The potential of jig fishing as an energy efficient method for catching whitefish around Shetland.

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Jig fishing, or automated handlining, was last attempted commercially in Shetland in the early 1990s. However, although the initiative was considered to be a success, the metier has not gained precedence over otter trawling. The recent difficulties encountered by the whitefish sector combined with advances in jigging machine technology indicated that an evaluation of this approach should be revisited. Jig fishing has significant economic benefits as little fuel is consumed in comparison to trawling. This reduces vessel running costs which, with current fuel prices, can also increase profit margins significantly. The aim of this study, carried out over a 15 month period, was to evaluate the commercial viability of jig fishing for whitefish around the Shetland Isles. Five hundred and sixty eight boxes of fish valued at £29,000 were caught and landed during 119 days fishing. The principal species in the catch were saithe (*Pollachius virens*) and pollack (*Pollachius pollachius*), while small quantities of cod (*Gadus morhua*), ling (*Molva molva*) and tusk (*Brosme brosme*) were also caught. Fuel costs while jig fishing were significantly lower than when otter trawling. Potential income combined with reduced running costs indicate that this metier has considerable potential to be successfully implemented by inshore fishermen.

Keywords: Jig fishing, energy, fuel, whitefish, Shetland.

Introduction

One of the challenges that has recently faced the fishing industry is the rapid escalation in fuel prices. In recent years average fuel prices in UK fishing ports have progressively increased, peaking at more than 32 pence per litre (excluding duty) in July 2006 (Figure 1). This in turn has increased total fishing expenses and has had a detrimental effect on profit margins. Anderson

et al. (2007) reported that in 2005 North Sea demersal trawlers under 24m and over 300kW had an average annual fuel expenditure of £74,700 (24.2% of total fishing expenses) while Scottish under 10m vessels fishing mobile gear had an average annual fuel expenditure of £9,900 (29.8% of total fishing expenses). In Shetland a similar scenario is evident. The annual fuel expenditure for one Lerwick registered 87 foot (26.5 metres) Campbeltown whitefish trawler rose from £161,754 (66% of fishing expenses) in 2000 to £250,552 in 2007 (56% of fishing expenses), an increase of almost £90,000 (B. Spence, pers. comm.). The decrease in fuel expenditure as a percentage of fishing expenses from 2000 to 2007 was in part due to significant increases in other fishing related expenses such as days at sea and quota rental over that period.

Current trends in energy costs suggest the need to develop and utilize energy efficient fishing gears and methods. One such method, jig fishing, or automated handlining, was attempted commercially in Shetland in the early 1990s (Nicolson, 1999). However, although the initiative was considered to be a success, the metier has not gained precedence over otter trawling. The recent difficulties encountered by the whitefish sector and an imperative need to conserve stocks and reduce discards, combined with advances in jigging machine technology, indicated that an evaluation of this approach should be revisited.

Jig fishing has a number of advantages over conventional otter trawling. The most obvious is the potential for significant savings on fuel. This is because fishing normally takes place while the vessel is drifting with the engine switched off. Automated handlines are also advocated as being conservation-orientated as, in comparison to trawl fisheries, they have a minimal impact on the ecosystem (Huse *et al*., 2002). Non-governmental organisations (NGOs) such as the Marine Stewardship Council (MSC) and the Marine Conservation Society (MCS) actively promote sustainable fisheries and, as consumers become more aware of the source of their fish, they are turning increasingly to products from fisheries which are proven to be sustainable and less damaging to the marine environment (Jaffry et al. 2004). In the current environmental and market conditions there is a renewed interest in jig fishing amongst fishermen.

The present study, through fishing trials, investigates the commercial viability of jig fishing in the inshore waters around Shetland. Revenue from fish landings and expenditure during fishing operations were recorded and then used to evaluate levels of profitability. Expenditure and profit margins between jig fishing and otter trawling are then compared.

