Update on underwater noise and offshore wind farms.

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Aim of study

- To evaluate the subsea noise from construction and operation of wind farms and to rate it in terms of its potential for environmental effect
- “Noise Audit” approach - may include noise during construction, operation and decommissioning

Introduction

- Underwater sound measurement
- Species perceived sound level (dB_{ht})
- Background noise
- Piling noise
- Operational noise

The underwater environment

- Most underwater animals use sound to navigate, communicate and explore their environment (fish, marine mammals, crustaceans, …)
- Man made underwater noise has great capacity to effect their environment
- How do we judge the significance of noise?

Underwater Source Levels

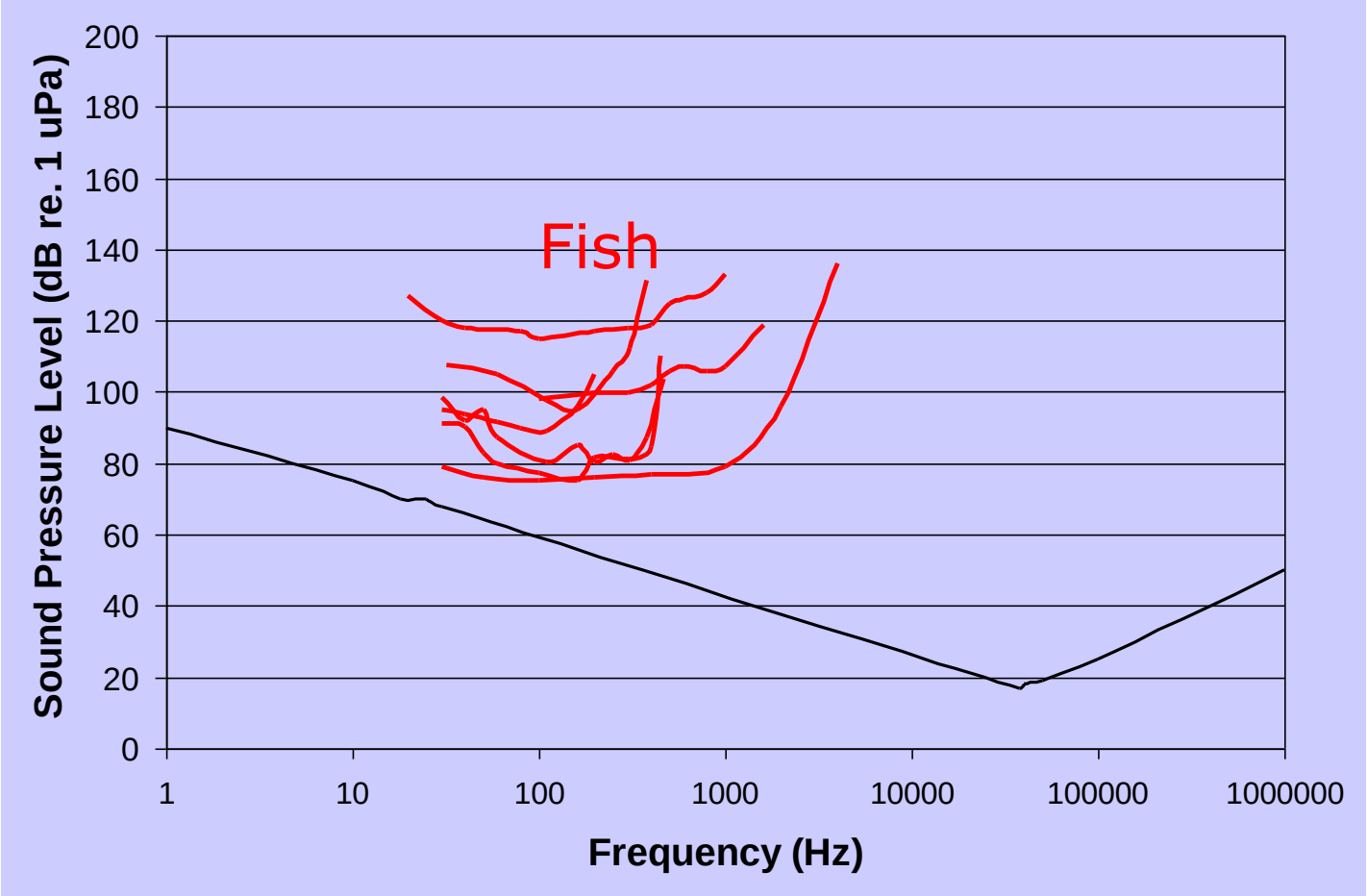
dB re 1 uPa @ 1 metre

Noise source	Source Level	Hear it!
Background noise	110-140	
Vessel	170-190	
Airgun array	190-240	
Piling	170-270	
Borehole blasting	220-260	

Impact of Underwater sound

- Lethal: Peak levels greater than 240 dB re. 1 uPa (10's of metres)
- Injury: Peak levels greater than 220 dB re. 1 uPa (100's of metres).
- Behavioural response: Can extend to many 10's Kms.

Underwater hearing threshold



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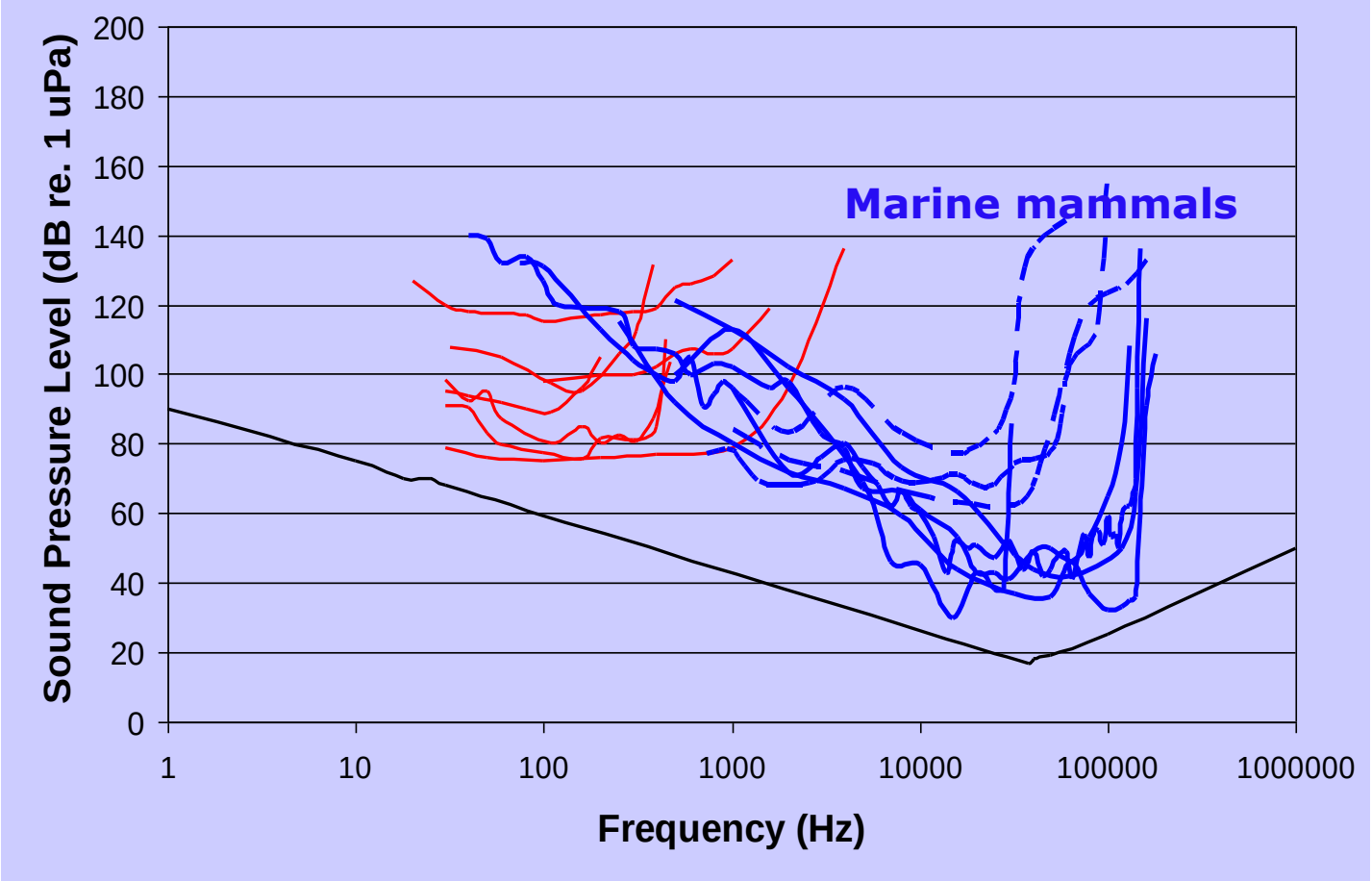
Underwater hearing threshold



