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Sumwing Beam Trawl Trials

Technical Report

MFV Margaret of Ladram E198, September –
October 2021

November 2021

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1. Executive summary

At the request of the Western Fish Producers Organisation (WFPO), Seafish were asked to provide technical support during a sea trial of an innovative Sumwing beam trawl. Beam trawl vessels in Holland and Belgium have used the Sumwing successfully with reported cuts in fuel consumption by as much as 30%.

This report details the work undertaken as part of a short sea trial carried out over the course of three days on the MFV Margaret of Ladram (E198). A 30m beam trawl vessel fishing from the port of Brixham on the south coast of Devon.

Although the Dutch and Belgium beam trawl vessels have used the Sumwing successfully, the technology had never been trialled on a UK fishing vessel operating on fishing grounds traditionally worked by the UK beam trawl fleet.

The report explains the methodology undertaken during the sea trial and the technical characteristic of the Sumwing beam trawl gear.

Utilising the vessel's electronic fuel and tension meters, data was collected of the litres per hour of fuel used, and the load when towing both the Sumwing and the traditional beam trawl. An assessment of the potential fuel saving is included in this report. Details of catch composition and discards were collected including an assessment of fish quality. Results from the trial showed a 42% saving in fuel, and on average since the trial, the skipper has reported a 30% fuel saving. Impact of the trawls on the seabed has been reduced substantially, resulting in a reduction of benthic discards by 69%. The reduction in seabed impact has improved the quality of the fish retained in the trawl and reduced wear and tear on the gear, doubling its lifespan.

2. Introduction

In July 2021, Seafish received a request from the Western Fish Producers Organisation (WFPO) to provide technical support for a sea trial of an innovative Sumwing beam trawl. The sea trial was to take place on one of their member beam trawl vessels fishing from Brixham. The project work was supported through funding from the Fisheries and Seafood Scheme (FaSS).

The Sumwing was designed in the Netherlands back in 2007 and has been used successfully by a variety of Dutch and Belgium beam trawl vessels. The Sumwing changes the traditional cylindrical shape of the beam trawl into a wing shaped design, similar to that of an aeroplane. The wing shape creates lift, allowing the beam to be towed or 'flown' just above the seabed. Although the Sumwing design had been used successfully, it had not been tested on a UK fishing vessel working fishing grounds prosecuted by the UK fleet.

The benefits of using the Sumwing design include a reduction in the drag of the fishing gear, improving fuel efficiency and reducing CO² emissions. The design of the Sumwing with its single foot arrangement, in the centre of the beam, also reduces the footprint of the beam trawl and seabed contact by up to 84%.



Picture of the Margaret of Ladram E198

The sea trial took place over the course of three days during September/October 2021. The vessel chosen to carry out the trial was the Margaret of Ladram E198, a 30m beam trawl vessel fishing from Brixham.

The Margaret's skipper Adam Cowan-Dickie had been in close contact with the Dutch designer of the Sumwing and fellow Dutch skippers, and was confident that the system could be used successfully on the Margaret of Ladram. Prior to the trial, modifications were made to trawl to bring the design in line with the nets currently used by the Brixham fleet.

Fuel consumption and trawl tension information were collected during the trial using the vessel's onboard fuel and tension monitoring equipment. In addition, an assessment of catch composition, catch quality, and benthic bycatch was made.



Picture of the Sumwing and open gear trawl

The sea trial was broken down into three parts to provide a short-term direct comparison between the Sumwing and a traditional beam trawl. The first stage of the trial consisted of 8 tows using the Sumwing trawl on both sides of the vessel. Subsequently, 6 tows were carried out with the traditional beam gear on both sides of the vessel. The final stage of the trial involved rigging the vessel with Sumwing gear on one side of the vessel and the traditional gear on the other side. The variation in the number of tows with each gear type was due to unfavourable weather conditions during the trial. The final stage was restricted to only 4 tows of between 1 hour 15 and 1 hour 30 minutes.

This report details the results of the trial including an assessment of fuel consumption and potential savings in fuel and emissions. The report will be shared openly to help the wider beam trawl industry reduce fuel consumption and seabed impact. The results will be particularly valuable for the beam trawl industry in the southwest of England and those operating in the North Sea. Presentations of the results will be provided to the Channel and West Sustainable Trawling Group as well as the Seafish South West Advisory Committee.

3. Gear trials methodology

3.1 Project aims

The aim of the trial was to collect and analyse fuel data and assess variations in catch quality and benthic bycatch between the traditional and Sumwing design of beam trawl.

