Field scale experiments to assess the effects of offshore wind farms on marine organisms











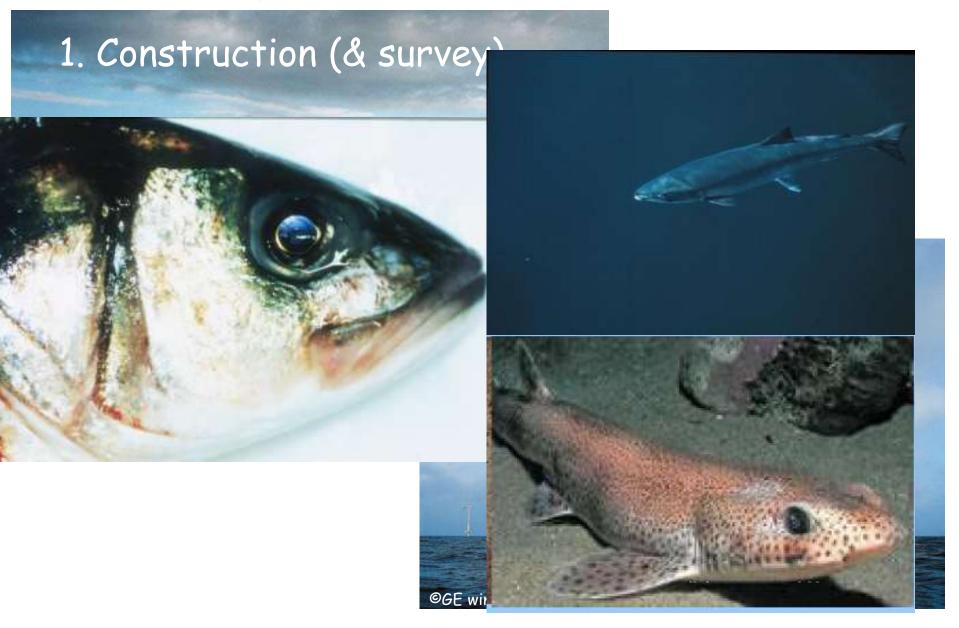


- Andrew B Gill

- Christina Mueller-Blenkle, Peter K McGregor, Mathias H Andersson, Julian Metcalfe, Victoria Bendall, Peter Sigray, Daniel Wood, Victoria Wearmouth, Yi Huang, Joe Spencer, Ian Gloyne-Philips & Frank Thomsen

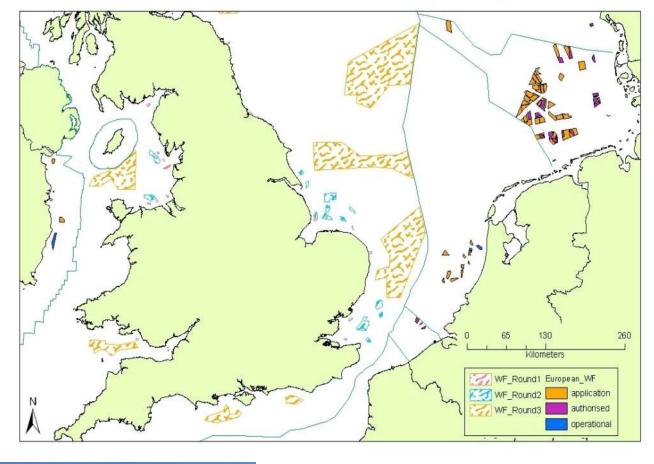


Spatial &Temporal Factors



Wind farm locations around the UK and neighbouring areas.

