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An Investigation into the Commercial Viability of Fish Traps and Jig Fishing in the Scottish Demersal Fishery

Fishing Industry Science Alliance (FISA) Project 09/14

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This report presents the results of marine and freshwater scientific work carried out for Marine Scotland under external commission.

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An investigation into the commercial viability of fish traps and jig fishing in the Scottish demersal fishery

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1 Introduction

Demersal fishing in Scotland is primarily undertaken by demersal trawlers. The mixed species nature of the trawl fishery and associated challenges in a single-species management system are well documented. Various high-profile campaigns have recently highlighted supposed flaws in the current management system, with the most notorious being that of discarding. Demersal vessels discard fish for a variety of reasons including lack of quota, damaged/less valuable fish and undersized fish. The EU Landing Obligation proposes to phase out discarding of commercial species, raising a number of issues for fishers and managers. Given the current scenario there is an opportunity to develop novel fishing gears that limit unwanted bycatch and discards and are deemed to provide sustainable catches of key demersal species.

Highly selective fishing methods have been developed in a number of European nations that are not currently utilised to their full potential in Scottish waters. For example, the use of demersal fish traps for species such as cod (*Gadus morhua*) and tusk (*Brosme brosme*) is widespread for inshore vessels in Norway and Sweden. Other methods such as automated hand lining (jigging) are widely used to target cod and saithe (*Pollachius virens*) in the Faroe Islands and Iceland. These fishing methods are generally associated with minimal bycatch as well as discards that exhibit relatively high survivability.

A number of studies have been undertaken to develop static gear that maximises catch efficiency (Sullivan & Walsh, 2006; Ovegard*, et al.*, 2011). Various trap designs have been developed and deployed with the aim of increasing catches of key target species (Furevik & Lokkeborg, 1994; Walsh & Sullivan, 2010) while reducing unwanted bycatch and discards (Ovegard*, et al.*, 2011). Studies have shown that commercially viable catches of cod are achievable in these regions.

1.1 Aims

The primary aim of this project was to investigate the commercial viability of fishing with demersal fish traps and automated handlines in the Scottish demersal fishery. Establishing a demersal fishery with traps and automated handlines would provide the inshore sector with additional options for undertaking an environmentally friendly fishing method. A similar project was successfully undertaken by NAFC Marine Centre in 2005, investigating the commercial viability of automated handline fishing for demersal species such as pollack (*Pollachius pollachius*), saithe, cod and ling (*Molva molva*). In this study, two separate projects ran concurrently in the North Sea and the west coast of Scotland. Methods and results for each part of the study are described below. A general discussion on the use of traps and jig fishing in Scottish waters also follows.

2 North Sea Trap Trials

2.1 Materials and Methods

Fourteen commercially available fish traps were purchased from Carapax Marine Group AB, Sweden. The traps were originally developed by the Norwegian Institute for Oceanic Research and further developed by Carapax. The foldable parlour traps measured 150 cm(L) x 100 cm(W) x 120 cm(H) and were constructed from 12 mm aluminium for the top and middle frame and 14 mm hot dip galvanised steel for the bottom frame. Traps were covered with 30 mm twisted black nylon netting and had two large soft eyes constructed from monofilament mesh. The bottom frame of each trap was roped for added durability and a zipper was incorporated into each section of the trap for fish removal. Each trap was fitted with a detachable bait bag.

Correspondence with the trap manufacturer revealed that the traps worked ideally in collapsible form in water currents of <1 knot. It was felt that this could potentially affect the efficiency of the traps around Shetland as the current speeds around the coast can increase to more than 3 knots. In order to determine whether the current had an effect on fishing capability, half of the traps were rigidified within a frame constructed at NAFC from 16 mm (⌀) rod iron to compare fishing efficiency of collapsible and rigid traps (Figure 1). Rigidified traps were fitted with 6 x 450 g buoyancy floats on the top of the frame to help the traps maintain their upright orientation when sinking to and resting on the seabed. Traps were deployed in sets of two (here referred as a leader), as illustrated in Figure 2. Each leader had 60-100 ftm of 12 or 14 mm rope on the end (depending on the depths fished) that was held to the seabed with an anchor made from 40 kg chain link. The first trap in the leader was located 5 fathoms from the anchor (referred to as the anchor trap) and the second trap was located ten fathoms from the anchor trap (referred to as the end trap). Each leader consisted of one collapsible and one rigid trap. Collapsible and rigid traps were alternated between the anchor and end position to account for any potential bias in trap position on the leader. Traps in the same leader were baited with the same bait. A number of different bait types were used during the study including herring, mackerel, squid, mussel, dog whelk, sand eel and crab. Leaders were hauled using a Spencer Carter 1 ton hauler. Due to their lightweight design, both collapsible and rigid traps were lifted over the gunwale of the vessel by hand.

Figure 1: Carapax collapsible trap rigidified within a frame constructed from 16 mm rod iron. © NAFC

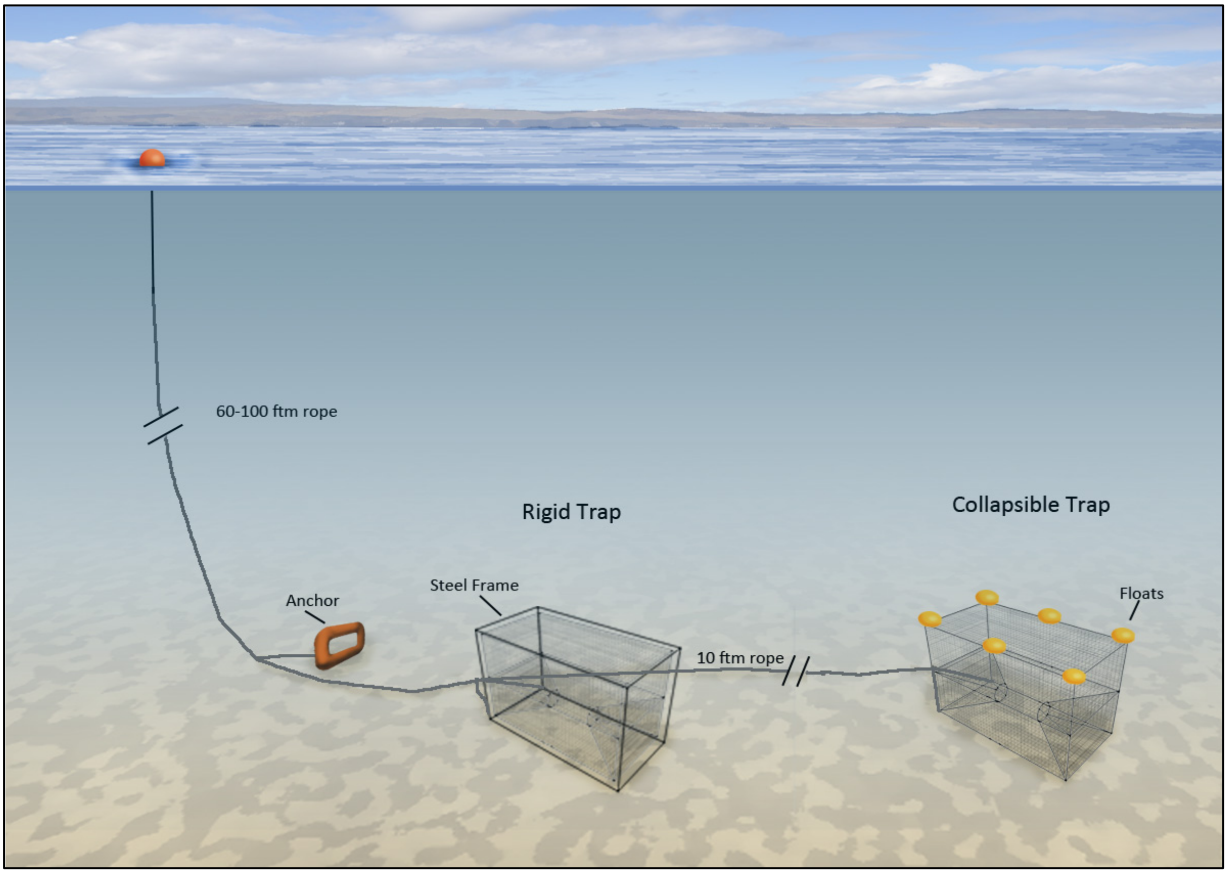

Figure 2: Layout of trap leaders for fish trap survey.

