Recommendations for additional research into pulse-trawl fisheries

Based on an inventory of stakeholder concerns

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Summary

The Netherlands and Belgium have developed pulse fishing while looking for more ecologically sustainable fishing methods with lower costs for catching flatfish and brown shrimp. In pulse fishing, electric pulses are used to startle the target species from the seabed, after which they end up in the net. The technique can only be used by fishers with a derogation. Pulse fishing is subject of various debates during the run-up to the European decision-making process on the possible lift of the derogation (within the reform of the Technical Measures Regulation). Some stakeholders have concerns about the potential impact of pulse fishing on the ecosystem and about the extra competition between different métiers as a result of the introduction of pulse fishing. It is essential to take those concerns seriously, as they impact the outcome of the pulse fishing debate.

In this report we made an inventory of stakeholders' concerns. Written and online media were searched; meetings were held with Dutch small-scale and shrimp fishers (not using the pulse technique); and concerns expressed through other channels were collected. We assessed whether the concerns are addressed within completed or ongoing research. In case they are not included in existing programmes, we propose what could be done to take the concerns into consideration.

Many concerns relate to direct effects of fishing with pulse on fish and benthic organisms. There are also many concerns on the indirect effects of exposure to pulse fields on normal functioning (e.g. reproduction, feeding) of (non-target) organisms that are exposed to pulse fields. Another category of concerns is management-related: stakeholders are concerned about the way fisheries managers deal with the introduction of a new (and more efficient) fishing gear. In the category 'fleet behaviour' an often expressed concern is the competition posed by Dutch fishers using a new and more efficient fishing gear. Also displacement of vessels is often mentioned: fishing vessels entering areas where they did not fish before switching to pulse fisheries.

Most of the stakeholders' concerns have already been covered by completed research or are part of ongoing research. The concerns that are not yet fully covered are: 1) visualization of direct effects of pulse fishing, by fishing in the wake of a pulse fishing vessel; 2) effects of pulse fishing on reproduction; 3) possible disadvantages for local fishers due to the arrival of pulse fishing vessels in 'their' areas; 4) local depletion of target species sole due to increased fishing pressure in an area; 5) risks of overfishing of shrimp due to increased fishing efficiency. Not always the results of finalized research have been communicated effectively with stakeholders: this may have led to concerns that remain even though the answers are there. We recommend putting more effort into visualization of results and effects, in order to reach a larger audience.

This research was carried out as part of the Policy Support Programme (Beleidsondersteunend onderzoek (BO) of the Ministry of Agriculture, Nature and Food Quality.

1 Introduction

The Netherlands is looking for more sustainable and cost efficient methods for catching flatfish and brown shrimp and in this context fishers have developed pulse fishing. In the pulse fishery for flatfish electrical pulses instead of tickler chains are used to startle the target species from the seabed. In the pulse fishery for shrimp, thanks to electric pulses fewer bobbins need to be attached to the (shorter) bobbin rope that is used to startle shrimp from the seabed.

Fishers who use the pulse gear are currently fishing based on a derogation. As part of the decision-making process on whether or not to allow pulse fisheries, the impacts of the gear on the ecosystem will have to be investigated. To this end, a multi-annual international research programme is currently taking place, named Impact Assessment Pulse-trawl Fisheries. Every year, the intermediate results of this impact study are shared with national and international stakeholders. In the run-up to the European decision-making process on the possible lift of the derogation (within the reform of the Technical Measures Regulation) stakeholders have reiterated existing concerns and expressed new concerns about the potential impact of pulse fishing in various media.

The objective of this project is to make an inventory of these concerns and update the research agenda.

Currently, about 80 Dutch fishing vessels have a derogation for fishing with a pulse gear on either flatfish or shrimp. An ongoing research programme investigates effects of pulse fishing on the ecosystem (www.pulsefishing.eu). The programme is financed by the European Fund for Maritime Affairs and Fisheries. The International Scientific Advisory Committee (ISAC), chaired by Prof. Dr. Michel J. Kaiser, acts as peer-review committee for the Impact Assessment Pulse-trawl Fisheries. In addition, Wageningen Marine Research (WMR) carries out a project dedicated to communication on pulse fisheries and to analyses of logbook data from pulse fishing vessels (www.wur.nl and www.wur.nl/nl/Dossiers/dossier/Pulsvisserij-3.htm).

The Impact Assessment Pulse-trawl Fisheries started in 2016 will end in 2019. The results should form the basis of in the European decision-making process on whether the derogation on pulse fishing can be lifted.

In January 2018 the European Parliament (EP) voted for a ban on pulse fishing as a part of the revision of Technical Measures. With this voting, the EP determined its position for the trilogue with the European Commission, the Council of the European Union and the EP. This trilogue will deal with the reform of the Technical Measures Regulation, including the decision on whether pulse fishing may remain or whether it should be banned.

Stakeholders from various countries have expressed concerns about pulse fishing. Some stakeholders have had the possibility to share those concerns during annual International Dialogue Meetings on Pulse Fishing. Stakeholder input from the first meeting in 2015 was used to inform the current multi-annual research programme Impact Assessment Pulse-trawl Fisheries, that at the time was in proposal stage (Anon., 2015). During subsequent meetings, results of this ongoing programme are shared. Outside the setting of the annual stakeholder meetings, the same and other stakeholders expressed their concerns in other meeting fora and in the media.

The Dutch Ministry of Agriculture, Nature and Food Quality (LNV), which funds the Impact Assessment Pulse-trawl Fisheries, feels it is important that stakeholder concerns are acknowledged and, where possible, are addressed as part of the decision-making process on pulse fisheries. In this context, LNV asked WMR to make a comprehensive overview of concerns and evaluate whether existing research programmes sufficiently address these issues. In case concerns are not yet addressed in existing research, WMR was asked to present proposals for additional research.

2 Assignment

In this project, we made an inventory of concerns that have been brought up on (effects of) pulse fisheries since the last International Dialogue Meeting on Pulse Fishing in January 2017 (Steins et al., 2017). These concerns may have been brought up formally or on written/online media.

After the inventory, a recommended additional research agenda was formulated. We investigated whether the concerns could be incorporated in ongoing research or whether extra research activities are needed. For new activities, a rough cost estimate has been included.

3 Materials and Methods

3.1 Inventory of concerns

3.1.1 Approach

From various sources we made an inventory of stakeholders' concerns about pulse fishing. We did a scrutiny of online and written media; held two meetings with Dutch small-scale fishermen and shrimp fishermen on the topic; and looked into other sources (e-mails directed to Wageningen Marine scientists, a Special Request for ICES and a statement by Danish fisheries representatives).

During the inventory we searched for concerns, which were categorised and counted by category. The defined categories were:

- Ecology, direct effects
- Ecology, indirect effects
- Ecology, discards and bycatch
- Ecology, bottom disturbance
- Ecology, laboratory vs. field
- Fish quality
- Chemistry
- Fleet behaviour, displacement of the fleet
- Fleet behaviour, competition
- Management
- Pulse characteristics
- Presentation

A distinction was made between pulse fishing for shrimp and for flatfish.

If a concern belonged to multiple categories, it was listed under both categories.

3.1.2 Concerns expressed in the media

A scrutiny of the media for concerns about pulse fishing was done for the period of November 2017 – April 2018 by searching printed and online articles gathered by WMR colleagues involved in the pulse fisheries debate. In addition, an online search was carried out using Google and Twitter with key words 'pulse fishing', '*pulsvisserij*' and '*pêche électrique*'. All articles that were referred to were downloaded.

Mainly media in the Dutch, English and French language were scrutinized. A few German and Spanish articles that were separately provided by other scientists were added to the list of media.

3.1.3 Concerns expressed in meetings with Dutch fishermen

Two meetings were held with Dutch small-scale fishers and shrimp fishers to give them an opportunity to ask questions and to express their concerns. The small-scale fishers were invited through a joint letter to their members by the national fishermen's organisations (Nederlandse Vissersbond and VisNed). All license holders of the shrimp fisheries got an invitation by letter from the ministry. Both meetings were held at a time and location that was easily accessible for the fishers (Ijmuiden for the small-scale fleet and Harlingen for the shrimp fleet). The attending fisheries scientists prepared a presentation to inform the attendees on the ongoing Impact Assessment Pulse-trawl Fisheries.

The first meeting took place on the 16th of March 2018 with small scale fishermen. Thirteen people representing the fishers were present: both practising fishers (gill netters and commercial anglers)

and representatives. Two fisheries scientists and one representative of the Ministry of Agriculture, Nature and Food Quality (LNV) were present. The minutes of this meeting – in Dutch – are included in this report as Annex 1.

The second meeting took place on the 6th of April 2018 with shrimp fishers. Twenty three people representing the fishers were present: both practising fishers and representatives. Five fisheries scientists (3 from WMR, 1 from Wageningen Economic Research (WEcR) and 1 from the Belgian fisheries research institute ILVO) and three representatives of LNV were present. The minutes of this meeting – in Dutch – are included in this report as Annex 2.

All concerns mentioned in the minutes were added to the list of concerns by category.

3.1.4 Concerns in other sources

WMR scientists received e-mails from stakeholders containing concerns about effects of pulse fisheries. Those concerns were added to our list of concerns by category.

France requested the International Council for Exploration of the Sea (ICES), in 2016, to: "*review the work of SGELECTRA and IMARES and to provide an updated advice on the ecosystem effects of the pulse trawl, and especially on the lesions associated and mortality for targeted and non-targeted species that contact or are exposed to the gear but are not retained on board, with special reference to those species covered by the Natura 2000 Directives, and on Natura 2000 habitats.*" (ICES, 2016) We identified the concerns mentioned in this special request and added them to our list.

In October 2017, a round table meeting was held between fisheries, science and government representatives from both France and the Netherlands. The meeting dealt specifically with pulse fisheries. Minutes of the meeting, written by the participating WMR scientists, were confidential. Nevertheless, the concerns that were described in these minutes could be used for the inventory carried out for this report.

On the 14th of October 2017 a question and answer session was held with several elasmobranch experts present in Amsterdam (the Netherlands) for the European Elasmobranch Association Annual Scientific conference. The aim of the session was to give the experts the opportunity to learn about the current research carried out on pulse fishing and give them the opportunity to pose questions to the lead scientist of the project who gave a detailed presentation on the research carried out in the past and planned for the coming years. The questions asked were included in our inventory.

Finally, concerns mentioned in a statement of the Danish Fishermen Producer Organisation (DFPO) on pulse fishing for shrimp were included in our inventory.

3.2 Knowledge gaps according to ICES WGELECTRA

The International Council for Exploration of the Sea (ICES) has a working group tasked with examining the effects of electric fishing on the marine environment (reduction of by-catch, impact on bottom habitat, impact on marine fauna, energy saving and climate related issues), in view of current technical developments on electrical fishing. This working group, WGELECTRA, is co-chaired by Adriaan Rijnsdorp (WMR) and Maarten Soetaert (ILVO). More information on this group can be found on http://www.ices.dk/community/groups/Pages/WGELECTRA.aspx.

In April 2018 the working group convened in the Netherlands and identified knowledge gaps on (the effects of) pulse fishing. For the purpose of this report, we included those knowledge gaps in a table and added information on the extent to which the knowledge gaps are covered in ongoing research.

3.3 Recommended Additional Research Agenda

The total list of concerns derived from the various sources was discussed in a workshop with seven scientists from Wageningen Marine Research and Wageningen Economic Research. Based on expert judgment the participants of the workshop assessed for each of the concerns whether they were covered by completed or ongoing research. In case concerns were not or partly covered, the established whether they could be answered by adjusting ongoing research or whether new research would be required.

All concerns that required extra research were included in a proposed additional research agenda. For each proposed research, the participants roughly estimated the costs and time needed to carry out the research.

3.4 Question ranking by the ISAC

The International Scientific Advisory Committee (ISAC) coordinated a self-assessment of the extent to which the Impact Assessment Pulse-trawl Fisheries addresses the questions of stakeholders raised as part of the stakeholder consultation exercise. This resulted in a list of questions on pulse fishing (see Annex 5). This list was sent to about 80 international stakeholders that had been attending the International Dialogue Meeting in January 2017, whom were asked to prioritize the research questions. Ranking could be done by category: bycatch, ecosystem, management and socio-economics.

There were only 12 respondents (~15%), meaning that no representative conclusions can be drawn from the results. It does, however, give an indication of what stakeholders think is important.

4 Results

4.1 Inventory of concerns

The inventory of concerns resulted in a table with the number of concerns by category, with frequency of occurrence by source (Table 1). Some expressed concerns belonged to multiple categories: in those cases they were copied and included in the list of concerns twice. The original 141 concerns are included in Annex 3.

In printed and online **media** (November 2017-April 2018), we identified a total of 87 concerns on pulse fishing. The minutes of the two **meetings with Dutch fishers** (Annex 1 and 2) contained another 25 concerns. In **other sources** we identified 29 concerns: 7 in e-mails sent to WMR staff; 5 in Special Requests to the International Council for Exploration of the Sea (ICES); 2 in the minutes of the round table meeting between French and Dutch fisheries, science and government; 14 in the question and answer session with elasmobranch experts; and 1 in an expression of concern by the Danish Fishermen Producer Organisation (DFPO) in February 2018.

