

Trawling Impact European Seas pulse trawl

Adriaan Rijnsdorp (IMARES)
Hans Polet (ILVO)

Overview

- BENTHIS overview
- Assessment framework
- Pulse trawl
 - Description of technique
 - Biological effects
 - Results of BENTHIS field studies
- Conclusions

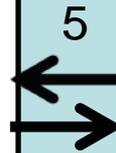
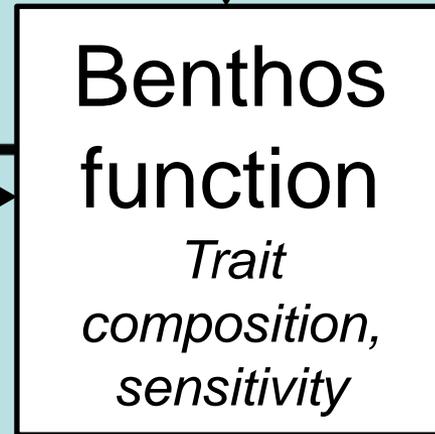
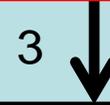
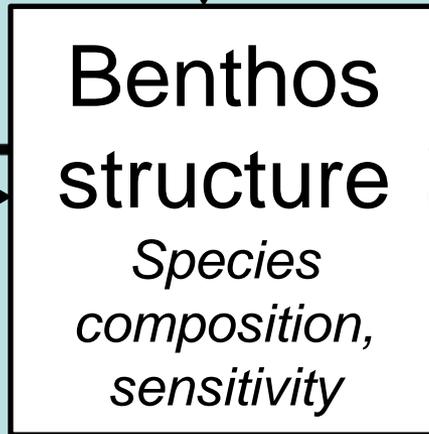
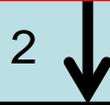
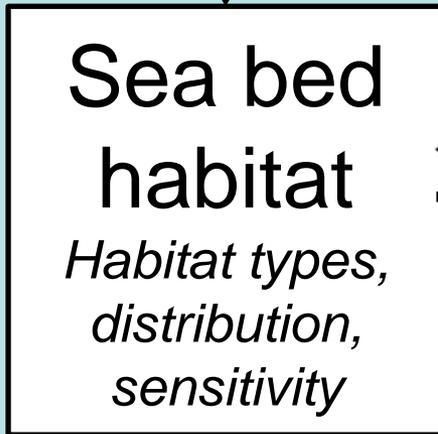
Effect on benthic ecosystem



© Baskohler.nl

Trawl footprint

type of gear, spatial distribution and intensity

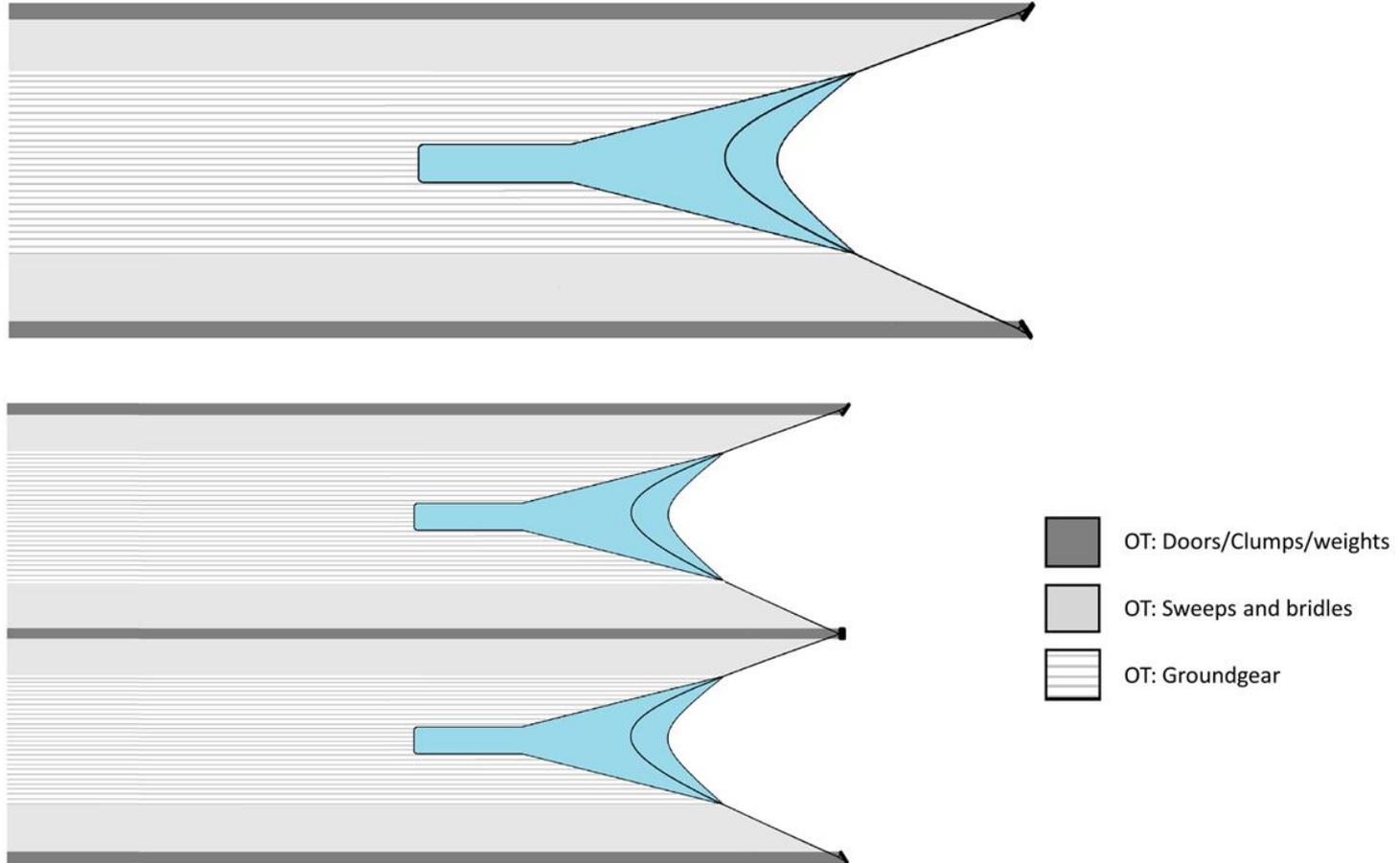


Indicators (MSFD)

Fishing pressure

Condition / Sea bed integrity

Otter trawl footprints



Trawl footprint

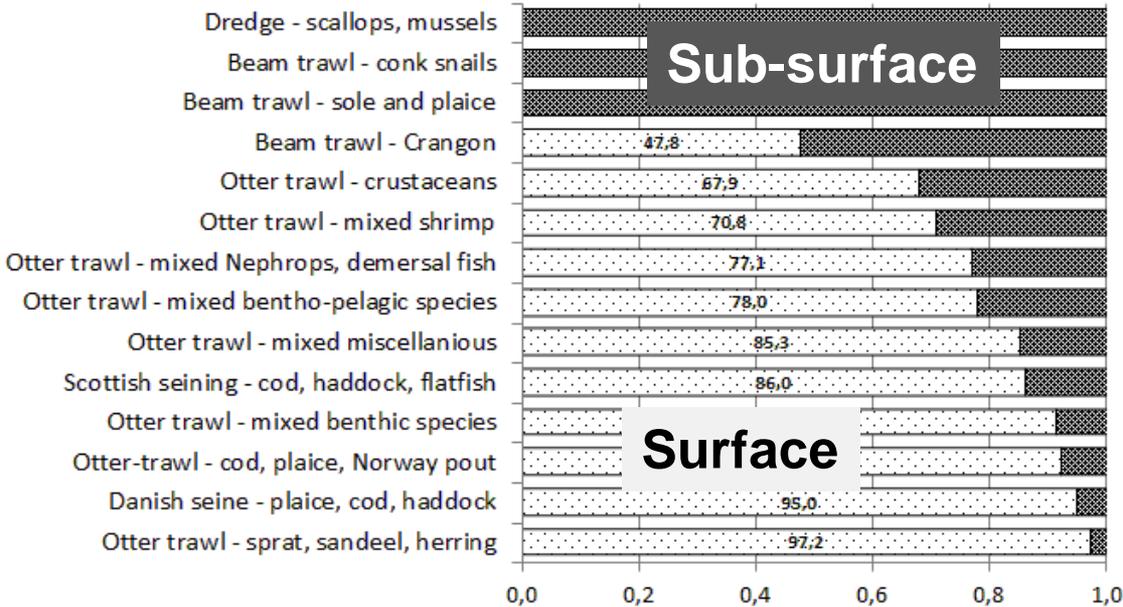
14 BENTHIS metiers defined from gear type and target species

- Footprints
 - Vessel size ~ gear width relationships
 - Gear width (surface & sub-surface)
- Metiers
 - Otter trawls (8 metiers): vessel size ~ door spread
 - Demersal seines (2): vessel size ~ seine rope length
 - Beam trawls (3): vessel size ~ total beam width
 - Dredges (1): vessel size ~ total dredge width

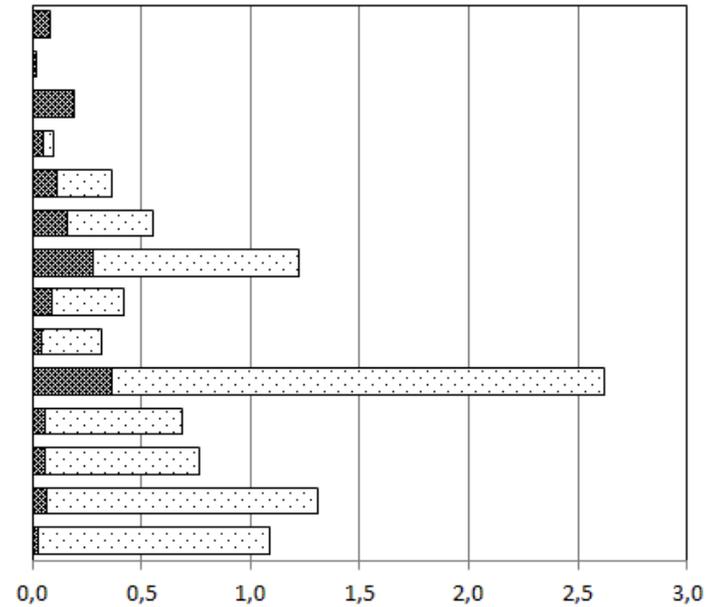
Trawling footprint

14 BENTHIS metiers (gear type & target species)

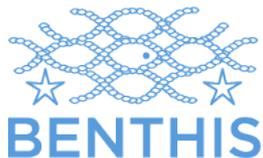
■ Surface and Subsurface impact □ Surface impact