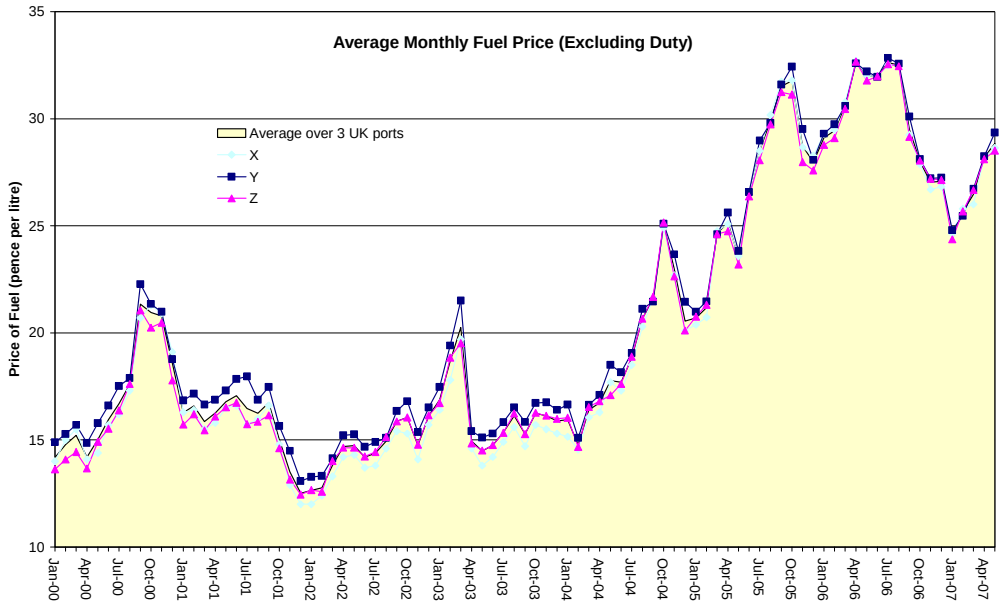

Figure 1 Average monthly price of marine diesel at UK fishing ports (Seafish, 2007).

Materials & Methods

Six Oilwind electric jiggers were purchased and installed on the *Atlantia* LK328 (10m, 120hp), after essential modification of the vessel's power supply during June and July 2005. In January 2006 the *Atlantia* was replaced by the *Atlantia II* LK502 (12.3m, 170hp) and the jigging machines were transferred to the new vessel.

The Oilwind jigging machines have a variety of different motor and jig function settings which allowed the user to alter the movement of the fishing gear to suit different environmental conditions and different target fish species. The six jigging machines were each equipped with 300m (164 fathom) of 400lb Dynema main line, an 18.3m (10 fathom) 300lb monofilament shock leader, and a nylon ring of 40mm inside diameter attached to the end of the leader.

A range of commercially available terminal fishing gear, deployed as six hook lure rigs weighted by a 7lb (3.18kg) lead sinker, were used. Gear trialled was typically similar to that used in the Faroese jig fishery. The most frequently used rigs were rubber eel lure rigs and Red Gill lure rigs.

Fishing grounds

As many areas as possible around the coast of Shetland were fished. In general, the selection of fishing grounds on any given day was largely dependant on weather conditions. Offshore grounds which were deemed to be accessible to inshore vessels in good weather conditions were also fished.

Fishing was mainly limited to areas that are not readily accessible to trawlers such as hard ground, areas of rocky peaks on the sea floor, and wrecks. Grounds that yielded reasonable quantities of fish were fished more often than unsuccessful grounds. This was, in part, to determine the extent of the fishing grounds and also to evaluate whether species and quantities of fish on the grounds fluctuated over time.

Conducting drifts

During fishing operations, the vessel was positioned so that, depending on the wind and the speed and direction of the tide, it drifted over the target area once the engine was switched off. The number of drifts undertaken over any one location was largely determined by the amount of fish caught.

Handling & storage of fish

Fish were gutted and washed and then boxed in ice in the hold of the vessel within one hour of being caught. The guidelines for storage of fish on small inshore vessels published by Sea Fish Industry Authority's fish technology department (Seafish 1997) were followed. Fish were stored in the hold for between one and three days, depending on the length of the fishing trip, before being sold through the Shetland Seafood Auction in Lerwick.

Data collected

A variety of data were collected throughout the study including fishing positions and environmental and catch data. For each trip, estimates of gear loss, fuel consumption, total grossing of fish landed, and average fish prices were recorded.