Table 1 Concerns on pulse fishing by category

Based on printed and online media between November 2017 and April 2018, meetings with fishermen and other sources. The individual concern numbers are split up by gear type: pulse trawl for flatfish, for shrimp or both. The numbers in the final three columns correspond to the concerns listed in Annex 3.

Category	Concern	Source	Concern numbers		
		(frequency)	Flatfish	Shrimp	Both
Ecology	What is the **direct effect** of pulse on fish and benthic organisms?	Media (25), Meetings (7), Other (9)	1, 15, 53, 54, 55, 56, 57, 58, 60, 61, 62, 66, 87, 88, 89, 101, 113, 115, 120, 122, 124, 126	91, 102	2, 3, 4, 10, 11, 13, 14, 37, 47, 48, 49, 50, 51, 84, 86, 90, 112
	What are **indirect effects** of pulse on organisms that have not been killed, but may have undergone negative impulses for their functioning (e.g. ability to reproduce)?	Media (16), Meetings (5), Other (11)	33, 35, 36, 37, 115, 117, 118, 119, 121, 124, 125, 127	91	3, 4, 7, 8, 10, 32, 38, 39, 40, 41, 42, 50, 52, 65, 74, 84, 85, 111, 112
	How many **discards** and **bycatch** is there in pulse fisheries?	Media (3)	19, 20		59
	What **bottom disturbance** is caused by pulse fisheries?	Media (4), Meetings (2), Other (1)	16, 17, 18, 46, 127		7, 108
	How do results from **laboratory research** translate into what happens in the field?	Media (1)			63
Fish Quality	Is the **quality** of fish caught with pulse different from fish caught with traditional beam trawl?	Media (3)	43, 44, 45		
Chemistry	What is the **chemical effect** of pulse in the sea water or sea bed?	Media (4)			24, 25, 42, 85
Fleet behaviour	Is pulse fishery carried out in areas where they did not fish before? Has the area where they moved to not been fished before? What is the impact of the **displacement**?	Media (4), Other (3)	26, 27, 28, 29, 30, 31, 123		
	How does pulse fishing **compete** with other fisheries? Do the other fisheries have a disadvantage due to the presence of pulse fishers because of (local) depletion of the stock?	Media (8), Meetings (5), Other (1)	15, 21, 22, 23, 70, 92, 93, 94, 96, 97, 106, 107, 114		95
Management	How does **fisheries management** deal with the introduction of a new (and more efficient) fishing gear? Avoid overfishing; avoid appearance of commercial fishing under the disguise of science. How do we make sure that the allowed pulse characteristics are not changed by fishermen, in order to increase catch efficiency?	Media (18), Meetings (4), Other (1)		33, 38, 104	5, 6, 9, 12, 64, 67, 68, 69, 76, 77, 78, 79, 80, 81, 82, 83, 100, 103, 109, 110
Pulse characteristics	What are **key characteristics**; How do they influence the direct and indirect effects?	Meetings (2), Other (3)			71, 72, 73, 105, 116
Presentation	Can we find ways to improve how we get messages on research outcome across to stakeholders by improving **visualization** of effects/results?	Media (1)	75		

4.2 Knowledge gaps according to ICES WGELECTRA

The ICES WGELECTRA, co-chaired by Adriaan Rijnsdorp (WMR) and Maarten Soetaert (ILVO), works on improving knowledge of the effects of electrical or pulse fishing on the marine environment. In April 2018 the working group had a meeting and identified knowledge gaps on (the effects of) pulse fishing (Table 3).

Table 3 Knowledge gaps according to WGELECTRA on pulse fishing, with additional information on the status of the research by category (last column).
Source first two columns: ICES WGELECTRA Report 2018, Chapter 15.

Category		Status
Lab vs field	Extrapolating results from laboratory experiments to the field. Further research should be focused on advancing the mechanistic understanding of how electrical stimuli affect marine life. Field studies remain important because effects that are not visible during laboratory experiments might still appear in the dynamic environment of the sea where multiple, variable and complex interactions may arise.	This is the core of the multiannual research programme
Sub-lethal effects	Effects on young life stages and in the reproductive phase need further investigation. When assessing these effects, not only mortality, but also parameters including growth and development, behaviour, stress and disease resistance need to be taken into account. Disease - One might hypothesize that exposure to electrical pulses may weaken an organism's physiological condition or immune system or alter its morphology, rendering it more susceptible to infectious or noxious agents.	No research planned
Behaviour	There are no studies that examined long time effects on the behaviour or interaction of exposed animals nor potential attraction or repulsion to repetitive electric pulse stimulus.	Attraction and repulsion are studied
Long term effects on individuals	Little is known about the long-term impacts on organism fitness for either fishes or benthic invertebrates. Particular gaps include: - Whether exposure to the pulse impacts reproductive capacity - Whether any injuries occurring in early life stages could cause developmental problems in juvenile and adult invertebrates and fish - Whether pulse trawling affects growth - Whether short term behavioural responses to pulse trawling translate into longer-term effects on energetics and fitness	No research planned
Population and Ecosystem consequences	Electric fields may penetrate into the sediment, potentially affecting benthos that live below the penetration depth of tickler chains. The effects of pulse exposure are not yet fully understood and the combined effects have not been studied yet. Trawling will impact different functional groups. However, there are still a number of evidence gaps on effects of pulse stimulus on the biogeochemistry of the benthic ecosystem, which will need further study. There are no studies on the	Studied in WP3 and WP4 of the multiannual research programme

	impact of pulse trawling on broader ecosystem functioning such as bentho-pelagic coupling, trophic function, habitat provisioning or ecological connectivity. There is currently no information on the potential for changes in the distribution of species populations caused by the fishing activity of pulse trawlers. There is the possibility for movements of populations based either on their avoidance of, or attraction to pulse trawling activity, and this should be investigated.	
Effects on sole stock	A change in the distribution of fishing effort with the transition from beam to pulse trawling has been identified. There has been an intensification of fishing activity in small areas in the southern North Sea, in areas most profitable for pulse trawls, i.e. with highest sole catches. The impact of the changed distribution in fishing effort on the population dynamics of sole should be investigated, taking account of the stock structure and the connectivity between nursery and spawning grounds.	A research proposal is being prepared
Welfare	The welfare of target and non-target marine organisms were not taken into account and this remains an issue that needs to be considered in future research.	No research planned

4.3 Question ranking by the ISAC

The list of questions on pulse fishing as composed in the coordinated action by the International Scientific Advisory Committee (ISAC) was ranked according to importance (as expressed by the non-representative 12 respondents). The number of votes by question is included in Annex 4. Below, we list the questions with the most votes by category:

- Bycatch:
    - What is the mortality of the different target and by-catch species that have been in contact with the gear but have escaped, for beam trawl with tickler chains and beam trawl with pulse? *(8 votes)*
    - What are the effects on non-target, non-commercial fish species from all types of pulse trawling? (For example effects on sandeel, gobies, dragonets, elasmobranchs or other characteristic species in areas that are pulse fished?) *(8 votes)*
- Ecosystem:
    - What are the long-term effects on populations of plants and animals living in and on the seabed (including mortality over longer time, reproduction, juvenile stadia and growth) in areas that have a been exposed to pulse fishing for years? *(7 votes)*
- Management:
    - Pulse gear is lighter than conventional gear this has caused a displacement into other areas (inshore), is there a way to research detrimental effects that this has had afterwards? *(6 votes)*
- Socio-economic:
    - How can experimental fisheries be regulated in such a way that a new fishery is truly experimental until it is proven to not have detrimental effects? *(8 votes)*

4.4 Observation

While carrying out the inventory for this report, it became clear that many of the concerns raised could already be answered by using completed research. This indicates that much of the already available information and knowledge on pulse fishing and its effects has not reached the stakeholders.

5 Recommended additional research agenda

5.1 Completed and ongoing research

5.1.1 Introduction

Before recommending required additional research, we first go into what research has already been completed or is ongoing. This overview is included to make it possible for the reader to know which kinds of research have been carried out. It gives an idea of where to look for answers in relation to specific topics.

5.1.2 Overview by ICES WGELECTRA

ICES WGELECTRA included an extensive overview of all research carried out so far in their 2018 report (ICES, 2018: Annex 4). A summary table of that overview is included as Annex 5 to this report. For more detail, we refer to Annex 4 of the ICES report.

In short, research has been carried out on:
- Catch composition: catch efficiency and bycatch;
- Fishing effort: trends in overall effort, local competition and fuel costs;
- Mechanical impact: seabed disturbance;
- Discards survival in flatfish fisheries with pulse trawl;
- Effects of pulse on various species: internal/external damage, mortality, reproduction, swimming behaviour, prey detection, feeding behaviour, (delayed) egg production.

5.1.3 Sustainability Score Card: pulse trawl vs. tickler chain trawls

Wageningen Marine Research carried out a preliminary assessment of the reduction of the ecological and environmental impacts of the tickler chain beam trawls by introduction of pulse trawls in the North Sea fishery for sole and plaice (Rijnsdorp, 2018). In this assessment, the scientific knowledge on various topics relevant to the comparison between tickler chain trawls and pulse trawls was evaluated. The evaluation was based on a number of environmental, ecological and fisheries management criteria, and evaluates the strength of the scientific evidence and its uncertainty. The assessment was based on the review and synthesis of the scientific knowledge by ICES WGELECTRA in January 2017 (ICES, 2017) and additional information that became available in 2017 (Desender, 2018; van der Reijden et al., 2017; Polet et al., 2017).

A result of this preliminary assessment was the table in Annex 6: a 'sustainability score card', including references to relevant reports and papers. A full assessment can be done once the ongoing impact assessment is finalised in 2019 (see section 5.1.3).

Information is included in the scorecard on impacts on:
- Environment: CO_2 emissions, seafloor disturbance, pollution;
- Benthic ecosystem: benthic biomass, ecosystem functions;
- Marine organisms: fractures or haemorrhages (due to pulse or catch process), skin lesions/scale loss, discard survival, development and growth of eggs and larvae, mortality of invertebrates, behaviour;
- Management of commercial stocks: species selectivity, size selectivity, discards (fish, benthos), risk of overfishing;
- Socio-economic: competition with other fishing fleets.

5.1.4 Impact Assessment Pulse-trawl Fisheries (IAPF): ongoing research

Ongoing research is mainly carried out in the Impact Assessment Pulse-trawl Fisheries as introduced in chapter 1. This programme consists of 4 Work Packages (WP):

WP1: Modelling the effects of pulse stimulation on marine fish and invertebrates
WP1 focuses on modelling the effects of electric stimulation on marine organisms, using a combination of controlled laboratory studies and field observations of damage that occurs in fish sampled aboard trawlers. This WP tries to answer the question on how fish (and invertebrates) interact with the electric field of the pulse trawl. In bullets, the main objectives of this WP are:

1. A model-framework for simulating spatio-temporal characteristics of electrical fields generated by pulse fishing gear in different environments.
2. A model-framework for linking external electrical fields to internal current flow in animals differing in size, shape and electrical properties. Fine tuning of the model frame work depends on data gathered in experiments that will be done in cooperation with Flanders Institute for Agricultural and Fisheries Research (ILVO) and Wageningen Marine Research (WMR)
3. Report on susceptibility of marine invertebrates to electrical pulses. Susceptibility concerns both survival and behavioural effects.
4. Report on behavioural responses in different groups of fish, both electroreceptive and non-electroreceptive, to low amplitude electrical pulses.
5. A model framework for numerical simulations of pulse fishing effects; specificity of catches, bycatches and potential collateral damage.
6. Report on damage in target and bycatch species in commercial electrical fishing, on the basis of X-ray photographs.

WP2: Differential effects of electrical pulse and conventional beam trawl fisheries on sediment biogeochemistry
WP2 examines the effects of pulse fishing on the benthic ecoystem and the ecosystem services (biogeochemical cycling) provided by sediment fauna. The main objectives in this WP are:

1. Conduct a field study in cooperation with the Dutch fishing industry comparing the short term impacts of electric pulse trawling and conventional beam trawling on the benthic ecosystem.
2. Conduct a field study experimentally assessing the immediate effects of electrical stimulation and physical perturbations on benthic biogeochemical parameters.
3. Conduct a field study assessing the long-term effects of electric pulse trawling on the benthic ecosystem.
4. Create predictive mechanistic models on how ecosystem functioning is affected by pulse trawling and tickler chain trawling.

WP3: In WP3 the work from WP1 and WP2 will be integrated, together with a fleet dynamic module reproducing fleet behaviour. A dynamic state variable model will be used to look at the association with habitat of pulse trawl and tickler chain beam trawl as it may be that the pulse trawl has access to another range of habitats than the tickler chain beam trawl. The main objectives in this WP are:

1. Develop a predictive model of the distribution of pulse trawl and beam trawl vessels in relation to the density of their target species and the distribution of sea bed habitats;
2. Develop a predictive model of the impact of pulse trawling and beam trawling on the benthic ecosystem;
3. Estimate the proportion of the catch of pulse trawls that is injured by the exposure to electrical stimulation.