Proportion surface – subsurface footprint



Swept area by hour (km²) of average vessel



From footprint to physical impact

- Penetration
- Collision
- Sediment mobilisation (resuspension)

From footprint to physical impact

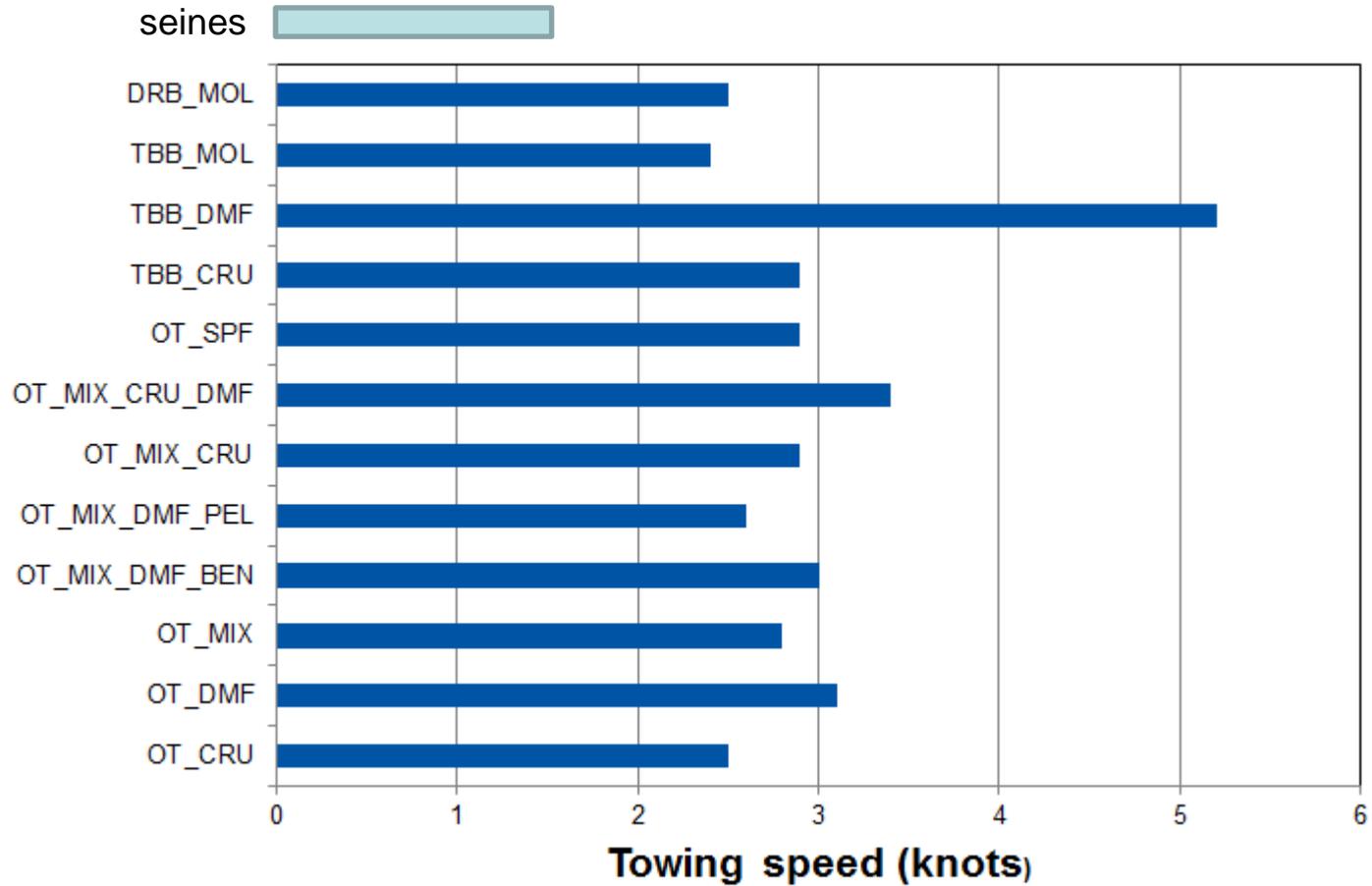
- Penetration (review Eigaard et al., 2015)
 - Mass (M) and geometry of object
- Collision
 - Impulse momentum $\sim f(U, M)$
- Sediment mobilisation
 - Drag $\sim f(S, U^2)$ (and sediment characteristics sea bed)

U = towing speed

M = mass component

S = frontal area component

Towing speeds



Trawl footprint

type of gear, spatial distribution and intensity

1

2

3

**Sea bed
habitat**

*Habitat types,
distribution,
sensitivity*

4



**Benthos
structure**

*Species
composition,
sensitivity*

5



**Benthos
function**

*Trait
composition,
sensitivity*



Indicators (MSFD)

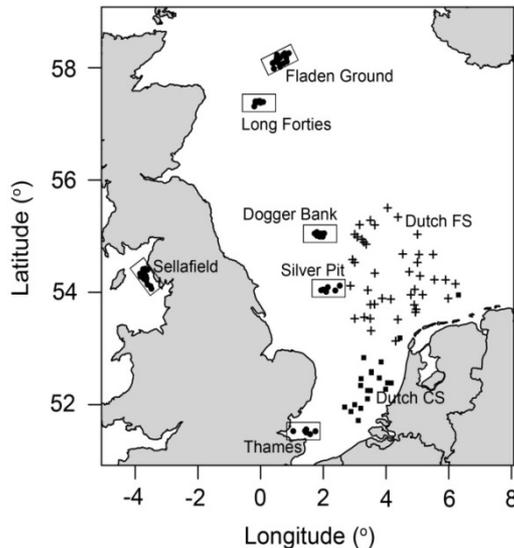
Fishing pressure

Condition / Sea bed integrity

Habitat sensitivity

- Natural disturbance
 - Shear stress sea bed (waves, currents)
- Benthos species composition
 - Sediment position (surface / subsurface)
 - Sturdiness
 - Longevity

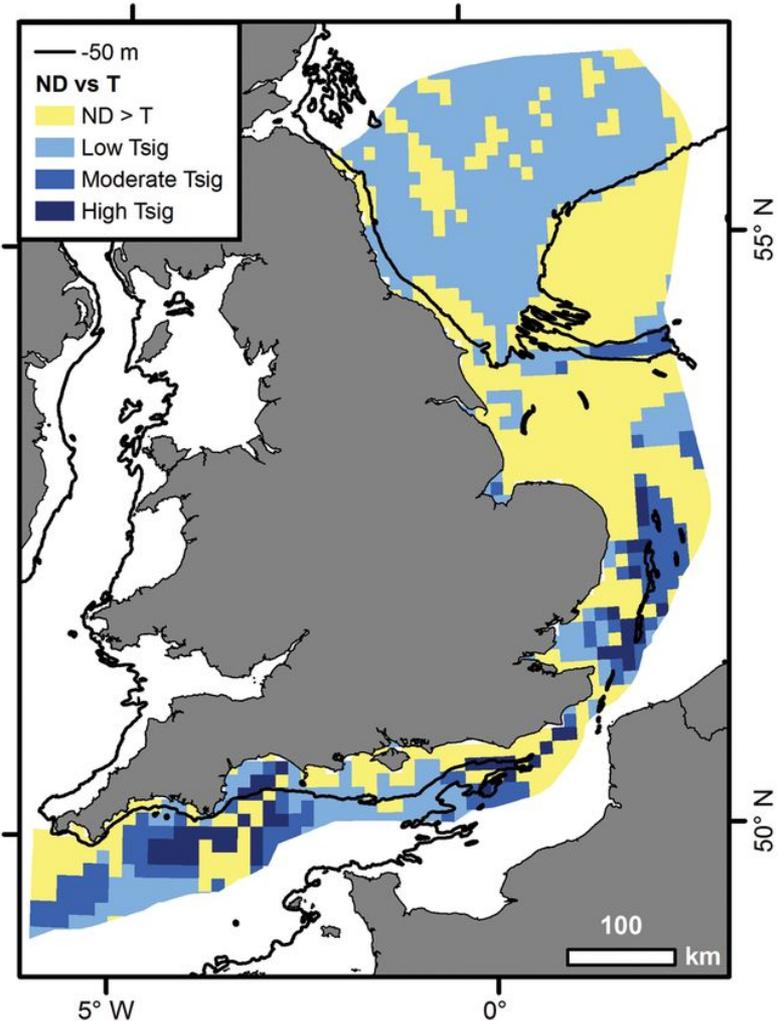
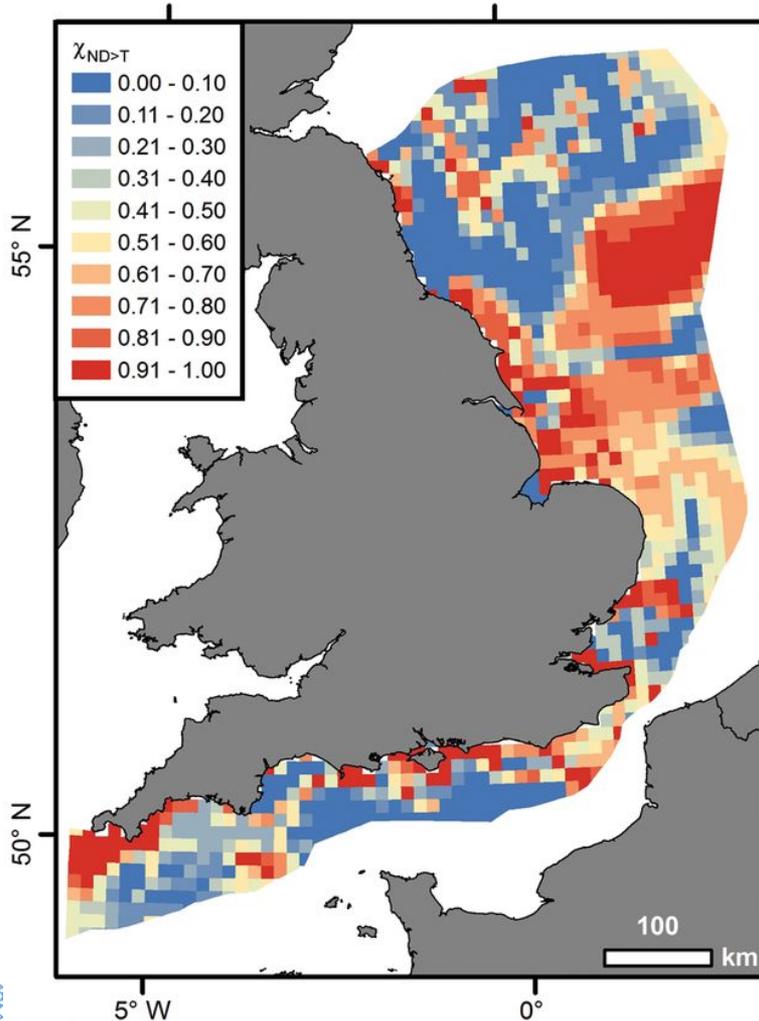
Trawling effect study