Fuel consumption

Fuel consumption was compared between jig fishing and otter trawling on two comparative fishing trips on the *Atlantia II*. A jig fishing trip during a 4 day period between 22nd and 25th May 2006 was compared to an otter trawling trip for 4 days between 30th April and 3rd May 2007. Fuel usage and associated costs were calculated as a percentage of the total gross earnings for each trip. The two trips chosen for comparison were considered to be representative of a successful fishing trip in terms of catch quantity and value for each fishing method.

When engaged in jig fishing fuel consumption was limited to steaming as the engine was switched off while fishing. Fuel consumption was estimated as follows: The number of litres of fuel (l) taken onboard was recorded each time the tanks were filled to capacity. The number of hours steaming (h) was recorded between each refill. Fuel consumption rates and hourly fuel costs were calculated as follows:

$$\text{Fuel consumption steaming } (l.h^{-1}) = \text{fuel consumed } (l) / \text{hours steaming } (h)$$

$$\text{Hourly fuel cost } (£.h^{-1}) = \text{litres per hour } (l.h^{-1}) * \text{fuel price } (£.l^{-1})$$

This was repeated each time the fuel tanks were filled and the average fuel consumption (l/h) over the study period was determined.

During otter trawling the number of hours spent steaming and trawling during each trip were recorded. The total number of litres consumed while steaming was estimated using the value determined from above. Total fuel consumption during trawling operations was determined by subtracting the consumption during steaming from the total consumption. Fuel consumption rates and hourly fuel costs during trawling operations were calculated as follows:

$$\text{Fuel consumption trawling } (l.h^{-1}) = \text{fuel consumed } (l) / \text{hours trawling } (h)$$

$$\text{Hourly fuel cost } (£.h^{-1}) = \text{litres per hour } (l.h^{-1}) * \text{fuel price } (£.l^{-1})$$

Data analysis

A Kruskal-Wallis test was used to determine if there was significant variation in the catch per unit effort (CPUE), measured as boxes per hour, between the three fishing ground types (hard ground, peaks and wrecks).

Results

A total of 1494 hours from 121 days were spent at sea during the 15 months that the study ran. During that time 476 hours were spent actively fishing while the remainder of the time, 1018 hours, was used travelling to and from port, searching for suitable grounds and steaming between fishing grounds.

Fishing grounds

A number of areas around Shetland were fished during the study (Figure 2). In total, 570 fishing operations (i.e. one or more consecutive drifts on a given ground on a given day) were carried out over the 15 month period. The operations were categorised according to the following seabed types: hard bottom, peaks, and wrecks. A total of 214 hours were spent carrying out 310 fishing operations on hard bottom, 129 hours were spent carrying out 152 fishing operations on peaks, and 97 operations were carried out during 133 hours on wrecks. There was a highly significant variation (Kruskal-Wallis test: K=39.1, d.f.=2, P<0.001) in the catch per unit effort (CPUE), measured as boxes per hour, between the three ground types, with wrecks yielding the highest CPUE, followed by peaks and then hard ground (Table 1).

The most lucrative fishing grounds were found towards the northern end of Shetland and were often more than 6 miles from the coast. The exposed nature of these grounds often resulted in the vessel being unable to fish them during adverse weather.

Pollack were the greatest contributor to the overall catch with a total of 292 boxes. A total of 204.5 boxes of saithe were also caught. Smaller amounts of other species including cod (17.5 boxes), ling (27 boxes), and tusk (4 boxes) were caught at different times throughout the project.