Fishing trials were undertaken on NAFC Marine Centre vessel *Atlantia II* for a six week period in July-August 2015 at various locations around Shetland. Soak times for traps were recorded.

Upon retrieval of traps, all saleable fish caught were recorded and length measured to the nearest cm. Catch weights of each species were also recorded. Any unmarketable by-catch was recorded and its general condition noted prior to release. A scale, modified from a catch-damage-index developed for cod (Esaiassen*, et al.*, 2013) and another for invertebrates (Depestele*, et al.*, 2011), was used to assess the condition of any bycatch that was returned to the sea (Table 1). All marketable fish was retained on board the vessel, landed at Scalloway fish market and sold through Shetland Seafood Auctions.

Catch composition, in relation to trap type, trap position and bait was analysed. Spatial variation in catch rates was examined and discard and bycatch composition and condition were evaluated. Finally, an assessment of the commercial viability of the fishery was made.

2.2 Results

A total of 18 deployments were undertaken around the west coast of Shetland. The locations of individual leader deployments are shown in Figure 3. The majority of deployments were made in the Scalloway Deeps, St Magnus Bay and around Muckle Flugga. Deployments were made in depths from 43 m to 137 m across a variety of seabed types.

Table 1

Catch damage index used to assess condition of bycatch and discards.

Species	Condition index			
	1	**2**	**3**	**4**
Finfish	No visible damage, swims away instantly	Minor descaling, minor damage to tips of fins	Major descaling, perforated skin, deep wounds/bites	Dead
Starfish	No visible damage	Arms missing	Worn and missing arms, minor disc damage	Major disc damage/crushed/ dead
Crabs/lobsters/other crustaceans	No visible damage	Legs missing/ small carapace cracks	Major carapace cracks	Crushed/ dead
Urchins	No visible damage	<50% spine loss	>50% spine loss/ minor cracks	Crushed/dead

2.2.1 Target Species Catch Composition

A range of commercially important species were captured during the study (Figure 4). Total numbers of each target species caught, retained and discarded are shown in Table 2. The most prevalent commercial species in the catch was conger eel (*Conger conger*), with considerable numbers captured irrespective of the ground type. All conger eels were of marketable size with no discards recorded. Catches of conger eel were typically higher near offshore wrecks (Figure 5). The largest number caught in a single leader was 81, captured near a wreck to the west of Shetland (Figure 4). The length range varied from 70 to 180 cm, with an average length of 125 cm.

Reasonable quantities of cod were caught (Table 2). A small number of cod discards, comprised primarily of undersized individuals were also captured. These fish were returned to the sea alive with little or no damage. On one isolated occasion there were a number of dead cod caught in the traps following a storm. This may have been due to the location of the traps in relatively shallow water at Muckle Flugga during strong northerly winds. The combination of wind strength and direction, shallow water and relatively strong tidal currents may have contributed to the disproportionally high mortality. The spatial distribution of cod catches is shown in Figure 5. Catches were higher at Muckle Flugga and St Magnus Bay. The length range of marketable cod varied from 35 to 109 cm, with an average length of 66 cm.

Lesser quantities of ling were captured over the study period (Table 2). Catches were highest at offshore areas around wrecks (Figure 5). Ling discards were comprised entirely of undersized fish that were released with little or no damage. The length range of marketable ling was 73 to 125 cm, with an average length of 104 cm.

Very small quantities of additional commercial species were also captured which, other than whiting, were all marketable size (Table 2). The whiting discards were comprised of two undersized fish that had become entangled in the mesh and were dead.

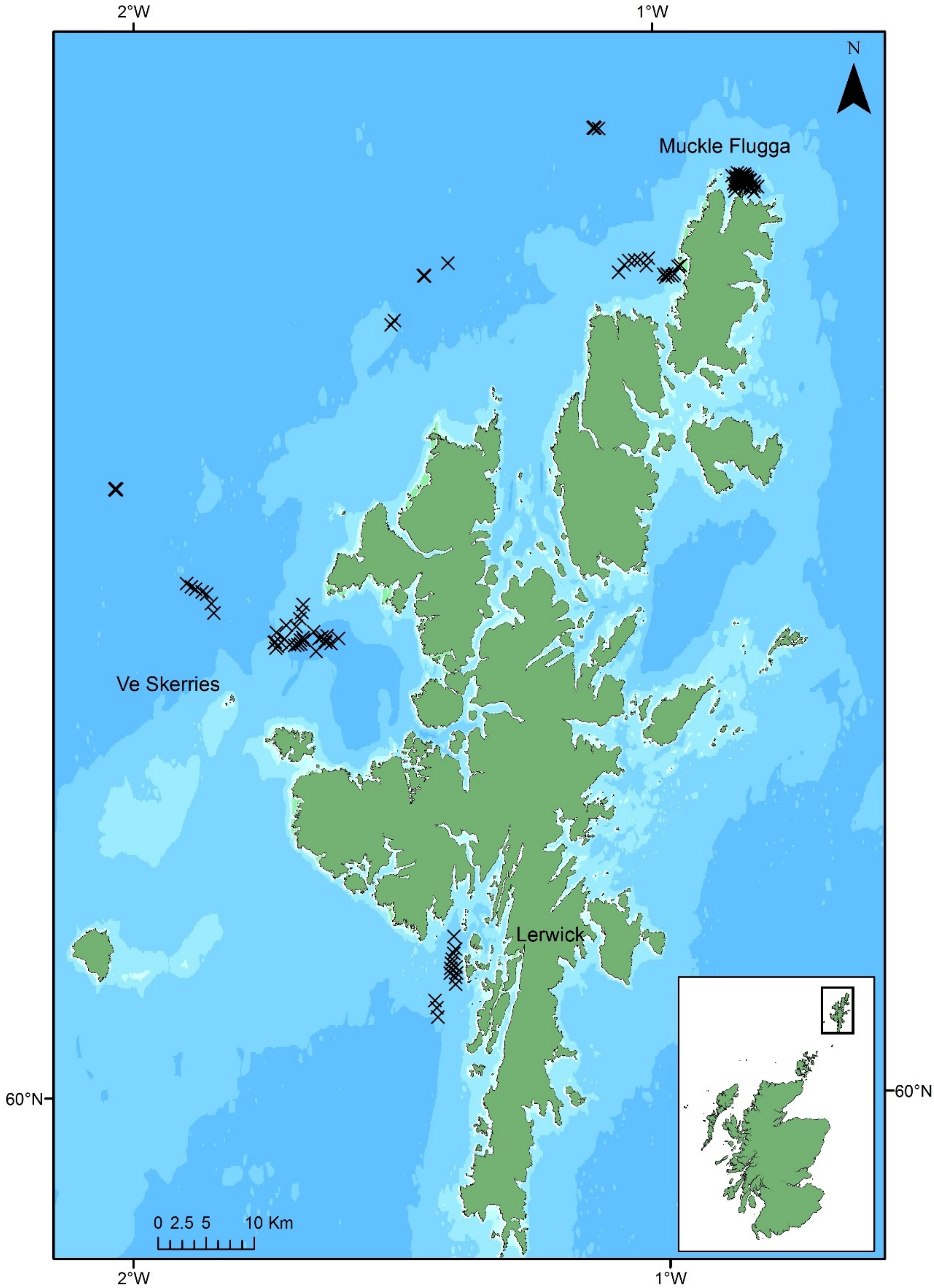

Figure 3: Location of individual trap deployments (X) around Shetland.

