CRANGON PULSE TRAWL

15/8/2016

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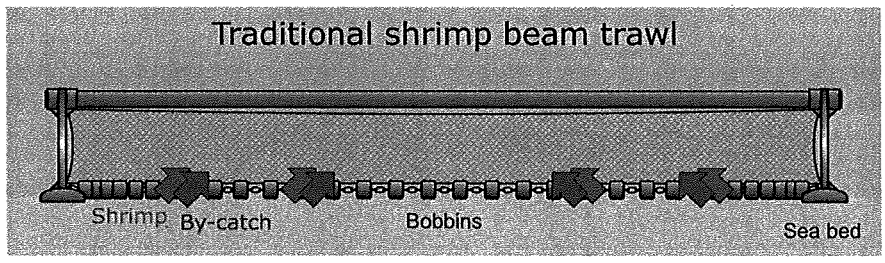
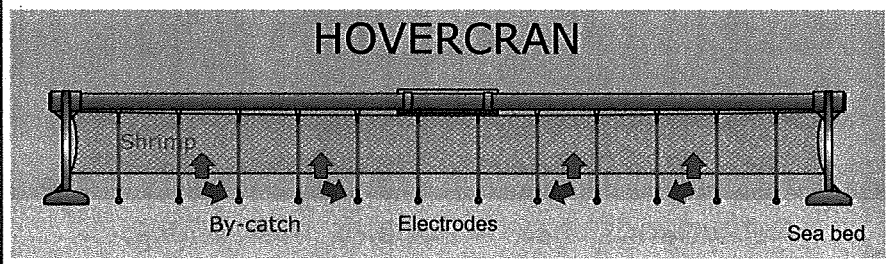
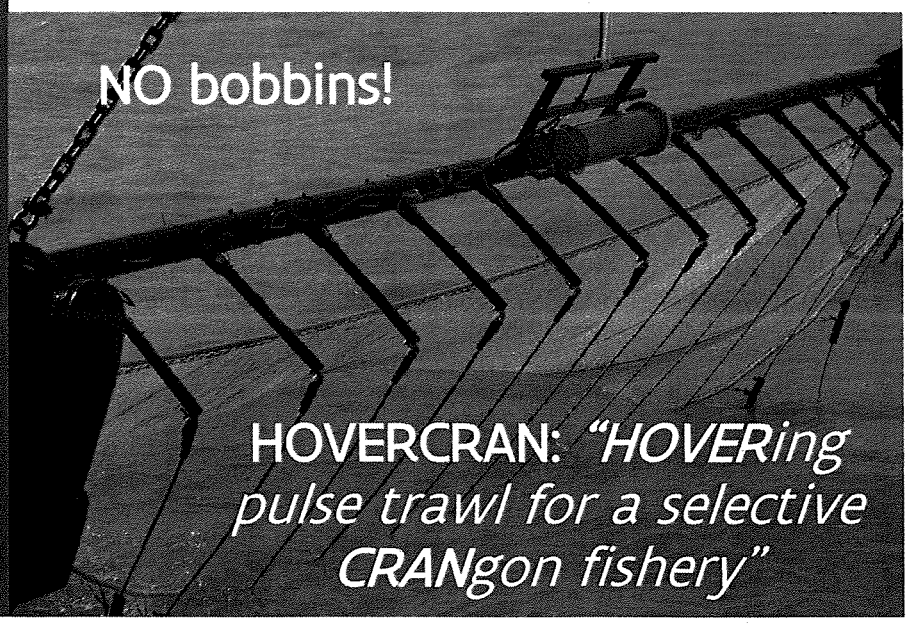
Instituut voor Landbouw- en Visserijonderzoek

Basic idea from the start





Basic idea: O 191 (2008 – 2010)



In practice

- The Netherlands: 5 vessels
- Germany: 2 vessels
- Belgium: 1 vessel, soon 2
- Almost all are equipped with the same Marelec system
- Subtle (and less subtle) differences in gear design lead to variable efficiency and by-catch levels: Controversy

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In practice

- Has led to EXTRA technical requirements in the Netherlands: max. 14 bobbins, max. 250kg, ...

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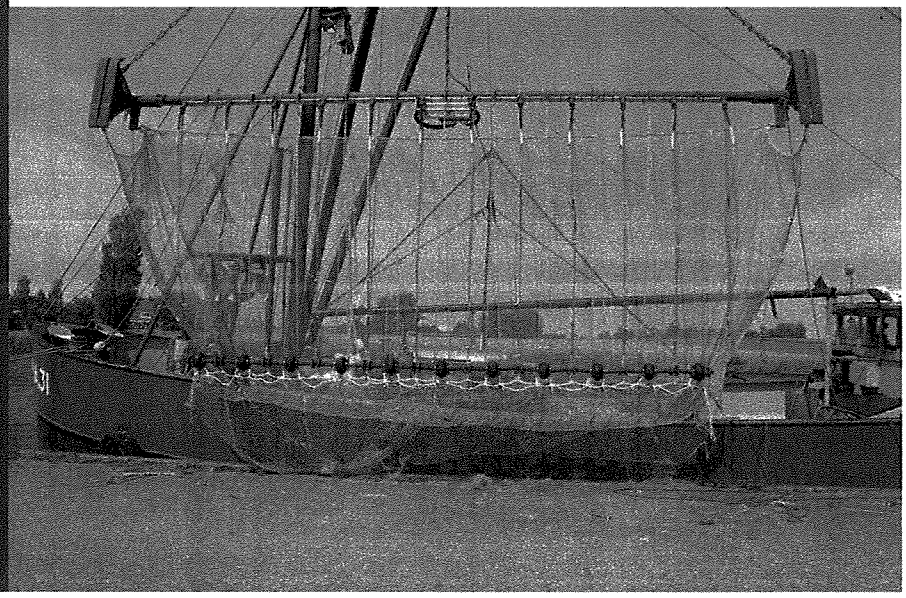
Case Study: Seasonal catch comparison HA 31



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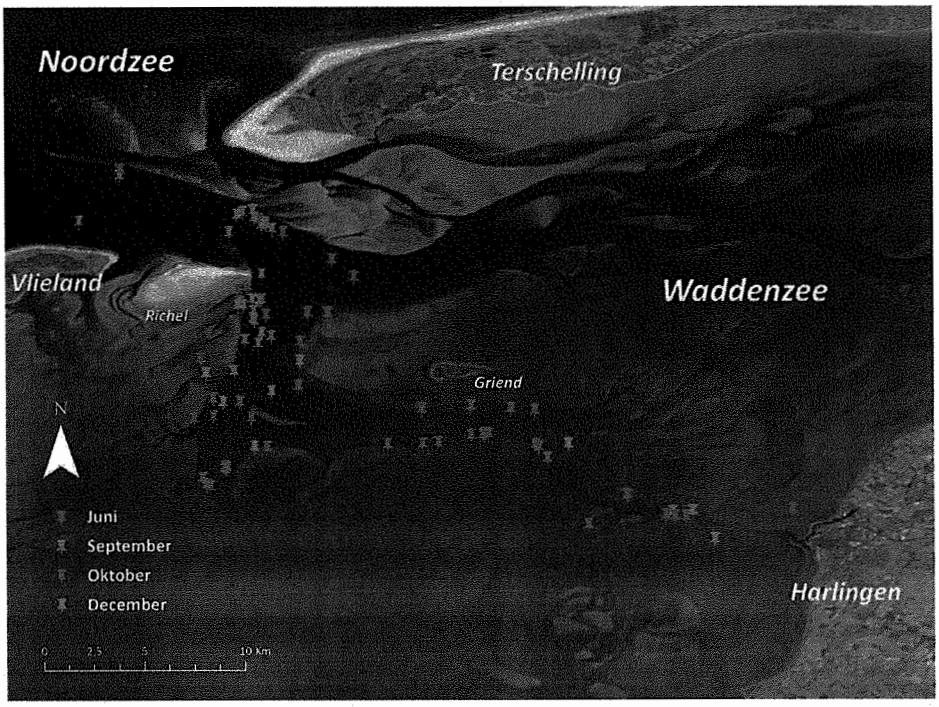
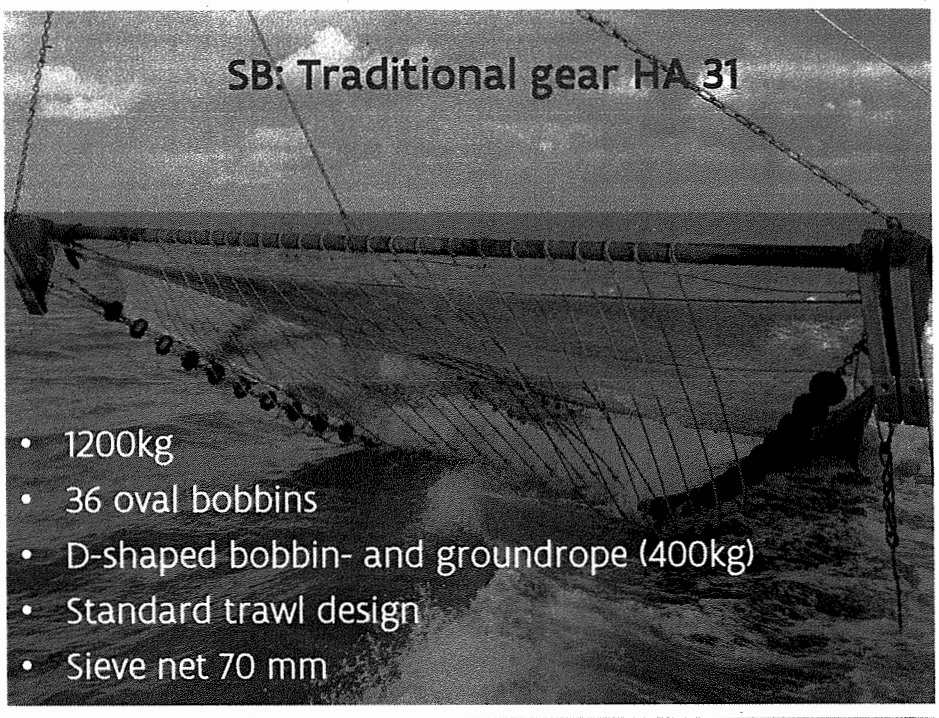
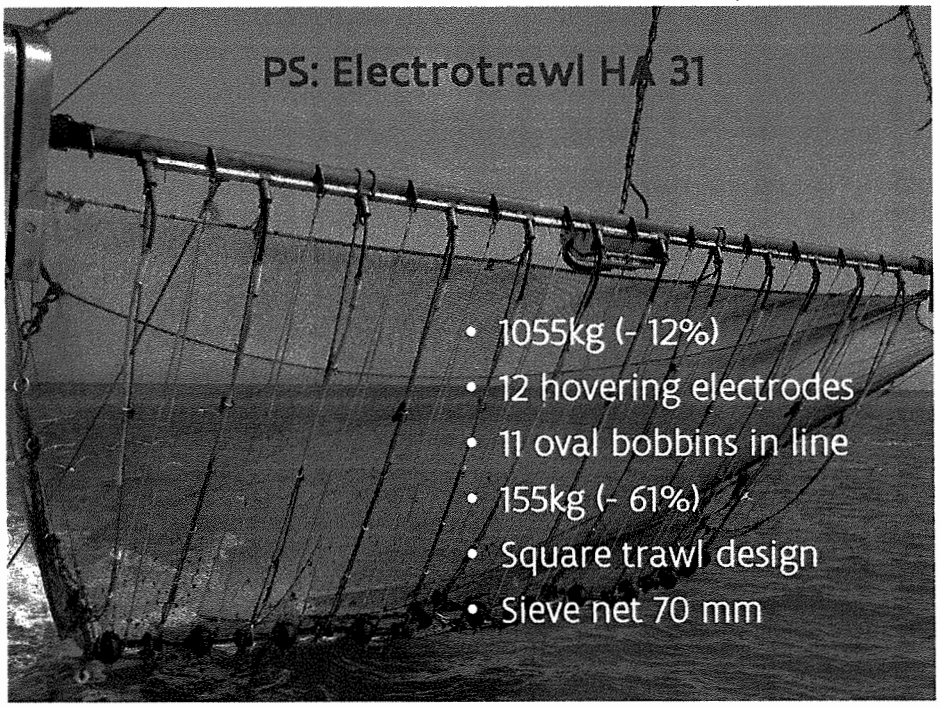