A Seafish gear technologist, accompanied by a representative of the WFPO, provided seagoing support during the trial and produced this report.

3.2 Trial plan

The trial was broken down into three one-day tests, comparing the new design of Sumwing beam against a traditional beam trawl design.

- Stage 1 Sumwing. Vessel rigged with a Sumwing beam on both sides.
- Stage 2 Traditional Beam. Vessel rigged both sides with a traditional beam trawl.
- Stage 3 Sumwing vs Traditional. Vessel rigged with a traditional beam trawl one side and the new design of Sumwing on the other side.

For each of the three gear set ups, fuel usage and tension data were collected using the vessels onboard monitoring system. The catch was sampled, and composition information collected. An assessment of catch quality, discards, and benthic impact was also carried out. Using the data collected during the trial, an economic assessment of the potential fuel saving of the Sumwing has been made providing a potential payback period.

Data will be disseminated to industry organisations and will form part of WFPO's submission to the Fisheries and Sustainable Seafood (FaSS) fund.

3.3 Vessel and skipper

The Margaret of Ladram E198, a 29.86m, 749kW beam trawler vessel based in the port of Brixham in Devon, is one of a fleet of vessels owned by the Greendale Group. The vessel generally fishes in ICES subarea VII and the western approaches, targeting a range of species including Dover sole, monkfish, plaice, brill, and turbot. The Margaret of Ladram is skippered by Adam Cowan-Dickie with a crew of 4-6. Adam was instrumental in the acquisition of the Sumwing, having spoken with the designer and Dutch skippers. The net design fitted to the Sumwing trawls prior to the trials were provided by Adam and closely resemble the design of trawls currently used by the Brixham fleet.

3.4 Sumwing beam trawl

The Sumwing beam is an innovative design of beam that is shaped like a wing rather than the traditional cylindrical beam. The wing creates lift like an aeroplane and is designed to 'fly' just above the seabed. The wing is filled with air, which reduces the weight of it underwater. Unlike a traditional beam trawl, the Sumwing does not use weight to get to the seabed, it flies down to the seabed like a plane landing. The towing warps pull the wing forward, the net counteracts that by pulling the wing aft. These two forces result in a turning force or simple torque on the wing. The torque twists the wing into a diving position. When the foot of the Sumwing reaches the seabed, it balances the wing into a horizontal position keeping the beam stable at a constant height above the seabed. The air-filled nature of the Sumwing makes it inherently light, minimising the pressure the gear exerts on the seabed. Only the surface area of the one foot is needed to balance the wing and keep it in position above the seabed.

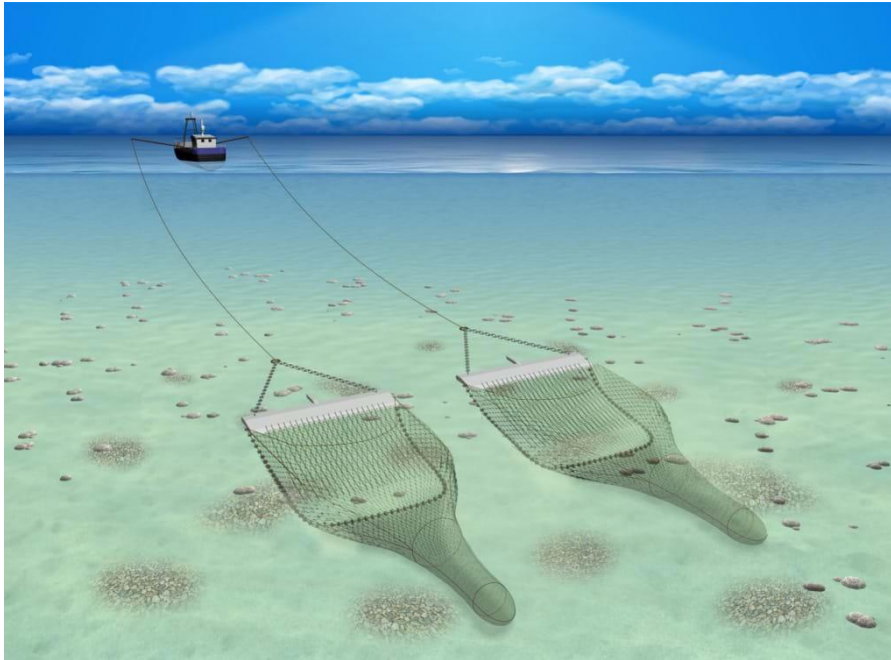


Diagram of a set of Sumwing trawls being towed

Due to the Sumwing design, drag is reduced when compared with a traditional beam trawl. Lowering drag reduces fuel consumption whilst fishing and therefore a reduction in CO² emissions.