Figure 4: Clockwise from top left: Collapsible trap being hauled on board *Atlantia II*; conger eels in collapsible trap; removing cod from collapsible trap via zipper; occasional large quantities of edible crab bycatch; full insulated bin of conger eels from one leader; conger eel and large cod in rigidified trap. © NAFC

Table 2

Composition of retained and discarded commercial species.

Common name	Species name	Number	Total weight (kg)	Number of discards	Average discard condition
Conger eel	*Conger conger*	246	1848	0	-
Cod	*Gadus morhua*	133	501	20*	1 (2.6)ǂ
Ling	*Molva molva*	35	241	3	1.6
Tusk	*Brosme brosme*	4	13	0	-
Pollack	*Pollachius pollachius*	1	1	0	-
Saithe	*Pollachius virens*	1	1	0	-
Thornback ray	*Raja clavata*	1	4	0	-
Haddock	*Melanogrammus aeglefinus*	1	1	0	-
Whiting	*Merlangius merlangus*	0	0	2	4

*Nine of the 20 discarded cod were marketable size but were dead in the traps following a storm.
ǂ Average discard condition for cod under normal working conditions was 1. This value increased to 2.6 due to dead cod in traps following a storm.

2.2.2 Comparison of Trap Type and Position

The total catch of commercial species for each trap type is shown in Table 3. Overall catches were similar between collapsible and rigid traps, with collapsible traps having 8% higher catches overall. Individual species catches varied considerably between the two trap types. Cod and ling catches in collapsible traps were approximately 95% and 50% higher respectively than in rigid traps (Table 3). Conger eel catches were 23% higher in rigid traps. The small number of tusk captured were equally split between the two trap types.

Trap position had a more considerable effect on total catch than trap type, with catches 15% higher in traps positioned next to the anchor. This was primarily driven by conger eel catches which were 15% higher in ‘anchor’ traps. Catches of cod and ling were very similar between the trap positions with only 7% and 5% difference respectively between the two trap positions. The small quantities of tusk caught were all captured in the traps positioned next to the anchor.

Table 3

Total catch of main commercial species in different trap and leader configurations.

Species	Trap type		Trap position	
	Collapsible	*Rigid*	*Anchor*	*End*
Conger eel	110	136	133	113
Cod	88	45	69	64
Ling	21	14	18	17
Tusk	2	2	4	0
Total	223	204	232	195

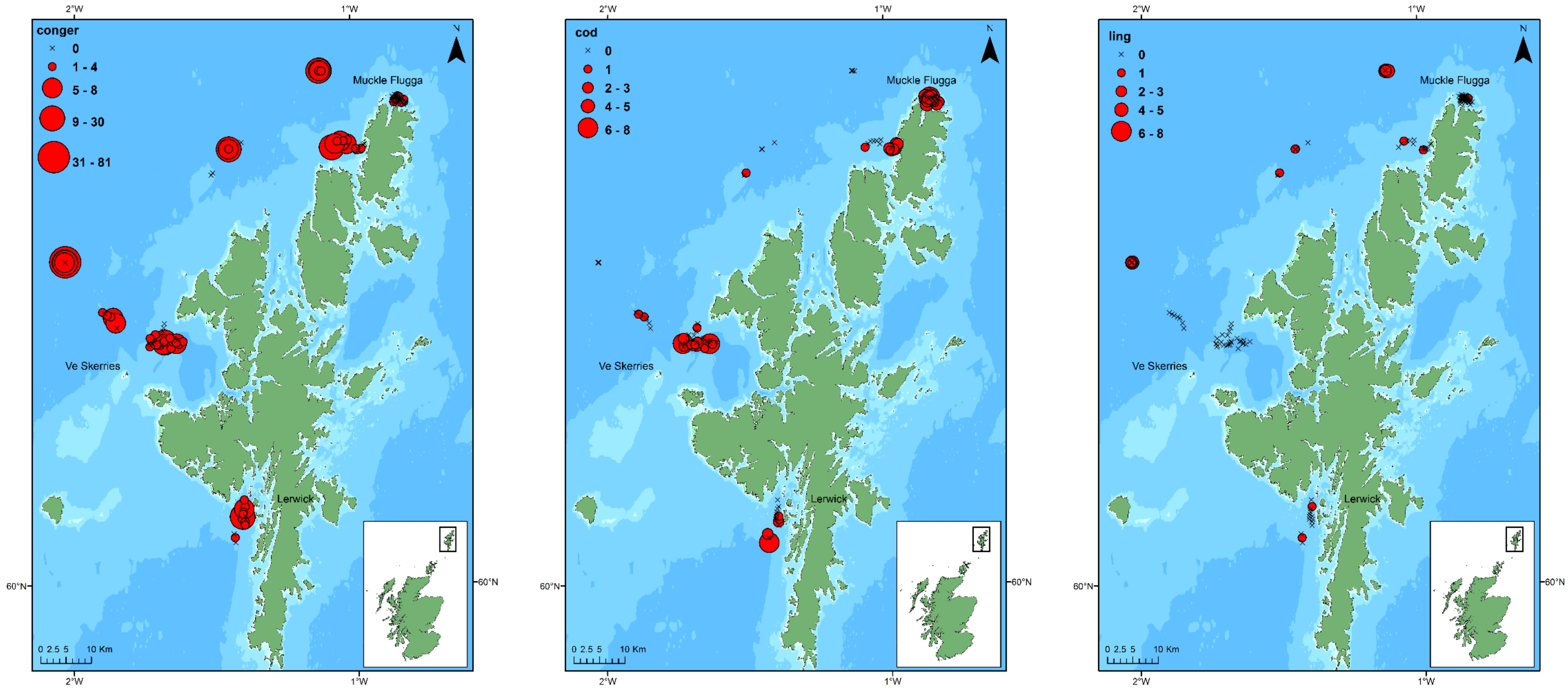

Figure 5: Spatial distribution of catches of the main commercial species caught in traps around Shetland; conger eel, and cod and ling. NB catch rates are number of fish per leader.

2.2.3 Bait

A variety of different baits were used over the course of the study. The catch rates of each of the three main commercial species in relation to the bait used is shown in Figure 6. Catches of conger eel were highest with mackerel and herring, with lesser quantities being caught with other baits. Cod catches were highest with squid and mussel and ling catches were highest with mackerel.