Spatial & Temporal Factors



(Adrian Judd, with permission)

Environmental effects framework

(from Boehlert & Gill 2010)

Marine Renewable Energy (Level 1)										
Wind	Wave	Near Shore Tida	l Ocean	Сипепt	Ocean Thermal					
		-								
Environmental Stressors (Level 2)										
Physical Presence of Devices	Dynamic Effects of Devices	Energy Removal Effects	Chemical	Acoustic	Electromagnetic Fields					
		-								
Environmental Receptors (Level 3)										
Physical Environment	Pelagic Benthic Habitat and Sp		Marine Birds	Marine Mammals	Ecosystem and Food Chain					
Environmental Effect (Level 4)										
Single/Short Term Single/Long Term		ng Term	Multiple/Short Term		Multiple/Long Term					
Environmental Impact (Level 5)										
Population Change Community Change		y Change	Biotic Process Alteration		Physical Structure/ Process Alteration					
Cumulative Impact (Level 6)										
Spatial		Temporal	Temporal		Other Human Activities					

ElectroMagnetic Fields

Focus - migration behaviour

behaviour in relation to the cable(s)







Crustaceans (crabs & lobsters)

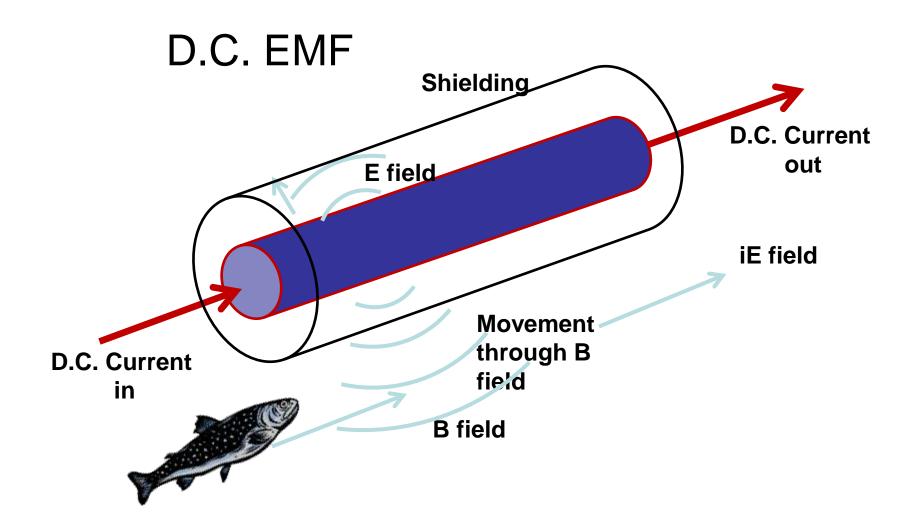


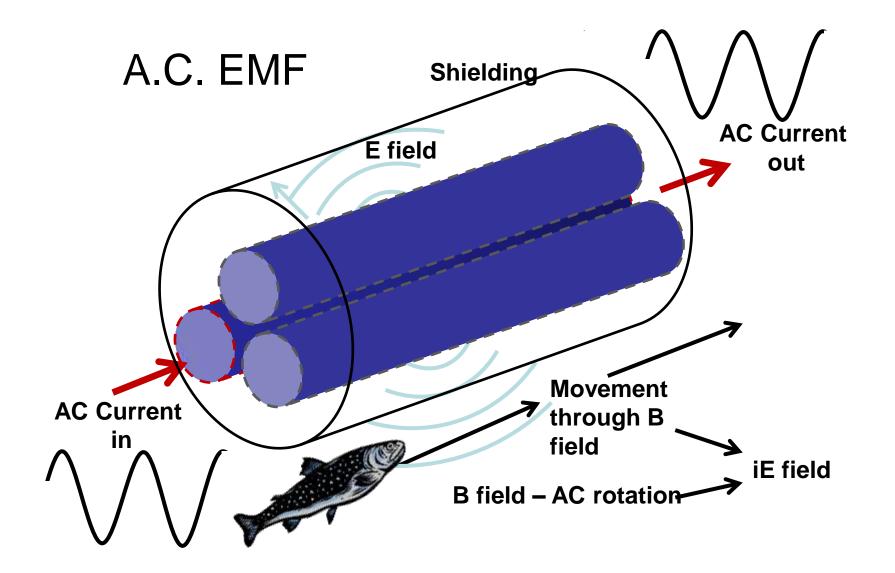
Elasmobranchs (sharks, skates & rays)



