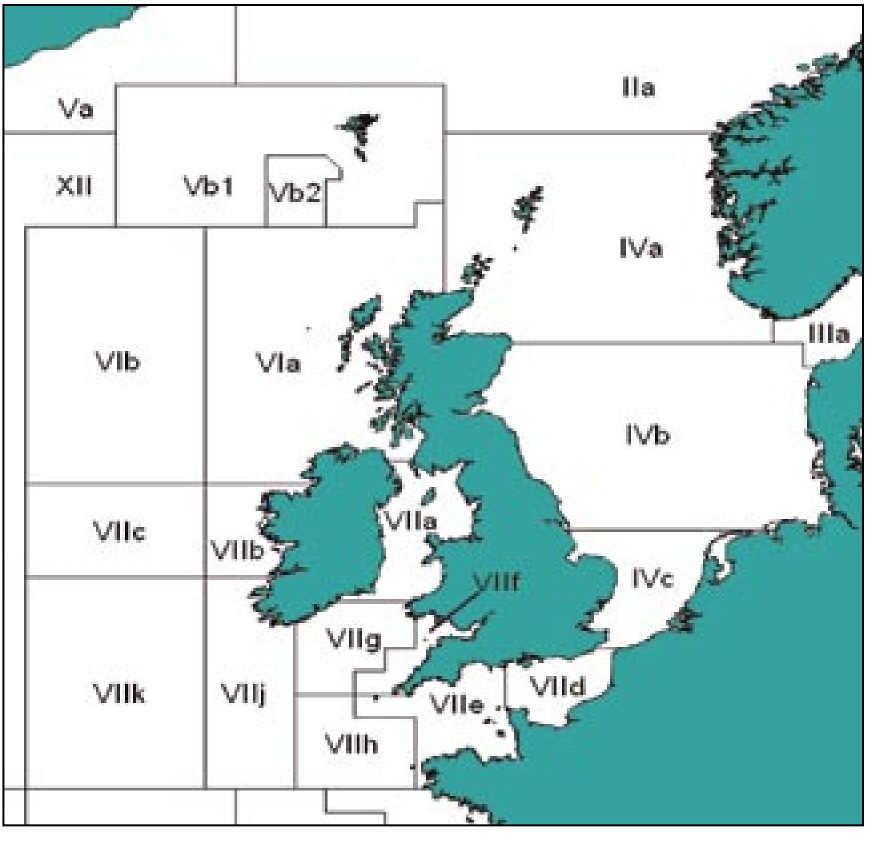

Figure 2. Map showing fishing grounds and ICES areas of NW Europe

1.3.2 Whitefish trawl

There are around 270 whitefish vessels over 10m in the diverse UK whitefish fleet. Around 100 of these vessels are based in Scotland, 35 in Northern Ireland, and the remainder in England and Wales. Decommissioning, cod recovery regulations, reduced quotas and effort limitation have all influenced the change in structure of this sector and the profitability of many vessels.

Vessel characteristics and the species these vessel target vary considerably depending on the area in which they fish. Over 24m Scottish whitefish trawl vessels typically fish eight to nine day trips, are 30m long on average, with engine power of 770 kW. These vessels target a mix of haddock, cod, monkfish, saithe and whiting. Whitefish trawlers based in the south west and English channel fish typically three to four day trips in areas VIId and VIIe, are 13m long on average, with 184 kW main engine power. These vessels tend to catch a greater variety of species including whiting, plaice, pollack, cod, monkfish, lemons, and non-quota species such as squid. The average age of a whitefish trawler is 30 years.

Following significant reductions in vessel earnings from the late 1990s into 2001/2002, average gross earnings for the North Sea and West of Scotland whitefish fleet increased in 2004/2005. The increase in fuel costs, combined with high spending on leasing quota and days at sea diminished net profits for these vessels in 2004 and 2005, however high costs have been offset to some extent recently by increasing fish prices.

The price of fuel will affect the viability of many vessels in this sector in 2006.

1.3.3 Nephrops trawl

There are approximately 450 nephrops trawlers in the UK, around 350 based in Scotland and North England and the remainder fishing from ports in Northern Ireland. The Scottish fleet operates in area IVab on the east coast and Via on the west coats. Nephrops trawling on the west coast is dominated by an inshore fleet of relatively older vessels between 10m and 20m long. The North Sea nephrops trawl fleet is dominated by larger 'offshore' vessels between 14m and 26m long including many former whitefish vessels and new purpose built vessels. Vessels based in Northern Ireland and England are typically smaller and older than Scottish nephrops trawlers.

Although nephrops stocks are currently reported to be stable[3], there have been concerns of increasing pressure on stocks from whitefish vessels moving into nephrops catching. Quota and price increases mean that revenues are expected to increase in 2006. However it is likely that increasing vessel running costs will negatively affect profit levels. Smaller vessels operating in this sector reported a relatively poor economic performance, compared with larger, more efficient vessels fishing further offshore.

Like other sectors of the fleet, high fuel costs continue to have an impact on crew share and vessel financial performance. Owners have cut back on vessel repairs and maintenance where possible to remain viable. This has been a general trend for the past 12 years. Crew recruitment and retention problems remain.

1.3.4 Scallop Dredgers

There are 178 registered scallop vessels operating from numerous ports and jetties around the UK. The character of the fleet is mixed, with a contrast between smaller traditional boats usually fishing day trips, and medium and large nomadic dredgers, up to 30m long, some with their own on-board freezers. Some vessels are converted whitefish trawlers as a result of restrictions in demersal fisheries. These vessels predominantly land king scallops. A number of vessels switch gear for part of the year to catch nephrops.

High fuel costs and amnesic shellfish poisoning closures have taken their toll on the scallop sector. Falling profits have been reported by many larger boats.

[3] Fisheries Research Services, Fish and Nephrops Stocks Information: 2006.

2. Research methods

2. Research methods

Seafish staff and Jubilee Fishing Company of Grimsby conducted the research. The study research methods involved a combination of desk research and interviews.

Fuel efficiency can be defined as:

- The amount of fuel required to catch a certain volume of fish. This is what we would call technical fuel efficiency; and
- The cost of fuel as a proportion of fish sales. This is what we would call business efficiency. Improving the value of fish without doing anything to change the way a vessel uses fuel can improve business efficiency.

There is a common misunderstanding about fuel efficiency which may arise when people think about fuel use per hour or per trip. This is not the correct way to think about fuel efficiency because efficiency is about the relationship between an input (fuel) and an output (fish). Any action which alters this relationship alters fuel efficiency.

An existing preliminary list of fuel efficiency measures, drawn up by Seafish in September 2005 and was expanded by contacting relevant people within or attached to the catching sector and support services.

The project team designed a questionnaire and interviewed members of the fishing industry either by telephone or in person. Interviewees were asked to comment on a range of questions including:

- Changes they had made to improve fuel efficiency;
- Potential methods to improve fuel efficiency;
- Extent of current uptake;
- Scope for future uptake;
- Current fuel purchasing practices; and
- Expected impact on the environment and effects on local economies of any changes in landings patterns that might result from widespread uptake of fuel-reduction catching methods.

Seafish also drew up a list of potential measures which may reduce fuel efficiency and interviewees were asked their opinions on whether these measures would be effective for them.

The survey data was analysed and individual case studies were compiled of fishing vessel businesses which have successfully implemented fuel efficient measures.

Given the small sample size an additional reliable source of information was needed to compliment survey findings. Industry experts from each of the fleet sectors were asked to comment on the findings from the data analysis and give their opinion on their experience from their own sector of the fleet. This ensured the survey findings could be realistically projected across the entire UK fleet.

2.1 Sample

Tables 2 and 3 provide a description of the interviewees in the survey sample.

Over 100 members of the fishing industry were contacted. 67 questionnaires were completed and 45 skippers chose not to complete the questionnaire as they had made no changes or did not wish to participate. A further 64 skippers completed fuel efficiency questions as part of another survey and their answers were included in the analysis.

