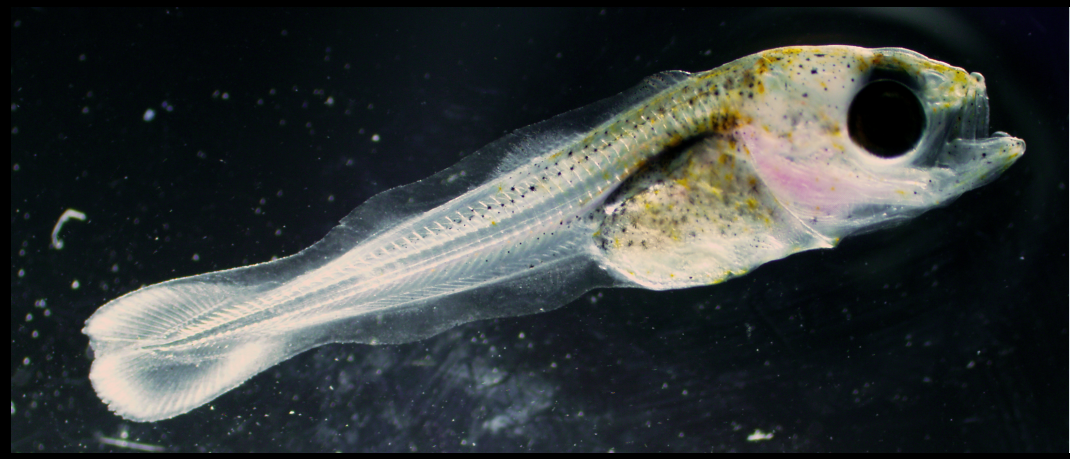
Assessing the impact magnetic fields generated by subsea cables connecting offshore wind farms on swimming and dispersal of fish larvae

Alessandro Cresci, Caroline M.F. Durif, Guosong Zhang, Torkel Larsen, Prescilla Perrichon, Anne Berit Skiftesvik, Howard I. Browman



HI project 15655: ”Assessing the impacts of offshore wind on the early life stages of fish”

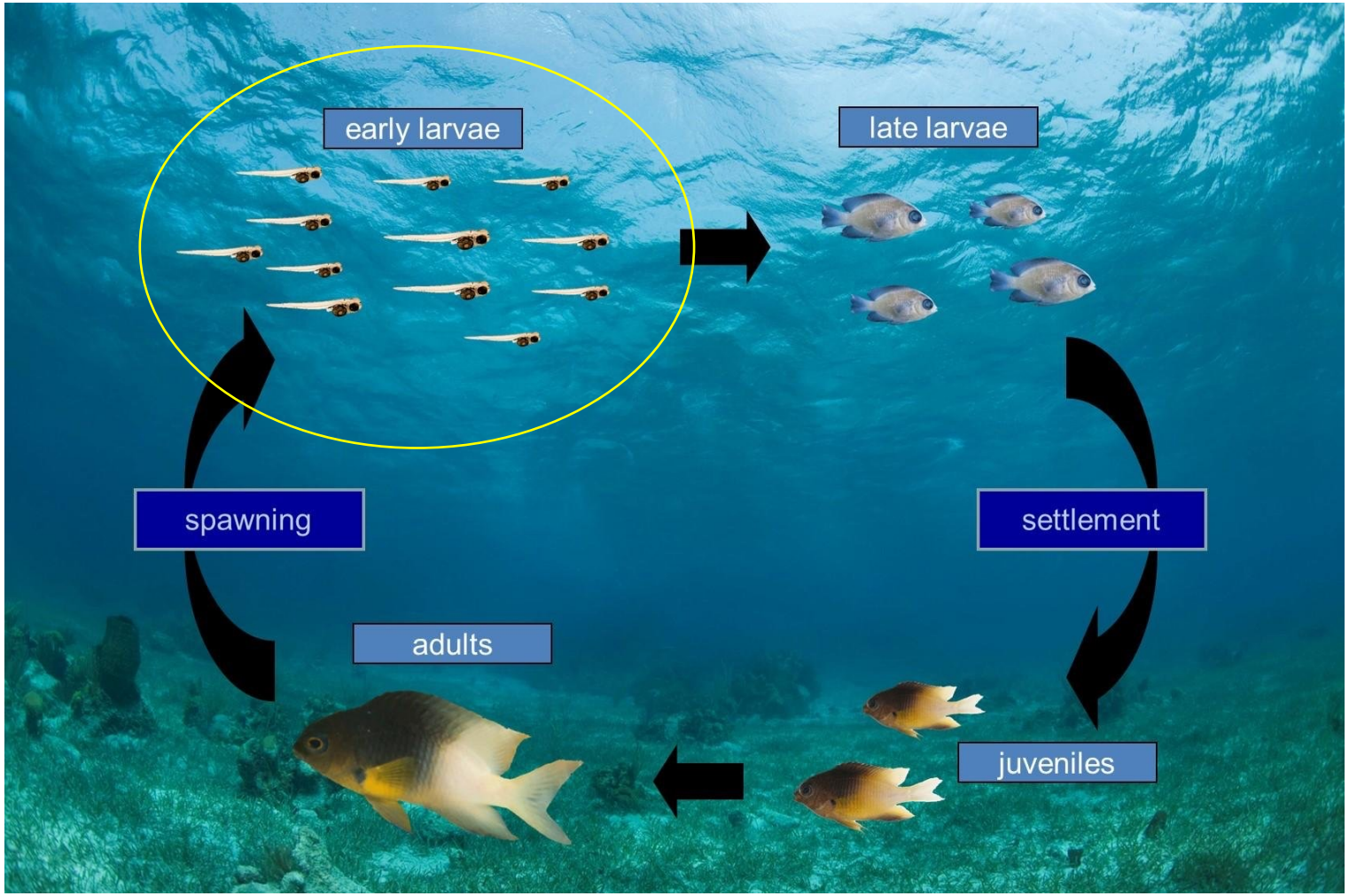
Speaker: Alessandro Cresci

www.fishlarvae.org

Havforskningsinstituttet, Austevoll Research Station, Storebø, Norway

The Dispersal of Fish Larvae

During the larval phase, fish drift through pelagic waters before settling in areas suitable for growth



Credit: Darren Johnson

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The Dispersal of Fish Larvae

Why it matters

Larval dispersal determines survival

Survival at the larval stage influences future recruitment (adults)

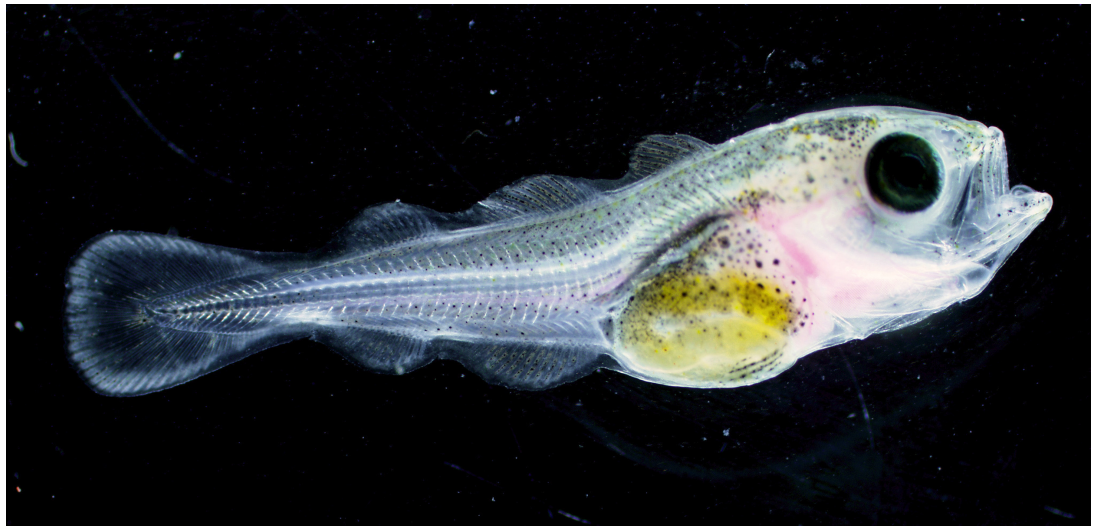
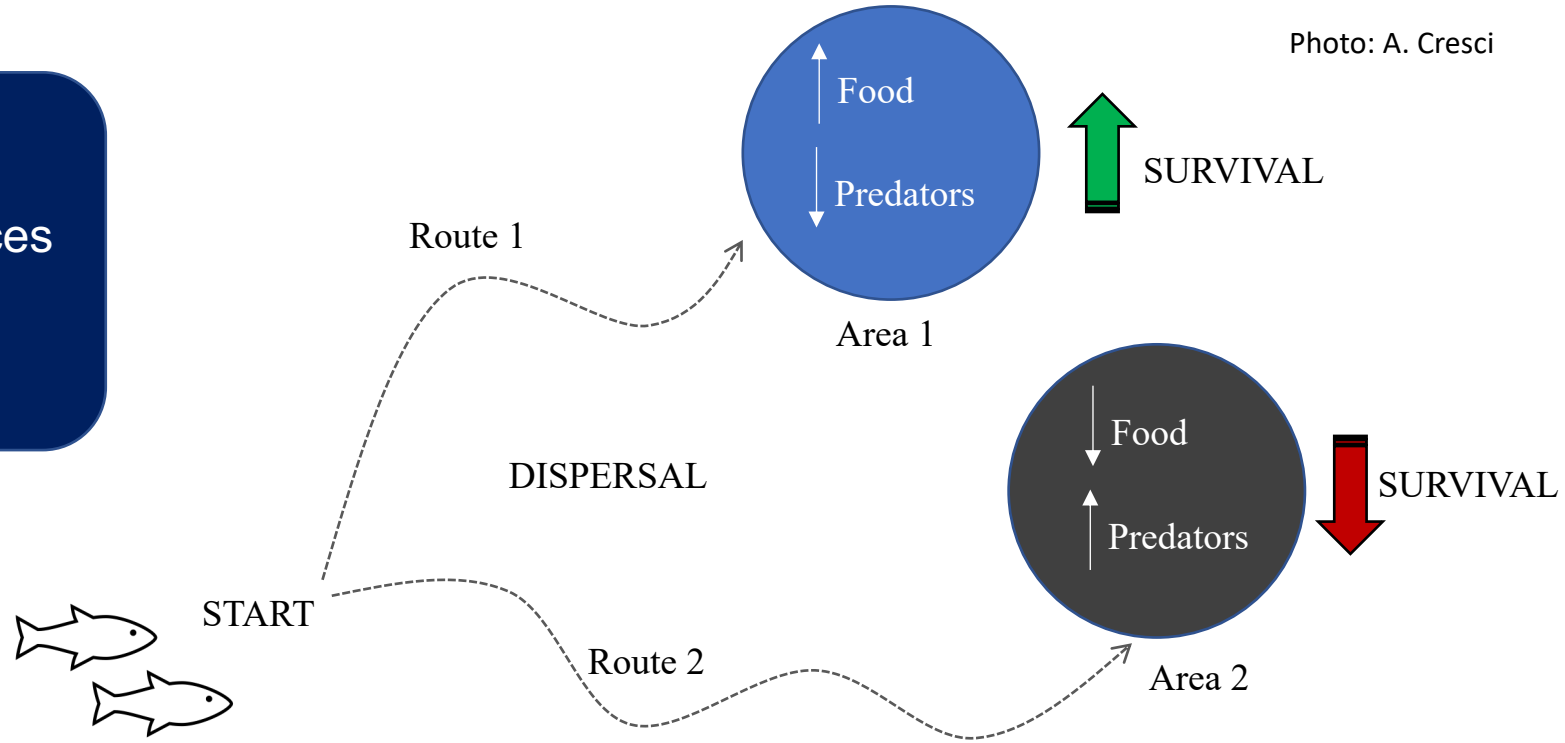


Photo: A. Cresci



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The Dispersal of Fish Larvae

Light pollution

Mouritsen et al. 2013

Celestial cues

(Parmentier et al. 2015)

Sounds

Pile driving

(Foretich et al. 2017)