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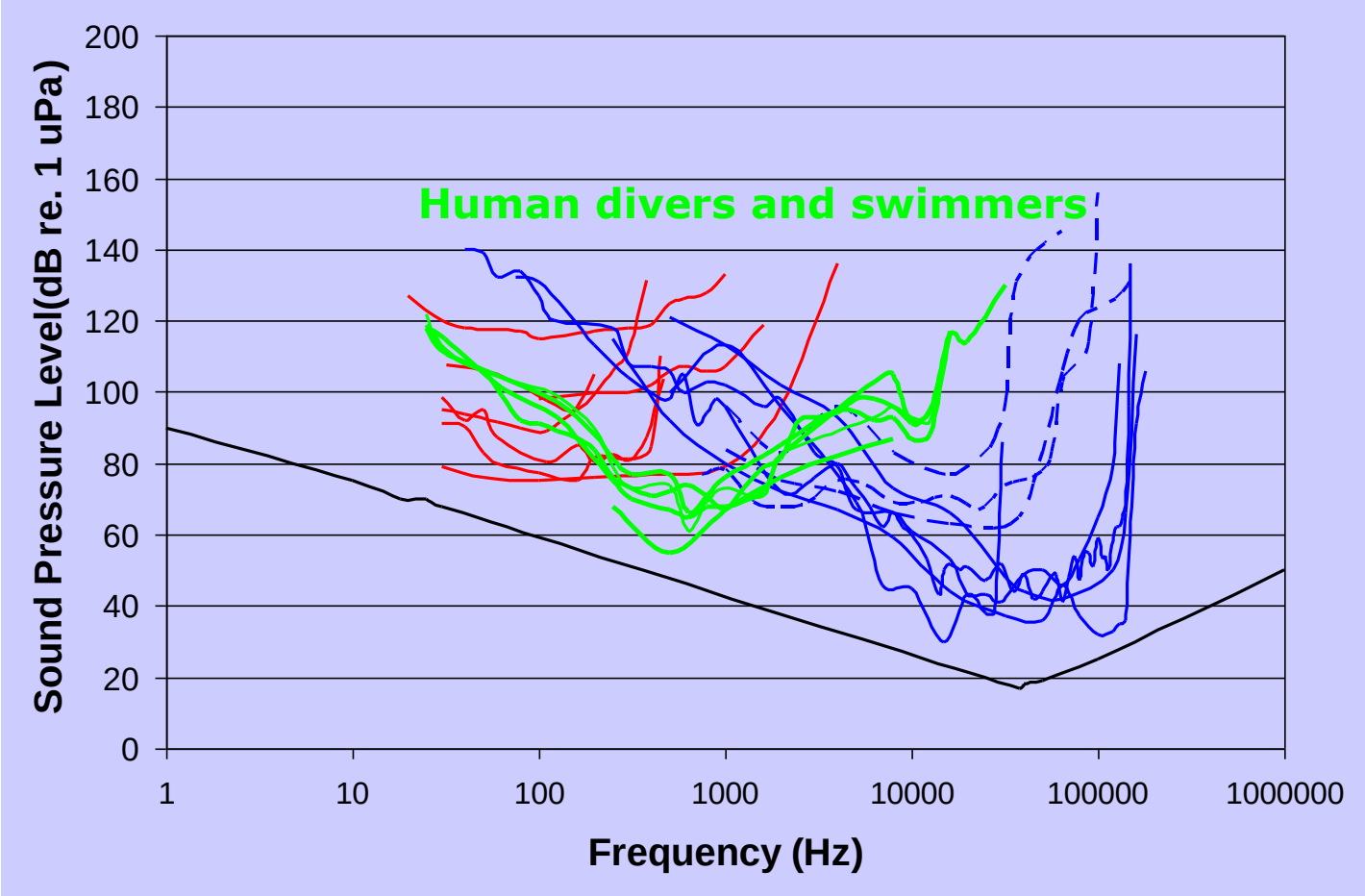
Underwater hearing threshold



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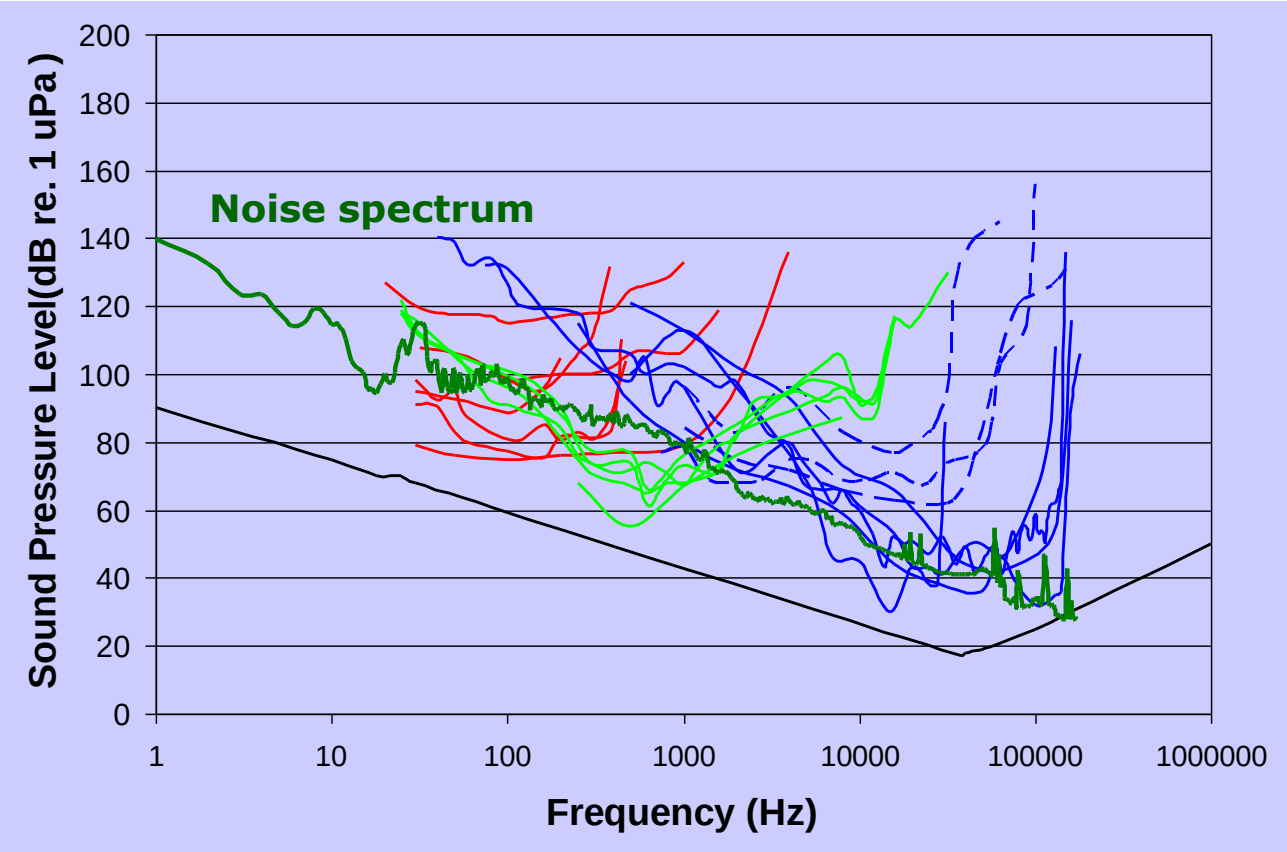
Underwater hearing threshold