Fleet segment	Sample	Active Population [4]	Sample %
Beam trawl	8	120	6.7
Whitefish trawl (over10m)	15	270	5.6
Nephrops trawl	44	450	9.8
Scallop dredge	5	178	2.8
Static gear (under10m)	37	3,843	1.0
Seine net	4	31	12.9
Pelagic	1	49	2.0

Table 2. Interview sample sizes by fleet segment[5]

Other industry representatives	Sample
Vessel agents	3
Fishermen's associations	4
Producer organisations	4
Technical (net makers, etc)	6

Table 3. Other industry representatives included in the survey sample

[4] Number of vessels that reported landings in 2005.
[5] Population statistics estimated from the 2005 economic survey of the UK fishing fleet.

3. Current response of the UK fishing fleet to high fuel costs

3. Current response of the UK fishing fleet to high fuel costs

Over the past 18 months or so UK fishing vessel owners have changed their attitudes towards fuel oil. Previously it was generally viewed as a significant expense, but one which the skipper or owner had little control over and therefore accepted without too much thought. Following the increase[6] in fuel price over the past 18 months the economics of fishing have changed as have the attitudes of the fishermen.

The current price of fuel has brought the issue to the front of most fishermen's minds and consequently it was a subject most interviewees had no problem discussing. In some cases however, individuals had made significant positive changes to their practices and were reluctant to share this information for fear of losing their competitive advantage.

3.1 Measures currently adopted by vessels

Most vessel owners surveyed reported making at least some small changes to their fishing methods and practices in an effort to reduce fuel use (per tonne of fish landed). These changes were both operational and strategic. Some changes have required little or no cost to the vessel business (for example, reducing vessel steaming speed), while other changes have required significant investment (for example, gear modifications and engine replacement). This distinction between changes that have required investment and those requiring little cost to the vessel owner is important.

The most common operational changes reported were:

- Changing towing patterns to minimise fuel use;
- Reconsidering going to sea in bad weather;
- Modifying gear to reduce fuel use, including: switching from single to pair trawling, reducing length of trawls, size of the trawl and changing the size and type of trawl doors;
- Reducing steaming speeds; and
- Reducing towing speeds.

The most common strategic changes reported were:

- Diverting fishing effort to fishing grounds closer to the mainland;
- Changing the landing port to nearest port to fishing grounds to reduce steaming time;
- Replacing the engine with a more fuel efficient engine; and
- Changing the fishing method and target species.

Some vessels owners did not make these changes purely because of high fuel prices. For example, a vessel owner replacing an engine may have brought forward this investment decision in order to benefit from lower fuel

[6] The average fuel price has fluctuated over the last 18 months but remains high compared to the last 3 year period (refer to figure 1).

consumption or the scheduled change may simply have coincided with the price increases.

As well as changing fishing methods and practices in an effort to improve fuel efficiency, some vessel owners have also been considering their current fuel purchasing practices including the possibility of entering bulk-buying schemes.

3.2 Uptake and scope for further uptake of fuel efficiency measures

Many vessel owners found it difficult to comment on what proportion of vessels in their segment have already adopted various fuel use efficiency measures or to comment on the value of benefit to the fishing industry as a result of adopting fuel efficiency measures.

Fuel efficiency measure	Uptake: (no. of vessels)	Uptake: (% of sample)	Estimated industry uptake	Barriers to uptake[7]	Costs	Benefit
Change trip planning practices[8]	32	24%	■■■	-	£	££
Reduce towing speed	8	6%	■■■	Knowledge and practicality	-	£
Reduce steaming speed	18	14%	■■■	Knowledge	-	££
Change landing port	8	6%	■■	Knowledge	£	££
Replacing engine	5	4%	■	Cost	£££	££
Change fishing method[9]	16	10%	■	All	£££	£
Change target species	6	5%	■	Regulation	££	£
Stop fishing temporarily [10]	1	1%	■	Cost	£	£
Modify gear	43	33%	■■■	All	£	£££
Preventative maintenance	5	4%	■	Knowledge and cost	£	££
Fit gear monitoring unit	1	1%	■	Cost	££	£
Reduce crew costs	1	1%	■	Practicality	-	£

Table 4. Summary table of uptake, barriers, costs and benefits of various fuel efficiency measures taken by vessels in the survey sample

Note: Estimated uptake, costs and benefits are illustrated in approximate categories of low (£ and ■), medium (££ and ■■), high (£££ and ■■■) based on data collected in this survey and knowledge of Seafish technical staff.

[7] Barriers to increased uptake fall into four broad categories: knowledge gaps (knowledge), capital availability (cost), regulation and practicality.
[8] Changing trip planning practices includes re-considering: steaming distance; not going to sea in bad weather; changing towing patterns to minimise fuel use and working cleaner grounds.
[9] Examples of changing fishing method are changing from beam trawl to otter trawl or single rig to twin rig.
[10] Stopping fishing temporarily involves fishing fewer days per year than would have been permitted by quota and days at sea regulations.

Fuel efficiency measure	Beam Trawl	Whitefish trawl	Nephrops trawl	Scallop Dredge
Change trip planning practices	50%	33%	30%	20%
Reduce towing speed	25%	13%	7%	20%
Reduce steaming speed	0%	40%	11%	20%
Change landing port	50%	13%	0%	20%
Replacing engine	25%	0%	2%	20%
Change fishing method	38%	53%	7%	0%
Change target species	25%	27%	0%	0%
Stop fishing temporarily	13%	0%	0%	0%
Modify gear	63%	93%	39%	0%
Preventative maintenance	0%	20%	2%	0%
Fit gear monitoring unit	0%	0%	2%	0%
Reduce crew costs	0%	0%	0%	0%

Table 5. Uptake of each fuel efficiency measure by the survey sample – proportion of our sample in each segment

Note: The percentages show the percentage of survey respondents in each segment who reported having made each change.

Industry experts from each of the fleet segments were asked to estimate what percentage of the segment had made each change and the scope for further uptake (for the remainder of the segment). Table 6 shows the estimated uptake and scope for further uptake (by vessels) of each fuel efficiency measure by each segment of the fleet based on data collected in our survey and knowledge of industry experts and Seafish staff.

Industry experts noted that the UK fleet has naturally focussed on the issues which give it the greatest amount of gain for the least amount of investment. There is scope for steady increase in the uptake of fuel efficient fishing methods and this is inherent in most skippers' plans for the future.

	Estimated industry uptake (number and % of vessels in each segment)				Scope for further uptake (number and % of vessels in each segment)			
	Beam Trawl	Whitefish Trawl	Nephrops Trawl	Scallop Dredge	Beam Trawl	Whitefish Trawl	Nephrops Trawl	Scallop Dredge
Change trip planning practices	60-90 (50-75%)	55-95 (20-35%)	45-135 (10-30%)	20-55 (10-30%)	c. 25 (c.20%)	c.55 (c.20%)	25-90 (5-20%)	35-55 (20-30%)
Reduce towing speed	5-30 (5-25%)	15-40 (5-15%)	25-45 (5-10%)	10-35 (5-20%)	10-45 (10-40%)	0 (0%)	0-45 (0-10%)	35-55 (20-30%)
Reduce steaming speed	c. 85 (c.70%)	215-270 (80-100%)	45-90 (10-20%)	c. 35 (c. 20%)	c.35 (c.30%)	c.55 (c.20%)	90-135 (20-30%)	c.35 (c.20%)
Change landing port	10-35 (10-30%)	30-55 (10-20%)	0 (0%)	10-20 (5-10%)	c.25 (c.20%)	c.25 (c.10%)	0-135 (0-30%)	c.20 (c.10%)
Replacing engine	5-10 (5-10%)	0-30 (0-10%)	25-45 (5-10%)	10-20 (5-10%)	0 (0%)	c.15 (c.5%)	0-90 (0-20%)	(10-35) (5-20%)
Change fishing method	10-35 (10-30%)	25-110 (10-40%)	0-45 (0-10%)	0-35 (0-20%)	c.25 (c.20%)	c.55 (c.20%)	25-90 (5-20%)	0-55 (0-30%)
Change target species	5-25 (5-20%)	15-55 (5-20%)	0 (0%)	c.35 (20%)	c.5 (5%)	15-30 (5-10%)	0 (0%)	0-55 (0-30%)
Stop fishing temporarily	5-12 (5-10%)	0 (0%)	0 (0%)	0 (0%)	c.35 (c.30%)	0 (0%)	0 (0%)	0 (0%)
Modify gear	70-120 (60-100%)	245-270 (90-100%)	45-180 (10-40%)	0-20 (0-10%)	c.10 (c.10%)	c.80 (c.30%)	c.135 (c.30%)	10-35 (5-20%)
Preventative maintenance	10-25 (10-20%)	25-55 (0-20%)	25-45 (5-10%)	0-20 (0-10%)	c.25 (c.20%)	c.55 (c.20%)	90-225 (20-50%)	35-90 (20-50%)
Fit gear monitoring unit	0 (0%)	0 (0%)	c.25 (c.5)	0 (0%)	0 (0%)	0 (0%)	90-135 (20-30%)	0 (0%)
Reduce crew costs	0 (0%)	0-15 (0-5%)	0-45 (0-10%)	0-20 (0-10%)	0 (0%)	c.15 (5%)	0-25 (0-5%)	0-10 (0-5%)

Table 6. Estimated industry uptake and scope for further uptake of fuel efficiency measures by fleet segment (estimated number and % of vessels in each segment)

3.3 Descriptions, costs and benefits, barriers to uptake

In this section we describe each of the fuel efficiency measures highlighted by the interviewees and industry experts in more detail and examine the costs, benefits and issues surrounding the measures. Barriers to uptake of the measures by more vessels are also presented.