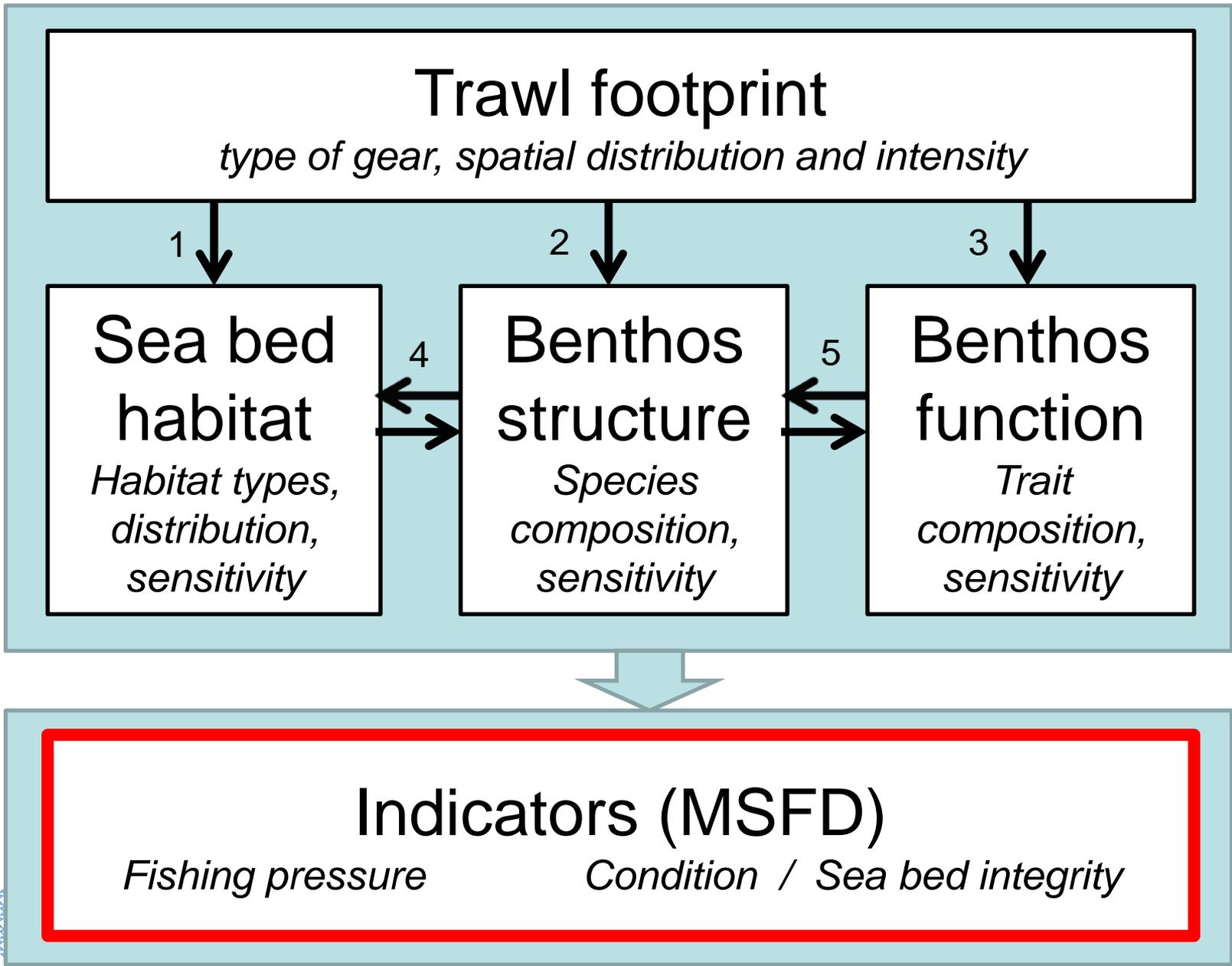


- Trawling gradient in 8 study sites
- Species composition determined by trawling and natural disturbance
- Trawling and Shear stress shift from large long-lived species to small short lived species in low energy habitat

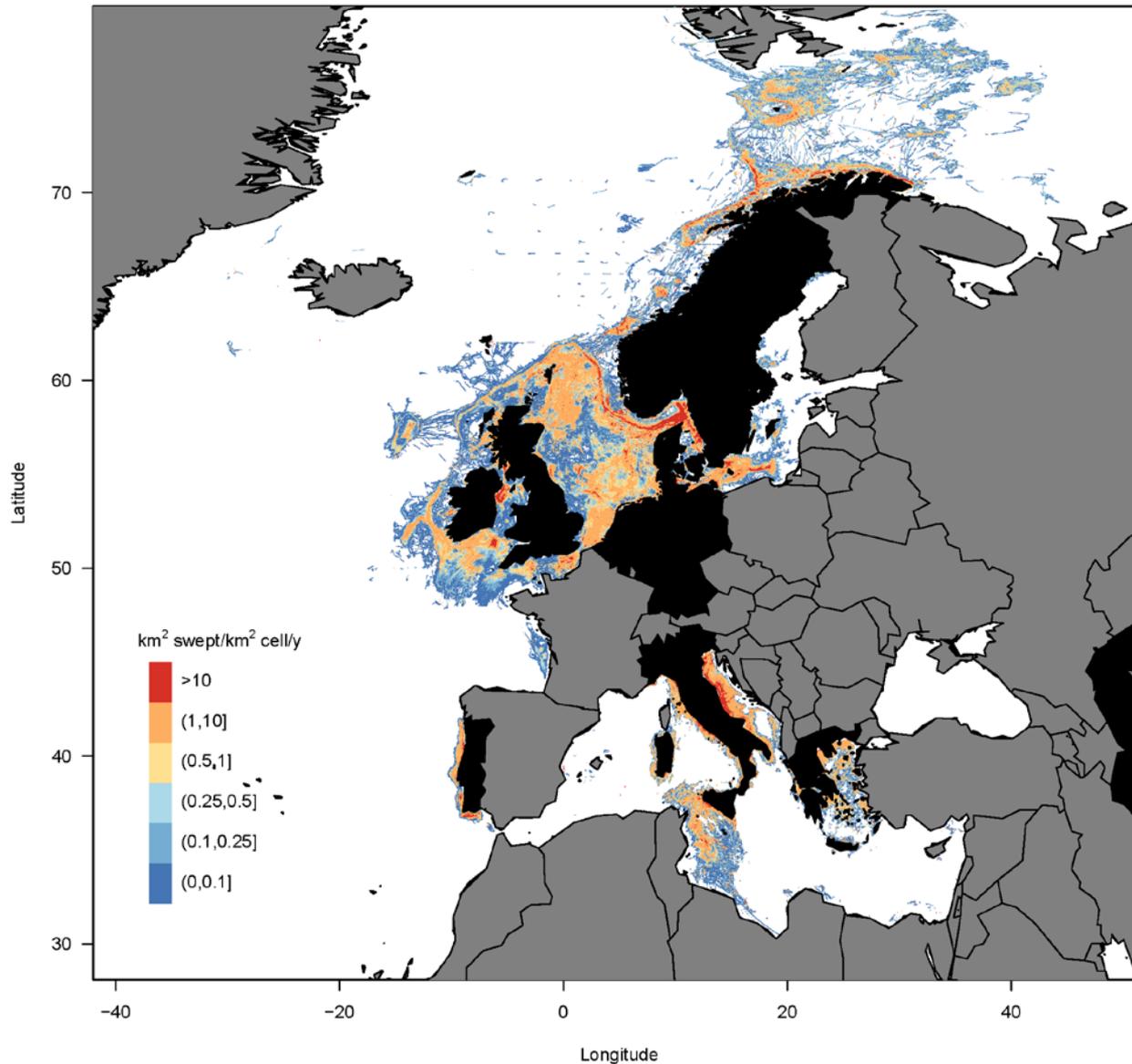
Estimated probability of natural disturbance (χ_{ND}) exceeding fishing disturbance (T).

Fishing against natural disturbance: yellow = natural disturbance is greater than fishing disturbance.