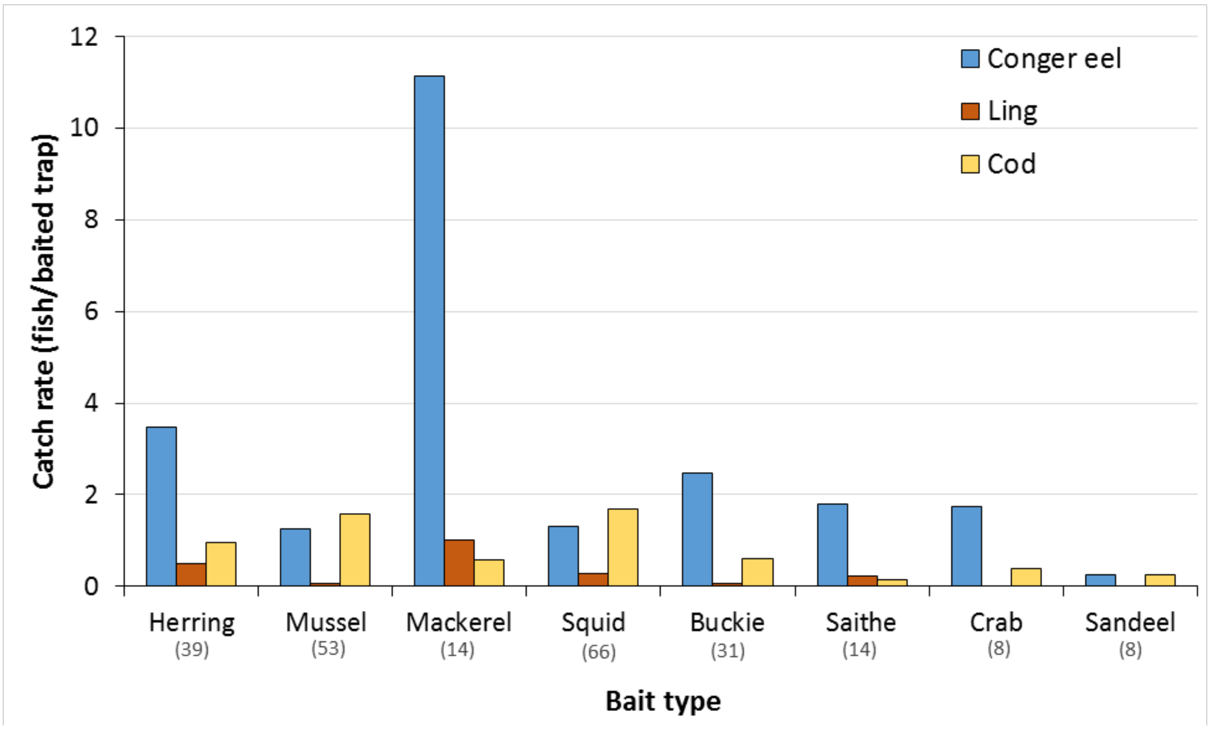

Figure 6: Catch rates of the three main species captured per bait type during the study. NB the number of traps baited with each bait type is shown () on the x axis.

2.2.4 Bycatch Composition

Varying quantities of bycatch species were captured throughout the duration of the study. The most prevalent species in the bycatch was the edible crab *Cancer pagurus* (Figure 4) and the hermit crab *Pagurus bernhardus* (Table 4). Considerable quantities of a variety starfish species were caught and the lesser spotted dogfish *Scyliorhinus canicula* was also captured in reasonable quantities. The majority of bycatch species, including the most prevalent ones, were returned to the sea with minimal damage, with an average condition index score of one. Very small numbers of squat lobster and poor cod were damaged due to entanglement in the trap netting, increasing their overall score to 1.6 and 2.6 respectively.

2.2.5 Commercial Viability

Commercial fish were caught in large enough quantities to land to the local fish market in Lerwick and Scalloway on a number of occasions. Prices received for fish are shown in Table 5. Conger eel prices showed the highest variation, ranging from fish that did not sell to prices as high as £0.69/kg. Cod and ling prices were more consistent and stable with cod prices ranging from £1.75-£2.83 and ling prices ranging from £1.35-£1.45. The total income from the 18 hauls was £1,468, equating to an average of £5.83 for each hauled trap (**Error! Reference source not found.**). Income from the study may have been higher if a more reliable market for conger eel was available.

Table 4

Total numbers caught and average condition of bycatch species

Bycatch	Number	Average condition
Edible crab	371	1
Hermit crab	344	1
Starfish	178	1
Lesser spotted dogfish	23	1
Squat lobster	16	1.3
Dog whelk	9	1
Poor cod	8	2.6
Sea urchin	8	1
Red whelk	5	1
Ballan wrasse	4	1
Octopus	3	1
Common skate	1	1
Cuttlefish	1	1
Queen scallop	1	1

Based on the estimated income per trap, an inshore vessel would potentially require 100-150 traps to provide an economically viable daily income. Estimated set-up costs, based on working 100 fish traps, are shown in Table 6. The principal outlying cost would be the purchase of traps. A variety of trap types and sizes are available from the manufacturer, providing for the individual requirements of different sized vessels. The traps trialled in this study and costed in Table 6 are the largest and most expensive traps available from the manufacturer. Set-up costs assume that a vessel would have the existing capability to haul trap leaders. If this was not the case then additional costs would be incurred to install an adequate hauling system.

The biggest potential issue for inshore vessels undertaking trap fishing would be quota availability. Two of the three main commercial species caught during this study, cod and ling, are subject to quota restrictions. In 2015 the monthly North Sea cod quota available to under 10 m vessels has varied from 500 kg to 1500 kg per month. Ling quota has remained constant at 250 kg per month. The scenario is more restrictive for over 10 m non-sector vessels, with only 100 kg of cod and 50 kg of ling available on a monthly basis in 2015. Quota would be less of an issue for vessels within a Fish Producers' Organisation.

Table 5

Price/kg received for landings of trap caught fish and associated income.

Date	Species	Min. price £/kg	Max. price £/kg	Catch value
17/07/2015	Conger eel	0.43	0.69	£518.00
17/07/2015	Ling	1.45	1.45	£130.00
17/07/2015	Cod	2.54	2.54	£25.00
24/07/2015	Conger eel	0.00	0.66	£30.00
24/07/2015	Ling	1.35	1.35	£221.00
24/07/2015	Cod	2.82	2.83	£126.00
03/08/2015	Cod	1.81	2.00	£115.00
08/08/2015	Cod	1.80	2.00	£98.00
13/08/2015	Cod	1.75	2.53	£205.00
		Species totals	Cod	£569.00
			Conger eel	£548.00
			Ling	£351.00
			Total income	**£1,468.00**
			Average income per hauled trap	**£5.83**

Table 6

Estimated gear set up costs for commercially available fish traps (based on 100 traps).

Gear	Number	Unit cost	Total cost
Traps (two eyes)	100	£73	£7,300
Rope (220 m coil)	25	£40	£1,000
Floats	600	£4	£2,400
Total			**£10,700**

2.3 Discussion

The results of this study highlight the potential for a commercially viable trap fishery in the northern North Sea, especially around the Shetland Isles. Given the limited nature and scope of the study, the catches and associated income could be interpreted as a ‘worst case scenario’. Further research is required to assess any potential intra-annual variation in the fishery and determine whether the fishery would be viable year-round or whether it would be more appropriate to target it on a seasonal basis.

Part of the remit of the study was to trial the traps in a number of different locations, using a variety of bait types and gear set-ups. It became clear during the study that there was a high degree of spatial variation in catches around Shetland. Future research into the development of the fishery would enable a focussed study on fishing grounds with the highest potential catches using collapsible traps, potentially yielding higher catches and increased income. This would also provide fishers with details on some of the most commercially viable grounds without the need for individual vessels interested in participating in the fishery having the potential financial burden of undertaking these trials.

2.3.1 Catch Composition

Reasonable catches of commercial species such as cod, ling and conger eel during the study suggest that the traps are suited to the capture of these species. However, the manufacturer’s suggestion that they may also be suitable for catching pollack were not borne out, despite the traps being set in areas where pollack catches were evident on automated hand lines. This suggests that, around Shetland, the traps may not be as suited to the capture of species such as pollack and saithe.

The condition of the limited number of discards and bycatch provides an encouraging perspective on the fishery. The results of the study suggest that the development of a trap fishery around Shetland could provide an opportunity to land commercial quantities of cod without the associated dead discards often found in other fisheries. Although cod discard rates were predominantly low, there was one occasion that a number of dead cod that were subsequently discarded were caught. It is unclear what the cause of the high mortality on this occasion was but it was probably due the unique set of conditions that the traps were set in as they may have been moving continually over a prolonged period. These conditions would not normally be expected in typical fishing situations.