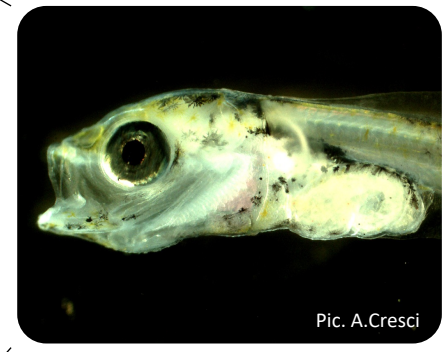
Odors

Oil spill

OWFs cables

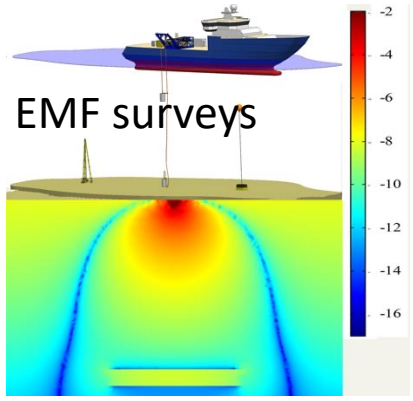
Myrberg and Fuiman, 2002

Electric fields



(Sweatman et al. 1988)

Chemical gradients



Bottesch et al. 2016

Magnetic field

Anthropogenic disruption

(Lecchini et al. 2005)

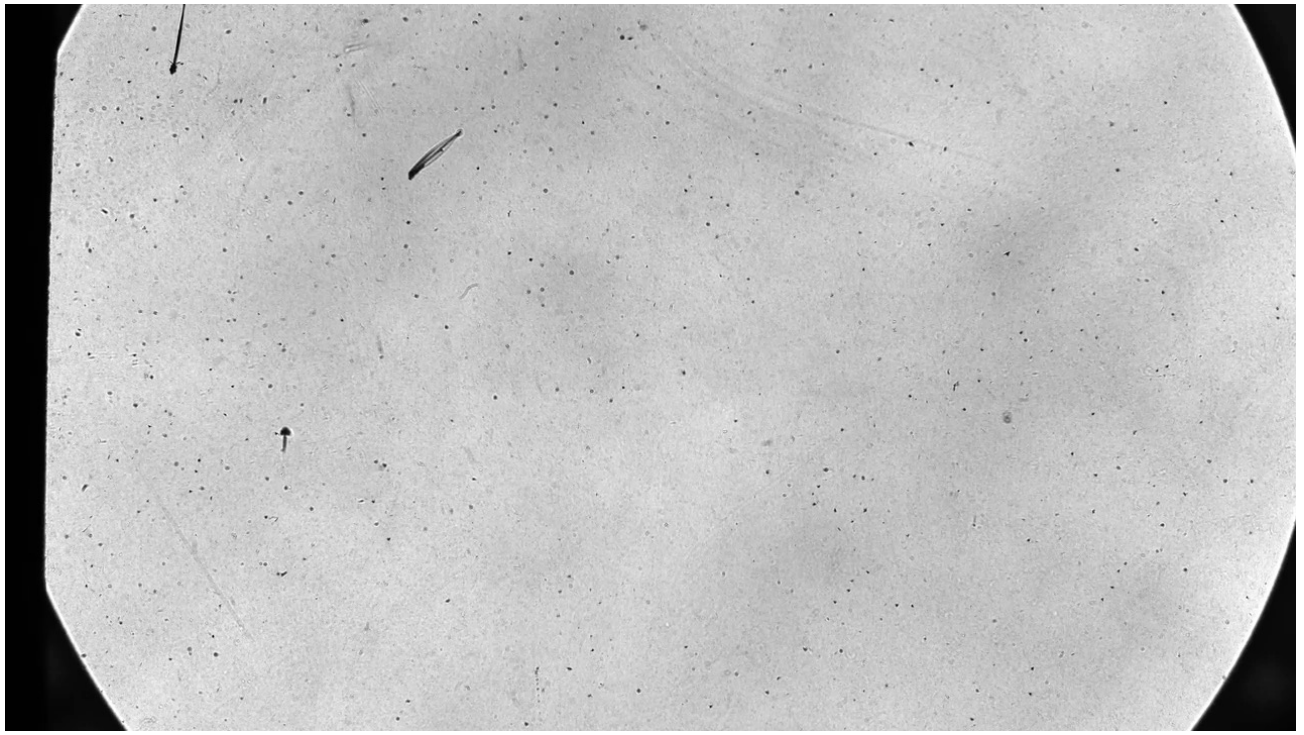
Visual cues

Dredging

IMR Austevoll Research station

Equipment and facilities – Rearing, labs and in situ equipment

3D trajectories and movement of fish larvae



www.fishlarvae.org

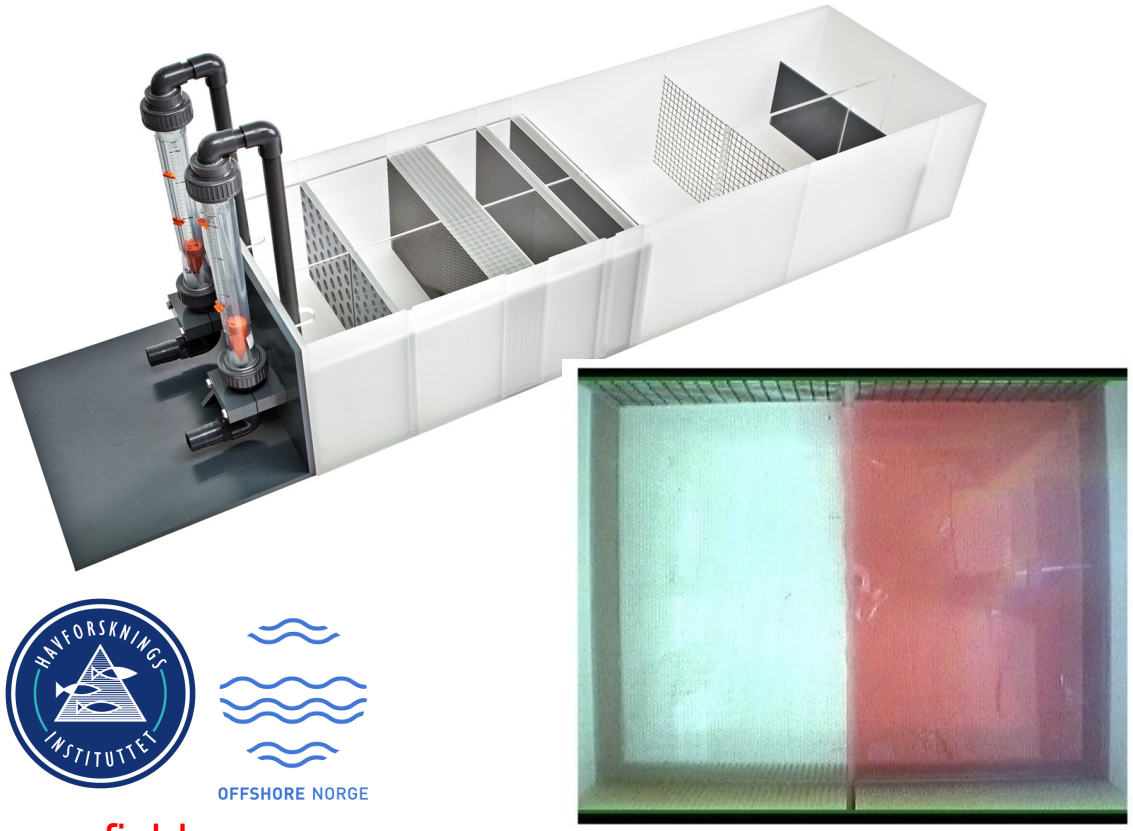
Equipment and facilities

Chemotaxis – Loligo System

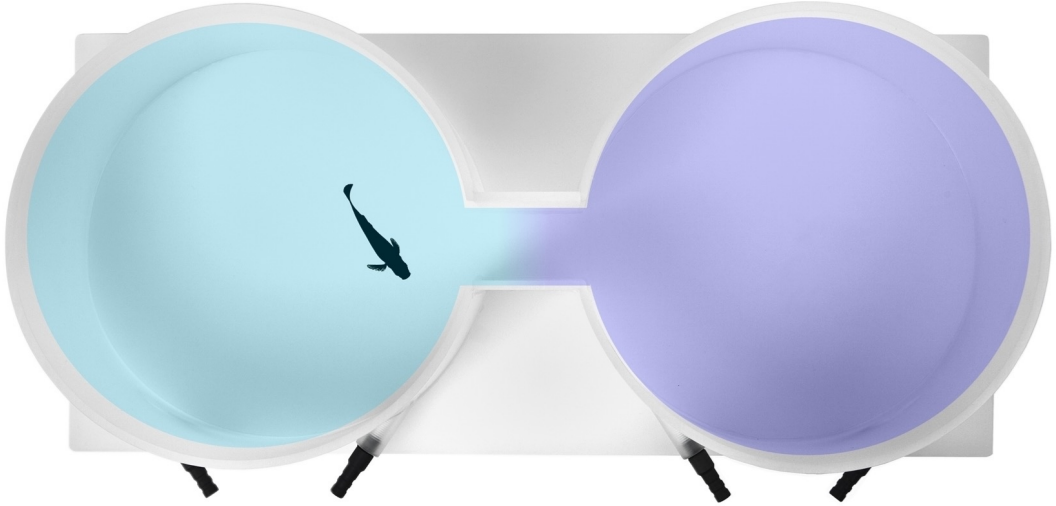
Impact of pollutants on:

- Ph preferences
- Temperature preferences
- Attraction to conspecifics
- Attraction to coastal water
- Avoidance of predators

Choice flume tank



Shuttle box tank



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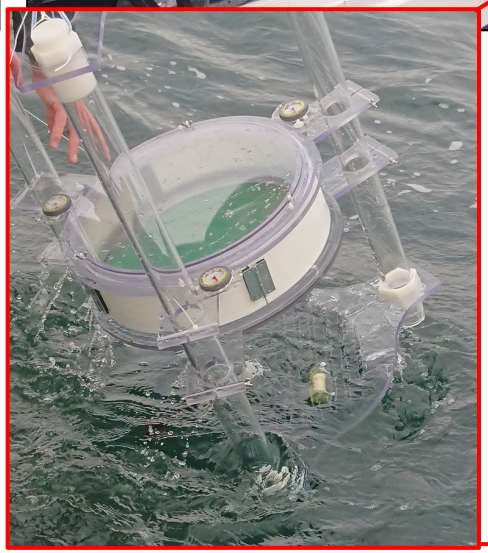
Equipment and facilities

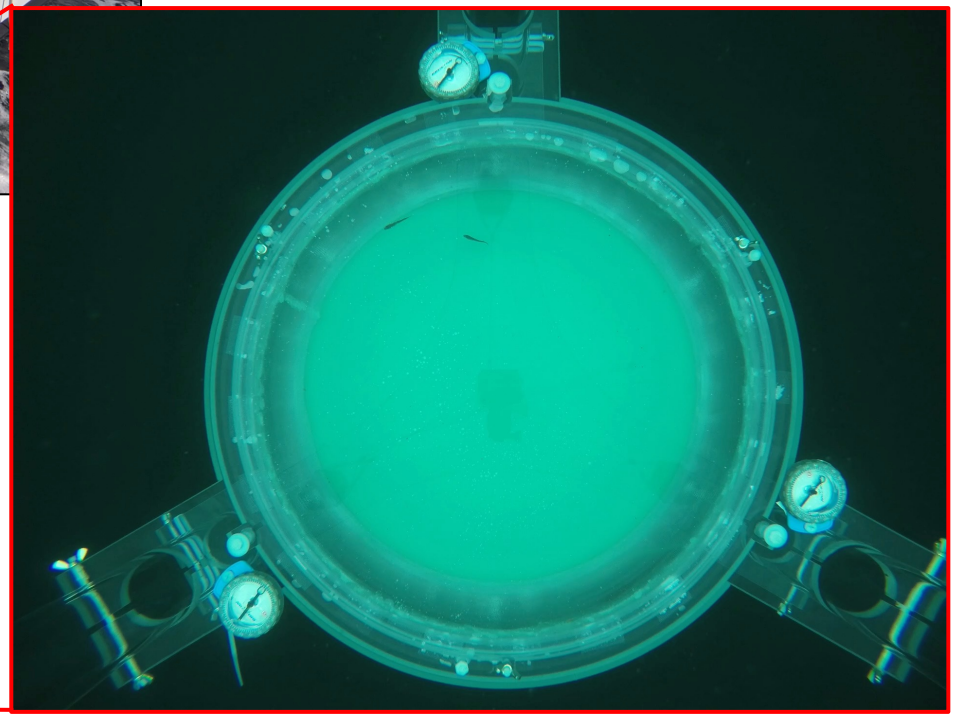
In situ quantification of larval fish swimming and orientation

