Assessment of the Notus Echo catch sensor in the Irish *Nephrops* fishery

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Key Findings

Optimal configuration consisted of mounting the Notus sensor on the upper part of the grid with a medium sensitivity setting

1

Further field testing of the Notus system will be conducted with a modified grid with a view to maximising uptake in gears commonly used by the Irish Fishing Industry

2

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Introduction

The Government's Draft Adaptation Plan outlines how increases in extreme weather events and changes in distribution of fish stocks are among the key climate change challenges facing the Irish Seafood Sector (DAFM, 2019). Climate change is also driving green technologies and a renewed emphasis on fuel efficiency as a means of reducing carbon emissions.

BIM's Business of Seafood shows how Ireland's most commercially valuable fisheries target small pelagic species such as mackerel and horse mackerel (BIM, 2019). Published in the journal "Nature" in 2018, a study on "Fuel use and greenhouse gas emissions of world fisheries" revealed how fisheries for small pelagic species are currently the most carbon efficient form of animal protein production globally (Parker et al., 2018). Consumption of small pelagic fish is also considered to be on par with a vegetarian diet in terms of the energy used in production (Pelletier et al., 2011; Hilborn and Hilborn, 2019).

Demersal fish and *Nephrops* are Ireland's next most valuable species. Fisheries for demersal fish are more carbon intensive than small pelagics. However, they are less so compared with trawling for crustaceans such as shrimp which are similar to *Nephrops*. While on the higher end for fisheries, crustacean trawling remains on the lower end of the spectrum compared with terrestrial forms of animal protein production (Parker et al., 2018).

Nevertheless, every sector needs to improve its energy efficiency. Likely increases in carbon tax on foot of recommendations from the recent Joint Committee on Climate Action (Oireachtais, 2019) will impact fuel prices and fisheries profit margins. Ongoing improvements in vessel and engine design will undoubtedly help. Optimising gear configurations can also greatly assist. In its 2018 report *'Impacts of climate change on fisheries and aquaculture'*, the FAO outlines how switching from single to multi-rig trawls with two to four nets in crustacean trawl fisheries achieves substantial savings in fuel (Barange et al., 2018). Multi-rig trawls are the predominant gear type used in the Irish *Nephrops* fishery.

The FAO report also describes how developments in fisheries instrumentation can improve fuel efficiency in well managed fisheries. Fish detection equipment and catch sensors help reduce fishing time and fuel consumption. However, their use has traditionally been restricted to fish rather than crustacean species which are more difficult to discern.

A new catch sensor addresses this issue. Developed initially for shrimp trawl fisheries, the Notus Echo is mounted on a rigid sorting grid close to the codend. The system uses underwater acoustics and a wheel house display unit to track catches as they strike the grid and pass through the trawl. In addition to potential improvements in energy efficiency, the sensor incentivises use of the sorting grid, one of the permitted selective gear options under the landing obligation discard plan in the Celtic and Irish Seas (EC, 2018). The primary aim of the current study was to calibrate device sensitivity to work for *Nephrops*.

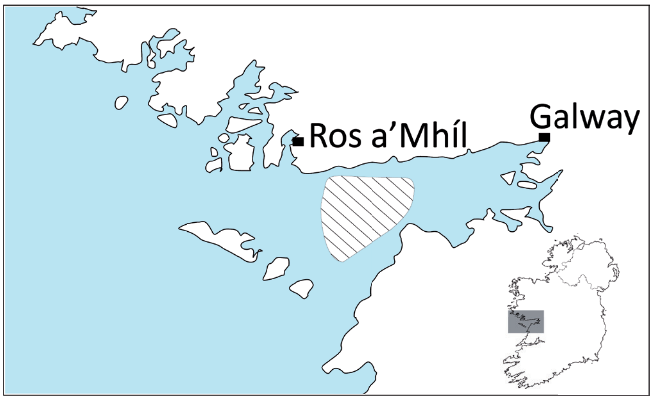

Figure 1. Trial location (hatched area)

Methods

The trial was carried out on board a single-rig whitefish vessel (MFV Karen Mary; DA57), over five days operating in ICES Division 7b (Figure 1). The Notus Echo system comprises a wireless sensor which detects strikes on a steel sorting grid, and a hydrophone deployed from the fishing vessel which is linked to a command and display unit in the wheel house (Figure 2). Two-way communication facilitates parameters such as data reporting rates to be adjusted which helps conserve sensor battery life when required.