WP4: Impact Assessment

This WP involves the integration of the different parts of the programme. The objectives are:

1. The fleet dynamic model developed in WP3 will be used to predict the spatial distribution of fishing effort of the Dutch fleet targeting sole using either the conventional beam trawl or using the pulse trawl. This will be done at the scale that is appropriate to estimate the impact of both gear types on the benthic ecosystem.
2. The sensitivity of the effort allocation patterns for the input parameters will be explored. Effort allocation patterns will be compared to the observed distribution patterns to test the validity of the model predictions.
3. Modelled effort distribution maps will be overlaid with distribution maps of biota to estimate impact for a selection of fish species and benthic invertebrates and maps of benthic functional groups, given the sensitivity of the biota estimated in WP1 and WP2.
4. Expected output (i) population level estimates of injuries for a number of fish species; (ii) estimate of discards in the beam trawl and pulse fishery when harvesting the available sole quota; (iii) estimate of the impact on the benthic ecosystem functioning. The above results will be integrated with results from other relevant studies which have been conducted in parallel with the current project.

In summary, there is ongoing research on:

- Susceptibility of marine invertebrates to electrical pulses (survival and behavioural effects);
- Behavioural response in fish (electroreceptive and non-electroreceptive) to electrical pulses;
- Injuries in the catch in commercial pulse trawl fishing;
- Effects of pulse fishing on the benthic ecoystem and the ecosystem services (biogeochemical cycling) provided by sediment fauna: short term and long term impact;
- Fleet behaviour in relation to density of target species and habitat distribution (effort allocation, exposure of habitats and species to fisheries);

5.2 New research questions

In the previous paragraph we reported on all completed and ongoing research. Many concerns that are raised are covered by this research: these are labelled with a green colour in Annex 3. There are several concerns that are not yet fully covered (labelled orange in Annex 3) or not covered at all (labelled red in Annex 3) and that need additional research in order to follow up on them (Table 5).

Table 5 Recommended additional research agenda pulse fishing

Issue	Concern numbers Annex 3	Proposed Research	Cost estimate	Time span
Fishers asked for a research in which direct effects of pulse fishing on the seabed community are made visible.	2, 58, 62, 84, 86, 87, 102	Fish in the wake of a pulse fisher to demonstrate the direct effects. Direct observation by fishers, guided by scientists. Both for pulse fishing on and on flatfish shrimp. *(This research is planned to take place at the end of 2018.)*	< 50.000 euro	< 3 months
What are the effects of pulse fishing on reproduction?	39, 40, 42, 52, 65, 125	Study the effects of pulse on sole gonads and eggs in the laboratory. Use the results to translate those to effects on other species where possible.	< 125.000 euro	< 1 year
Effect of the increase in pulse fishing on the dynamics of local stocks in the southern North Sea and eastern Channel.	9, 12, 15, 107	A study of the effect of fishing on the dynamics of local sole populations including (i) tagging experiment to quantify the seasonal movements of sole of different spawning stocks in the southern North Sea and eastern Channel; (ii) modelling study of the spatial dynamics of local stocks; (iii) modelling the effects of fishing on the dynamics of the local stocks.	< 200.000 euro	< 2 years
Competition: Do local fisheries have a disadvantage due to pulse fishers arriving in the fishing area?	21, 22, 23, 26, 27, 28, 30, 31, 92, 93, 94, 96, 97, 104, 113, 114	Study to what extent the transition to pulse fishing has resulted in an increase in local fishing pressure, and compare economic data from local fishers before and after the arrival of pulse fishers. International research on changes in spatial patters by fleet (VMS data) and on economic information by fleet (logbook and auction data).	< 75.000 euro	< 6 months
Does pulse fishing for shrimp increase the risk of overfishing of shrimp?	5, 6, 33, 38, 104	Does higher catch efficiency lead to higher risk of growth overfishing of shrimp? Comparing efficiency of shrimp fishers using pulse trawl versus traditional shrimp trawl with a logbook programme for comparing CPUE data. The consequences for management and implications for the HCR should be taken into account.	< 75.000 euro	< 1 year

6 Recommendations

This study envisaged to carry out an inventory of concerns that are not covered by completed or ongoing research. The assessment whether a concern was covered and whether additional research was needed, was based on expert judgment. We did not do an extensive gap analysis for each of the concerns in which we checked which research (partly) covered the concern. Neither did we aim to answer to all concerns. If a more detailed approach is desired, that should be carried out in a more extensive study.

We advise the Ministry of LNV to involve the ISAC and, where possible, the stakeholder community in their decision-making process in relation to commissioning further studies based on this report.

We also recommend increasing efforts in making information more accessible and understandable for a larger audience. To this end, we could invest in visualisation of effects and results through infographics, videos and photos.

7 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 December 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

Furthermore, the chemical laboratory at IJmuiden has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2021 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation. The chemical laboratory at IJmuiden has thus demonstrated its ability to provide valid results according a technically competent manner and to work according to the ISO 17025 standard. The scope (L097) of de accredited analytical methods can be found at the website of the Council for Accreditation (www.rva.nl).

On the basis of this accreditation, the quality characteristic Q is awarded to the results of those components which are incorporated in the scope, provided they comply with all quality requirements. The quality characteristic Q is stated in the tables with the results. If, the quality characteristic Q is not mentioned, the reason why is explained.

The quality of the test methods is ensured in various ways. The accuracy of the analysis is regularly assessed by participation in inter-laboratory performance studies including those organized by QUASIMEME. If no inter-laboratory study is available, a second-level control is performed. In addition, a first-level control is performed for each series of measurements.
In addition to the line controls the following general quality controls are carried out:

- Blank research.
- Recovery.
- Internal standard
- Injection standard.
- Sensitivity.

The above controls are described in Wageningen Marine Research working instruction ISW 2.10.2.105. If desired, information regarding the performance characteristics of the analytical methods is available at the chemical laboratory at IJmuiden.

If the quality cannot be guaranteed, appropriate measures are taken.

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Justification

Report C106/18
Project Number: 43.181.00.221

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: ir. Edward Schram
Researcher

Signature: 

Date: 19th of December 2018

Approved: Dr. ir. T.P. Bult
Director

Signature: 

Date: 19th of December 2018

Annex 1 Minutes of an information meeting on pulse fisheries with Dutch fishers using passive gears

WAGENINGEN
UNIVERSITY & RESEARCH

Notulen

BIJEENKOMST
Bijeenkomst passieve visserij rond vragen over pulsvisserij

BO-43-023.02-014

LOCATIE
Zeehaven IJmuiden

DATUM
16 maart 2018

AANWEZIG
Durk van Tuinen (Nederlandse Vissersbond), Pim Visser, Maarten Drijver, Noor Visser (VisNed), Teun van Dam (PO Delta Zuid), Miranda Bout (NetVisWerk), Kees Mos (staand want), Willem de Waal, Ger de Ruiter (LIFE Nederland), Rems Cramer (staand want), Arjen Korving (staand want en handlijn), Andries Visser (staand want), Boy Raspoort (staand want), Evelien Ranshuysen (LNV), Nathalie Steins, Adriaan Rijnsdorp (WMR).

DATUM
27 maart 2018

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Achtergrond
De Nederlandse Vissersbond en VisNed hebben van de Nederlandse passieve visserij het verzoek gekregen een bijeenkomst te organiseren rond de pulsvisserij en de vraagstukken die er nog leven, o.a. ook rond de interacties tussen puls en andere visserijen. Adriaan Rijnsdorp en Nathalie Steins zijn namens Wageningen Marine Research (WMR) aanwezig om de stand van zaken van het onderzoeksprogramma toe te lichten en vragen te beantwoorden. Hun deelname wordt gefinancierd vanuit het BO-project Pulsvisserij: inventarisatie aanvullende kennisagenda (BO-43-023.02-014) van het Ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV). Evelien Ranshuysen is vanuit LNV aanwezig om vragen te beantwoorden. Durk van Tuinen (Vissersbond) zit de vergadering voor.

De discussie tijdens het overleg gaat soms breder dan alleen de pulsvisserij. In dit verslag zijn alleen de vragen en antwoorden rond pulsvisserij opgenomen. Er wordt in het verslag niet verwezen naar individuele sprekers, zodat aanwezigen vrijuit kunnen spreken.

Voorafgaand aan de bijeenkomst zijn de aanwezige vertegenwoordigers in de gelegenheid gesteld om vragen in te dienen ter voorbereiding van de presentatie door WMR. In het voorstelrondje wordt opgemerkt dat een aantal vragen steeds terugkomen omdat op deze vragen nog geen bevredigend antwoord is gekomen.

Proces besluitvorming puls
Het Europees Parlement heeft gestemd voor een totaalverbod. De Europese Commissie wil doorgaan met de 84 vergunningen en het onderzoek afwachten. De Visserijraad heeft als standpunt om 5% toe te staan. In de zogenaamde triloog moet men tot overeenstemming komen. Tot die tijd blijft de pulsvisserij zoals die nu is met een ontheffing plaatsvinden.

In de tussentijd blijft ook het onderzoek doorgaan. De bijdrage van de onderzoekers aan de triloog is dat de Raad voor Onderzoek der Zee (ICES) nog voor de zomer een advies uitbrengt over de vergelijking van de boomkor en de pulskor op de duurzaamheid voor het ecosysteem vanuit het perspectief van het benutten van het

tongquotum. Voor de sleepnetvisserij die niet op tong is gericht hoef je immers geen pulskor te gebruiken.

Onderzoeksprogramma: wat weten we en wat weten we (nog) niet?
Adriaan Rijnsdorp (WMR) leidt het meerjarige onderzoeksprogramma en presenteert de resultaten tot nu toe. Ook gaat hij in de presentatie in op de vragen die vooraf zijn gesteld. De presentatie is als bijlage aan het verslag toegevoegd.

Adriaan Rijnsdorp benadrukt dat het onderzoek in het meerjarige onderzoeksprogramma bedoeld is om fundamentele kennis op te bouwen om te leren begrijpen hoe in de praktijk de interacties tussen puls en andere dieren in zee werken. Een van de onderzoekers kijkt bijvoorbeeld wanneer en hoe verschillende dieren op blootstelling aan de puls (met verschillende veldsterkte) reageren. Als je dat eenmaal weet uit de laboratoriumonderzoeken, dan heb je de informatie die nodig is om te beoordelen of bijvoorbeeld zeebaars er last van heeft dat er puls activiteit in zijn buurt is en daarom misschien wegzwemt.

De vragen en antwoorden naar aanleiding van de presentatie zijn hieronder weergeven. Iedere vraag is cursief weergegeven. De antwoorden zijn van de onderzoekers van WMR tenzij er expliciet is aangegeven dat de reactie van andere aanwezigen komt.

Hoe gevoelig is kabeljauw voor de eventuele uitstraling van de puls buiten het net?
Als het lukt om aan levende kabeljauw te komen, dan is het de bedoeling dat daar ook in het laboratorium naar wordt gekeken. Als je uit het laboratoriumonderzoek weet hoe de kabeljauw reageert, kun je dit door vertalen naar de praktijksituatie. Maar in dat stadium zijn we nu nog niet.

Is in het begin alles dood in het sleepspoor? En hoe meet je dat dan?
Als je een sleepnet over de bodem sleept, worden er dieren gedood of verwond. Bijvoorbeeld omdat ze door het vistuig geraakt worden. Als je dan meteen na het slepen een monster neemt, kun je niet zeggen "die is dood door de visserij en die leeft nog". Uit 20 jaar internationaal onderzoek is als beste methode naar voren gekomen dat je twee dagen wacht na de sleep totdat de aaseters de dode dieren hebben opgegeten opeten. Dan kun je na 2 dagen zien wat er aan dieren zat vóór de visserij en 2 dagen erna. Dit wetenschappelijk gezien de beste methode.

Blijft de vissnelheid bij puls hetzelfde?
Je ziet uit de gegevens dat de schepen in de beginperiode van de puls nog aan het zoeken zijn naar de optimale vissnelheid. Voor de grote kottervloot weten we door het onderzoek van de VMS en logboekgegevens dat de snelheid is afgenomen. Voor de eurokotters wordt dit nu ook doorgerekend. Deze onderzoeksresultaten worden bevestigd door aanwezige vissers uit de kottersector. In het begin wilden de pulsvissers nog wel eens harder vissen omdat ze dat gewend waren met de wekkers. Maar het werd de pulsvissers al snel duidelijk dat langzamer vissen betere resultaten oplevert.

Waar pulsvissers zitten, wordt niet met wekkers gevist. In de zuid kan het verschil in vangstefficiëntie tussen puls en wekkers niet vergelijken, want ze vissen niet meer op dezelfde bestekken vissen. Maar dat wordt wel in de analyse van de logboekgegevens en de VMS gedaan.
Uit de beginperiode hebben we die gegevens wel, want toen werd er nog in dezelfde gebieden gedaan. De schatting over de vangstefficiëntie is op basis van de jaren met voldoende puls- en boomkorvisserij in dezelfde gebieden. Hieruit blijkt dat de

vangstefficiëntie van tong per uur vissen van grote kotters over het gehele jaar gerekend tussen de 25% en 30% hoger is.

Aanwezigen uit de kottersector geven aan dat de verschillen in vangst vooral in de zomer te zien zijn. In de winter kun je als wekkervisser dichter bij de pulsvloot komen. Het vergelijk in de zuid maken in de huidige situatie is lastig want de wekkers en puls vissen op verschillende bestekken. Benoorden de grens IJmuiden kun je het vergelijk wel maken.

Als het onderzoek de gegevens uit 2010-12 gebruikt dat zijn toch gedateerde gegevens? Dat is toch niet voor nu realistisch. We zien nu iedere week de vangsten afnemen. In 2010 vingen we makkelijk met 2 kleine bordjes van 100kg makkelijk 15 kg tongen op een trek. Afgelopen jaar konden we nog niet aan 3 kg komen.
Ook het tongbestand is over de jaren veranderd. Je kunt verminderde tongvangsten niet zomaar aan de pulsvisserij toeschrijven.