3.5 Open gear beam trawl

The trawl used during the trial on both the Sumwing and the traditional beam was an open gear trawl. Open gear is defined by using several chain ticklers fitted in front of the trawl. The ticklers interact with the seabed to displace fish living on the seabed so they can be captured in the trawl net towed behind. This type of trawl is commonly used on 'clean' fishing ground with a sandy or muddy substrate.

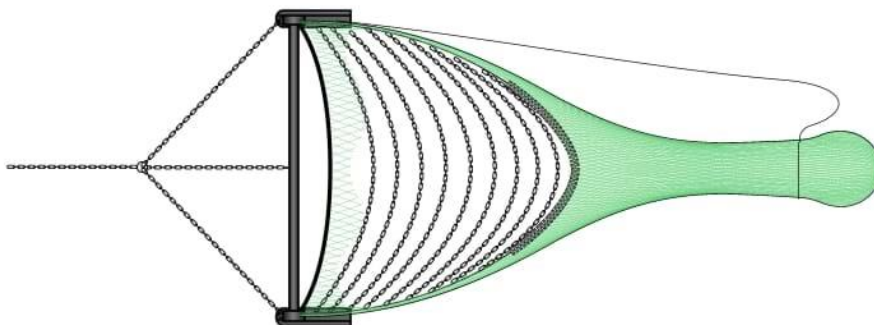


Diagram of an open gear beam trawl

3.6 Chain mat trawl

The other type of trawl commonly used by southwest beam trawlers is the chain mat trawl. This trawl has a matrix of chains in front of the net rather than ticklers. The idea behind the chain matrix is to avoid large rocks and boulders from entering the trawl and damaging the gear. This allows the trawl to be towed over a wider range of 'harder' ground than can be fished with open gear.

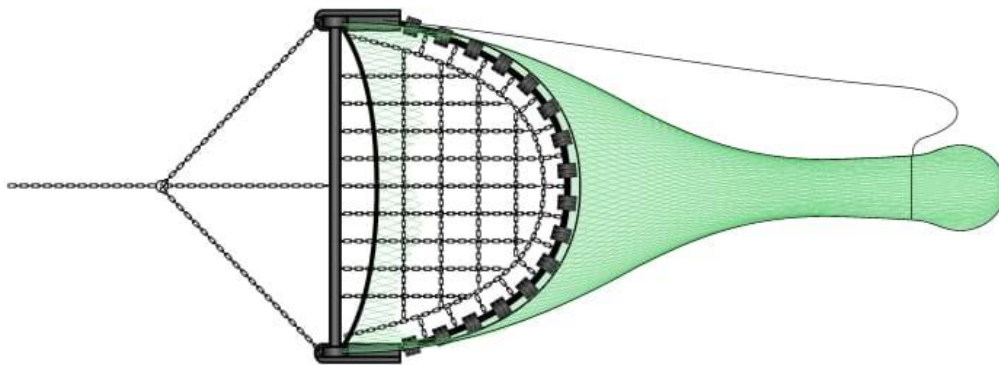


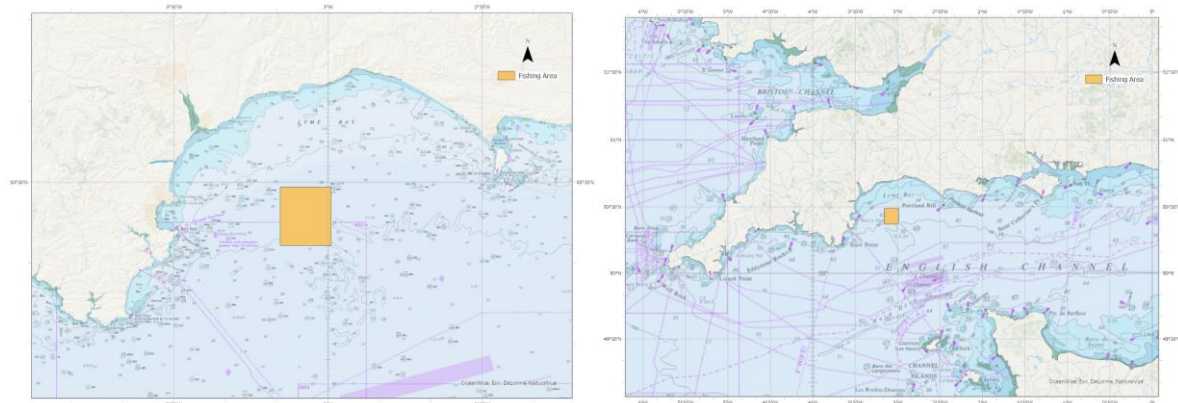
Diagram of a chain mat beam trawl

Due to the design of the beam trawl and how the chains are rigged, Sumwings are currently only used in conjunction with open gear trawls. Although work is currently being carried out by the Dutch and Belgium fleet to design a Sumwing that could be used with a chain mat beam trawl.

