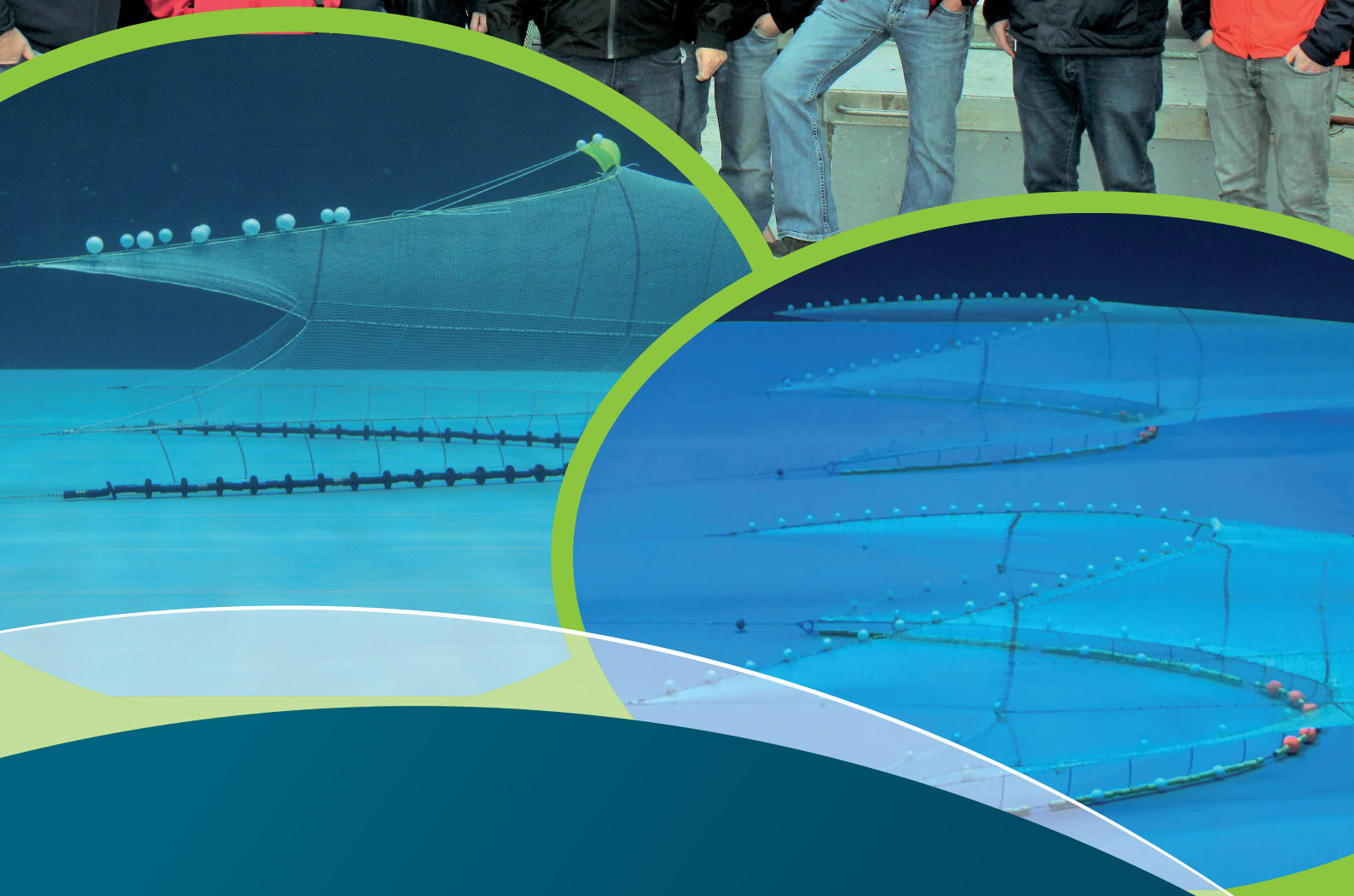

Irish Fishing Industry Flume Tank Workshop, Newfoundland

Fisheries Conservation Report

December 2018

BIM Ireland's Seafood Development Agency

Irish Fishing Industry Flume Tank Workshop, Newfoundland

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Key Findings

1. The raised fishing method was further developed and improved by altering the bridles and using kites on the headline.
2. A further Irish gear trial is planned to transfer the knowledge gained from the flume tank.
3. Irish industry participants provided excellent feedback on the flume tank facilities and local industry visits.