Perceived loudness dB_{ht}



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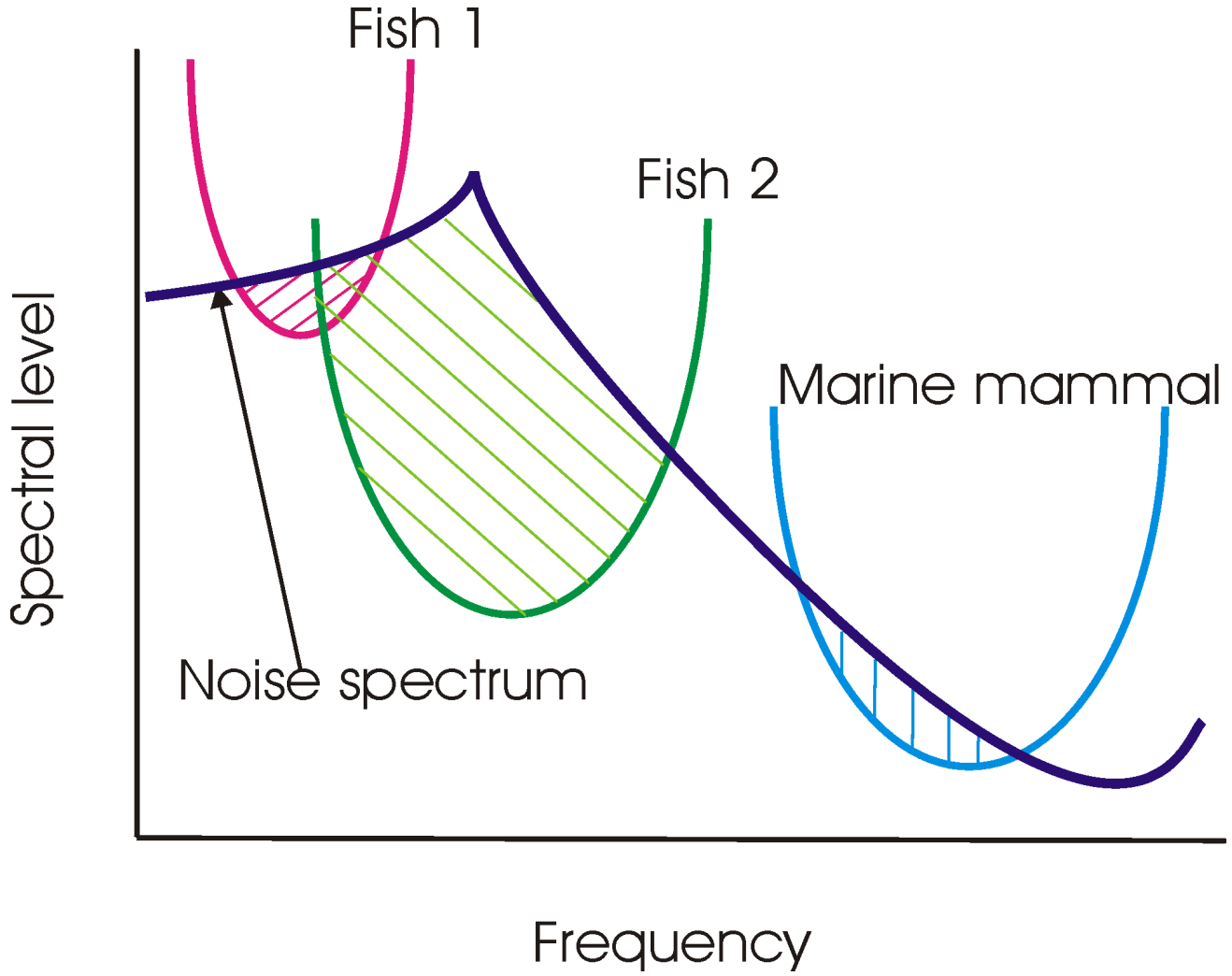
Perceived 'loudness' dB_{ht}

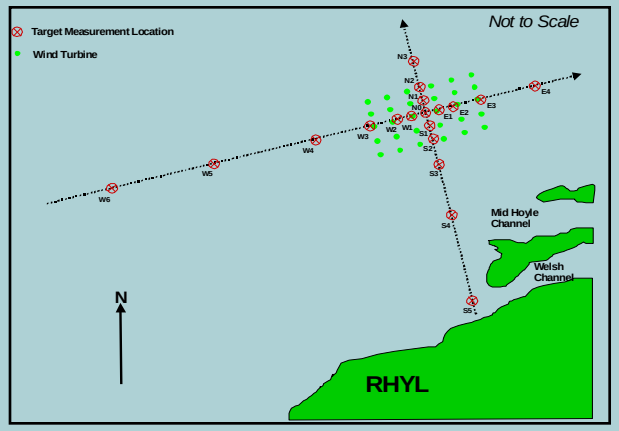


Effects of noise

Level	Comment	Effects	Human equivalent
< 0 dB_{ht}	Animal can't hear it	No reaction	Soundproof room
0-90 dB_{ht}	Increasingly loud	Reactions primarily cognitive	e.g. office, workshop 50 - 70 dB_{ht}
90-130 dB_{ht}	Unbearably loud	Instinctive reaction (avoidance)	Roadhammer >100dB_{ht}
> 130 dB_{ht}	Deafening	Traumatic hearing damage	Gunfire near ear

Underwater noise survey

- UW sound recording 1 Hz to 175 kHz.
- Dynamic range up to 100 dB.
- Overall sound level (Pk-Pk).
- Species perceived sound level (dB_{ht})