4. Results

4.1 Fishing area

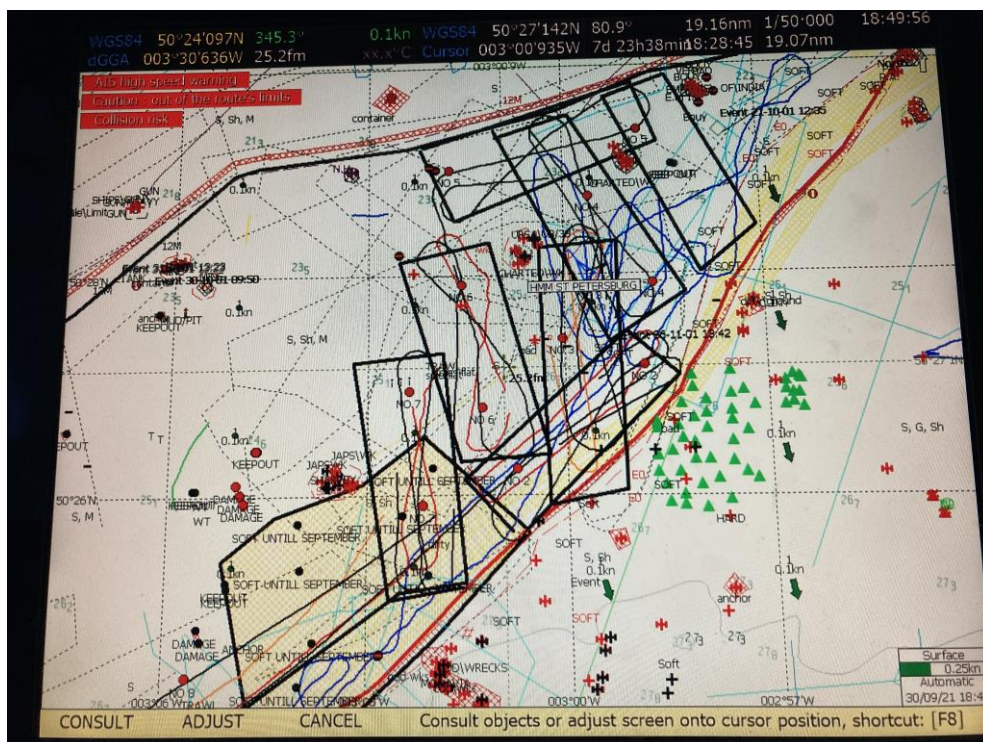
Due to the nature of the trial and the need to be within easy access of Brixham harbour to allow the fishing gear to be changed over during the trial, Adam, skipper of the Margaret of Ladram, chose a fishing area to the east of Brixham on the edge of the 12-mile limit. Owing to the vessel's size and licence restrictions, the vessel is restricted from fishing inside the UK's 12-mile limit. The chosen area is commonly fished by the Margaret of Ladram. During the trial another Brixham beam trawler was encountered fishing in the same location. The subsequent commercial trip carried out by Adam and the Margaret of Ladram was also carried out in a similar area. The charts below show the area fished during the trial.



Pictures of the area fished during the trial

Within the trial area highlighted, to standardise as much as possible, it shows the areas fished with each gear type. Adam set out a series of 8 boxes in which each of the tows would be carried out. It was the intention to carry out 1 tow in each of the 8 boxes with both the Sumwing trawls, followed by a similar number of tows with the traditional beam trawls, thus providing a direct comparison between the 2 gear types. Due to the deterioration in weather conditions during the trial, having completed 8 tows with the Sumwing, it was only possible to complete a further 6 tows with the traditional gear.

A record was kept of which tows were completed with each gear type. The 8 boxes chosen for the tows can be seen (outlined in black) from the screen shot of the Margaret's plotter below.