3.3.1 Changing trip-planning practices

Description

The rise in fuel prices has forced fishermen to reconsider their operating practices. Previously it may have paid for fishermen to steam long distances to fishing grounds in order to catch the best fish and get the best prices. However, as a result of the fuel price increases, the economics of this practice may be less viable. Other influencing factors, such as days at sea restrictions and quotas also come into consideration and it can be difficult to separate the influences of fuel price increases from these.

Fishermen are reducing their steaming distances and choosing to work closer to shore. An example of this was the practice of Scottish whitefish boats making alternating trips between the inshore and offshore grounds, with the inshore trip being referred to as the 'fuel trip'.

Other practices which have come under closer scrutiny from fishermen include fishing in bad weather, towing against the tide, working cleaner grounds and operating in periods of poor fishing. Whitefish vessels may tie up during the spring spawning season because they expect fish quality and prices to be low, and would rather use the fuel and the days at sea when they expect a better return.

Costs and benefits
In all cases fishermen are examining more closely the costs and benefits of various factors and this influences their decision making. For example, if bad weather is expected, when deciding whether or not to go fishing, a fisherman would consider the following factors: distance to the fishing grounds and the level of shelter offered, long term weather forecast, days at sea allowance, quota, recent quality of fishing, supply of fish to the market and the potential of landing to a hungry market. The cost of such a trip in bad weather will inevitably be more than in good weather. However this can be offset by a good market price upon landing. Previously the main consideration would have been whether the vessel would have been capable of fishing in the conditions.

The difference in revenue for an eight - ten day trip between poorer quality and better quality fish could be £2,000 - £5,000 for the same cost of fuel.

Barriers to uptake
There are no significant barriers preventing fishermen from doing this and the benefits can be major. In some cases it is clear that more transparent market information might enable skippers to make more reliable business choices. Unfortunately it was near impossible for any of the interviewees to quantify the benefits given that there were so many factors at play, but they were able to state that changing the way they made their decisions about when or whether to start a trip, and where to fish, had helped them mitigate the high fuel prices.

3.3.2 Reducing towing speed

Description
Most fishermen have experimented with towing speeds to reduce fuel costs. This is a delicate balancing exercise between the volume and value of fish caught and the fuel used per tow.

Costs and benefits
Below a critical speed (2.5 knots) the fish are able to out-swim the net and the losses sustained outweigh the benefit gained from reduced fuel consumption. Towing at a faster speed (4+ knots) is no longer efficient and the majority of the fleet have reduced their towing speed to a point where they aim to maximise their catch per unit of fuel used, rather than minimising the fuel use or maximising the catch.

Barriers to uptake
It is relatively simple for fishermen to implement changes in relation to towing speed although lack of information on exact fuel consumption can make it difficult to find the optimum speed. The financial benefit is very much dependent on the individual vessel, its engine and its gear and can be difficult to quantify, but significant enough to be noticeable.

Most beam trawlers already tow at the optimum speed so further lowering towing speed would create a lower catch per unit effort (CPUE) which would not be efficient. There is limited scope for some of the larger vessels to reduce towing speed but the smaller beam, trawlers would struggle to tow at a slower speed due to the effect of the sea on the vessels (heavier boats manage to handle sea conditions better). The whitefish trawl and nephrops trawl also mostly tow at optimum speeds and have limited scope to alter speeds due to the effect on the catch. Scallop vessels are targeting a static stock so there is more scope to reduce towing speed.

3.3.3 Reducing steaming speed

Description
Over the past 30 years owners have built vessels with increasingly bigger, more powerful engines which use increasing amounts of fuel. This gradual change has been driven by many factors including increased gear size and overall efficiency of operations. These larger engines do not necessarily result in faster fishing boats however and today's fleet is generally slower than 20 years ago. For many reasons it is often desirable to steam as quickly as possible and which may require the engine to run 'flat out'. Unfortunately when steaming 'flat out' the engine is operating at or close to its maximum revolutions per minute (revs), which is the least fuel-efficient output of the engine.

Many vessels in the beam trawl fleet and the large whitefish trawl vessels fish a long way away from shore so the steaming component of their fuel usage is high. Many vessels in these fleet segments have adjusted steaming speeds.

Costs and Benefits
By reducing steaming speed to optimum efficiency the vessel will consume up to 50% less fuel whilst delivering 70% or more of the maximum speed. Given current fuel prices this reduction in steaming speed can have a big impact on the running costs of a fishing vessel.

One interviewee said he saved 450 litres of fuel per eight – ten day trip by steaming 0.5 knot slower and suggested this would be a typical saving for whitefish and beam trawl vessels.

A cost of this measure is vessels use up more of their days at sea allocation by steaming slower. Many vessel owners have to purchase extra days at sea in order to catch their quote allocation.

Barriers to uptake
Days at sea restrictions can have a negative affect on vessels optimising steaming speed. Many vessels have already reduced their steaming speed, however there is a trade off with time on the fishing grounds for fleet segments which have days at sea restrictions. In order to maximise a vessel's fishing opportunity within its days at sea allowance, it is important to minimise time spent steaming and maximise time spent fishing. However, the need to minimise steaming time must be balanced with the need to optimise engine and fuel efficiency.

3.3.4 Changing the landing port

Description
The majority of skippers surveyed avoid steaming to distant ports to reduce fuel costs. Traditionally fishermen have preferred to land in their home port. In response to the high fuel costs, fishermen are landing in the nearest port and selling their fish at that port or arranging transport to take the fish to a preferred market across land. Worthy of note is the fact that vessels from the north east of Scotland have worked on the west coast of Scotland and instead of steaming home they land their catch on the west coast, from where it is transported to markets such as Aberdeen and Peterhead.

The scallop and nephrops fleet's fish mainly inshore so this does not apply as they already fish close to their port of landing. The driver for changing landing port is not so much related to cost of fuel (although to some it may especially vessels working to the west) but due to days at sea restrictions.

Costs and benefits
There are very few quantitative costs associated with this measure. We can identify items such as the social cost of nights away from home for the crew but this is difficult to measure.

Case Study 1 - *Change of landing pattern*

Eventide, GY120, year of build: 1964

Name of vessel:	MFV Eventide GY 120
Mode of Fishing:	Gill net fishing on wrecks
Type of vessel:	17m wood construction
Owners:	Jubilee Fishing Company (Grimsby)

Background

MFV Eventide has fished from her base port of Grimsby since 1989, fishing in the North Sea and primarily catching cod. One of MFV Eventide's main fishing grounds lies approximately 40 miles from the Dutch coast and 150 miles from Grimsby. Because the cod market in Grimsby is buoyant the Eventide traditionally returned to her base port to discharge her catch and get ready for her next trip.

Action

Because of the major increase in fuel prices and the introduction of the 'Days at Sea' regime it has become necessary to change fishing patterns to reduce fuel usage and maximise the number of fishing days allocated to the vessel. This has been achieved by unloading the catch at the port of Scheveningen in Holland, which is approximately 50-60 miles from the fishing grounds, instead of returning to Grimsby. MFV Eventide normally lands the catch from two or three trips (six - seven days each) into Scheveningen and then returns to her base port of Grimsby to give the crew time off and carry out routine repairs to the vessel. Discharging three trips into Scheveningen instead of returning to Grimsby each time saves approximately 50 hours steaming time. This constitutes a saving of approximately 1,100 litres of fuel based on the Volvo 170kW engine burning 22 litres per hour.