Noordzee
Terschelling
Vlieland
Richel
Waddenzee
Griend
N
Juni
September
Oktober
December
Harlingen
0 2.5 5 10 Km


SB: Traditional gear HA 31
• 1200kg
• 36 oval bobbins
• D-shaped bobbin- and groundrope (400kg)
• Standard trawl design
• Sieve net 70 mm


PS: Electrotrawl HA 31
• 1055kg (- 12%)
• 12 hovering electrodes
• 11 oval bobbins in line
• 155kg (- 61%)
• Square trawl design
• Sieve net 70 mm

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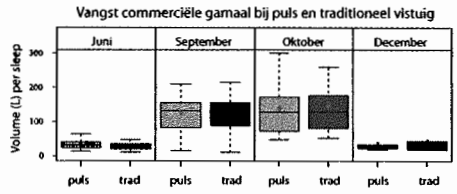
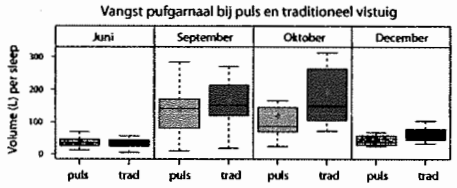
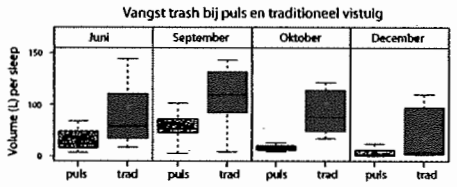
Results







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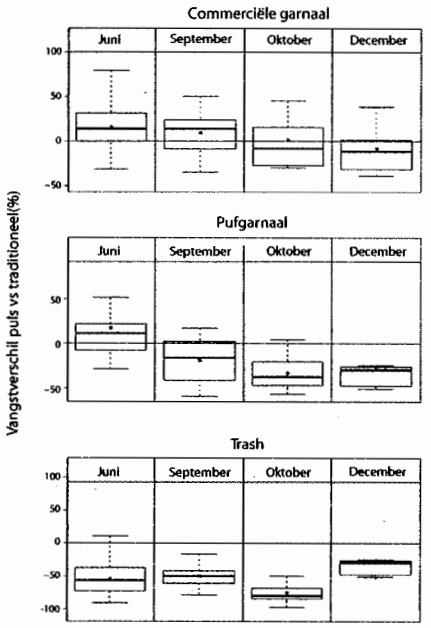
Results



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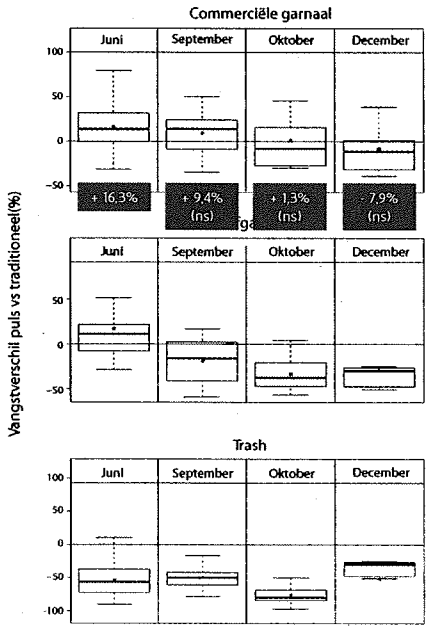

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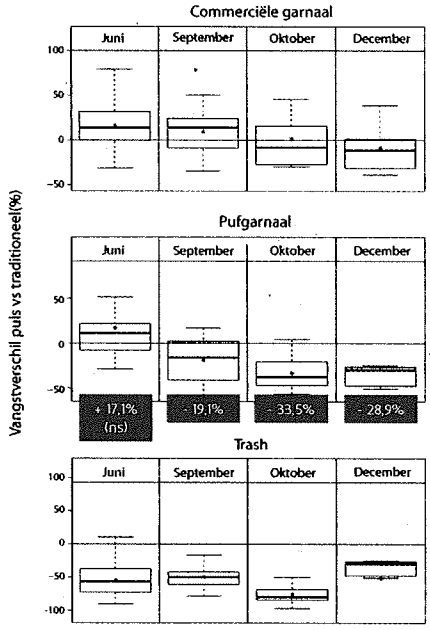
Results



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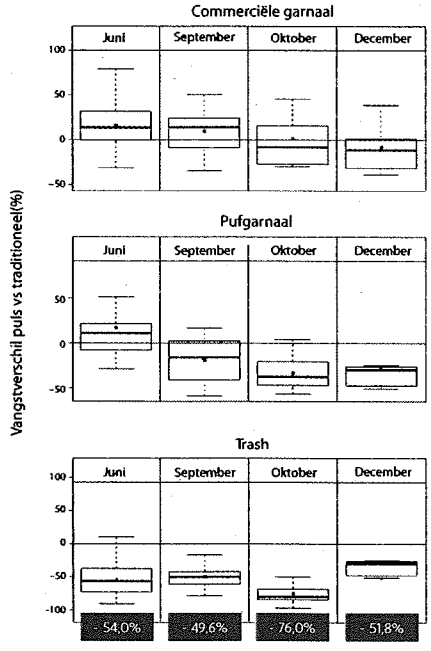

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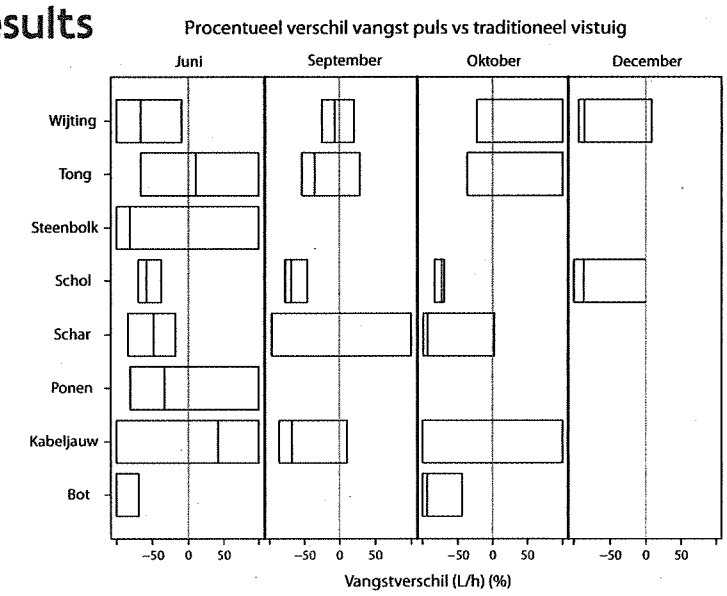
Results



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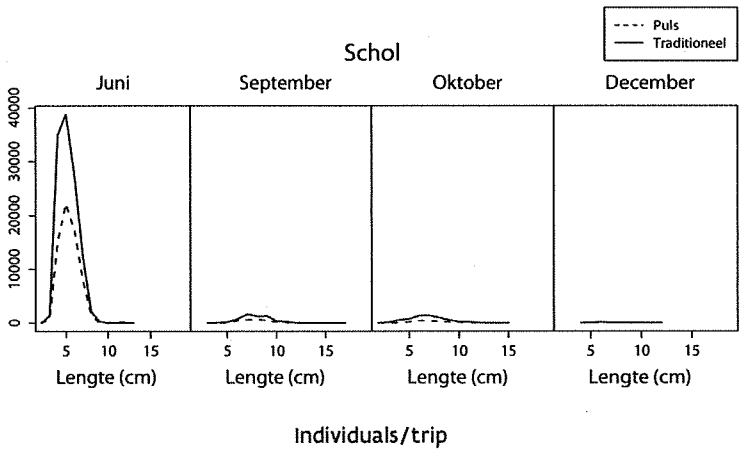
Results



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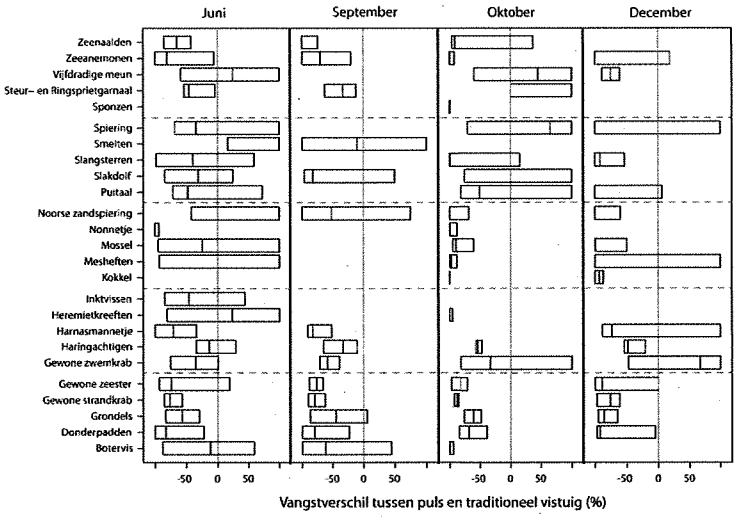
Results



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Conclusions

- Increase in commercial catch: max. 9% (early summer)
- Reduction in discarded shrimp: -19 to -31%
- By-catch reduction: -50 to -76%
- Reduction drag resistance: -23%
- Unique configuration (1 out of many): Importance of bobbin rope design

	Hauls	Total Pulse (L)	Total Traditional (L)	Factor	% Difference
Commercial shrimp	72	6495	6350	0,98	-2%
Discarded shrimp	71	6466	8202	1,27	21%
Non-shrimp discards	73	1323	3917	2,96	66%