Cues that fish larvae follow:

- Sound
- Magnetic fields
- Sun
- Celestial cues
- Currents
- Odors

Cutting edge acoustic equipment





Drifting in situ chambers

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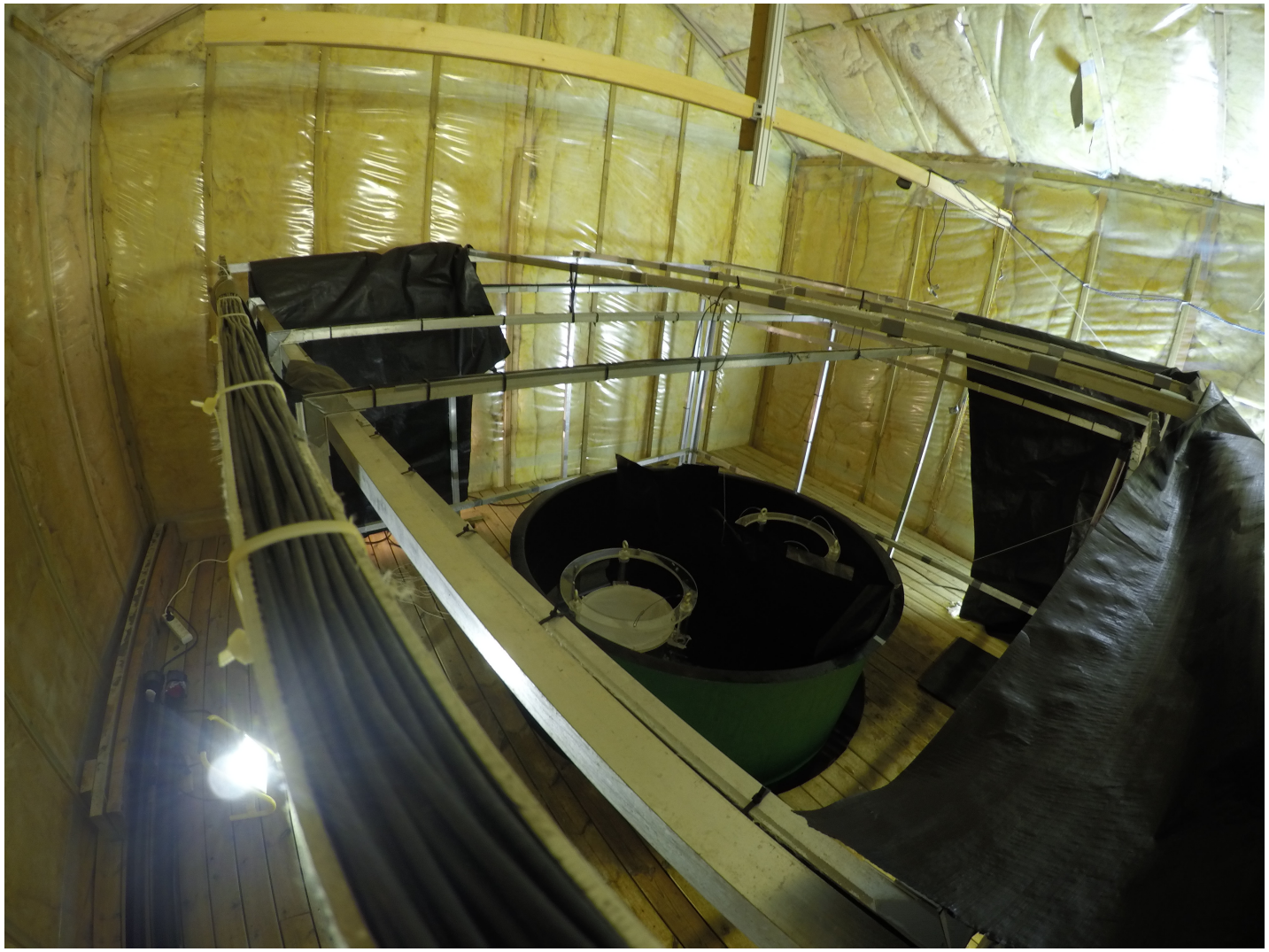
Equipment and facilities

Magnetoreception lab – MagLab

Impact of anthropogenic activities on the ability to orient using the Earth's magnetic field



Impacts of operating offshore wind turbines

Low-frequency operational sound

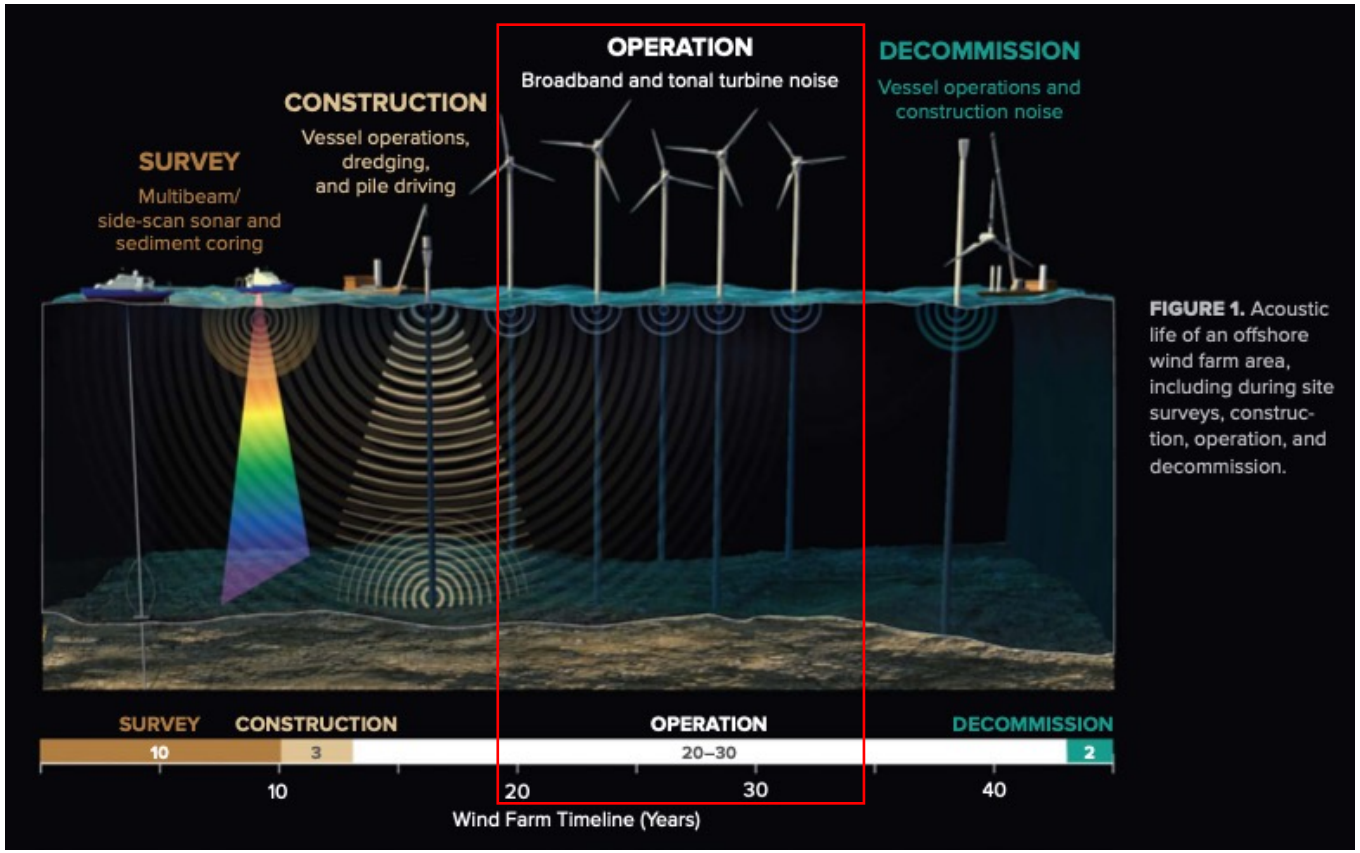
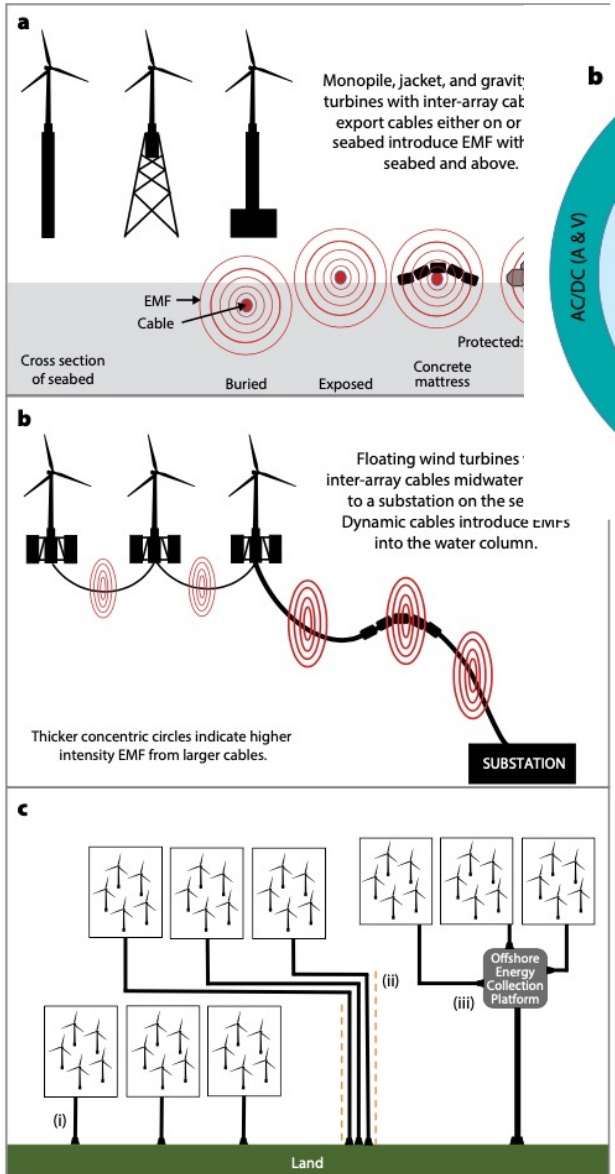
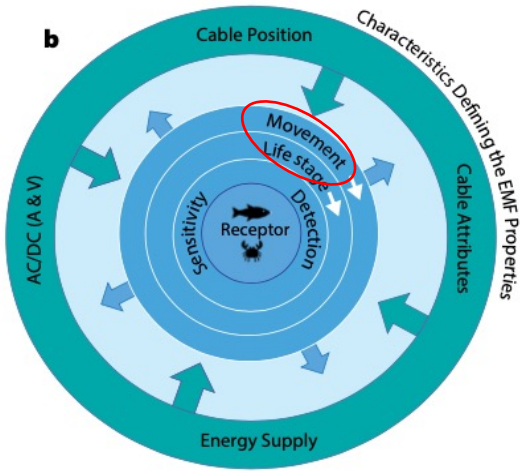


FIGURE 1. Acoustic life of an offshore wind farm area, including during site surveys, construction, operation, and decommission.

From Mooney et al., 2020.

Electromagnetic fields (EMF) from subsea cables





From Hutchison et al., 2020.

