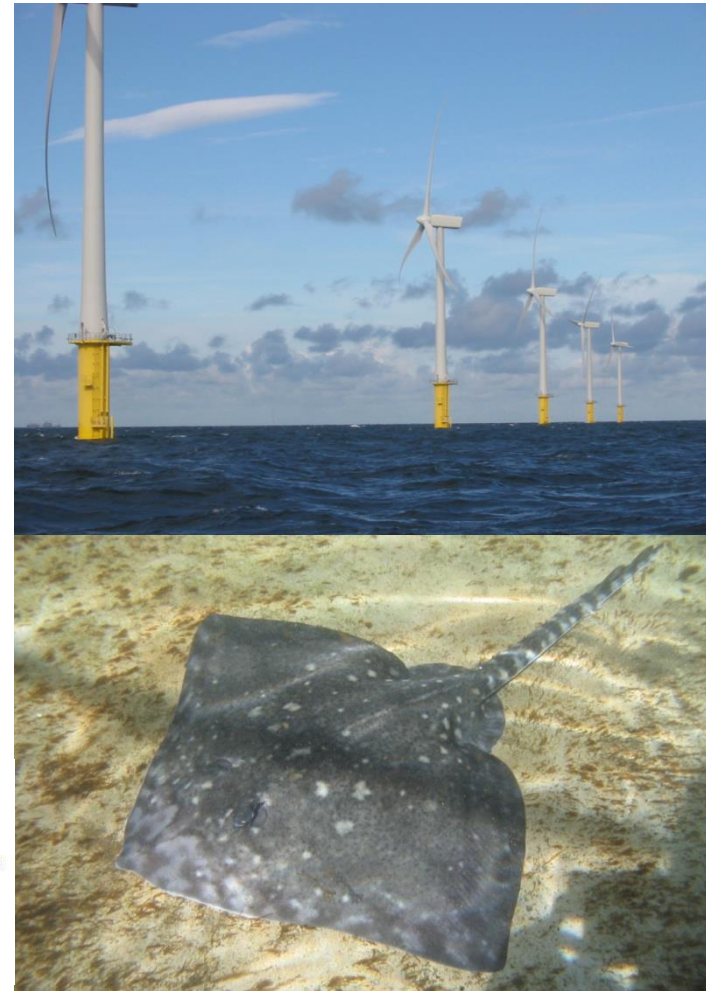
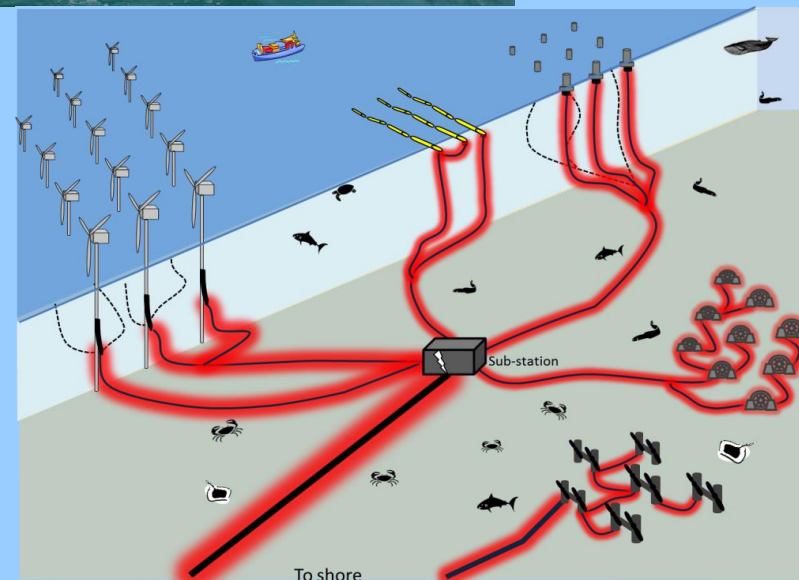
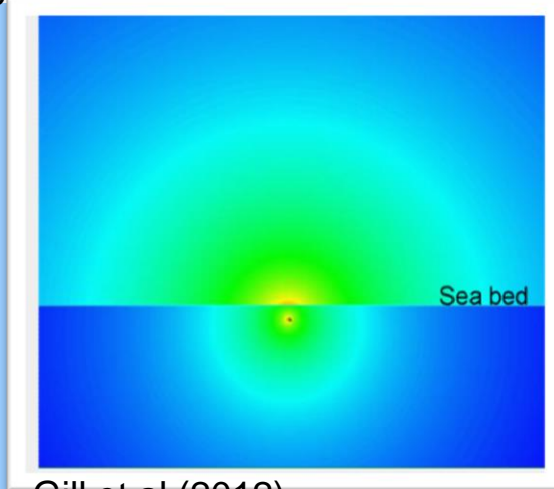
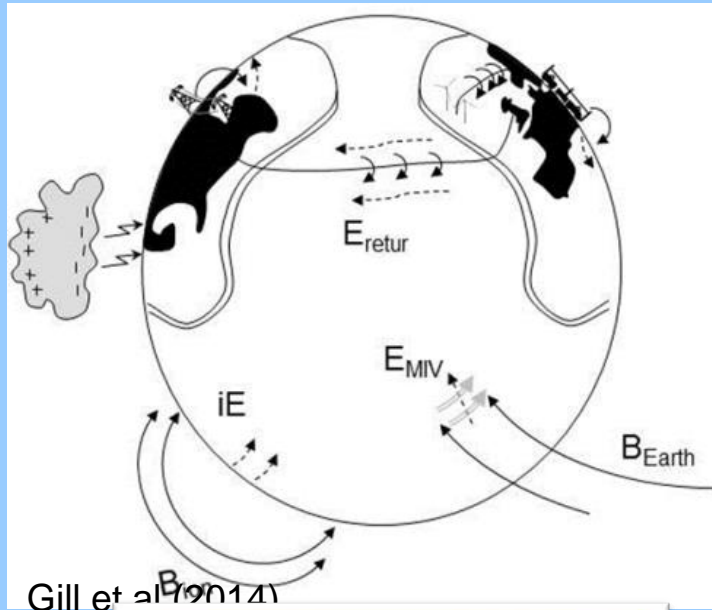