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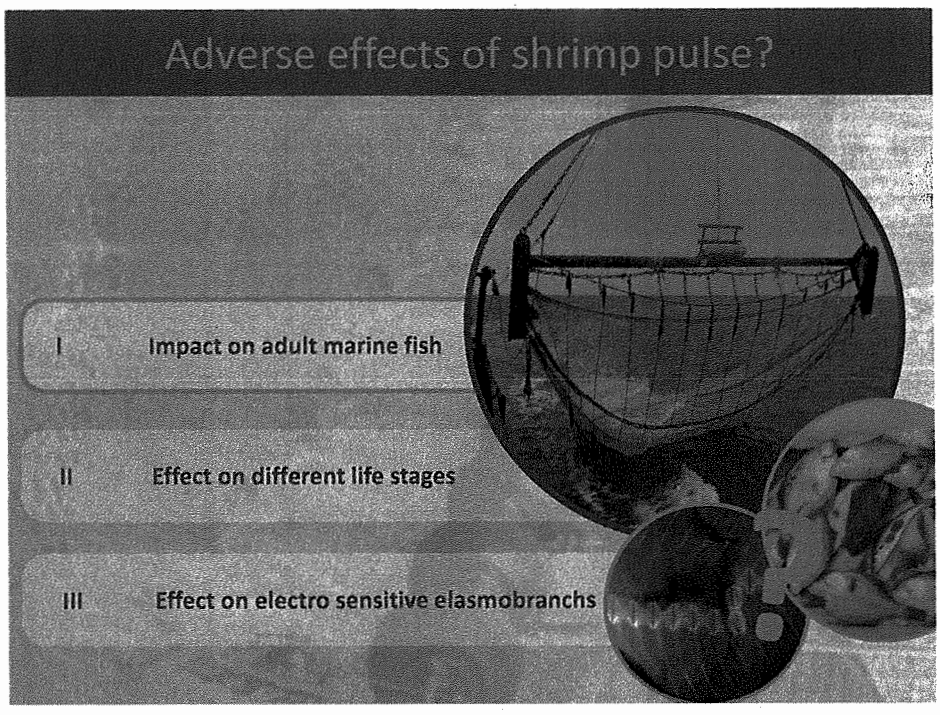
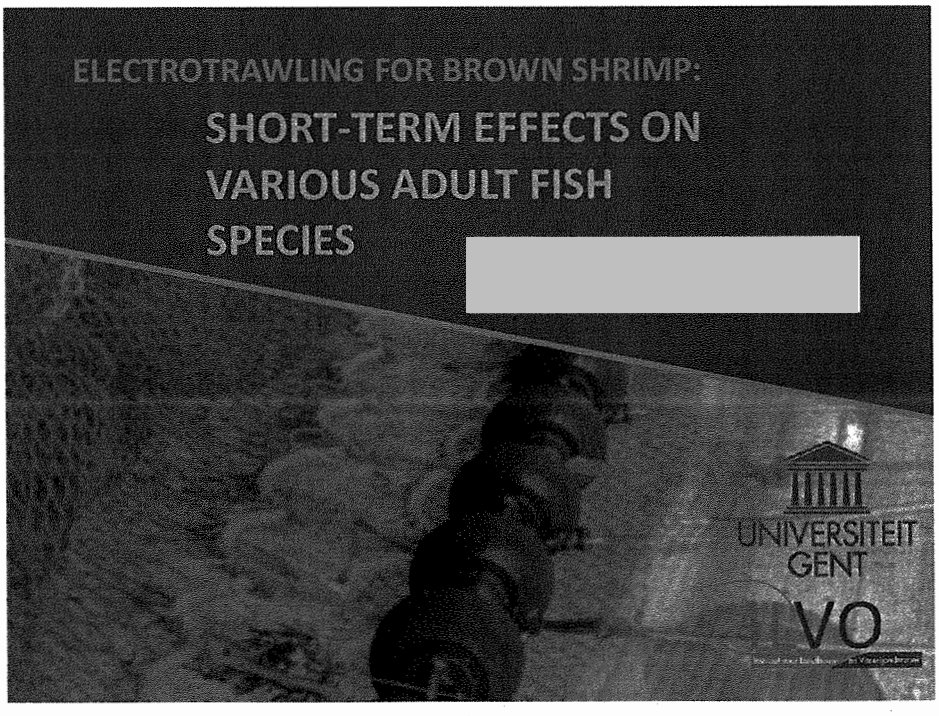
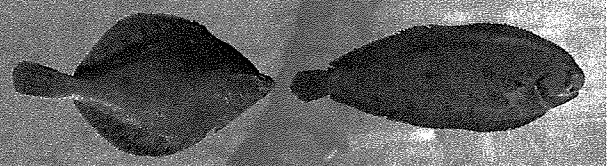


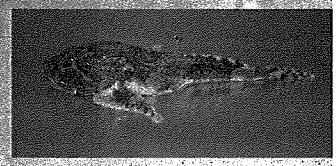


Material & Methods

SPECIES



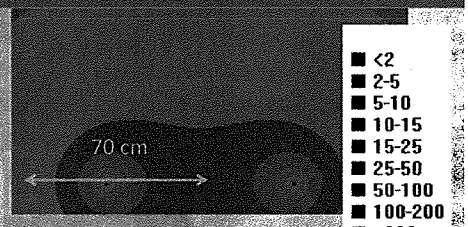
# 220	Exposed	Control
Plaice	25	24
Sole	30	20
Armed bullhead	20	21
Bull-rout	19	21
Atlantic cod	20	20

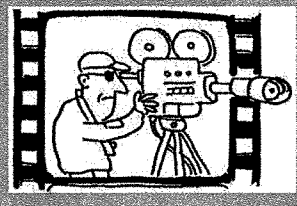


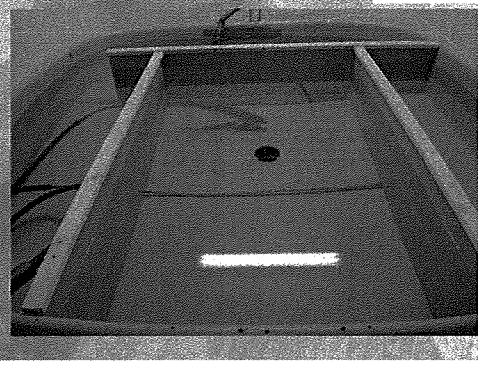
Material & Methods

EQUIPMENT

- Simulation of field conditions
- Exposure for 5s to 5Hz shrimp pulse
- Heterogeneous electrical field
- Between 3 electrodes







Material & Methods

SAMPLING

- Observe **behavioral reactions**
  10 min before – 20 min after
- After 24h
  - inspect for **macroscopical** damage
  - **microscopical** analysis:
    sample dorsal muscle, gills, heart, liver, spleen, intestines and kidney
- **X-ray** to observe spinal injury

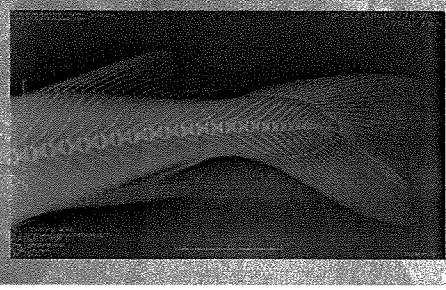
Results

Survival

- No mortality

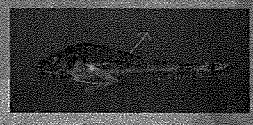
Radiographs

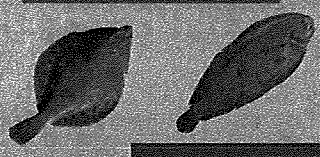
- No spinal injury



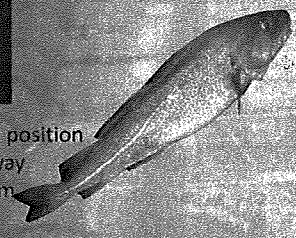
Results

Behaviour





- 7/20 No change in position
- 11/20 shooting away close to the bottom
- 2/20 upward



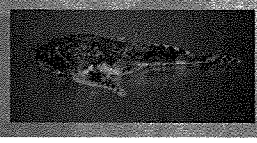
ACTIVITY

\- +

- Burrowed in the sand
- No change in position

- 6/19 Gills & pectoral fins open
- 12/19 move around close to bottom
- 5/19 upward
- More active after exposure than controls

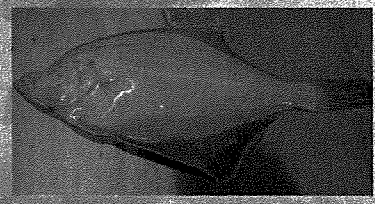
- Burrowed in the sand
- 21/30 no change in position
  - 4/30 upward
  - 5/30 movement close to the bottom



- 5/20 paralysed?
- 1/20 Gills open
- Rest very active swimming behaviour

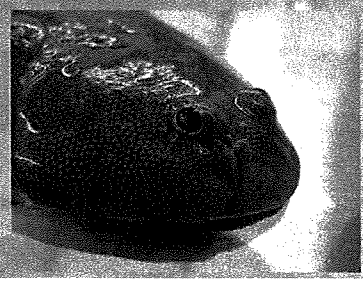
Results

Macroscopic



Plaice
- Multifocal cutaneous petechiae on tail
  - 12/25 E & 14/24 C

Sole
- Multifocal cutaneous petechiae
  - 2/30

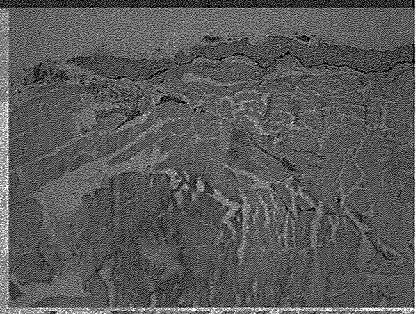


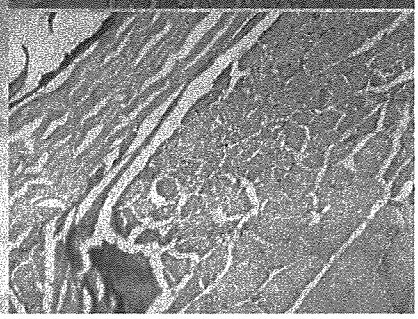
In cod, armed bullhead and bull-rout no macroscopic abnormalities were found

Results

Microscopic

- In five exposed animals, two plaices, one sole and two bull-routs, a focal **small hemorrhage** between **dorsal muscle** fibers was found, which was never encountered in control animals





Conclusion

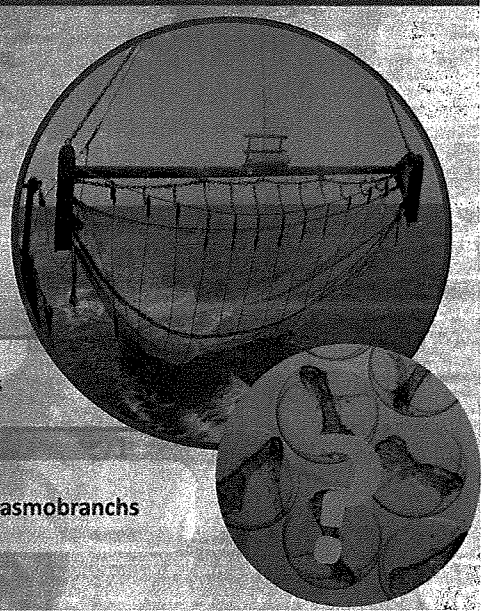
- No mortality after 14 days
- Behaviour
  - Not only shrimp react
  - 1/3 sole swam upward (25% polet et al. 2005)
  - Range from passive to active depending on species
- Macroscopically
  - No significant effect of exposure
- Microscopically
  - 5 small pointshaped bleedings in exposed animals
- No spinal injury

Adverse effects of shrimp pulse?