Fishing pressure (intensity # / yr)



Assessment framework & Indicators

Gear

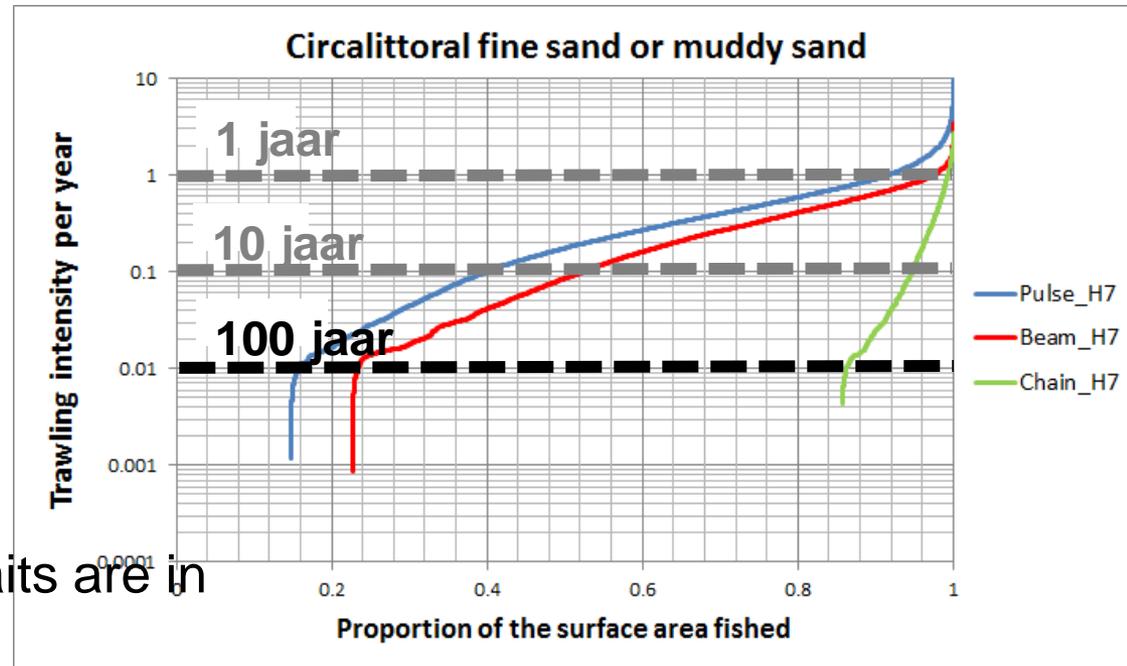
- Foot print (area swept by hour)
- Physical impact
 - Weight and speed of gear components
- Trawling intensity

Indicators

- Pressure
 - %unfished; %fished > 1
 - Area with 90% effort
- Trawling impact
 - Reduction area where traits are in reference state

Habitat

- Level natural disturbance
- Species composition (longevity, biogenic taxa)



Pulse trawl

Pulse trawl

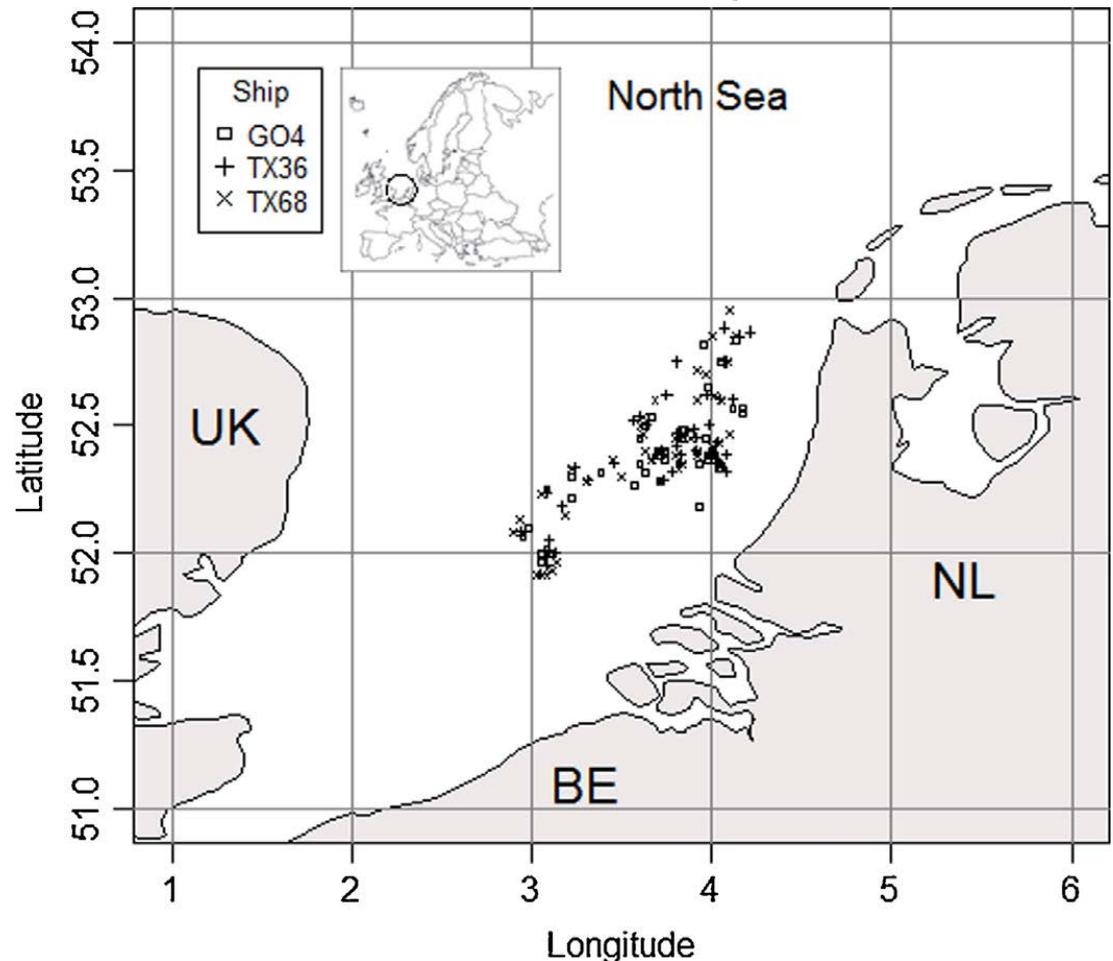
- Overview
 - Catch efficiency and selectivity
 - Description of the gear and pulse technique
 - Experiments (injuries, behaviour)
 - cod
 - dab
 - benthic invertebrates
 - BENTHIS: field studies
 - Conclusion



4-3

Selectivity & Catch efficiency

Comparative fishing experiment in 2011: TX36 (HFK), TX68 (Delmeco), GO4 (tickler chain beam trawl)



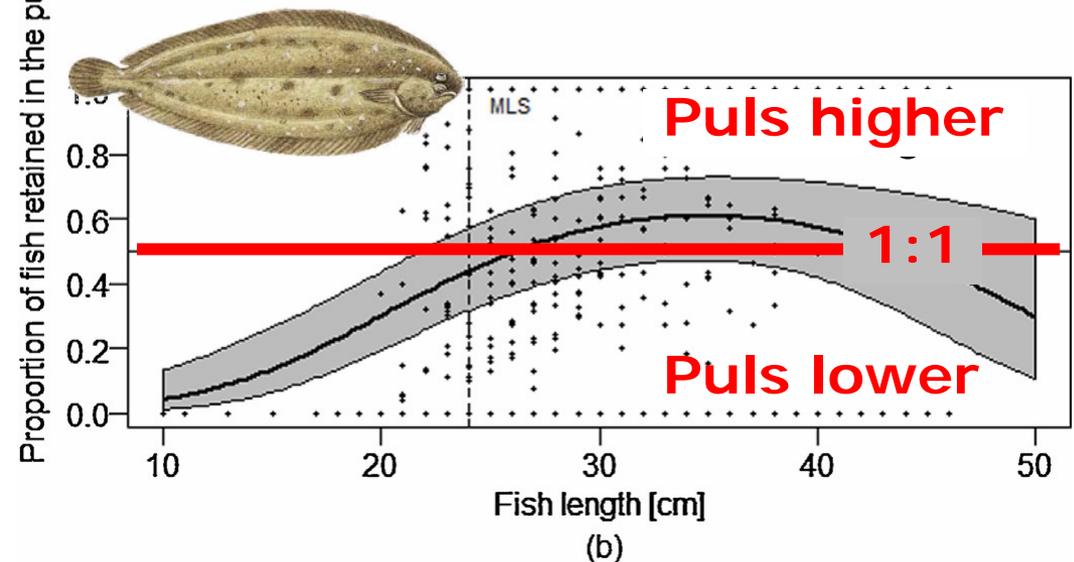
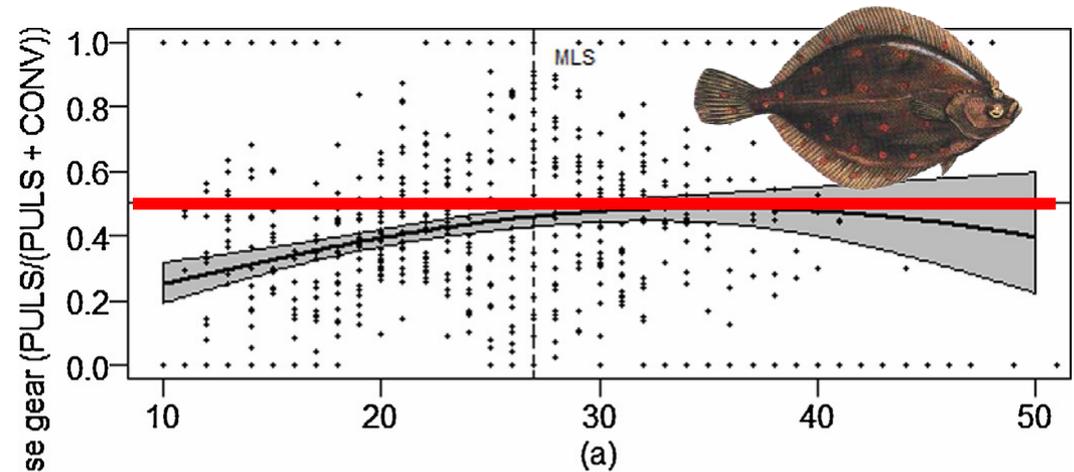
Van Marlen et al. (2014)
Fisheries Research

Catch efficiency

	Tickler chain n=33	Pulse n=2*33	Ratio Puls /tickler	P
Plaice (kg/hectare)	1.34	1.26	94%	ns
Sole (kg/hectare)	0.59	0.61	103%	ns
Landings (baskets / hectare)	0.10	0.08	81%	<0.001
Discards (baskets / hectare)	0.59	0.25	43%	<0.001