Waar het onderzoek naar de vangst efficiëntie over gaat is: er ligt een bepaalde hoeveelheid tong op de zeebodem. Als je die tong bevist met het ene tuig, vis je dan meer, minder of hetzelfde dan met het andere? Voor de jaren dat er overlap is in de gebieden zie je dat je met de puls 25% tot 30% meer tong per uur vangt dan de wekkers. Dat betekent dus dat je met het wekkertuig tong laat liggen. Als je met een puls vist dan vis je sneller de tongen op de zeebodem weg dan met een wekkertuig.

WMR-onderzoeker Pieke Molenaar heeft filmpjes in het pulsnet gemaakt. Je ziet dat de schollen snel achter in de kuil terecht komen en tegen het net worden gedrukt. De tongen blijven echter zwemmen en proberen eruit te komen. Maar dan komen ze in het wekveld terecht en verkrampen ze weer en vliegen ze terug. Bij de wekkers was dat natuurlijk niet het geval. Daarom visten ze ook sneller. Maar zo leidt het wekveld dus wel tot meer tong die in het net blijft.

Verklaart de toegenomen efficiëntie voor de tongvangst waarom er voor kleine vissers na een puls niets meer te vangen is? Vroeger zochten de passieve vissers de wekkervissers op want het was visnamig voor de staand want en nu met de puls hoef je het niet te proberen. Is die 30% meer niet juist de boterham van de andere visserij?
De hoeveelheid vis die je vangt, is bepaald door quotum dat een schip heeft. Als je per uur meer tong vangt met de puls, dan ben je eerder klaar met het vissen van je quotum.
Je kunt uit de informatie die we hebben niet concluderen dat de toegenomen vangstefficiëntie op tong ervoor zorgt dat er geen vis meer voor de anderen overblijft. Wel kan er grotere concurrentie zijn als vissers op eenzelfde visgrond vissen. De minder efficiënte methode kan dan minder vangen.

De aanwezigen uit de kottersector bevestigen dat je met puls effectiever vangt.

Belgische, Franse en Britse vissers zeggen dat de zeebodem zo dood is als een pier als er een pulsvisser is geweest en je er nooit meer wat vist. Als dat zo is hoe verklaar je dan dat als je als pulsvisser er na het weekend weer komt, je dan weer op dezelfde besomming op dit bestek uitkomt?
Deze vraag leidt in eerste instantie tot een discussie over het continu vissen dat sommige kotters nu doen en de vraag of er een weekendverbod moet komen. Deze discussie is niet genotuleerd.

In reactie op de vraag en de discussie over wel of niet een weekendverbod, geeft Adriaan Rijnsdorp aan dat als je gevist hebt, het voedsel voor de vis er nog steeds is. Je verwacht dus dat daar weer opnieuw vissen naar toe gaan en de hoeveelheid vis zich ververst. Dat herstel zie je niet als je 7 dagen vist en het gebied niet met rust laat. We hebben wel eens onderzocht hoeveel vis er op een lokale visgrond voorkomt in vergelijking met de omgeving. Omdat de lokale grond waar zo'n 20/30% meer vis ligt relatief klein is, betekent het niet dat als de lokale concentratie verdwenen is er geen vis meer is. Ze is alleen minder dicht opeen gepakt en daarom moeilijker te vangen.

Toen we begonnen met staand want zie je de vangsten per lengte net eerst toenemen en dan neemt het weer af. Vissen de staand want vissers andere tongen of vertonen die tongen die je staand want vissers vangen een ander gedrag? Hebben we de tongen die meer zwemmen soms weggevangen? Als zijn er tongen die dieper in de grond zitten dan andere tongen, want die dieper ingegraven tongen van je met de puls misschien wel.
We weten niet of er genetische verschillen zijn binnen het tongbestand, die er bijvoorbeeld toe leiden dat je vissen hebt die dieper zitten dan anderen. Wat we wel weten, is dat als de tongen gaan trekken vanwege de paai je ze makkelijker met staand want vangt en niet met de wekkers. Dat was vroeger zo en is nu nog steeds zo

Maakt de pulsvisserij de bodem minder stuk dan de wekkers?
Ja. Dat is aangetoond in het BENTHIS-onderzoek. Het pulstuig ploegt de bodem minder diep om. In combinatie met de lagere vissnelheid van de grotere kotters is de sterfte van bodemdieren met de helft verminderd.

Wat is de invloed van puls op bodemleven?
Het effect op ongewervelde dieren wordt in het grote programma bekeken. Wat we nu al weten, komt vanuit het onderzoek aan de Universiteit van Gent. Uit dit onderzoek komen absoluut geen desastreuze resultaten. De Vlaamse onderzoekers vonden meestal niks en als ze wat vonden en het experiment herhalen konden ze het niet opnieuw aantonen. Dus zelfs als je een effect denkt te zien en je doet een herhalingsexperiment dan verdwijnt het weer. Dat betekent dus dat iets anders het effect heeft veroorzaakt. Daarom zijn onderzoekers altijd voorzichtig met het trekken van conclusies.

In de kust hadden de staand want vissers 's winters een relatief goede visserij op schol en schar. De afgelopen jaren is alles verminderd en afgelopen 2 jaar is de vis bijna verdwenen. We sterven in de zeesterren in de kustwateren. Schol en schar zijn gebaat bij bewoeling door de bodem. En daar is de tong ook bij gebaat want daar waar zeesterren zijn is geen tong. De puls is te goed, te effectief.
Het is wetenschappelijk niet verantwoord om te concluderen dat deze veranderingen door de pulsvisserij komen.

Is er niet een structurele verandering in de tongstand in de kustzone? De vangst wordt steeds meer plekkerig. Ook voor de puls zagen we dat al. Vroeger was de tong meer verspreid en zit de tong meer op specifieke plekken. Dit is ook zo voor de wrakken. Vroeger had ieder wrak wel kabeljauw en zeebaars, nu heeft 1 wrak alles.
De visstand in de kustzone wordt al jaren gemonitord als onderdeel van de Wettelijke Onderzoekstaken maar een analyse van mogelijke veranderingen in de visstand die je op basis van dat onderzoek zou kunnen doen, is geen onderdeel van het pulsonderzoek.

Hoeveel onderzoek is er gedaan naar de vangsten van de staand vissers? De veranderingen in vangsten in de staand want visserij die hierboven worden beschreven, zijn 10 jaar geleden al begonnen, dus voordat de puls er was. We zien nu ook allemaal andere soorten in de vangst. De kabeljauw zit ergens anders en niet meer op de plekken waar wij ze vroeger vingen. Mullen en 'mooie meiden' vingen we ook nooit en nu is er flyshoot visserij op die soorten. Er zit minder voedsel in het water. Zandsuppleties hebben ook effecten. Het is dus makkelijk om naar de puls te wijzen, terwijl geen pulsvisserij hier dan geen oplossing is.
Het is ontzettend belangrijk dat dat je als onderzoeker bewust blijft over alle grote veranderingen in de zee. Als je kennis hebt wat elektrisch vissen met de organismen in zee doet, dan kun je die kennis koppelen aan de waarnemingen van de vissers. Dat is hoe wij het aanpakken: eerst in het lab kijken wanneer en hoe organismen reageren op verschillende pulsfrequenties en dan die informatie vertalen naar de praktijk. Dat levert veel meer op dan je blijft praten over de honderd mogelijke verklaringen waarom vis wegblijft uit de vangsten van kustvissers.

Als we de vangstgegevens van de wrakkenvissers zouden hebben over de jaren heen, dan kun je die gegevens vergelijken met de VMS van de schepen die erlangs visten (wekkers en puls, en in de tijd). Je zou dit in principe met logboekgegevens kunnen doen, maar de kwaliteit van de logboekgegevens van de staand want visserij zijn hoogstwaarschijnlijk een beperkende factor. Dit zou dus beteken dat de wrakkenvissers en andere passieve vissers al hun eigen vangstgegevens en locaties moeten delen met het onderzoek. Voor het invoeren van die gegevens en de analyses moet vervolgens financiering worden gevonden.

Kan overbevissing in Het Kanaal de toevoer van vis naar de zuidelijke Noordzee belemmeren?
WMR is met het Franse onderzoeksinstituut IFREMER bezig met een onderzoeksvoorstel om de mate van uitwisseling van tong over de grens van Het Kanaal en Noordzee in kaart te brengen.

Wat doet puls met voedsel zeebaars (zandspiering).
Naar deze vraag kijken we nu in het meerjarige onderzoek. Het antwoord kunnen we op dit moment nog niet geven.

Het onderzoek naar de verstoring van de bodem wordt in de Vlakte van de Raan gedaan. Dat is maar een postzegel. Dat is toch veel te klein?
De Vlakte van de Raan is gekozen omdat dit een van de weinig gebieden is waar al een aantal jaren niet is gevist. We nemen uitgebreide bodemmonsters en dan is zo'n postzegel heel groot. Het is niet nodig om de hele Noordzee te onderzoeken om indicatie te krijgen van de effecten.

Is de Vlakte van de Raan gekozen afgeleid van de vraag van de Belgische kleinschalige vissers die aangeven ze geen vis meer vangen in hun gebieden?
We doen dit onderzoek in het Friese Front en de Vlakte van de Raan. . De Vlakte van Raan is een van de weinige gebieden waar al enige jaren al niet meer gevist is. Het Friese Front heeft een andere zeebodem en andere bodemdieren. Omdat die gebieden verschillend zijn kunnen we goede gegevens verzamelen voor vertaling naar de schaal van de Noordzee omdat die immers niet ook overal dezelfde zeebodem heeft.

Hoe heeft de uitstraling van de puls rond de Vlakte van de Raan effect op de dieren die in de vlakte leven?
Het effect van de puls op verschillende organismen onderzoek we in het lab. Die gegevens kunnen we dan gebruiken om te kijken wat dit in de praktijk betekent, dus ook voor de dieren in de Vlakte van de Raan.

Waarom heeft het zo lang geduurd voordat het onderzoek is gestart?
Deze vraag wordt beantwoord door de kotterorganisaties en door EZ. Het meerjarenonderzoek is laat gestart door een combinatie van factoren: (1) het vinden van de financiering (2.5mln euro), (2) de aanbestedingsregels waar de overheid mee te maken heeft, en (3) het opzetten van de aanpak voor het onderzoek.

Het is belangrijk om niet uit het oog te verliezen dat er al heel lang onderzoek gedaan wordt naar de puls, ook in België, en dat dit meerjarenonderzoek niet het eerste onderzoek is. Eerst was het onderzoek gericht op de technische fase (ontwikkeling puls en experimenteren met commerciële toepassing op de UK153). De tweede fase richtte zich op het basisonderzoek. Dat basisonderzoek leidde ertoe dat in Brussel de "seinen op groen" gingen (2014). De derde fase waar we nu in zitten is de verdiepingsslag. Uitkomsten uit het basisonderzoek en het lopende onderzoek leidden ook tot nieuwe vragen.

LIFE heeft tijdens de laatste internationale bijeenkomst een vraag ingediend om een boomkor met kleine mazen in het kielzog van de puls te laten vissen om te kijken wat er met de vangsten gebeurt.
Dit is niet onderzocht maar wel uitvoerbaar. Op dit moment is hier geen financiering voor. Als je dit onderzoek doet, is het wel belangrijk om het eerst goed samen eens te worden over de onderzoeksvraag en de onderzoeksopzet om niet het risico te lopen dat het uiteindelijke onderzoek niet aan de verwachtingen voldoet en wordt afgeserveerd omdat er na afloop onenigheid komt over de onderzoeksvraag.

Hoe zat het met de foto over de wormen die onderaan een pulstuig kleefden en in de media verschenen?
De kotterorganisaties geven aan dat de foto eind april 2016 is genomen door een Urker garnalenvisser in de Sylt. Deze Urker vond dode wormen in de vlerken van het net. Hij viste in het spoor van een garnalenkotter die met de puls aan het vissen was. Het ging dus niet om een platvis pulstuig. Dit was wel de suggestie die werd gewerkt in het programma Nieuwsuur. Bekend is dat ten oosten van de Amrumbank wel vaker wormen worden gevangen door alle vistuigen die daar actief zijn. In Visserijnieuws van 2 februari 2018 is dit verhaal al toegelicht.

WMR geeft aan dat op de foto niet te zien of het wormen of mesheften zijn. Het is niet mogelijk te reconstrueren wat er aan de hand was. Uit het afgeronde onderzoek in België en het lopende onderzoek bij WMR blijkt tot nu toe geen negatief effect van de puls op wormen.

Wat is de reden voor het verbod op pulsvisserij in China?
De puls in China leidde tot expansie en overbevissing. Er was geen enkele begrenzing in de vorm van een beheer voor duurzame visserij. Het is belangrijk effecten die optreden omdat er geen goed beheer is, niet te verwarren met effecten van het vistuig. Met ieder vistuig, of het nou puls of andere sleepnetten of passieve tuigen betreft, kun je een bestand overbevissen of significante schade aan het ecosysteem toebrengen als het visserijbeheer niet op orde is.

