



Environmental Impact of Marine Renewable Energy

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Plan of Presentation

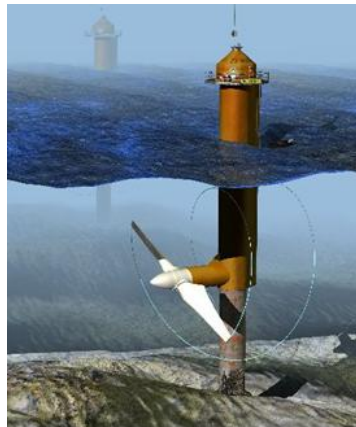
Environmental Impact of Marine Renewable Energy

- Assessment of potential negative environmental impacts
- *Consideration of potential positive benefits*
- Summary of likely concerns: what is important?
- *Conclusions*



Scope of Presentation

- Assess biological component only today
- Operational impact, not construction
- Will consider wave, tidal and offshore wind devices, but not cover barriers.





Plan of Presentation

Environmental Impact of Marine Renewable Energy

- **Assessment of perceived negative environmental impacts on biodiversity**
 - Collision
 - Noise
 - Electromagnetism
 - Physical Structure



Collision hazards: most high profile concern?

BBC NEWS **LIVE** BBC NEWS CHANNEL

Last Updated: Wednesday, 3 March, 2004, 05:24 GMT
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Wind farm 'threat to bird life'

Bird conservationists are warning they may fight government plans to build more wind farms around Britain.

Research is needed to avoid putting the farms where birds could be threatened by rotating blades, the Royal Society of the Protection of Birds (RSPB) says.



Wind farms pose a threat to birds, conservationists say

BBC NEWS **LIVE** BBC NEWS CHANNEL

Last Updated: Tuesday, 3 July 2007, 09:13 GMT 10:13 UK
E-mail this to a friend Printable version

Wind farm 'is threat to eagles'

By Paul Rincon
Science reporter, BBC News

Golden eagles are gravely threatened by a £200m wind farm scheme proposed for the Hebridean island of Lewis, campaigners have warned.