Selectivity (plaice & sole): lower bycatch undersized flatfish

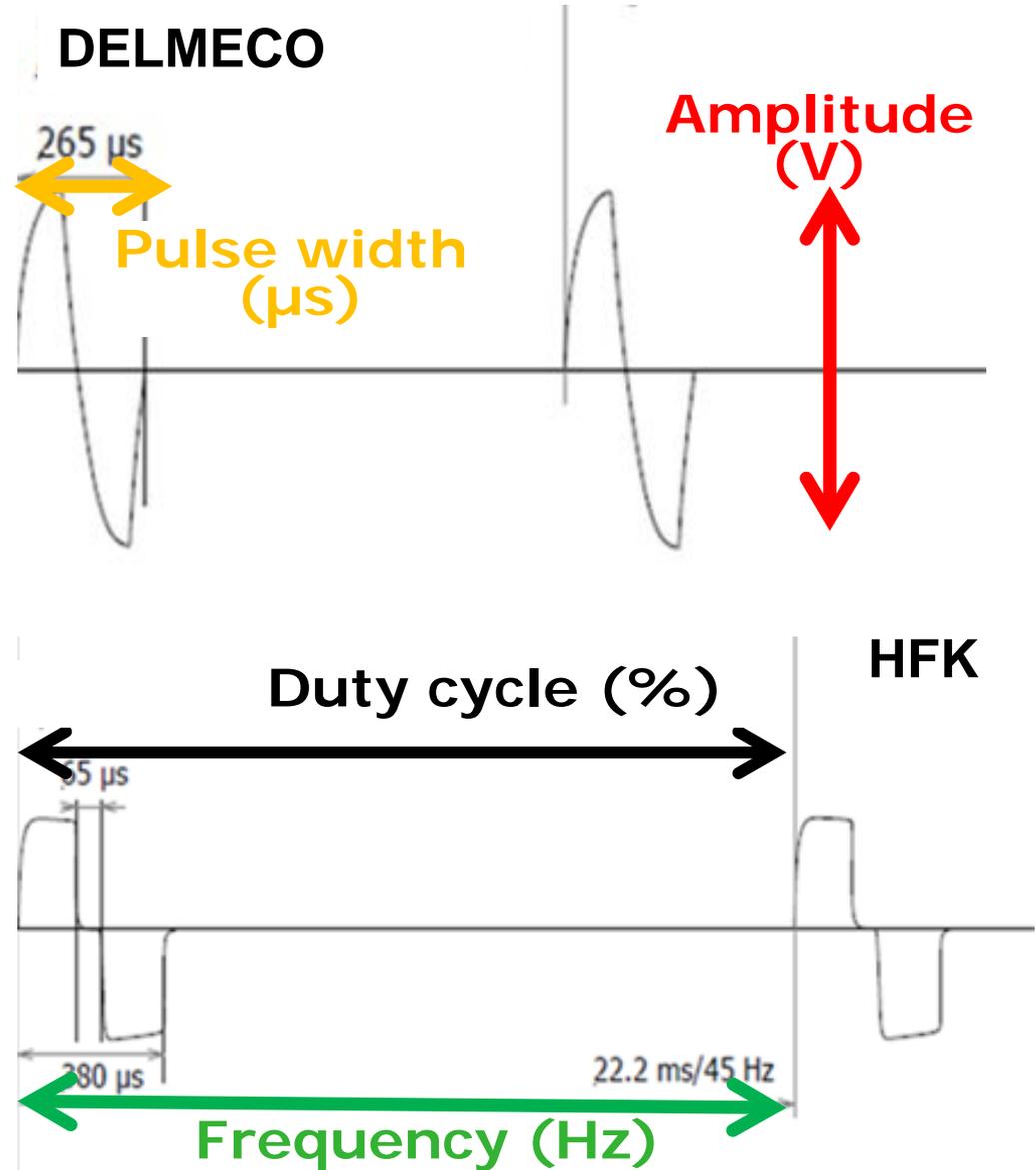
Catch
per unit area swept
Pulse / Tickler chain



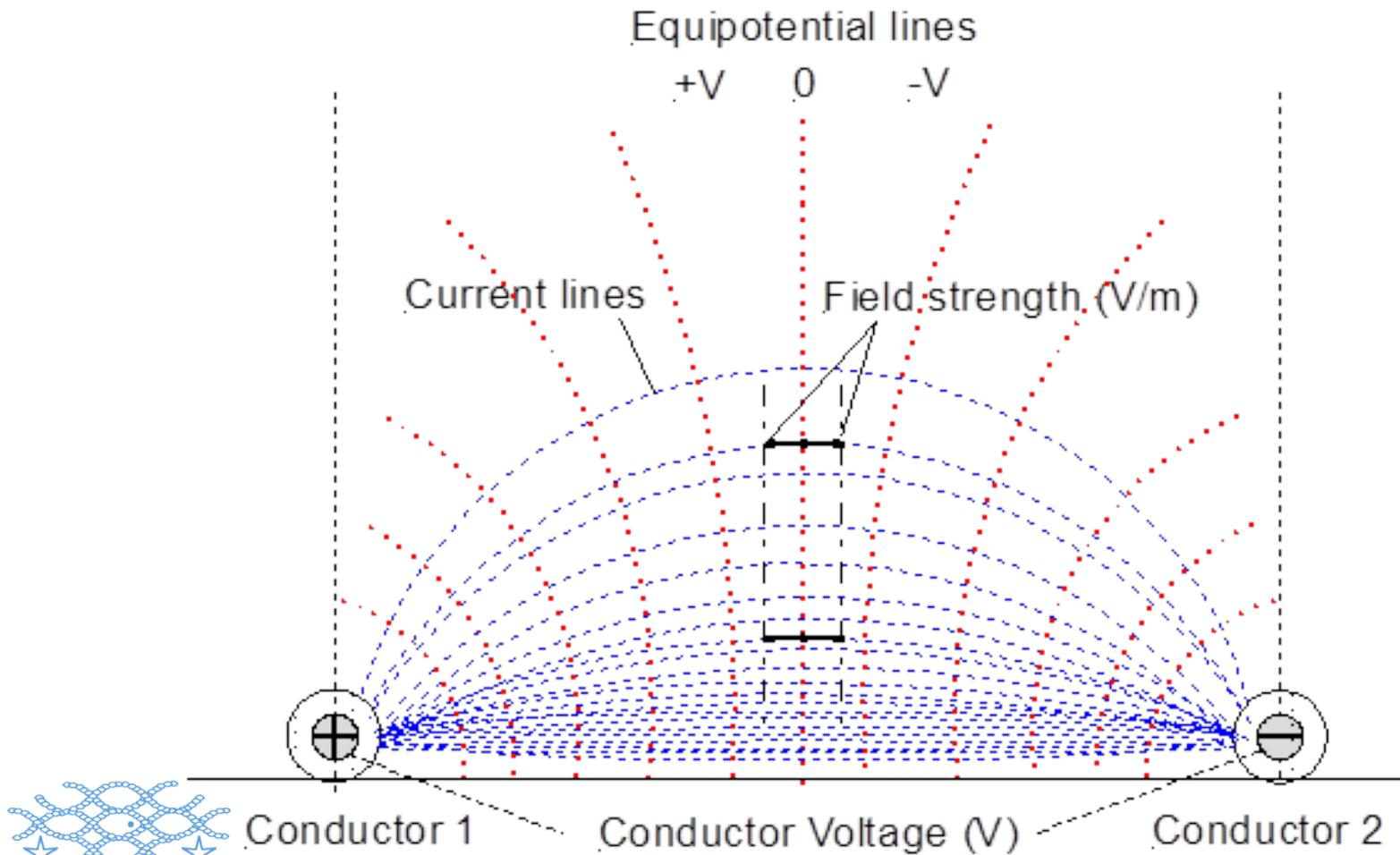
Van Marlen et al. 2014

Pulse parameters

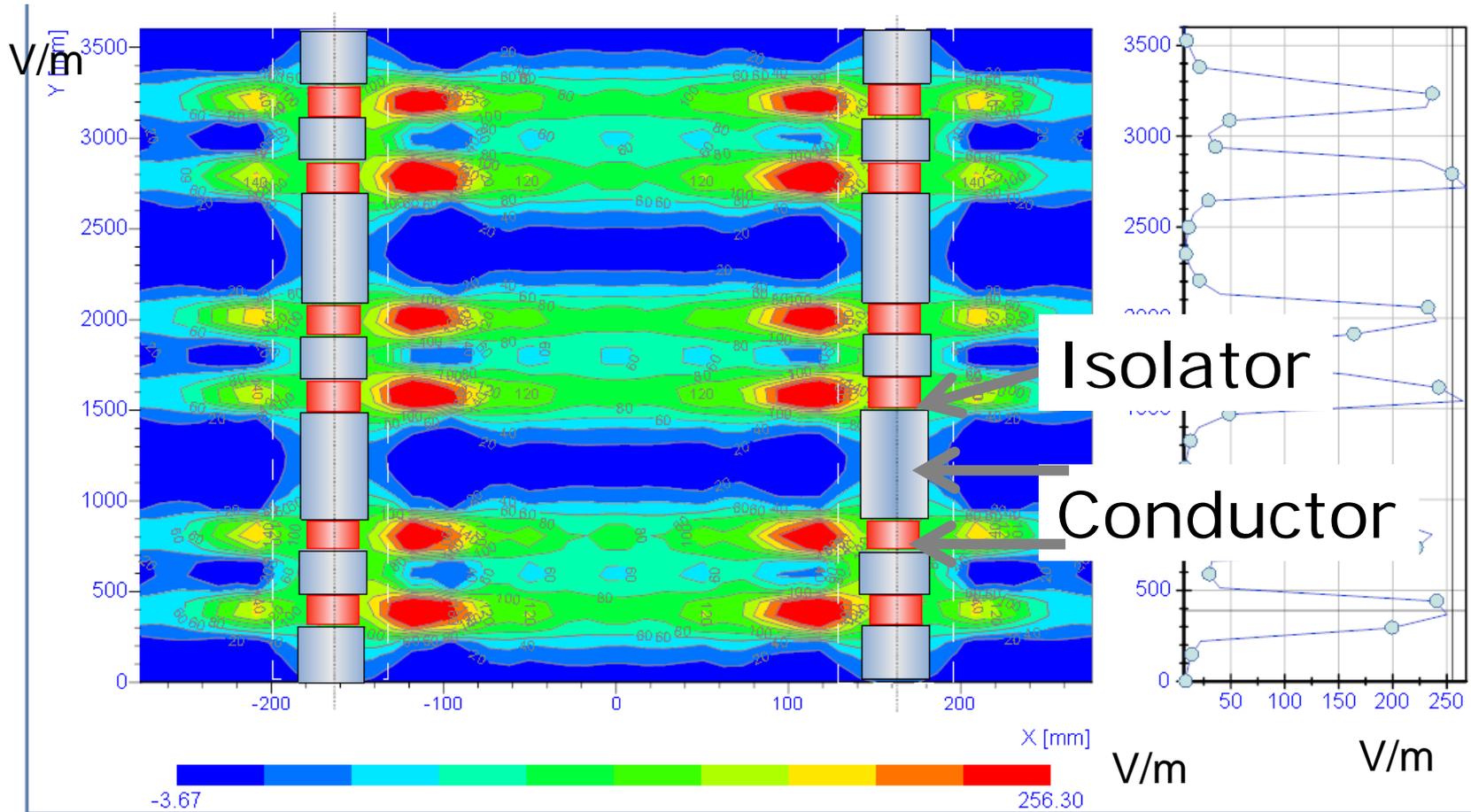
- Pulse type
 - Delmeco
 - HFK
- Amplitude (V)
- Frequency (Hz)
- Pulse width (μs)
- Duty cycle (%)