2.3.2 Comparison of Trap Type

The variation in catches between rigidified and collapsible traps evident in this study suggests that collapsible traps would be the most effective at maximising catches of the most lucrative species such as cod and ling. It is currently unclear why collapsible traps that have the potential to lose their optimal fishing shape in areas with strong currents would fish better than rigid traps that are forced to retain the optimal fishing shape. One hypothesis is that collapsible traps may hold their optimal fishing shape during periods of slack tide (and decreased current) when fish are foraging and feeding, enabling fish to enter the traps. When the current increases the trap may lose it shape, causing the hard eyes to collapse and retain any fish trapped inside. This would allow the traps to fish during optimal times and retain fish as current speeds increased and natural foraging activity is known to decrease (Lokkeborg*, et al.*, 1989). The hard eyes on the rigid traps would remain open and, due to their size and shape, may potentially allow fish to easily enter and leave the trap.

The sole use of collapsible traps would be beneficial in a commercial setting as the rigidified traps require a significant amount of deck space on a vessel, making the deployment and storage of the traps difficult. The use of collapsible traps would also allow easier transportation of significant quantities of gear to different fishing grounds when appropriate.

2.3.3 Assessment of Gear Suitability and Durability

The durability of the traps varied between fishing areas. Traps contained within the rigid frame lasted throughout the duration of the study with little or no damage. However, many of the collapsible traps suffered minor damage including holes in the monofilament eyes and bending of the frames. The joining part of the rectangular frame on one of the traps came apart and needed to be repaired. The majority of damage was incurred in areas of open water with strong tides suggesting that the trap design is more suited to sheltered water with relatively weak tidal currents. Despite this, the traps could potentially be made more durable with additional rope around the rectangular frames.

The zipper proved to be an effective means of removing fish from the traps although the pull tab broke away from the slider on a number of traps, making opening and closing the zipper more difficult. The bait bag configuration on the traps also proved to work reasonably well although the lack of consistency of the placement of the different parts of the clips holding them in place proved frustrating. It would have been beneficial if the bait bags were interchangeable between traps but the inconsistent placement of male and female sections of the clips made this impossible.

2.3.4 Commercial Viability

The results of the study in the northern North Sea suggest that fishing with collapsible fish traps could be commercially viable around Shetland. However, further work is required to assess seasonal variability in catches and investigate further the spatial variation in catches. The development of a trap fishery has the potential to provide an additional source of income for inshore vessels, allowing them to utilise valuable cod quota and deliver a high quality product with minimal environmental impact.

3 West coast of Scotland Traps and Jigging Trials

3.1 Materials and Methods

3.1.1 Fish Traps

Four triple parlour fish traps were designed and constructed by Jim Mair, Marine Scotland. The mesh size in each of the traps was 12 mm. Each trap had three vertical entrances in the first compartment, which was baited (Figure 7). A large funnel entrance led to the first parlour section and a second large funnel entrance led from the two bottom sections to an upper chamber. When fish entered the top panel they had at least two entrances to negotiate before potentially escaping. Each trap was foldable for storage purposes but was made rigid prior to deployment.

Traps were deployed in sets of two (here referred to as a leader), as illustrated in Figure 2. Each leader had 60-100 ftm of 12 or 14 mm rope on the end (depending on the depths fished) that was held to the seabed with an anchor made from 40 kg chain link. The first trap in the leader was located five fathoms from the anchor (referred as the anchor trap) and the second trap was located ten fathoms from the anchor trap (referred to as the end trap). Traps were baited with the same bait, mackerel and crushed shellfish, throughout the entire study. Mackerel were caught fresh daily with jigging machines. Traps were hauled with the vessel’s creel hauler and lifted aboard by hand or using the vessel’s landing derrick when necessary.

Fishing trials were undertaken on *Sea Spray* OB 140 for a six week period in June 2015 to July 2016 at various locations on the west coast of Scotland. Soak times were recorded for each deployment. Due to the limited budget (there was only enough finance available to cover material costs), fishing was restricted to *Sea Spray's* daily crab grounds and deployments were undertaken when opportunities arose.

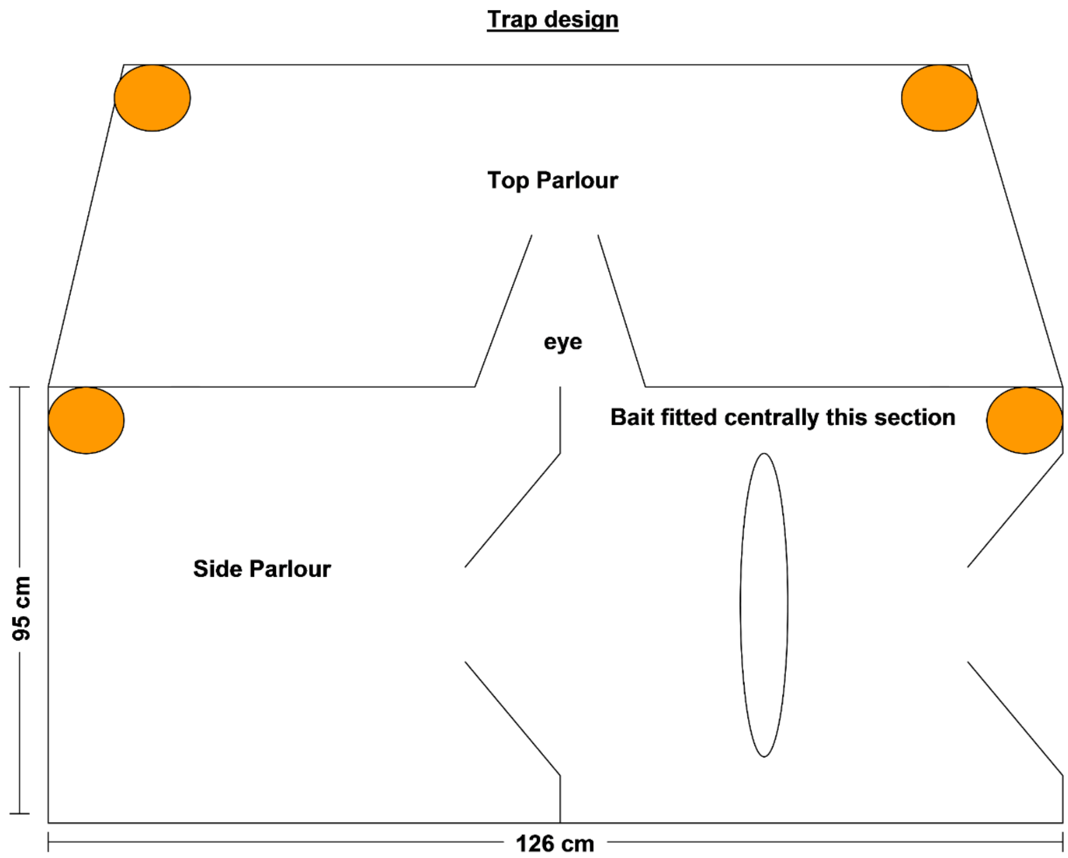

Figure 7: Fish trap design used in West of Scotland study.

Upon retrieval of traps, all saleable fish caught were recorded and lengths measured to the nearest cm. Any unmarketable by-catch was recorded and its general condition noted prior to release. A scale, modified from a catch-damage-index developed for cod (Esaiassen*, et al.*, 2013) and another for invertebrates (Depestele*, et al.*, 2011), was used to assess the condition of any bycatch that was returned to the sea (Table 1). The majority of marketable fish were recycled for crab pot bait for *Sea Spray*, which was an indirect gain for the vessel. More pollack would have been landed if the quota regulation had allowed and at times large marks of pollack were being fished but the vessel moved to target saithe, which was subsequently landed.

3.1.2 Jig Fishing

Two Belitronic 5000e jigging machines (Figure 8) were fitted to *Silver Spray* in June 2015. Jiggers were used to capture bait for use in traps and to ascertain presence of suitable fishing grounds. Mackerel feather rigs were used for catching bait and rubber eel lures were used when targeting larger marketable fish. Jiggers were deployed using standard built-in settings and functions.

