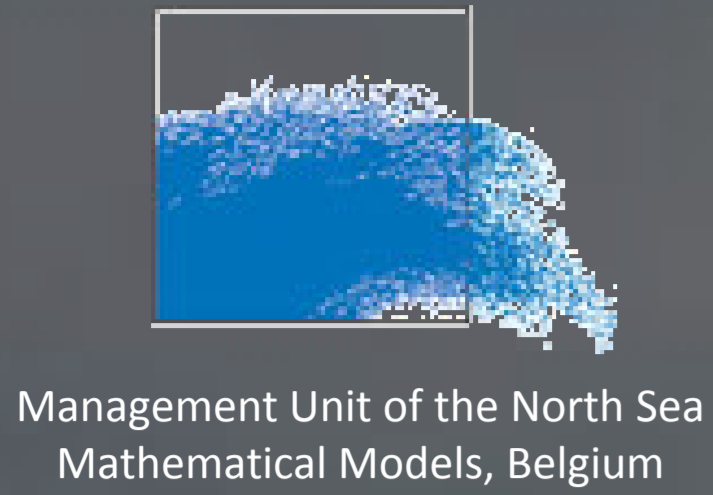


The impact of underwater noise on the early life stages of fish

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MSFD 11th Descriptor to achieve a Good Environmental Status (GES)

'Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment'

Offshore wind farm at Bligh Bank (Belgium)

Background noise: ~90-100 dB re 1µPa for frequencies ranging between 10 – 2000 Hz.

Construction phase: pile-driving generates strong impulse low frequency underwater noise over a short period. Estimated sound pressure level (SPL_{peak}) is 270,7 dB re 1 µPa @ 1m.

Operational phase: continuous low frequency noise generation for the next 20 years, which is on average ~20 dB higher than the background noise.