Wat is het effect van de garnalenpuls op alles wat groter is dan garnaal?
Deze vraag wordt in het lopende onderzoek meegenomen. Daar hebben we nu nog geen resultaten van. Dus die vraag kunnen we op dit moment niet beantwoorden.

Wordt er met meer dan 12 Volt gevist? En wat betekent de hoogte van het voltage voor de vangst?
Het eerste deel van de vraag wordt door LNV beantwoord. In de Europese Verordening Technische Maatregelen is vastgelegd dat het werkelijke voltage tussen de elektroden ten hoogste 15V bedraagt. Deze eis is opgenomen in de nationale pulstoestemming van elke visserman. Dit wordt geregistreerd of automatisch gemaximeerd (begrensd) in het systeem.

WMR geeft aan dat volgend jaar, als het labonderzoek is afgerond, antwoord gegeven wordt op hoe vissen op andere puls instellingen reageren en wat hiervan het effect op de vangbaarheid zal zijn.

Zijn van de individuele pulsschepen rapporten beschikbaar met onderzoeksresultaten?
Nee. Onderzoek is op het vlootniveau. Het is ook niet toegestaan individuele gegevens/resultaten openbaar te maken vanuit de privacy wetgeving.

Aanbevelingen vanuit de groep aanwezig passieve vissers
Het onderzoek is wel goed in de basis, maar er is veel onrust omdat er over lange lengtes van de kust internationaal de visstand is afgenomen. De Britten zien het, de Fransen en de Belgen. De passieve visserij vindt het belangrijk dat we daarover de feiten verzamelen. Want ook boven Esbjerg zien de kustvissers veranderingen in de vangsten en daar is geen pulsvisserij. Wat vangt de staand want visserij over de tijd heen en waar zouden die veranderingen dan door kunnen komen? Dit raakt ook aan de vraag over de eventuele trendbreuk in bodemfauna in de Hollandse kust. Dit wordt niet onderzocht maar de gegevens over bodemleven zijn er wel.

Annex 2 Minutes of an information meeting on pulse fisheries with Dutch shrimp fishers

WAGENINGEN
UNIVERSITY & RESEARCH

Notulen

BIJEENKOMST
Bijeenkomst garnalenvissers rond vragen over pulsvisserij

BO-43-023.02-014

LOCATIE
De Lichtboei Harlingen

DATUM
6 april 2018

AANWEZIG
Zie bijlage 1

DATUM
6 april 2018

ONS KENMERK:
1814029-NS-JS-LCS

CONTACTPERSOON
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Achtergrond
Het ministerie van Landbouw, Natuur en Voedselkwaliteit heeft een bijeenkomst georganiseerd rond de pulsvisserij en de vraagstukken die er nog leven, o.a. ook rond de interacties tussen puls en andere visserijen. Adriaan Rijnsdorp, Jimmy van Rijn en Josien Steenbergen zijn namens Wageningen Marine Research (WMR) aanwezig om de stand van zaken van de onderzoeksprogramma's rondom tongpuls en garnalenpuls toe te lichten en vragen te beantwoorden. Hun deelname wordt gefinancierd vanuit het BO-project Pulsvisserij: inventarisatie aanvullende kennisagenda (BO-43-023.02-014) van het Ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV). Evelien Ranshuysen, Herman Snijders en Wilbert Schermer Voest zijn vanuit LNV aanwezig om vragen te beantwoorden. Herman Snijders zit de vergadering voor. Maarten Soetaert van het ILVO is ook aanwezig en kan direct vragen beantwoorden n.a.v. de onderzoeken aan de Universiteit van Gent.

De discussie tijdens het overleg gaat soms breder dan alleen de pulsvisserij. In dit verslag zijn alleen de vragen en antwoorden rond pulsvisserij opgenomen. Er wordt in het verslag niet verwezen naar individuele sprekers, zodat aanwezigen vrijuit kunnen spreken.

Voorafgaand aan de bijeenkomst zijn de genodigden in de gelegenheid gesteld om vragen in te dienen. Deze hebben de basis gevormd voor de presentatie door WMR.

In Visserijnieuws van 13 april 2018 is verslag gedaan van de bijeenkomst[1].

Programma
Het programma bestond uit een inleiding van Herman Snijders van het ministerie van LNV. Snijders licht toe hoe de zaken er in Europa voor staan. Vervolgens ging Adriaan Rijnsdorp van Wageningen Marine Research in op de zorgen van de vissers. Hij werd hierin bijgestaan door Maarten Soetaert van het ILVO, waar een groot deel van het onderzoek heeft plaatsgevonden. De presentatie staat in bijlage 2. Na de pauze was het tijd voor discussie en aanvullende vragen uit het publiek. Om de discussie op gang te brengen werden vragen gesteld met behulp van het programma Mentimeter (www.metimeter.com) waarop de deelnemers anoniem antwoord konden geven met hun smartphone. De vragen en uitslagen worden weergegeven in bijlage 3. Vragen en discussie punten die voortkwamen uit de Mentimeter vragen zijn in het onderstaande (vraag & antwoord) verslag verwerkt.

[1] https://www.visserijnieuws.nl/nieuws/zorgpunten-garnalenvissers

Proces besluitvorming puls

Het Europarlement heeft gestemd voor een totaalverbod. De Europese Commissie wil de pulsvisserij onder enkele technische voorwaarden breed toestaan. De Raad van Visserijministers van de EU heeft als standpunt om 5% toe te staan en het onderzoek af te wachten. In de zogenaamde triloog, waarin deze partijen bij elkaar komen, moet men tot overeenstemming komen. Tot die tijd blijft de pulsvisserij zoals die nu is met een pulstoestemming plaatsvinden.

In de tussentijd blijft ook het onderzoek doorgaan. De bijdrage van de onderzoekers aan de triloog is dat de Raad voor Onderzoek der Zee (ICES) nog voor de zomer een advies uitbrengt over de vergelijking van de boomkor en de pulskor op de duurzaamheid voor het ecosysteem vanuit het perspectief van het benutten van het tongquotum.

Onderzoeksprogramma: wat weten we en wat weten we (nog) niet?

Adriaan Rijnsdorp (WMR) leidt het meerjarige onderzoeksprogramma en presenteert de resultaten tot nu toe. Ook gaat hij in de presentatie in op de vragen die vooraf zijn gesteld. De presentatie is als bijlage aan het verslag toegevoegd (bijlage 2).

Adriaan Rijnsdorp licht toe dat het onderzoek in het meerjarige onderzoeksprogramma bedoeld is om fundamentele kennis op te bouwen om te leren begrijpen hoe in de praktijk de interacties tussen puls en andere dieren in zee werken. Een van de onderzoekers kijkt bijvoorbeeld hoe verschillende dieren, en bij welke prikkelsterkte, op blootstelling aan de puls reageren. Als je dat eenmaal weet uit de laboratoriumonderzoeken, dan heb je de informatie die nodig is om te beoordelen of bijvoorbeeld zeebaars er last van heeft dat er puls activiteit in zijn buurt is en daarom misschien wegzwemt. Hij benadrukt dat er zoveel mogelijk wordt geprobeerd om vragen en zorgen uit het veld mee te nemen in dit onderzoek.

De vragen en antwoorden waarop tijdens en na de presentatie zijn hieronder weergeven. Iedere vraag is cursief weergegeven. De antwoorden zijn van de onderzoekers van WMR en/of ILVO tenzij er expliciet is aangegeven dat de reactie van andere aanwezigen komt.

Wat is de invloed van puls op garnalen?

Bij enkele vissers leeft de vrees dat de garnalen zich nadat ze in aanraking zijn gekomen met de (tong)puls niet meer kunnen voortplanten. Het effect van de puls op garnaal is in België tijdens het promotieonderzoek van Maarten Soetaert aan de Universiteit van Gent getest. Het onderzoek heeft geen duidelijk schadelijke effecten van de tongpuls op garnaal gevonden. Er was geen verschil in overleving van garnaal die 1x of 4x aan een commerciële tongpuls was blootgesteld in vergelijking met een controlegroep. Pas bij een extreme blootstelling van 20 keer, iets dat in zee niet voorkomt, was er een wat lagere overleving in vergelijking met 1 van de 2 controlebehandelingen, maar niet met garnalen die met een ketting verstoord geweest waren. Bij blootstelling aan de garnalenpuls werd geen effecten op overleving waargenomen, zelfs niet na 20 blootstellingen. Er was ook geen effect te merken van elektrische pulsen op het aantal garnalen dat eieren droeg. Naar de vruchtbaarheid van de eitjes als gevolg van de puls is geen onderzoek gedaan omdat de levenscyclus in het laboratorium nog niet gesloten is. Grote schade is echter niet echt te verwachten. Ter vergelijking: de elektrische blootstelling die in aquacultuur gebruikt worden om dieren steriel te maken is +- 1000x langer en 500x intenser dan wat een ei of larve zou ervaren bij een blootstelling in de pulskor op tong.

In het huidige lopende onderzoek is verder aandacht voor de impact van de puls op het garnalenbestand in het veld. Want naast de testen in het lab is het ook belangrijk om te bepalen hoe vaak een blootstelling überhaupt plaatsvind. Hiertoe wordt gekeken naar de visserij intensiteit van de pulsvisserij op basis van VMS gegevens, wekveld van de puls en blootstelling bij passage (= 1.5 seconde).

Wat is de invloed van puls op bodemleven?

Het effect op ongewervelde dieren wordt in het grote programma bekeken. Wat we nu al weten, komt vanuit het onderzoek aan de Universiteit van Gent en proeven die in Nederland door WMR zijn uitgevoerd. Uit deze onderzoeken komen geen negatieve resultaten. De onderzoekers vonden meestal niks en als ze wat vonden en het experiment herhalen konden ze het niet opnieuw aantonen. Dus zelfs als je een effect denkt te zien en je doet een herhalingsexperiment dan verdwijnt het weer. Dat betekent dus dat iets anders het effect heeft veroorzaakt.

Hoe zat het met de foto over de wormen die onderaan een pulstuig kleefden en in de media verschenen?

Het gaat hier om een foto van dode wormen in de vlerken van het net die eind april 2016 is genomen door een Urker garnalenvisser (UK156) in de Sylt. De UK156 viste in het spoor van de WR40. Het is moeilijk te reconstrueren wat hier aan de hand was. Het is ook niet helemaal duidelijk of het om mesheften of wormen gaat. Door de universiteit van Gent is onderzoek gedaan naar het effect van puls op zagers en tijdens deze laboratorium experimenten is geen effect waargenomen. Het is wel zo dat de proeven in het laboratorium om praktische redenen uitgevoerd zijn zonder zand. Het is dus niet bekend of zagers of andere wormen door de pulsen uit de bodem komen.

Om de waarnemingen in het veld te staven wordt voorgesteld om achter een tongpulser en een garnalenpulser aan te vissen met een garnalenkor. Zo kan direct worden waargenomen wat er gebeurt. Het ministerie zegt toe zich hard te maken om dit onderzoek mogelijk te maken en is momenteel (mei 2018) aan het kijken naar financieringsmogelijkheden.

Waarom heeft het zo lang geduurd voordat het onderzoek is gestart?

Deze vraag wordt beantwoord door de kotterorganisaties en door EZ. Het meerjarenonderzoek is laat gestart door een combinatie van factoren: (1) het vinden van de financiering (2.5mln euro), (2) de aanbestedingsregels waar de overheid mee te maken heeft, en (3) het opzetten van de aanpak voor het onderzoek.

Het is belangrijk om niet uit het oog te verliezen dat er al heel lang onderzoek gedaan wordt naar de puls, ook in België, en dat dit meerjarenonderzoek niet het eerste onderzoek is. Eerst was het onderzoek gericht op de technische fase (ontwikkeling puls en experimenteren met commerciële toepassing op de UK153). De tweede fase richtte zich op het basisonderzoek. Dat basisonderzoek leidde ertoe dat in Brussel de "seinen op groen" gingen (2014). De derde fase waar we nu in zitten is de verdiepingsslag. Uitkomsten uit het basisonderzoek en het lopende onderzoek leidden ook tot nieuwe vragen.

Zorg: de garnalenpuls is efficiënter dan de gewone klossenpees

Kennis over de vangst efficiëntie van de garnalenpuls komt uit verschillende onderzoeken in het veld uitgevoerd door het ILVO. Uit het veld blijkt dat de puls in sommige gevallen efficiënter is dan de conventionele kor met klossenpees. Dit is echter afhankelijk van het seizoen en van de optuiging. Het ecologische voordeel van de garnalenpuls; minder bijvangsten is ook sterk afhankelijk van de optuiging; Hoe

minder klossen, hoe minder bijvangsten. Om het moment wordt er een onderzoek uitgevoerd naar de vangsten van garnalenpuls ten opzichte van garnalenvissen met klossenpees. Bij dit onderzoek zijn de 5 actieve garnalenpulsers in Nederland betrokken.

Een van de deelnemers stelt; of allemaal aan de puls of niemand. Dit is als het gaat om concurrentie verreweg het eerlijkst. Ministerie reageert dat in de huidige context een uitbreiding van het aantal vergunningen op de korte termijn niet reëel is. Op de lange termijn is de intentie wel dat er meer puls mogelijkheden komen, ook voor de garnalenvissers, maar dit is afhankelijk van de uitkomsten van de Europese discussies. Vanuit het publiek wordt benadrukt dat bij invoering van een nieuw tuig dat potentieel efficiënter is het van belang is dat wordt nagedacht over beheer. Met de huidige vloot is al sprake van een groei-overbevissing. Dat kan alleen maar erger worden. Het ministerie reageert dat het punt is genoteerd, maar dat zoals hierboven is aangegeven er geen ruimte is om na te denken over uitbreiding. Daarvoor moeten we eerst maar eens kijken in welke mate we door mogen gaan met puls.