Costs

There are no identifiable extra costs for this example.

Benefits

Comparison between landing into Scheveningen and landing into Grimsby:

Three six-day trips landing in Grimsby
Engine running 552 hours (18 days fishing) @ 22 litres per hour. **Total 12,144 litres**

Three six-day trips landing in Scheveningen
Engine running 502 hours (18 days fishing plus return to Grimsby) @ 22 litres per hour.
Total 11,044 litres

Fuel saving of £352 for 18 days fishing (1,100 litres @ 32p per litre).

Annual fuel saving of £2,738 (based on 140 days at sea).

This represents a saving in fuel of approximately 10% for the three fishing trips. A newer, shorter vessel could expect higher benefits for reducing steaming time than the well streamlined eventide.

The vessel uses about 35% of its Days at Sea allocation (140 days) landing in Scheveningen in this pattern. The vessel uses the remainder of its days fishing equidistant between the Dutch and UK coasts, unloading catches in Grimsby or Scheveningen, whichever port offers a higher price for cod on the day of unloading.

The decision surrounding where to land is partly a technical decision but also depends on business efficiency, ie if fish prices in a particular port are higher than a competing port then it might be worth steaming to it.

Barriers to uptake
There are few barriers to preventing this practice beyond knowledge and familiarity and most fishermen who can benefit from this fuel saving practice do so. The benefits vary from vessel to vessel but are certainly significant. Days at sea restrictions are another motivation for this behaviour change.

3.3.5 Replacing the engine

Description
The average age of vessels in the UK fleet is increasing and in many vessels the engines are now outdated. It is not unusual to see 50 year old technology - old Gardner and Kelvin engines are fairly commonplace.

A small but significant number (five) of the interviewees stated that they had replaced an engine recently, but this was not necessarily purely an attempt to overcome the effects of high fuel prices. In some cases the engine may have been damaged beyond repair and was replaced for that reason. In other instances the engine was due for renewal and this merely coincided with the fuel price increases.

Costs and Benefits
For many vessels in the UK fleet, the benefits of changing an old engine for a new, more technologically advanced engine are considerable in economic and environmental terms. Changing an engine entails more than just swapping a new engine for an old one - the gearbox, shaft and propeller may have to be altered, all of which adds to the capital investment required.

Barriers to uptake
A barrier to the uptake of this efficiency measure is the cost of replacing the engine and the lost fishing time. Despite high fuel costs it is unlikely that the UK fleet will be able to undertake a program of investment in engine renewals using privately raised capital.

Case study 2 – Replacing the engine

Name of vessel:	MFV Eventide GY 120
Mode of Fishing:	Gill net fishing on wrecks
Type of vessel:	17m wood construction
Owners:	Jubilee Fishing Company (Grimsby)

Background
MFV Eventide ran on a Volvo Penta type TMD 102a engine, rated 170 kW at 1,800 rpm since 1988. In May 2004 the engine broke down and was found to be beyond economic repair.

Action
The owners installed a new engine : a Volvo Penta type TMD 103a, rated at 170 kW at 1,800 rpm, a more fuel efficient version of the old engine.

Costs
The purchase cost of the re-power of MFV Eventide was £22,000, including the cost of the engine.

The cost of the re-power includes:

- Cost of capital = £1,100 (5% of total cost);
- Annual depreciation of the new engine = £2,200 (ten years straight line); and
- Lost profits due to lost fishing = 0 (because days at sea per year is limited by regulation).

Benefits
Since installing the new engine, the vessel has used around 40 litres of fuel per day less, a reduction of around 7%. Based on the year 2005, when the vessel fished for 140 days plus 30 days on guard-ship duty, the vessel saved 6,300 litres, which at 32p per litre, gave a total saving of £2,016.

The total cost of replacing the engine exceed fuel savings in this case.

Case study 3 – Replacing the engine

Name of vessel:	Carhelmar BM23
Mode of Fishing:	South West beam trawler
Type of vessel:	23.8m steel-hulled beam trawler
Owners:	Interfish of Plymouth

Background
The vessel was built in Holland in 1989 for Mr John Lovell and based in the port of Brixham in Devon. She was originally powered by a Stork Workspoor type DR216 engine that was naturally aspirated. Two DAF type 1160 generator sets of 106 kW at 1,500 rpm provided 415 volts of three-phase power to the vessel. The engines were run alternately.

In 2000 the vessel was sold to current owners Interfish of Plymouth, who continued to operate the vessel as a beam trawler fishing south coast grounds. The fuel consumption for a seven-day fishing trip was between 16,000 and 18,000 litres.

Action
In 2004 the Carhelmar was re-engined in Holland with a modern Mitsubishi type 563A turbo-charged engine, at similar power to the Stork Workspoor. The two DAF type 1160 generator sets were replaced with Cummins type 'C' series engines, giving a power of 120 kW at 1,500 rpm.

Costs
The total cost of the new (Mitsubishi) engine and gear box = approximately £70,000.

The total cost includes:

- Cost of capital = £3,500 (5% of total cost);

- Annual depreciation of the new engine = £7,000 (ten years straight line); and

- Lost profits due to lost fishing = 0 (because days at sea per year is limited by regulation).

Benefits
Since the re-power, the skipper, Mr David Murphy, has confirmed that the fuel consumption has fallen from 14,000 litres for a seven-day fishing trip to between 10,000 and 11,000 litres for a trip of the same duration, operating in the same areas as before the re-power. At 32p per litre for diesel fuel this gives a saving of around £1,120 per trip, equal to around £29,760 per year (based on 2005 where the vessel fished for 186 days).

The old Stork Workspoor Engine was a dry sump type engine which carried the lubricating oil in a separate storage tank of approximately 200 litres. To compensate for oil loss through leaks and consumption the skipper was topping the tank with between 12 and 13 litres per day. The oil in the storage tank (200 litres) was replaced on an annual basis.

The new Mitsubishi engine sump holds 70 litres of lubricating oil which is replaced every 600 hours of running. Very little topping up is required between oil changes.

Based on the vessel fishing 186 days (running 24 hours per day) the Stork Workspoor engine would use approximately 2,600 litres of lubricating oil at £1.15 per litre costing £2,990.

Based on the vessel fishing 186 days (running 24 hours per day) the Mitsubishi Engine would use approximately 700 litres of lubricating oil at £1.15 per litre costing £805.

The annual saving on the cost of lubricating oil is estimated by the owners to be £2,185.

The total annual saving is expected to be around £31,945 (for both the savings in fuel consumption and lubricating oil).

3.3.6 Changing fishing methods

Description

Sixteen of the fishermen interviewed stated that they had changed their fishing method in response to fuel price increases. Some had moved from beam trawling to otter trawling. Several of the English North Sea vessels and some of the Scottish North Sea vessels have switched from single trawling to pair trawling and some had moved to targeting nephrops. Interestingly some vessels have switched from single-rig to twin-rig trawling while others have switched from twin-rig to single-rig trawl. The biggest change has been in the beam trawl sector where vessels have shifted from fishing with beam trawl to twin rig, predominantly fishing for the same species but some vessels are now targeting nephrops.

Costs and benefits

The benefits of these changes are variable and wholly dependent on the circumstance of the vessel. Interviewees found it difficult to quantify the benefit of making the changes, beyond stating that they believed there was an improvement in fuel efficiency ie fuel cost as a percentage of fish sales value.

Barriers to uptake

These opposite changes (single-rig to twin-rig and twin-rig to single-rig) suggest a lack of information and understanding among fishermen as to which method is appropriate to their needs. This indicates that lack of knowledge may be a barrier to effective change. In the case of anchor seining, a number of interviewees stated that they saw this as a fuel efficient method of fishing but were disappointed that the knowledge of the gear and techniques had been all but lost to the industry.

The fact that skippers are making changes in both directions may also reflect the fact that there is not one single solution to high fuel costs which is appropriate to all vessels in all situations.

Other barriers to change include availability and cost of licences, availability and cost of quota units to buy or hire, and the cost of refitting the vessel and purchasing new gear.