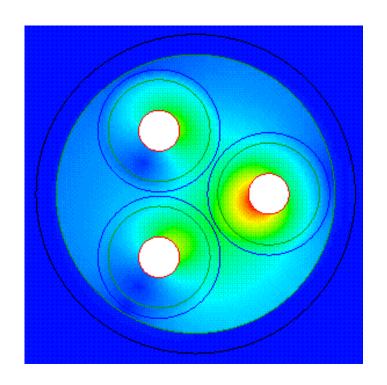
Shark response to E-field





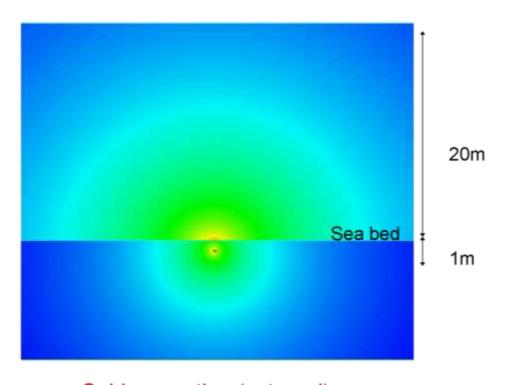


EMF emissions from AC windfarm cables



Cable x-section (internal)

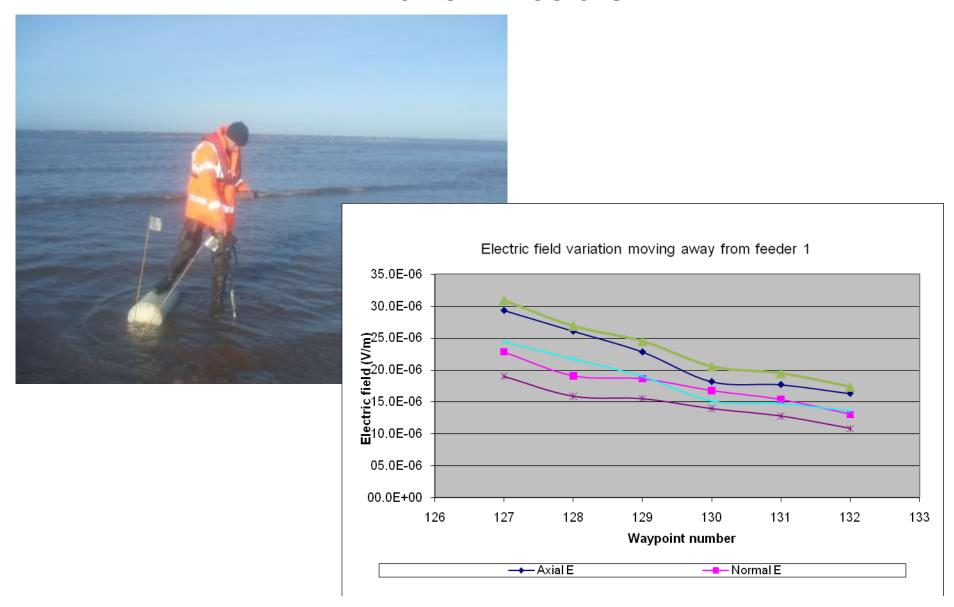
Magnetic field



Cable x-section (external)
Induced electric field

 Approximates to E field of 0.9μV/cm (50 Hz) at surface of seabed (ie. within range of detection by EM-sensitive species)

