

Jig fishing pilot study in Shetland coastal waters

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Introduction

Commercial jig fishing, also known as automated handlining, is a method of fishing using hooks with lures which are 'jigged' up and down in the water. Jig fishing techniques have been used for centuries by European vessels fishing Icelandic, Newfoundland and North Sea fishing grounds. Many of the techniques used then are still in use today¹. In recent years however, the advent of hydraulic or electric automated jigging machines has eliminated much of the manual labour required to haul fish from great depths. Modern automated jigging machines are equipped with a computerised motor which enables the user to program the machine to suit individual requirements (Figure 1).



Figure 1: An Oilwind automated jigging machine installed on the NAFC Marine Centre fishing vessel *Atlantia II*.

Automated handline fisheries are often advocated as being conservation orientated as, in comparison to trawl fisheries, they have a minimal impact on the ecosystem². There are a number of studies that provide evidence that line fisheries also select for larger individuals when compared with trawling, thus resulting in reduced discarding of undersized fish^{3,4}. Jig fishing for whitefish, which involves allowing the vessel to drift with the engine switched off, also has environmental and economic

benefits in terms of low fuel consumption when compared to trawling.

Jig fishing was last attempted commercially in Shetland in the early 1990s⁵. Although the initiative was considered to be a success at the time, the method was not widely adopted. However, recent difficulties encountered by the whitefish sector and the need to conserve stocks and reduce discards, combined with advances in jigging machine technology, have renewed interest in this fishing method. In view of this the Shetland Fishermen's Association asked the NAFC Marine Centre to undertake a pilot study of jig fishing in the inshore waters around Shetland. The aim of the pilot study was to investigate the practicalities and economic viability of jig fishing in Shetland coastal waters.



Figure 2: A variety of fishing gear was trialed during the jig fishing pilot study.

Methods

Six Oilwind electric jigging machines were purchased and fitted, following the installation of a 24 volt power supply, on the NAFC Marine Centre's fishing vessel *Atlantia* during June and July 2005. A variety of gear types were trialled (Figure 2).

The majority of the coastal waters around Shetland were fished (Figure 3). In general, selection of fishing grounds on any given day was largely dependant on weather conditions. 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. Selection of specific grounds was based on information passed on by fishermen, local knowledge, and information gathered from fishermen's chart plotter data. Other grounds were identified using the echo sounder on the *Atlantia* and *Atlantia II* while travelling between known fishing grounds.

During fishing operations, the vessel was positioned so that, depending on the wind and tide speed and direction, it drifted over the fishing ground when the engine was switched off. If few fish were caught during the drift the vessel moved to different grounds.

Normally, within one hour of being caught, fish were gutted and washed and then boxed in ice in the hold of the vessel following guidelines for storage of fish on small inshore vessels published by Sea Fish Industry Authority's fish technology department⁶. Fish were stored in the hold for between one and three days, depending on the length of the fishing trip. All fish were landed at ports in Shetland and sold through the Shetland Seafood Auction in Lerwick.

Data collected included information on environmental conditions, catch, fishing grounds, costs incurred and market prices. A number of statistical tests were carried out to explore relationships and differences between catch rates in a number of areas. Tests were also utilized in order to investigate relationships between catch rates and a number of environmental variables.

Results

Fishing grounds

A total of 1505 hours from 121 days were spent at sea during the 15 months that the project ran. During that time 476 hours were spent actively fishing while the remainder of the time, 1029 hours, was used travelling to and from port, searching for suitable grounds and steaming between fishing grounds.

A number of areas around Shetland were fished during the project (Figure 3). In total, 570 fishing operations 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. Catches were generally higher on fishing grounds to the north of Shetland.