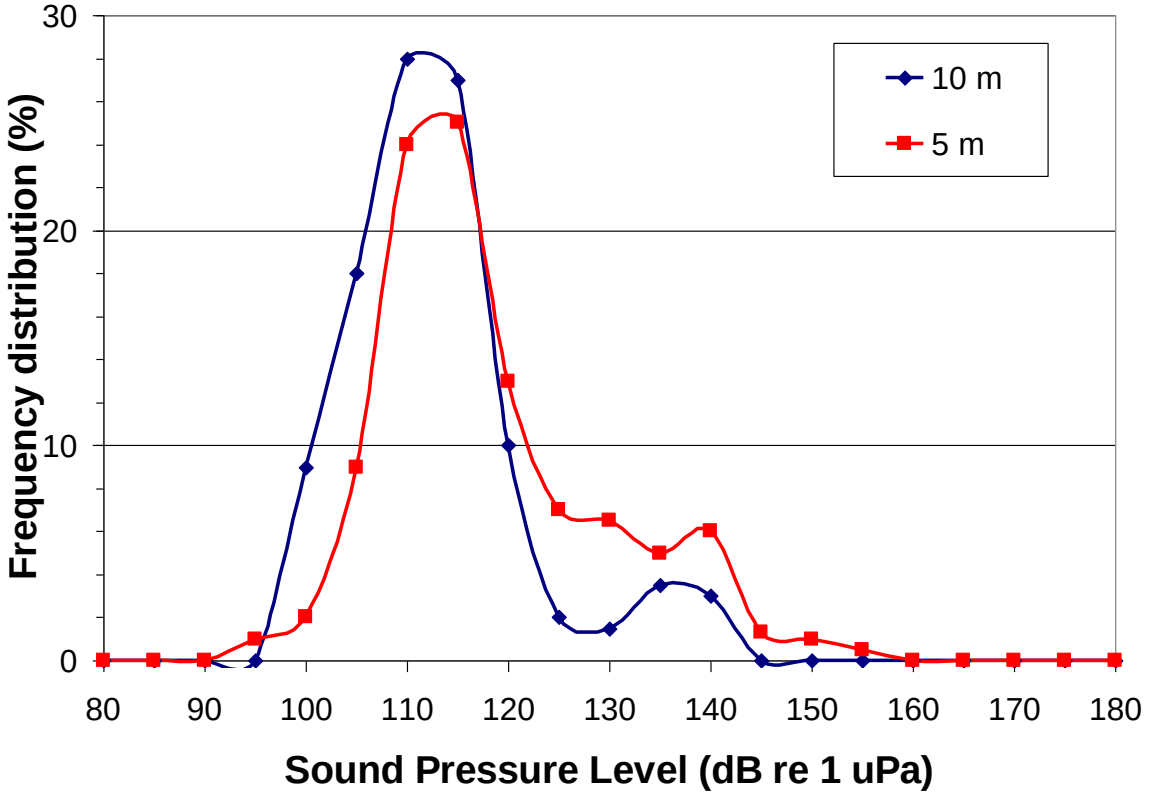
Background noise

- Measure existing levels of noise prior to the wind farm development
- Determine statistical variation.

Background Noise

Overall Sound Pressure Level

North Hoyle



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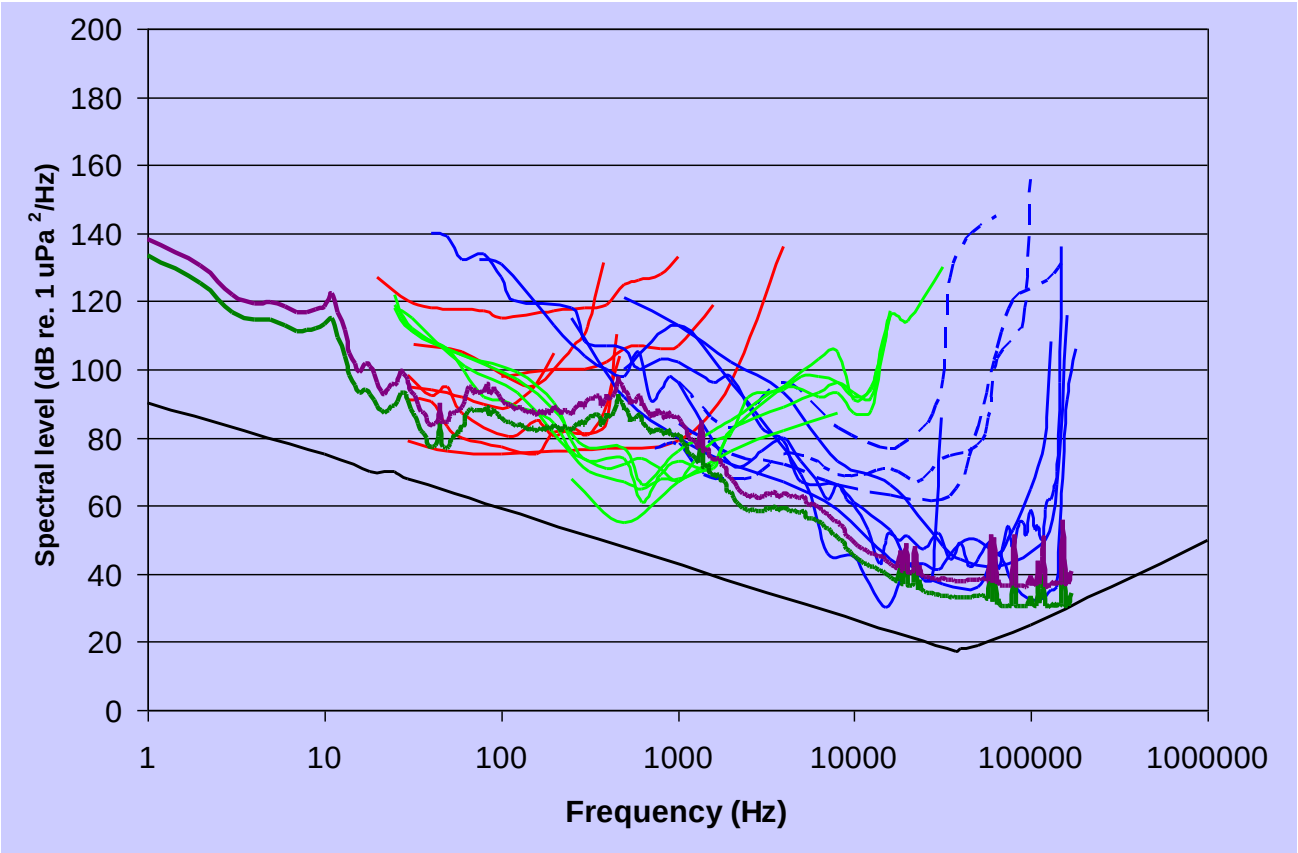
Background Noise