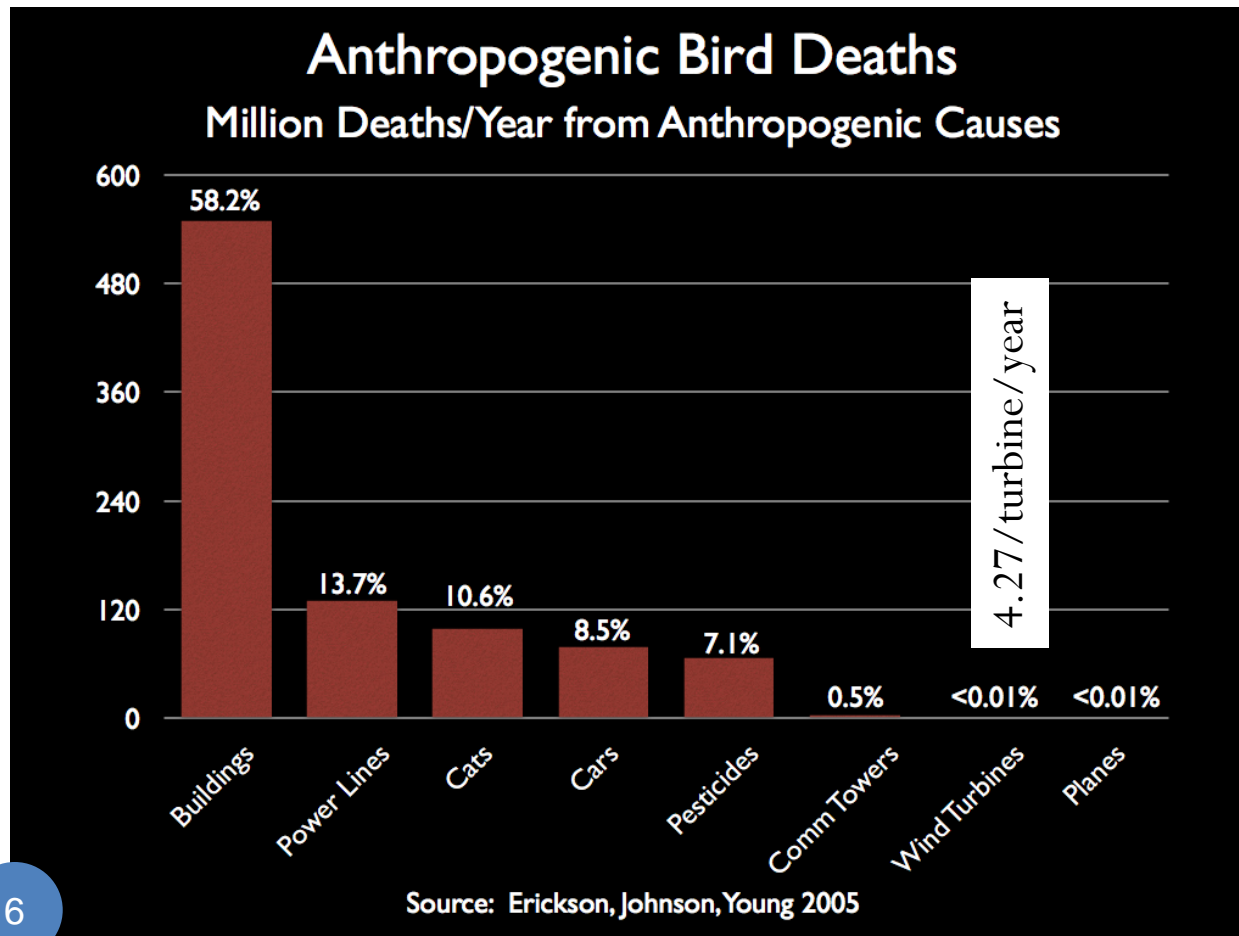
Three of the predatory birds a year could be killed in collisions with turbine blades - the highest mortality from any wind power project in the UK.

The Pairc peninsula is a good habitat for golden eagles

Up to 40,000 bird deaths/year in the US from wind turbines



Context: US “unnatural” bird deaths

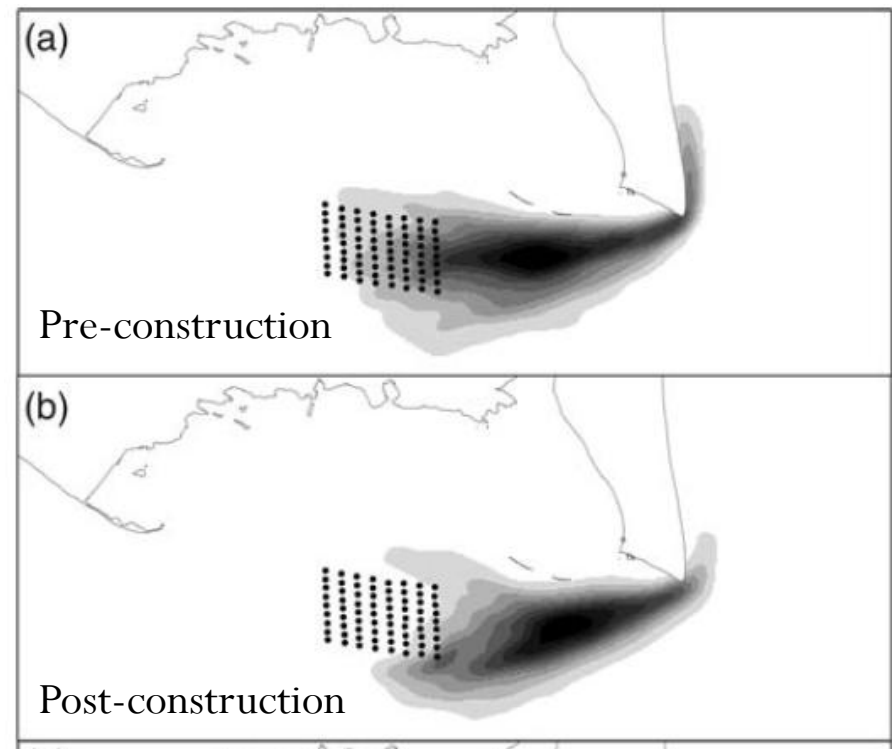


Data primarily from
land – offshore
windfarms?