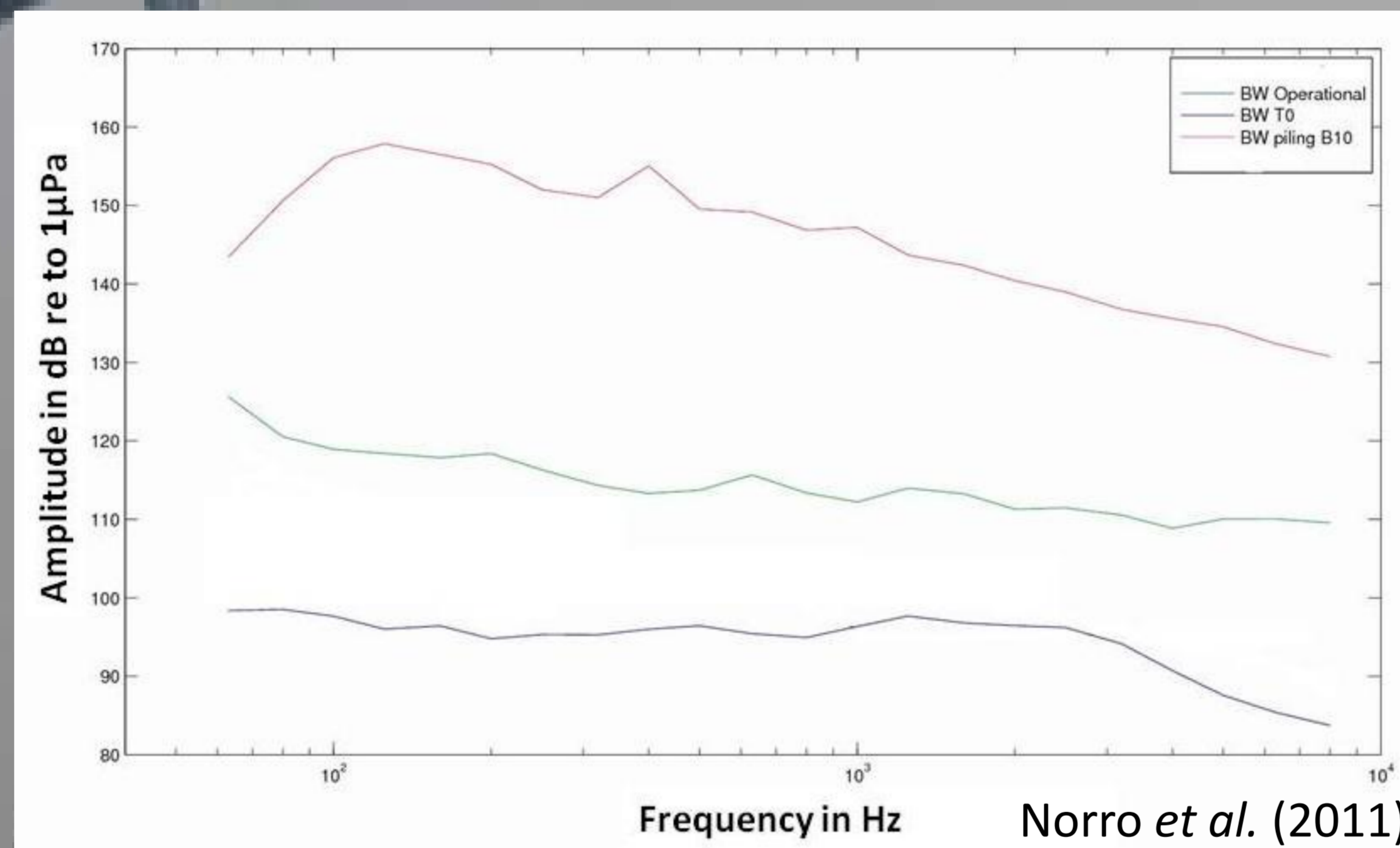
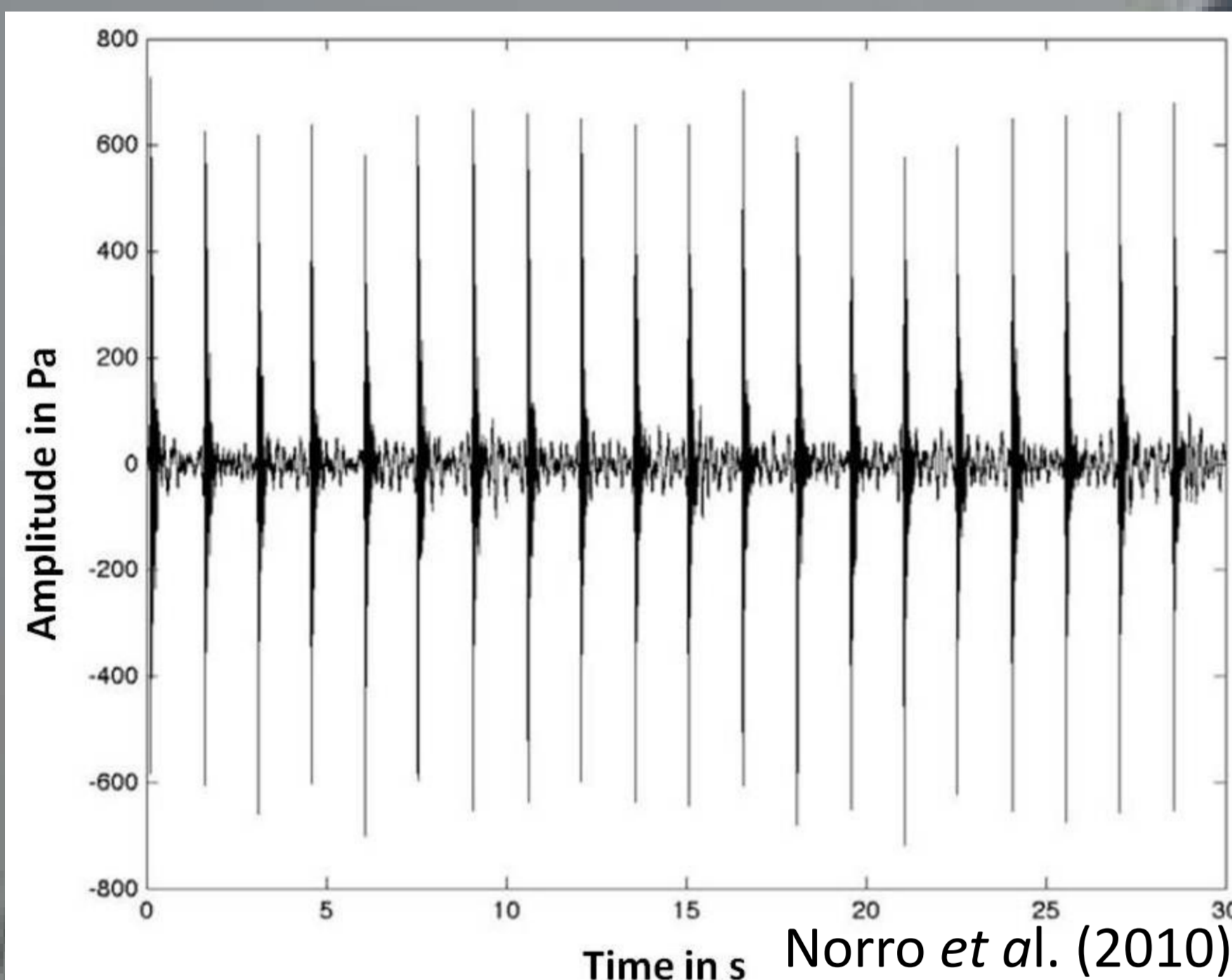
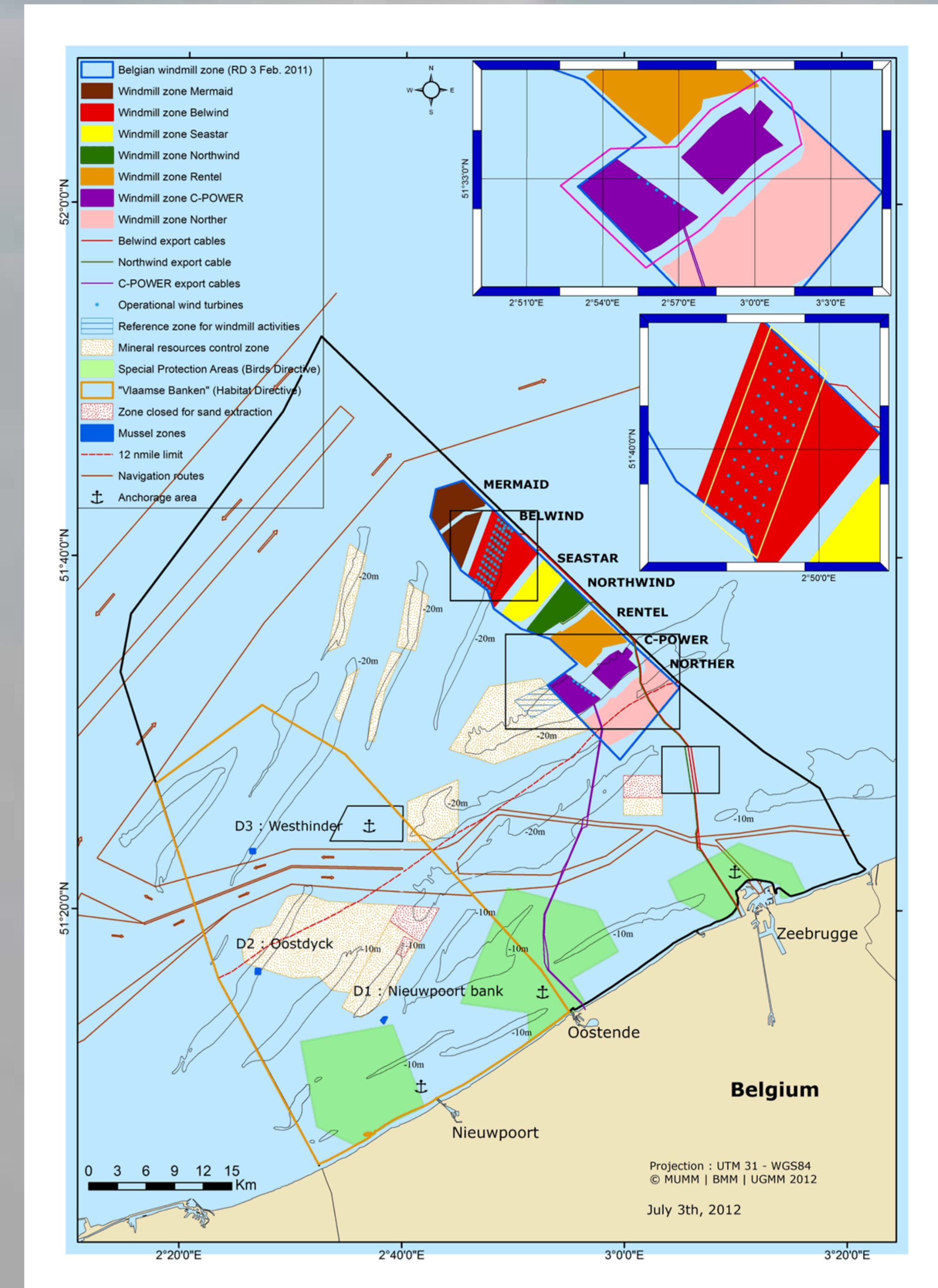
Sound susceptibility of marine fish