Mean and 95% confidence interval



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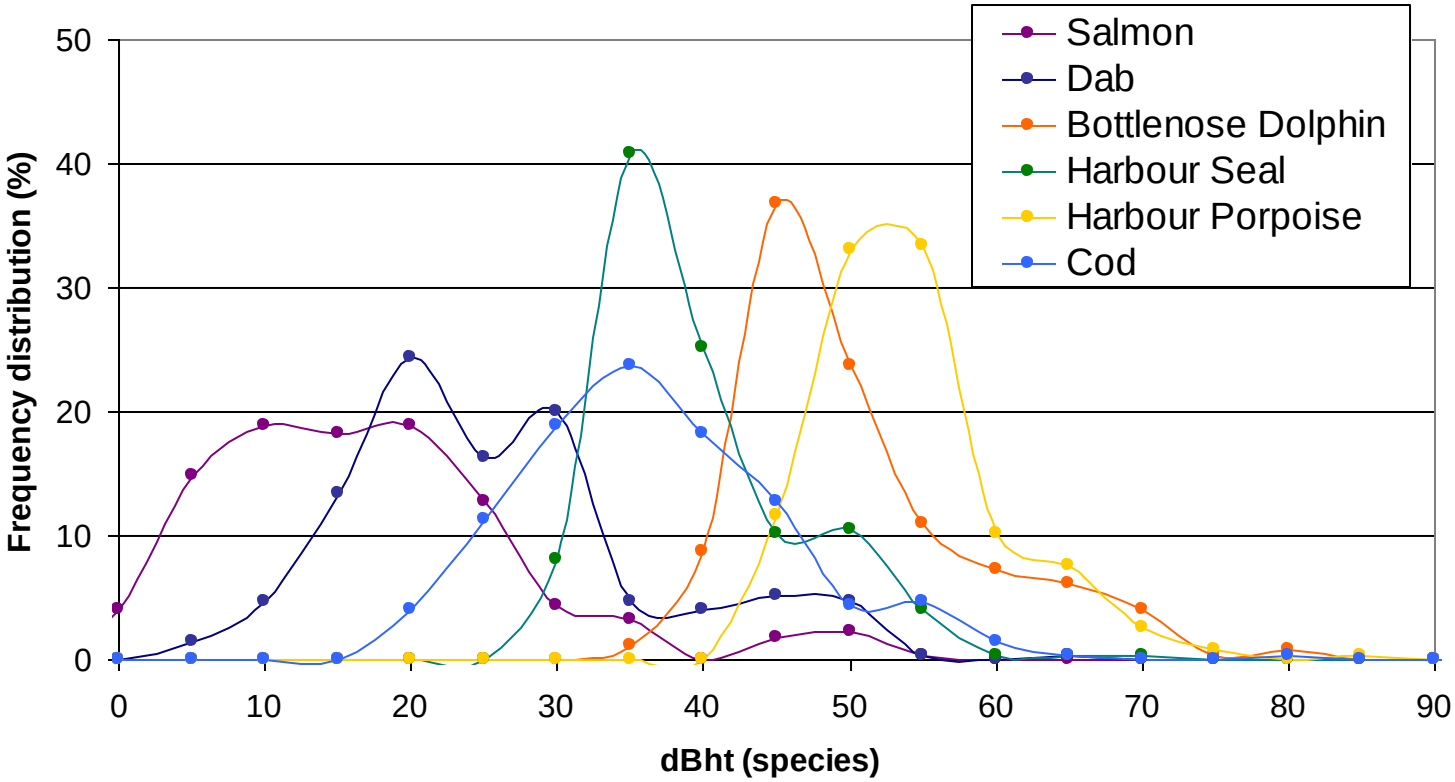
Background noise

Species perceived sound level (dB_{ht})



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Background Noise Summary

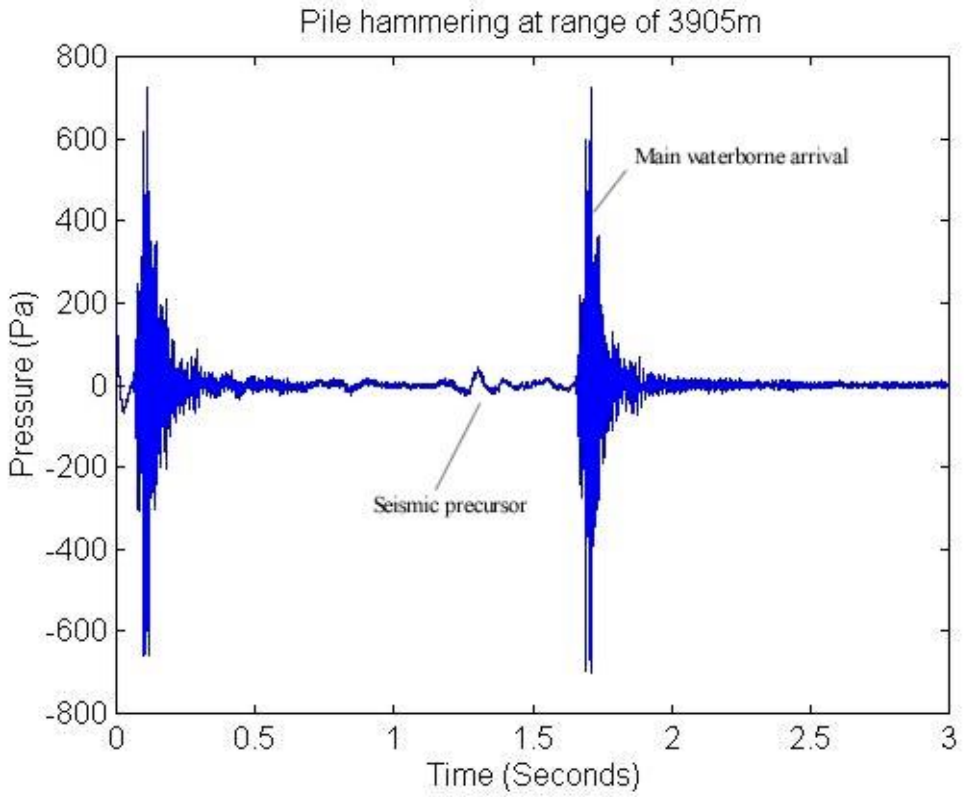
- Shallow coastal waters are a noisy environment when compared with deep waters.
- Greatest variation caused by shipping movements (< 1 kHz).

Piling Noise

- Short duration impulse noise.
- Pile strike every 1 to 3 seconds for up to 6 hours.
- Piling operation takes many months

Underwater piling noise

Hammering of a 4.3 m diameter pile, measured at a range of 3.9 km.



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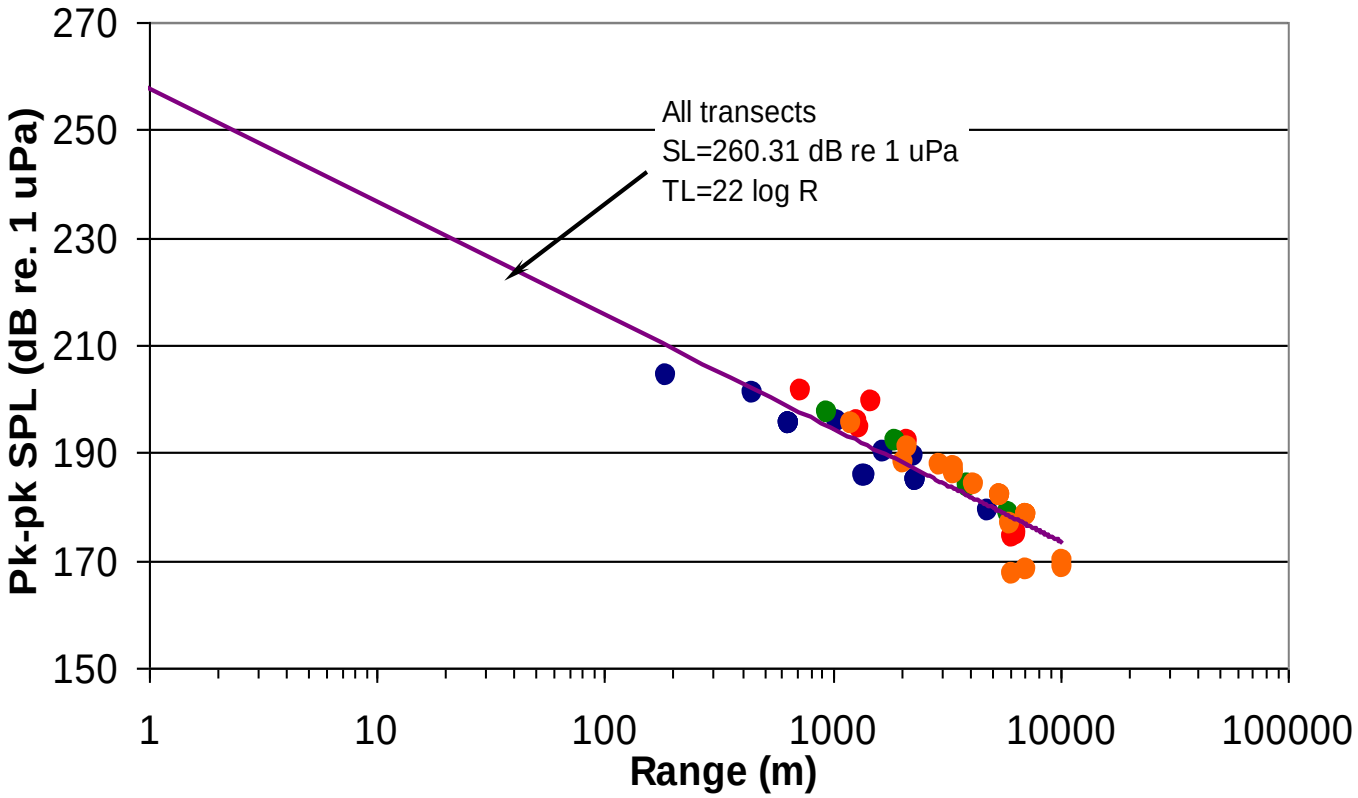
Piling Noise