Measured E and B field of operational wind farm cable



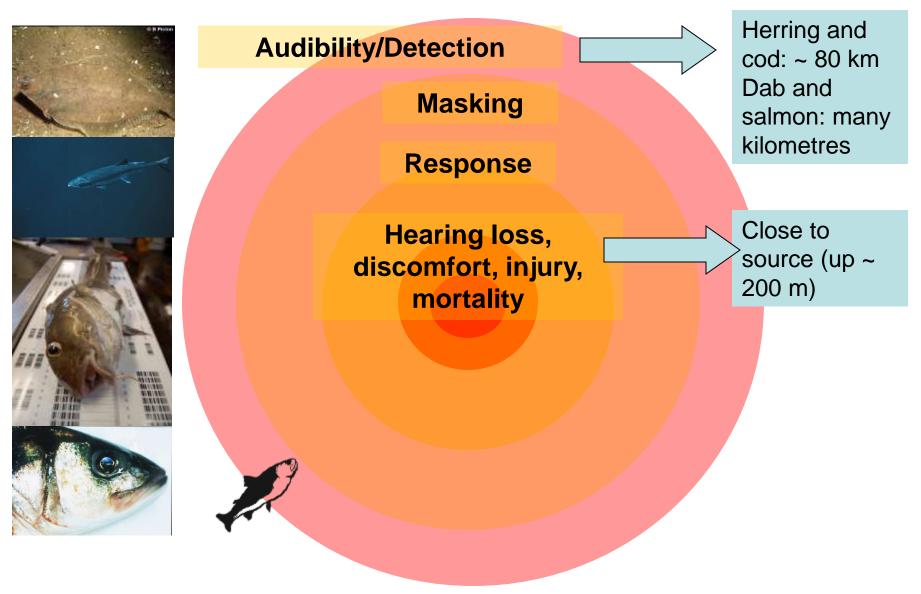
Pile Driving Operations

 Very high sound pressures generated (260 dB re. 1 uPa @ 1m)



from Offshore Windfarm & Environment Conference 2004, Denmark

Zones of noise influence



(Thomsen et al. 2006))

COWRIE studies

taking the lab out into the field









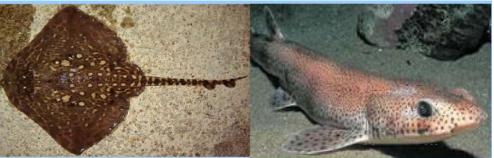




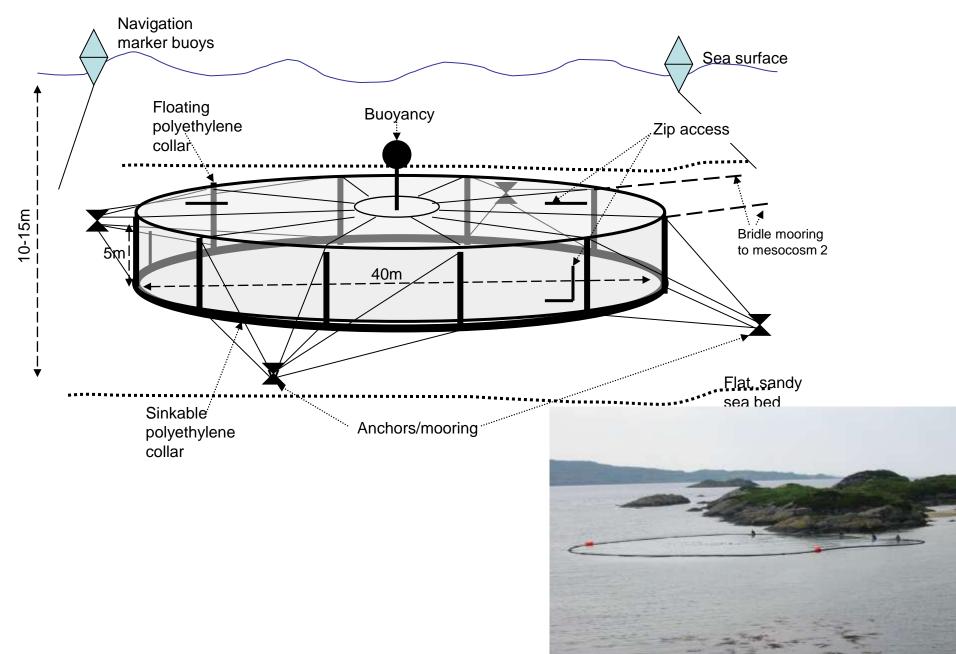
- Specific research question to answer (e.g.)
 - Q. Do electromagnetic sensitive fish respond to EMF emitted by offshore wind farm cables?
 - Q. Does pile driving affect the behaviour of marine fish
 - Mesocosm (large fish pen) based study
 - Focus on semi-realism <u>but</u> study control
 - Remote coastal site away from background EMF & noise
 - Relevant species with different attributes
 - Behavioural study with remote methods