# Effects of electromagnetic fields (EMF) from offshore wind facilities

Andrew B Gill PhD FRSB  
PANGALIA Environmental  
Founder/Owner



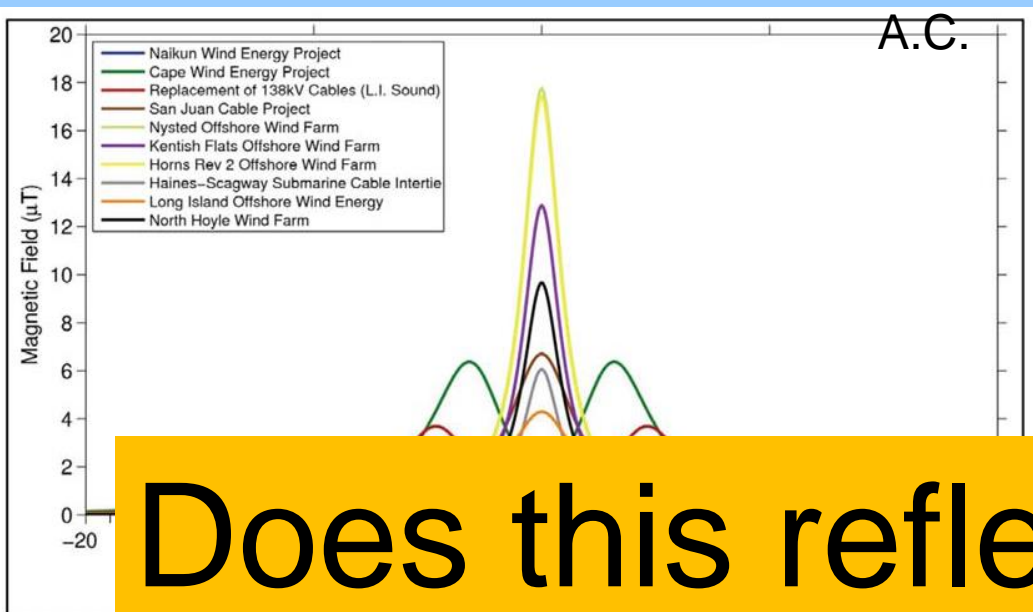
# What we need to know about EMF – Abiotic - type and scale



Gill et al (2012)