Peak Sound Levels, 4.3 m diameter pile.



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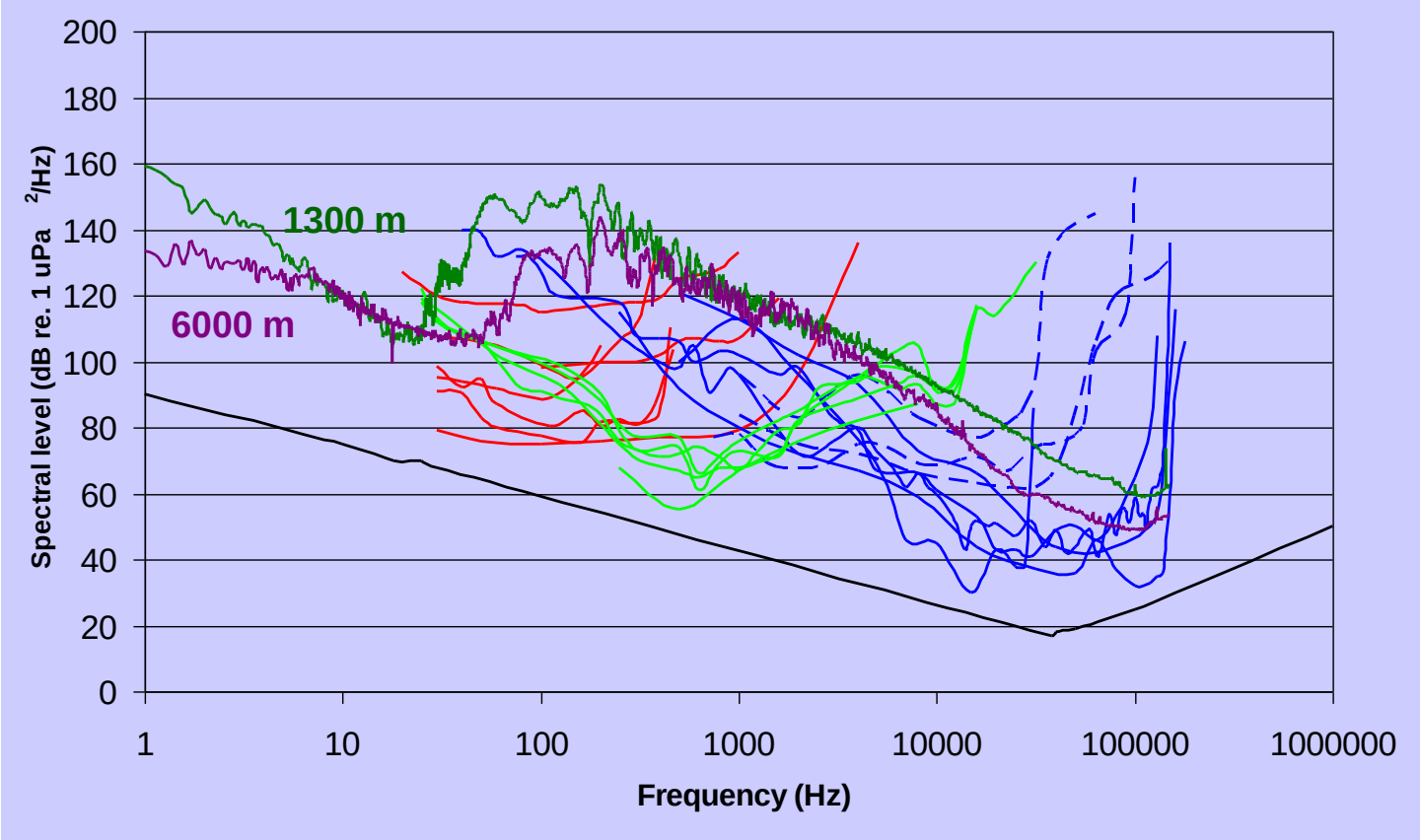
Piling Noise

Spectral content at 1300 and 6000 m



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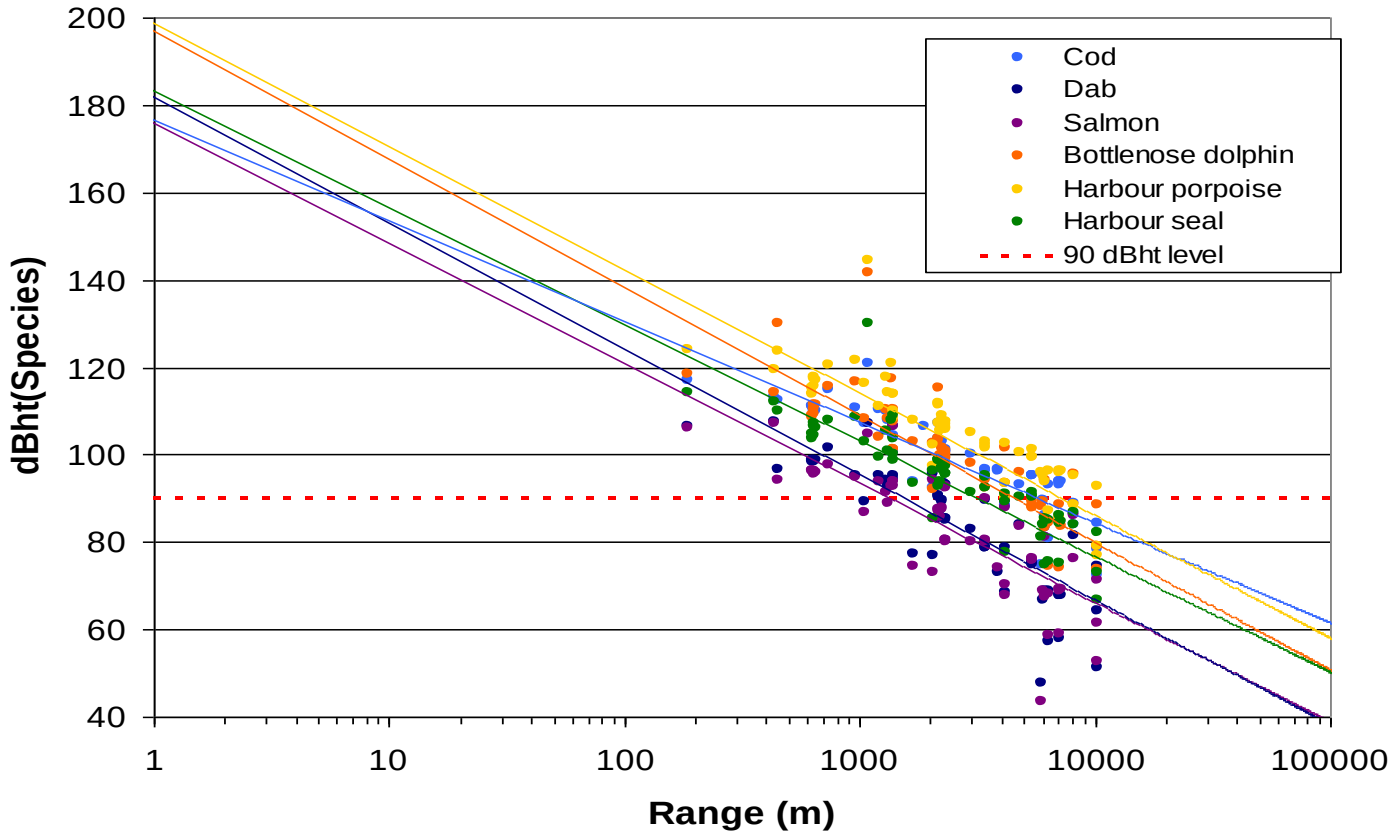
Piling Noise