Deployment of jiggers to target marketable fish was predominantly undertaken in the south of the study area. Traps were deployed in the morning, hauling of crab gear took place during the day and fishing with jiggers normally took place later in the day when time allowed. All saleable fish caught were recorded and length measured to the nearest cm. Any unmarketable by-catch was recorded and its general condition noted prior to release.

Figure 8: Belitronic 5000e jigging machine.

Catch composition, in relation to trap position and bait, was analysed. Spatial variation in catch rates was examined and discard and bycatch composition and condition were evaluated. Finally, an assessment of the commercial viability of the fishery was made.

3.2 Results

3.2.1 Fish Traps

A total of 35 deployments were undertaken around the west coast of Scotland. The locations of individual leader deployments are shown in Figure 9. The majority of deployments were made on crab grounds frequented by the *Silver Spray* on the west coast of Lewis. Deployments were made in depths from 25 m to 110 m across a variety of seabed types. Catches varied considerably between deployments, suggesting that it is a very target specific fishery.

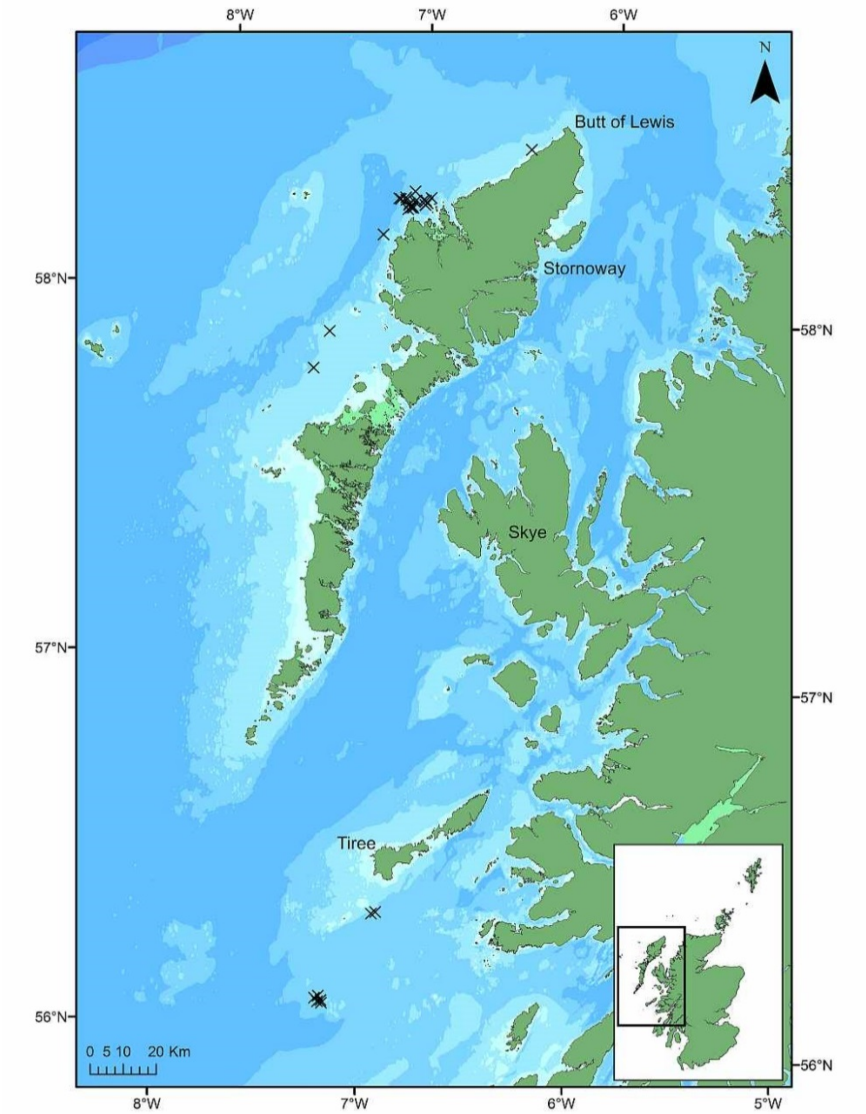

Figure 9: Location of individual trap deployments (X) around the west coast of Scotland. Jig fishing was undertaken at locations south of Tiree.

3.2.1.1 Target species catch composition

A range of commercially important species were captured during the study (Figure 10). Total numbers of each target species caught, retained and discarded are shown in Table 7. The most prevalent commercial species in the catch was saithe (*Pollachius virens*), with considerable numbers captured irrespective of the ground type. Catches of saithe were typically higher towards the south end of the study area on reefs and harder areas unfishable by demersal trawlers (Figure 11). The largest number caught in a single leader was 461, captured on mixed seabed west of Lewis (Figure 11). The length range varied from 22 to 67 cm, with an average length of 37 cm.

Reasonable quantities of whiting and haddock were caught (Table 7). The majority of haddock in the catch were of marketable size while the majority of whiting were undersized. Catches of haddock and whiting were higher at the west of Lewis (Figure 11) on traditional crab grounds (although haddock are rarely captured in crab creels). Varying quantities of cod, ling, conger eel, plaice, pollack and tusk were also caught (Table 7, Figure 11). The average condition of all discards was one (based on the index in Table 1).

Figure 10: Clockwise from top left: Collapsible trap next to standard creel on *Silver Spray*; catch of cod and saithe from fish trap; typical catches from typical crab grounds; potential bait solution for crabbers (461 fish from one trap). © NAFC

Table 7
Composition of retained and discarded commercial species.

Common name	Species name	Number caught	Number of discards	Average discard condition
Cod	*Gadus morhua*	51	9	1
Saithe	*Pollachius virens*	206	689	1
Haddock	*Melanogrammus aeglefinus*	117	17	1
Plaice	*Pleuronectes platessa*	9	4	1
Pollack	*Pollachius pollachius*	14	4	1
Whiting	*Merlangius merlangus*	136	231	1
Ling	*Molva molva*	59	6	1
Conger eel	*Conger conger*	15	0	1
Tusk	*Brosme brosme*	12	12	1

