WORKING GROUP ON ELECTRICAL TRAWLING (WGELECTRA; outputs from 2023 meeting)

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Contents

i Executive summary

The Working Group on Electrical Trawling (WGELECTRA) works on improving knowledge of the effects of electrical or pulse fishing on the marine environment.

During the 2023 meeting, the working group considered a discussion on razor clam eletrofishing research trials, the only ongoing research on electrofishing. The final wrap-up of recent research on sole pulse was also highlighted.

Topics discussed by the group during the past 3 years confirmed findings that were discussed in the extensive Scientific WGELECTRA report at the end of the previous cycle in 2018. The main conclusion is that the application of electricity to catch fish has many potential applications in technological innovations to improve the sustainability of a fishery by improving the selectivity, reducing unintended bycatch or reduce the impact on the benthic ecosystem.

Pulse trawling was banned by the European Union in 2019. As a consequence, no new research on this topic has been approved since then. Due to lack of new research projects, the group agreed that there is not enough content to discuss in the coming years, and therefore decided to dissolve the group and transfer its members to the Joint ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) where the group originated.

ii Expert group information

Expert group name	Working Group on Electrical Trawling
Expert group cycle	Multiannual fixed term
Year cycle started	2021
Reporting year in cycle	3/3
Chairs	Mattias van Opstal, Belgium
	Edward Schram, The Netherlands
Meeting venue(s) and dates	9th – 10th November 2021, online meeting
	28th September 2022, online meeting
	13th of April 2023, online meeting
	4th October 2023, online meeting

1 Presentations

1.1 Presentation of PhD thesis research in the European Parliament

Pim Boute reported to WGELECTRA about his visit to the European Parliament (EP) on the 28th March 2023. In the EP, he presented his research findings described in his PhD thesis, entitled "Effects of electrical stimulation on marine organisms", which he conducted within work package 1 of the Impact Assessment Pulse-trawl Fishery (IAPF) project. This presentation was during a public event organised by the European People's Party and, specifically, the Member of European Parliament (MEP) Peter van Dalen (member of the Dutch Christian Union party). After the PhD defence of Boute on 25 April 2022, he was invited by MEP van Dalen to present his findings in the European Parliament. In his presentation to WGELECTRA, Boute provided information on what motivated him to go to the EP, the program and course of the public event, and media attention. Finally, he mentioned a new, peer-reviewed publication out since WGELECTRA 2022, which is linked to work package 1 of the IAPF project.

1.2 Update on Scottish Government razor clam electrofishing trial

Dr Clive Fox and Chloe Blackwater (Scottish Association for Marine Science)

Background

The trial has been running under Scottish Statutory Instruments No. 419, The razor clams (Prohibition on Fishing and Landing)(Scotland) Order 2017. The target is *Ensis siliqua* and the majority of the catches are exported to the Far East. The trial is restricted to set areas around the Scottish coast which must also be certified for water quality for shellfish harvesting. The fleet comprises around 20 licenced vessels which have daily catch limits, a restricted number of days in the year and tightly defined technical specifications regarding the electrofishing rig. The razor clam electrofishing is rather different to the pulse-trawls as previously used in the southern North Sea by the Dutch fleet and comprises a continuous AC current of 18-24V supplied through pairs of brass rods which are towed behind an insulating spreader bar. Razor clams emerge from the sediment in response to the electrical field and clams of desirable size are collected by a diver swimming a meter or so behind the electrodes.

In addition to the technical regulations, operations must comply with the UK Health and Safety Executive Shellfish diving regulations which include a requirement for a full dive team on the vessel including standby diver, ship-to-diver voice communications, and rigorous compliance with decompression times.

Fishers involved in the trial are expected to keep detailed logs of their catches, and to supply samples to Marine Directorate Science. The vessels also carry AnchorWatch, a remote electronic monitoring system (REM) which allows Marine Directorate to record precise fishing locations and also when the electrodes are powered.

The overall aim of the trial is to establish whether the fishery can be run on a sustainable basis given that the main concerns are the efficiency of the method which could lead to stock depletion, and whether there may be other ecosystem impacts or effects on non-target species (Scottish Government, 2019; Scottish Government, 2021). The trial has recently been extended for a further 12 months until early 2024 to allow for the collection and analysis of further scientific data.

Surveys

A number of surveys have been conducted on the grounds using a video-camera rig which is towed behind one of the fishing vessels (Fox *et al.*, 2019). The surveys provide direct estimates of the densities and sizes of razor clams on the grounds and results to date have been published in a series of Marine Directorate reports (Fox, 2018; Fox, 2021; Fox, 2023b; Fox, 2023a). These are providing a baseline with which future survey derived densities and sizes can be compared. In addition, estimates of stock biomasses can assist in setting sustainable harvest rates.