Species perceived sound level (dB_{ht})
4.3 m diameter pile



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Further evidence

- Piling: World's largest offshore wind farm was build on Horns Reef in the Danish North Sea in 2002; observations from ship surveys showed a significant change in behaviour of harbour porpoise on days with pile driving at distances up to 15 km from the wind farm

(Tougaard, J, Carstensen,J, Skov,H, Teilmann,J, and Henriksen, O D (2003). Effects from pile driving operations on harbour porpoises at Horns Reef offshore windfarm, monitored by T-PODs and behavioural observations. Report by National Environmental Reseach Institute, Frederiksborgvej 399, DK-4000 Roskilde,Denmark)

Piling Noise Summary

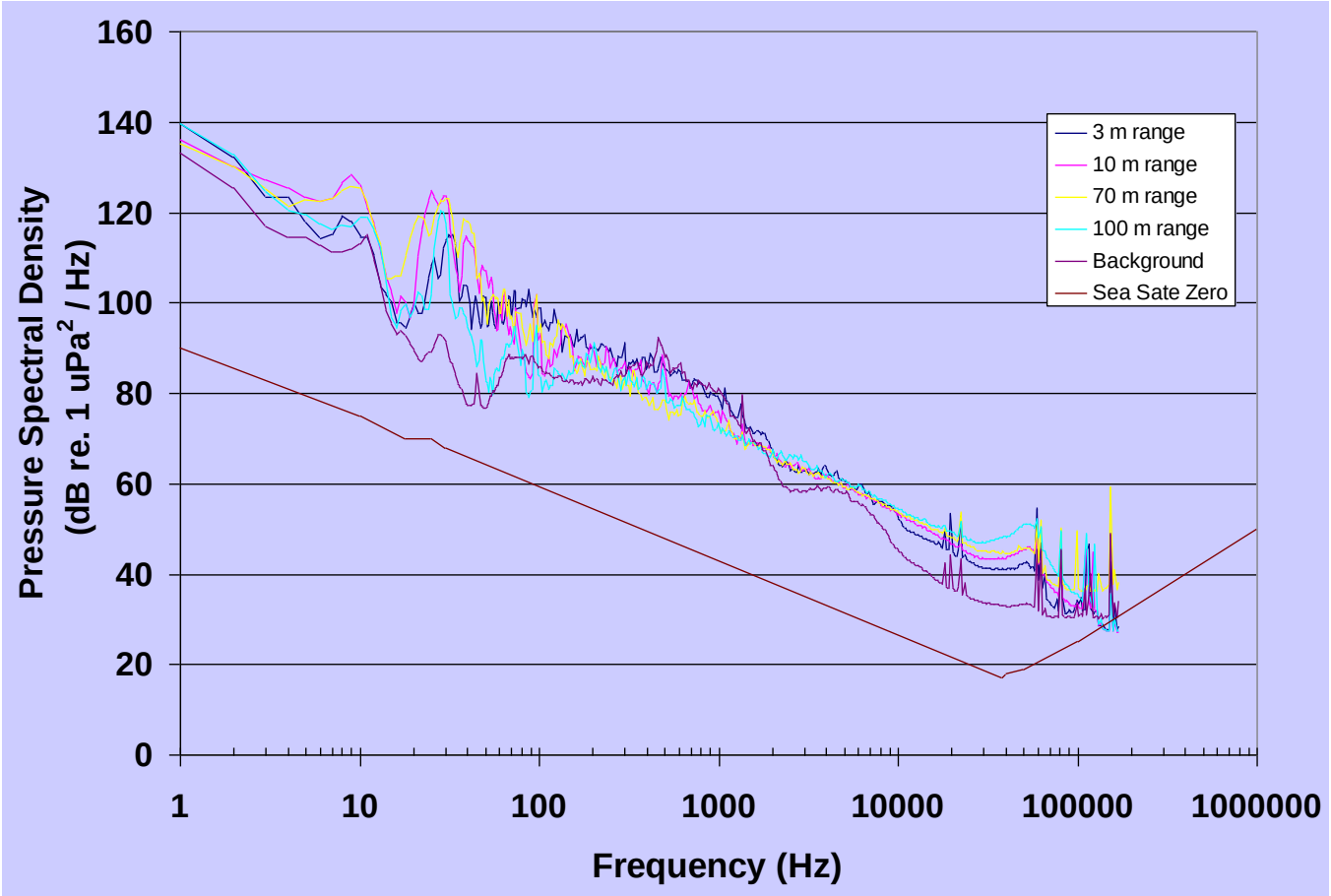
- Impact piling generates extremely high underwater sound levels, and should be regarded as capable of causing significant environmental effect.
- Development of mitigation measures ?

Operational Noise

- Subsea noise measurement from operational wind farm.
- Broadband noise for many years.