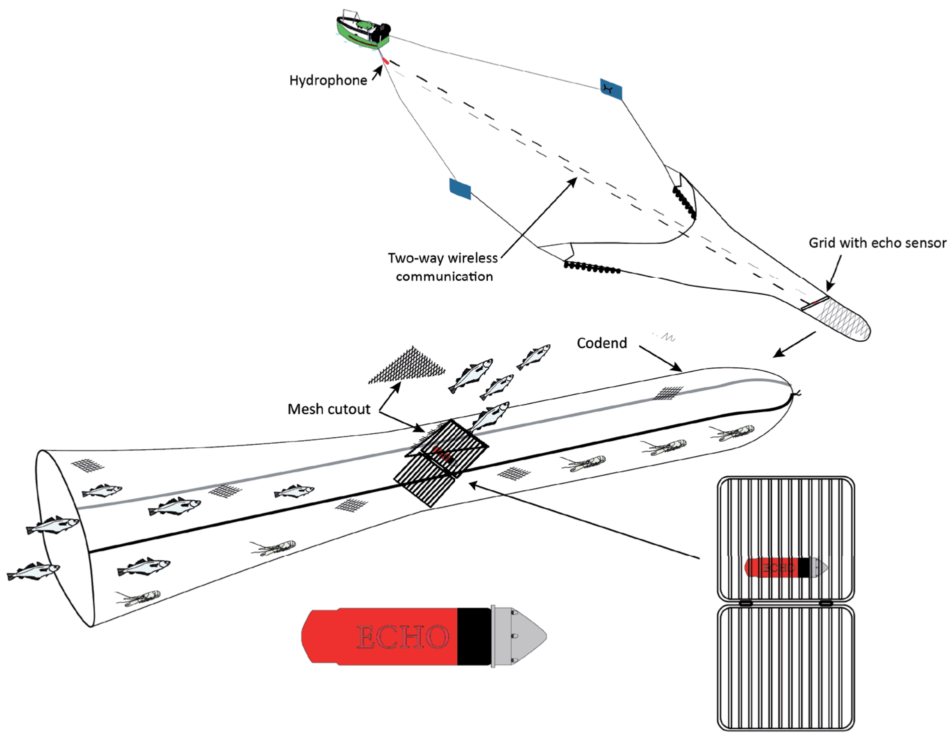

Figure 2. Notus system setup

Configuring the sensor involved adjusting the sensitivity of the device to accurately detect *Nephrops*. The sensitivity is altered by changing the voltage internally in the unit: low voltage corresponds to high sensitivity and vice versa. *Nephrops* generally move along the bottom of the trawl (Catchpole and Revill, 2008) and strike the bottom half of the grid. The sensor was moved to different parts of the grid to take account of this in determining optimal sensitivity. The sensor was mounted on a standard *Nephrops* grid with 35 mm bar spacings (Figure 2). *Nephrops* and fish catches were sampled to provide background information on total catch weights.

Cameras were placed in front of the grid to assist in ground truthing sensor outputs. GoPro (hero 5 black) and Paralenz cameras were used to capture video footage of *Nephrops* hitting the grid. The GoPro was enclosed in an anodised aluminium housing (2,600 m depth rating), attached to a bespoke camera mount constructed from a 12 mm nylon baseplate with stainless steel shield (21 × 29.5 × 17 cm; W × L × H). The baseplate was mounted to the net using 3 mm polyethylene (PE) twine.