Migrating birds may avoid windfarms

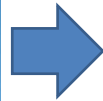
- Eider ducks migrating through Danish windfarms
- 200,000/year
- Changed course to avoid area
- Caused extra 500 m flight in migration of 1400 km
- Huge windfarms?



Marsden et al 2009



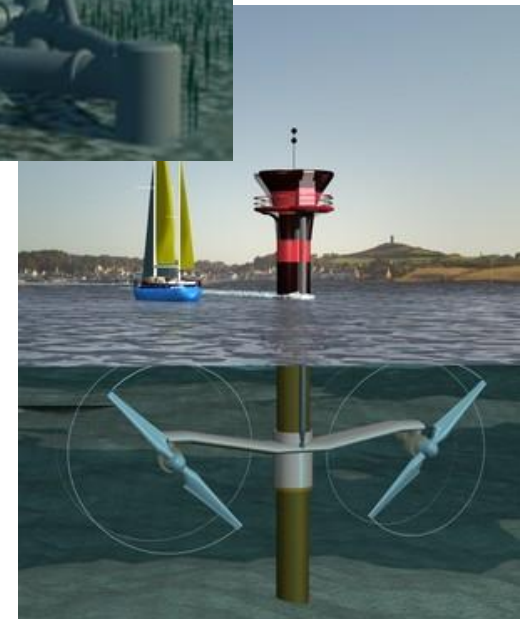
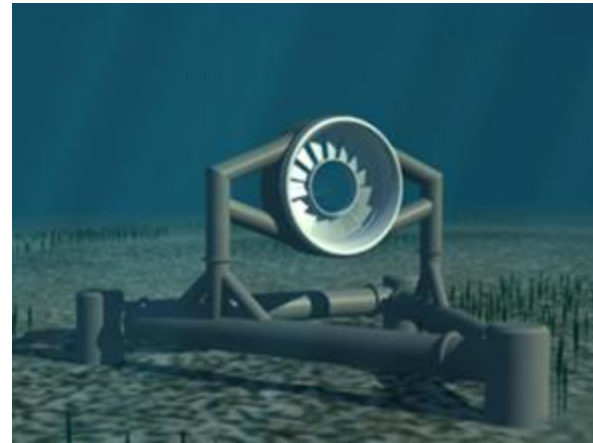
Do we have right design of offshore turbine?





Similar process for tidal turbines

- Speed and design key to avoiding marine mammal collisions
- Marine mammals will avoid larger, slower moving turbines





Interaction between mammals and turbines?

- Little evidence that marine mammals and tidal turbines come in contact
- 3 years into monitoring in Strangford Lough, NI
- Graham Savidge (Queens University, Belfast):
 - *“the half million movements recorded so far suggest turbines and seals avoid one another”*
- Wider/longer term impacts?