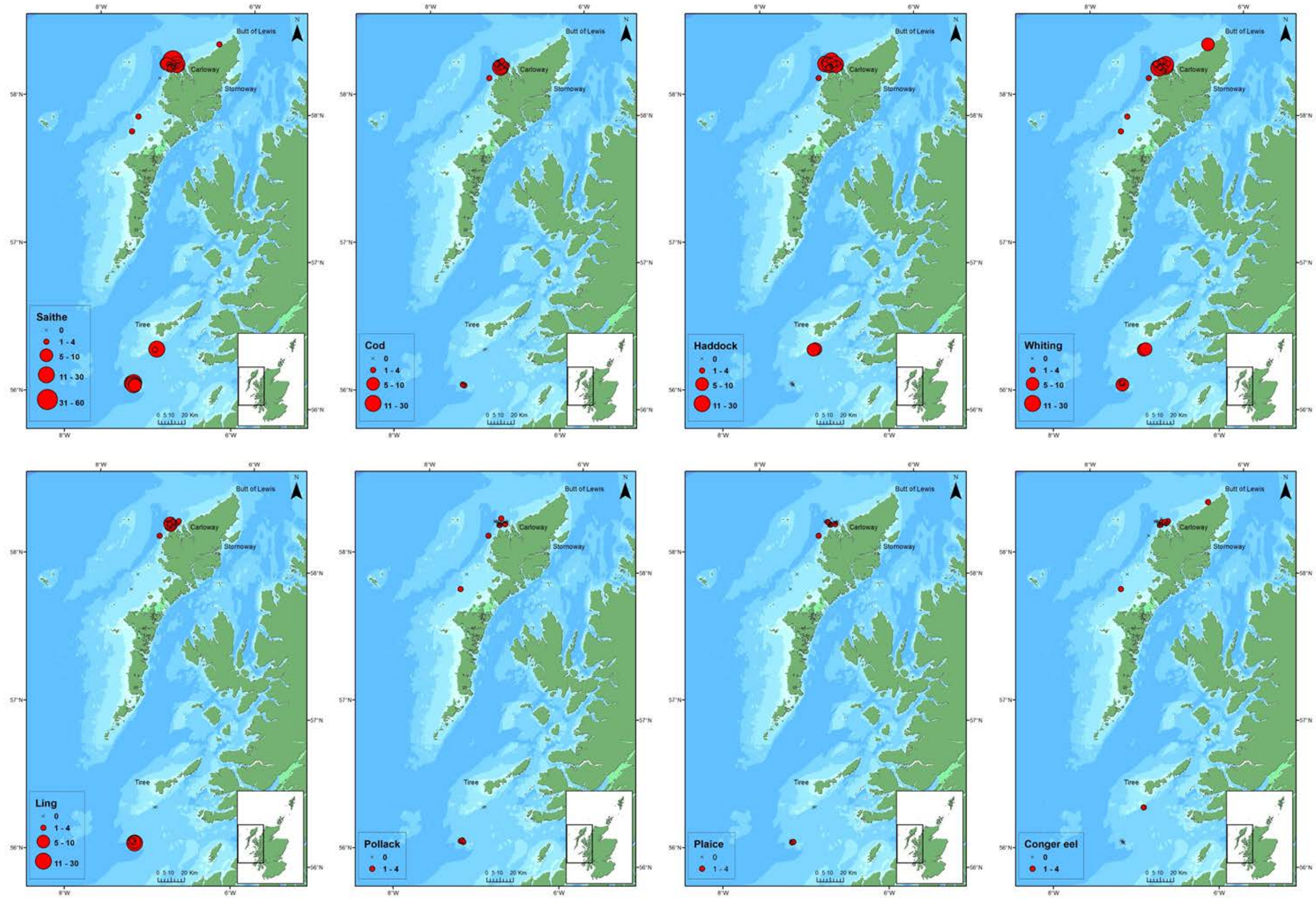

Figure 11: Spatial distribution of catches of the main commercial species caught in traps on west coast of Scotland. NB catch rates are number of marketable fish per leader.

3.2.1.2 Comparison of trap position on catch rates

Trap position had a considerable effect on total catch for some of the commercial species captured. For example, conger eel catches were considerably higher in end positioned traps. However, the effect of trap position on catch rates varied considerably between deployments for some species such as saithe and haddock.

Table 8

Total catch of main commercial species in different trap and leader configurations.

Species	Anchor	End
Cod	36	24
Conger	8	20
Haddock	72	15
Ling	30	18
Plaice	2	11
Pollack	9	9
Saithe	230	705
Whiting	7	153
Tusk	7	5
Total	**401**	**909**

3.2.1.3 Bycatch composition

Varying quantities of bycatch species were captured throughout the duration of the study. The most prevalent species in the bycatch was the edible crab *Cancer pagurus* and the poor cod *Trisopterus minutus* (Table 9). Considerable quantities of other shellfish species including velvet crab and squat lobster were also caught. Small quantities of lobster were also captured. The majority of bycatch species, including the most prevalent ones, were returned to the sea with minimal damage, with an average condition index score of one.

Table 9

Total numbers caught and average condition of bycatch species.

Bycatch	Number	Average condition
Brown Crab	379	1
Poor Cod	124	1
Velvet Crab	97	1
Common Dab	81	1
Squat Lobster	43	1
Lesser Spotted Dog	30	1
Grey Gurnard	25	1
Lobster	9	1
Wrasse	6	1
Octopus	4	1
Rockling	1	1
Three Bearded Rockling	1	1

3.2.2 Jig fishing

Jigging was undertaken on a total of five occasions during late summer 2016 at Blackstone reefs, south of Tiree (Figure 12), a popular area for local vessels to catch saithe and pollack for bait. Fishing was undertaken for a total of 4-5 hours on each occasion. The most prevalent species in the catch was saithe (Table 10). Pollack was also caught in considerable quantities although, due to quota restrictions, fishing was moved from areas of high pollack catches to areas with higher catches of saithe. Smaller quantities of cod and ling were also captured during the study (Table 10). There was a variety of sizes of each species caught with saithe ranging from 41-83 cm, pollack ranging from 45-87cm and cod ranging from 57-61cm. The two ling caught were 71 and 76 cm. Due to the size of the lures being used there were no undersized fish caught during the deployments.

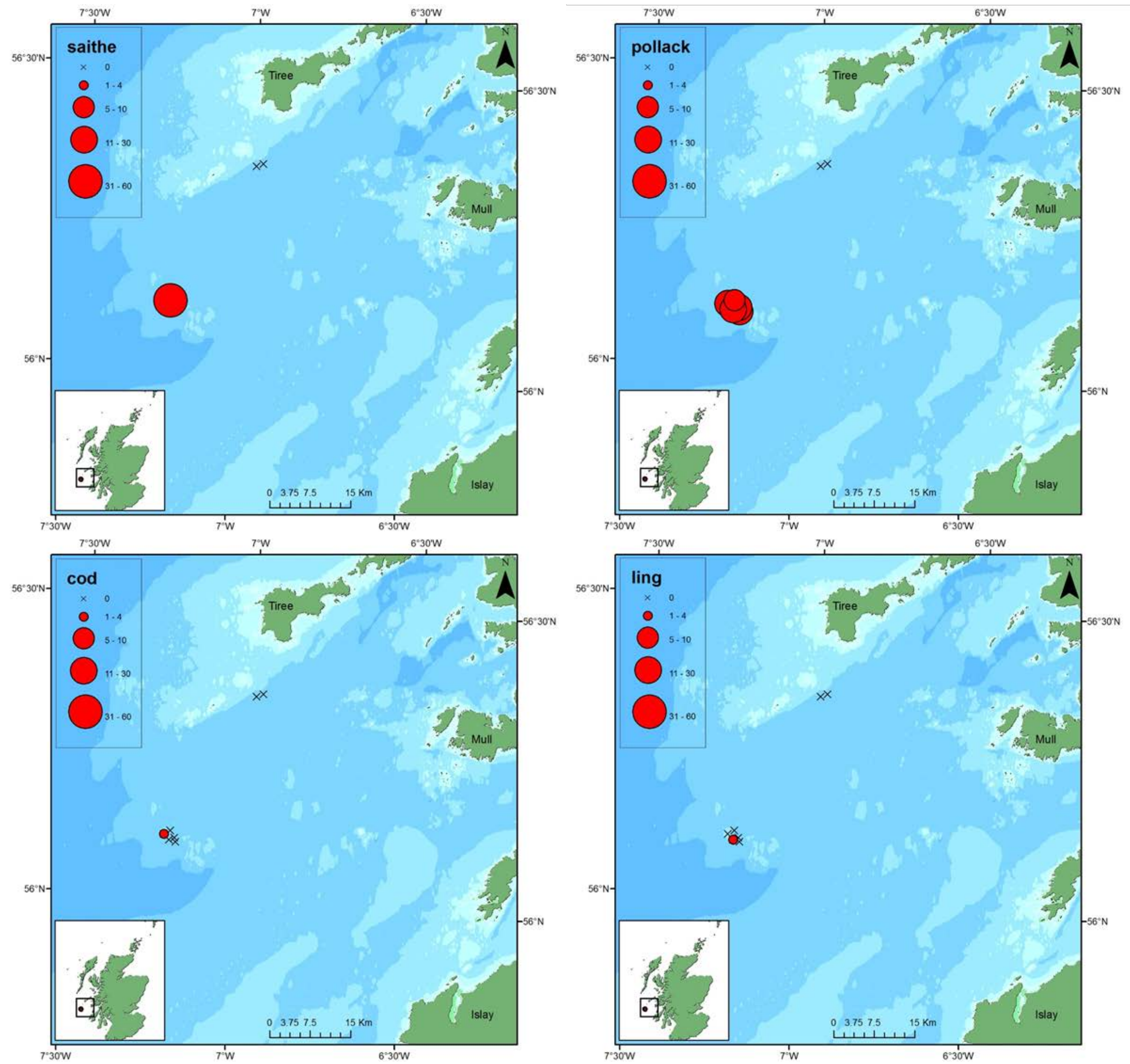

Figure 12: Spatial distribution of catches of the main commercial species caught on jigging machines on the west coast of Scotland. NB catch rates are number of marketable fish per day.