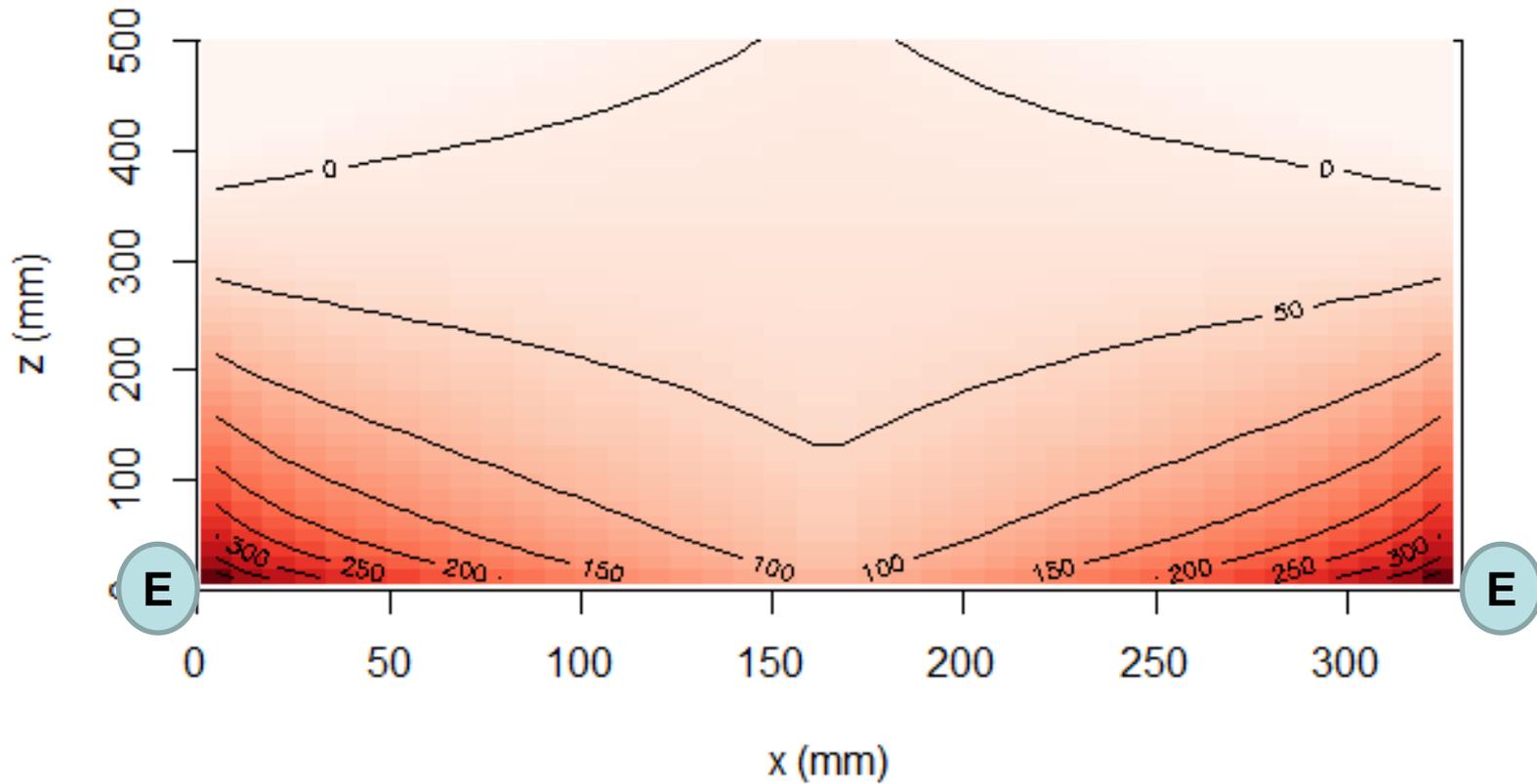
Current (A) and field strength (V/m)



Field strength (V/m) in horizontal plane (3.5cm)

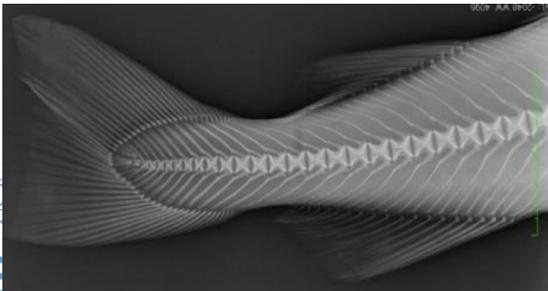
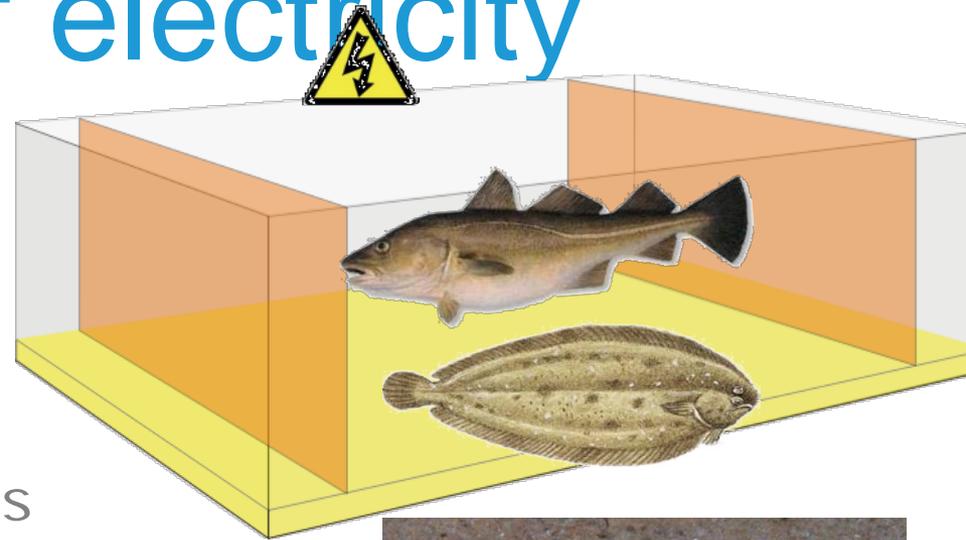


Field strength (V/m) in vertical plane



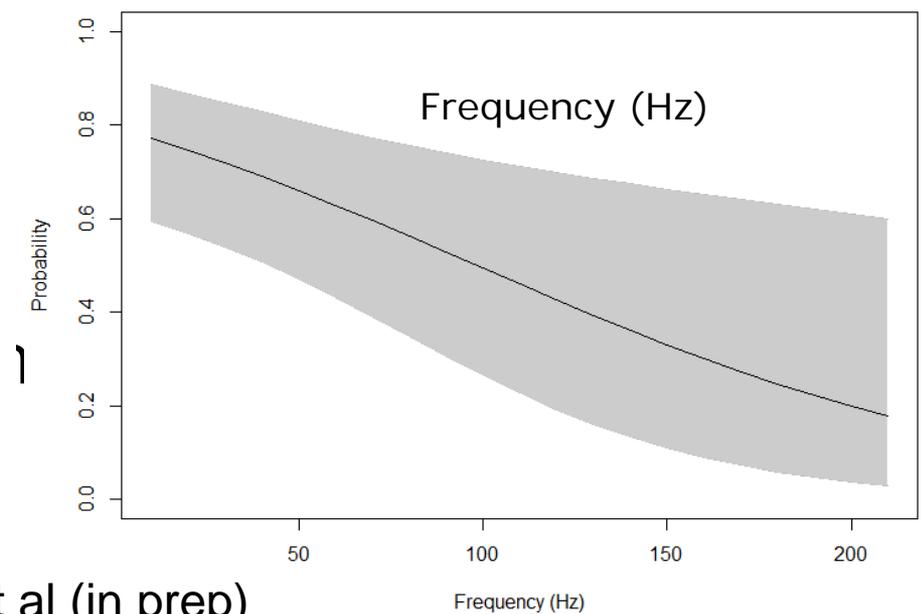
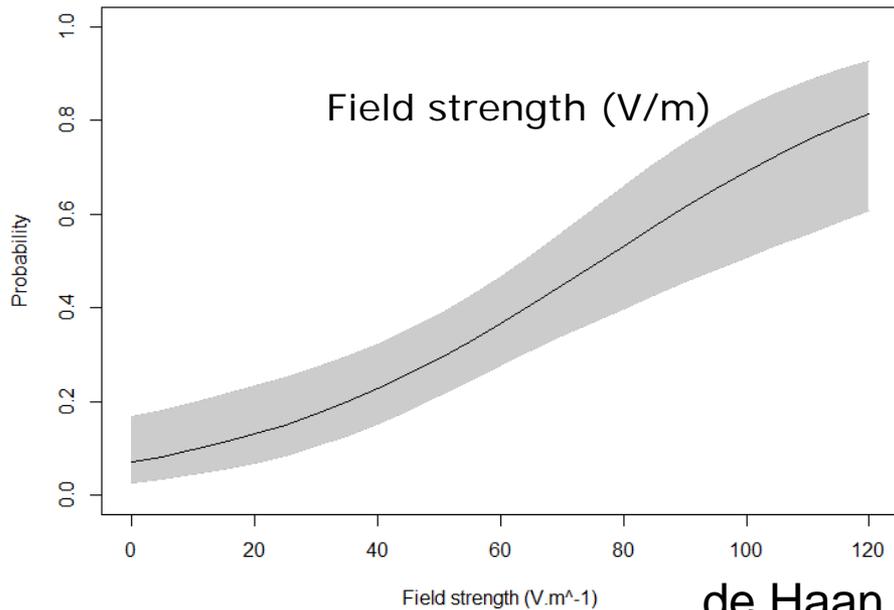
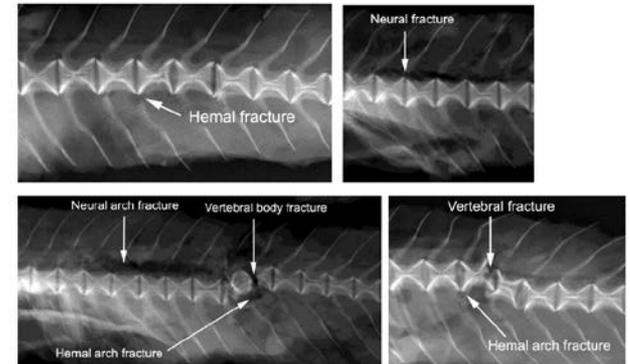
Effects of electricity