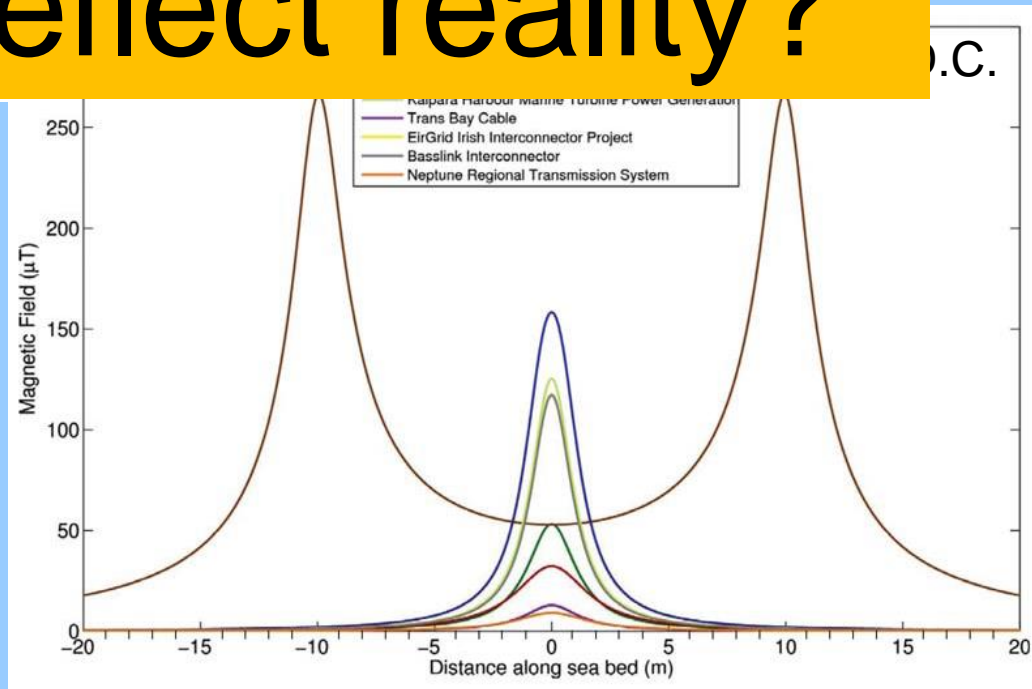
Gill et al (2014)

# EMF dissipation – A.C. and D.C. models



Does this reflect reality?

From: Normandeau et al (2011)



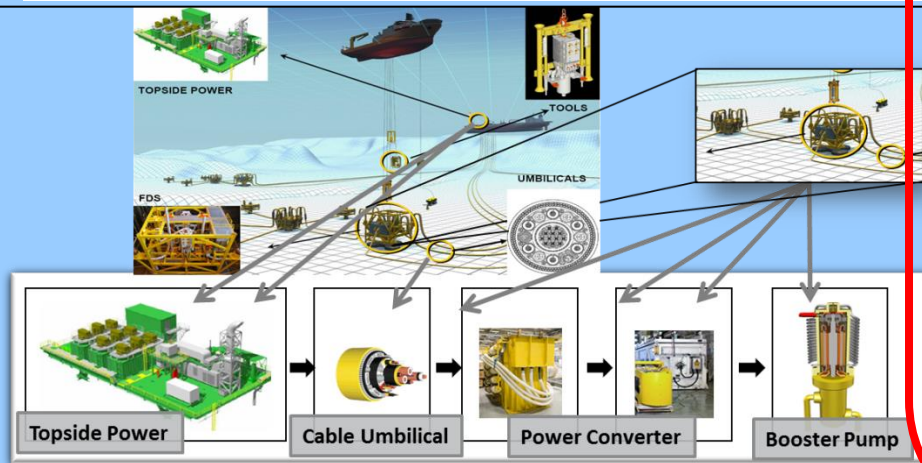
# BOEM - EMF effects from HVDC on migratory species

1. Determination of EMF emitted

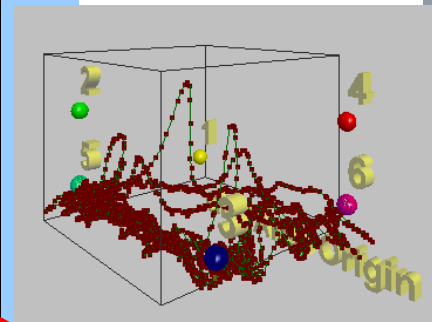
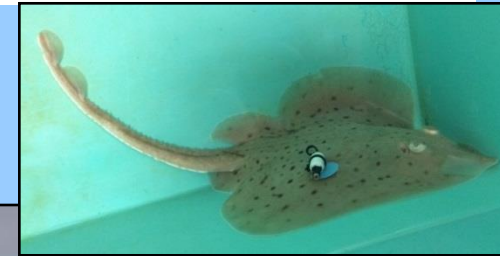
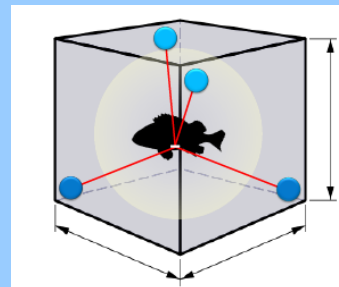