Table 10

Composition of retained commercial species caught during jigging activity.

	Number of fish			
Deployment	**Saithe**	**Pollack**	**Cod**	**Ling**
1	110	19	4	
2	94	19		
3	81	18		
4	60	7		
5	147	17		2
Total	**492**	**80**	**4**	**2**

3.3 Discussion

The results of this study suggest that a commercial trap fishery may be viable and free of dead discards in higher density offshore areas. The concept of a gadoid capture fishery in static traps was also evident during the study. It should be noted that the present study yielded positive results despite the geographical limitations due to funding availability. A larger vessel working on offshore areas could potentially haul a significant quantity of traps that could yield commercially viable catches comprised of a variety of species. This was evident in previous deployments undertaken at Rockall where significant catches of ling (112 kg), tusk (7 kg) and conger eel (21 kg) were captured from a single trap (Figure 13).

Jigging operations were undertaken primarily at Blackstones reef. Deployments of jigging gear was limited to five days due to restricted resource availability, i.e. the boat skipper was committed to hauling crab gear to provide a principal source of income. Despite this, the reasonable catches of marketable fish on the occasions that jigging was trialled suggest that this method could be developed into an environmentally friendly fishery free of dead discards for vessels on the west coast of Scotland.

Figure 13: Trap catch breaking the surface at Rockall. © NAFC

3.3.1 Catch Composition

The large variety of species evident from the catches of custom built traps from the west coast suggests that the traps developed by Marine Scotland are very versatile and can be used to target a range of commercial species.

Catches of haddock were relatively good in the traps, especially when compared with shellfish creels. Anecdotal evidence suggests that, while catches of cod, ling and tusk are relatively common in shellfish creels, catches of haddock and whiting are rare. Catches of haddock were also rare in the traps deployed in Shetland. This suggests that the configuration of the traps used on the west coast is more suitable for catching species such as haddock.

As with other fisheries, catch composition in traps would probably exhibit an element of seasonal variability. This would allow experienced skippers to build experience over time of the most appropriate areas to target specific species, dependent on quota availability.

Deployments of jigging gear highlighted the quality of fish available using this method. Unfortunately, catch rates of specific lure types were not recorded during jigging operations due to limited resources. Despite this, catches of the different species were noted to be similar on the different lures used (predominantly rubber eels).

3.3.2 Assessment of Gear

If an offshore fishery on the west coast was to be pursued commercially a more robust design of trap could be developed on a commercial scale. It was noted during the study that small but significant improvements could be made in processing catches from the traps. A mechanism to enable the traps to be emptied more easily, i.e. lifting the trap and allowing the catch to fall into a box below, as well as availability of replacement bait bags, would improve the turnover speed for individual traps. As such, a larger vessel would provide the space necessary to work with larger numbers of traps.

The mesh size used in the west coast traps was of a size (12 mm) that would retain larger quantities of smaller fish. It is hypothesised that the presence of small fish in the trap may have encouraged larger predatory fish to enter the trap in pursuit of smaller fish. This may have been a contributory factor to the range of species evident in the catches.

The process of configuring the vessel to set up for the Belitronic jigging machines was found to be relatively straightforward. During normal usage the machines were found to operate efficiently and with minimal maintenance required. The machines were able to haul catches of fish to the surface without any problems. Other brands of jigging machine are available for purchase but anecdotal evidence suggests that Belitronic machines provide the best value for money. For example, NAFC Marine Centre previously undertook a jigging study using Oilwind machines and noted that the aftercare service provided by the company was not sufficient for regular maintenance of the gear.

4 General Discussion and Conclusions

The combined results of the studies undertaken in the northern North Sea and the west of Scotland highlight the potential for a fishery to be developed using fish traps and/or jigging. Catches of a variety of commercially important species were evident in both areas. However, it should be noted that the study undertaken here was undertaken with limited resources and within a limited timescale and area.

Two different types of trap were used in the different study areas and, due to restricted resources, there were no direct comparisons made between the two trap types. As such, it is unclear whether one trap type fished better than the other although both trap types were found to have advantages and disadvantages. Traps on the west coast of Scotland had a smaller mesh size that the ones deployed in the northern North Sea. This may have resulted in larger quantities of smaller fish being retained in the traps, potentially attracting larger predatory fish. A study on the effect of mesh size on catch rates would be beneficial to determine whether the presence of smaller fish in the trap does indeed attract larger predatory fish and increase catches of commercial species. The results of this study have highlighted future research requirements for further understanding and developing the commercial viability of trap and jig fishing as follows:

- The method needs to be trialled further in offshore, higher density fish areas. As with shellfish fisheries, locating traps to catch specific species at different times of year would require knowledge of fish movement and densities in specific areas. This would be gained through experience or consultation with skippers using other methods.
- There is still significant potential to develop a bespoke trap design that is suited to the fishing grounds around Scotland. For example, shellfish creel designs have evolved over a significant number of years to provide optimal gear for catching crabs and lobsters. A similar application to fish traps would

produce an optimal trap design for targeting whitefish species on a commercial scale.

- A study of fish behaviour in relation to different trap designs would be hugely beneficial to any developing fishery. This could be undertaken using underwater cameras to investigate interactions of fish with different gear designs. This could significantly improve the process of designing optimal fish traps.
- The results of this study suggest that trap fishing could be used in conjunction with jigging to provide optimal results. For example, traps can be deployed early in the morning and jigging machines deployed during the day while traps are fishing. Jigging machines can also be used to test specific grounds for the presence of fish prior to setting traps as well as supplying fresh bait for use in traps.

The points raised above highlight there is still a significant amount of research required in order to develop a commercial trap fishery in Scotland. Despite this, the development of a trap fishery for demersal species has the potential to provide a high quality, commercially viable fishery (with reduced dead discards) if further research and investigation is undertaken.

5 Summary

The EU Landing Obligation proposes to phase out discarding of commercial species, raising a number of issues for fishers and managers. Given the current scenario there is an opportunity to develop novel fishing gears that limit unwanted bycatch and reduce dead discards and are deemed to provide sustainable catches of key demersal species.

This study investigated the commercial viability of fishing with demersal fish traps and automated handlines in the Scottish demersal fishery. Two separate projects ran concurrently in the North Sea and the west coast of Scotland. Fish traps were deployed in both areas, with commercially available cod traps trialled in Shetland and custom designed traps trialled on the west coast of Scotland. Jigging with automated Belitronic machines was also trialled on the west coast of Scotland.

A range of commercial species were captured. Cod, conger eel and ling were most prevalent in Shetland while saithe, haddock and whiting were caught in larger numbers on the west coast of Scotland. Unmarketable fish, bycatch and unwanted species were found to be in very good condition and returned to the sea alive in most instances. Jigging catches on the west of Scotland were found to be similar to those seem previously in Shetland, with saithe and pollack being the principal catch species.

The combined results of the studies undertaken in the northern North Sea and the west of Scotland highlight the potential for a fishery to be developed using fish traps and/or jigging. The results of the study have highlighted future research requirement for further understanding and developing the commercial viability of trap and jig fishing in Scottish waters.

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7 Acknowledgements

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