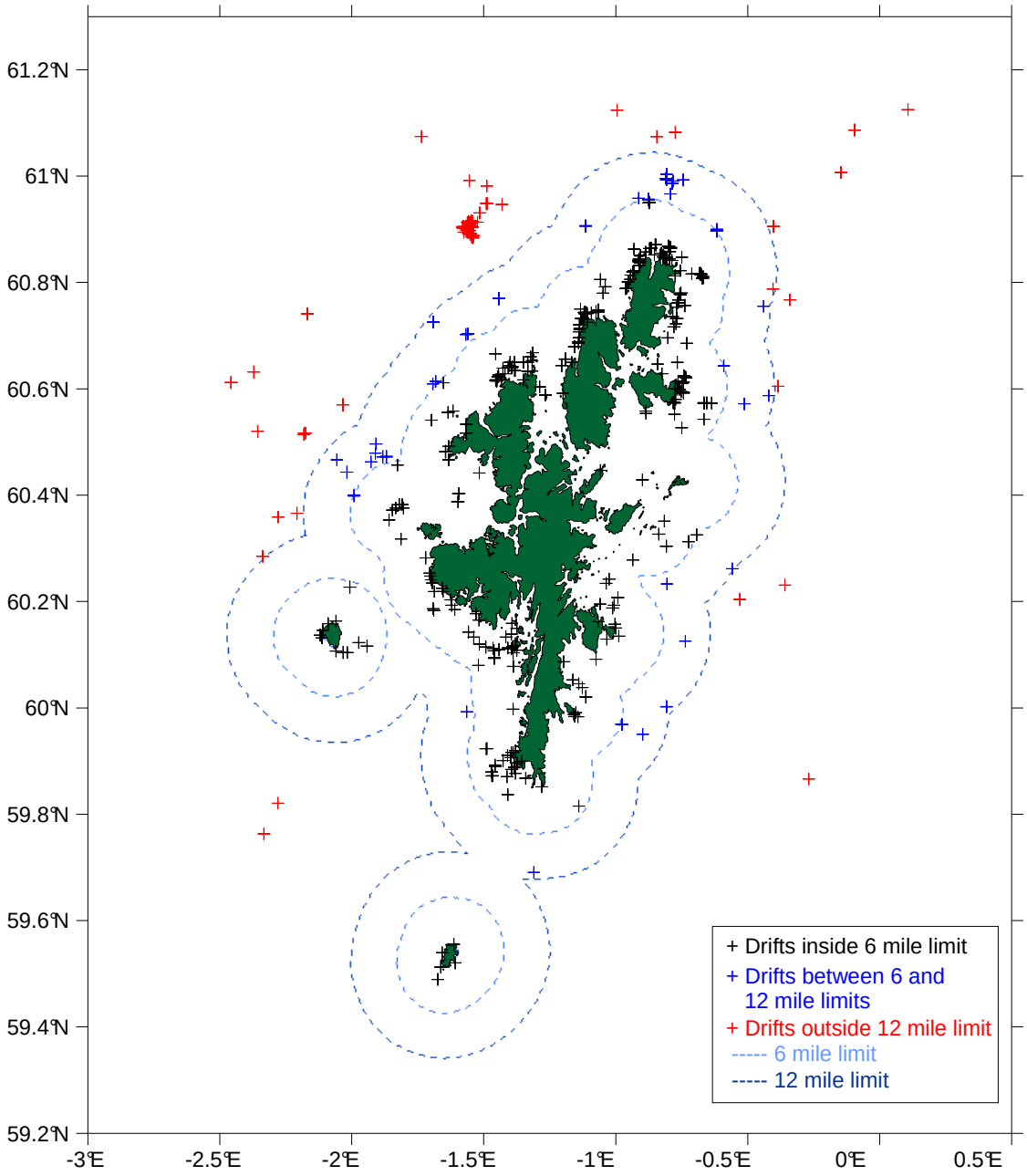

Figure 2 Geographical positions of individual jig fishing operations completed around Shetland.

Table 1 Total catch of the five main species, time spent fishing and CPUE for the different ground types fished.

Ground type	Time fishing (hrs)	Boxes of fish per ground type					Total boxes
		Pollack	Saithe	Ling	Cod	Tusk	
Hard	214	35	1	5	11	1	53
Peaks	129	132	2.5	1	5	2.5	143
Wrecks	133	125	201	21	1.5	0.5	349
Total	476	292	204.5	27	17.5	4	545
		Total CPUE (boxes per hour)					
		Pollack	Saithe	Ling	Cod	Tusk	**Total boxes per hour**
Hard	214	0.2	0.01	0.02	0.05	0.00	0.25
Peaks	129	1.0	0.05	0.01	0.03	0.01	1.14
Wrecks	133	0.9	1.5	0.2	0.01	0.00	2.62
Total	476	0.6	0.4	0.05	0.03	0.01	1.15

Fish prices

There were 50 landings of fish with a first sale value of £29,931 during the study. Total landings varied from month to month (Table 2) with the highest landings, £5,540 for 11 days fishing, in May 2006. The average daily gross was £228.