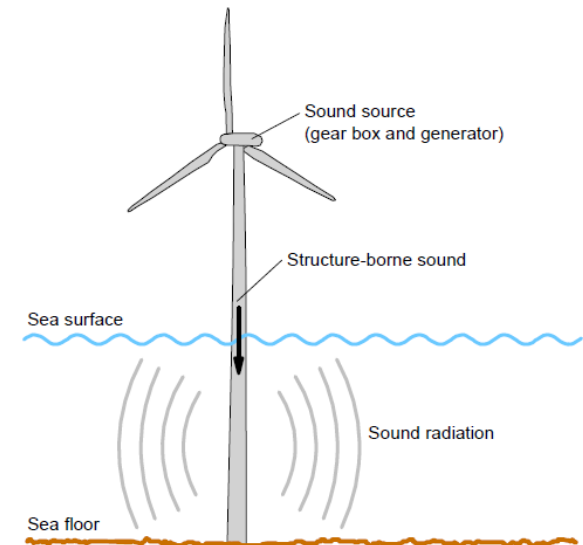
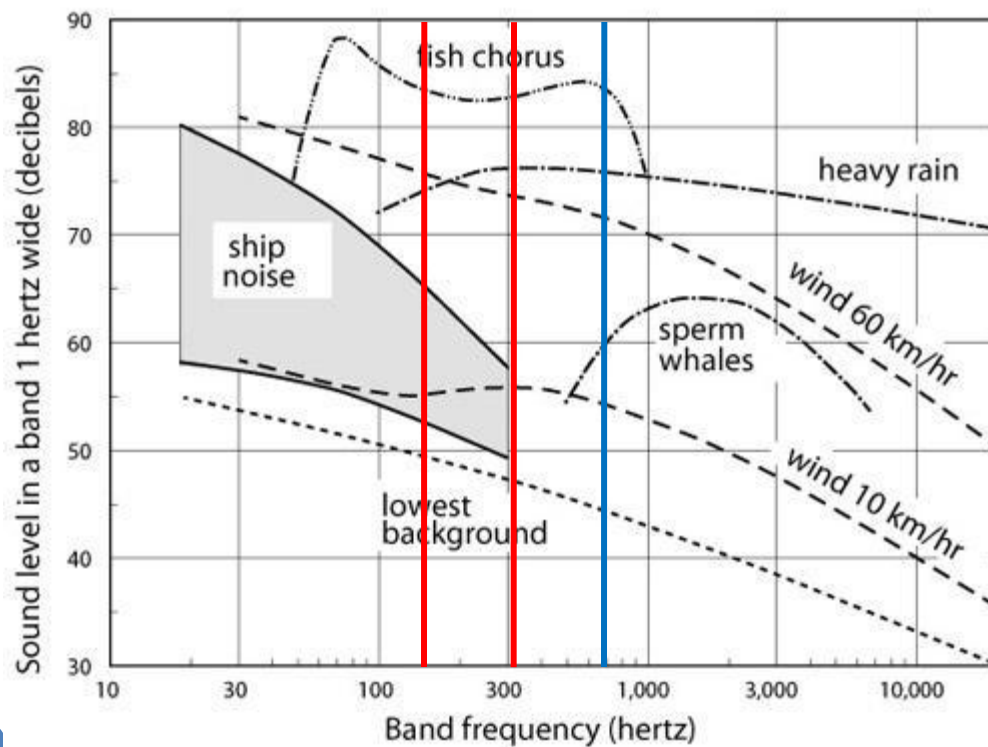
Summary: Collision

- Bird kills: offshore much less a problem than on land, esp. newer larger turbines
- *Migrating birds avoid or fly round turbines*
- Little evidence of collision problem between marine mammals and tidal stream (avoidance?)
- *Wider disturbance effect, esp. for large or many developments?*