Floats were added to the baseplate in order to eliminate any negative effect on the trawl's operation. The Paralenz camera is a self-contained unit constructed of aerospace - grade aluminium and titanium screws. The camera is conveniently light (155 g) so no extra floatation is required and has a depth rating of 250 m with 2.5 hours battery life. This camera was mounted directly onto the net using 3mm PE twine and cable ties. To illuminate the area around the grid at depth, an Anchor, wide angle (120-degree beam) 5,000 lumens video dive light constructed from aluminium was mounted to the trawl in a PVC pipe to prevent damage. Video footage was recorded using wide-angle field-of-views. Footage was obtained at 48 and 60 frames per second respectively in the Go Pro and Paralenz in 1080p HD resolution on 128 Gb microSD cards. All video footage was assessed at sea to confirm if *Nephrops* were hitting the grid. Camera angles were adjusted as required through out the trial.

Results

Table 1. Catch details

Haul	Duration (hr: min)	*Nephrops* catch (kg)	Total catch (kg)
1	2:27	120	131
2	0:54	102	108
3	3:22	172	180
4	2:42	136	146
5	2:20	87	90
6	3:34	97	110
7	2:55	76	83
8	2:32	121	130
9	2:46	120	133
10	3:08	125	182
11	2:34	58	77
12	3:13	63	87
13	2:40	79	99
14	2:42	23	36
15	2:23	47	67

Fifteen hauls were completed over five days averaging 160 min duration (Table 1). *Nephrops* accounted for 84% of the retained catch with the remainder mainly comprising small, fish and crabs (predominantly *Liocarcinus* sp.).

The sensor was initially set up on the grid's lower half with a 0.60 v (high sensitivity) setting. This was considered too sensitive (Figure 3a). The sensor was reset to the lowest sensitivity at 1.25 v. The output showed a flat line with small peaks suggesting the sensitivity was too low (Figure 3b).

The apparent optimal configuration consisted of mounting the sensor on the upper part of the grid with the sensitivity set at 1.00 v (Figure 3c). A review of underwater camera footage after this haul showed a relatively high number of *Nephrops* passing through the grid early on in the tow suggesting that the echo system was working well.