Wat is de reden voor het verbod op pulsvisserij in China?
De puls in China leidde tot expansie en overbevissing. Er was geen enkele begrenzing in de vorm van een beheer voor duurzame visserij. Het is belangrijk effecten die optreden omdat er geen goed beheer is, niet te verwarren met effecten van het vistuig. Met ieder vistuig, of het nou puls of andere sleepnetten of passieve tuigen betreft, kun je een bestand overbevissen of significante schade aan het ecosysteem toebrengen als het visserijbeheer niet op orde is.

Bijlage 1: Aanwezigen[2]

Naam	Organisatie/ vaartuig
Johan K. Nooitgedagt	NVB
Mark Nijhof	Heiploeg
Pieter van de Vis	TX21
Richard van de Vis	TX21
Kees Droog	WON17
Bouke Smid	WK10
Egbert van der Tuin	NVB
Corrie Nagel	HA31
Anneke Koornstra	Ons Belang
M. Koornstra	HA41
S. Koornstra	HA4
DW van tuinen	NVB
Jan de Vries	LO5
S. Verroen	Fish and Farm
M. Drijver	Visned
G.J. Wiegman	PO Wieringen
Maarten Soetaert	ILVO
Adriaan Rijnsdorp	WMR
Josien Steenbergen	WMR
Jimmy van Rijn	WMR
Evelien Ranshuysen	Ministerie LNV
Herman Snijders	Ministerie LNV
Wilbert Schermer Voest	Ministerie LNV
Jan De Haan	WR57
A. Stouten	GO57
Johan Rispens	ZK18
Jelle van der Burg	WR212
Rein van der Burg	WR212
Gerard Kranendonk	WR12
Sietze Miedema	OL37
Wim Zaalmink	WEcR

[2] Zo goed als compleet, echter enkele aanwezigen hebben zich niet geregistreerd.

Bijlage 2: Presentatie Adriaan Rijnsdorp - Pulsonderzoek en zorgen over negatieve effecten pulsvisserij
Start op de volgende pagina

Bijlage 3. Uitslagen Mentimeter
Volgt direct na bijlage 2.

Annex 3 Total list of concerns, including type of source and category

Concerns that were identified in different sources: media, meetings with Dutch fishermen, or other (e-mail; France' request to ICES to advise on the ecosystem effects of the pulse trawl; round-table meeting between fisheries, science and government representatives from both France and the Netherlands; question and answer session with elasmobranch experts; statement of the Danish Fishermen Producer Organisation). Colour code: green means that the concern is covered by completed or ongoing research; orange concerns are partly covered; and red concerns are not covered.

Nr	Concern	Source	Category
24	What is the chemical effect of pulse: on oxygen and nutrients	Media	Chemistry
25	Electrifying saltwater and organic material is known to produce harmful by-products such as chlorine and heavy metals.	Media	Chemistry
42	The technique's impact on eggs, juveniles, plankton, water chemistry and electro-sensitive species likes sharks and rays has yet to be properly studied.	Media	Chemistry
85	There is a lack of research available on the impact of pulse trawling on ecological processes of the seafloor community, such as nutrient cycling, microbial assemblages and biogeochemistry.	Media	Chemistry
7	Pulse fishing damages seafloor, young fish, shellfish and invertebrates. "massacre under water"	Media	Ecology - Bottom Disturbance
16	Is bottom disturbance by pulse less than by traditional beam trawl?	Meetings	Ecology - Bottom Disturbance
17	Pulse trawlers extracting flatfish still use a thick cable (the footrope) that drags across the bottom, so the physical damage they cause remains extremely high	Media	Ecology - Bottom Disturbance
18	The Dutch pretend that their pulse gears of hundreds of kilos and 12 meters width hoover above the sea bottom and do not touch it. There is not enough evidence that there is hardly a physical impact of pulse on the seafloor	Media	Ecology - Bottom Disturbance
46	Industrial electric pulse trawlers plough up the seabed, indiscriminately electrocute all marine life and discard up to 60% of their catch	Media	Ecology - Bottom Disturbance
108	Bottom disturbance research is carried out in a small area (Vlakte van de Raan). Isn't that area too small for such research? Why is that area chosen?	Meetings	Ecology - Bottom Disturbance
127	What are long term effects on fish reproduction and functioning of the seafloor habitat? Long term monitoring is needed	Other	Ecology - Bottom Disturbance
1	What happens with the benthos when the pulse fishers move out of the mud grounds as agreed under the voluntary exclusion zoning?	Other	Ecology - Direct Effects
2	Is every organism in the wake of the pulse gear dead? How is that measured?	Meetings	Ecology - Direct Effects
3	What is the effect of pulse on food for seabass (zandspiering)?	Meetings	Ecology - Direct Effects
4	Does the technique transform the ocean into a desert?	Media	Ecology - Direct Effects

Nr	Concern	Source	Category
10	Pulse fishing creates a massacre in the sea and will change the seafloor into a desert	Media	Ecology - Direct Effects
11	Pulse fishery is non-selective and threatens all organisms at the sea bottom	Media	Ecology - Direct Effects
13	Possibly lethal effect of pulse on non-commercial species (slakdolf, pitvis, harnasmannetje, zandspiering, grondels, koornaarsvis, zeenaalden, spiering, sprot enz)	Media	Ecology - Direct Effects
14	Pulse is a disaster for biodiversity	Media	Ecology - Direct Effects
15	Fishers in the southern North Sea have been reporting that since the industrial scale ramping up of electric pulse fishing in the area they have seen a drastic reduction in the key target species, sole, cod and seabass. They are also reportedly hauling large amounts of already dead fish and observing dead shellfish, starfish and small fish in areas fished by electro trawlers (southern North Sea = dead zone)	Media	Ecology - Direct Effects
37	Shrimp may be killed by pulse trawl: because of the electric shock they cannot jump away when the *onderpees* comes and hits them.	Media	Ecology - Direct Effects
47	Electrocution of the marine environment	Media	Ecology - Direct Effects
48	Electric fishing could damage the environment	Media	Ecology - Direct Effects
49	Dutch fishermen want to sterilise the sea for ecological reasons	Media	Ecology - Direct Effects
50	Pulse fishing is dangerous for the ecosystem	Media	Ecology - Direct Effects
51	Pulse is a weapon of mass destruction	Media	Ecology - Direct Effects
53	How sensitive is cod outside of the gear for pulse?	Meetings	Ecology - Direct Effects
54	Between 50 and 70% of large cod that come close to a passing electrode at realistic field strengths suffer fractured vertebrae. The cracking of their spinal columns through electric shocks also creates internal haemorrhages.	Media	Ecology - Direct Effects
55	Are the injuries observed in cod restricted to cod, or potentially present in all gadoids?	Other	Ecology - Direct Effects
56	many observations of burn marks, bruises and deformation of the skeleton	Media	Ecology - Direct Effects
57	Cod can get heavy cramps leading to breaking backbone	Media	Ecology - Direct Effects
58	Pulse knocks out all fish and leaves them broken and skinned	Media	Ecology - Direct Effects
60	More than 50% of cod that had been close to pulse had damaged spines.	Media	Ecology - Direct Effects

Nr	Concern	Source	Category
61	We question the last sentence of this point stating that the electric pulse is mild and that minimum disturbance occurs. Evidence presented in peer reviewed literature has shown that large gadoid fishes which come close to pulse trawls can suffer from haemorrhages and muscular contractions which cause breakages of the spine. Furthermore, any organism that comes into contact with the trawl is effectively electrocuted, this cannot described as minimum disturbance.	Other	Ecology - Direct Effects
62	Fish caught with pulse show burn marks, bruises and deformation of the skeleton	Media	Ecology - Direct Effects
66	80% of undersized plaice and sole dies due to the pulse	Media	Ecology - Direct Effects
84	What is the effect of pulse on organisms on the sea bottom?	Meetings	Ecology - Direct Effects
86	Could we have a beam trawler with small meshes fishing in the wake of a pulse trawler to study the catches?	Meetings	Ecology - Direct Effects
87	Small scale fishers who fish in an area where a pulse trawl has been find a desert/graveyard	Media	Ecology - Direct Effects
88	Small scale fishers who fish in an area where a pulse trawl has been find a desert/graveyard	Media	Ecology - Direct Effects
89	If a (sole) pulse vessel has been on a fishing ground, for days there cannot be fished for shrimp	Media	Ecology - Direct Effects
90	After passage of electric trawls there are no longer worms or shrimps.	Media	Ecology - Direct Effects
91	What is the effect of shrimp pulse on all organisms bigger than shrimp?	Meetings	Ecology - Direct Effects
101	A statistically significant lower survival rate for ragworm.	Media	Ecology - Direct Effects
102	Shrimp pulse fishing kills worms (of zagers). Normally a shrimp fisher does not catch worms, but in the trace of shrimper WR40 many dead worms were caught.	Media	Ecology - Direct Effects
112	What is the effect of pulse on seabed organisms?	Meetings	Ecology - Direct Effects
113	What are the effects of pulse fisheries (incl. illegal net adaptations) on the catches of young fish and how does that affect the French fisheries?	Other	Ecology - Direct Effects
115	What happens to elasmobranch species assessed so far after multiple exposures?	Other	Ecology - Direct Effects
120	More research needed regarding the impact of different frequencies and strengths of pulses on movement and attraction/avoidance	Other	Ecology - Direct Effects
122	There has to be a comparative study of survivorship between traditional beam trawling vs. pulse trawling vs. foil trawling without pulse! Just researching pulse trawling makes it difficult to compare, which stands at the core of determining whether this is a more sustainable method of fishing.	Other	Ecology - Direct Effects
124	What are the impacts of different gear types on different benthic habitats. Can pulse fishing have an impact on habitats not associated with impact by beam trawling at present?	Other	Ecology - Direct Effects

Nr	Concern	Source	Category
126	How can you extrapolate findings from a very resilient species like catshark onto other species? (different skin, body, sensor-morphology and physiology). Emery (1984) discusses the different impacts on fish with thicker skins and scales to electrofishing.	Other	Ecology - Direct Effects
19	Considerably higher bycatch rates for some species, compared to traditional beam trawls with sieve nets	Media	Ecology - Discards & Bycatch
20	Pulse fishing is not selective. About 60% of the catch is discarded	Media	Ecology - Discards & Bycatch
59	Pulses lead to suffering fish and more juveniles in the catch	Media	Ecology - Discards & Bycatch
3	What is the effect of pulse on food for seabass (zandspiering)?	Meetings	Ecology - Indirect Effects
4	Does the technique transform the ocean into a desert?	Media	Ecology - Indirect Effects
7	Pulse fishing damages seafloor, young fish, shellfish and invertebrates. "massacre under water"	Media	Ecology - Indirect Effects
8	Pulse fishing affects not only the wider marine environment, but also threatens juvenile fish and spawning grounds, meaning future fish stocks might be jeopardized.	Media	Ecology - Indirect Effects
10	Pulse fishing creates a massacre in the sea and will change the seafloor into a desert	Media	Ecology - Indirect Effects
32	Shrimp exposed to electric shocks have a significantly higher risk of subsequent infection with a virus	Media	Ecology - Indirect Effects
33	Pulse trawling allows shrimp fishers to operate in clear water and during daylight, when shrimp are inaccessible to conventional fishing, so this could greatly increase the catch rate.	Media	Ecology - Indirect Effects
35	Pulse fishing results in shrimp not returning to the coast - shrimp may get disoriented	Media	Ecology - Indirect Effects
36	Sole pulse fishing damages reproduction in shrimp (effects on egg carrying shrimp)	Media	Ecology - Indirect Effects
37	Shrimp may be killed by pulse trawl: because of the electric shock they cannot jump away when the *onderpees* comes and hits them.	Media	Ecology - Indirect Effects
38	Negative effects of pulse fishing on shrimp stock	Media	Ecology - Indirect Effects
39	Studies in freshwater suggest that electric shocks can be highly damaging to both fish eggs and fish embryos, but we have no idea whether the same effect occurs in salt water.	Media	Ecology - Indirect Effects
40	What is the impact on fish stocks in general, on eggs, juveniles or electrosensitive species like rays and sharks	Media	Ecology - Indirect Effects
41	What do we know about the effects on eggs, young fish, worms that are food for the fish?	Media	Ecology - Indirect Effects
42	the technique's impact on eggs, juveniles, plankton, water chemistry and electro-sensitive species likes sharks and rays has yet to be properly studied.	Media	Ecology - Indirect Effects
50	Pulse fishing is dangerous for the ecosystem	Media	Ecology - Indirect Effects