Age and growth determination

Updated growth curves have been determined on samples of razor clams (*E. siliqua*) from five of the fishing areas. The growth curves are based on visual interpretation of shell increments and back calculation of shell sizes at age. Oxygen isotope profiles have also been reconstructed from three of the shells and results generally support the visual interpretation of annuli. Considerable effort was taken to try alternative methods of age determination such as thin-shell sections which have been previously reported as being successful. However, problems were encountered with micro-fractures and cracks which possibly result from stress in the shells as they are held using elastic bands for transport. However, based on the oxygen isotope validation, direct visual interpretation appears to give reliable results and is a much faster technique.

Experiments on recovery of non-target organisms

Initial studies into the effects of this form of electrofishing suggested there would be limited impacts on non-target organisms as those studied (sandeels, crabs, starfish) either seemed to recover after a few minutes or did not appear to react to the electrical stimulation (Murray *et al.*, 2014; Murray *et al.*, 2016). Further experiments have been conducted where recovery of shore crabs (*Carcinus maenas*) and starfish (*Asterias rubens*) was monitored using physiological and behavioural indicators such as haemolymph lactate, feeding rates, and respiration rates for up to 10 days after exposure to the electrical field. Results were compared between groups of exposed and control animals, the latter being treated similarly but not exposed to the electrical field. The results showed a short-term stress response in crabs, but indicators returned to basal levels by 24 h. There was some indication of a slightly higher stress response in summer versus winter, which may be related to differences in water temperatures. Starfish did not seem to be affected by the electrical stimulation and there were no statistically significant effects on the indices recorded. These recent results provide further evidence supporting the contention from the Murray studies that non-target species should recover quickly after exposure to this form of electrofishing.

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1.3 Perspectives for future development and management for pulse trawling for sole

Pieke Molenaar, Edward Schram, Wageningen Marine Research

Dutch mixed demersal fisheries uses tickler chain beam trawls to target sole (*Solea solea*) and European Plaice (*Pleuronectes platessa).* This fisheries discards large quantities of undersized plaice (<27 cm). Discards survival probabilities are 14% when undersized plaice were caught by pulse beam trawls (Schram et al., 2023a) and 8% when caught by tickler chain beam trawls (Schram et al., 2023b). The condition in which fish are landed on deck has a strong effect on their survival probability when discarded and only 7% of the undersized plaice caught by tickler chain beam trawls is in good condition (Schram et al., 2023a). Increasing survival probability may thus be achieved by increasing the proportion of fish in good condition. This may be achieved by the implementation of the Modular Harvesting System (MHS). The MHS is a novel cod-end originally developed in New Zealand by *Precision Seafood Harvesting Limited, Timaru, New Zealand* to reduce fish damage during trawling, haul back and unloading (Moran *et al.*, 2023). The MHS is a membrane-like fabric tube with escapement holes that replaces the mesh lengthener and cod-end of a trawl. The terminal section of the MHS is non-porous, which allows fish to be lifted aboard in a fluid environment. This and the graded flow reduction and open geometry of the MHS reduces fish damage during trawling, haul back and unloading (Moran *et al.* 2023). Based on the strong relation between the condition in which fish are discarded and their survival probability, the reduction in fish damage achieved by the MHS was predicted to increase survival probabilities of bycatches when returned to sea. Captive observation based discards survival experiments comparing MHS to traditional trawls showed a five to ten times increase in survival probability for fish caught with the MHS (Schram et al., 2023b). Survival can be further increased by refinement of the catch sorting process. The ultimate sole trawling gear could result from combining pulse trawls with MHS technology. Compared to tickler chain beam trawls the pulse trawl results higher discards survival due to lower mechanical impact on fish. This lower impact is the result of smaller catches resulting in faster onboard processing and less impact of collisions with benthos and debris. Using MHS and refining the catch sorting process may further increase discards survival probabilities of plaice but also other species as well as better quality of marketable fish. Further benefits included lower fuel consumption resulting in better economic performance and lower carbon footprint of the fisheries and reduced seafloor disturbance compared to tickler chains. The question is how to introduce a new gear with a higher sole catch efficiency and avoid local sole depletions and conflicts with other fishers relying on sole catches. We propose to introduce a maximum effort (hours) in each ICES rectangle depending on sole availability. International research into the combination of MHS technology with pulse trawling and effort management is needed.