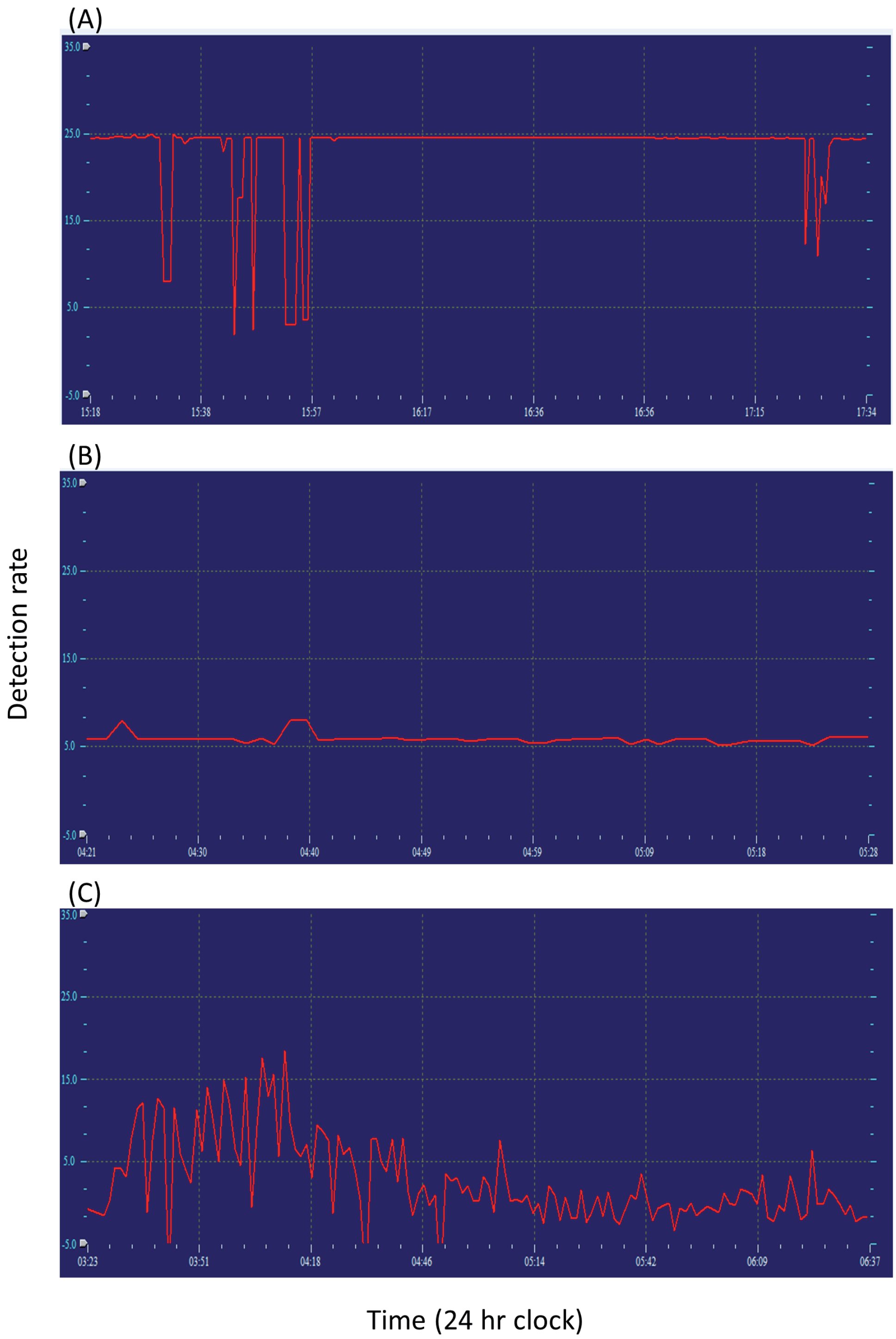

Figure 3. Graphical output from Notus sensor with (A) high (B) low and (C) optimal sensitivity settings