Operational Noise

- Impact depends on frequency as well as level



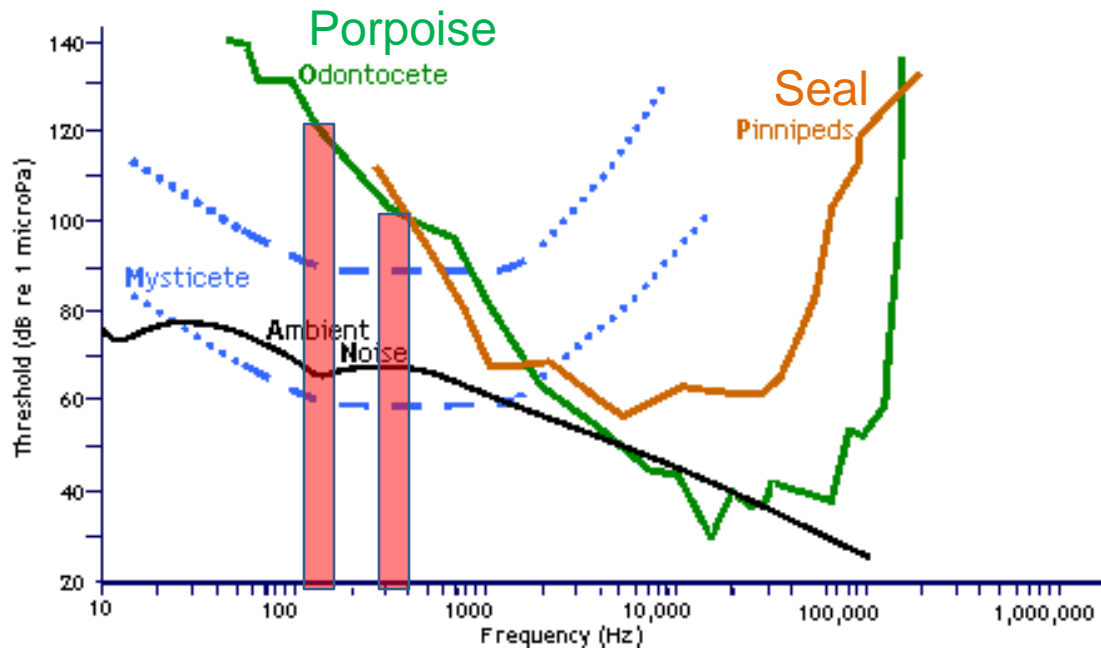
Horns Rev, 100 m

- Peak sound 150 and 300 Hz
- No sound > 800 Hz



Operational Noise

Estimates of the hearing thresholds for some groups of marine mammals



Office of Naval Research, 2001

Horns Rev, 100 m

- 150 Hz = max 122 dB
 - 300 Hz = max 112 dB
 - Porpoise: audible at 100 m
 - Seal: audible up to 1 km
 - Fish: audible up to 4 km
- (Thomsen et al 2006; Andersson et al 2007)

Nysted Wind farm

- Seal colony 4 km away
- No impact on behaviour

Seabirds

- May use noise as avoidance cue
- (Larsen & Guillemette 2007)



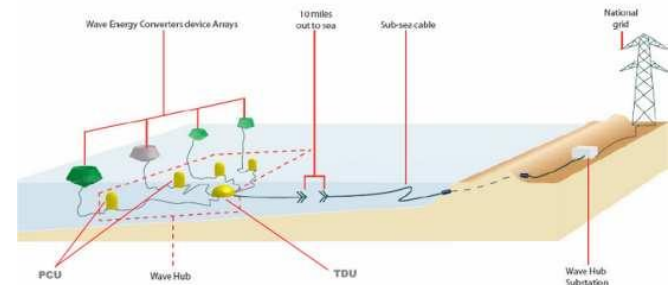
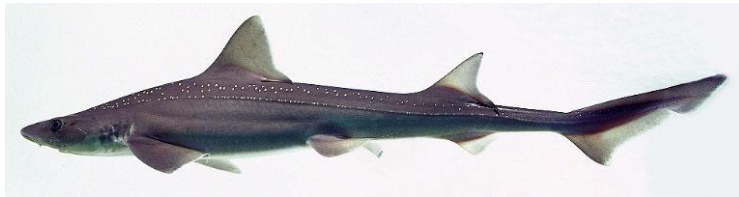
Summary: Noise

- Most noise from turbines only just in hearing range of coastal marine mammals
- *Fish more sensitive, but effects “should be restricted to very close ranges” (Thomsen et al. 2006)*
- Little evidence of noise impact on mammals beyond construction, where effect can be severe; recovery evident during subsequent operation
- *Tidal and wave devices – need to assess noise regime and limit frequencies in sensitive wavelengths*