I **Impact on adult marine fish**

II **Effect on different life stages**

III **Effect on electro sensitive elasmobranchs**



ELECTROTRAWLING FOR BROWN SHRIMP:

SHORT-TERM EFFECTS ON DIFFERENT LIFE STAGES OF COD (and sole – not presented)

UNIVERSITEIT GENT

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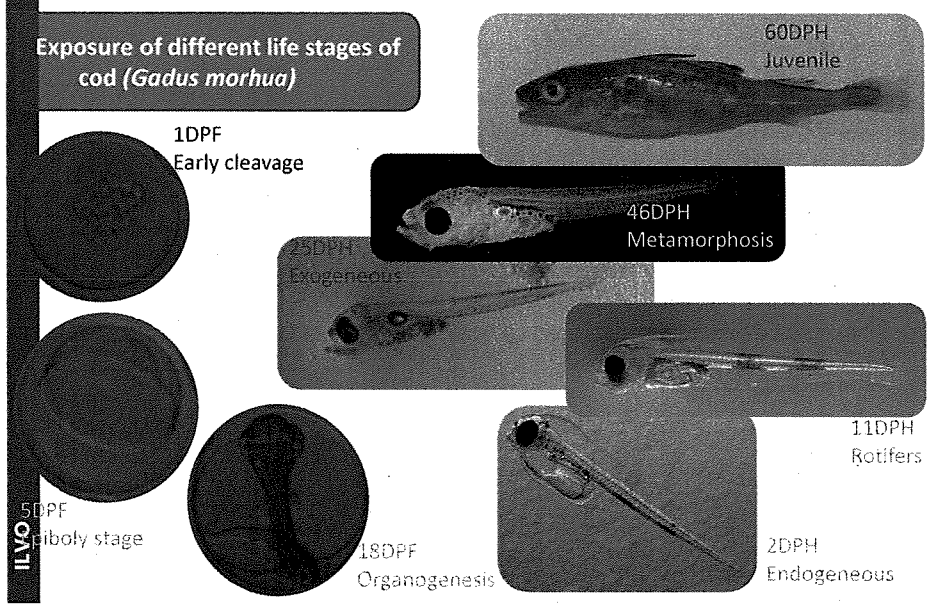
Materials & Methods

Exposure of different life stages of cod *(Gadus morhua)*



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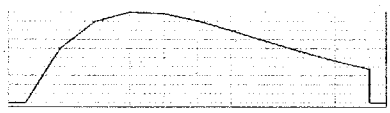
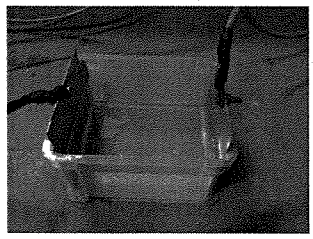
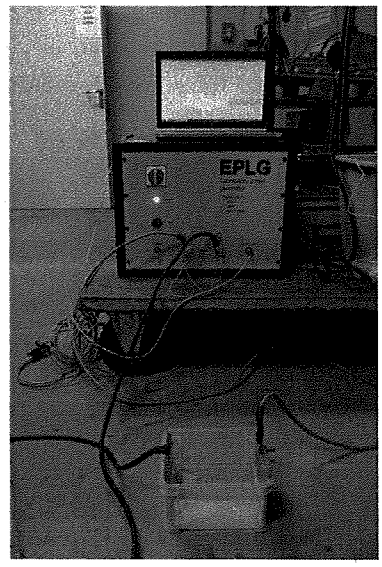
Materials & Methods

Exposure characteristics

- Shrimp pulse in homogeneous electrical field
- 150V/m
- 5Hz
- 5 seconds







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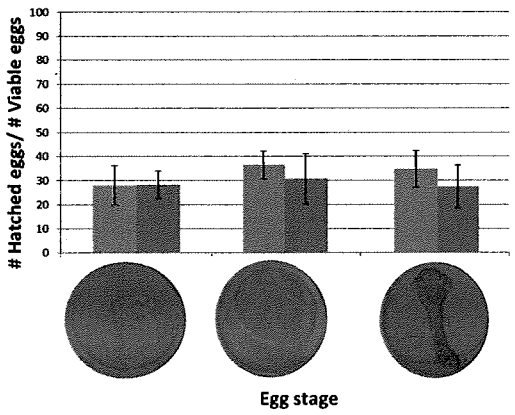
Results

Egg stages

Hatching



Egg stage

- No significant difference in hatching rate between control and exposed groups

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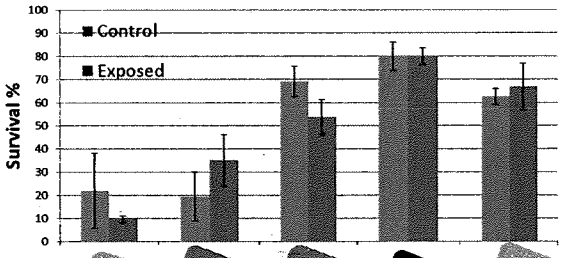
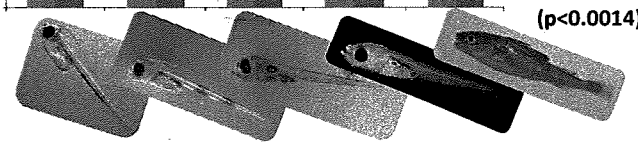
Results

Larval & Juvenile stages

Survival larvae & juvenile stages





Developmental stage

- There is a significant effect of stage
- No significant survival differences in Larval stage 4, 5 and 7 or the juvenile stage 8 between control & exposed groups
- Survival is significantly higher in the control group of the 6th stage, OR 1.94 ($p<0.0014$)!

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Summary

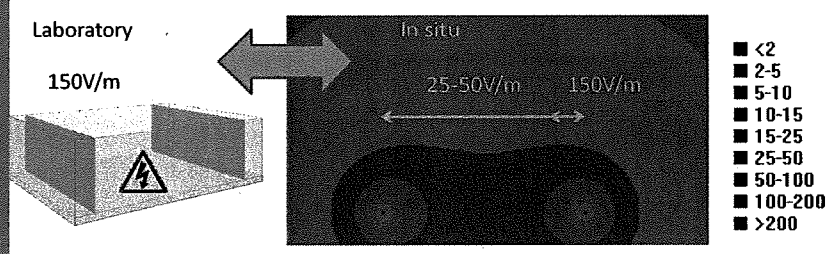
Conclusions

Morphometrical analyses: on-going !

- Eggs: No significant differences
- Larvae: Significant difference in artemia feeding stage
- Juvenile: No significant differences

Discussion

- In situ situation
  - Heterogeneous electrical field



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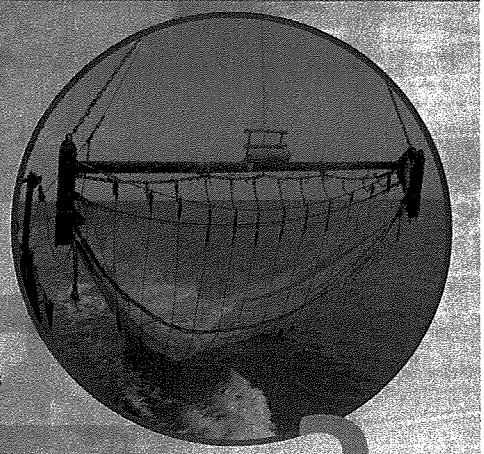
Adverse effects of shrimp pulse?



I Impact on adult marine fish

II Effect on different life stages

III Effect on electro-sensitive elasmobranchs

Ongoing Research

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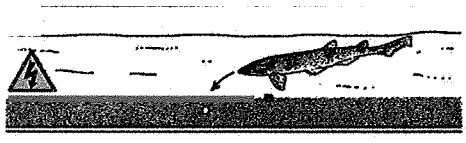
Electrosensitive Elasmobranchs

- **Ampullae of lorenzini (AoL)**
  Electrosensitive organs
  - Morphological
  - Functional analysis
    - By simulating prey with electrodes

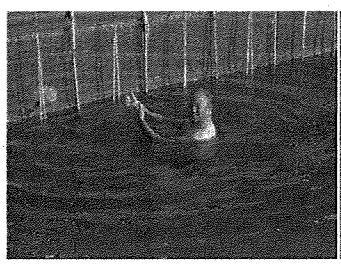


Acknowledgements

- Institute for Agricultural and Fisheries Research, Belgium
- Faculty of Veterinary Medicine, Ghent University, Belgium
- Faculty of Science, Ghent University, Belgium
- The Norwegian Institute of Food, Fisheries and Aquaculture Research
- IMARES, the Netherlands

- The Institute for Innovation by Science and Technology, Belgium
- The European Fisheries Fund
- The Flemish Government
- Aquaculture infrastructures for excellence in European fish research (AQUAEXCEL)

Thanks!



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Vlaanderen

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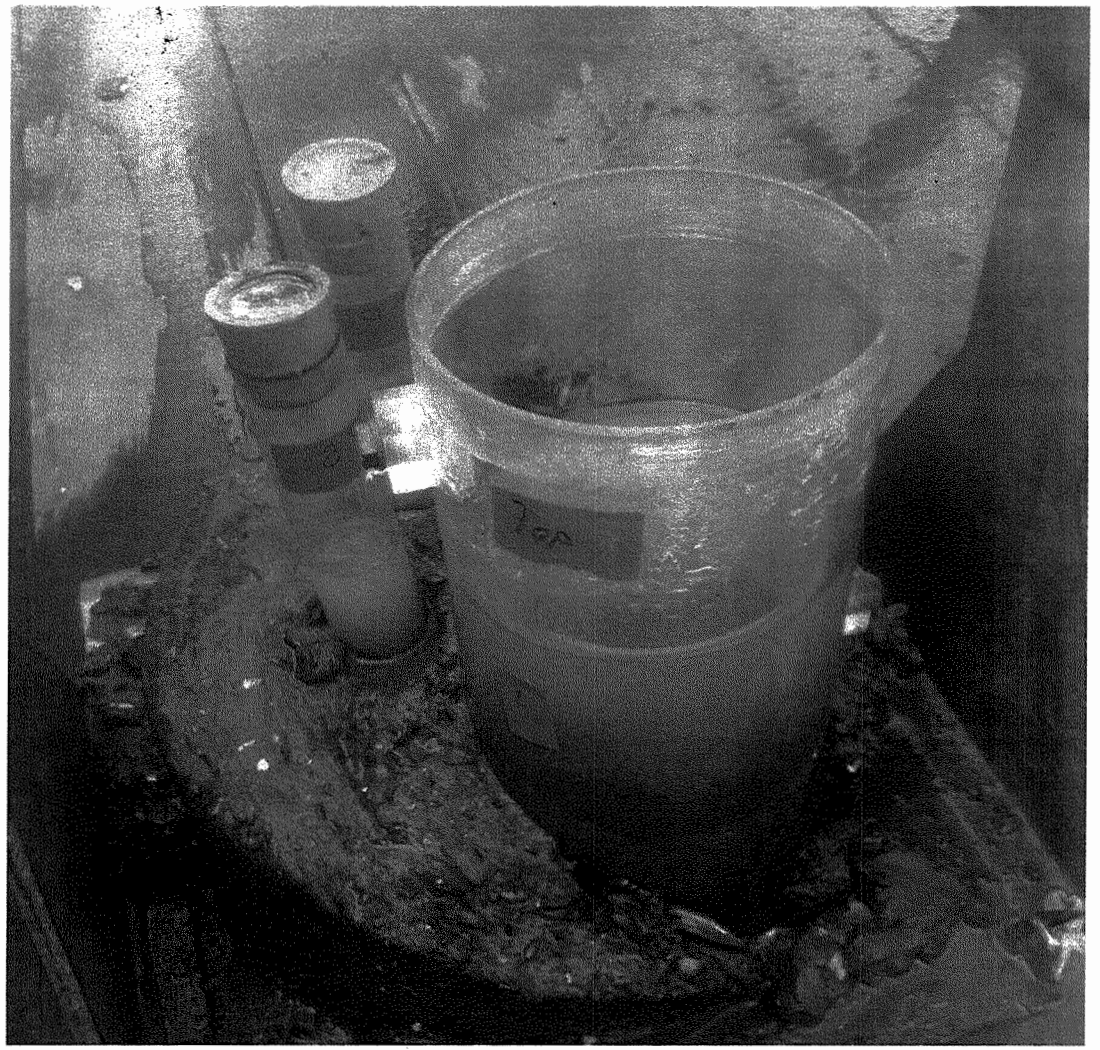
WP 2 - Effects on sediment biogeochemistry and ecosystem functioning



WP leader:

(NIOZ)

PhD Student:

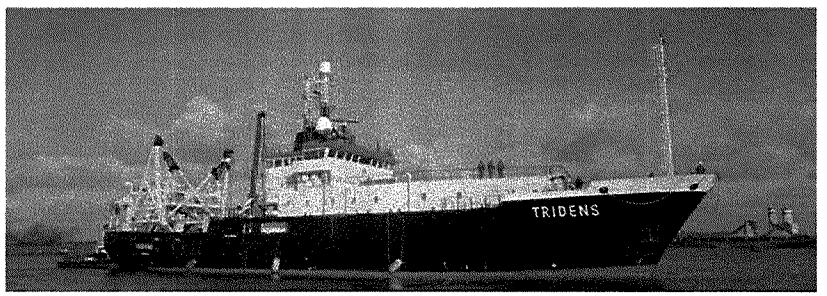
(NIOZ)

IMARES
WAGENINGEN UR

NIOZ

WP2 – Field Studies: Ecosystem Effects (Nutrient Dynamics)

Task 2.1 Field campaign 1.
Experimental assessment of the short-term effect of pulse stimulation on sediment nutrient cycle



Task 2.2 Field campaign 2.
In situ effects of pulse and beam trawling on the benthic ecosystem

Task 2.3 Field campaign 3.
Long-term effects of fishing

Task 2.4 Predictive model

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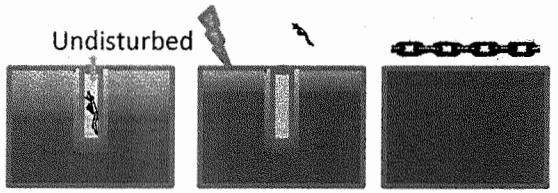
Task 2.1 Field campaign 1.