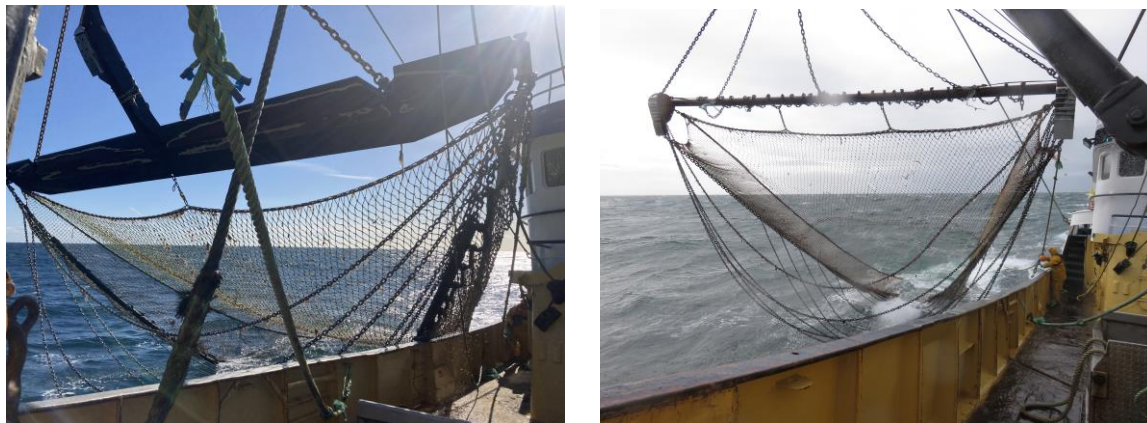


Picture of the Margaret of Ladram's plotter

To provide a direct comparison, the third stage of the trial saw the Sumwing trawl towed alongside the traditional beam trawl. Adam took a commercial decision to fish in the area that had been most productive on previous tows. Four tows were completed with this set up.

4.2 Fishing gear

Prior to the commencement of the trial, Adam had been in close communication with the designers of the Sumwing and fellow Dutch skippers who had experience of working with the Sumwing. During pilot trips using the Sumwing, Adam made some modifications to the rigging of the gear. After rectifying some early issues Adam was happy with how the Sumwing was technically performing during the shooting, towing, and hauling process. Having completed a successful trip the week before, Adam was confident that the Sumwing trial would achieve a fair comparison with the traditional trawl.



Picture of the Margaret of Ladram's Sumwing (left) and traditional beam (right)

The pictures above show the wing design of the Sumwing with a central foot arrangement, compared with the traditional tubular beam fitted with skids at either end. Both beam designs are fitted with a set of open gear. The footprint of the beams on the seabed is much reduced, with the Sumwing trawl only having a small stabilising 'foot' in the centre of the trawl rather than the two larger 'shoes' at either end of the traditional beam.

The nets used during the trial, although initially supplied by the Dutch supplier of the Sumwing, had been adapted by Adam in collaboration with Darren Edwards from Brixham Trawl Makers. Since the trial, further modifications have been made to the net, making it longer and reducing the amount of netting in the bosom of the trawl. This makes the trawls more comparable with the open gear traditionally used by Adam and other Brixham skippers. The nylon netting originally supplied by the Dutch trawl maker has been replaced with polyethylene netting which further reduces the weight and drag of the trawls.

4.3 Fuel consumption and tension

The Margaret of Ladram is fitted with a fuel flow meter and Marelec warp tension meters. This technology allowed the fuel usage in litres per hour and towing tension to be monitored and recorded. The Marelec tension system records the load on each of the two warps in real time. The pictures below show a record of the towing tensions when both gear types were being towed simultaneously. The Sumwing on the port side shown in red, and the traditional gear on the starboard side shown in green. The relative towing tensions are seen highlighted

VESSEL NAME	Margaret of Ladram									
Time/Date Leave Harbour	29.09.21		Time/Date of Landing				Total Hauls for Trip			
Fuel meter reading on Sailing			Fuel meter reading on Landing							
Modifications since last trip - to gear or vessel (gear change, new net, antifoul, oils change etc)										