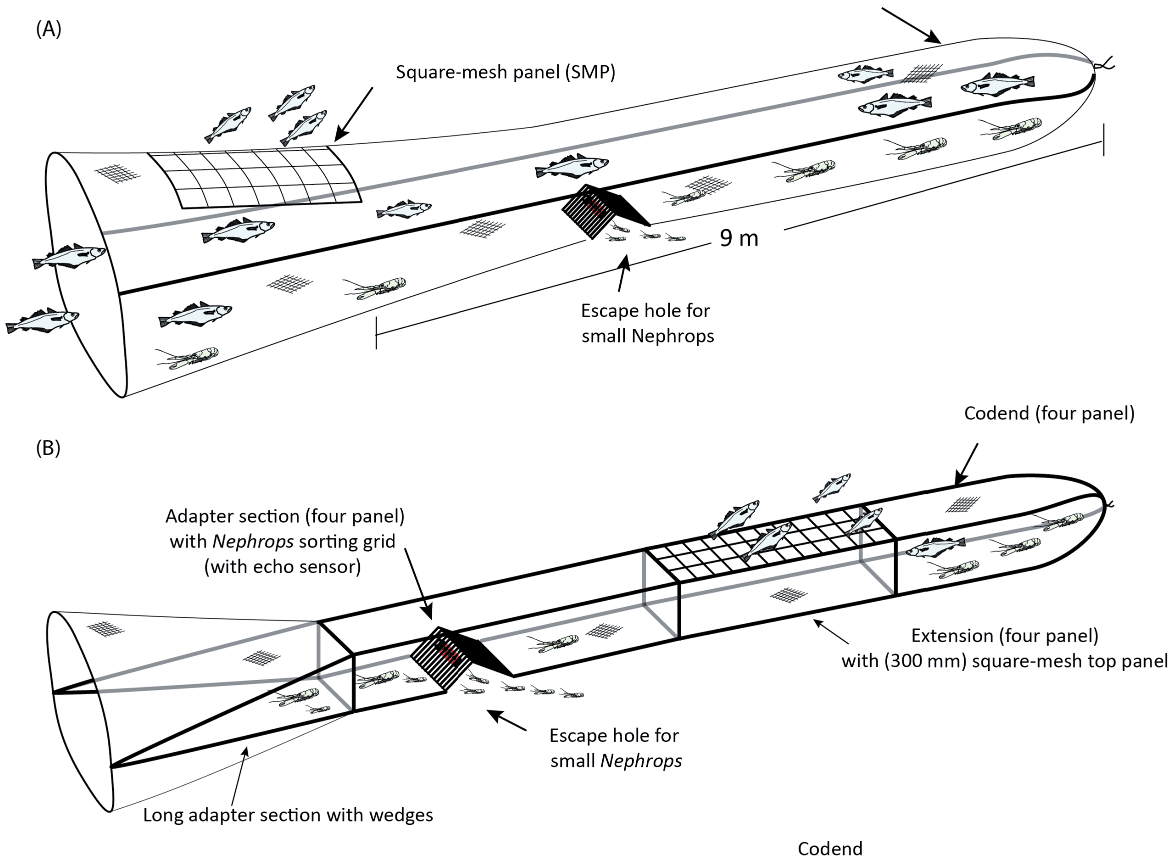

Figure 4. Potential modified grid/Notus echo set up in (A) the 300 mm SMP and (B) the SELTRA

Discussion

Preliminary field testing of the Notus Echo system provided positive results on calibrating the device to work with *Nephrops*. Limited grid usage may be a barrier to uptake of the Notus system in Ireland. Sorting grids generally reduce catches of all fish species across all size classes, and essentially aim to provide a single species fishery for *Nephrops*. Vessels operating in mixed *Nephrops* fisheries are, however, generally entitled to catch fish species which can make a major contribution to catch value (Cosgrove et al., 2019). Sorting grids can also be subject to handling difficulties when hauling on a vessel's net drum and power block (Graham and Fryer, 2006). Hence, Irish vessel owners generally use other permitted selective gears such as a 300 mm square mesh panel (SMP) or SELTRA panel which retain some fish species such as monkfish and are easier to handle (BIM, 2014; Tyndall et al., 2017).

The benefits associated with *Nephrops* catch detection may assist in driving uptake. Grid modifications can also assist. BIM previously developed a half grid system which significantly reduced undersize *Nephrops* catches by up to 35% while maintaining fish catches (Cosgrove et al., 2016).

The device could be incorporated in a trawl with either a 300 mm SMP or SELTRA (Figure 4). Emanating from a BIM study (Oliver et al., 2017), a high survivability exemption exists for *Nephrops* caught with selective gears in ICES subarea 7 until the end 2021. Further reductions in catches of undersized *Nephrops* would further enhance survival and potentially support future renewal of the exemption. The benefits of this type of gear would include:

- Proven substantial reductions in unwanted fish catches
- Substantial reductions in undersize *Nephrops* catches boosting survival and supporting future exemptions
- Improved operational efficiency through real-time detection of targeted *Nephrops*
- All of the above incorporated in gears commonly used by Industry

In summary, this type of gear has major potential to help vessel owners improve operational efficiency and reduce environmental impacts while meeting challenges posed by the landing obligation. Further field testing of the Notus system will be conducted with the modified grid with a view to maximising uptake by the Irish Fishing Industry.

Acknowledgments

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