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1.4 Pulse trawl comparison trial: Comparing electro-pulse with tickler-chain beam trawl fishing in the southern North Sea flatfish fishery

Marieke Desender, Pieke Molenaar (Wageningen Marine Research), Joanna Ford, Sam Smith, Robert Forster, Roi Martinez, Thomas Catchpole

While there is a growing body of evidence on the impacts of pulse trawling, one of the main limitations are the insufficient numbers of studies comparing catch performance of pulse to beam trawling.

Therefore, two practical field trials were conducted in March 2019 to enhance the understanding regarding the impacts of pulse trawling for flatfish in the southern North Sea.

In the first trial, a pulse vessel equipped with its commercial gear (two 12m PulsWing trawls) was compared with a sister vessel rigged with two 12m SumWing trawls each with 18 tickler chains. Both vessels (>221kW) fished as close together as possible in the mid-Southern North Sea fishing grounds. Shooting and hauling was synchronized for sampled hauls on the two vessels. Both vessels deployed the trawls for tows of ~2 hours, reflecting normal commercial practice. Catch (landings, discarded fish, benthos and inert material) was compared on 19 hauls. Additionally, on six separate hauls the condition of discarded plaice and sole was established using a visual vitality assessment (reflexes and injuries) method.

In the second trial, data were collected from the PulsWing vessel only, during the next fishing trip after trial 1. The same gear was deployed but the vessel operated on different grounds located further south and closer to the UK coast than in trial 1. Catch data were generated on 18 hauls and data from vitality assessments on discarded plaice and sole were generated from an additional 6 hauls.

In summary, the most consistent benefits of the PulsWing were the reduced fuel costs while maintaining viable catches of marketable sole and the substantially lower catches of benthos. In a direct comparison with the SumWing trawl, the PulsWing generated only half the discards. Discard rates for both trawls were consistently high, and selectivity was poor for fish species other than sole. The condition of discarded plaice and sole was better with the PulsWing, but the chances of survival of these fish were still limited. The performance of the PulsWing differed between the two fishing areas.

1.5 Evaluation of spatial-temporal trends of the UK inshore fleet in relation to pulse trawling

Marieke Desender, Roi Martinez, Tom Catchpole

An often-expressed concern amongst stakeholders is the increased competition towards other metiers when using a more efficient pulse trawl. Displacement of vessels has been indicated, whereby vessels move away from areas where pulse trawlers are pres

from beam trawlers. 75% of the total North Sea sole quota is allocated to the Netherlands, and in 2018, 86% of the Dutch sole catches were taken by pulse trawlers. Since 2009, overall sole catches by the combined Dutch beam and pulse trawl fleet has declined by 10%, and the total Dutch beam and pulse effort has reduced by 14%. According to the ICES advice in 2019, sole and plaice were harvested at sustainable levels, and biomass has increased since 2007 and 2008 respectively (ICES, 2019a; 2019b). This illustrates a positive situation at the stock level, but changes in the availability of sole to fishing fleets may have occurred at a more local scale.

In the southern North Sea, the UK fleet is dominated by inshore small vessels (under 10m in length), using mostly gill and trammel nets and otter trawls. The number of under 10m UK otter trawlers operating in the southern North Sea has declined by 44% and netters by 29% during the period 2009 to 2018. The amount of fishing days has declined by 47% for netters and 14% for otter trawlers. Sole landings have decreased in terms of total weight (-36% and -61%) and per unit of fishing (-26% and -38%) by the UK inshore netters and otter trawlers, during the same period. Therefore, UK vessels operating in the southern North Sea were catching less sole on each fishing day and less sole overall.

The substantial reduction in sole landings by the UK inshore small-scale netters and otter trawlers correlates with four factors observed in the Dutch fleet during the same time period:

1. The transition from beam trawling to pulse trawling; a fishing method that catches around 1.5; times more sole per unit area than beam trawling;
2. The change in fishing areas, whereby pulse trawling is concentrated closer to the UK coast;
3. The ability of pulse trawlers to gain access to (rockier/muddier) fishing grounds that were less available to beam trawlers, including some close to the UK;
4. Once fishing grounds have been identified, the decline in sole catch rate on successive tows is slower for pulse trawlers than for beam trawlers. This means more sole is

extracted from each fishing area by pulse trawls compared with beam trawls, and less time is spent in search for new fishing grounds.

These observations might indicate that the UK small scale fleet experienced an increase in competition for sole from the Dutch fleet, and this correlates with a substantial decline in sole landings by UK vessels. The lower catchability of plaice by the pulse trawlers also correlates with an increase in plaice landings by the UK inshore fleet.