Monthly market prices of individual species fluctuated greatly overall. The highest gross profit by species was for pollack, with sale value of £20,540 (price range: £1.00/kg to £2.59/kg; average £1.72/kg). Saithe had a sale value of £5,876 (price range: £0.41/kg to £0.95/kg; average: £0.60/kg). Cod had a sale value of £1,817 (price range: £0.98/kg to £3.31/kg; average: £1.88/kg). The remainder of the catch was made up of ling (value: £1,607; range: £0.29/kg to £1.68/kg; average: £1.11/kg) and tusk (value: £95; range: £0.28/kg to £0.77/kg; average: £0.56/kg).

Table 2 Monthly jig fishing total and average catch values.

Month	Days at sea	Total Boxes	Total value	Average catch value per day	Average catch value per box
August 05	11	57.75	£3,206.00	£291.45	£55.52
September 05	7	11.25	£532.71	£76.10	£47.35
October 05	10	27.50	£2,115.78	£211.58	£76.94
November 05	8	30.25	£1,933.79	£241.72	£63.93
December 05	3	1.75	£90.54	£30.18	£51.74
April 06	6	45.00	£2,519.09	£419.85	£55.98
May 06	11	118.00	£5,540.13	£503.65	£46.95
June 06	7	62.25	£2,547.74	£363.96	£40.93
July 06	12	42.00	£1,517.90	£126.49	£36.14
August 06	8	24.50	£1,667.00	£208.38	£68.04
September 06	11	46.75	£3,335.26	£303.21	£71.34
October 06	5	31.00	£2,029.25	£405.85	£65.46
November 06	2	4.50	£472.93	£236.47	£105.10
January 07	5	0	£0.00	£0.00	£0.00
February 07	7	15	£753.78	£107.68	£50.25
March 07	5	21	£868.11	£173.62	£41.34
April 07	3	32	£801.96	£267.32	£25.06
Total	**121**	**570.50**	**£29,931.97**	**£236.12**	**£53.06**

Running expenses

The main expenses incurred when jig fishing were fuel (diesel), fishing gear and ice (Table 3). The most significant running expense was fuel with a total of 15,408 litres costing £4,866.51. Fuel costs represented 16% of the total gross earnings. Fuel consumption often varied greatly depending on the amount of time spent steaming between established fishing grounds and looking for new fishing grounds.

Comparison of fuel consumption & costs on Atlantia and Atlantia II

Table 4 provides detailed information on fuel consumption from August to December 2005 on the *Atlantia*. A total of 2,956 litres of fuel were consumed during 271 hours steaming over a 40 day period. The total cost of fuel over the period was £963.64. The price of fuel over the period ranged from £0.28

per litre to £0.36 per litre with an average price of £0.33 per litre (± 0.01 s.e.). Average fuel consumption over the period was 10.9 ± 0.57 litres/hour costing £3.59 ± 0.18 per hour. Fuel costs averaged at £7.50 per box of fish landed and represented 12.2% of the total gross earnings.

Detailed information on fuel consumption on the *Atlantia II* from April 2006 to April 2007 is provided in Table 5. During this time 12,452 litres were consumed costing £3,902.87. Over 700 hours were spent steaming during the 87 days the vessel was at sea. The price of fuel over the period varied from £0.25 per litre to £0.34 per litre with an average price of £0.31 ± 0.01 per litre. Average fuel consumption was 17.7 ± 1.8 litres/hour and the fuel cost incurred while steaming was £5.42 ± £0.44 per hour. Fuel costs averaged at £8.80 per box of fish landed and represented 17.7% of the total gross earnings.

Table 3 Average daily running expenses incurred by the *Atlantia II* during the jig fishing pilot study.