Magnetic fields can affect marine animals

Brown crab

2.8 mT affect spatial distribution of brown crab (*Cancer pagurus*)

Scott et. al., 2018

Little skate

10 µT affect spatial distribution of little skate (*Leucoraja erinacea*)

Hutchison et. al., 2020

Raimbow trout

10 mT attract raimbow trout larvae (*Oncorhynchus mykiss*)

Jakubowska et. al., 2021

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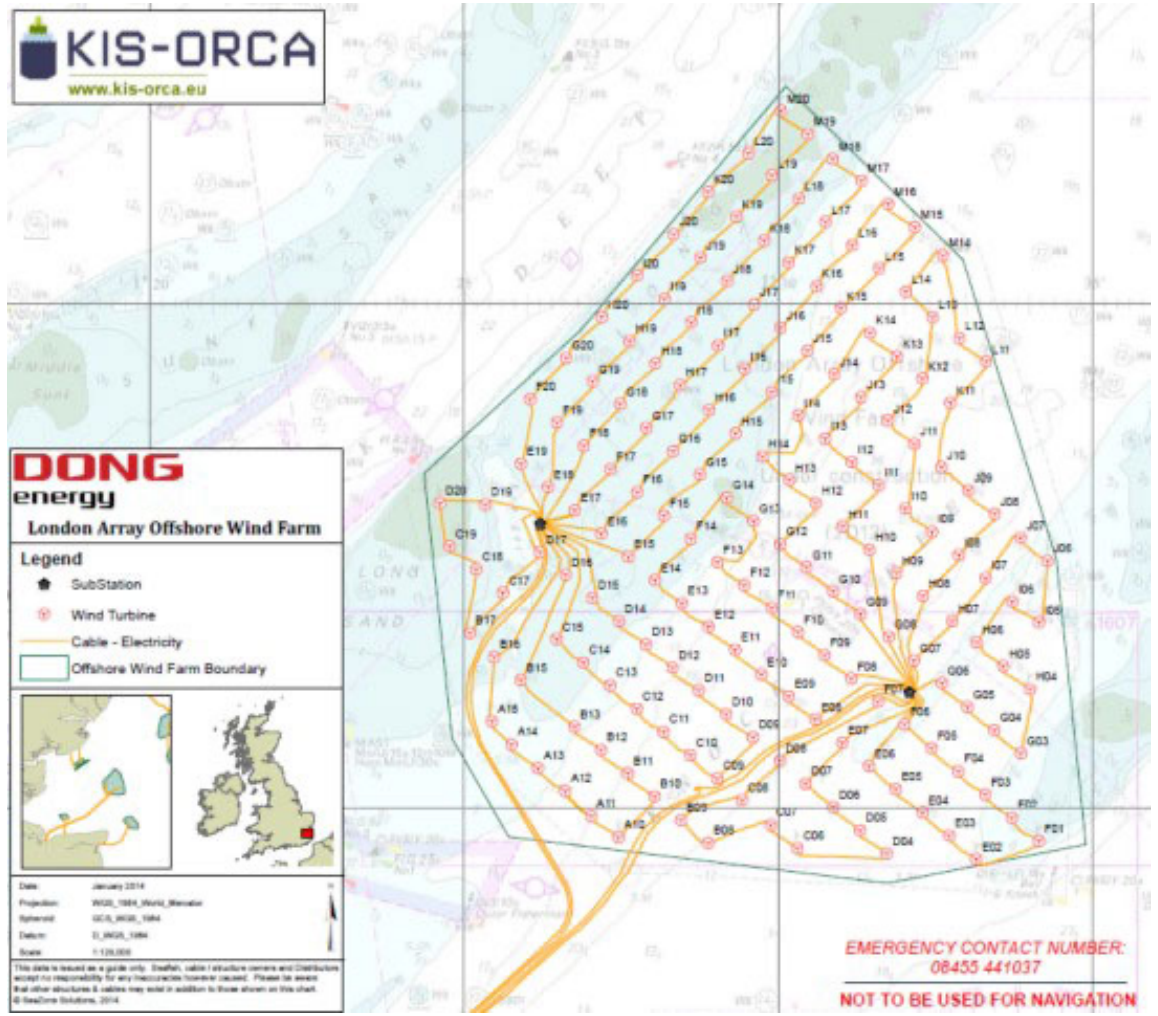
(However, there are also several examples of absence of effects)

Future offshore wind farms will cover large areas of contintental shelf

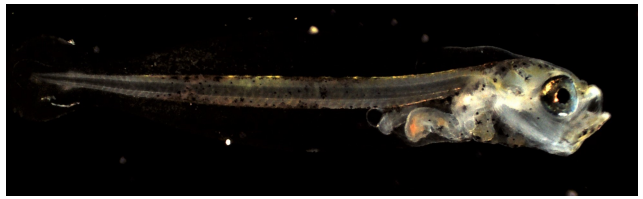


Offshore wind turbines and dispersal of fish larvae

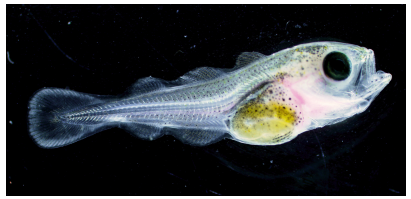
The dispersal phase of fish larvae plays a key role in recruitment.

Planned near-shore and offshore wind farms will be in the proximity of spawning areas of commercial fish

Saithe



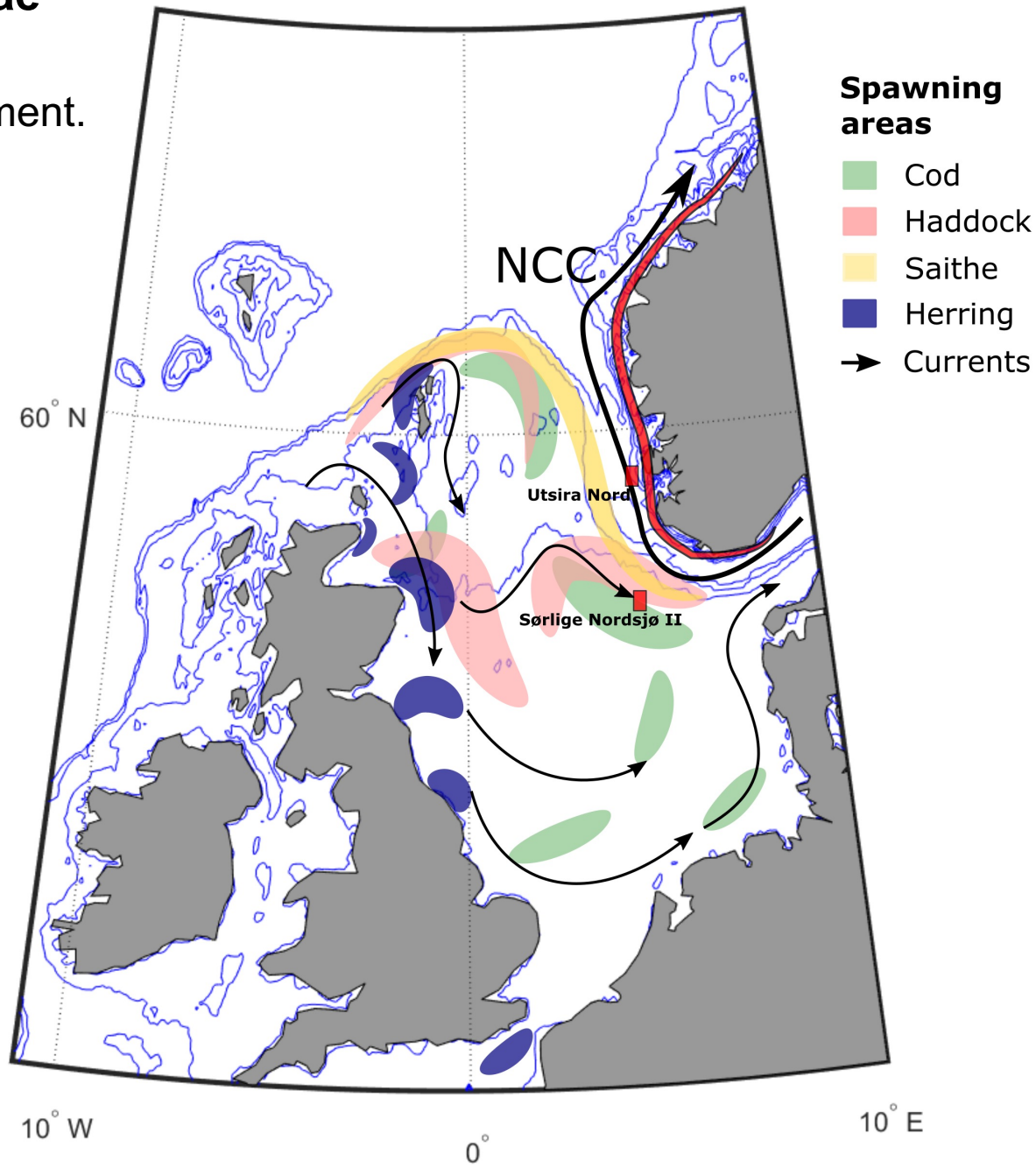
Haddock



Sandeel

Herring

Cod



Objectives and research questions

Does exposure to MF from DC cables affect swimming behavior and spatial distribution of fish larvae?

Does low-frequency operational sound of wind turbines affect orientation and swimming during dispersal?

Essential knowledge to understand large-scale impacts of offshore wind facilities on fish.