Operational noise

North Hoyle



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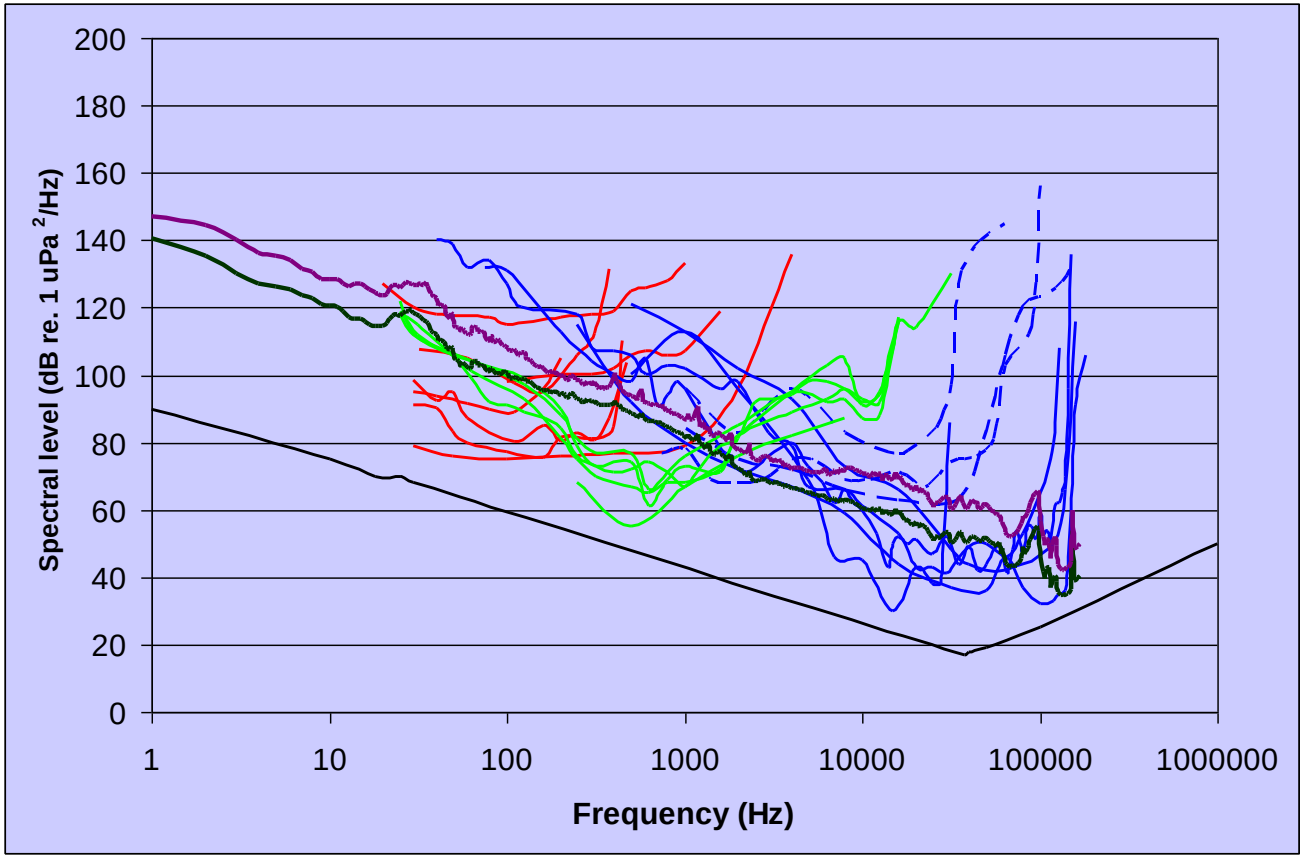
Operational Noise

Mean and 95% confidence interval



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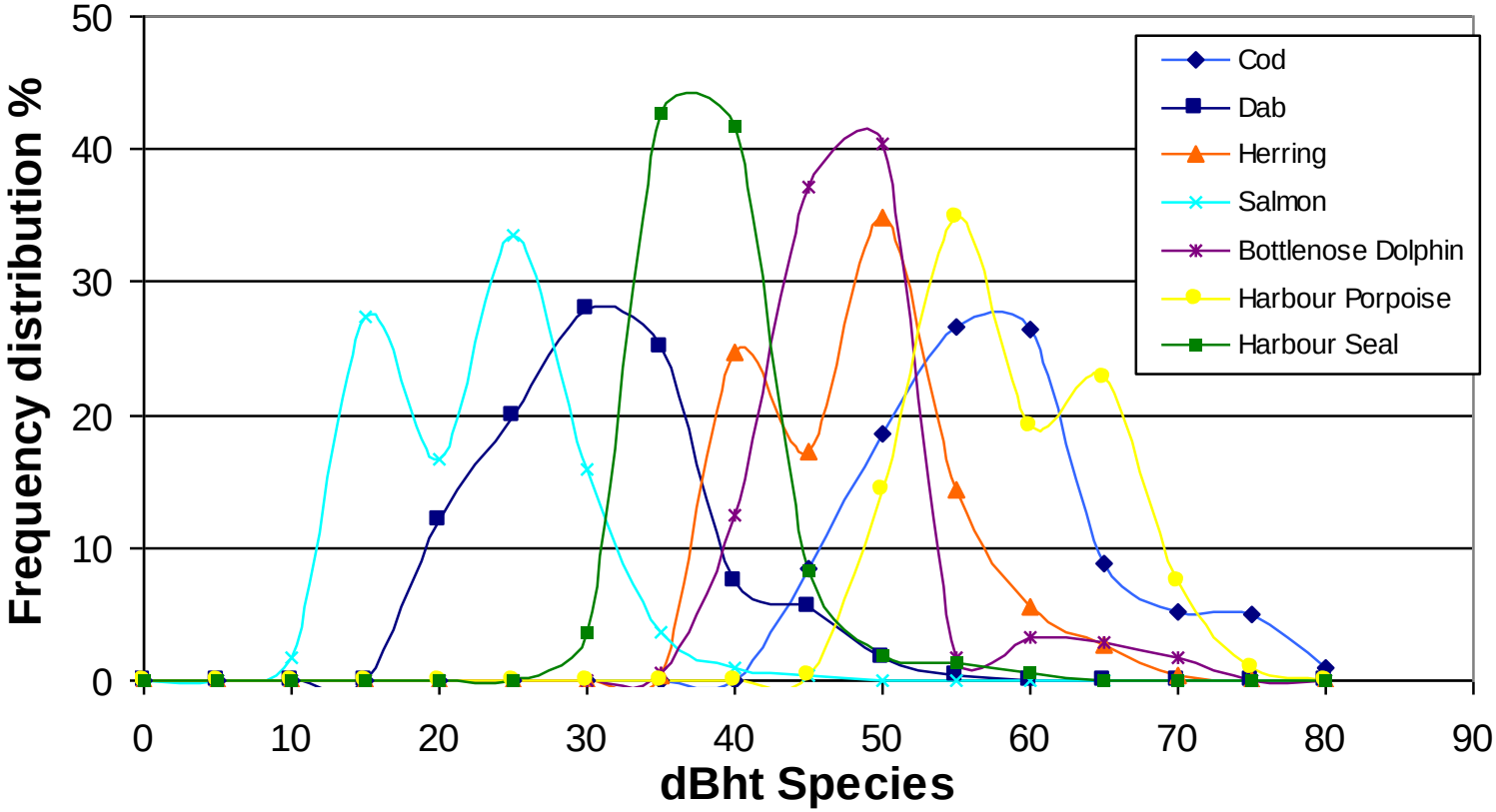
Operational Noise

Species Perceived Sound Levels

North Hoyle



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Conclusions (so far …)

- Shallow coastal waters are a noisy environment.
- Construction noise and particularly piling has the potential for significant environmental effect.
- Operational wind farm noise is marginally above shallow water noise and is therefore unlikely to adversely effect marine species.

Programme

- Blyth – Operational noise.
- North Hoyle – Background, construction noise.
- Scroby Sands – Background and construction noise.

Report: JR Nedwell, J Langworthy and D Howell. *Assessment of sub-sea noise acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; Initial measurements of underwater noise during construction of offshore windfarms and comparison with background noise.* 544R0423, May 2003.

Programme

- North Hoyle – Operational noise.
- Scroby Sands – Operational noise.
- 1 x Construction noise.
- 2 x Operational noise.

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