Electromagnetic fields (EMF)

- Produced by sub-surface cables transferring electricity to shore
- *Range of marine organisms detect (and use) EMF, e.g. bony fish, sharks/rays, marine mammals*
- Cable EMF attract a few sensitive species (Gill et al 2009); can detect up to 295 m away. Consequence?
- *Limited evidence for any wider impact of offshore power cables (Ohman et al 2007)*





Physical Structure

- Construction in soft sediment changes nature of seabed, often replacing soft sand with hard material
- Estimates of habitat lost at windfarm (Wilson 2007)
 - 452 m² sediment habitat/turbine (12m Ø circle)
 - 102 m³ water column/turbine
- Providing new structural habitat...link to positive impacts?

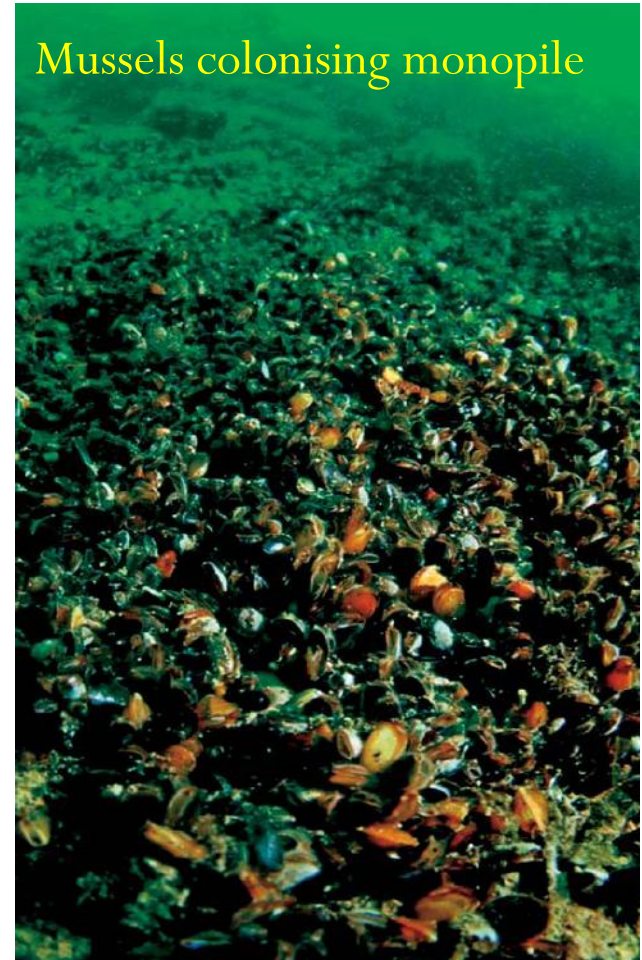




Provision of physical structure

- Historical loss of reef habitat due to 100s of years of bottom fishing (Roberts 2007)
- *Underwater piles/anchoring provides artificial reef habitat*
- Increases production and diversity of locality
 - Horns Rev – 60x increase in available food biomass in windfarm area

