HAMMER: a tool to predict the impact of man-made noise on fishes

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Man-made underwater noise is a global problem

Fish and Noise: Why should we care?

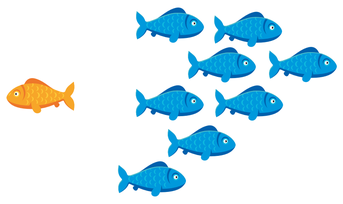
> All fish sense sounds and use natural soundscapes (e.g. for finding food, choosing mates, orientation and predator avoidance).
> Fish can be impacted by noise (see next box).
> Fish underpin many marine food webs.
> Many fish species are commercially important and provide food security for millions of people.
> Several fish species are protected or are of conservation concern (e.g. salmon and eels).
> Underwater noise is included in national and international legislation (e.g. EC 2008; DEFRA 2009).

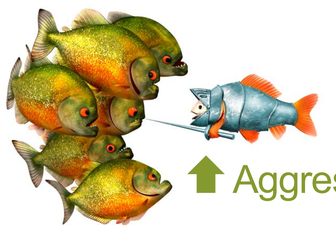
Impacts of man-made noise on fish

Hearing damage

Stress

Communication





Aggression

Aim:

To improve a predictive tool that simulates the impact of anthropogenic noise on fish.

Modelling tool (HAMMER*)

The tool consists of three parts:

✓ Underwater acoustic propagation model
✓ Hydrodynamic model
✓ Ecological response model

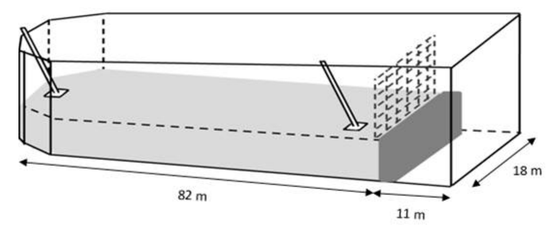
However, important parameters for predictive modelling are lacking!

* Hydro-Acoustical Model for Mitigation of Environmental Response

Impacts of pile driving on Atlantic cod (*Gadus morhua*)

Experiments were performed in a shipbuilding dock to obtain parameters for modelling impacts of pile driving noise

Dock experiment



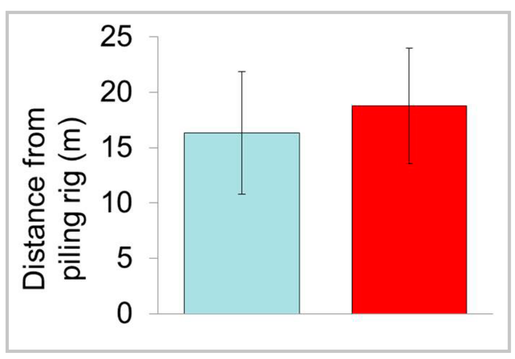
✓ Pile driver to create impulse piling
✓ 3D positioning of 71 cod (every 2.5 s)
✓ Local wild caught cod tested

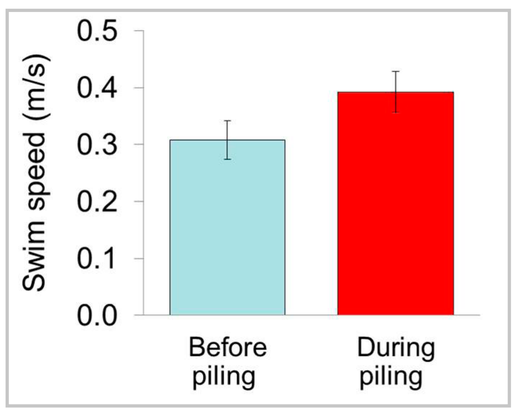
Design:

> Fish received 48 hours acclimatization
> 2-hour long pile driving sequences (5x)
> Trials lasted five days

Picture 1. Post driver and piling setup.