Cover photo

Matthew McHugh (BIM), Robert Dawe, Patrick McClenaghan Jnr, Patrick McClenaghan, Shaun McClenaghan, John Boland (FFAW), Ivan Batten (Ocean Navigator), Brad Porter (Eastern Mariner), Adrian McClenaghan, and Martin Oliver (BIM)

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
Co-funded by the Irish Government and the European Union

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

EUROPEAN UNION
This measure is part-financed by the European Maritime and Fisheries Fund

Introduction

The draft discard plan for North-Western waters from 2019 to 2021[1] contains lists of gear options for vessels targeting *Nephrops* and whitefish species in the Celtic and Irish Seas. At the time of writing, implications for vessels targeting *Nephrops* in the Irish Seas are minimal given that the selective gears are already used in response to cod management measures. In the Celtic Sea, *Nephrops* vessels using an 80 mm codend with 120 mm square mesh panel will be required to adopt a more selective gear, but a range of options previously tested by BIM and the Irish Industry such as the SELTRA are available to pick from.

Depending on the target species, vessels targeting whitefish in the Celtic Sea will also have a range of gears to choose from, but challenges remain if low quota species such as cod and black sole are to be avoided while viable whiting catches are maintained. Although not on the list of prescribed measures, raising the fishing line from the ground gear provides an additional option for vessels to reduce unwanted catches while boosting landings of targeted species: A previous BIM trial demonstrated reductions in cod by 39%, flatfish by 57% and skates & rays by 80%, and an increase in whiting by 87%[2]. While the results were extremely encouraging, post-trial testing by the vessel owner revealed some issues with gear performance in rough weather and strong tides, so further testing was required. Our colleagues in Newfoundland have lots of practical experience with this type of gear and a well-equipped flume tank to test Irish adaptations, paving the way for an Irish Industry visit in November 2018 to work on fine tuning this important gear option.

Five Irish skippers and two BIM staff (Matthew McHugh and Martin Oliver) attended the workshop. Gear demonstrations with scaled net models were carried out by Harold DeLouche and George Legge from the Centre for Sustainable Aquatic Resources (Memorial University) who have over twenty years of experience of conducting flume tank courses.

Gear assessment

Here we present a summary of the key findings, all iterations of the testing can be found in the appendix. The original raised fishing line, similar to the full-scale model tested during Irish sea trials was tested first (Table 1). After initial viewing, it was decided to alter the rigging from two single bridles to a split upper (V) and a lower bridle (Figure 1). Following some minor adjustments, the gear was tested at three different towing speeds with data on trawl performance parameters collected (Table 2).

Table 1. Standard rig configuration (at full scale)

Characteristic	Specification
Door type	Thyboron Type 2
Door Area (m^2)	2.70
Trawl type	300 Balloon
Footrope length (m)	24
Headline length (m)	33
Upper bridle length (m)	40
Lower bridle length (m)	40
Upper bridle extensions (m)	6
Lower bridle extensions (m)	6
Sweep length (m)	45.6
One float buoyancy (kgf)	7.5
Total floats (no)	44
Total floats buoyancy (kgf)	330

Next, canvas kites were added to the headline to provide additional lift with a view to maintaining the opening between the fishing line and ground gear. The optimal configuration involved removing the equivalent of 25 plastic floats (or 187.5 kgf) that were replaced by two x 1.35 m^2 kites (equivalent at full scale), set at 44° angle of attack (AOA). It was decided that some floats should be retained to protect against potential failure of the kites (Figure 2 and 3). Additionally, a smaller float was attached to the top of each kite to make sure they were correctly orientated and to prevent against potential inversion. Substantial improvements in headline height were observed at higher towing speeds with the kites (Table 3). The kites were further assessed at different AOAs (26 and 65°). Minimal difference in trawl performance was observed at 26° but at 65° AOA the kites appeared to bounce making them unstable and causing the netting directly behind them to ripple. Additional potential benefits if using kites include improved trawl stowage on net drums, and reduced use of plastic in the marine environment.