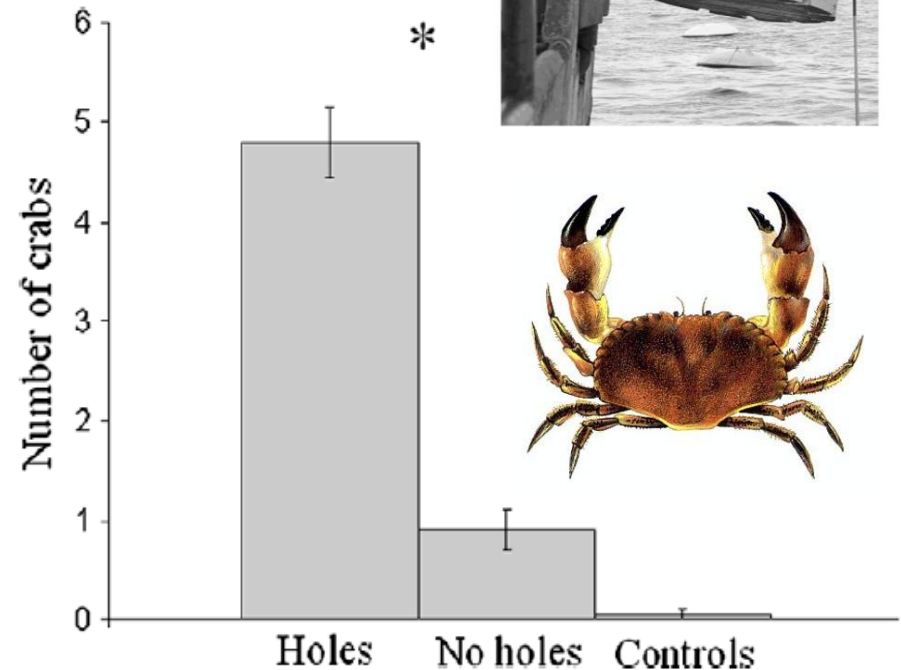
Mussels colonising monopile





Provision of physical habitat – fishery boost?

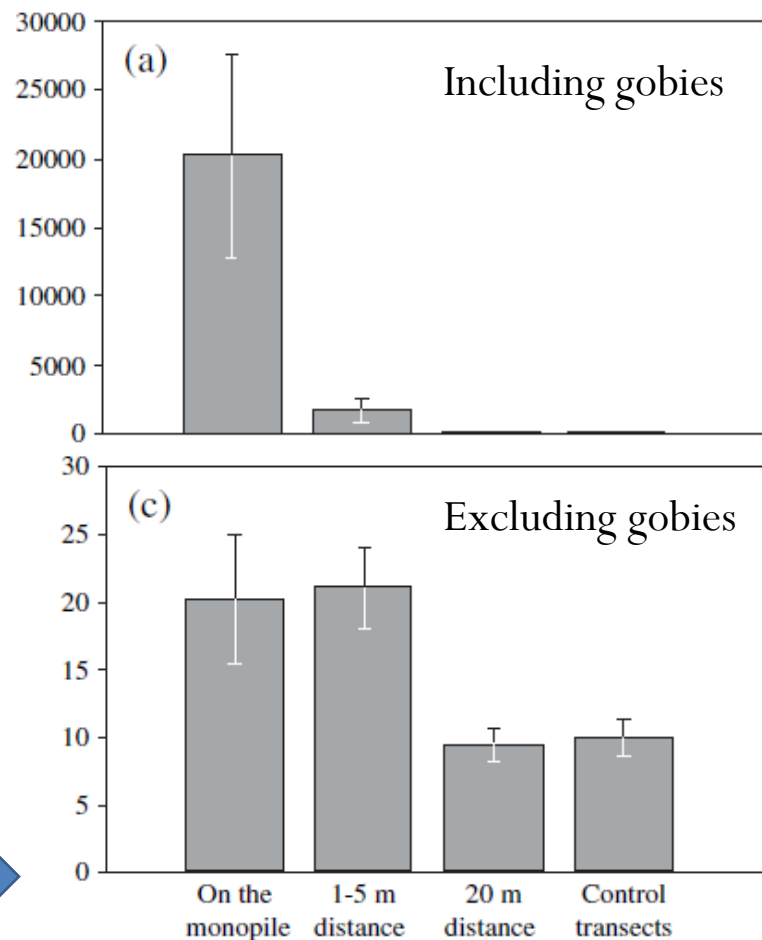
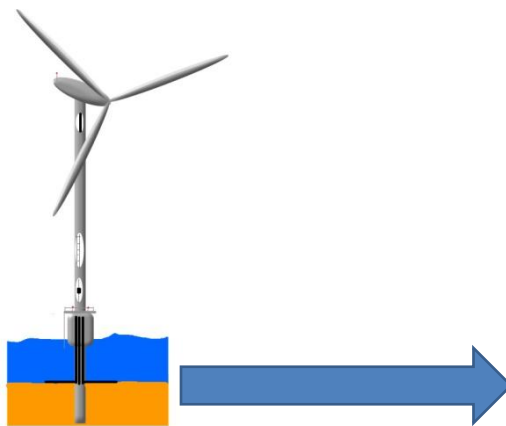
- Physical structure can boost fisheries populations
- Langhamer & Wilhelmsson (2009) – wave energy foundations
 - Edible crabs boosted if holes provided
- Can environmentally enhance engineering structures for fishery gain