Short-term effect of pulse stimulation on sediment nutrient cycle – on board

Methods:

- Large Boxcores incubated onboard in large tanks/cooling containers
- Measurements taken in overlying water (nutrients, oxygen)
- 4 hours incubation
- artficial perturbation
  - (1) electrical pulses and removing large animals
  - (2) mechanical disruption of sediments
- Same measurements repeated.



Requirements:

- Large box cores
- Enough benthic biomass/diversity
- (Area that is fished by pulse)
- → Preferred area: **Oyster grounds / Dogger bank**

Utilise BTS in 2016 - 2018 to spread effort / cover higher spatial variability

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Task 2.1 Field campaign 1.

Set-up:

- BTS will be carried out by Tridens from 2016 onwards.
- Designate one week of BTS for extra programme
- request 24 hour crew for one week
- Boxcore sampling carried out during/early morning before fishing (7:15am).
- Planning together with BTS route to minimise steaming time
  - → per station: 6 cores plus cores for porewater profiles
  - Number of stations and station locations/distances to be decided

Personnel:

- 3 NIOZ staff for one week to carry out coring
- Post-processing of data by NIOZ (PhD)

Timing:
Aug/Sep 2017 and 2018

Task 2.2 Field campaign 2.

Short-term effect of pulse stimulation on sediment nutrient cycle – in situ

Set-up:

- Follow a puls/beam trawl fishing boat and sample in its wake
- In situ lander positioned in and out of the fishing track
- Measures nutrient and oxygen fluxes
- Repeat on board incubations.
  - 6 cores for nutrient fluxes plus cores for porewater profiles

Personnel:

- One week of Pelagia ship time; possibly combined with NorthSea monitoring of NIOZ
- 5 NIOZ staff to carry out in situ and on board experiments.
- Post-processing of data by NIOZ (PhD)

Note: Relies on **collaboration with sector** to carry out treatments

Timing:
2017 or 2018

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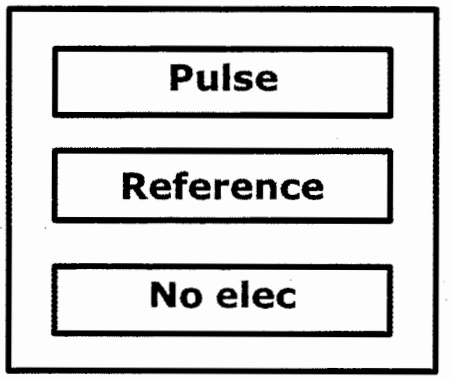
Task 2.3 Field campaign 3.

Long term effects of fishing: field study

BACI-design experiment - three treatments: (1,2) pulse, (3) without electricity

Set-up:

- Vlakte van de Raan
- One reference area, highly fished
- One reference area, closed for fishing
  - Three treatments:
    - Pulse fishing at low intensity
    - Pulse fishing at high intensity
    - Pulse fishing without electricity



- Sampling:
  - T0 (before fishing)
  - T1 (immediately after fishing
  - T2 (48 hours later)

Timing:

- Summer 2018

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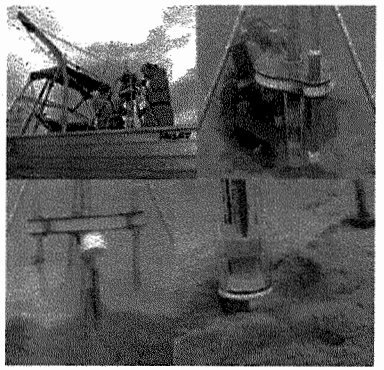
Task 2.3 Field campaign 3.

Measurements ~BENTHIS:
- Boxcores: benthos
- Flux measurements
- Multibeam, SPI
- Fishing (stomachs/injuries)



Ship
- One week of Simon Stevin ship time; cooperation with ILVO
- 2 NIOZ staff to carry out experiments
- ILVO, IMARES: focus on fishes
- Post-processing of data by NIOZ (PhD) , and ILVO (multibeam, fish) and IMARES (SPI, fish)

Note: Relies on **collaboration with sector** to carry out treatments

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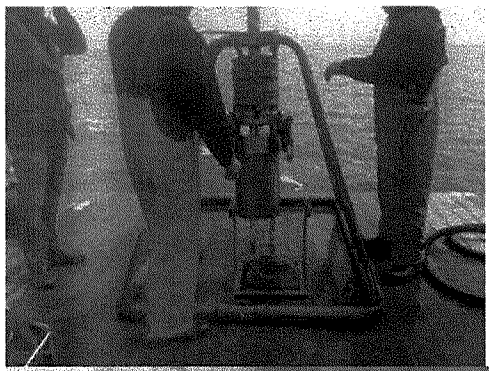
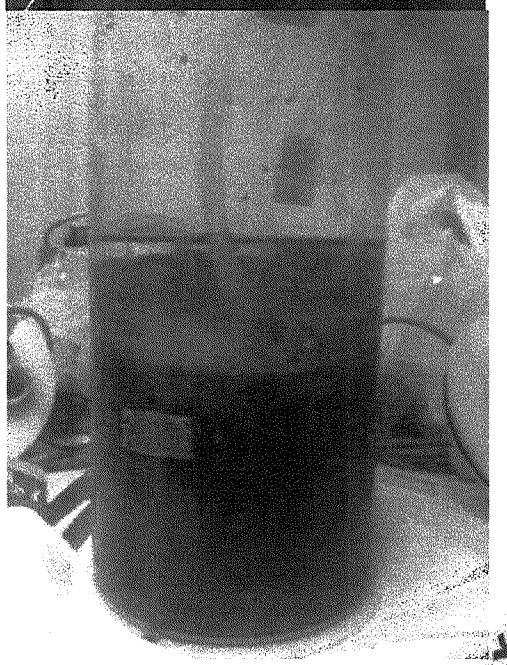
Measurements

Current work: Eastern Scheldt monitoring
- Monthly intertidal and subtidal benthic core samples

Importance to IAPF
- Develop familiarity with the methodology
- Characterisation of the experimental sediments

Measurements:
- Nutrient Fluxes (discrete samples)
- Porewater nutrients
  - Top 5cm/Bottom 5cm
- O2 Consumption (continuous measurement)
  - Sediment community O2 consumption (SCOC)
  - Macrofaunal O2 respiration
- Bioirrigation
  - Uranine (continuous measurement)
  - Bromide (discrete samples)





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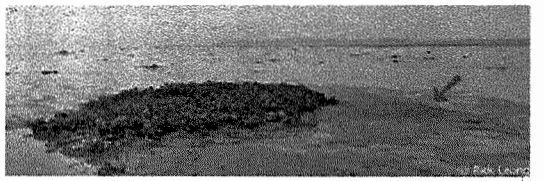
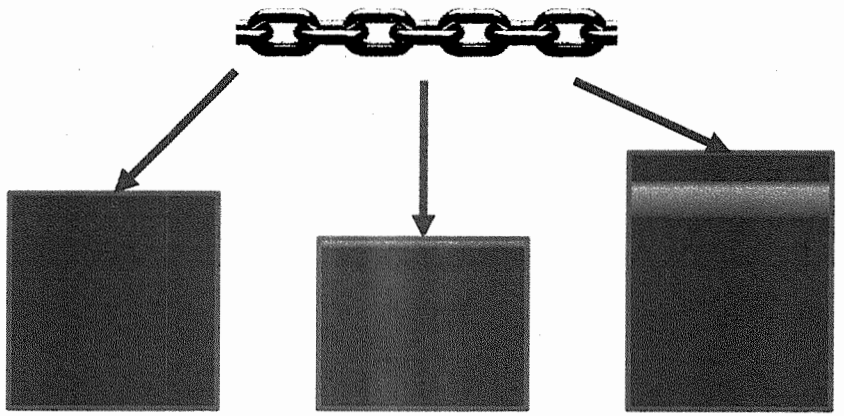
Preliminary Perturbation Experiments

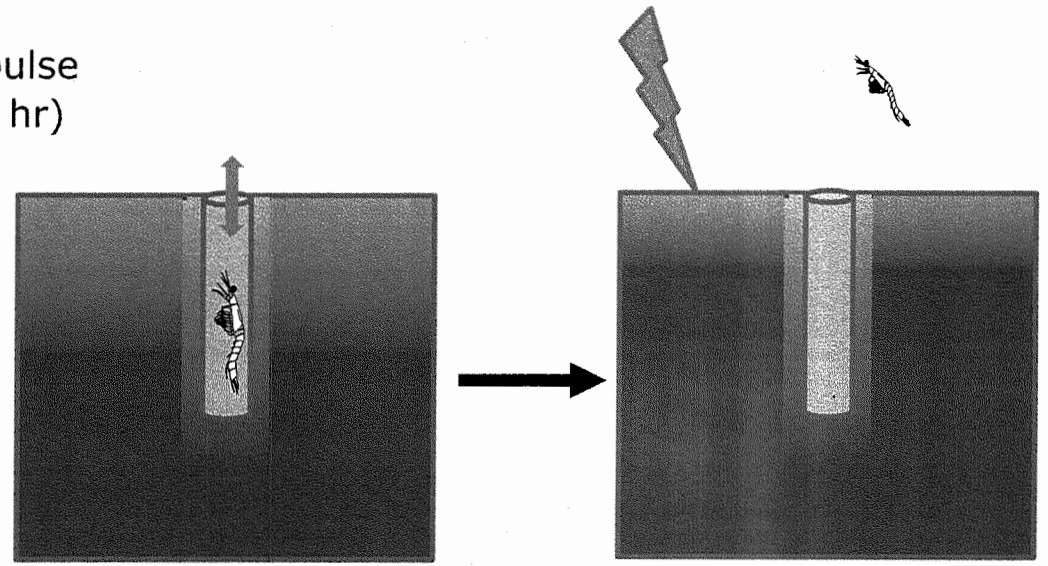


Intertidal perturbation experiments
- Eastern Scheldt

Sediment disturbance experiments
- Three treatments (top 8cm)
  - Mixed sediment
  - Sediment removal
  - Sediment added



Electrical pulse experiments
- Initial incubation (4 hr)
- Application of electrical pulse
- After pulse incubation (4 hr)



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Progress pulse research (WP3 + WP4)