Gear Type (Summing, Traditional or Mix)	START		STOP		Fuel Consumption Reading firhr	Towing Tension reading	Revs	SQG	Tide +/- knots	Sea State
	TIME	Flow Meter Reading	TIME	Flow Meter Reading						
Summing	6 21.20	138				3.8	790	5.1	X0.4	WSW 4/5
"	6 22.50	130				3.7	780	5.1	X0.2	"
"	7 23.20	124				4.0	720	5.0	X0.1	"
"	7 23.50	114				3.8	760	5.5	X0.1	"
"	7 00.20	143				4.5	790	5.1	X0.2	"
"	8 00.50	125				3.7	780	5.4	-0.3	"
"	8 01.20	130				4.0	780	5.0	-0.3	"
"	8 01.50	160				4.3	830	5.1	-0.5	"
OPEN GEAR	1 0835	221				6.0	920	5.1	+0.5	SW 5-7
Traditional	1 0905	208				5.5	900	5.1	+0.6	"
"	1 0935	206				5.5	900	5.0	+0.6	"
"	2 0950	202				5.8	910	5.2	+0.6	"
"	2 1020	210				5.2	900	4.7	+0.5	"
"	2 1040	224				5.2	910	4.5	+0.4	"
"	6 11.05	211				4.9	900	4.7	X0.3	"

Sumwing Beam Trawl Trials, SR761

Trawl type	Average flow meter reading L/hr	Average warp/towing tension (tonnes)	Average revs	Average speed over the ground
Sumwing trawl	126	3.8	767	5.1
Traditional trawl	216	5.5	904	4.7

The results show that the average load/tension when towing the Sumwing compared with the traditional gear reduced from 5.5 tonnes to 3.8 tonnes, a 1.7 tonnes reduction. This reduction in load reduces the engine revs whilst achieving the required speed over the ground of 5 knots. The reduction in engine revs resulted in a reduction of the average litres of fuel used during the trial from 216L/hr to 126L/hr, a saving of 90L/hr.

Adam highlighted that in trying to replicate the tows and match the SOG of the tows using the Sumwing, the vessel's engine was operating at near its maximum capacity when fishing with the traditional gear, particularly when towing against the tide. This would not be standard practice. Generally, Adam would look to utilise the tide, towing with it, to reduce engine revs whilst still achieving the desired speed over the ground.

The increase in engine revs required to match the speed over the ground, and the knock-on effects of increased fuel consumption, must be considered when reviewing these results.

Since the trial was completed, the skipper has reported an average fuel saving of 60-70 litres per hour while fishing normally. Further adjustments to the trawls are ongoing to improve this further.

Even though the Margaret of Ladram's engine was being operated at near maximum capacity when towing the traditional beam, it proved difficult to match the SOG achieved with the Sumwing due to the increased load. The average SOG using the traditional beam was 4.7 knots compared with an average speed of 5.1 knots with the Sumwing. The improved SOG achieved by the Sumwing represents a 9% increase in the area fished.

4.4 Fuel saving assessment

Using the data obtained from the trial as a guide to the potential fuel savings possible when using the Sumwing, the figures below show the cost savings that could be made if the Sumwing was used in preference to a set of traditional beams.

The figures are indicative only and do not account for the additional fuel consumed during the trial to match the speed of the traditional gear with that of the Sumwing. The potential increase in fishing time that could be achieved using the Sumwing through extended tow durations has not been factored in, nor has the potential saving in auxiliary fuel costs.

Calculation:

(The figures calculated below give an indicative cost saving based on the data collected during the sea trial.)

Taking the average fuel saving of 90 litres per hour seen during the trial and an average towing time of 18 hrs per day, the potential saving totals 1,620 litres per day.

Given a fuel price of £0.60 per litre the saving per day is £972.00.

On average, if a SW beam trawler carries out 200 fishing days per year, the potential saving per year is £194,400.

The cost of a set of two Sumwing beams is approximately £30,000 more than a set of traditional beams. The payback period to cover the additional cost of the Sumwing beams with the fuel saved equates to 31 days fishing.

Since the trial was completed, the skipper has reported an average fuel saving of 60-70 litres per hour while fishing normally. This is in contrast to the 90 litres per hour recorded during the trial. This is due to the trial affecting his normal fishing pattern when trying to replicate tow positions and directions.

4.5 Catch composition

Catch composition was assessed at the end of each haul and a record made of the key species caught. As it was not possible to weigh the catch onboard, catch levels were assessed by eye and volumes of each species retained and discarded were estimated. The catch records from stages one and two are shown below.

It should be noted that the tow durations with the Sumwing were 1 hour 15 minutes in duration compared with only 1 hour for tows undertaken with the traditional gear. The variation was due to concerns about the potential increase in discards and benthic material if the traditional gear was towed for longer than an hour.