Provision of physical habitat – fishery boost?

- Increase in fish populations at Wind Farm (Wilhelmsson et al 2006)
- Noise?





Marine Protected Areas & Renewable Energy

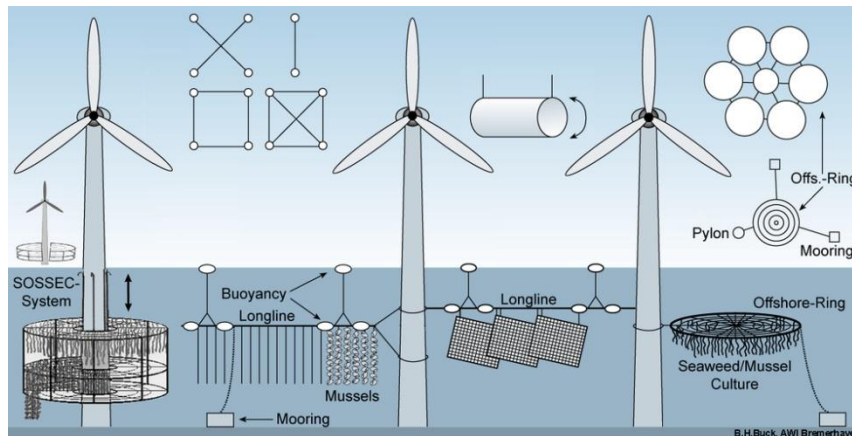
- Other maritime activity, esp. towed fishing, difficult or impossible within renewable energy arrays
 - Provide *de facto* MPAs
- Some evidence energy farms boosting, or concentrating, biodiversity
- Location key – industry work in partnership with conservation bodies?
- Shift in emphasis of “impact” of renewable energy developments
- *Punt et al 2009. Ecological Economics*





Fishery consequences

- Some fishing methods will be excluded but...
- *Stock enhancement*
- Static gear can fish within area?
- *Great potential for aquaculture, e.g co-location with windfarms*





Summary: suggested likelihood of impacts

Likelihood of wide-scale operational impacts on populations

Impact	Offshore Wind	Wave	Tidal Stream	
Bird & mammal collision	Low	Minimal	Low	“-ve”
Bird & mammal displacement	Low	Minimal	Low	
Noise impact	Low	Low	Low	
EMFs	Minimal	Minimal	Minimal	
Physical Structure	High	Medium	Medium	“+ve”
Exclusion of activity	Medium	High	High	



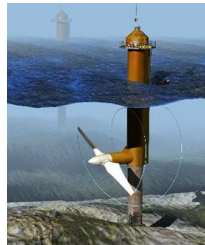
Conclusions and ways forward

- Evidence suggests few wide-scale negative impacts of marine renewable developments at organism population level are likely: major coordinated studies needed
- *Design and location are key to minimising impact*
- Major impacts could be regarded as positive – industry needs to work more closely to develop these & influence perception in addition to positive value re climate change
- *Partnership needed to allow co-location of suitable activity, fishery enhancement, conservation areas, etc.*
- Aesthetics may remain a key problem



Thanks to co-authors and input from PRIMaRE team:

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