3.3.7 Modify gear

Description

Amongst the interviewees gear modification or tuning was the second most common change in practice in response to the fuel price increases. Industry members continually modify their gear regardless of the financial climate, however recent changes tend to be back to smaller, more fuel-efficient gears. Drag caused by a fishing net can account for 80% of fuel consumed so any changes in this area are likely to yield the greatest benefits.

Most beam trawler owners are experimenting with gear weight reduction, though only a few have changed the chain mat size. Other changes which have been investigated include reducing the beam size and running the chains mat for longer, having the dual financial benefit of being lighter and longer lasting albeit more prone to damage. Most if not all the beam trawl fleet have now moved to wheels rather than shoes on the beam ends to reduce friction on the seabed.

Many vessels in the whitefish fleet have also experimented with changing their nets. Examples include: using a lighter twine; using a smaller net; using a hopper net rather than high-drag nets; using a net with larger mesh size; and changing from a single net to a multi-rig. Most of these changes are relatively simple to make, however if not done correctly they can have a detrimental effect on the performance of the net and therefore knowledge is critical to success.

The nephrops fleet have similar issues to the whitefish fleet and therefore share many of the gear modifications. As a general trend most Nephrops vessels are experimenting with lighter gear and doors. The nets are becoming shorter and depending on quota entitlement, the headline heights are dropping all of which helps reduce the drag of the net. Indication from the interviewees is that these developments are in their early stages but will be taken up by the whole fleet in a short period of time.

Costs and benefits

The benefits of changing the gear can be significant, particularly given the fact that more fuel is consumed in towing the gear than at any other stage in the fishing process. None of the interviewees could quantify the exact financial benefit of changing their gear but stated that the improvements were big enough to be noticeable.

Detailed interviews with vessel owners produced estimates of benefit ranging from 3% to 20% improvement in fuel efficiency resulting from modifying the set up of towed nets and trawl doors. This is clearly very significant. It is apparent that even making correct or optimal use of existing gear can generate fuel savings of up to 10% for the same volume of fish caught, or, increase the volume of fish caught for the same amount of fuel used. Either way, it seems likely that it is well worth investing in ensuring that gear is correctly set up.

Some interviewees noted that modifying gear has helped improve the quality and price per kg of fish. For example increasing the size of the fishing circle can give skippers two choices:

a) Tow for the same amount of time, use the same amount of fuel and increase the volume of fish caught; and

b) Tow for less time, use less fuel and catch the same volume of fish of better quality (due to shorter tow time) and therefore an average higher price.

Knowledge can be a restricting factor, some fishermen commented that their net manufacturers were less able to advise them correctly on these issues than the Seafish gear technology advisors.

Barriers to uptake

In the beam trawl sector most potential improvements in beam construction have already been made leaving little scope for change. Recent developments in the Dutch fleet have seen beamers swapping beam trawls for otter trawls worked on an outright system. This work has been aided by Seafish gear technologists and there is significant scope for the UK fleet to adopt similar method of fishing. There is also more scope for improvement in the whitefish and nephrops trawl and pair trawl fisheries.

A barrier to implementation to any major gear alteration is cost. Very often the alteration will take the form of a new net and given their expense, fishermen prefer to wear out an old net before buying a new one. As mentioned above knowledge of gear and its correct set up is also a restricting factor.

Given the difficult financial state of some segments of the fleet, it is difficult and risky for the fleet to experiment with new gears and this creates a 'catch 22' scenario.

Case study 4: Modify gear[11]

Challenge II, UL33, Year of build 1995

Name of vessel:	Challenge II, UL33
Mode of Fishing:	Demersal trawler

Background

Seafish carried out sea trials to compare the drag of twin trawls of traditional polythene twines with new trawls of reduced twine.

In calm weather the vast majority of fuel is consumed to overcome the drag of the trawl gear and only a very small proportion to propel the vessel (around 10 – 20%). This means that gear drag is the main element which needs to be reduced to save fuel.

Drag of gear can be reduced by making the trawl smaller, reducing the opening (wingend spread and headline height), reducing the twine surface area of netting, reducing the ground contact friction or using lower drag doors and components. Twine surface area can be reduced either by using larger mesh sizes and/or reduced twine diameters.

If the same design of trawl is used but with smaller diameter twines the drag will reduce compared with the original trawl with larger diameter twines. Openings may increase if the same doors and floats are used, lessening the benefit of the reduced drag potential.

Action

Seafish carried out sea trials in March 2005 to compare the drag of twin trawls of traditional polythene twines with new trawls of reduced twine diameters (from nominally 4mm down to 3mm diameter). The trawls were built by Jackson Trawls of Peterhead and tested aboard MFV Challenge II (UL 33). Challenge II tows either a single trawl or twin-rig trawls depending on the grounds fished. These trials were conducted on the twin-rig trawls.

The old and new trawls were identical apart from the twine diameters ie rope lengths, number of meshes and mesh sizes. The doors, clump, ground gear, sweep lengths and flotation remained exactly the same when changing from the old trawls to the new.

The new trawls had an estimated reduced drag of 6% compared with the old trawls and an increased mouth opening of 10%. These changes are the result of a reduction in the twine surface area of 14% (from 155m^2 for the old trawls down to 134m^2 for the new trawls). These comparisons were made at 3.0 knots towing speed.

Costs

The new nets cost approximately £700 - £1,400 (each net) more than the old nets.

Benefits

The skipper had two options:

- Accepting a 6% reduction in drag (in this case giving approximately a 6% reduction in fuel consumption per tow); or
- Increasing the vessel's speed by 5%, from 3.0 knots to 3.15 knots (using the same fuel consumption but spending less time at sea).

If the skipper invested in new smaller doors (this would be an additional cost) and reduced the number of floats, a further reduction in drag would be expected, with further improvement in fuel efficiency. For a vessel whose fuel bill is £200,000 per year this 6% saving would equate to £12,000.

[11] The information for this case study is based on: Ward, Montgomerie and Lart, Seafish, fuel efficiency trials using Jackson trawls with reduced twine diameter on MFV Challenge II, SR578, August 2005.

3.3.8 Preventative maintenance

Description

In any business, preventative maintenance tends to be one of the first budgets to be cut when financial pressures take hold. Seafish staff are aware that preventative maintenance in the fishing industry has been on the decline for over ten years. However, vessel owners are now focused on more preventative maintenance due to days at sea restrictions which mean they do not want to risk losing days at sea due a breakdown. Vessels also have more days in harbour when they can undertake maintenance.

There is always scope for improvement and some insurance companies are now insisting on regular (between vessel survey) checks which promotes good practice.

Costs and benefits

At best a reduction in ongoing maintenance is only a short term strategy which offer no long-term return, and has significant safety implications.

Previously boats carried spares such as injector sets or motors and pumps. Today damage sustained at sea often necessitates that a vessel returns to shore for repairs, at potentially higher cost than the cost of good maintenance.

In addition, and critically for this study, poor maintenance can lead to poor efficiency.

The benefit of preventive maintenance is difficult to measure as a given problem may not have manifested if the correct maintenance had been carried out, however in the long-term the money saved through preventative maintenance is likely to be greater than the cost.

Barriers to uptake

The barrier to preventative maintenance is principally the initial cost and assessment of the cost benefit relationship. Vessels which are struggling financially cannot afford to replace inefficient components or carry large quantities of spares aboard. When ashore they cannot afford to pay for external contractors to come aboard and carry out work.

Cases when regular maintenance can improve fuel efficiency:

Maintaining the paint system:

It is important to maintain as little friction as possible between the hull and the water because friction has a negative effect on fuel efficiency.

More marine growth means more friction, which means more power is required to propel the ship through the water.

Marine growth fouling on the hull can seriously increase friction between hull and water, accelerating fuel consumption. An increase in resistance of over 30% has been noticed on ships that have been left to foul, and in some cases the hull has become so badly fouled that 30% more power was actually required just to maintain regular speeds.

Badly maintained paint can also result in an increase of marine growth and rough paintwork increases friction between the hull and the water in much the same way as fouling.

Regular engine maintenance

Regular maintenance will ensure that the engine is running efficiently. A poorly maintained engine will run less efficiently which could have a detrimental effect on the fuel consumption.

This applies to all the components of a vessels power system. Faulty or badly worn components may affect fuel efficiency and the long term additional cost in fuel may exceed the cost of replacing the component.