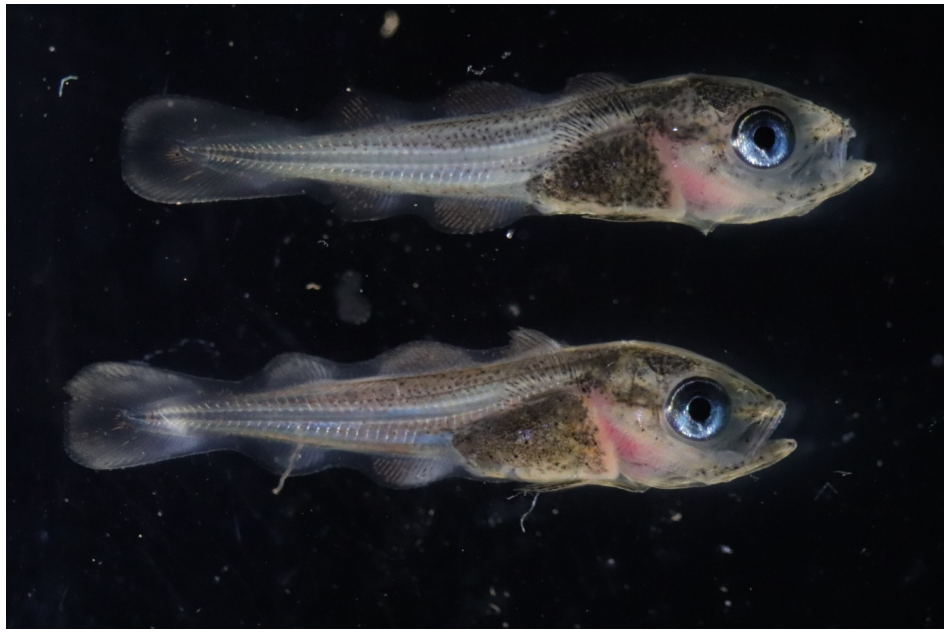


Photo: A. Cresci

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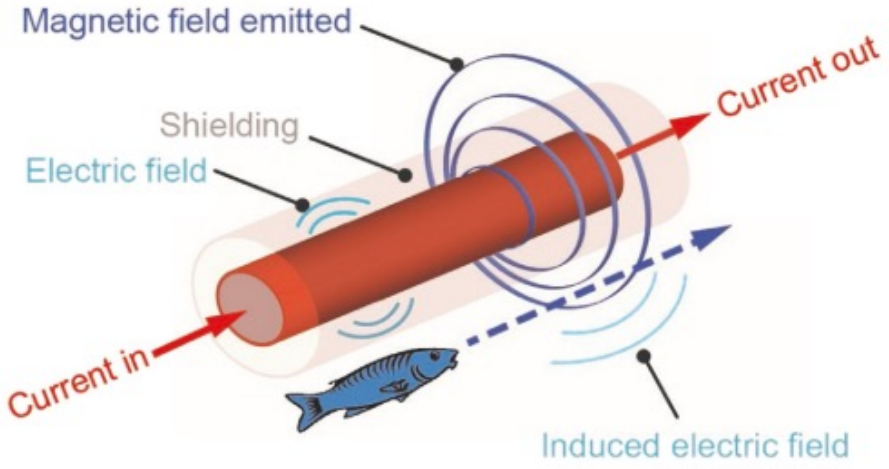
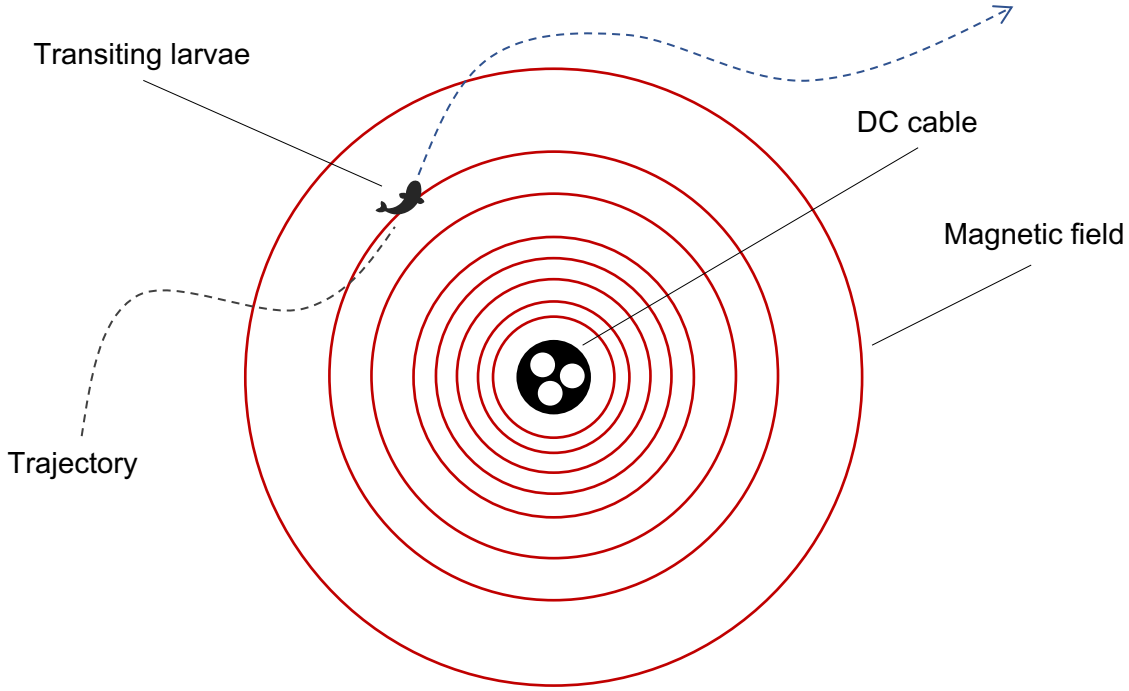
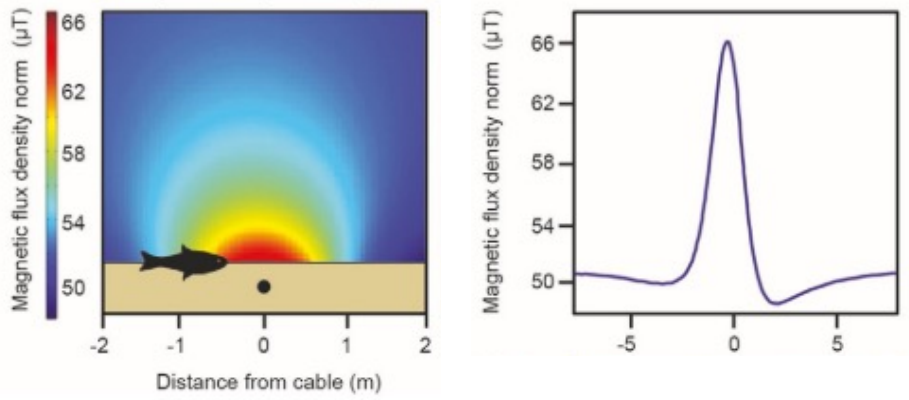
Exposure to MF from DC cables



Hutchinson et al. 2021





Hutchison et al. 2021

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Exposure to MF from DC cables: *Target species*

Atlantic haddock (*Melanogrammus aeglefinus*)

Photo: Erling Svensen/ Havforskningsinstituttet

- Demersal species
- Larvae drift over the continental shelf
- Larvae are magnetosensitive
- Species of great ecological and commercial imporance

Sandeel (*Ammodytes marinus*)

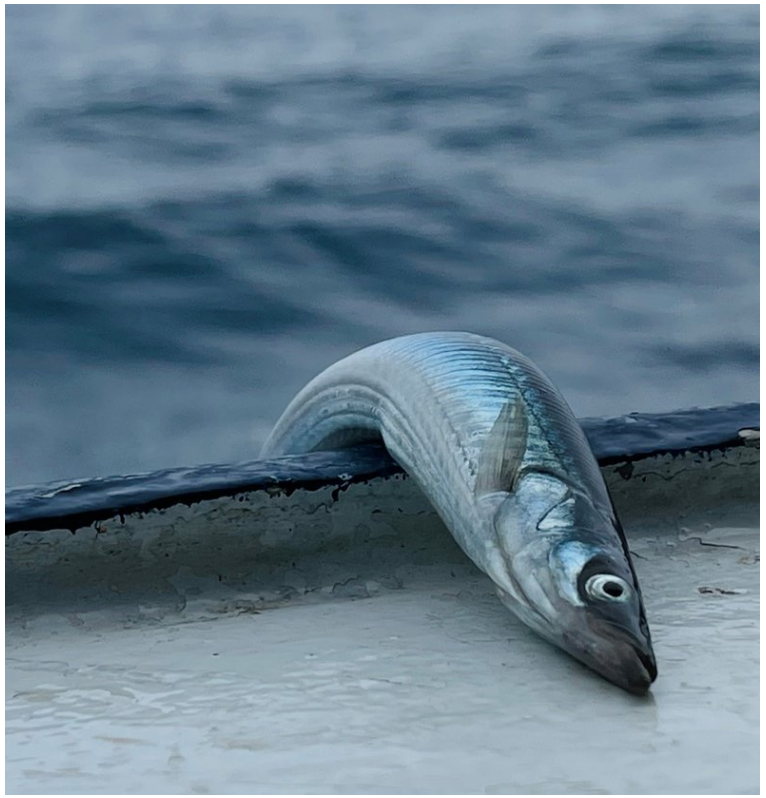

Photo: Åse Husebø/ Havforskningsinstituttet

- They live in tight association with soft bottom
- Larvae drift over the continental shelf
- Keystone species in the North Sea – link in food webs

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MF and haddock larvae

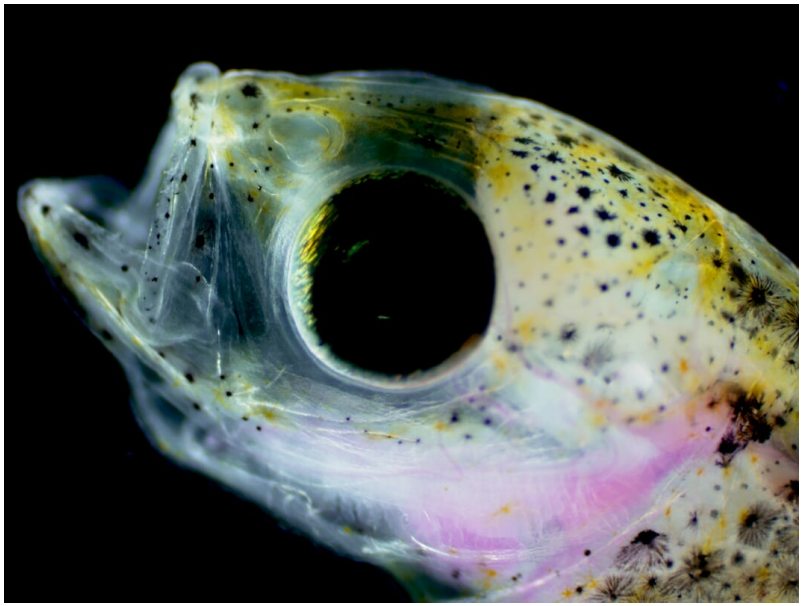

Photo: A. Cresci

Ny forskning: Fiskeyngel forstyrres av undersjøiske strømkabler

Ørsmå fiskelarver forstyrres av magnetfelt fra undersjøiske strømkabler. Dermed kan store havvindprosjekt påvirke fiskematprodusentene.

SVØMTE SAKTERE: Forskere fra Havforskningsinstituttet utsatte hyselarver for magnetfelt tilsvarende det som skapes av strømkabler under vann. Da svømte larvene halvparten så fort.

FOTO: ALESSANDRO CRESCI / HAVFORSKNINGSINSTITUTTET


Marius Eriksen Guttormsen
@mguttorm
Journalist


Sofie Retterstøl Olaisen
Journalist

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Oppdatert 10. okt. kl. 15:54

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MF and haddock larvae

PNAS nexus
PNAS Nexus
The National Academy of Sciences of the United States of America