2. Evaluation of power system behaviour w.r.t environmental conditions

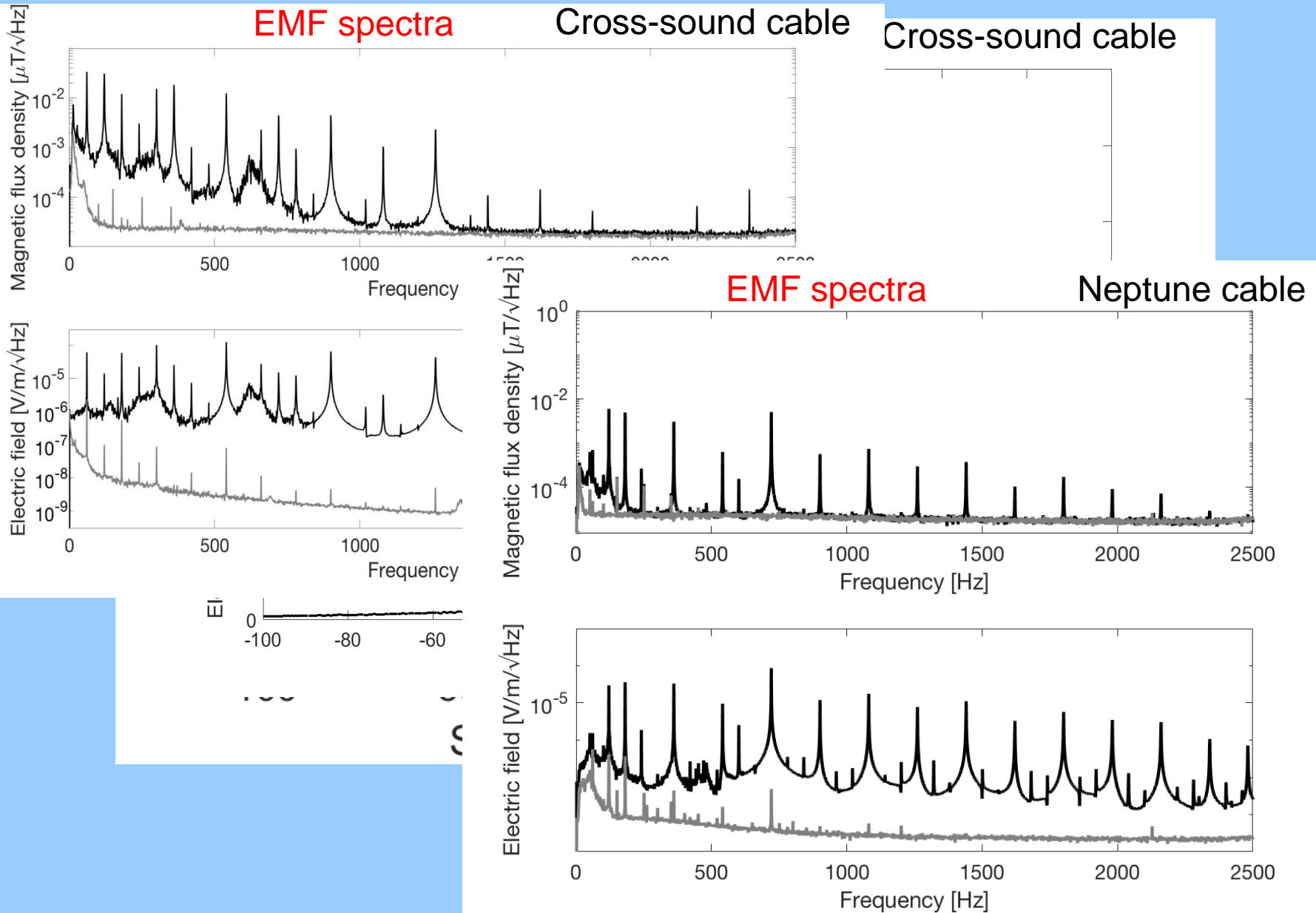
3. Response of species to encounter with EMF emitted



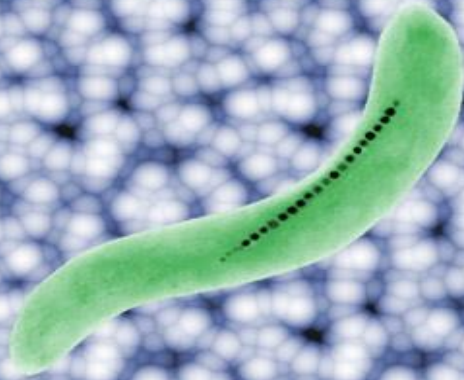
An example of subsea power distribution network (Figure courtesy: ANSYS)