Sumwing beam (stage one), weights in kg (estimated by volume)

Haul no.	Haul time	Sole	Plaice	Brill	Turbot	Gurnard	Cuttle	Monk	Ray	Whelk	Other
1	15:20	48	42	12	3	9	-	-	-	-	-
2	16:55	42	9	15	9	-	36	3	-	-	-
3	18:25	24	6	12	6	3	21	-	-	-	-
4	20:05	30	6	15	6	-	3	-	-	-	3
5	21:35	21	15	12	6	-	6	-	-	-	1
6	23:05	54	12	12	6	-	12	3	-	-	-
7	00:35	78	-	18	12	-	21	-	-	-	6
8	02:05	42	33	6	3	-	6	-	-	-	6

Traditional beam (stage two), weights in kg (estimated by volume)

Haul no.	Haul time	Sole	Plaice	Brill	Turbot	Gurnard	Cuttle	Monk	Ray	Whelk	Other
1	09:35	30	24	9	3	-	24	-	-	-	24
2	10:50	30	9	12	6	-	18	-	-	12	2
3 (tow 6)	12:05	27	9	3	3	-	18	-	-	9	9
4 (tow 3)	13:20	30	12	12	6	-	-	-	-	12	1
5 (tow 7)	14:35	30	-	6	6	-	12	-	-	12	12
6 (tow 8)	16:00	42	-	16	8	-	6	-	-	6	24

Stage three of the project involved a direct comparison between the Sumwing and the traditional beam trawls being towed at the same time. Four tows were completed with tow times ranging between 1 hour 15 minutes to 1 hour 30 minutes. A summary of the key species caught can be seen below.

Weights in kg (estimated by volume)

Haul	Dover sole		Cuttlefish		Brill/turbot		Mixed species	
	Sumwing	Traditional	Sumwing	Traditional	Sumwing	Traditional	Sumwing	Traditional
1	30	45	6	12	12	12	12	42
2	33	42	6	6	12	12	18	24
3	27	36	3	6	15	22	9	18
4	24	24	9	9	12	18	9	12

During stage three, catches of Dover sole, the main target species, were higher in the traditional trawl on 3 of the 4 tows. The biggest difference in catches of sole was on the first haul where the traditional trawl caught 15kg more than the Sumwing trawl. On the fourth haul catches of sole were similar in both trawls. There was a slight increase in the total weight of cuttlefish and brill/turbot caught over the 4 tows in the traditional trawl of 9kg and 13kg respectively. In terms of other species caught, these included plaice, whelks, gurnard, monkfish, and ray. The traditional trawl caught more (48kg in total) of these species over the course of the 4 hauls.

The net length has been increased since the trial and the amount of netting in the bosom of the trawl reduced allowing the net attached to the fishing line to fly just above the seabed. These modifications bring the trawls in line with the standard open gear design, ensuring catches are similar.

4.6 Benthic impact and discards

To assess the interaction of the beams on the seabed, the volume of discards was recorded for each of the hauls during the trial. The photographs below give an example of the species discarded during the trial.



Discards on the conveyor (left) and sample basket of discards (right)

The volume of discards was recorded for each haul and broken down into 3 categories (crabs, fish, and shell/stones/starfish). The tables below show the discards for the 8 hauls carried out using the Sumwing trawl and the 6 hauls carried out with the traditional beam.

Haul no.	Gear type	Discards			Total volume (baskets)
		Crabs	Shell/stones & starfish	Fish	
1	Sumwing	70%	-	30%	5
2	Sumwing	50%	25%	25%	4
3	Sumwing	80%	15%	5%	3.5
4	Sumwing	85%	10%	5%	3
5	Sumwing	85%	5%	10%	3
6	Sumwing	80%	5%	15%	5.5
7	Sumwing	55%	5%	40%	5.5
8	Sumwing	60%	20%	20%	12
Average		71%	12%	19%	5 baskets

Haul no.	Gear type	Discards			Total volume (baskets)
		Crabs	Shell/stones & starfish	Fish	
1	Traditional	30%	60%	10%	25
2	Traditional	5%	75%	20%	15
3	Traditional	10%	80%	10%	12
4	Traditional	10%	80%	10%	13
5	Traditional	15%	80%	5%	12
6	Traditional	20%	50%	30%	20
Average		15%	71%	14%	16 baskets

In assessing the volume of discards and benthic material between the two gear types, the Sumwing trawl caught on average 5 baskets per haul compared with an average of 16 baskets per haul with the traditional gear. The reduction in the volume of discards is thought to be a result of the decreased footprint of the Sumwing on the seabed and its single central 'foot' not channelling the benthic material/discards into the trawl net.