- Lab experiments (ILVO, University Gent, IMARES)
 - Exposure 2 sec
 - Cod & Sole & Dogfish
 - Brown shrimp & Nereis
- Measurements
 - Survival (2 weeks) & behaviour
 - Macroscopic
 - X-ray & Histology



Uni Gent: Marieke Depestele;
Maarten Soetaert; Annemie
Decostere;
ILVO: Hans Polet;
IMARES: Dick de Haan; Bob
van Marlen

Effect pulse on injury probability



de Haan et al (in prep)

Overview single exposure experiments

	Behavioural response	Injuries	Mortality	Feeding
Cod	Escape (<20 Hz) Cramp (>20Hz) Epileptic (120V)	fractures haemor- rhages	no	resume normal feeding
Sole	Escape (<20 Hz) Cramp (>20Hz) Epileptic (extreme)	None	No	resume normal feeding
Dog- fish	Escape	None	no	Resume feeding; deposition viable eggs
Shrimp	Jump (<20 Hz) Cramp (>20Hz)	None	No	-
Nereis	movement	None	no	-

Dab: single exposure experiment to study ulcers

- Three groups of 50 dab
- Maximal exposure
 - DELMECO (60V)
 - HFK (70V)
 - Reference group (not exposed)
- After 1 week killed and examined for lesions, ulcers, wounds, parasites
- No effects detected

Field experiments: tickler chains versus pulse



Large vessels (2000 hp)
sumwing



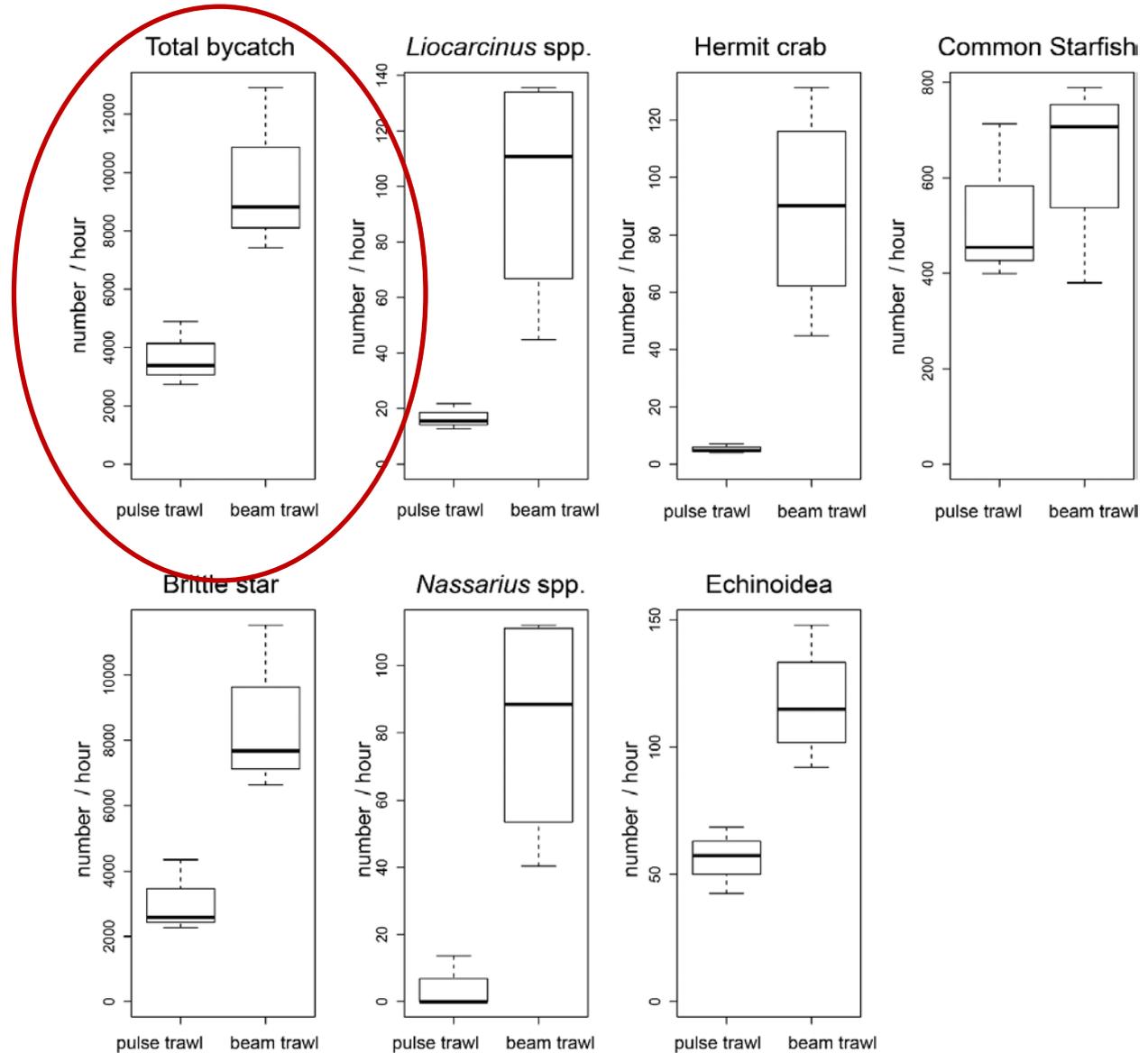
Euro cutters (300 hp)
Traditional gear

Field experiments

- ✓ **Tickler chains** versus **pulse**
- ✓ **Low energy** vs **high energy habitat**



Biological impact: catch comparison

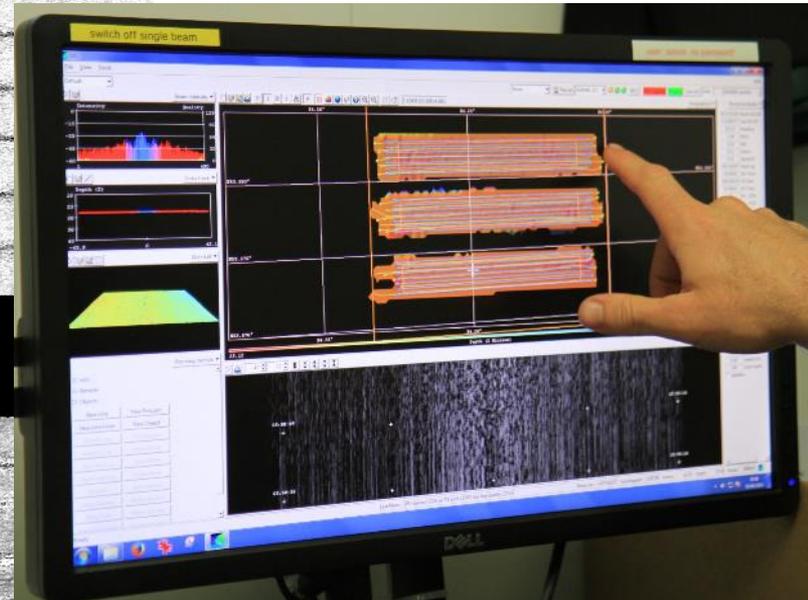


Physical impact

Tickler chains

Not fished

Puls



SPI – preliminary results

Tickler chains

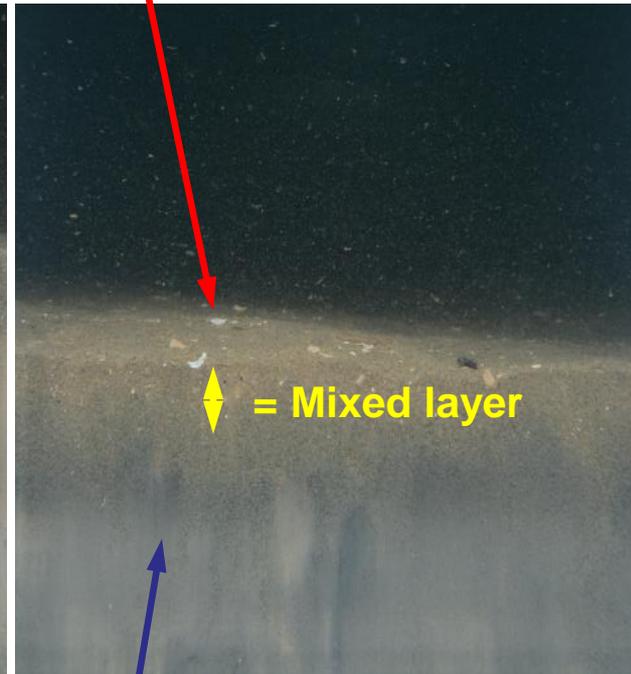
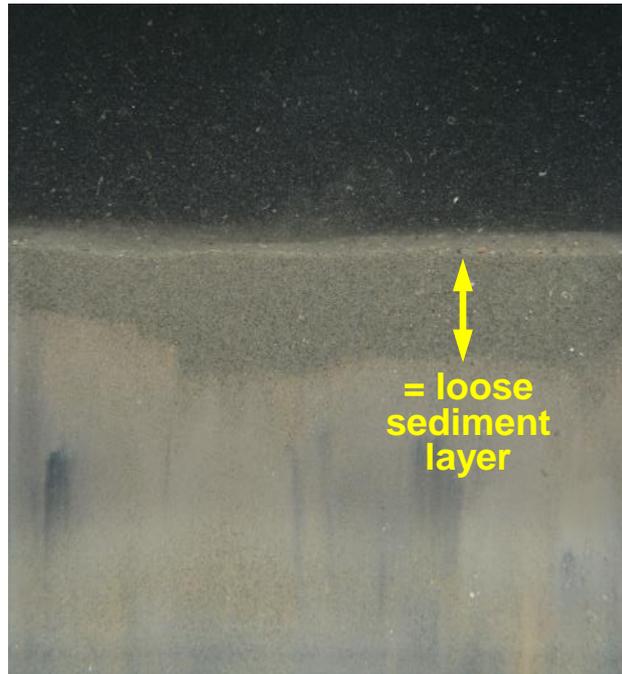
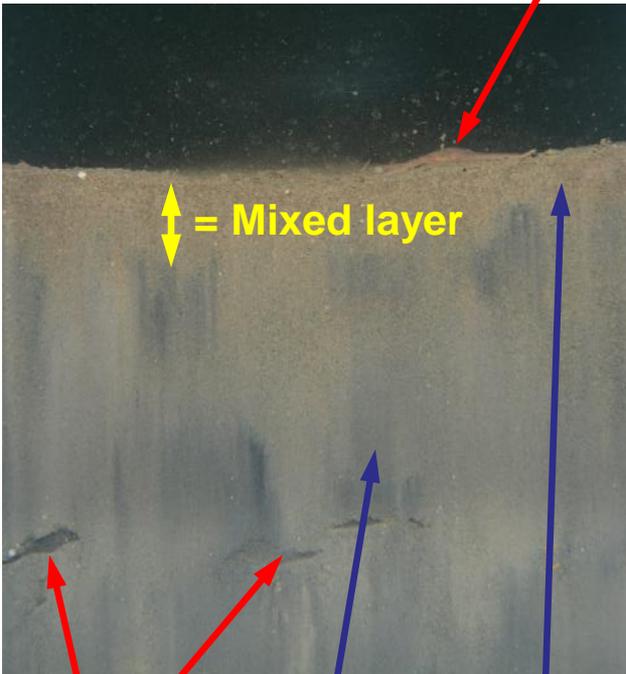
T0