For example one vessel owner noted his vessel's fuel consumption increasing over a 12 month period. This was at first thought to be the result of a change in the size of doors he was using. It was not until an engine stoppage, due to the day service tank running empty, that the return fuel line filter was found to be blocked and that all the diesel being delivered to the engine by the fuel pump was passing through the combustion chamber and out the exhaust without being burned. Once the fuel filter was unblocked consumption fell by 45%.

3.3.9 Stop fishing temporarily

Description
Stopping fishing temporarily (fishing few days per year than would have been permitted by quota and days at sea regulations) may seem to be a drastic reaction to the increase in fuel prices, however for some businesses it is the least cost option.

Some vessel owners are tying up their boat for part of the year and leasing out quota and selling days at sea, or using the boat for other purposes (eg guard vessel work).

Costs and benefits
Vessel owners have found that by sending the vessel to sea, more money is lost than if the vessel was tied up in port and the quota is leased out. In other instances interviewees stated that at certain times of the year when they know that the fishing will be uneconomic they tie-up their vessels.The benefit of such an action will be marginal and form part of a damage limitation strategy.

Barriers to uptake
Uptake of this measure is low, since any vessel doing this on a long term basis would find itself out of business due to loss of skilled crew. At present this measure mainly applies to the beam trawl fishery. Some beam trawlers have already tied up (for short periods during the year) due to difficulties paying crew as a result of increased fuel cost. Once a vessel loses its crew, it has lost the means to use the fixed asset (the vessel) to generate profit from the fishery. It is not a straightforward proposition to put together a skilled crew for a fishing vessel.

This measure does not apply to the other fleet segments at the moment due to lower fuel consumption. Fuel cost is around 45% - 55% of total sales for beam trawlers.

3.3.10 Other measures

Some vessel owners have taken tactical measures such as bulk buying of fuel as a short term solution. This can benefit the individual vessel by reducing costs over a short time period but in an environment of high fuel prices this is unlikely to deliver a significant benefit across the fleet.

3.3.11 Other gear types

The main technical and strategic changes reported by other sectors of the fleet were similar to those already outlined above. The pelagic sector for example reported trying to develop more efficient gear, changed the type of trawl doors, reducing steaming speed, and modifying nets (lighter twines and alternative mesh construction for new designs to reduce drag).

Those vessel owners lining and netting reported changed landing port to the nearest port to fishing grounds, and not fishing when expected returns from a trip are expected to be marginal. One owner replaced the engine with a more fuel efficient unit. Potters / creelers surveyed have reduced vessel steaming speed. Seine netters reported reducing steaming speed, net modifications, and only fishing in favourable weather when returns are expected to be better.

3.4 Impacts of specific fuel efficiency measure - UK fleet overview

We asked interviewees to comment on the possible impacts (other than improving fuel efficiency) of adopting additional fuel efficiency measures. We provided a number of categories under which impacts might occur. These were:

- Volume of target species caught;
- Fishing area;
- Which species caught;
- Place of landing;
- Quality of catch;
- Environmental impact;
- Average or minimum size of target species;

- Bycatch;
- Time at sea;
- Price per kg; and
- Number of crew required.

Many survey respondents thought adoption of several of the fuel efficiency measures would have little or no impact on their vessel businesses or on the wider environment. Of those respondents who thought there may be some change many noted that some of the measures have had additional positive economic and environmental impacts.

Tables A1 – A4 in Appendix 1 illustrate the answers (opinions) given, for each major fleet segment in the study.

The main positive impacts noted were:

1. Some of the measures (notably changing trip planning practices and modifying gear) have improved the marketability of fish. For example shorter trips (from changing trip planning practices) and reduction in tow time (from modifying gear) have helped improve catch quality and the price per kg of fish; and

2. Some of the fuel efficiency measures can have a positive effect on the environment. In particular:

    - some fuel efficiency measures (for example installing fuel efficient engines and some gear modifications) produce less carbon emissions; and

    - some of the fuel efficiency measures can decrease contact with the seabed and as a result create less impact on the bottom (for example using lighter trawls).

In isolation these positive impacts may not amount to much however wide uptake of fuel efficiency measures could potentially have a more significant positive economic and environmental impact on both vessel businesses and the wider environment.

3.5 Overview of barriers to increased uptake of fuel efficiency measures

Our research findings show further improvements can be made to help increase uptake of the identified fuel efficiency measures. The barriers to increased uptake fall into four broad categories: regulation, knowledge gaps, capital availability, and practicality.

3.5.1 Regulation

In some cases regulation is encouraging the very behaviour that market pressures are discouraging. For example restrictions on permitted days at sea (includes both fishing and steaming time) should act as a deterrent to travelling greater distances to fishing grounds. In some cases it encourages fishermen to consume more fuel by 'racing' to the ground 'flat out' rather than steaming at the optimal speed for efficient operation of the engine. The increment in fuel cost can be as much as 30%.

3.5.2 Knowledge gaps

Knowledge is of critical importance when making any business decision. Examples of existing knowledge gaps which act as barriers to increased uptake are:

1. The visibility of fuel costs to vessel owners is greater when looking at cost of running their own vessel than the cost inherent in alternative transportation methods. By changing their landing port and having the catch transported by truck to market or processor, the cost to the customer for transporting the catch may be higher. For example the fish sales price at the port which is further away from the processor could be lower to offset the cost of road / ferry transport (eg considering landing in Lerwick instead of Peterhead).

    There is also the incremental cost of returning the boat and crew 'home' which may add cost without generating any revenue. Further analysis and knowledge sharing may help to better inform decisions relating to this issue.

2. Changing fishing grounds to those closer to shore and/or changing species targeted requires a fully costed evaluation of the options. It may require gear changes and additional training for the crew. New customers and markets may have to be identified. A strategic change of this nature requires a change of mindset on the part of everyone involved. However, it also provides an opportunity to evaluate the business. Finding the mental space and energy when onshore to consider this sort of change is difficult given existing industry pressures. There is a knowledge gap compounded by a level of fatigue acting as a barrier to strategic change.

3. Equipment maintenance and replacement, if optimised, will have a direct financial benefit to the fleet. However, the most cost effective way of powering a given boat does not appear to be well understood across the fleet. As a result the business case required for investment can be weakly presented. This knowledge gap is doubly troublesome as capital is scarce.

Given the diverse nature of the fishing industry it is impossible to expect every fisherman to hold expert knowledge of all areas critical to his operation eg naval architecture, gear technology, mechanics, electronics, refrigeration, financial management, business economics, marketing, etc.

3.5.3 Practicality

With many of the operational practices (changing trip planning practices, gear modifications and reducing towing and/or steaming speeds) there is a trade off between reducing fuel cost and continuing to satisfy stakeholders (market desire for a particular product, crew desire for work, etc). The practical limit for the 'easy' changes within the fleet has probably been reached.

3.5.4 Capital availability

For many of the fuel efficiency measures, further uptake requires additional investment. Many interviewees in this survey reported that it was difficult to raise the extra capital needed. Many vessels businesses are struggling to pay existing loans and these businesses are highly unlikely to be able to raise further capital. Capital is scarce within several major sectors of the fishing fleet and the poor financial health of certain fleet segments acts as a barrier to increased investment.

4. Potential benefits of increased uptake

4. Potential benefits of increased uptake

Our survey results show that fishermen have experienced some clear benefits by taking steps to improve fuel efficiency.

The potential benefits fall into three main categories:

- Catch value remains the same (or in some cases decreases) and fuel use decreases - for example preventative maintenance, changing trip planning practices and reducing steaming speed;
- Catch value increases and fuel use remains the same (or in some cases increases) – for example changing target species, some gear modifications and improving care and quality of the catch; and
- Catch value increases and fuel use decreases – for example changing fishing method, some gear modifications or purchasing / building a new vessel with fuel efficiency in mind.

Benefits all need to be weighed against the overall cost of making the change and any potential loss to CPUE (catch per unit of effort). Fishermen undertake cost and benefit analyses regularly as they try and balance the ongoing risks of the fishing profession with the benefits but they do not always have the information they need to do this accurately and so can sometimes make sub-optimal decisions.

Table 8 illustrates estimated financial benefit (excluding costs) per segment that might arise from further vessels adopting each fuel efficiency measure. The number of further vessels is based on estimated scope for further uptake (from table 6).