# EMF from HVDC power cables, USA



# What we know about EMF – biotic?



<http://www.asknature.org/images/>



<http://left-out.net/photo/content/2015/5/blue-whale>

**EM sensitive animals have evolved (and continue) to live in an EMF environment (both AC and DC)**

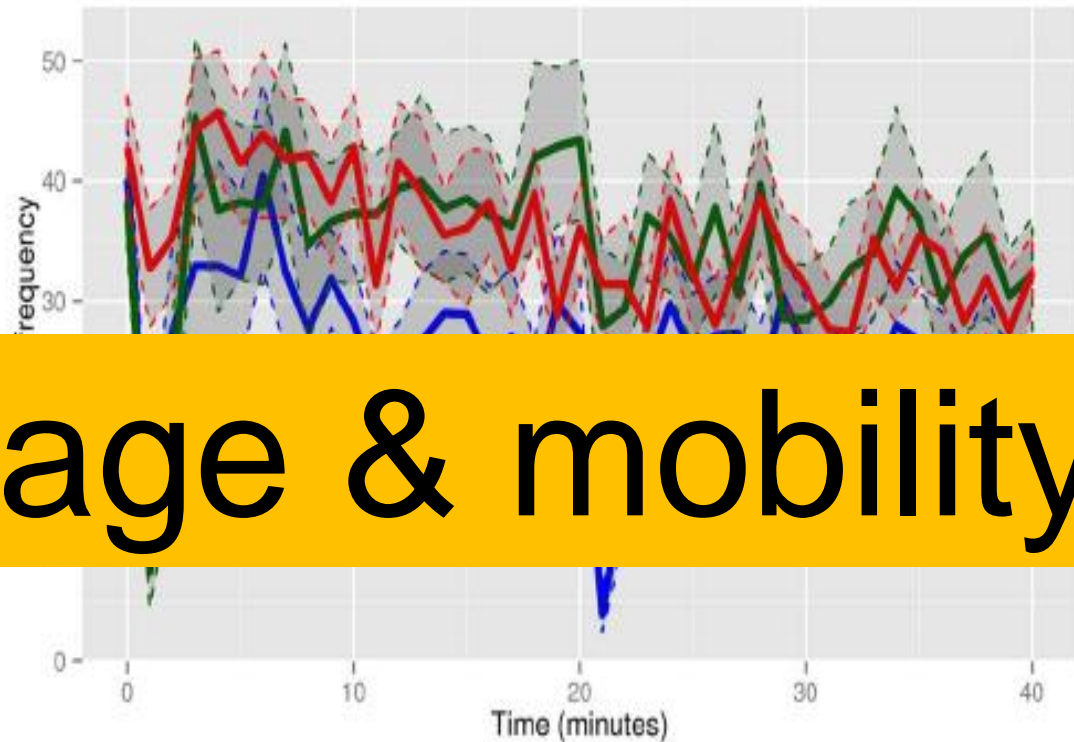
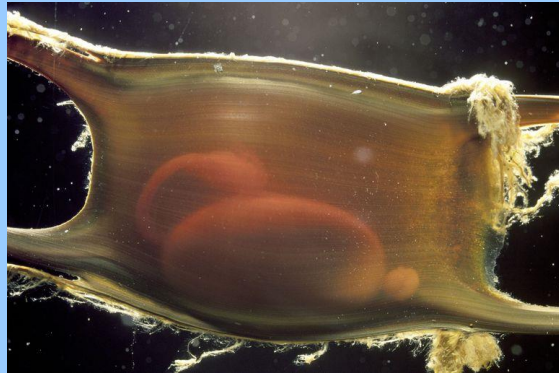