Nr	Concern	Source	Category
52	Knowledge gaps on the indirect effects of pulse trawling, such as on reproduction, incidence of disease and ecosystem-level impacts.	Other	Ecology - Indirect Effects
65	What is the delayed mortality and long-term population effects as well as sub-lethal and reproductive effects of pulse trawls? What are cumulative effects?	Other	Ecology - Indirect Effects
74	Pulse fishery will remove hiding and recovering places for brown shrimp in areas where the fishery for brown shrimp takes place.	Other	Ecology - Indirect Effects
84	What is the effect of pulse on organisms on the sea bottom?	Meetings	Ecology - Indirect Effects
85	There is a lack of research available on the impact of pulse trawling on ecological processes of the seafloor community, such as nutrient cycling, microbial assemblages and biogeochemistry.	Media	Ecology - Indirect Effects
91	What is the effect of shrimp pulse on all organisms bigger than shrimp?	Meetings	Ecology - Indirect Effects
111	What is the effect of pulse on shrimp reproduction?	Meetings	Ecology - Indirect Effects
112	What is the effect of pulse on seabed organisms?	Meetings	Ecology - Indirect Effects
115	What happens to elasmobranch species assessed so far after multiple exposures?	Other	Ecology - Indirect Effects
117	What are the long-term effects of electric currents, associated with pulse trawling, on elasmobranchs' ability to geolocate? Is it throwing sharks off their migratory route?	Other	Ecology - Indirect Effects
118	What is the overall long-term impact on elasmobranchs' sensor-physiology (analogous problems surrounding cabling around offshore wind parks etc.)?	Other	Ecology - Indirect Effects
119	What is the impact of pulse fishing on the food source of elasmobranchs? If shellfish for example get pulsed on numerous occasions within a short time period, what is the impact on them?	Other	Ecology - Indirect Effects
121	What is the impact of the animals that are not directly pulsed, but still exposed in surrounding waters?	Other	Ecology - Indirect Effects
124	What are the impacts of different gear types on different benthic habitats. Can pulse fishing have an impact on habitats not associated with impact by beam trawling at present?	Other	Ecology - Indirect Effects
125	Snyder (2003) looked at the internal injuries to fish by electrofishing that were not externally obvious, he also stated that electrofishing over spawning grounds can harm embryos. Would pulse fishing impact on the egg cases and development of juvenile rays if they were exposed to electrical current as they cannot move away from the approaching fishing gear?	Other	Ecology - Indirect Effects
127	What are long term effects on fish reproduction and functioning of the seafloor habitat? Long term monitoring is needed	Other	Ecology - Indirect Effects
63	There is a complete lack of controlled field research to know if lab findings can be applied to real world conditions.	Media	Ecology - Laboratory vs field
43	Catch of pulse fishers is of poor quality, stressed and often with hematomes. Fish cannot be used in kitchen.	Media	Fish Quality

Nr	Concern	Source	Category
44	>60% of the sole landed at Urk's auction is laded by pulse. Up to 40-58 cents more per kilo (except for the largest specimen). Pulse-caught sole looks better and is thicker.	Media	Fish Quality
45	The quality of fish caught by electric trawlers is perhaps less bad than that of conventional beam trawlers but it remains low compared to the quality of fish caught by artisans.	Media	Fish Quality
15	Fishers in the southern North Sea have been reporting that since the industrial scale ramping up of electric pulse fishing in the area they have seen a drastic reduction in the key target species, sole, cod and seabass. They are also reportedly hauling large amounts of already dead fish and observing dead shellfish, starfish and small fish in areas fished by electro trawlers (southern North Sea = dead zone)	Media	Fleet Behaviour - Competition
21	What is the difference in catch efficiency between traditional beam trawlers and pulse trawlers?	Meetings	Fleet Behaviour - Competition
22	Can lower sole catches by fishers using passive gear be explained by increased efficiency of pulse fishers?	Meetings	Fleet Behaviour - Competition
23	Plaice and dab catch by gill netters reduced drastically in last 2 years: could this be because the bottom is not trawled anymore (as by beam trawl) or is the pulse fishery too effective?	Meetings	Fleet Behaviour - Competition
70	3/4 of the Dutch sole is caught with pulse	Media	Fleet Behaviour - Competition
92	Pulse trawl fishing brings small-scale fishers to their knees (economically).	Media	Fleet Behaviour - Competition
93	Fish are monopolized by a few industrial fishers	Media	Fleet Behaviour - Competition
94	Technical innovation would induce the sacrifice of many fishermen to compensate for the efficiency gains of pulse vessels	Media	Fleet Behaviour - Competition
95	A ban on pulse fishing would be a social disaster for Dutch fishers: 60 fishers would lose their permit and their investment of 3 tons of euros	Media	Fleet Behaviour - Competition
96	If most sole off the coast of northern France is caught by Dutch fishers, this would endanger the existence of the local fishery	Media	Fleet Behaviour - Competition
97	Because of Dutch pulse fishers and their illegal activities in the Channel, sole catches in the area have decreased with 43% between 2013-2017.	Media	Fleet Behaviour - Competition
106	Fishers state that an area fished by pulse fishers is a dead zone. How come after the weekend the same pulse fishers have good catches in that same area?	Meetings	Fleet Behaviour - Competition
107	Could overfishing in the Channel reduce the influx of sole towards the southern North Sea?	Meetings	Fleet Behaviour - Competition
114	What is the effect of the pulse fisheries in the 'Belgian waters' on the catches of French and Belgian small-scale fishers in the most southern North Sea?	Other	Fleet Behaviour - Competition
26	Electric fishing allows boats to catch flatfish on muddy bottoms, which is difficult with conventional beam trawling, so it is likely to spread fishing damage into some of the few areas that were not previously being repeatedly wrecked	Media	Fleet Behaviour - Displacement
27	Pulse fishing is a strong competitor: vessels can fish on grounds where beam trawlers could not go.	Media	Fleet Behaviour - Displacement
28	Lighter pulse vessels can fish in areas which before were only accessible by small-scale fisheries	Media	Fleet Behaviour - Displacement

Nr	Concern	Source	Category
29	The impact of fishers moving into previously un-trawled muddy grounds around the mouth of the Thames Estuary is also under-studied.	Other	Fleet Behaviour - Displacement
30	The activity is also expanding into areas of softer ground not traditionally fished by towed gear, potentially increasing the footprint of beam trawling in the North Sea and causing gear conflicts and anecdotal local depletion of fisheries resources in inshore UK and French fisheries.	Media	Fleet Behaviour - Displacement
31	Did fishing intensity increase: more pulse fishing than tickler chain fishing in a coastal Belgian area?	Other	Fleet Behaviour - Displacement
123	Does pulse trawling allow fishermen to exploit new habitats that are not accessible to traditional beam trawling?	Other	Fleet Behaviour - Displacement
5	Increasing efficiency and increasing environmental impact (about fisheries in general, but also specifically about pulse) - fear for overfishing	Media	Management
6	Pulse fishing could lead to overfishing	Media	Management
9	Pulse fishing is decimating stocks in UK waters	Media	Management
12	The Dutch have ravaged the sea and there are no more fish. 4-5 years are needed to get the fish back at the French coast	Media	Management
38	Negative effects of pulse fishing on shrimp stock	Media	Management
64	It is unclear whether the current legislative framework is sufficient to avoid the deployment of systems that are potentially harmful for some marine ecosystem components (e.g. cod)	Other	Management
67	Lack of control concerning development of pulse fishing	Media	Management
68	The number of vessels using pulse has been totally uncontrolled	Media	Management
69	Pulse fishers do not comply with quota	Media	Management
76	Europe is using 'scientific research' as an excuse to kill marine life by trawling	Media	Management
77	Fishing with 84 vessels is no experiment, it is an industrial scale	Media	Management
78	The problem is that many fishing vessels are not scientifically monitored. They only tried the method without gaining data.	Media	Management
79	Dutch pulse fishers were fishing commercially under the disguise of science	Media	Management
80	Dutch government played tricks to get more permits	Media	Management
81	What Japan does with whaling, the Dutch do with pulse fishing	Media	Management
82	About 100 Dutch cutters fish for so-called 'scientific' ends	Media	Management
83	84 vessels equipped with pulse instead of 15	Media	Management
100	The EU and NL have provided the Dutch fleet with €5.9 million since 2015	Media	Management
103	Why did it take so long to start research on pulse effects?	Meetings	Management
104	Is shrimp pulse more efficient than the traditional shrimp trawl?	Meetings	Management
109	Why is there a prohibition of pulse fishing in China?	Meetings	Management
75	Electrocuted fish float up to the surface and are caught in the net	Media	Presentation
71	What does the voltage of pulse do to the catch?	Meetings	Pulse Characteristics

Nr	Concern	Source	Category
72	Which are the key pulse characteristics and thresholds below which there is no evidence of significant long-term negative impact on marine organisms and benthic communities?	Other	Pulse Characteristics
73	What are the pulse parameters used during fishing operations?	Other	Pulse Characteristics
105	Does fishing speed of a pulse vessel change over the years?	Meetings	Pulse Characteristics
116	Is it possible for a skipper to change the pulse settings?	Other	Pulse Characteristics

Annex 4 List of questions gathered by ISAC

(Rephrased) questions resulting from the inventory by the International Scientific Advisory Committee, organised by category: bycatch, ecosystem, management and socio-economics.

In each category the order of rows is based on the number of votes given to the question by stakeholders (n=12). Stakeholders were requested to participate in a voting procedure, to establish a ranking in questions. For each of the question categories a limited number of votes was permitted (shown below with the total number of questions given in []):

- Bycatch = 4 votes [14]
- Ecosystem = 11 votes [38]
- Management = 3 votes [10]
- Socio-economic = 3 votes [11]

A total of 12 respondents participated in the ranking exercise:

- Commercial fishers: 4
- Recreational fishers: 1
- eNGO: 3
- Research Scientists: 1
- Process/retail: 1
- Government: 2

Stakeholder Questions	Category	Votes #
What is the mortality of the different target and by-catch species that have been in contact with the gear but have escaped, for either gear type?	Bycatch	8
What are the effects on non-target, non-commercial fish species from all types of pulse trawling? (For example effects on sandeel, gobies, dragonets, elasmobranchs or other characteristic species in areas that are pulse fished?)	Bycatch	8
How does the mortality risk for target and non-target species change when the pulse characteristics are altered, what are the optimum characteristics of the pulse to enable commercial catches while minimising impacts?	Bycatch	7
What is the physiological impact on fishes caught by the Pulse trawl but that then escape the net? Is predation risk increased for these fish in the short to medium term and are their long-term effects of spawning potential?	Bycatch	6
What is the quantity of dead discarded and escaped flatfish generated by pulse trawlers during normal commercial practice and what is the impact of this on other fisheries (there is considerable stakeholder interest in whether the ad hoc occurrences of substantial quantities of dead/decomposing flatfish witnessed by inshore trawlers and netters is attributable to the nearby operations of pulse trawlers)?	Bycatch	5
What is the impact of the pulse trawl on sole juveniles (and other species)?	Bycatch	3
Do different sizes and species of fish respond differently to the electrical pulses (i.e. have higher or lower catchability and mortality)?	Bycatch	3
What are the direct effects of pulse gear on elasmobranches i.e. mortality/stress response/disturbance	Bycatch	2
Electrical barriers have been used as a fish deterrent (i.e. power plant inlets) – would a similar effect of a round fish deterrent be in evidence during the pulse trawling operation?	Bycatch	2

Stakeholder Questions	Category	Votes #
When using pulse technology commercially, what are the physical characteristics of the pulse that can be modified [legally], and how does modifying the pulse characteristics affect catch performance?	Bycatch	1
Does the number of small cod that pass into the net and out through the meshes of the net differ between pulse and the traditional trawl?	Bycatch	1
Does pulse trawling change mesh selectivity (increase or decrease selection parameters L50% and SR) of the codend for target and bycatch fish-species?	Bycatch	1
What explains the cause of the initial positive findings in pulse trawl studies compared with less positive results in the more recent studies?	Bycatch	1
What are the effects of pulse fishing on under-sized cod when measured in field experiments using net covers to retain the cod?	Bycatch	0
What are the long-term effects on populations of plants and animals living in and on the seabed (including mortality over longer time, reproduction, juvenile stadia and growth) in areas that have a been exposed to pulse fishing for years?	Ecosystem	7
Are there potential effects of cumulative exposure to pulse DC, and what are the effects of cumulative exposure specifically on benthos and on eggs/larvae (with initial focus on commercial fish species)?	Ecosystem	6
What are the long-term effects of repetitive sub-lethal exposure to pulse trawling to benthic and (epi)benthic microbiota?Focused on the effects of the electric component of the pulse trawl (so not the physical disturbance)	Ecosystem	6
What are effects of electric pulses on species with electro-receptor organs, both from a single trawl and cumulatively?	Ecosystem	6
What is the effect of pulse gear on elasmobranch, specifically on skates, and other Endangered Threatened and Protected species?	Ecosystem	6
What is the effect of encountering a pulse trawl on escapees (fish coming into contact with the gear but not fished up)?	Ecosystem	6
What types of North Sea environments are the most vulnerable to pulse fishing?	Ecosystem	6
What are the consequences of long term effects of repetitive sub-lethal exposure of (epi)benthic microbiota for the food web?	Ecosystem	5
What are the effects of pulse trawling on eggs, larvae and juveniles residing in and around the benthos?Focused on the effects of the electric component of the pulse trawl (so not the physical disturbance)	Ecosystem	5
What is the effect of pulse fishing on different sizes of cod, including juveniles, especially when fishing in areas containing many cod (northern North Sea)?	Ecosystem	5
How do the ecosystem effects of pulse trawling compare with that of traditional methods?	Ecosystem	5
What are the effects on benthic invertebrate fauna in areas that are pulse fished?(for example infauna such as polychaetes or bivalves as well as mobile epifauna such as crab species)	Ecosystem	4
What is the mid to long term Impact on benthic communities of pulse trawls?	Ecosystem	4
What is effect of pulse trawling on the interaction between benthic and pelagic habitats?	Ecosystem	4
What are the effects of electric pulses on the biogeochemistry of the water column?	Ecosystem	4
What are the effects of electric pulses on larvae and juveniles residing in and around the benthos, both from a single trawl and cumulatively?	Ecosystem	4