Definite conclusions cannot be drawn on the causes of these correlations due to limitations in the data from the UK inshore fleet and the influence of other factors, such as competition with other marine users (aggregates and renewable energy), changes to local fish distribution and external influences on vessels operators. However, the evidence supports the anecdotal information that UK inshore sole landings have declined substantially in parallel to the introduction and increased activity of pulse trawls in the same fishing area.

It would be useful to monitor the effect of ceased pulse trawl activity on fishing opportunities and landing patterns of the inshore UK fleet. An under 10m reporting programme is expected to generate more robust data that could be used for this purpose. Also, defining the activity of pulse and beam trawlers separately in VMS and logbook records would enhance international data analysis of the impact of pulse vessels and their possible interactions with national fleets.

2 Discussion on future of the working group

Pulse trawling was banned by the European Union in 2019. As a consequence, no new research on this topic has been approved since then. During the past 3 years the group focused on discussions of the final results of finishing projects, on the history of pulse trawling, and on what went wrong during implementation (in the Netherlands) in recent years. Due to lack of research, the group agreed that there is not enough content to discuss in the coming years, and therefore decided to dissolve the group and transfer its members to Joint ICES/FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) (where the group originated).

Annex 1: List of participants

Name	Institute	Country (of institute)
Clive Fox	Scottish Association for Marine Science (SAMS)	United Kingdom
Pim Boute	Rijksuniversiteit Groningen	Netherlands
Guy Claireaux	IFREMER	France
Arianna Servili	IFREMER	France
Justin Tiano	Wageningen Marine Research	Netherlands
Pieke Molenaar	Wageningen Marine Research	Netherlands
Marieke Descender	CEFAS	United Kingdom
Chloe Blackman	Scottish Association for Marine Science (SAMS)	United Kingdom
Mattias van Opstal	ILVO	Belgium
Edward Schram	Wageningen Marine Research	Netherlands

Annex 2: Resolutions

2020/FT/EOSG07 A **Working Group on Electrical Trawling (WGELECTRA),** chaired by Mattias van Opstal, Belgium, and Edward Schram, the Netherlands, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2021	9-10 November	Online Meeting	Interim report by 31 of December 2021 to ACOM-SCICOM	
Year 2022	28 September	Online Meeting	Interim report by 26 of October 2022 to ACOM-SCICOM	
Year 2023	4 October	Online Meeting	Interim report by 1 of November 2023 to ACOM-SCICOM	

ToR descriptors[1]

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	Produce a state-of-the-art review of all relevant studies on marine electrofishing. Yearly update it by evaluating and incorporating new research to it.	a) Science Requirements b) Advisory Requirements	2.1, 6.1, 6.4	Yearly update	Review report
b	Discuss and prioritise knowledge gaps, and discuss ongoing and upcoming research projects in the light of these knowledge gaps, including the experimental set up	a) Science Requirements b) Advisory Requirements	2.1, 2.7, 6.4, 6.6	Year 1, 2 & 3	Scientific research adressing knowledge gaps or questions from management
c	Create a platform for the application for supra-national joint research projects on electrotrawling and scientific publication of the obtained results	a) Science Requirements b) Advisory Requirements	3.1, 6.6	Year 1, 2 & 3	Joint projects and publications among participants and others Collaboration with other related WG's such as WGNSSK, WGCRAN
d	Discuss and synthetsze new and emerging techniques and technologies that have potential to become alternatives for Electrical Trawling	a) Science Requirements b) Advisory Requirements	2.1, 2.7, 4.1, 4.5	Year 1, 2 & 3	Joint projects and publications among participants and others Collaboration with other related WG's such as WGFTFB
e	Discuss future for electrical trawling and the lessons learned when deploying new technologies.	a) Science Requirements b) Advisory Requirements	2.7	Year 1, 2 & 3	Joint projects and publications among participants and others Collaboration with other related WG's such as WGFTFB

[1] Avoid generic terms such as "Discuss" or "Consider". Aim at drafting specific and clear ToR, the delivery of which can be assessed

Summary of the Work Plan

YEAR 1	– DISCUSSING & EVALUATING ONGOING& RECENTLY COMPLETED RESEARCH – EVALUATING AND PRESENTING RESULTS FROM RESEARCH PROJECTS – ANSWERING POSSIBLE REQUESTS
Year 2	- Updating the review document - Discussing & evaluating ongoing& recently completed research - Evaluating and presenting results from joint research projects - Answering possible requests
Year 3	- Finalise the review document - Discussing & evaluating ongoing& recently completed research - Evaluating and presenting results from joint research projects - Answering possible requests

Supporting information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There is a very close working relationship with all the groups.
Linkages to other organizations	