Running expense	**Amount (Total value in £ or % of total catch value)**
Fuel	£34-£47
Gear	£15
Ice	£15
Food	£10
Landing dues	2.50%
LHD limited (agent)	3%
Fishermen's Association (including hire of quota)	2%

Table 4 Jig fishing fuel consumption from August to December 2005 on *Atlantia*.

Fishing period (2005)	Total steaming (hours)	Total fuel consumed (litres)	Fuel price (£ per litre)	Fuel consumed (litres/hour)	Total fuel cost (£)	Fuel cost (£/hour)
1-8 Aug	47.5	429	£0.36	9.03	£154.40	£3.25
9-25 Aug	50.5	500	£0.31	9.90	£155.00	£3.07
2-29 Sep	50.25	620	£0.34	12.34	£208.63	£4.15
10-21 Oct	30.25	350	£0.35	11.57	£123.27	£4.08
24 Oct-3 Nov	41	515	£0.29	12.56	£147.55	£3.60
18 Nov-8 Dec	51.75	542	£0.32	10.47	£174.80	£3.38
Total	271.25	2956			£963.64	

Table 5 Jig fishing fuel consumption from April 2006 to April 2007 on *Atlantia II*.

Fishing period (2006-2007)	Total steaming (hours)	Total fuel consumed (litres)	Fuel price (£ per litre)	Fuel consumed (litres/hour)	Total fuel cost (£)	Fuel cost (£/hour)
28 Mar-15 May '06	110.75	1400	£0.34	12.64	£475.44	£4.29
16 May-8 Jun '06	98	1900	£0.32	19.39	£611.99	£6.24
15 Jun-20Jul '06	122	1402	£0.33	11.49	£468.83	£3.84
24 Jul-23 Aug '06	118	2100	£0.34	17.80	£712.74	£6.04
1 Sep-16 Oct '06	90.25	2050	£0.31	22.71	£626.89	£6.95
17 Oct-3 Nov '06	41.5	1000	£0.25	24.10	£250.90	£6.05
23 Jan-4 Apr '07	165.75	2600	£0.29	15.69	£756.08	£4.56
Total	746.25	12452			£3,902.87	

Jig fishing vs. otter trawling

Nine species of fish with a total weight of 1988 kg were landed from the May 2007 otter trawl trip while only two species with a total weight of 2911 kg were landed from the May 2006 jig fishing trip (Figure 3). Price/kg and total value for each species are shown in Table 6.

Fuel consumption varied significantly between jig fishing and otter trawling (Table 7). When jig fishing, fuel consumption was limited to periods when the vessel was steaming to and from port, between fishing grounds and repositioning between drifts. A different pattern of fuel consumption occurred when otter trawling, where the majority of fuel was consumed while the vessel was actively engaged in fishing operations such as shooting, towing and hauling the net.

Each comparative trip was four days duration. Fuel consumption while otter trawling was almost twice that of jig fishing although the total gross value of the catch for each method was similar (Table 7). Fuel costs, as a percentage of total gross, were therefore significantly lower when jig fishing (4.7%) than when otter trawling (8.2%). Fuel consumed equated to £2.10 per box of fish landed when jig fishing and £5.61 per box of fish landed when otter trawling. Following the deduction of fuel costs for each fishing method, gross earnings were £115 higher for jig fishing.

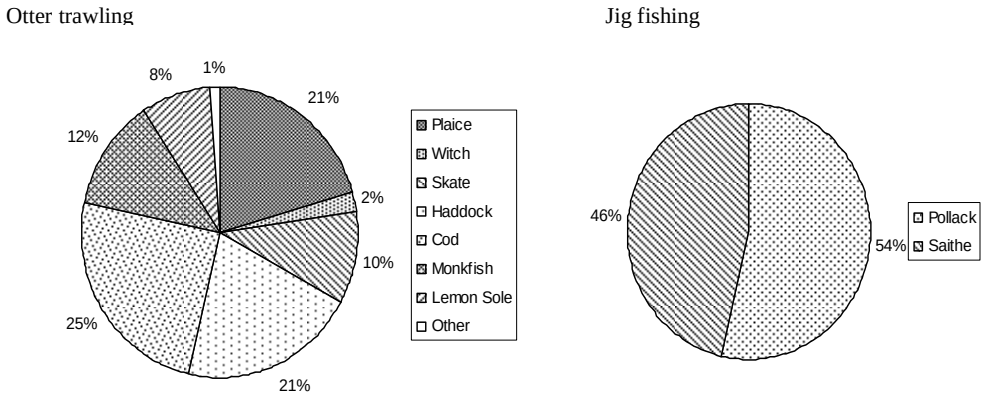

Figure 3 Weight of individual species as a percentage of total weight of fish caught during otter trawling and jig fishing comparative studies.