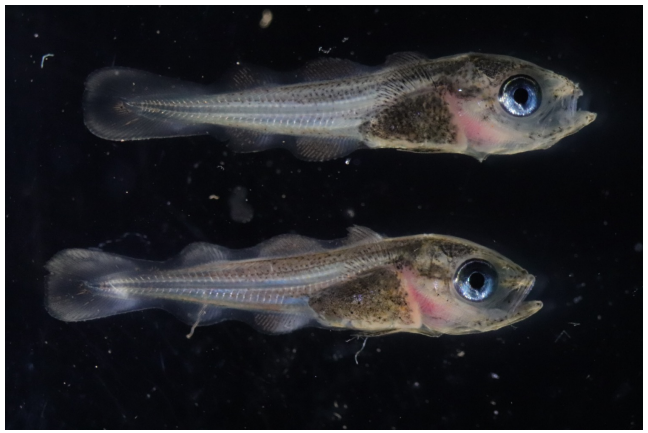


Photo: A. Cresci

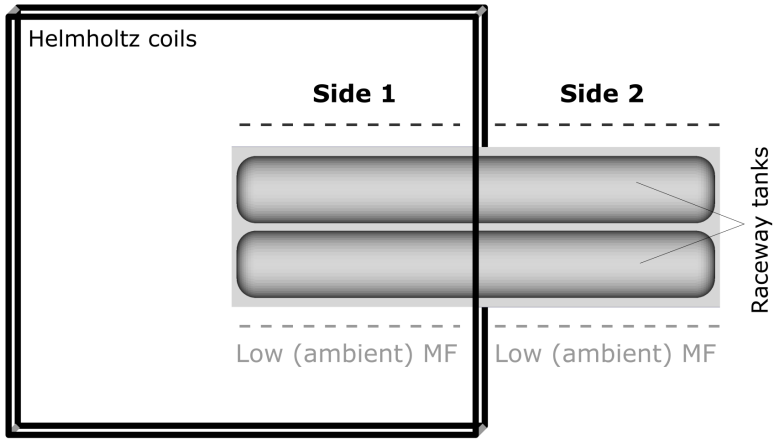
N = 92

Controls = 46
Exposed = 46

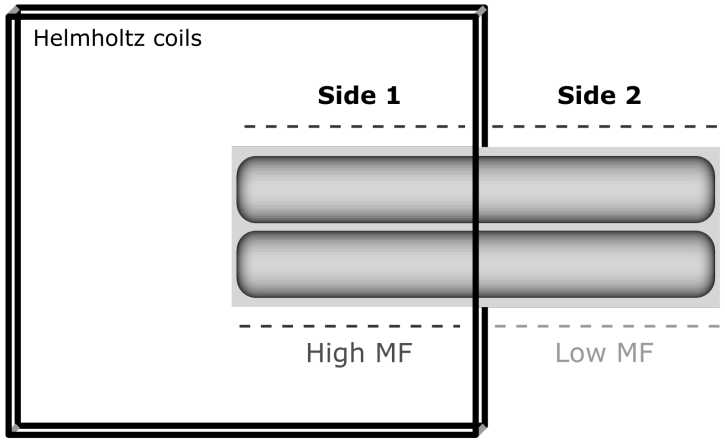
Age: 31-33 dph
Length: 8.2 ± 1.2 mm SL

A

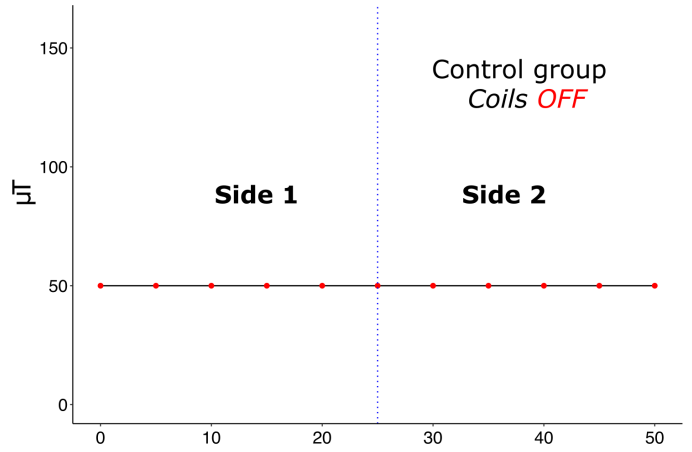
Control group
Coils OFF

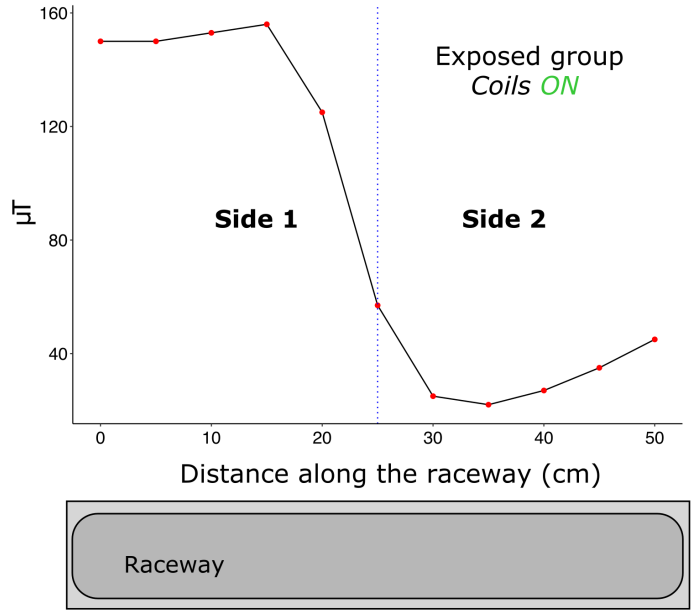


Exposed group
Coils ON



B





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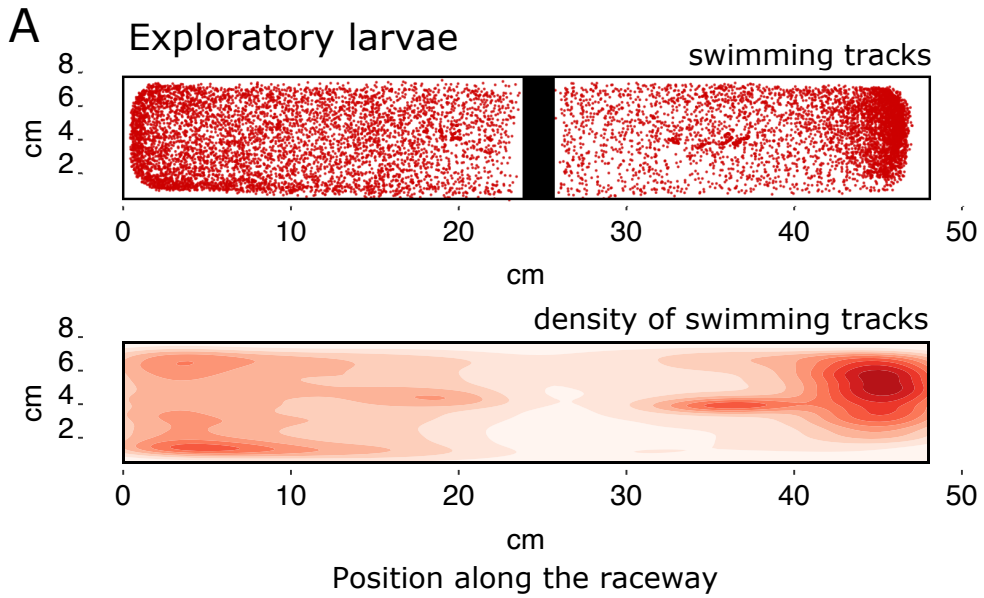
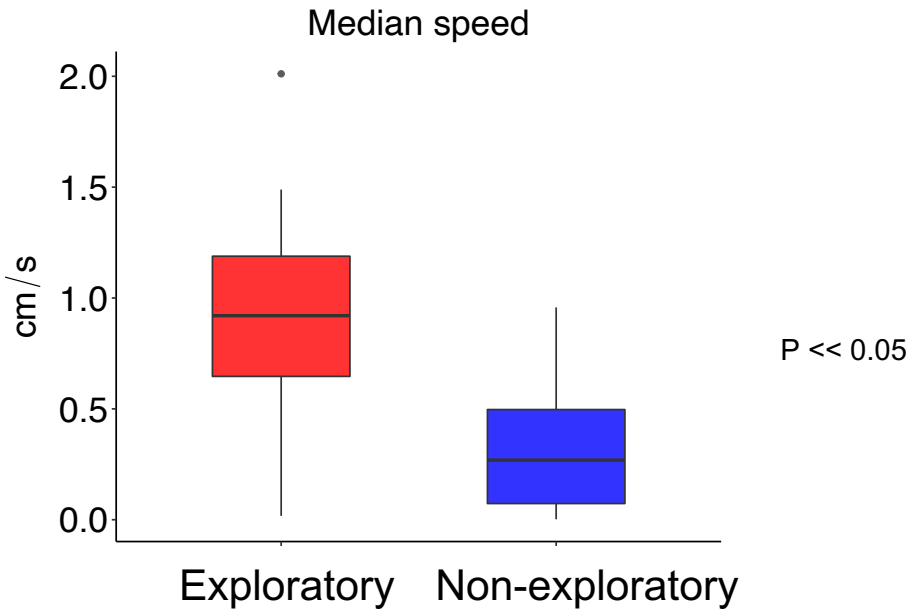
Larvae displayed very distinct exploratory behavior

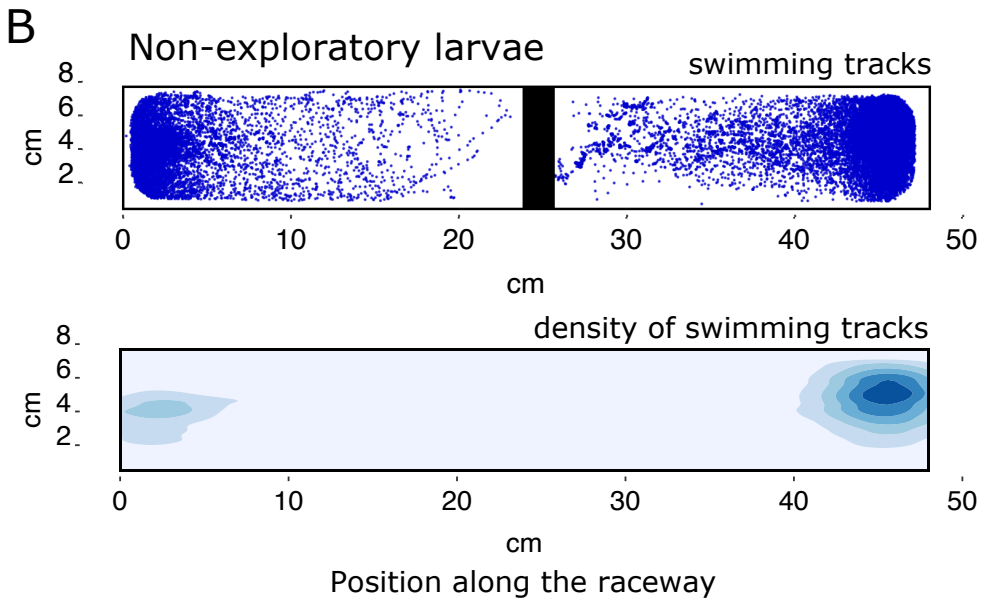
N=20 (22%)

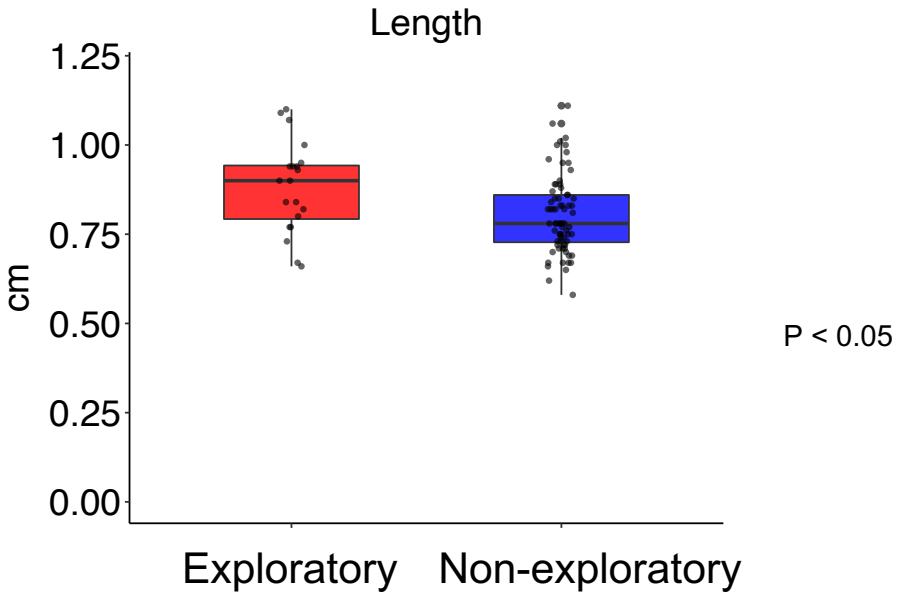




P << 0.05

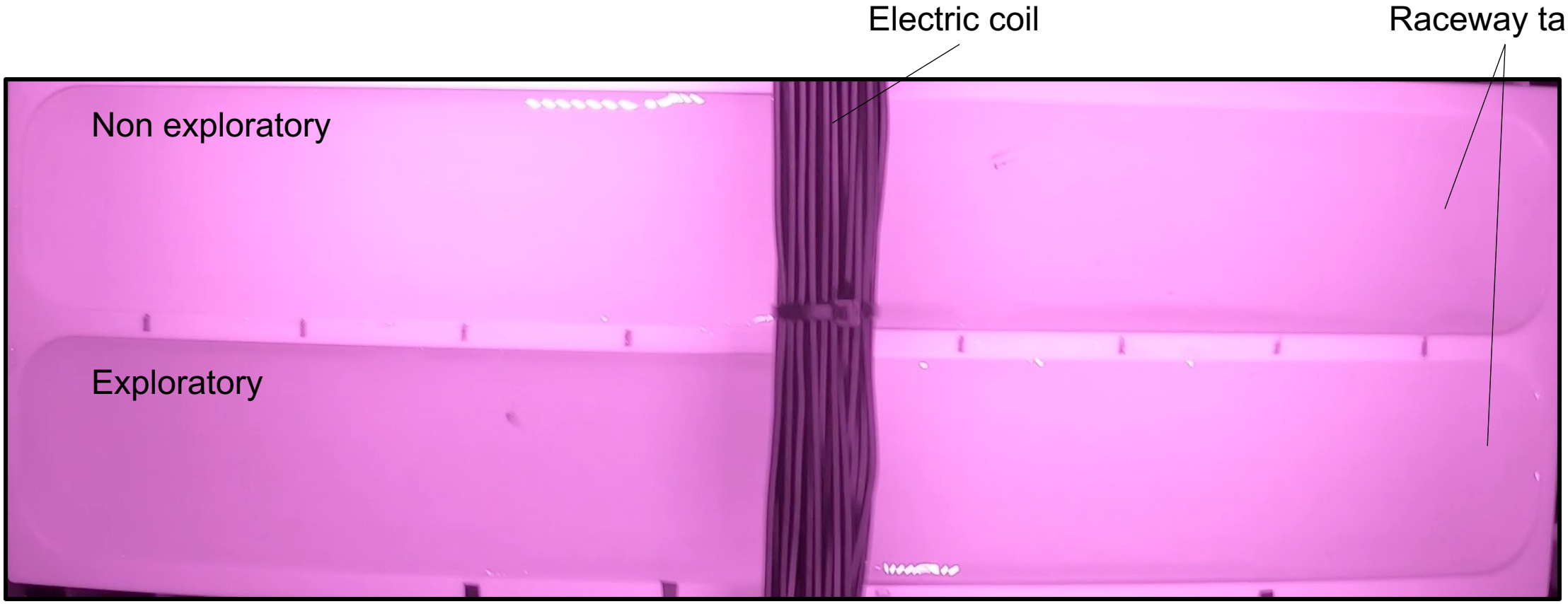
N=72 (78%)