Source: Walter Baxter



Source: ABGill

# Evidence of response to anthropogenic EMF – early life stage



## Life stage & mobility

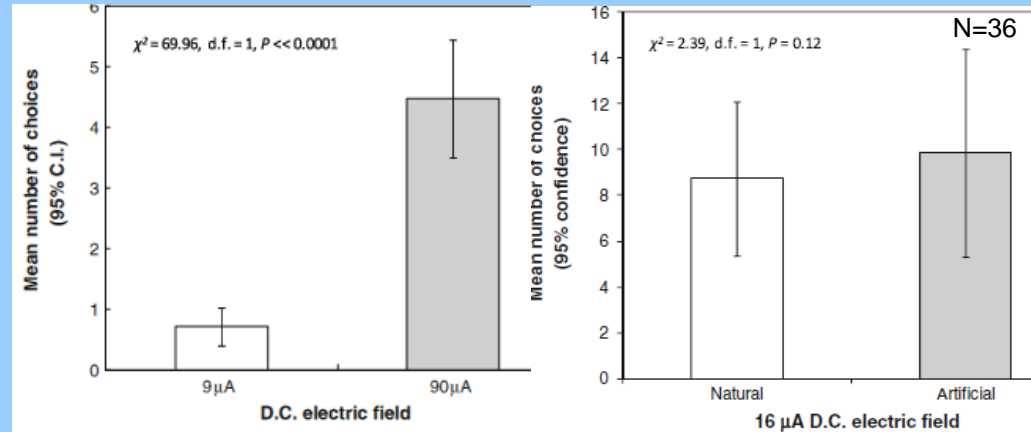
**Figure 3** TBF over time for different electric field treatments (*green line = constant, blue line = intermittent, red line = control*). *Colored dashed lines show 95% confidence intervals, respectively*. A clear dip in ventilatory activity can be seen at minutes 1 and 21 for the intermittent treatment, representing the onset of electric field stimuli. **Ball et al (2015)**

# Sensory discrimination - lab studies

Kimber et al (2009) *Anim Behav*  
 Kimber et al (2011) *Mar Biol*  
 Kimber et al (2013) *Anim Cogn*



<http://web.ukonline.co.uk/aquarium>

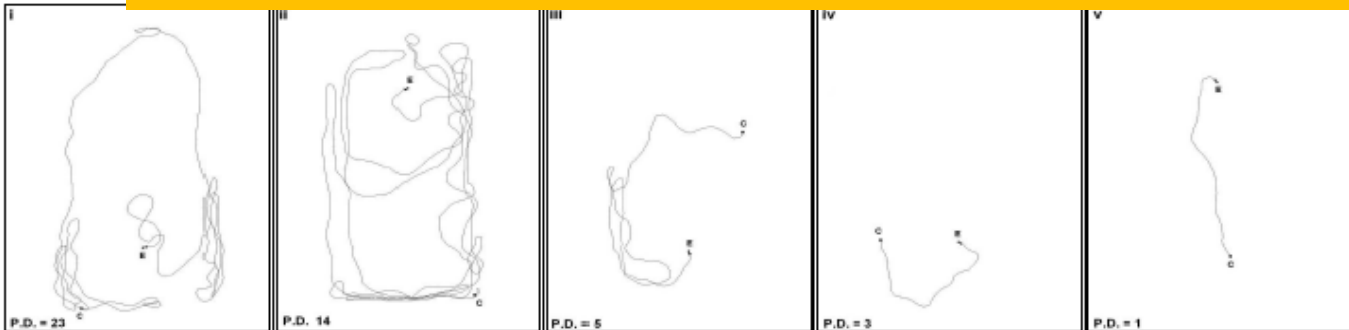


## Encounter context + animal abilities

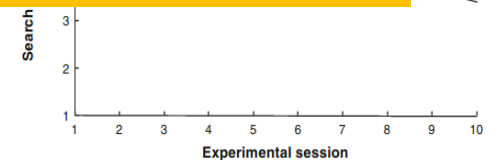
Before interval:



After interval:



Catshark Blue 1501



HGZLMM; N = 24



# BOEM - EMF effects from HVDC on migratory species

1. Distribution of EMF

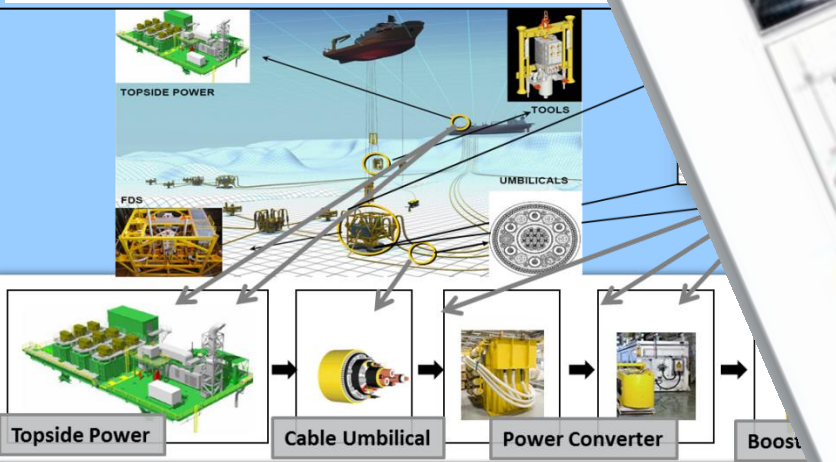


## Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables



Response of species to EMF emitted

## 2. Evaluation of power system w.r.t environmental conditions



An example of subsea power distribution network (Figure courtesy: ANS)