Finally, a dropper trawl configuration with no ground gear and an increased weight of dropper chains was tested (Figure 4). To counter the lighter configuration, we removed the equivalent of 11 full size floats. Overall the dropper trawl performed similar to the other configurations (Table 4). Before we tested kites with the dropper trawl, it became apparent that there was nothing to protect the net from snagging on the seabed, especially on rougher substrates, and it is not currently considered suitable for Irish bottom trawl fisheries. A number of other trawls which are used locally to reduce unwanted catches were subsequently deployed in the flume tank and discussed.

1 https://ec.europa.eu/transparency/regdoc/rep/3/2018/EN/C-2018-6789-F1-EN-MAIN-PART-1.PDF

2 McHugh, M., Browne, D., Oliver, M., Tyndall, P., Minto, C., and Cosgrove, R. 2018. Raising the fishing line to reduce cod catches in demersal trawls targeting fish species. Irish Sea Fisheries Board (BIM), Fisheries Conservation Report, May 2017. 9 pp.

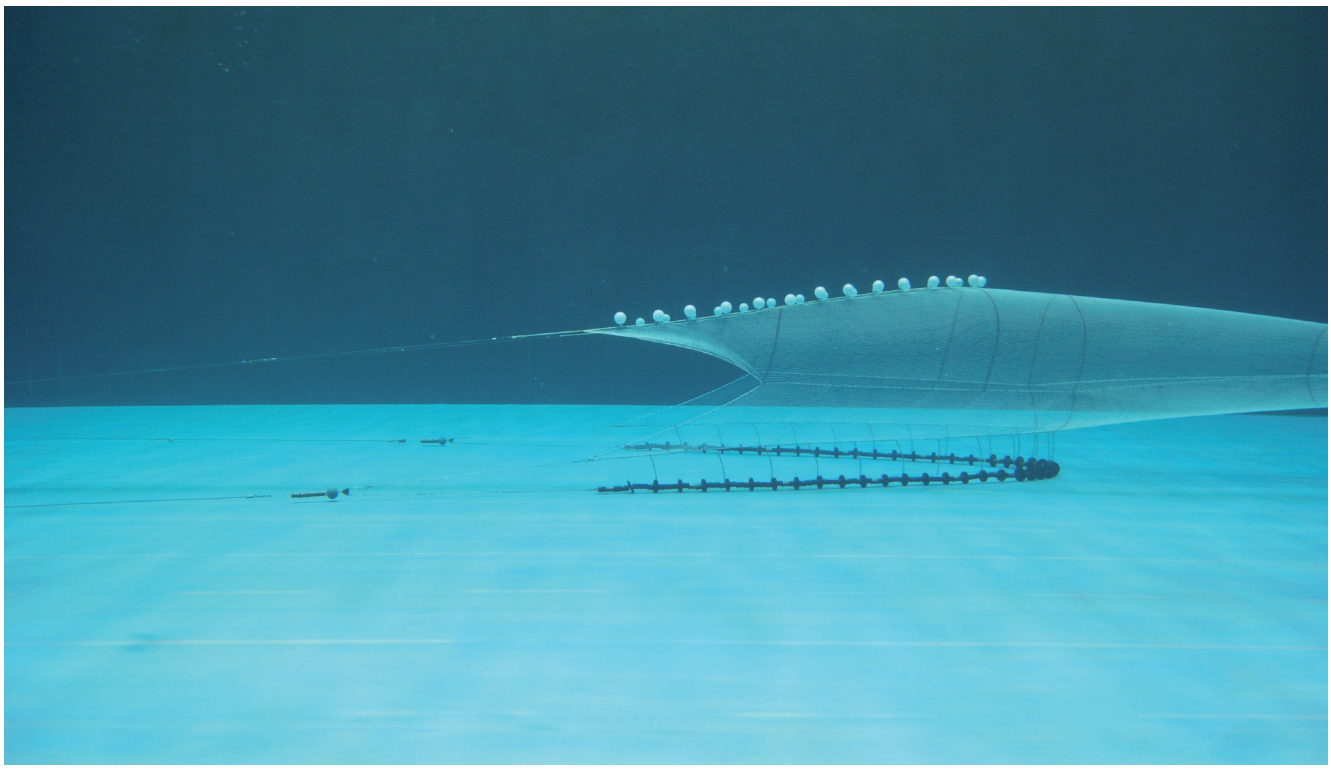

Figure 1. The standard raised fishing line trawl

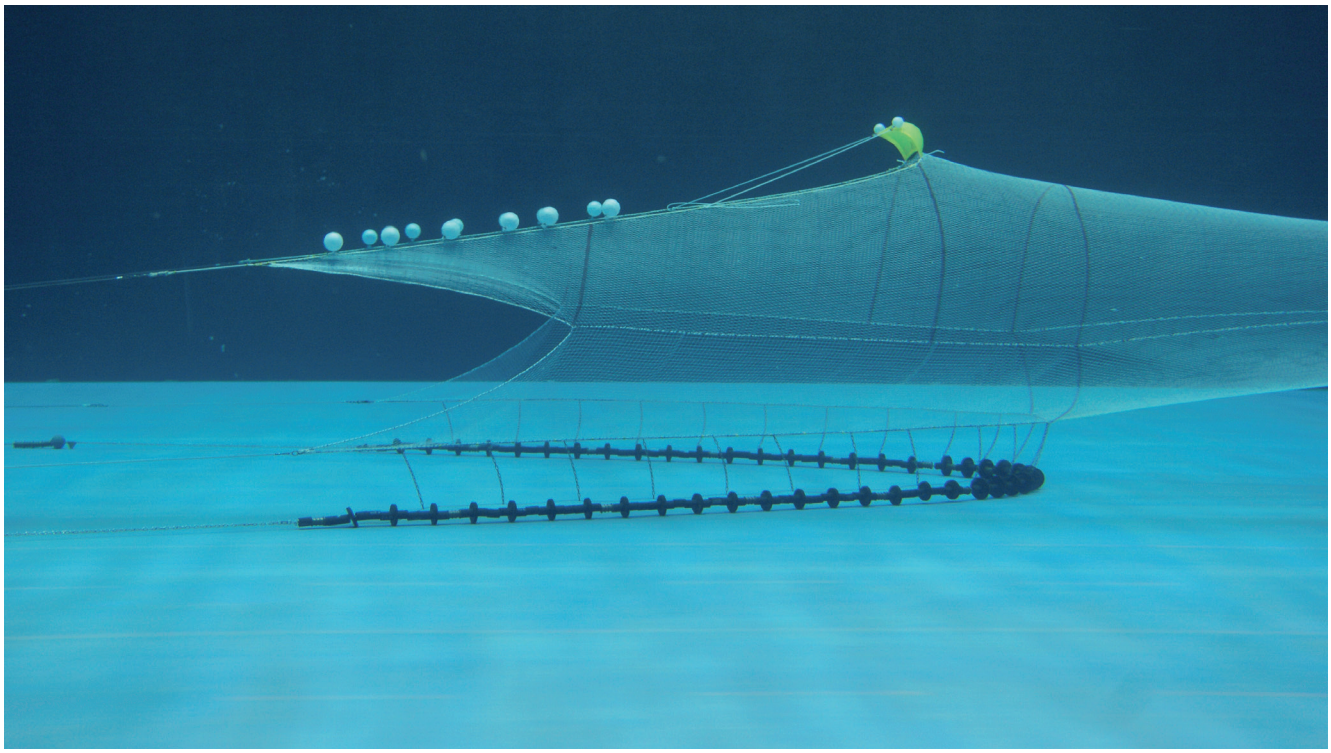

Figure 2. Side profile of the trawl with two kites in the centre of the headline

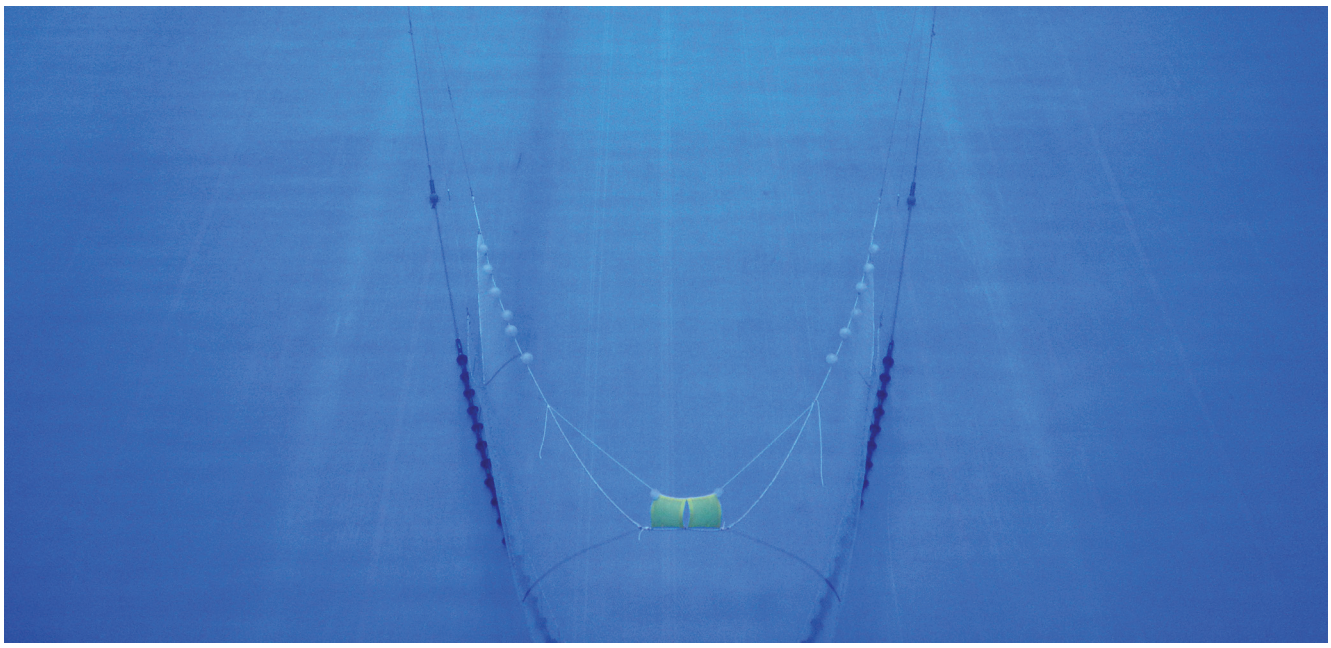

Figure 3. Overhead view of the trawl with two kites in the centre of the headline.