26 January 2018, [redacted]

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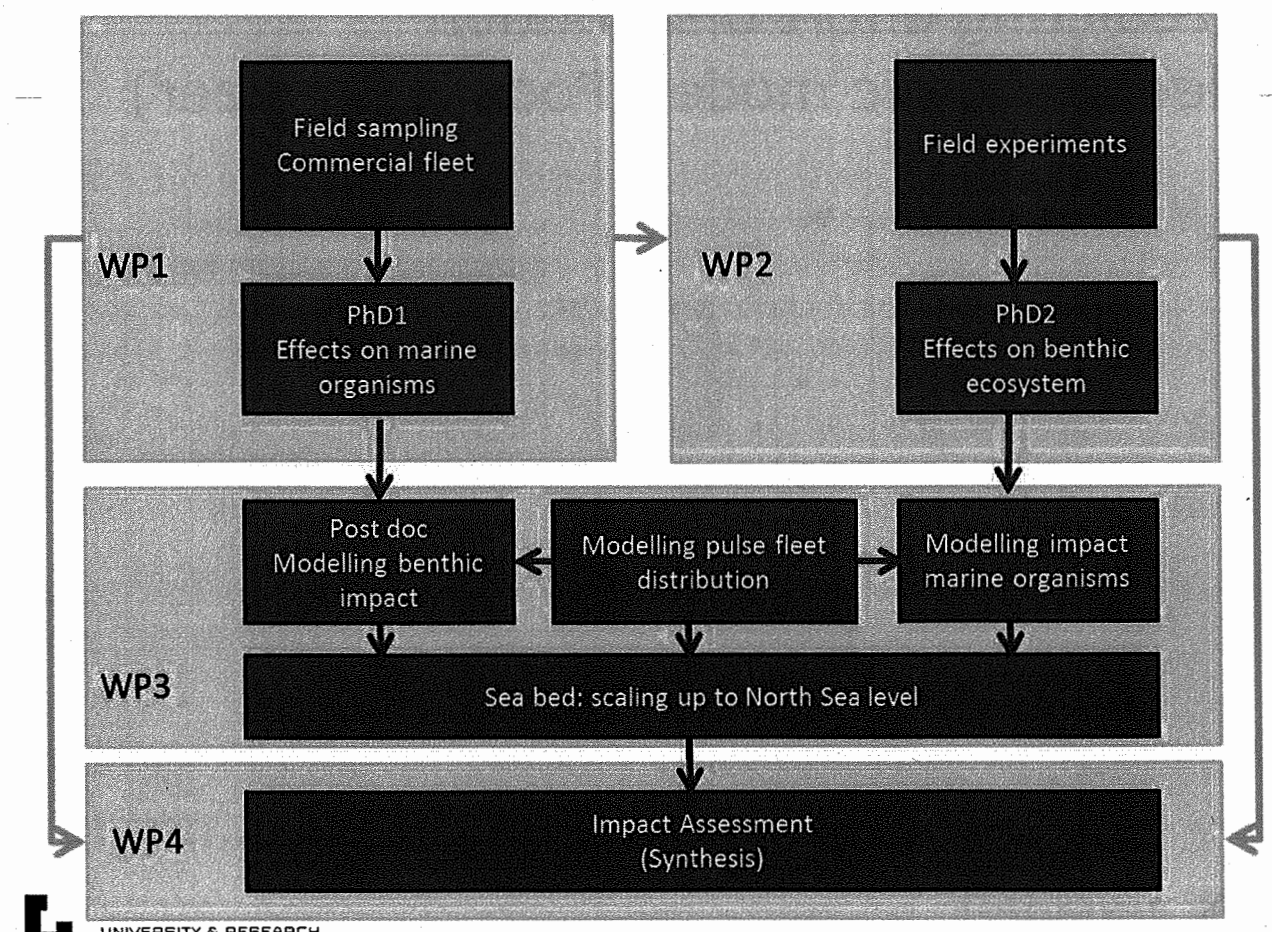

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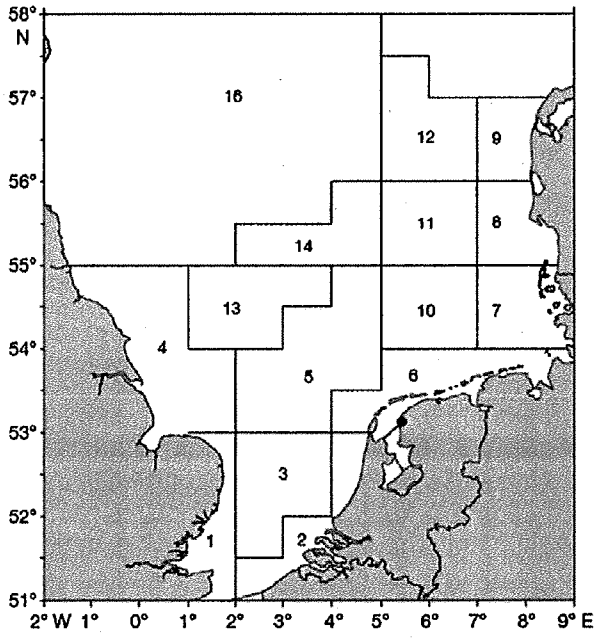
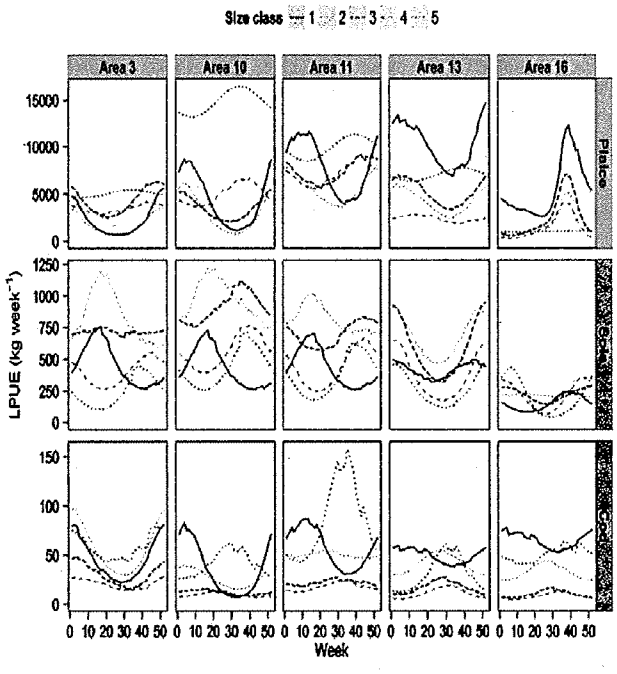
WP3 - Tasks

- Task 3.1 Predictive model of the distribution of pulse and beam trawling in space and time
  - DSVM ( )
  - Habitat association ( )
  - Frequency distribution of repeated exposure (still to do)

- Deliverable 1. Manuscript on predicting the small scale distribution of pulse and beam trawling in relation to sea bed habitat

Predicting effort distribution fleet dynamic model ( )



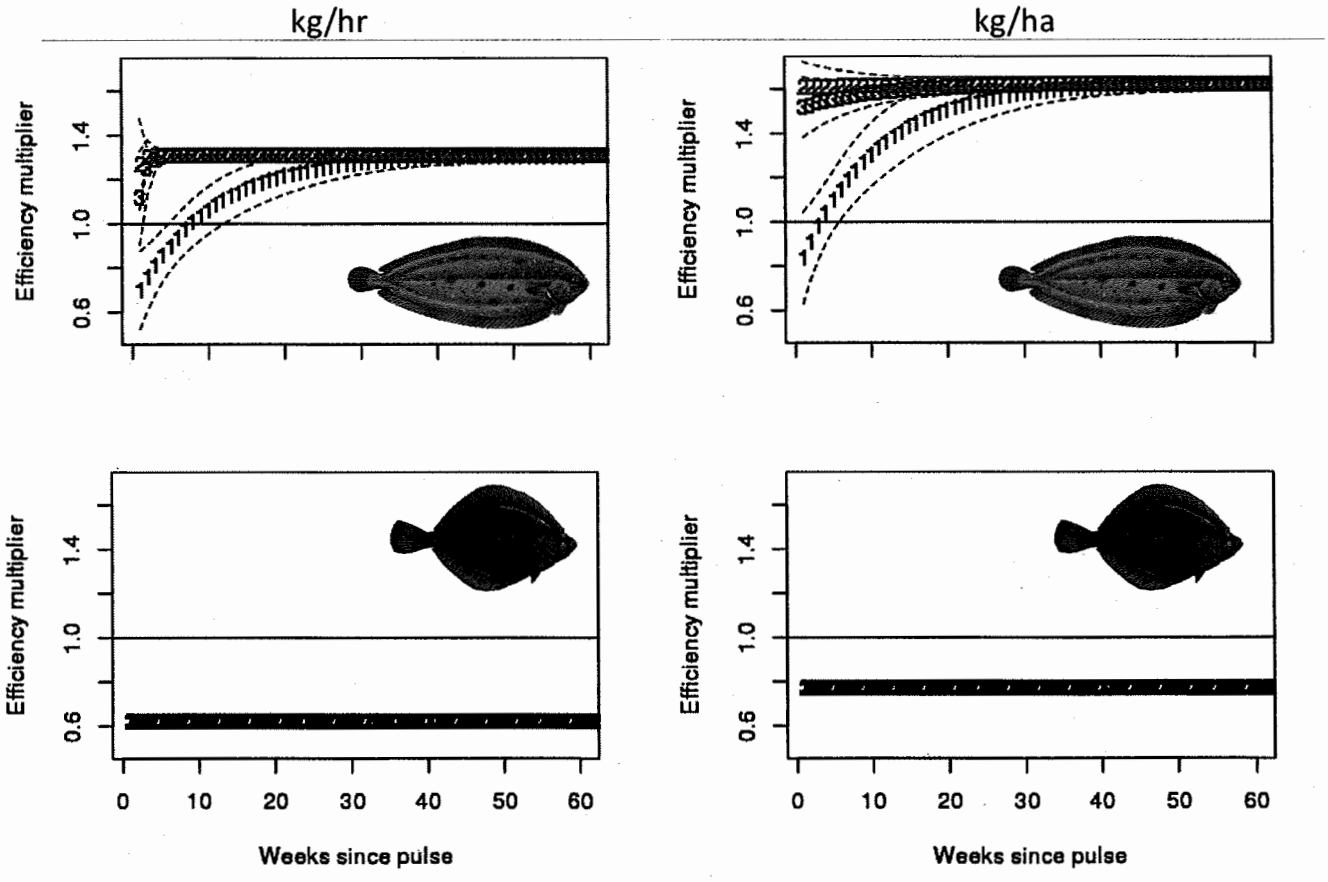


Fleet dynamic model

- Model refinement (fleet definition; harbours)
- Re-parameterisation pulse and beam trawl
  - Catch efficiency by species
  - Size selectivity by species

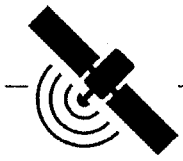
- Downscaling effort to scale of gear * habitat interaction (Hintzen)
  - Stability in fine scale effort distribution
  - Habitat association

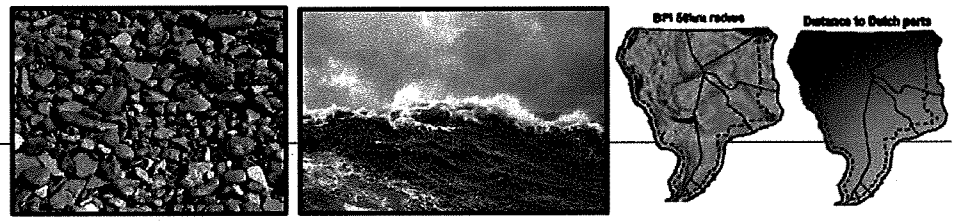
Changes in catch efficiency pulse / tickler