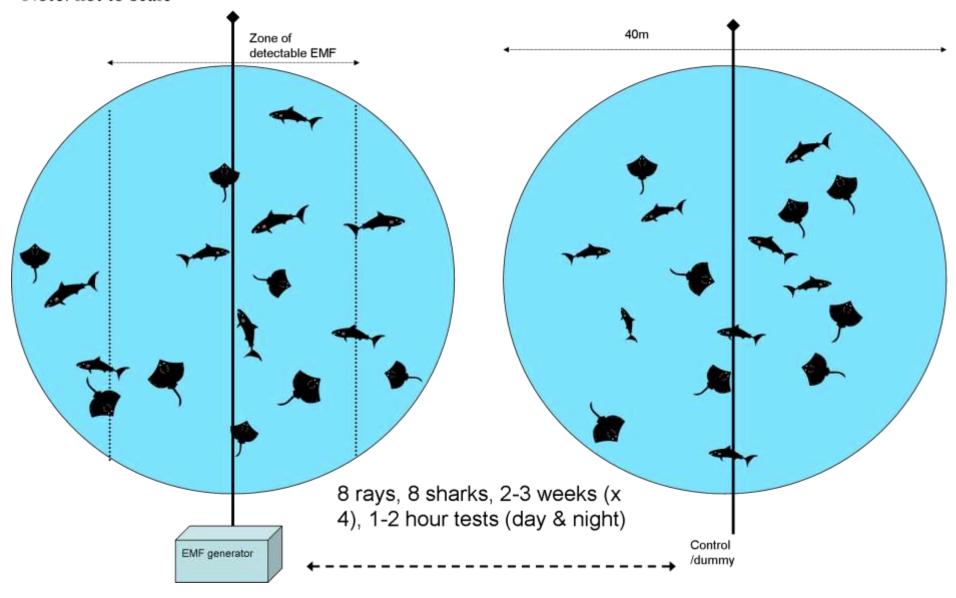




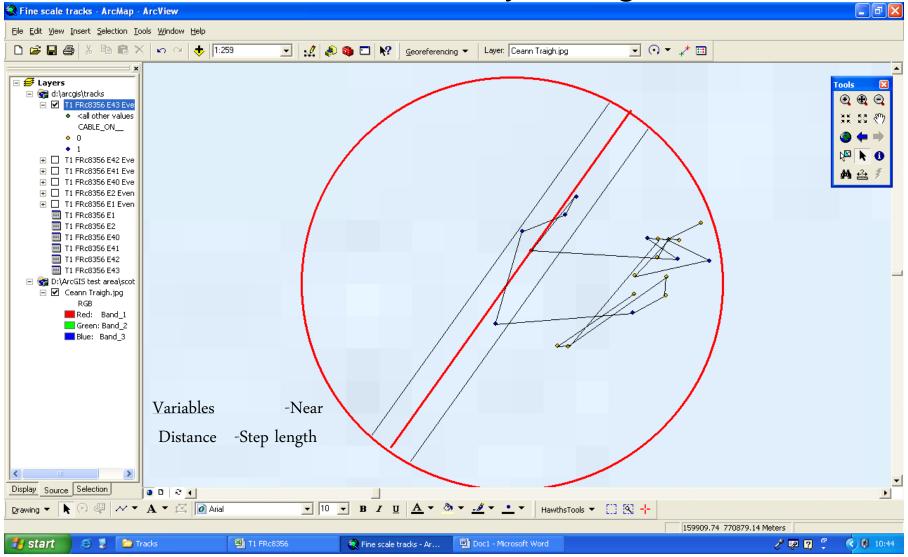
COWRIE Mesocosm studies



Note: not to scale

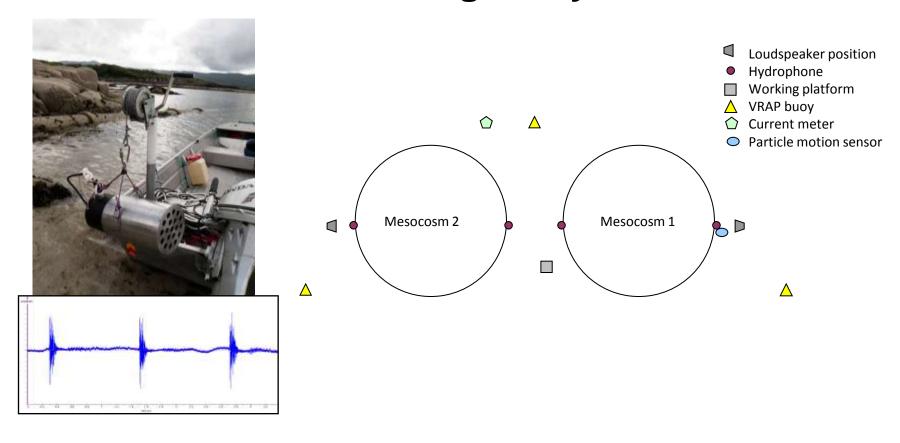


Fine scale movement of ray during 3 hour event



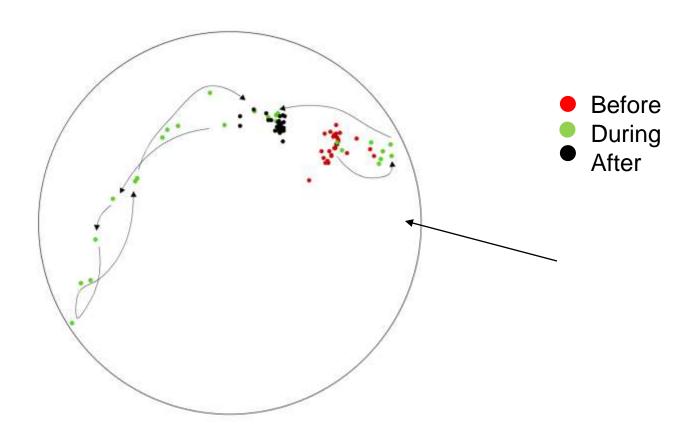
 Benthic catshark non-random distribution more likely in cable zone when energised.

Pile driving study



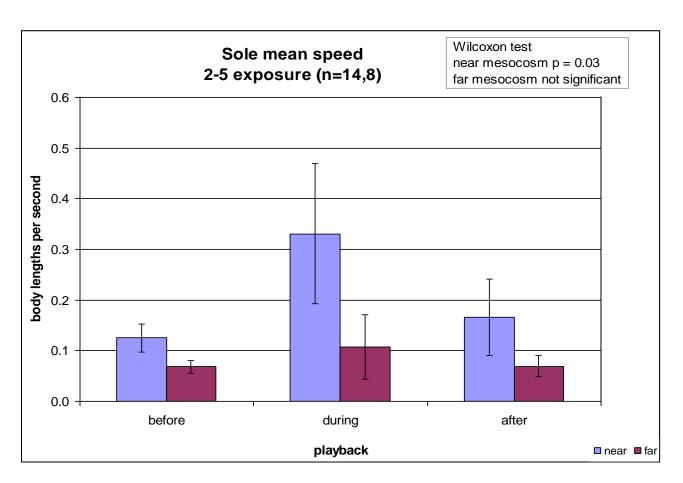
- High quality recordings from real pile driving collected by Itap (2006-2008)
- Playback left or right side (gradient) 20km received sound level
- Trial 10 min playback and 10 min pre- and post playback
- Trial with tagged fish in each mesocosm, 62 trials, 50 Individuals
- Recordings of position, speed and direction of movement of fish every 45-90 secs

Movement response



• ~ 50% of cod and 30% of sole showed movement response

Swimming speed increase in sole



 $(RL = 144 - 156 dB re 1\mu Pa Peak 6.5 x 10^{-3} to 8.6 x 10^{-4} m/s^2 peak)$

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Cumulative Impact (Level 6)										

Moving forward

- Investigating potential ecologically relevant interactions between marine organisms and offshore wind energy
- Baseline understanding of the organisms of interest
- Consider effects relating to different phases
 - Installation
 - Operation
 - Decommissioning
- Appropriate spatial scale
- Appropriate temporal scale
- Ecosystem level considerations
- Drivers landscape policy (eg. EIA & MSFD in EU)
- Relevance to offshore industry, regulators, other stakeholders