# Findings Summary



Total Distance Travelled

-



Sp  
H  
**Response (effect) +  
distribution**

Proportion of large  
turns

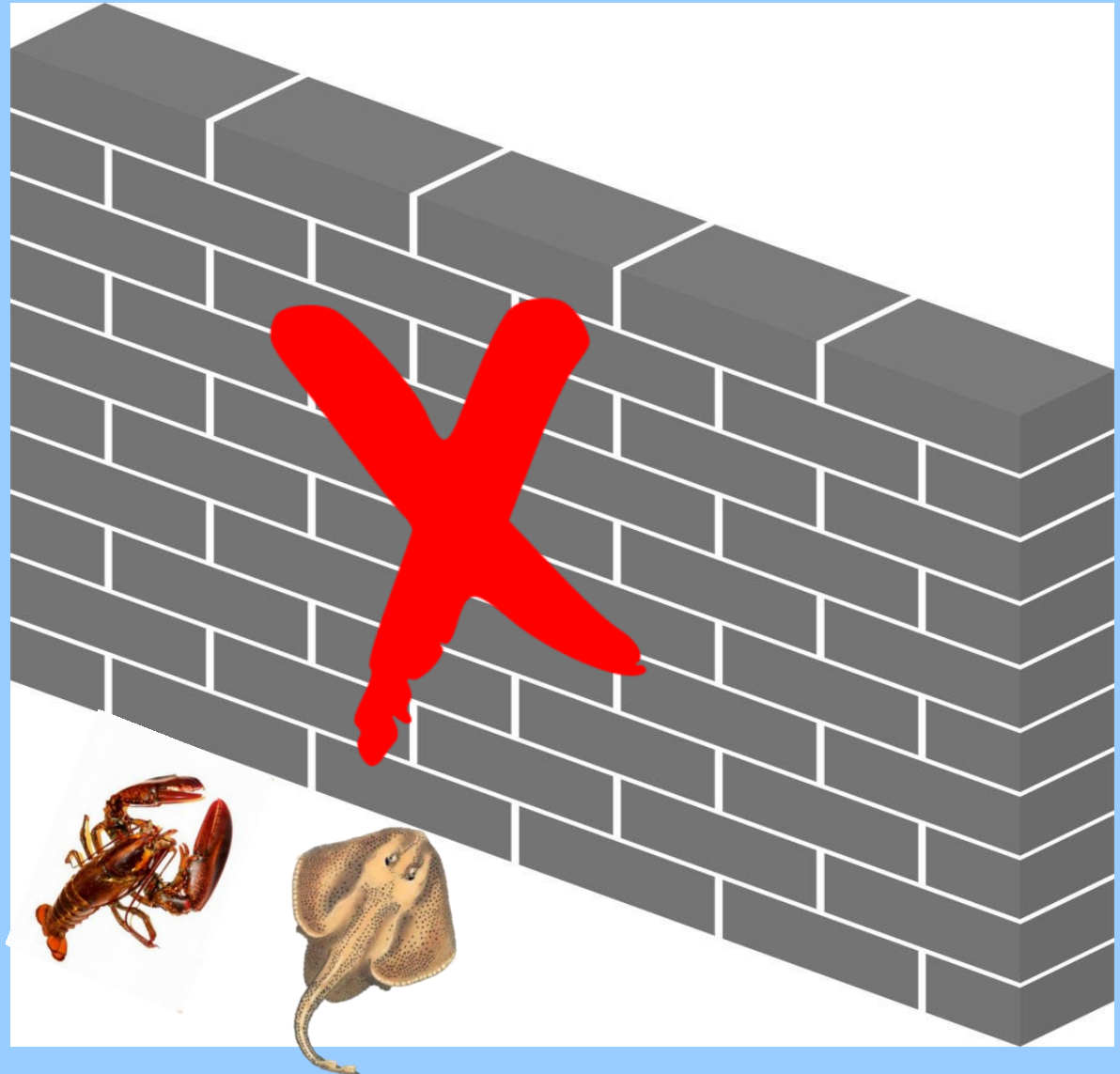


Spatial distribution



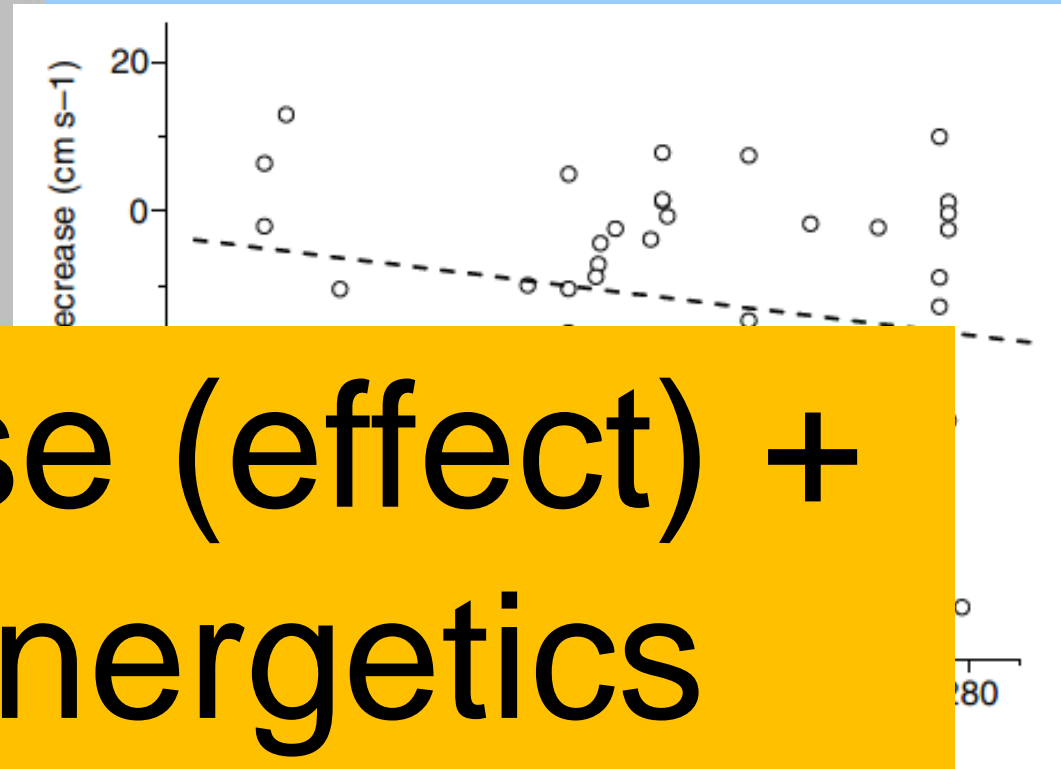
# What does it mean?

The EMF from the Cross Sound Cable in this study did not prevent the lobsters or skates from crossing the cable



# Field study evidence

Westerberg & Lagenfelt 2008



Response (effect) +  
animal energetics

**Figure 5.** Linear regression of speed deficit and the simultaneous, root mean square, current in the sub-sea cable. The deficit is the decrease of swimming speed in the middle (cable) interval compared with the mean swimming speed of the same eel in the northern and southern intervals.

# Summary EMF and OWF

- Evidence of - Electric and/or Magnetic field