Estimates have been calculated using:

- Approximate daily benefit (in GBP);
- Average days at sea; and
- Scope for further uptake for each segment of the fleet.

These estimates are based on data collected in the survey, knowledge contributed by industry experts and Seafish staff, case studies and other Seafish work.

	Beam Trawl *(120 vessels in segment)*	Whitefish trawl *(270 vessels in segment)*	Nephrops trawl *(450 vessels in segment)*	Scallop Dredge *(178 vessels in segment)*
Change trip planning practices	**c. £20,000** Calculation: daily benefit £4.80 (avg 15 litres fuel saved per day) x 155 days per year x 25 boats.	**c. £55,000** Calculation: daily benefit £4.80 (avg 15 litres fuel saved per day) x 220 days per year x 55 boats.	**c. £40,000** Calculation: daily benefit £4.80 (avg 15 litres fuel saved per day) x 220 days per year x 40 boats.	**c. £35,000** Calculation: daily benefit £4.80 (avg 15 litres fuel saved per day) x 180 days per year X 40 boats.
Reduce steaming speed	**c. £100,000** Calculation: daily benefit of £17.90 (avg 56 litres fuel saved per day) x 155 days per year x 35 boats.	**c. £210,000** Calculation: daily benefit of £17.90 (avg 56 litres fuel saved per day) x 220 days per year x 55 boats.	**c. £220,000** Calculation: daily benefit of £9.00 (avg 28 litres fuel saved per day) x 220 days per year x 110 boats.	**c. £70,000** Calculation: daily benefit of £9.00 (avg 28 litres fuel saved per day) x 220 days per year x 35 boats.
Change landing port	**c. £80,000** Calculation: daily benefit of £20.80 (avg 65 litres of fuel saved per day) x 155 days per year x 25 boats.	**c. £55,000** Calculation: daily benefit of £9.60 (avg 30 litres of fuel saved per day) x 220 days per year x 25 boats.	**c. £100,000** Calculation: daily benefit of £9.60 (avg 30 litres of fuel saved per day) x 220 days per year x 50 boats.	**c. £15,000** Calculation: daily benefit of £4.80 (avg 15 litres of fuel saved per day) x 180 days per year x 20 boats.
Stop fishing temporarily	**c. £450,000** Calculation: Benefit of £5,000 per trip (average difference between good trip and bad trip) x 3 (delaying 3 trips in the spring until later in the year x 30 boats.	N/A (no scope for uptake)	N/A (no scope for uptake)	N/A (no scope for uptake)
Modify gear	**c. £130,000** Calculation: daily benefit of £83 (assuming 5% reduction in fuel cost for the same fish revenue) x 155 days per year x 10 boats.	**c. £2,600,000** Calculation: daily benefit of £149 (assuming 5% reduction in fuel cost for the same fish revenue) x 220 days per year x 80 boats.	**c. £1,300,000** Calculation: daily benefit of £44 (assuming 5% reduction in fuel cost for the same fish revenue) x 220 days per year x 135 boats.	**c. £70,000** Calculation: daily benefit of £19 (assuming 5% reduction in fuel cost for the same fish revenue) x 180 days per year x 20 boats.
Preventative maintenance	**c. £90,000** Calculation: daily benefit of £23 (assuming 2% reduction in fuel cost for the same fish revenue) x 155 days per year x 25 boats.	**c. £720,000** Calculation: daily benefit of £60 (assuming 2% reduction in fuel cost for the same fish revenue) x 220 days per year x 55 boats.	**c. £590,000** Calculation: daily benefit of £18 (assuming 2% reduction in fuel cost for the same fish revenue) x 220 days per year x 150 boats.	**c. £55,000** Calculation: daily benefit of £6 (assuming 2% reduction in fuel cost for the same fish revenue) x 180 days per year x 50 boats.
Estimated total financial benefit	**c. £870,000**	**c. £3,640,000**	**c. £2,250,000**	**c. £245,000**

Table 8. Estimated annual potential benefit (in GBP) of increased uptake of each fuel efficiency measure by fleet segment

5. Opportunities and issues for industry and government

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5.1 Industry

To improve fuel efficiency it is clear that no single solution will be the best answer for all types of vessel in the fleet. Each vessel owner can benefit from considering the measures presented here and evaluating the potential benefit of the same action for their individual vessels. If fuel prices continue remain high, more radical action will become necessary. The fall in prices in recent weeks is good news for the fleet but fuel is still around twice the price that the vessel businesses were designed for.

Dissemination of knowledge among skippers and vessel owners is important to ensure maximum efficiency of use of current gear. Seafish port seminars, gear courses and workshops can help to achieve this.

5.2 Government

For policy makers in fisheries administrations it is important to realise the impact of regulations on industry profitability in light of current pressures caused by high fuel prices.

The findings from the survey suggest interventions to encourage investment in fuel efficient engines and gear would be most welcome. In addition low rate sources of capital and incentives for research and development could have both a concrete financial benefit to the fleet and support carbon emission reduction targets of the government. Funding to assist in the development of media for improving fishermen's knowledge and understanding of optimal use of existing gear could also play a big part in curbing current knowledge gaps. Possible media could include Seafish port seminars and DVDs filmed especially to illustrate common issues, choices and problems, including example cost benefit analyses.

Consistent policy that recognises the pressures on the industry should be the government's objective. There are regulatory issues and opportunities to encourage best practises. For instance, government should consider how days at sea restrictions and proposed zoning of the seas will impact the fuel consumption behaviours of the UK fleet. As noted above the inclusion of steaming time in the days at sea calculation can prompt vessels to steam at speeds that are higher than is optimal for fuel efficiency. Closing inshore areas to fishing puts further pressure on the vessel operators to travel great distances at speed. The activity that the government wishes to curtail is the overfishing of specific areas. Measures should be directly tied to that activity. Perhaps a restriction of the amount of time gear can be deployed would be a better measure.

5.2.1 Issues for the fishing Industry and fisheries Administrations to consider

5.2.1.1 Impediments to change

In most instances, financial outlay is necessary in order for a fisherman to change fishing practices. Given the poor financial state of the

UK whitefish fleet[12], it comes as no surprise that many of the interviewees in this survey cited capital availability as a restricting factor. In addition, uncertainties in some sectors relating to quota levels and potential changes in quota management rules make it more difficult to obtain external funding. Many fishermen are now finding themselves in a catch 22 situation. In order to improve their fuel efficiency and overall profitability they need to invest, however they do not have the available capital to do so and are unable to secure the necessary funds externally.

5.2.1.2 Lack of knowledge

Knowledge of options and potential impacts is of critical importance in decisions about business change. In many cases transfer of knowledge is the key to overcoming barriers to increased uptake. This is a market failure as small vessel businesses do not have the resources, time, money or contacts to scan their environment to get the best information available, which they would need in order to maximise business efficiency. This market failure is not unique to the catching sector but one that concerns small businesses in general.

It is important that fishermen have access to experts who can guide their decision making. However in some cases the answers to the questions that the fishermen are seeking have yet to be discovered. New technologies are coming onto the market all the time, while some standard questions still need to be quantified and answered.

In order to guide fishermen towards a less fuel-dependent future, substantial knowledge gaps need to be filled and this information needs to be communicated effectively. Government, industry and Seafish can all play a role to help full knowledge gaps and to address the other barriers inhibiting uptake of fuel efficiency measures.

5.2.1.3 Regulations and government policy

The purpose of government regulations is to change behaviour. The fishing industry is among the most heavily regulated industries in the UK. While all regulations have a primary goal, some have secondary unexpected effects. Many of the interviewees stated that regulations such as days at sea restrictions or quotas were preventing them from changing their practices.

One issue picked up throughout the interview process concerns the rules of vessel design. The design of the vessel hull has a major bearing on the efficiency of a vessel and many new vessels tend to be 'rule beaters'. They are designed to comply with specific rules relating to their length, often at the expense of safety and efficiency. Many fishing vessels have extreme length to beam ratios, often around 2.5:1, with an underwater form that is exceptionally full. They are being built like this to beat classification rules. Length to breadth ratios of between 3 and 4:1 minimise resistance when free running and enhance sea-keeping performance. While there are reasons behind the classification rules, it might be worth now looking at those reasons and weighing them against the long term savings that allowing longer sleeker vessels would bring the fishing industry.