Down-scaling effort to scale of gear

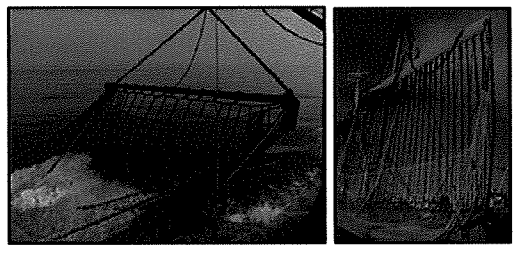
(





VMSping ~ explanatory variables *

gear + fancy(space + time)



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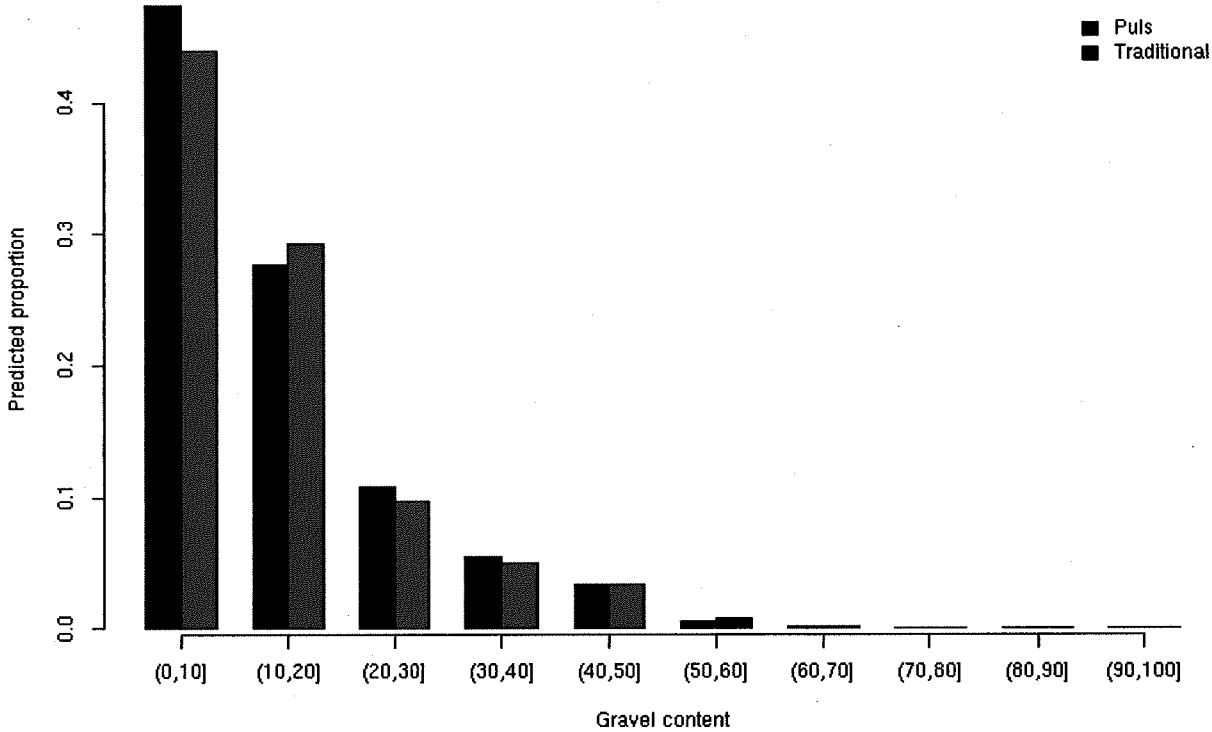
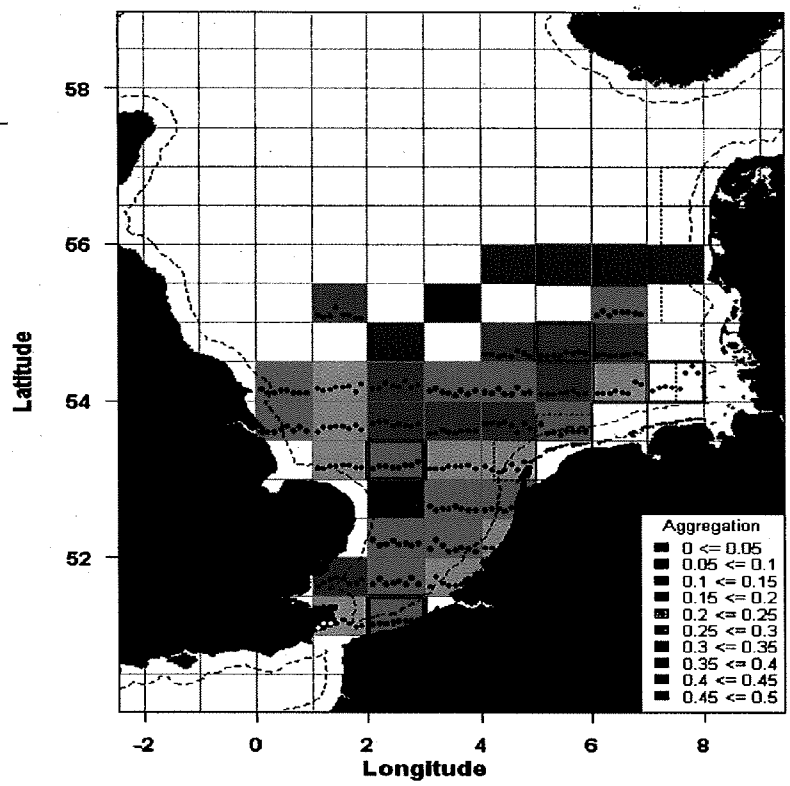
Habitat association: Gravel content



Stable fine-scale distribution (aggregation parameter of negative binomial distribution)



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WP3 - Tasks

- Task 3.2 Predictive model of the impact of pulse trawling and beam trawling on the benthic ecosystem at the scale of the North Sea
  - Model electric field (3d) around pulse trawl (WP1)
    - Thresholds injuries / behaviour
  - Mechanic impact (BENTHIS PD, LL)
  - Model sediment resuspension (BENTHIS spin off)
  - Impact module from WP2
  - Distribution model of benthic communities / functional groups
- Deliverable 2 - Manuscript on the effect of a transition from the beam trawl to the pulse trawling on the benthic ecosystem

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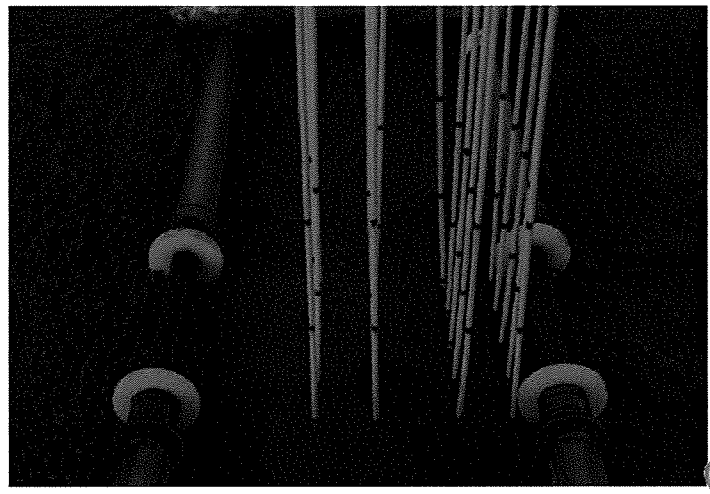
Field strength around pulse trawl: measurements in situ

- Array electrical probes on, 10 & 20 cm above, 10 & 20 cm in seabed
- Pair Delmeco conductors
- Two study sites:
  - Neeltje Jans
  - Mokbaai



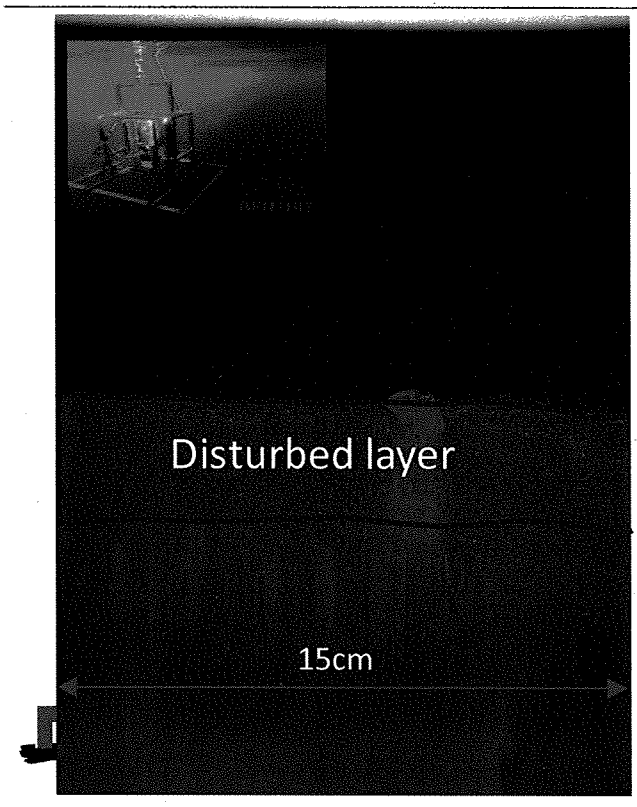
Results

Date	Data (ID)	Position Probe (mm)		V Elect	Field strength (Z axis)				
		X	Y		C conductors				
					-20	-10	0	+10	+20
2016-12-14	4	57.5	180	60	19	48	171	69	23
	6	57.5	180	60	19	46	211	69	23
2016-12-15	9	57.5	180	60	18	44	210	68	21
	10	57.5	180	60	18	44	209	67	21
	9	162.5	180	60	31	64	107	66	26
	10	162.5	180	60	31	64	107	66	26
	13	57.5	180	51	14	36	185	55	17
	14	57.5	180	54	15	39	201	59	18
	13	162.5	180	51	26	53	89	55	22
	14	162.5	180	54	27	57	96	59	23

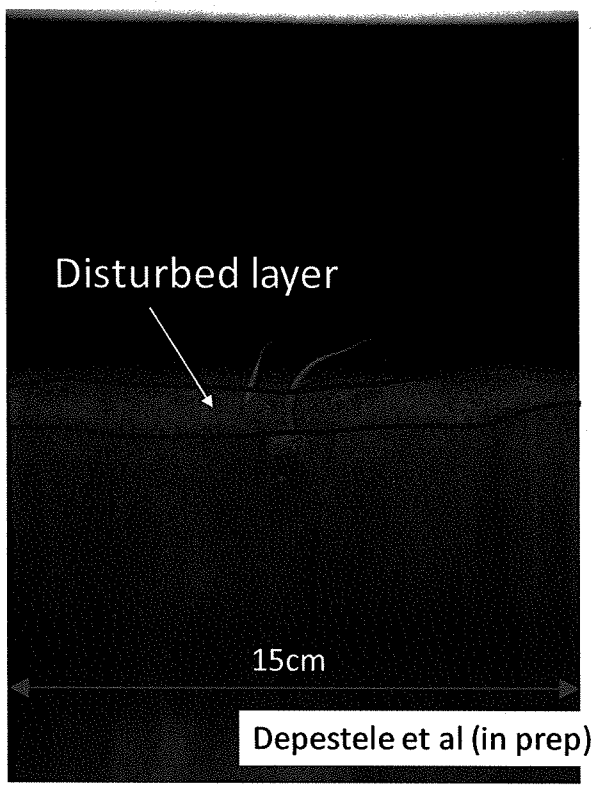
Mechanical disturbance sea bed (BENTHIS: WMR, ILVO, CEFAS)