Table 6 Average prices received for fish landed during otter trawling and jig fishing comparative studies.

Otter trawling

Species	Total weight (Kg)	Total Value (£)	Price (£/kg)
Plaice	410	£541.92	£1.32
Witch	41	£34.43	£0.84
Skate	205	£116.22	£0.57
Haddock	410	£584.19	£1.42
Cod	492	£854.00	£1.74
Monkfish	246	£482.08	£1.96
Lemon Sole	164	£568.11	£3.46
Other (Turbot, Squid)	20	£104.12	£5.21
Total	**1988**	**£3,285.07**	

Jig fishing

Species	Total weight (Kg)	Total Value (£)	Price (£/kg)
Pollack	1558	£2,346.58	£1.51
Saithe	1353	£954.46	£0.71
Total	**2911**	**£3,301.04**	

Table 7 Comparison of fuel consumption and associated costs during jig fishing and otter trawling operations on *Atlantia II*.

		Jig fishing	Otter trawling
Days at sea		4	4
Steaming	Time (hours)	26.75	11
	Fuel consumed (litres)	482	195
	Cost (£)	155.20	63.37
Fishing	Time (hours)	20.25	44
	Fuel consumed (litres)	0	635
	Cost (£)	0	206.38
Catch	Total boxes	74	48
	Value (£)	3,301.04	3,285.07
Total fuel consumed (litres)		482	830
Fuel price (£/litre)		0.322	0.325
Total fuel cost (£)		155.20	269.75
Fuel cost as percentage (%) of total gross		4.7	8.2
Gross earnings less fuel costs (£)		3,145.84	3,015.32

Discussion

Fishing grounds

One of the most significant findings of the jig fishing study was the marked difference in catches around Shetland and the results indicate that vessels wishing to participate in a jig fishery around Shetland would be heavily reliant on offshore wrecks and areas of peaky seabed to the north of Shetland to yield the best catches, the sustainability of which is unknown. The remote location of these fishing grounds would require vessels to spend longer periods of time steaming to the grounds, reducing fishing time and increasing fuel consumption and running costs.

Target species

Catch data indicated that the two most available species for vessels in a jig fishery are saithe and pollack. Pollack were caught predominantly on wrecks and peaks in this study and are known to exhibit life history traits suited to life on a reef or similar structure. (Sarno *et al*., 1994). Saithe were caught almost

exclusively on wrecks to the north of Shetland. Catches in these areas may be due to their proximity to recognised saithe spawning grounds, which are to the north and east of Shetland (Anon, 2004). Saithe are typically of lower market value than many of the species caught otter trawling. This was evident from comparisons of the total catch value for each of the fishing methods; a smaller quantity of higher value species were caught otter trawling with a similar gross value to the larger quantities of lower value species caught jigging. This suggests that considerable quantities of fish and therefore quota would be required for jigging to attain a similar grossing to otter trawling.

Catches of other species such as cod, ling and tusk would probably serve as a bycatch to saithe and pollack. However, since the completion of the trials there has been a significant upturn in the volume of cod caught by the small number of inshore vessels periodically engaged in jig fishing around Shetland (I. Gray, pers. comm.). This increase has been concurrent with the overall increase in cod catches experienced by fishermen targeting areas around Shetland (L. Tait, pers. comm.).

Availability of quota to vessels wishing to engage in jig fishing also plays a significant role in determining its commercial viability. At present, under 10 metre vessels fishing in the North Sea have severe restrictions on total allowable catches (TACs) of cod while vessels over 10 metres are restricted in their ability to catch North Sea cod and saithe. As such, it may be necessary for vessels to lease or buy additional quota, thus increasing fishing expenses and lowering profit margins.