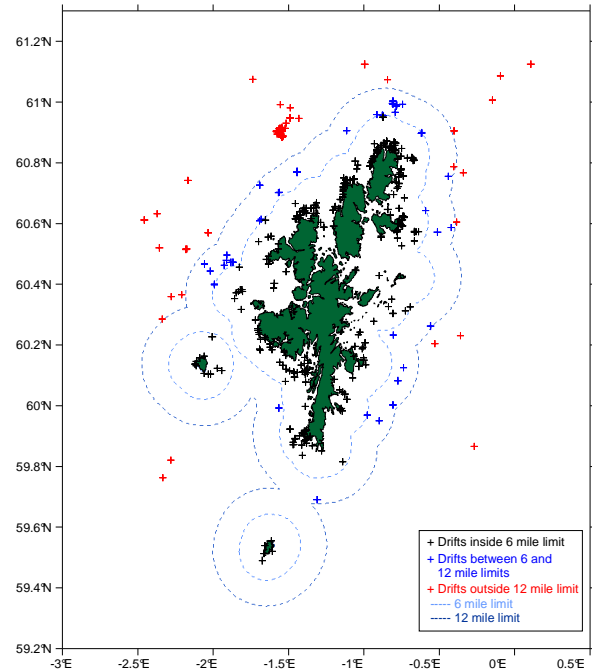


Figure 3: Positions of individual jig fishing operations completed around Shetland.

Catch

There was a significant difference in the amount of fish caught, measured as total boxes, between the three areas, with wrecks yielding the greatest amount of fish, followed by peaks and then hard ground (Table 1). A statistical test indicated that there was highly significant variation 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).

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
		Lythe	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)					Total boxes per hour
		Lythe	Saithe	Ling	Cod	Tusk	
Hard	214	0.20	0.01	0.02	0.05	0.00	0.25
Peaks	129	1.00	0.05	0.01	0.03	0.01	1.14
Wrecks	133	0.90	1.50	0.20	0.01	0.00	2.62
Total	476	0.60	0.40	0.05	0.03	0.01	1.15

Lythe and saithe (Figure 4) were the greatest contributors to the overall catch making up 53.6% and 37.4% of the total catch respectively. Smaller numbers of cod (3.2%), ling (5%), and tusk (0.7%) were also caught at different times throughout the project.

Jig fishing pilot study



Figure 4: Saithe caught on rubber eel lures on a wreck west of Muckle Flugga.

Environmental conditions

A number of environmental variables were observed to have an influence on catch rates during the study. The variable which had the most noticeable impact was tide. In many places a steady fishing would suddenly stop when the tide changed. This was especially noticeable in an area of peaks 15 miles north-northwest of the Ramna Stacks. A statistical test indicated that there was a significant difference in catch rates (boxes per hour) at different stages in the tidal cycle in this area. However, there was no clear relationship between tide and catch rates at other fishing locations. For example, on a nearby wreck, 15 miles north of the Ramna Stacks, a statistical test suggested there was no significant difference in catch rates at different stages in the tidal cycle. Wind speed and direction, daylight patterns and weather conditions also had an effect on catch rates.

Market prices

There were a total of 50 landings of fish valued at £29,931. Ninety three of the 121 days fishing produced enough fish to justify a landing. The value of the landings varied from month to month with the highest landings, £5,540 for 11 days fishing, seen in May 2006 (Table 2). The average daily gross during May was £503 while the overall project average was £228.

Market prices of individual species fluctuated greatly. The most profitable species was lythe with a contribution of £20,540 towards the total gross. Prices for lythe ranged from £1.00/kg to £2.59/kg with an average of £1.72/kg. Saithe valued at £5,876 were landed and prices ranged from £0.41/kg to £0.95/kg; average price: £0.60/kg. Cod valued at £1,817 was sold for prices between £0.98/kg and £3.31/kg; average price: £1.88/kg. The remainder of the catch was made up of ling valued at £1,607 with a price range of £0.29/kg to £1.68/kg; average price: £1.11/kg and tusk valued at £95, ranging in value from £0.28/kg to £0.77/kg; average price: £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
Aug-05	11	58	£3,206	£291	£56
Sep-05	7	11	£533	£76	£47
Oct-05	10	27	£2,116	£212	£77
Nov-05	8	30	£1,934	£242	£64
Dec-05	3	2	£91	£30	£52
Apr-06	6	45	£2,519	£420	£56
May-06	11	118	£5,540	£504	£47
Jun-06	7	62	£2,548	£364	£41
Jul-06	12	42	£1,518	£126	£36
Aug-06	8	25	£1,667	£208	£68
Sep-06	11	47	£3,335	£303	£71
Oct-06	5	31	£2,029	£406	£65
Nov-06	2	5	£473	£236	£105
Jan-07	5	0	£0	£0	£0
Feb-07	7	15	£754	£108	£50
Mar-07	5	21	£868	£174	£41
Apr-07	3	32	£802	£267	£25
Total	121	571	£29,932	£236	£53