BENTHIS

Beam trawl tickler

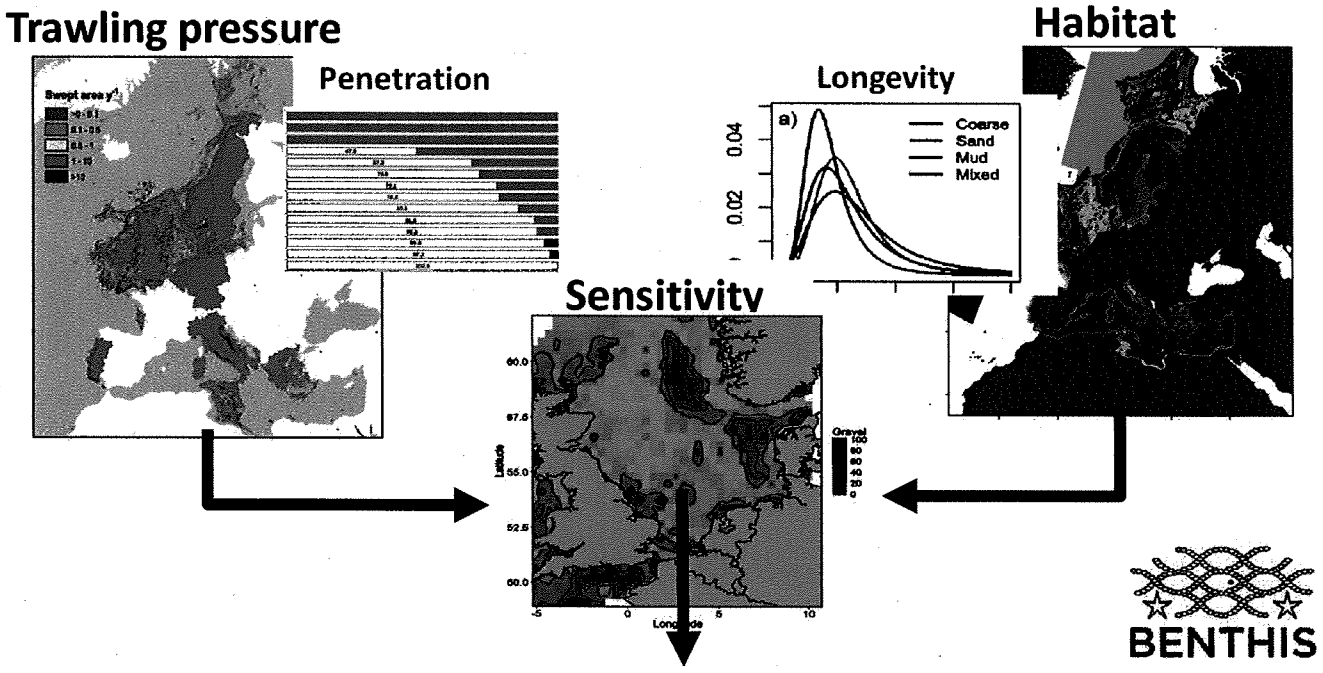


Pulse trawl



Depestele et al (in prep)

Assessment framework



BENTHIS

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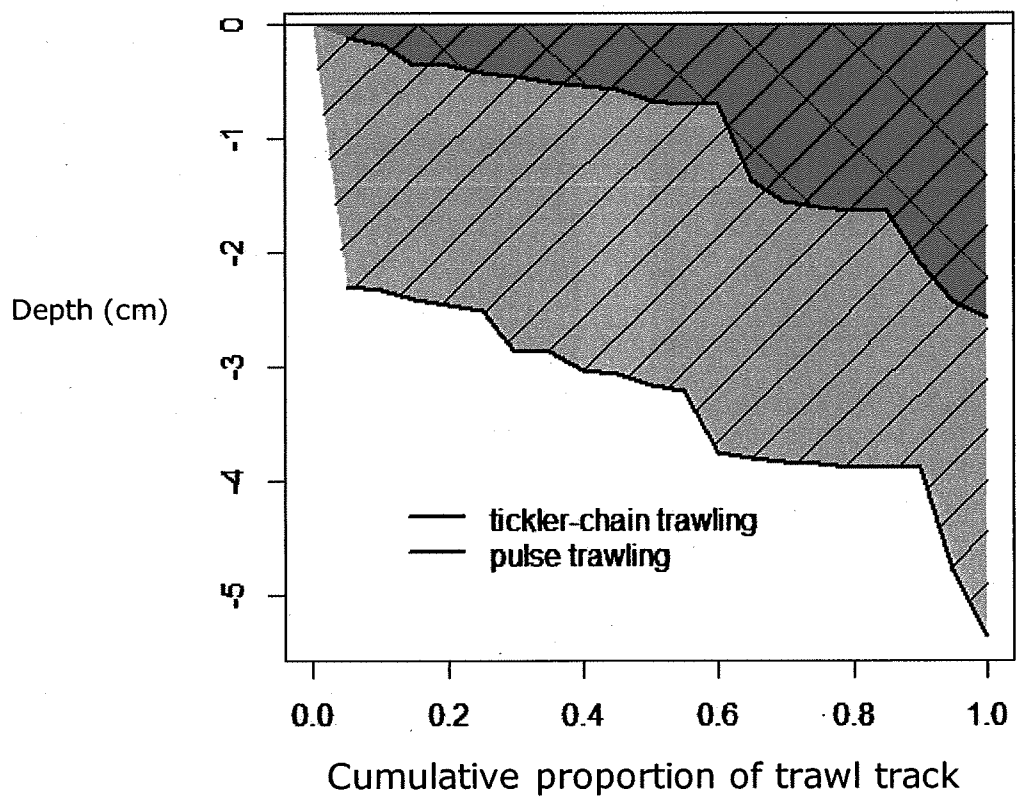
SEVENTH FRAMEWORK PROGRAMME

Depth of disturbed layer (SPI)



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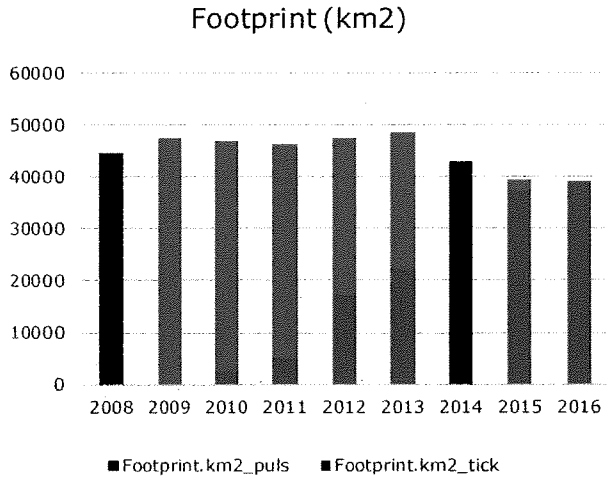
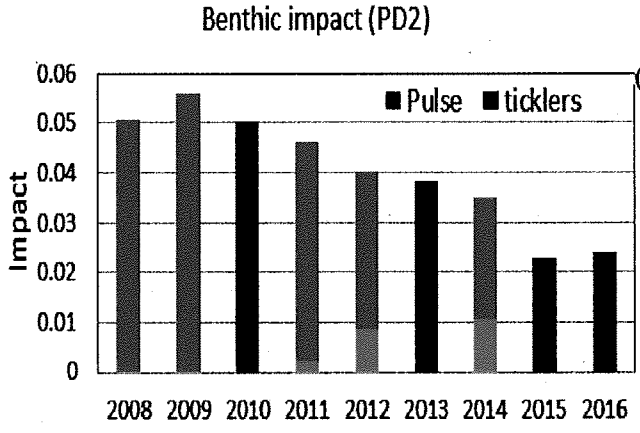
SEVENTH FRAMEWORK PROGRAMME

Footprint and impact





Reduction in impact due to

- lower footprint (surface area fished)
- reduced penetration (mortality)

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WP3 - Tasks

- Task 3.3 Catch proportion injured by exposure to the pulse stimuli
  - Model electric field (3d) around pulse trawl (WP1)
  - Model spatial distribution number of fish species (discards, marketable size)
    - Cod, whiting, gurnards, others (match WP1)
    - Elasmobranch
  - Distribution of egg / larval stages

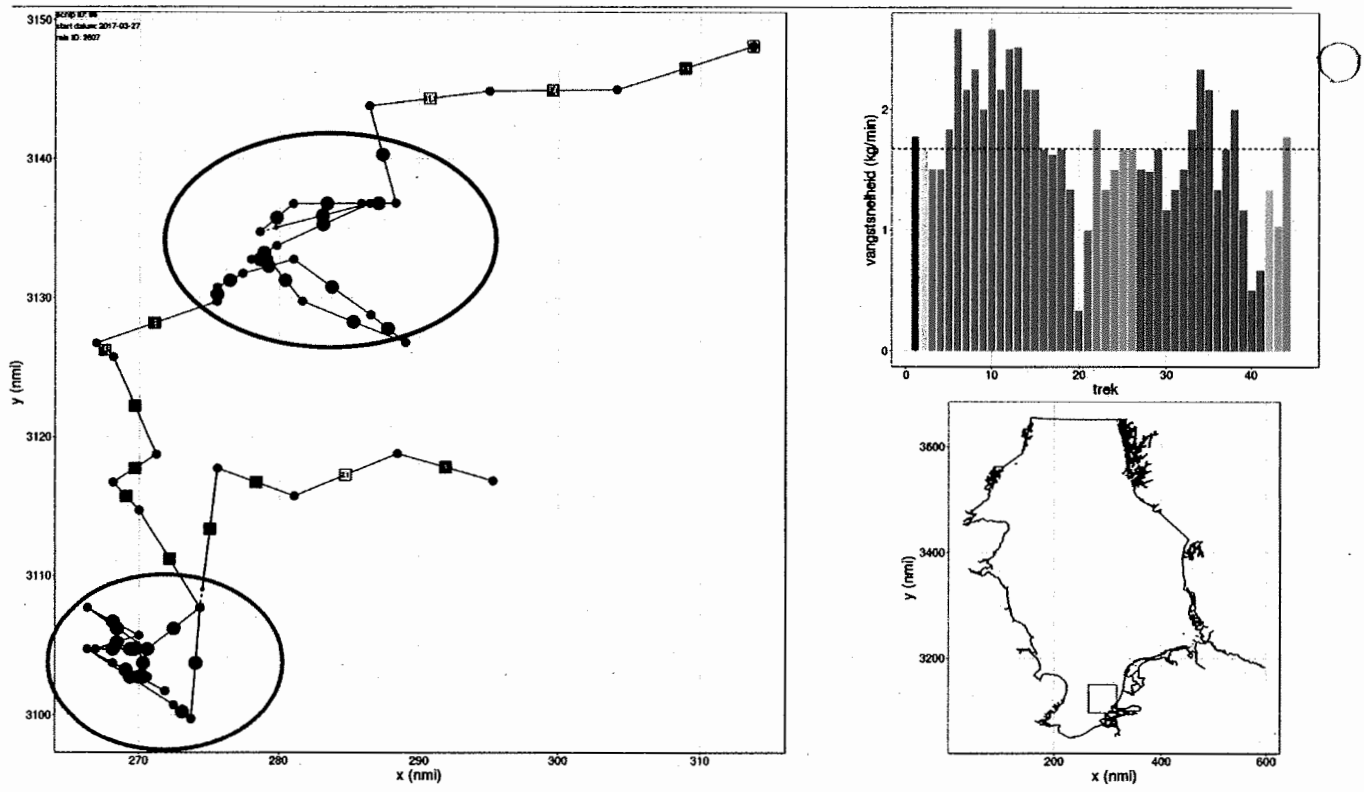
- Deliverable 3 - Manuscript on the effect of a transition from the beam trawl to the pulse trawling on the discarding

WP4

- Synthesis
  - WP1, WP2, WP3
  - Other relevant project
    - Survival experiments ( )
    - Development in fleet (catch per tow logbooks)
    - Fishing patterns ( )

Overview results ongoing work

Fishing patterns: small scale dynamics of exploitation



Suggested modifications