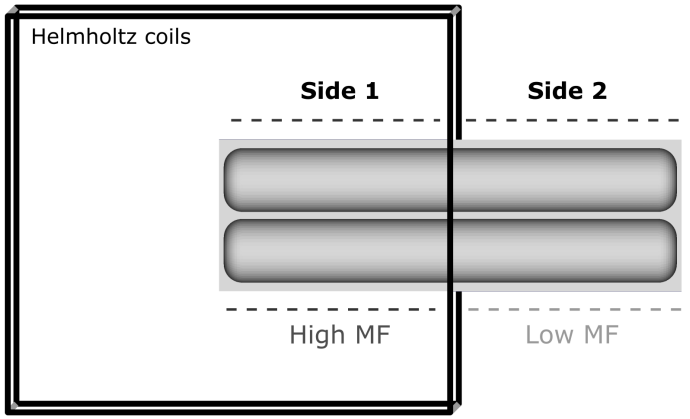




P < 0.05

Larvae displayed very distinct exploratory behavior





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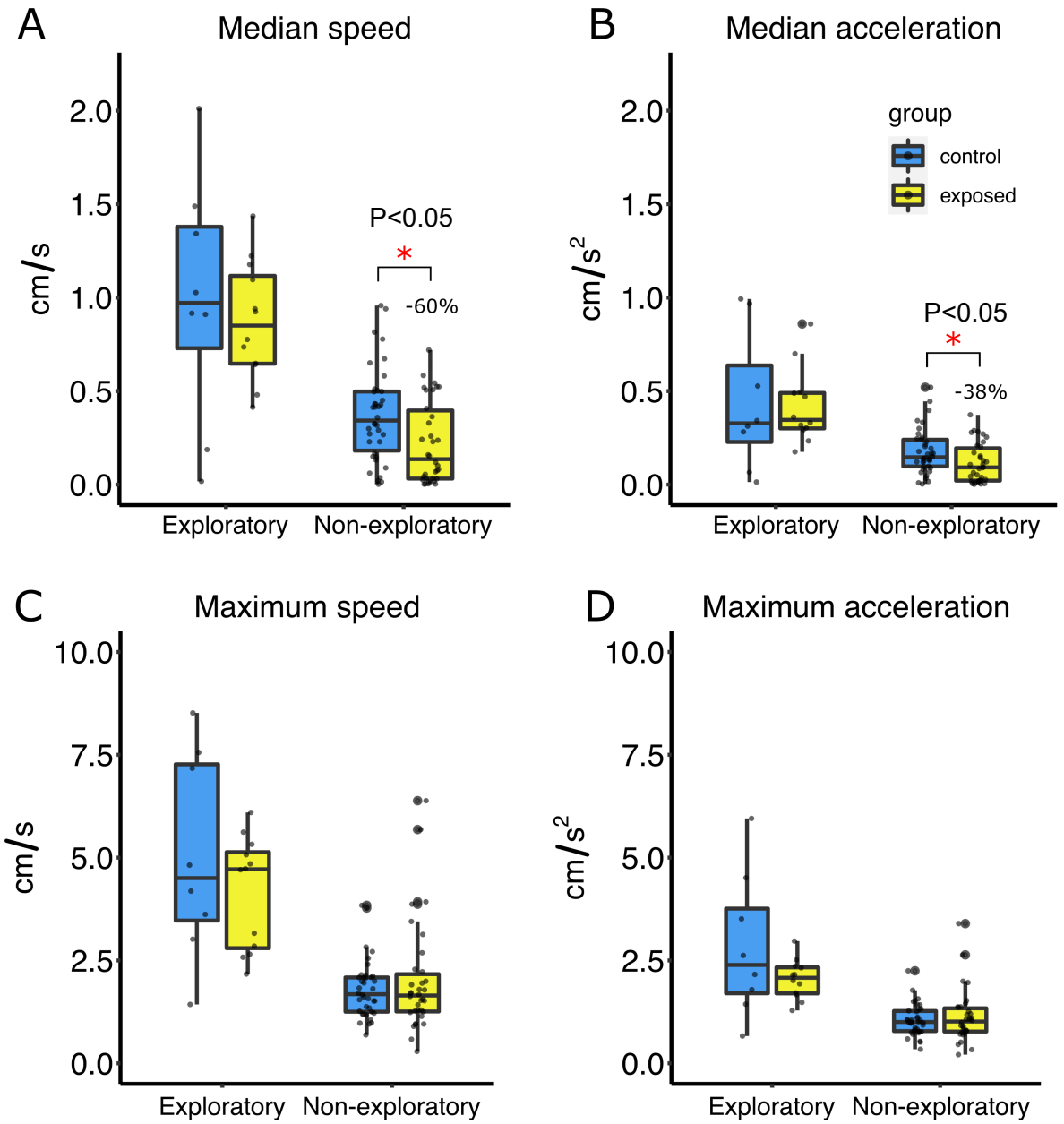
Impact of MF on exploratory and non-exploratory larvae



MF and Sandeel larvae

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Magnetic fields generated by the DC cables of offshore wind farms have no effect on spatial distribution or swimming behavior of lesser sandeel larvae (*Ammodytes marinus*)

Alessandro Cresci [a,*], Prescilla Perrichon [a], Caroline M.F. Durif [a], Elin Sørhus [b], Espen Johnsen [b], Reidun Bjelland [a], Torkel Larsen [a], Anne Berit Skiftesvik [a], Howard I. Browman [a]

[a] Institute of Marine Research, Austevoll Research Station, Sauganeset 16, N-5392, Storebø, Norway
[b] Institute of Marine Research, Bergen, Norway