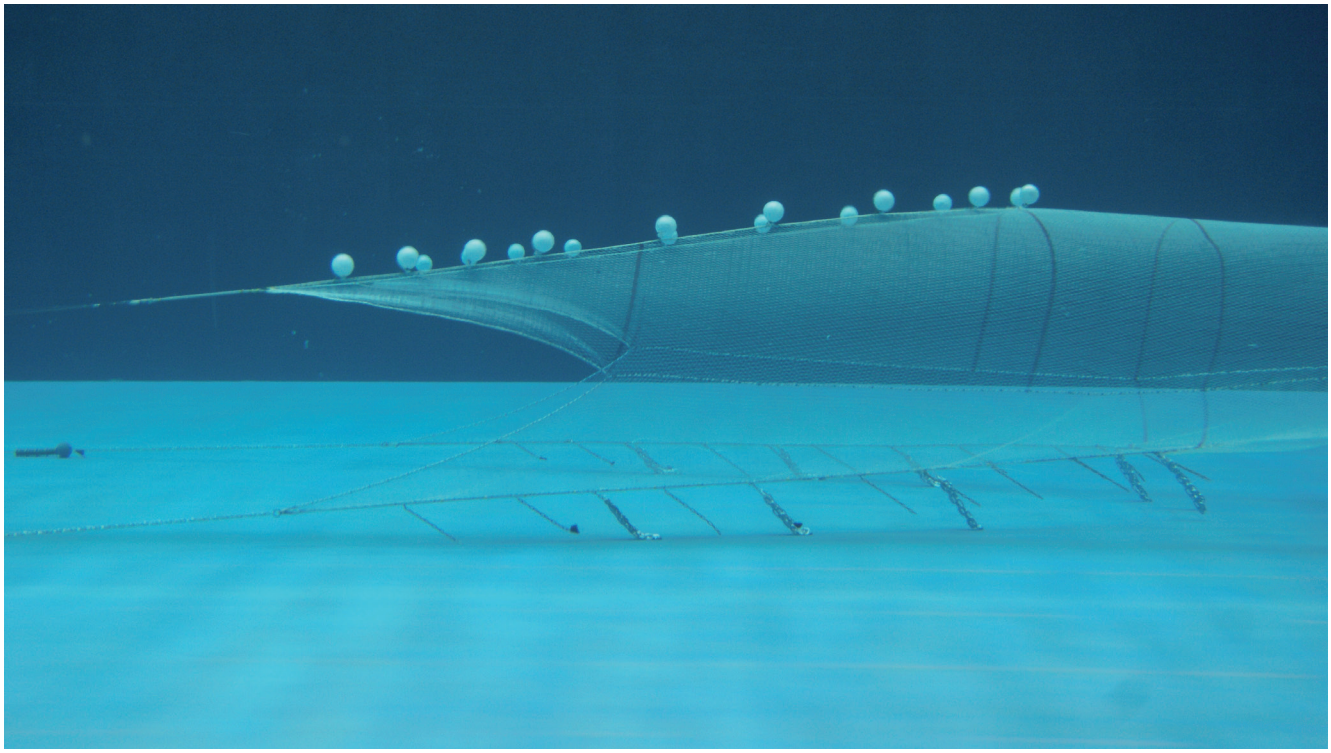

Figure 4. Dropper trawl (with ground gear removed)

Table 2. Baseline data for the standard rig (Table 1)

Towing speed (kts)	Spread (m)				Opening (m)		Tension (tonnes)			Mouth Area (m^2)	Mouth Drag (kgf/m^2)	Bridle angle (degrees)
	Door	Upper wing	Lower wing	Mean wingend	Wing	Headline	Port	Starboard	Total			
3.00	54.00	12.10	12.60	12.30	3.60	6.20	1.80	1.80	3.70	76.30	48.10	14.20
3.50	54.40	12.00	12.20	12.10	3.50	5.70	2.30	2.40	4.70	69.00	68.10	14.30
4.00	55.10	11.90	12.20	12.00	3.30	5.30	2.90	3.00	5.90	63.60	92.50	14.60

Table 3. Data for the standard rig with kites replacing floats. In this configuration the equivalent of 25 full scale floats (or 187.5 kgf) were removed and replaced with two kites (1.35 m^2 each—equivalent at full scale), set at 44o angle of attack (AOA).

Towing speed (kts)	Spread (m)				Opening (m)		Tension (tonnes)			Mouth Area (m^2)	Mouth Drag (kgf/m^2)	Bridle angle (degrees)
	Door	Upper wing	Lower wing	Mean wingend	Wing	Headline	Port	Starboard	Total			
3.00	53.70	11.10	11.90	11.50	3.00	6.10	1.88	1.83	3.71	69.60	53.30	14.40
3.50	55.20	11.20	11.80	11.50	3.00	6.10	2.31	2.28	4.60	70.80	64.90	14.90
4.00	54.70	11.10	11.10	11.10	2.70	6.00	3.02	2.94	5.96	66.20	89.90	14.70

Table 4. Data for the standard rig with ground gear removed and replaced with dropper chains. In this configuration the equivalent of 11 full scale floats (or 82.5 kgf) were removed, leaving 33 in total.

Towing speed (kts)	Spread (m)				Opening (m)		Tension (tonnes)			Mouth Area (m^2)	Mouth Drag (kgf/m^2)	Bridle angle (degrees)
	Door	Upper wing	Lower wing	Mean wingend	Wing	Headline	Port	Starboard	Total			
3.00	55.60	12.10	11.90	12.00	3.30	5.00	1.60	1.40	3.10	60.10	50.80	14.70
3.50	55.90	12.40	12.00	12.20	3.20	4.80	2.00	1.80	3.80	58.10	65.90	14.70
4.00	57.20	12.40	12.30	12.40	3.00	4.40	2.50	2.30	4.80	54.00	89.00	15.20