Fuel consumption

Due to the nature of the jigging study, a significant proportion of the available time was spent steaming and searching for potential fishing grounds around Shetland. This reduced the amount of time that was available for fishing and subsequently reduced the potential income from catches while the expenditure (fuel consumption) was increased. In a commercial situation, the proportions of time divided between steaming to and from grounds, searching for grounds and fishing would develop differently over time. Once a vessel had identified a number of regular grounds the amount of time spent searching would reduce, as long as the grounds stayed viable, and by

travelling directly to fishing grounds the amounts of fishing time would be longer.

Jig fishing vs. otter trawling

The results of the jig fishing/otter trawling comparative studies highlight the commercial potential for jig fishing around Shetland. Differences in fuel consumption costs per box of fish caught emphasize the potential savings in fuel costs while jigging. These savings may be significant in the long term, resulting in increased profit margins for the vessel and crew. Decreased fuel consumption also has obvious environmental benefits due to lower emission levels (Ziegler & Hansson, 2003). Ideally, fuel consumption would have been recorded using a fuel flow meter. However, such a device was not fitted to the vessels participating in this study.

Another long term benefit of jig fishing over otter trawling is the decrease in wear and tear on the engine and other working parts of the vessel. During trawling operations the engine is constantly under strain, increasing wear and the need for maintenance. Jig fishing minimizes wear on the engine as it is normally switched off when fishing, which can be up to 50% of a fishing trip.

Although fuel costs and wear may be lower during jigging operations, other costs such as initial set up costs may be significantly higher for jig fishing than for otter trawling. The cost of rigging out a 12 metre vessel such as the *Atlantia II* for otter trawling is currently in the region of £6,000 (A. Johnson, pers. comm.). This figure would include the purchase of trawl wire, trawl doors and a fully constructed whitefish trawl. Vessels without a trawl winch fitted would be required to install one at additional cost. In comparison, the cost of rigging out a 12 metre vessel for jig fishing is approximately £13,000. Included in the price are 6 jigging machines, Dynema main line, fishing line and a short term supply of hooks, lures and sinkers. Installation by an electrical engineer would be expected to cost in the region of £4,000. Everyday gear replacement costs, consisting of terminal gear such as hooks and sinkers, are relatively high compared to otter trawling; however, during trawling operations there is the potential for gear costs to be significantly higher if nets are lost.

The present jig fishing/otter trawling comparative studies are examples of two successful trips, with reasonable quantities of fish caught for each metier. A successful jig fishery relies heavily on a vessel's ability to fish on exposed

grounds. The number of successful trips is therefore highly dependant on weather conditions as few fish are caught in sheltered inshore areas. Conversely, otter trawling has been proven to provide reasonable catches in sheltered inshore areas enabling vessels to fish in most weather conditions. There is therefore a greater likelihood of a steady income when otter trawling while income from jig fishing will be highly weather dependant.

Commercial viability of jig fishing

The results of this study indicate that jig fishing in waters around Shetland has the potential to become a profitable diversification for inshore vessels. However to determine its long term commercial viability the following factors need to be taken into consideration:

- Initial set up costs (machines and licenses) are high therefore a financial assistance scheme may be required.
- Weather restrictions would likely result in the fishery being seasonal. The most lucrative grounds are in areas often inaccessible to smaller vessels.
- Little is known about the resistance of localised fishing grounds (e.g. wrecks) to substantial fishing effort. Catches from many areas suggest that recovery periods are needed following intense fishing activity.
- The current quota system may provide inadequate access to key species for vessels wishing to establish a fishery.
- Resources would be required for marketing and promotion to increase the sale value of jig caught fish, e.g. by promoting it as a sustainable fishery with a minimal impact on the environment.

Conclusion

Jig fishing for whitefish around Shetland has the potential to be commercially viable, at least on a seasonal basis. Results indicate that there is potential for increased profit margins due to significant savings in fuel costs in comparison to otter trawling. However, if jig fishing is to reach its full potential a co-operative approach may need to be considered so that issues such as constancy of supply, volume and niche marketing could be addressed in order to achieve higher prices.

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