Brittle star

T1

Broken shells

T3



Holes

Brown = oxidised sediment

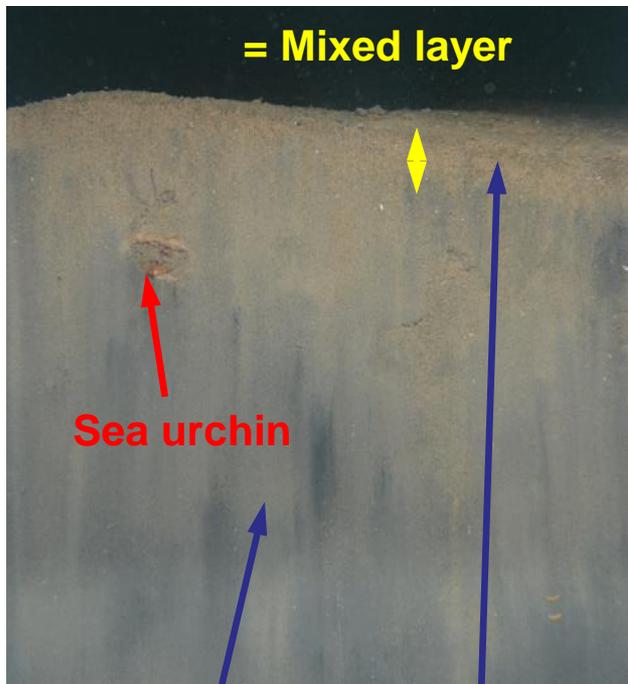
Grey = reduced sediment

Grey = reduced sediment

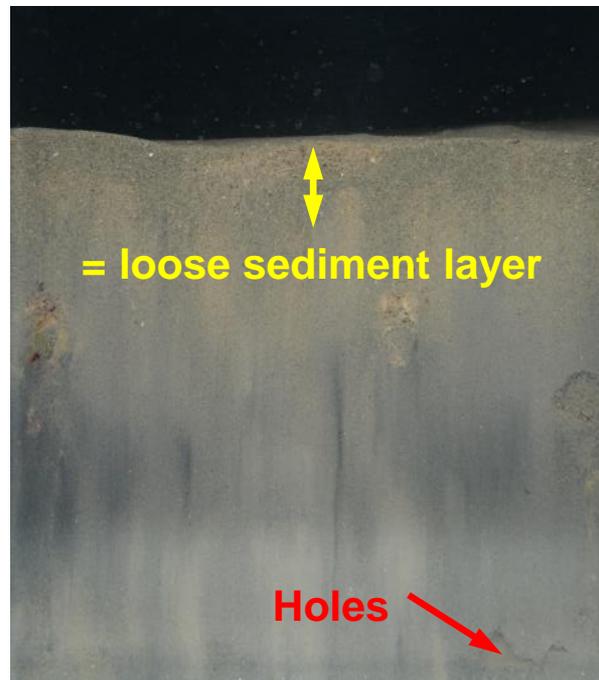
SPI – preliminary results

Puls

T0

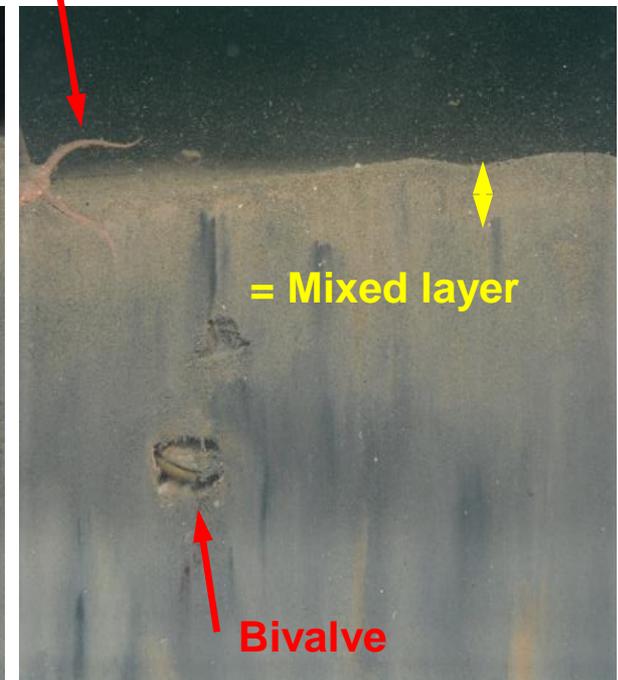


T1



Brittle star

T3

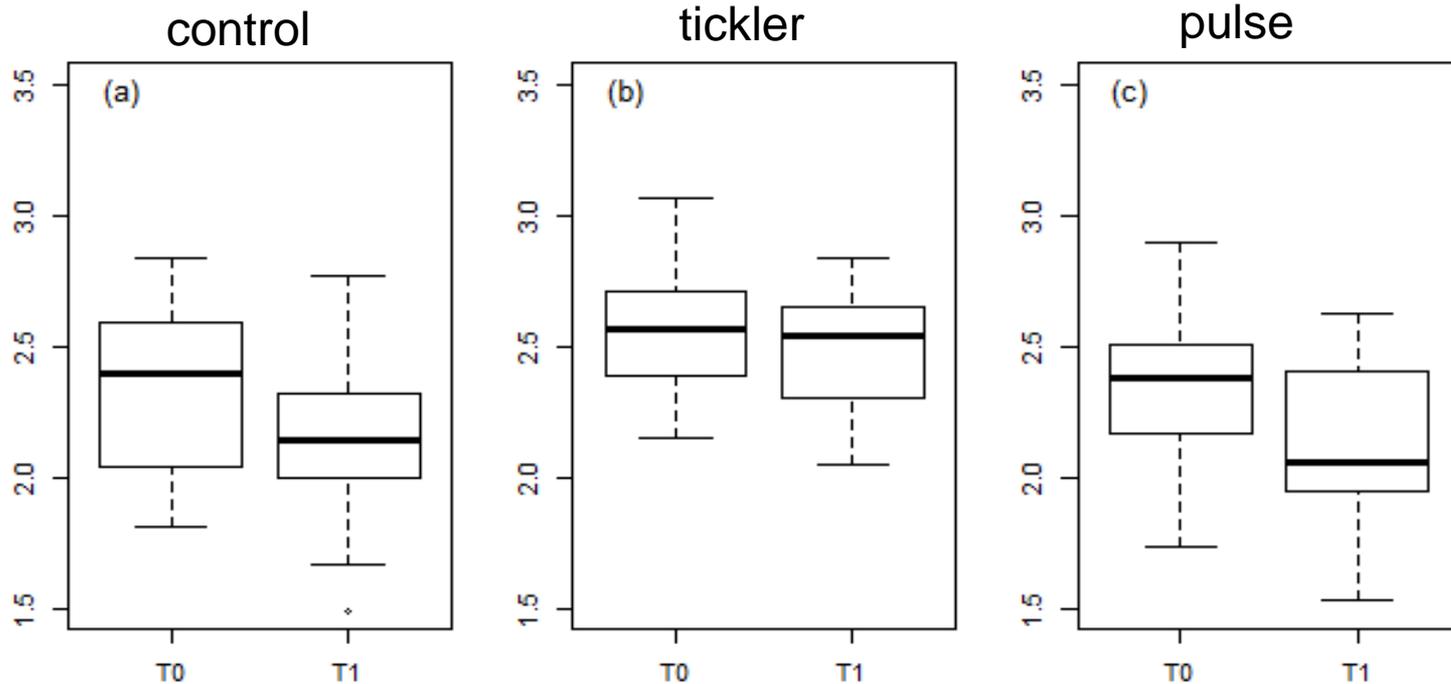


Brown = oxidised sediment

Grey = reduced sediment

Biological impact: mortality

- Preliminary result
 - No significant effect.



Conclusions

field experiments BENTHIS

- Physical impact clearly visible
- Pulse penetrate less deep than tickler trawl
- Tickler catches more bycatch (benthos)
- Preliminary: no significant decrease in biomass benthos due to trawling (both tickler and pulse)



Overall conclusions pulse trawl

- Reduction in
 - Bycatch of undersized fish
 - Bycatch of benthic invertebrates
 - Penetration depth
- Trawl path mortality
 - Preliminary results do not show a significant result.
 - Statistical power to be estimated

Knowledge gaps

- Effect on physiology marine organisms (what & why!)
 - What type of organisms are sensitive?
 - Sensitivity of different life stages
 - What is long-term effect on organisms that are exposed repeatedly?
 - Effect on electro sense organs (rays and sharks)
- Effect on geo-chemistry
 - electrolysis (release of nutrients or contaminants)
- Effect on functioning benthic ecosystem
- Upscaling effects to fleet level and ecosystem level