  - Type (AC / DC)
  - v background
- Receptors
  - Fish (teleosts & elasmobranchs)
  - Marine/aquatic invertebrates
  - Marine/aquatic mammals & turtles
- *Movement & distribution*
  - Altered Migration - large scale
  - Movement pattern - Medium scale
  - Avoidance or attraction - Small scale
- *Life history*
  - Early life stage development
  - Physiological / biochemical change (e.g. Energetic)
  - Prey /predator detection
- Caveat warning:

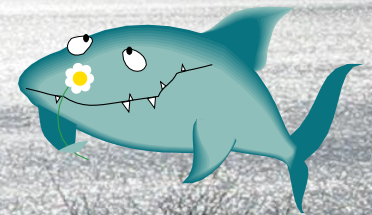
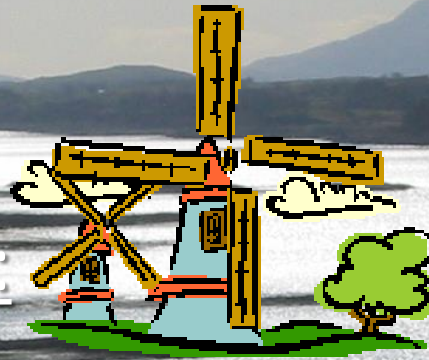


Poor understanding of receptor animals and what the effects/responses mean in terms of biological/ecological/fisheries/socioeconomic significance (i.e. Impact)

# Thanks

&

Very happy to talk further :



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[www.pangalia.com](http://www.pangalia.com)