[12] The Seafish 2005 economic survey of the UK fishing fleet (not yet published) shows typical profit levels are low for whitefish.

6. Conclusions and recommendations

6. Conclusions and recommendations

6.1 Conclusions

1. Vessel owners have taken a wide range of steps with the aim of improving the fuel efficiency of their catching operations.

2. Benefits have been identified and estimated but it is often very difficult to quantify benefits and to distinguish which step generated which benefits.

3. No single fuel-efficiency measure is suitable for the whole of any single segment of the fleet.

4. Vessel owners and government can take action to further improve fuel efficiency among the UK fishing fleet.

5. Some measures taken appear to offer a good likelihood of generating benefits in fuel-efficiency and do have scope for further uptake.

6. Substantial knowledge gaps need to be filled and this information needs to be communicated effectively. Fisheries administrations, industry and Seafish can all play a role to help full knowledge gaps to address the other barriers inhibiting uptake of fuel efficiency measures. This report can play a key part.

6.2 Recommendations for industry

1. Each vessel owner can benefit from considering the measures presented here and evaluating the potential benefit of the same action for their individual vessels.

2. Dissemination of knowledge among skippers and vessel owners is important to ensure maximum efficiency of current gear. Seafish port seminars, gear courses and workshops can help to achieve this.

3. The Seafish training and research and development teams can help provide knowledge and advice on fuel efficient gear operation. They can be contacted on 01482 327837.

4. Seafish Economics Team can help evaluate the likely costs and benefits of proposed changes: 0131 558 3331.

6.3 Recommendations for fisheries administrations

1. Fisheries administrations can encourage investment in fuel efficient engines and gear technologies.

2. Funding to assist the development of new media to improve knowledge and understanding of optimal use of existing gear could also play a big part in curbing current knowledge gaps.

3. Government's stated policy for fisheries is to help the industry to be profitable and sustainable (Securing the Benefits report). Specific regulations need to be evaluated to ensure they do not counter these aims. For example vessel design regulations need to be re-assessed to make sure they are encouraging fuel efficient vessels.

Appendix 1.
Impacts of specific fuel efficiency measures

Appendix 1. Impacts of specific fuel efficiency measures

Table A1. Scallop dredge segment

Impact	Change trip planning practices	Reduce towing speed	Replace engine
	Fishing closer to port of unloading		
Volume of target species caught	No change	Volume of target species reduced	No change
Which species caught	No change	-	No change
Quality of catch	No change	-	No change
Average size of target species	No change	Possibly grossing less	No change
Time at sea	Less	No change	No change
Number of crew required	No change	No change	No change
Fishing area	Fishing restricted to grounds closer to the port	No change	No change
Place of landing	No change	No change	No change
Environmental impact	No change	Less carbon emissions	Less carbon emissions
Bycatch	No change	No change	No change
Price per kg	No change	No change	No change

Key: - no answer

Table A2. Beam trawl segment

Impact	Change trip planning practices			Reduce towing speed	Reduce steaming speed	Change landing port
	Avoid towing against the tide	Fish closer to home port	Avoid fishing in bad weather			
Vol. of target species	-	No change	-	Less	No change	No change
Which species caught	No change	Possibly less sole	No change	Less plaice, slightly more sole	No change	No change
Catch quality	No change	No change	-	No change	No change	-
Average size of target species	No change	No change	No change	No change	No change	No change
Time at sea	No change	Less	Less	No change	Slightly longer	Less
No. of crew required	No change	No change	No change	No change	No change	No change
Fishing area	No change	Restricted to fishing in certain areas	No change	No change	No change	-
Landing port	No change	No change	-	No change	No change	Land at different port
Env. impact	-	No change	-	No change	No change	-
Bycatch	No change	No change	-	No change	No change	-
Price per kg	-	-	-	-	No change	-

Key: - no answer

Replace engine	Change fishing method		Stop fishing temporarily		Modify gear	
	Modify vessel from beam to trawling	Switch from beam trawl to dredge	Lay up vessel when fuel expensive	Guard ship work instead of fishing	Smaller frame & dropper chains on beams	Fit hard rubber wheels to beams
No change	-	No change	Potential reduction	Reduction	Possibly lower	No change
No change	Less flatfish, more roundfish	Changed from whitefish to scallops	No change	No change	Possibly less sole	No change
No change	No change	-	No change	No change	No change	No change
No change	No change	-	No change	No change	No change	No change
No change	No change	No change	Less	Less	No change	No change
No change	No change	Two extra	No change	Less crew required	No change	No change
No change	No change	No change	No change	-	No change	No change
No change	No change	No change	No change	No change	No change	No change
Less carbon emissions	Less damage to seabed	More damage to seabed	No change	-	Slightly less damage to seabed	Slightly less damage to seabed
No change	No change	Small sole bycatch	No change	-	Possibly less sole	No change
No change	-	-	No change	-	No change	-

Table A3. Whitefish trawl segment

Impact	Change trip planning practices			Reduce towing speed	Reduce steaming speed	Replace engine
	Land at closer port	Stop engine in port if not required	Operate closer to shore			
Vol. of target species caught	-	No change	No change	No change	Smaller	-
Which species caught	No change	No change	Range of species may be effected	No change	No change	-
Quality of catch	-	-	Benefited from shorter trips	No change	No change	-
Average size of target species	-	No change	-	No change	No change	No change
Time at sea	-	No change	Less	Slightly longer	Longer	No change
No. of crew required	No change	No change	No change	No change	No change	-
Fishing area	No change	No change	Working only in inshore areas	No change	Fishing closer inshore	No change
Place of landing	Changed	No change	No change	No change	No change	No change
Env. impact	No change	Less carbon emissions	More pressure on inshore grounds	No change	No change	No change
Bycatch	No change	No change	No change	No change	No change	No change
Price per kg	A little bit higher at home port	No change	Slightly higher price (shorter trips raise quality)	-	-	No change

Key: - no answer

Change fishing method		Improve maintenance		Modify gear		
Switch from trawl to dredge	Switch to pair trawl	Propeller and hull maintenance	Clean diesel injectors	Modify trawl doors	Reduce length of trawls	Change from single rig to triple rig
-	-	No change	-	No change	Less flatfish caught	Difficult to judge
	No change	No change	-	No change	No change	Move from mixed demersal fishery to targeted flat fish fishery
No change	No change	No change	-	No change	No change	Reduction in tow times has improved quality
-	No change	-	-	No change	No change	No change
	-	No change	-	No change	No change	No change
	One less	No change	No change	No change	No change	No change
Same areas	No change	No change	No change	No change	No change	No change
No change	No change	No change	No change	No change	No change	No change
More damage to the seabed (dredge)	No change	No change	Reduced carbon emissions	No change	No change	Less impact as not covering as much ground
No change	No change	No change	No change	No change	No change	Less discards
No change	No change	No change	No change	No change	In ratio of fuel used to fish landed	No change

Table A4. Nephrops trawl segment

Impact	Reduce towing speed	Modify gear		
		Modify trawls and trawl doors	Reduce size of trawls	Smaller nets and lighter doors
Vol. of target species caught	Negligible effect	Increased efficiency	No change	No change
Which species caught	No change	-	No change	No change
Quality of catch	No change	-	-	Improved quality
Average size of target species	No change	-	No change	No change
Time at sea	No change	-	No change	No change
No. of crew required	No change	-	No change	No change
Fishing area	No change	-	No change	No change
Place of landing	No change	No change	No change	No change
Env. impact	No change	-	Less fuel consumed so less carbon emissions	Less fuel consumed so less carbon emissions
Bycatch	No change	-	-	No change
Price per kg	No change	No change	No change	No change

Key: - no answer

				Installed gear monitoring unit
Switch from twin-rig to quad-rig gear	Switch from multi-rig to single-rig gear	Install kort nozzle	New propeller nozzle	
Increased volume	Decreased volume	-	No change	Increase volume
-	No change	Increase volume	-	No change
Improved quality	No change	No change	No change	No change
No change	No change	-	No change	No change
Longer	No change	-	No change	No change
-	No change	-	No change	No change
-	No change	-	No change	No change
-	No change	-	No change	No change
-	Less damage to sea bed with single rig	-	Less carbon emissions	No change
Reduced	-	-	No change	No change
Improved because taking shorter trips	-	-	No change	-