Photo: P. Perrichon

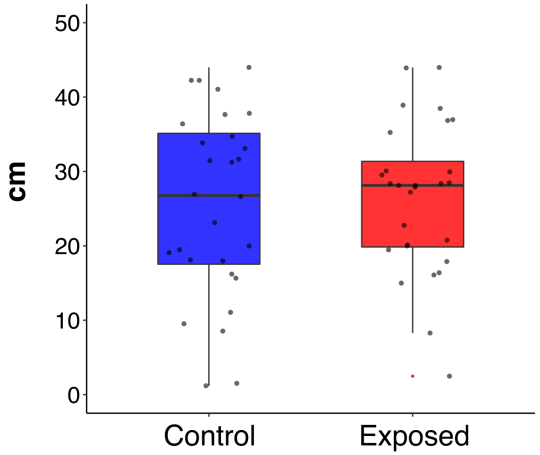
Photo: P. Perrichon

N = 56

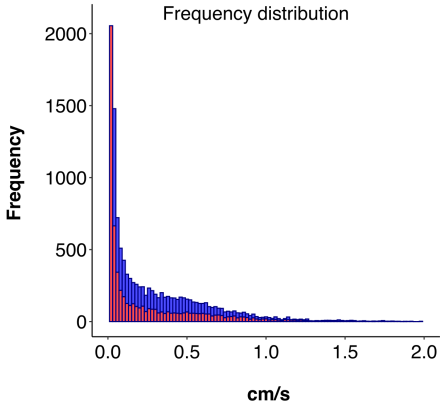
Controls = 28
Exposed = 28

Age: 17-24 dph
Length: 9-13 mm SL

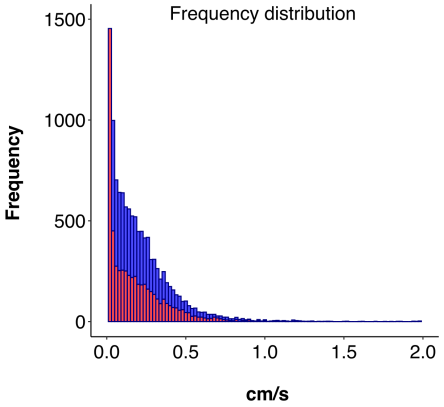
Median position along the raceway

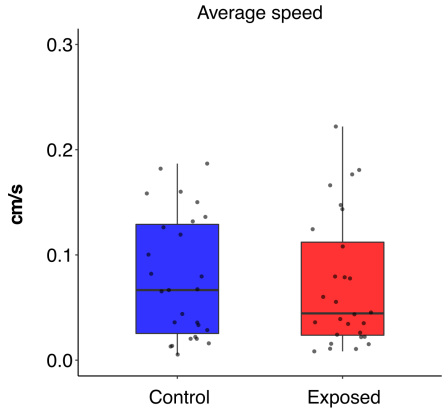


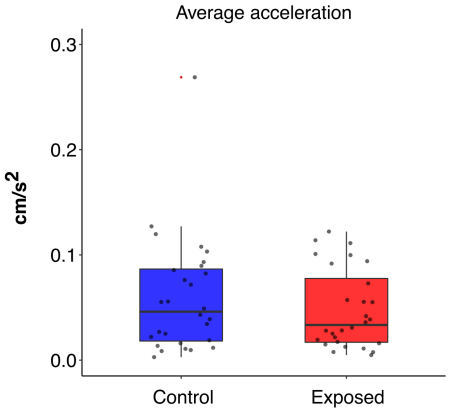
A *Speed*

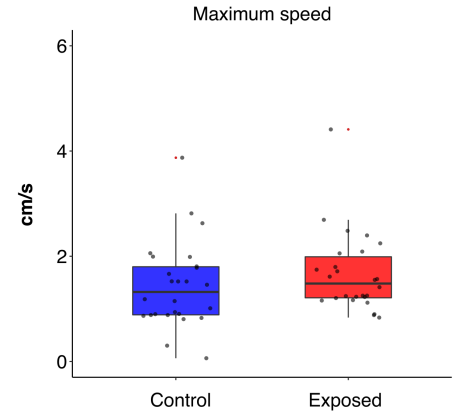


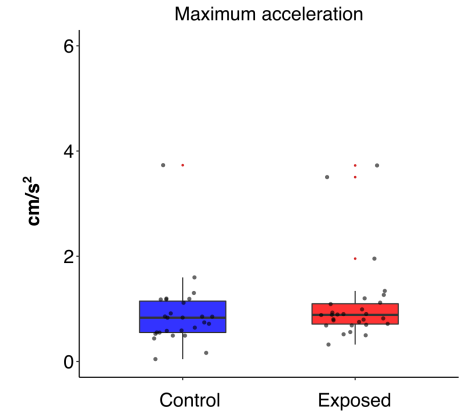
B *Acceleration*











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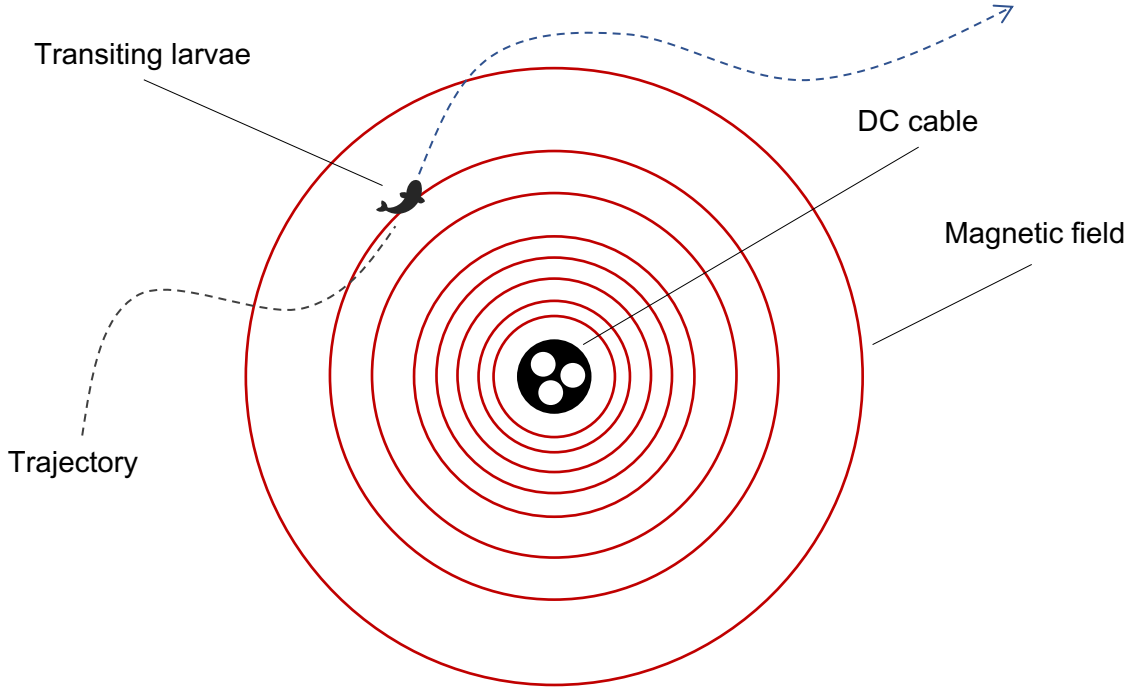
Conclusions – MF and fish larvae

Exposure to MF from DC cables:

Does not attract or repell haddock or sandeel larvae

Substantially reduces swimming activitiy of non exploratory haddock larvae, but does not affect sandeel larve



Selective Impact depending on species and exploratory tendency

Downstream impacts on dispersal/survival?

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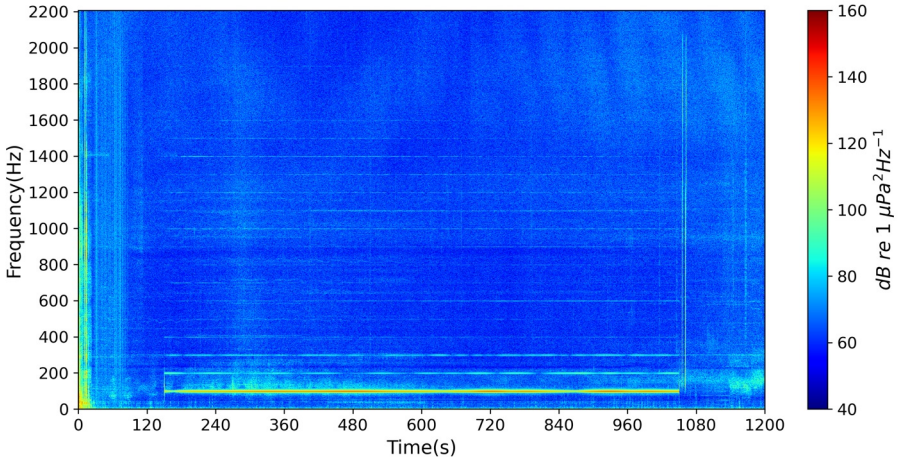
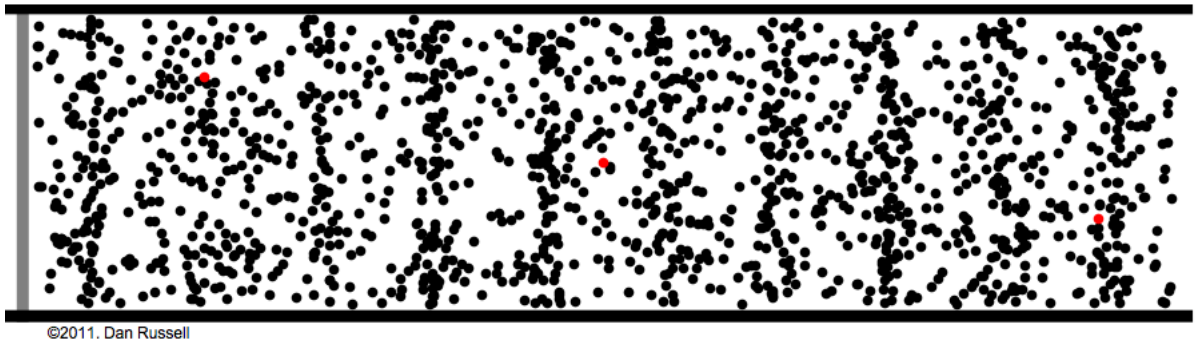
NEXT - Impacts of low frequency sound on larval behavior

When sound passes through water..

Sound pressure



Particle motion – the directional component



Why this is hard to study

You cannot study it in the lab - the soundscape in a tank is not the same as in situ

Fish predominantly respond to the particle motion component of sound

High tech, military-grade equipment needed to reproduce the sound and measure the particle motion

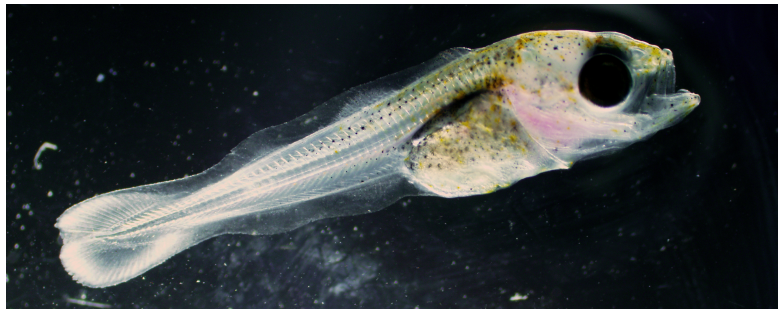
Looking at larval behavior *in situ* is HARD

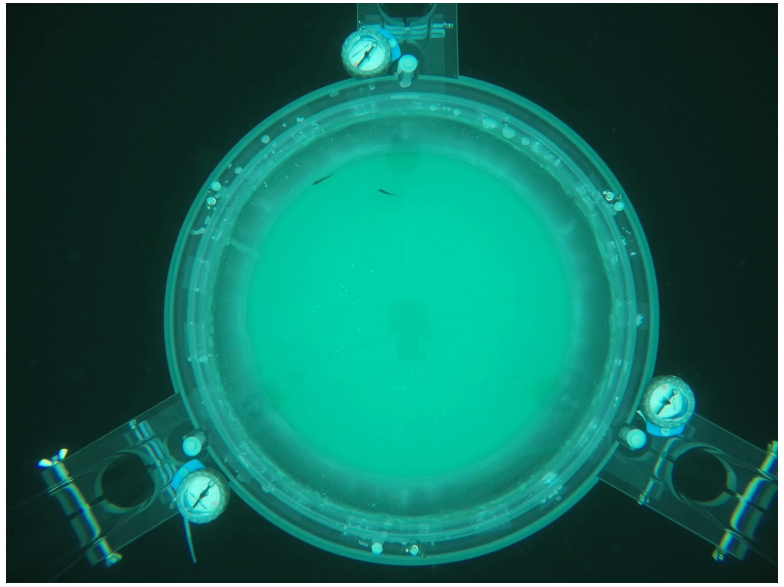
Impacts of low-frequency sound on orientation and swimming of cod larvae (*Gadus morhua*)

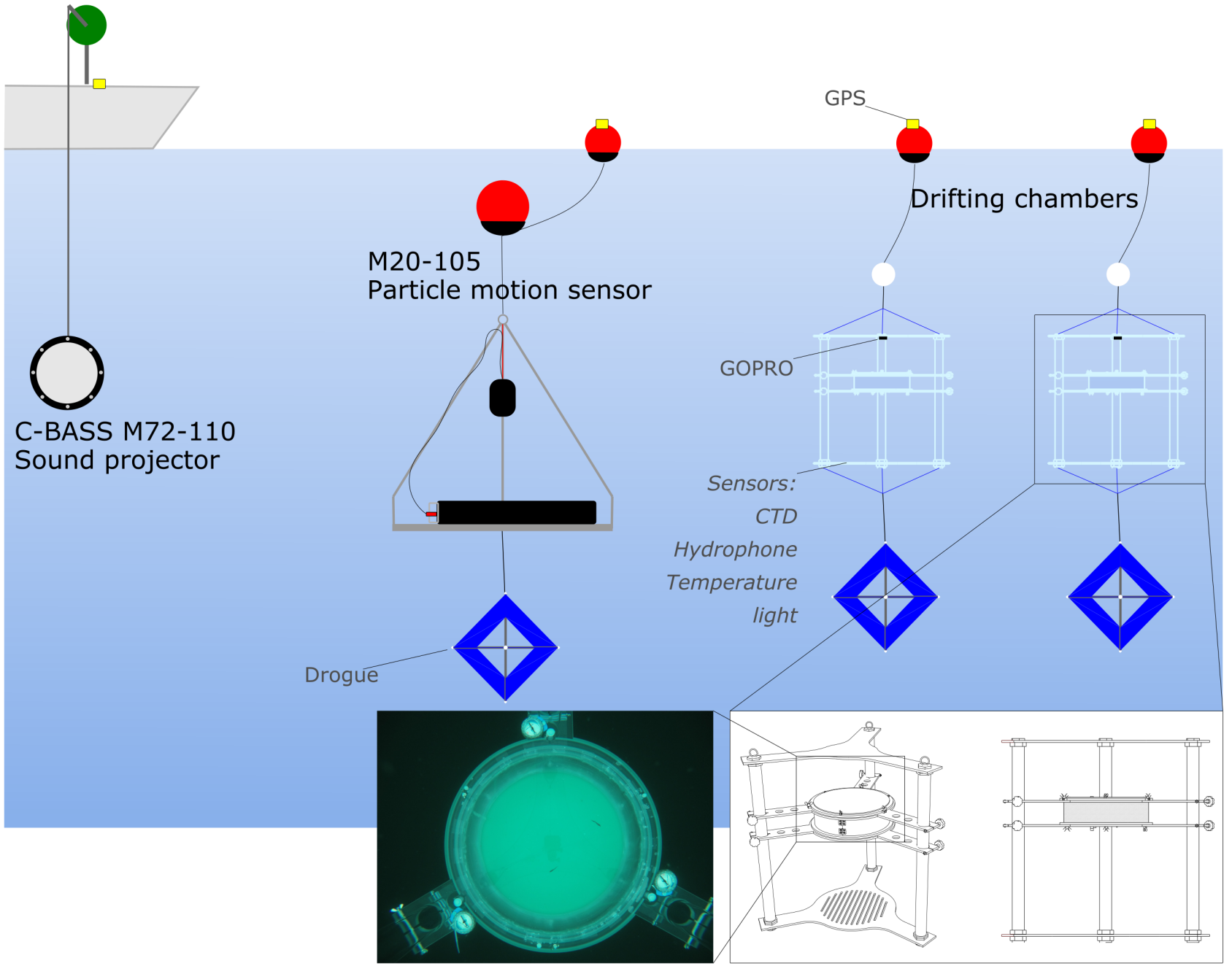
Experimental design

Control – projector OFF - N=45
Exposed – projector ON - N=44

Sound – **100 Hz tone** for 15 min







Thank you!