Stakeholder Questions	Category	Votes #
Is pulse trawling less impacting on the marine ecosystem than traditional beam trawling?	Ecosystem	4
What type of impact can pulse fishing have on the functioning of ecosystems?	Ecosystem	4
What is the influence of pulse-trawling on invertebrates, particularly all life-history stages of Crangon crangon?	Ecosystem	3
By how much does pulse trawling reduce or increase the mortality of benthic organisms in the sediment, depending on habitat type, compared to regular beam trawling?	Ecosystem	3
How do the (potential) effects of pulse trawling on epi(benthic) microbiota and associated consequences to biogeochemistry and the food web translate into effects on fish stocks?	Ecosystem	3
What is the mpact of pulse trawls on local biogeochemistry?	Ecosystem	3
Does pulse fishing have a chemical impact on benthic ecosystems?	Ecosystem	3
What is the impact on larvae and eggs of sole (survival rate after the passage of the pulse trawl)?	Ecosystem	3
Is the recruitment of juvenile sole linked to the occurrence of pulse trawling?	Ecosystem	3
What are the effects on the fish that are exposed to the electric pulses but not caught in the pulse trawl net?	Ecosystem	3
How can pulse trawling be improved to produce more environmentally friendly impacts?	Ecosystem	3
What are the consequences of long-term effects of repetitive sub-lethal exposure of (epi)benthic microbiota to biogeochemistry?	Ecosystem	2
What are the immediate and medium-term effects of pulse gear on the biogeochemistry of the area swept?	Ecosystem	2
What is the response of Ichthyoplankton and other Zooplankton to the exposure by a range of pulse parameters representative for the commercial pulse trawls?	Ecosystem	2
What are the differences in terms of noise generation between pulse and other fishing gears and are they significant in comparison to other sources of noise?	Ecosystem	2
What are the effects of pulse gear on invertebrate infauna and epifauna? e.g. mortality/disturbance?	Ecosystem	1
What are the effects of electric pulses on microbenthos, both from a single trawl and cumulatively?	Ecosystem	1
What are the effects and persistence of effects of pulse fishing on the bio-geochemistry of the swept area of sediment?	Ecosystem	1
Is it possible to map the overlap of pulse trawl activity and sole habitats at different functional stages of the life cycle?	Ecosystem	1
What is the impact of pulse trawling on species protected within MPAs?	Ecosystem	1
To what extent can the results of the research on ecological impact of flatfish pulse trawling can be transferred to shrimp beam trawling ?	Ecosystem	1
What effect does commercial pulse trawl operation have upon site fidelity and life history characteristics of commercially important thornback ray (Raja clavata) stocks within the Thames Estuary, UK? (with specific regard to their electro-detection ability and site fidelity within preferential feeding, reproductive, spawning and nursery grounds)	Ecoystem	0
Pulse gear is lighter than conventional gear this has caused a displacement into other areas (inshore), is there a way to research detrimental effects that this has had afterwards?	Management	6
How has the distribution and intensity of the beam trawl fishery changed since the advent of pulse fishing ?	Management	5

Stakeholder Questions	Category	Votes #
What are the trends in the distribution and frequency of this gear since its introduction? (For example has and will the swept area increase or decrease, how many more or fewer vessels will pulse fishing in the coming years, bearing in mind changes in efficiency and limitations of TACs?)	Management	5
Does science indicate the need for specific controlled frequency parameters outside of the original EU voltage limit?	Management	5
How is the ability to alter pulse characteristics best regulated?	Management	4
How can we prevent/control an increase in fishing effort and fishing mortality using pulse trawl?	Management	4
How will Netherland ensure that the voltage, not at any time exceed 60 volts?	Management	4
Where a fishing vessel may work at higher than allowed voltages (even at extremes) can this be shown to increase (or otherwise) vessel catch rates?	Management	1
How will Netherland monitor and ensure that no powered pulse fishing is carried out north of 55 degrees?	Management	1
Are there wishes to expand the pulse area to the north (north of 55 degrees)?	Management	1
How can experimental fisheries be regulated in such a way that a new fishery is truly experimental until it is proven to not have detrimental effects?	Socio-economic	8
How have different stakeholders been affected by the transition of the Dutch fleet to pulse fishing? (social and economic study on the relative losses and gains of different groups of European stakeholders, who lost something and who gained something, in other words: how did pulse fishing change the distribution of rights and resources?). (This question is useful in order to better understand why pulse fishing is such a politically sensitive topic and maybe this helps to think of solutions to also make the people benefit who feel they lost something).	Socio-economics	6
How much more or less efficient is the pulse trawling than beam trawling? (For example has there been an increase or decrease in the 'hours fished : tonnes of target fish caught' ratio with pulse fishing)	Socio-economics	4
How does the impact in terms of biodiversity loss and CO-2 emission per kg of fish caught by a pulse vessel compare to the impact per kg of the same fish species caught by other commonly used fishing gears (and maybe experimental fishing gears that could be used in the near future)?	Socio-economics	4
What would be the consequences of a ban on pulse fishing for employment opportunities in the entire production chain (producers of the pulse technique, cooperation's, fishing sector, fish auction, fish traders, retail, etc.)?	Socio-economics	3
When valuing the impact on marine habitats and the fuel efficiency, how does the balance look like for pulse trawling compared with tickler chain trawling?	Socio-economics	3
Who are the consumers of fish that is produced by the Dutch pulse fishing sector? What alternative food products would these consumers have in case of a ban on pulse fishing? (in terms of nutritional value and accessibility)	Socio-economics	2
What is the energy-efficiency (litres of fuel/kg catch of target species) of pulse trawling compared to regular beam trawling?	Socio-economics	2
How does the impact, in terms of CO-2 emission and biodiversity loss, of the animal proteins produced by the pulse trawl compare to the impact of the production of other animal proteins (i.e. chicken, beef, pork, aquaculture seafood).	Socio-economics	2

Stakeholder Questions	Category	Votes #
To what extent is the current situation with pulse fishing on shrimp harmful for the image regarding pulse fishing in general - and perhaps a menace for the flatfish pulse - since studies indicate that the impact of the shrimp pulse is less then the flatfish pulse?	Socio-economics	1
Is applying the pulse trawl a cost-efficient measure to fulfil the obligations of the MSRL? What costs and benefits (in monetary terms) are involved when using the pulse trawl?	Socio-economics	1

Annex 5 Summary table of studies on pulse fisheries

This summary table containing an overview of the type of studies that have been carried out on pulse fishing is based on Annex 4 of the ICES WGELECTRA report 2018. The results on pulse fishing for ensis are not included in this table.

ICES 2018. Report of the Working Group on Electrical Trawling (WGELECTRA). 17–19 April 2018, IJmuiden, the Netherlands ICES CM 2018/EOSG:10. 155 pp.

Subject	Type of pulse fishing		
	Various	Brown shrimp	Flatfish
Catch composition		Catch efficiency Bycatch	Catch efficiency Bycatch
Fishing effort			Trends overall effort Fishing intensity vs. exposure of organisms Local competition Fuel costs
Mechanical impact		Seabed disturbance	Seabed disturbance
Discard survival			(Delayed) Mortality and vitality of sole, plaice and dab
Effect of the pulse field on:			
Cod		Swimming behaviour Spinal fractures Histological examination Reproduction Mortality of embryos, larvae and juveniles	Spinal fractures various length classes
Whiting			Spinal fractures
Seabass			Spinal fractures
Plaice		Swimming behaviour	
Sole	Mortality Injuries (macro and micro)	Swimming behaviour Reproduction Mortality of embryos and larvae	
Dab	Injuries (macro and micro) Skin ulceration		Injuries
Catshark		Prey detection	Mortality Injuries Prey detection Reproduction
Lesser spotted dogfish			Behaviour (Delayed) Feeding behaviour (Delayed) Injuries (Delayed) Mortality (Delayed) Egg production
Bullrout & Armed bullhead		Behaviour Spinal fractures Macrospocic lesions Microscopic lesions	

Subject	Type of pulse fishing		
	Various	Brown shrimp	Flatfish
Swimming crab			Behaviour
Hermit crab	Behaviour		Behaviour
European green crab			Behaviour, Food intake & survival
Common prawn	Behaviour		
Brown shrimp		Behaviour Direct mortality Delayed mortality Injuries Egg carrying	Behaviour Mortality Injuries Moulting rate Egg loss Delayed survival and lesions Viral infections
Echinodermata	Behaviour		Behaviour Survival
Polychaetes		Delayed mortality	Behaviour Survival Delayed survival and lesions
Bivalbes	Behaviour		Behaviour Survival
Whelk	Behaviour		

Annex 6 Sustainability score card: comparison pulse trawl versus tickler chains

Preliminary assessment of the contribution of the pulse trawl to improve the sustainability of the sole trawl fisheries by reducing the adverse impact on the environment, benthic ecosystem and marine organisms, and the consequences for the sustainable management of commercial stocks and socio-economy. The colour code shows whether the pulse trawl is an improvement (green) or deterioration (red) compared to the tickler chain trawl. The intensity of the colour reflects the degree of support and uncertainty.

Rijnsdorp, A.D., 2018. Preliminary assessment of the reduction of the ecological and environmental impacts of the tickler chain beam trawls by pulse trawls in the North Sea fishery for sole and plaice. Brief report Wageningen Marine Research, reference 1802455 AR-bc.

	Impact of pulse trawl relative to tickler chain trawl	Strength of support (1=proven; 2=indicative 3=inferred)	Uncertainty 1=low 2=medium 3=high	Comment	Source
Environment					
CO2 emissions	46% lower	1	1	Due to lower fuel consumption	Turenhout et al (2016)
Seafloor disturbance	~50% lower	1	1	Due to lower towing speed and reduced penetration in seabed	Polet et al (2017); Depestele et al (2016, 2018)
Pollution	Reduced	3	1	Due to lower towing speed and lighter gear the wear of the gear is reduced	
Benthic ecosystem					
Impact on benthic biomass	~50% lower	1	2	Due to lower towing speed and reduced penetration in seabed the mortality of mechanical disturbance is reduced	Polet et al (2017); Depestele et al (2016, 2018)
Ecosystem functions	improved	2	2	Logical consequence from the above	
Marine organisms					
Fractures / haemorrhages due to electrical	Increased	1	1	In cod (9%) and whiting (2%) but not in flatfish. The incidence rate is un-	Van Marlen et al. (2014); De Haan et al

	Impact of pulse trawl relative to tickler chain trawl	Strength of support (1=proven; 2=indicative 3=inferred)	Uncertainty 1=low 2=medium 3=high	Comment	Source
pulse				certain (small sample size) Cod, whiting relative small proportion of total catch	(2016); Soetaert et al (2016a, 2016b)
Fractures / haemorrhages due to catch process	reduced	2	2	Lower towing speed and cleaner catch	Uhlman et al (2016)
Skin lesions / scale loss	reduced	2	2	Lower towing speed and cleaner catch	Uhlman et al (2016); Schram & Molenaar (2018); van Beek et al (1990)
Discard survival	improved	1	1	Lower towing speed and cleaner catch. Only in roundfish pulse may increase mortality due to spinal fractures (uncertain)	Van der Reijden et al (2017); Schram & Molenaar (2018)
Development and growth eggs and larvae	No or small adverse effect	2	2	Experiments with cod and sole	Desender et al. (2017b); Desender (2018)
Mortality of invertebrates	No, or small adverse effect	2	2	Few experiments	Soetaert et al (2015, 2016c)
Behaviour	No effect	2	2	catshark	Desender et al (2017a)
Management of commercial stocks					
Species selectivity	More sole	1	1	Increased catch rate of sole relative to other species	ICES (2017a)
Size selectivity	No effect on size selectivity	2	2	Conflicting evidence from comparative fishing trials	ICES (2017a)
Discards (fish)	Reduction in discards relative per kg sole	3	3	Inferred from higher selectivity of sole	
Discards (benthos)	Substantial reduction	1	1		ICES (2017a)

	Impact of pulse trawl relative to tickler chain trawl	Strength of support (1=proven; 2=indicative 3=inferred)	Uncertainty 1=low 2=medium 3=high	Comment	Source
Risk of overfishing	No effect	1	1	TAC restrict fishing effort North Sea flatfish fisheries	ICES (2017b, 2017c)
Socio-economic					
Competition with other fishing fleets	increase	1	1	If fishers exploit the same grounds	Sys et al (2015); Rijnsdorp et al (2008)

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Wageningen Marine Research is the Netherlands research institute established to provide the scientific support that is essential for developing policies and innovation in respect of the marine environment, fishery activities, aquaculture and the maritime sector.

Wageningen University & Research:
is specialised in the domain of healthy food and living environment.

The Wageningen Marine Research vision
'To explore the potential of marine nature to improve the quality of life'

The Wageningen Marine Research mission
- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- Wageningen Marine Research is an independent, leading scientific research institute

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