When the two trawls were towed alongside each other, the volume of benthic material/discards showed similar results as can be seen in the table below, showing an average reduction in discards of 10 baskets per haul.

Haul no.	Discards (baskets)	
	Sumwing	Traditional
1	4	12
2	4	14
3	6	20
4	4	12
Average	4.5 baskets	14.5 baskets

Catches from the two different trawls when collected in the hoppers can be seen below. Catches with the Sumwing trawl can be seen to be much 'cleaner' with very few shells and starfish being caught.



Sumwing catch (left) and traditional beam catch (right)

In the third stage of the trial where the beams were fished alongside each other, the difference between catches of benthic material and discards, particularly shells, was very apparent. The Sumwing catching very few or no shells whatsoever and the traditional beam catching up to 7 baskets of shells per haul.

4.7 Fish quality

The amount of benthic material and discards retained in the trawl will affect the quality of the fish being retained. When the fish caught in the Sumwing beams were initially landed on Brixham market, the sales agents had commented on the quality and appearance of the fish when compared to other Brixham beam trawlers. The sales agents were able to market the superior quality of the fish as being specifically caught by the Sumwing. By reducing the bulk and the more abrasive items in the cod end of the net, such as shells, the quality of the total catch is improved as the likelihood of fish being crushed or damaged during fishing is reduced. This not only improves the quality of fish being landed to market, but it also benefits those fish and shellfish that are being discarded through improved survivability when returned to the sea.

The appearance of the cuttlefish is a good gauge as to the quality of the total catch. Cuttlefish lose a lot of their colour from their appearance if damaged in the net or whilst mixing with other fish and benthic material in the cod end. The cuttlefish pictured below, from the Sumwing trawl, have retained their colour and show very little signs of any damage. The plaice are also of an excellent quality with no visible signs of abrasion. It is hoped that the improved quality of the fish being landed when using the Sumwing trawl has the potential to improve the market price.



Sumwing caught cuttlefish (left) and plaice (right)

4.8 Reduction in use of consumable parts

Due to the innovative Sumwing design, the impact on the seabed is reduced. This is evidenced by the large reduction in benthic material being caught in the trawls. An unexpected benefit of this impact is to reduce wear on the beam trawl chains. Usually, the chain wears down and stretches such that it requires replacing every eight weeks. The chains currently fitted to the Sumwing have been used for five months without requiring replacing and without stretching.

5. Discussion

This short trial demonstrated that the Sumwing could be operated successfully on fishing grounds traditionally fished by southwest beam trawl vessels using open gear beam trawls. It highlights potential fuel savings with the additional benefit of reducing CO² emissions.

Although when fished alongside each other, the catch volume from the Sumwing was less than the volume caught in the traditional beams, but the skipper is confident that with further adaptations and development of the Sumwing trawl, catches can be improved.

The substantial reduction in discards caught in the Sumwing trawl will potentially allow the skipper to increase the tow times whilst still maintaining the quality of the catch. Reducing the number of times the gear needs to be hauled during the trip will increase the potential fishing time. Extending the tow time from 1hr to 1 hr 30 mins will increase fishing time by 90 minutes in every 24-hour period, an increase in fishing time of around 8%.

The reduction in the number of hauls will also reduce the wear and tear on the deck machinery and warps, further reducing the amount of fuel used by the auxiliary engine which is used to run the hydraulics during the hauling process.

Reducing the overall drag of the trawl using the Sumwing, there is the opportunity for the skipper to increase towing speed and cover a wider area in any given period, whilst still maintaining a fuel saving.

Further analysis will be required to make a full assessment of how all these various impacts and any further modifications affect the running costs and profitability of the vessel in the longer term.

6. Further action and work

The skipper and crew, working in conjunction with Brixham Trawl Makers, intend to make further modifications to the Sumwing trawl to improve its fishing efficiency, so that it achieves equivalent catches to that of the traditional beam design. The skipper is confident that this can be achieved whilst maintaining the improvement in fuel saving and the reduction in benthic impact.

Once the improvements have been made to the Sumwing, observations of the gear's performance using an underwater camera would be valuable in allowing the skipper and crew to view the gear during fishing operations. The use of the camera will support the skipper and gear maker to fine tune the trawls, improve performance and sustainability attributes, and further assess the benthic impact of the trawl on the seabed.

A future assessment of gear modifications and the impacts on fuel consumption, towing speed, benthic impact, and fish quality will need to be carried out to fully assess all potential benefits and costs associated with operating the Sumwing.

7. Acknowledgements

Adam Cowan-Dickie & the crew of the Margaret of Ladram E198

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