Potential profit margins

On the NAFC Marine Centre's current vessel *Atlantia II*, a 12 metre, 170hp vessel, daily fuel costs while jigging were £34-£47, depending on fuel prices. This is in comparison to fuel costs when trawling, which averaged between £49 and £67 per day.

The average cost of replacing gear lost as a result of becoming stuck fast in the seabed was £15 per day. On many days no gear was lost while on others the cost of lost gear could be as high as £60. The rate of gear loss was highly dependant on the ground being fished, the strength of the tide and the speed of the vessel drifting over the ground. Some of the other costs involved included ice, food, landing dues, agent's commission and Association commission (Table 3).

Profit margins fluctuated from month to month. In May 2006, when catches were at their best, average daily gross was £503. During this month expenses incurred amounted to approximately £124 per day. After expenses, the highest average profit was £379 per day.

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

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%

Discussion

Fishing grounds

The reason why catches were greater at the northern end of Shetland is unclear. Results also indicate that vessels wishing to participate in a jig fishery around Shetland would be heavily reliant on offshore wrecks and peaks to yield the best catches. Catches on inshore areas of hard ground and peaks were generally low in the majority of areas fished.

Catch

Lythe, the greatest overall contributor to the catch, would be the most profitable species to target with jigging machines. The most successful method of catching lythe during this study, jigging artificial lures close to the seabed, is a reflection of the known behavioural traits of this species⁷.

A number of wrecks at the northern end of the islands have the potential to yield good catches of saithe. It is unclear if they are permanently resident on specific wrecks, if they move between wrecks or if they migrate away from the area completely. One previous study reported saithe migrating from the Norwegian coast to Faeroese and Icelandic waters, sometimes in large numbers⁸.

Cod, ling and tusk were all caught in smaller numbers throughout the study indicating that catches of these species would typically serve as a bycatch to the more abundant species such as lythe and saithe.

Environmental conditions

Unlike trawl and other net fisheries, jig fishing relies on the target species being motivated to respond to the deployed gear. A variety of environmental variables may affect fish feeding behaviour at any one time namely, temperature, prey, current, wind, barometric pressure, light, turbidity, bottom type, conspecifics and competitors⁹. Fish responses to changes in environmental conditions were evident on many occasions throughout this pilot study and further research is required to better understand the effects of these changes on fish feeding motivation and behaviour.

Market prices

Jig caught fish often received prices similar to and occasionally less than average market prices on any given day. This may have been due to the relatively small quantities of jig caught fish often landed. This indicates that further promotion of the product may be needed to achieve premium prices.

Price fluctuations at different times throughout the study had a marked effect on the vessel's earning ability. This was especially evident with lythe as prices varied between £41 and £106 per box at different times of year.

Profit margins for local vessels could be significantly higher than those observed in this study. Vessels could spend longer periods working on known marks of fish rather than spending time moving between different areas as was common practise during this study.

Commercial viability of jig fishing

In considering the commercial viability of jig fishing in the waters around Shetland the following factors need to be taken into consideration:

- Initial set up costs (machines and licences).
- The possibly seasonal nature of a jig-fishery (due to weather restrictions) at certain times of year.
- Little is known about the resilience of localised fishing grounds (e.g. wrecks) to sustained fishing effort.
- The need to access quota for certain species.
- The marketing and promotion of jig-caught fish to increase its sale value, e.g. by promoting it as a sustainable fishery.

Conclusion

The results of this pilot study indicate that jig fishing could be profitable in the waters around Shetland, at least on a seasonal basis. However to reach its full potential a co-operative approach may need to be considered to address issues such as marketing and promotion.

Acknowledgements

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