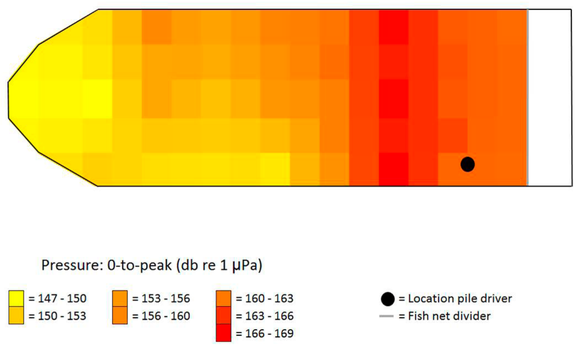
Results





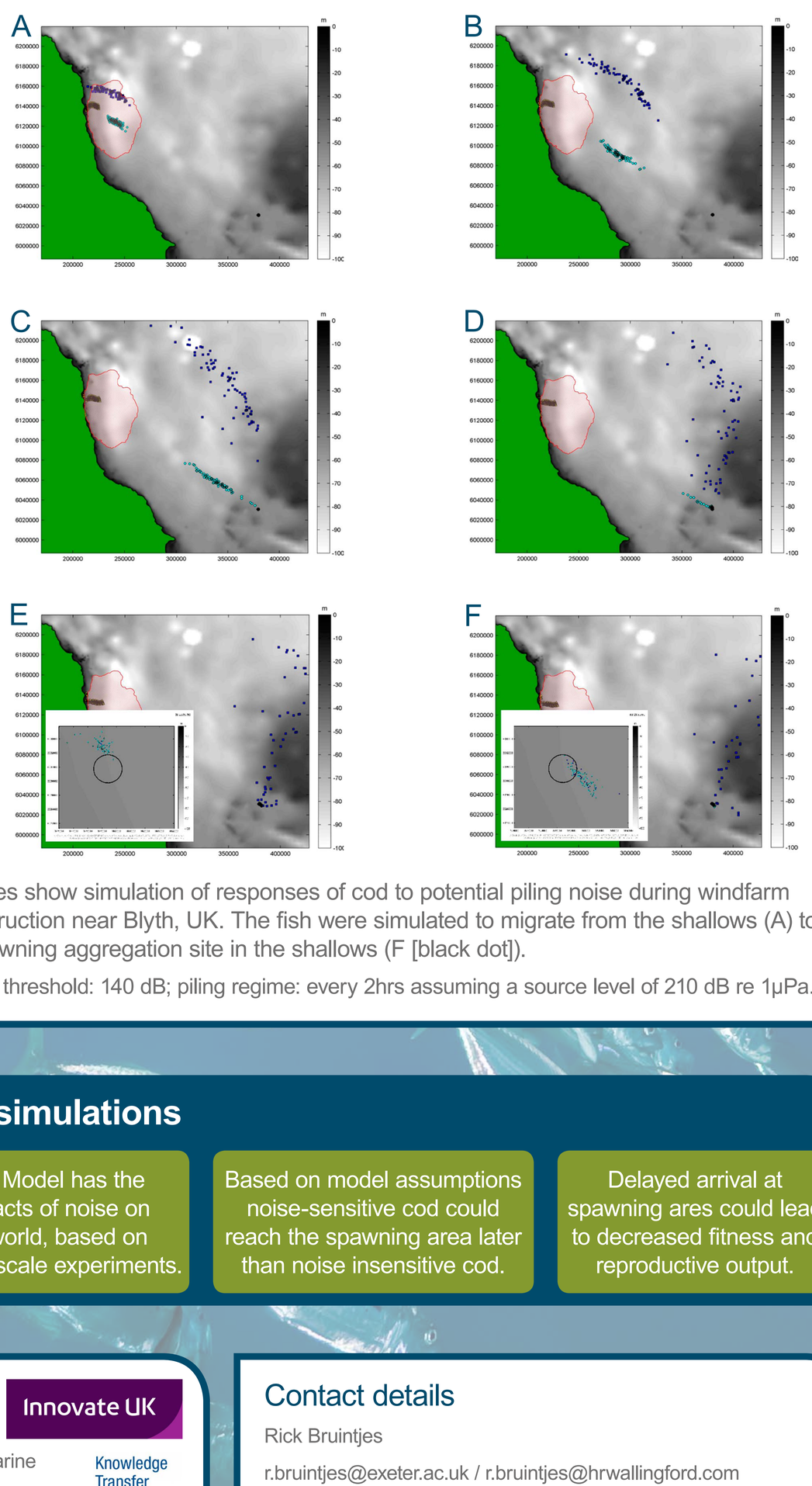
These results are statistically significant at $p < 0.05$

Experimental noise levels



Example predictions from parameterised modelling tool

Modelling response of migrating cod to pile driving noise



Figures show simulation of responses of cod to potential piling noise during windfarm construction near Blyth, UK. The fish were simulated to migrate from the shallows (A) to a spawning aggregation site in the shallows (F [black dot]).

Noise threshold: 140 dB; piling regime: every 2hrs assuming a source level of 210 dB re 1µPa.

Are cod affected by pile driving noise?

Cod increased their distance from the noise source during pile driving compared to periods of ambient noise conditions.

Cod increased their swimming speed during pile driving compared to periods of ambient noise conditions.

Conclusions from simulations

The Ecological Response Model has the potential to model the impacts of noise on fish behaviour in the real world, based on parameters obtained in large scale experiments.

Based on model assumptions noise-sensitive cod could reach the spawning area later than noise insensitive cod.

Delayed arrival at spawning ares could lead to decreased fitness and reproductive output.

Definitions

*HAMMER: Hydro-Acoustic Model for Mitigation and Ecological Response (Rossington et al. 2013. Marine Pollution Bulletin)

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Knowledge Transfer Partnerships

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