Local Industry visits

In addition to the flume tank, a number of local industry visits were arranged to learn more about Newfoundland approaches to improving fisheries. We visited Hampidjan Canada Ltd in Spaniard's Bay where we were shown around the net loft and discussed gears used locally such as T90 mesh which is becomingly increasingly popular with Newfoundland fishers. We met some of these operators in Port de Grave and Petty Harbour and discussed their strategies for reducing unwanted catches and broader issues affecting the respective industries. A visit was also arranged to the offices of the Fish, Food and Allied Workers Union (FFAW-Unifor) which represents around 15,000 workers who are mostly involved in the fishing industry. The trip ended with a tour of the Notus electronics company which manufactures trawl sensors. Their new echo sensor has major applications to the Irish *Nephrops* fishery. Consisting of a microphone and transducer attached to a rigid sorting grid, the device detects crustaceans such as shrimp or *Nephrops* as they come into contact with the grid. Linked to the Notus wheelhouse display, the system provides key information on localised catch rates which greatly improves operational efficiency. In the context of the EU landing obligation, the system also provides a major incentive for vessels targeting *Nephrops* to use the sorting grid which effectively eliminates most of the unwanted fish catch from the trawl.

Conclusion

Flume tank testing of the raised fishing line worked very well and it is planned to transfer the knowledge gained to a further field test of the gear in 2019. Feedback from participants on the trip was excellent although greater availability of models of the type of trawls used in Irish fisheries would be ideal.

Acknowledgements

BIM is grateful to the Irish Industry participants, Paul Winger, Harold DeLouche and George Legge from the Centre for Sustainable Aquatic resources, and John Boland from (FFAW for his time and organising the visits to Port de Grave and Petty Harbour. This work was funded by the Irish Government and part-financed by the European Union through the EMFF Operational Programme 2014-2020 under the BIM Sustainable Fisheries Scheme.

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	MI 300 Balloon Trawl				
								Rig 1					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.00	54.0	12.1	12.6	12.3		3.6	6.2	1.8	1.8	3.7	76.3	48.1	14.2
3.50	54.4	12.0	12.2	12.1		3.5	5.7	2.3	2.4	4.7	69.0	68.1	14.3
4.00	55.1	11.9	12.2	12.0		3.3	5.3	2.9	3.0	5.9	63.6	92.5	14.6

Notes:
Rig 1 - 6m extension added to footgear and fishingline to allow 1m toggle chains to extend it's full length. 6m also added to headline

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 2	Footgear shortened by 0.6m per side				
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50	54.4	12.1	12.3	12.2		3.4	5.6	2.3	2.3	4.6	68.2	68.0	14.3

Notes:
Comments: Fishingline now sitting aft of footgear

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 3					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50	54.4	12.0	12.3	12.2		3.4	5.5	2.3	2.3	4.6	67.0	69.2	14.3

Notes: Rig 3 - footgear shortened by another 0.6m per side (total of 1.2m per side).
Comments: Centre of footgear (bosum) lifting off seabed

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 4					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.00	54.1	11.9	12.2	12.1	0.0	3.3	6.1	1.8	1.8	3.6	73.4	48.9	14.3
3.50	54.4	12.1	12.2	12.2	0.0	3.0	5.6	2.3	2.3	4.6	68.1	67.1	14.3
4.00	54.6	11.9	12.0	11.9	0.0	2.7	5.2	2.8	2.9	5.7	61.9	92.0	14.4

Notes: Rig 4 - Fishingline wire extended to upper bridle (1.8m from fwd end of bridle with 3.5m wire extending back to fishingline)

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 5					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50	54.4	11.7	12.1	11.9		3.2	6.1	2.3	2.4	4.7	71.9	65.8	14.5

Notes:
Rig 5 - An equivalent of 10 - 11" floats added to bosom and quarters

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 6					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50	54.6	12.1	12.3	12.2		3.3	5.7	2.3	2.4	4.6	70.1	66.3	14.3

Notes:
Rig 6 - The 10 extra floats removed from bosum and attached to forward wingtip

MARINE INSTITUTE FLUME TANK								Company	BIM				
TRAWL MODEL MEASUREMENTS								Trawl	300 Balloon Trawl				
DATE: October 15-18, 2018								Rig 7					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50	54.3	11.5	11.9	11.7		3.1	6.1	2.4	2.3	4.7	71.4	65.8	14.5

Notes:

Rig 7 - the 10 extra floats plus 10 existing floats moved to centre and quarter of headline

MARINE INSTITUTE FLUME TANK								Company	BIM				
TRAWL MODEL MEASUREMENTS								Trawl	300 Balloon Trawl				
DATE: October 15-18, 2018								Rig 10					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	19	142.5	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.00	53.7	11.1	11.9	11.5		3.0	6.1	1.88	1.83	3.71	69.6	53.3	14.4
3.50	55.2	11.2	11.8	11.5		3.0	6.1	2.31	2.28	4.60	70.8	64.9	14.9
4.00	54.7	11.1	11.1	11.1		2.7	6.0	3.02	2.94	5.96	66.2	89.9	14.7

Notes:

Rig 8 - 2.7 sq. m kite added (4 model floats removed) - no measurements - no pics - video only

Rig 9 - no measurements - fishingline collapsed

Rig 10 - 1.35 sq.m kite(44°AOA), 12 model floats (19 full scale) on wings

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 11					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	19	142.5	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50							6.6	2.3	2.3	4.6			

Notes:
Rig 11 - kite AOA adjusted to 26 degrees (reduced kite bridle by 3cm/side). Equivalent to 24cm/side full scale

MARINE INSTITUTE FLUME TANK TRAWL MODEL MEASUREMENTS DATE: October 15-18, 2018								Company	BIM				
								Trawl	300 Balloon Trawl				
								Rig 12					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	19	142.5	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.50							5.4	2.3	2.3	4.6			

Notes:
Rig 12 - Kite AOA increased to somewhere approx. 65 deg. Kite very unstable. Lengthened kite bridles by 3cm/side

MARINE INSTITUTE FLUME TANK								Company	BIM				
TRAWL MODEL MEASUREMENTS								Trawl	300 Balloon Trawl				
DATE: October 15-18, 2018								Rig 15					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 2	2.70		40.0		40.0	6.00	6.00	45.60	0.0	7.50	33	247.5	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*			
3.00	55.6	12.1	11.9	12.0		3.3	5.0	1.6	1.4	3.1	60.1	50.8	14.7
3.50	55.9	12.4	12.0	12.2		3.2	4.8	2.0	1.8	3.8	58.1	65.9	14.7
4.00	57.2	12.4	12.3	12.4		3.0	4.4	2.5	2.3	4.8	54.0	89.0	15.2

Notes:

Rig 13 - Footgear removed and toggles left on fishingline (no measurements)

Rig 14 - Footgear removed, toggles still on and 9 dropper chains added (droppers 31kg each) no measurements

Rig 15 - Footgear removed, toggles still on and 9 dropper chains added (droppers 31kg each) 10 model floats removed (Equivalent to removing 6 - 11" floats)

MARINE INSTITUTE FLUME TANK								Company	BIM				
TRAWL MODEL MEASUREMENTS								Trawl	300 Balloon Trawl				
DATE: October 15-18, 2018								Rig 15					
Door type	*Door area (m^2)*	*Backstr. length (m)*	*U.bridle length (m)*	*M.bridle length (m)*	*L.bridle length (m)*	*U.bridle ext. (m)*	*L.bridle ext. (m)*	*Sweep length (m)*	*Wingend weight (kgf)*	*1 float bouy. (kgf)*	*Float no. Headline*	*Total bouy. (kgf)*	*Kite area (sqm)*
Type 15	3.10		40.0		40.0	6.00	6.00	45.60	0.0	7.50	44	330	

Towing speed (kts)	SPREAD					OPENING		TENSION			*Mouth area (m^2)*	*Mouth drag (kgf/m^2)*	*Bridle angle (deg.)*	*Door Height (m)*
	Door (m)	*U.wing (m)*	*L.wing (m)*	*Mean w/e (m)*	*R/Hopper (m)*	*Wing (m)*	*Headline (m)*	*Port (tonnes)*	*Stbd (tonnes)*	*Total (tonnes)*				
3.50	54.3	11.4	11.6	11.5	0.0	3.0	5.7	2.2	2.2	4.4	65.4	67.9	14.5	1.8

Notes:

Rig 15 - Same as Rig 15, but with Type 15 doors. Doors off bottom (no pictures or video)

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