Depends on complexity of the hearing structures

e.g. the presence of a swim bladder and the presence of a connection between a gas bladder and the inner ear. The specialization of the hearing mechanisms determines the **width of the hearing frequency range** and the **hearing threshold level**

Depends on active or passive transport

The transport of fish eggs and larvae is mainly determined by the currents in contrast to the juveniles and adults which can actively swim away from the sound source



Aims of the PhD study

- To assess the **acute** and **chronic** effects of **short-term exposure** of construction noise on fish
- To assess the **acute** and **chronic** effects of **long-term exposure** of operational noise on fish
- To assess the difference in response between **fish species**
- To assess the vulnerability of **different life stages** of fish: eggs, larvae and juveniles

1. Sound parameters

Particle motion: measured by 3 accelerometers

Sound pressure: measured by 1 hydrophone

- Sound pressure level (SPL)
- Single strike and cumulative sound exposure level (SEL)

2. Test organisms are eggs, larvae and juveniles of

Sole (*Solea solea*)

European seabass (*Dicentrarchus labrax*)

Cod (*Gadus morhua*)



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3. Research opportunities at sea

2013: Construction of monopiles at Lodewijkbank

2014: Construction of mono-/pinpiles at Bligh Bank

4. Experimental design

Cage experiments: Impact of pile-driving on juvenile fish

- Different **short-term** exposure periods and distances from the construction site
- Monitoring of **behaviour** and **survival** in cages during and a **necropsy** after exposure

Playback experiments:

- (1) Impact of short-term exposure to pile driving noise on eggs, and larvae
- (2) impact of long-term exposure to operational noise on eggs, larvae and juveniles

- Transducers play back the recorded sound in the aquaria
- Different embryonic and larval stages will be exposed
- Effects on **behaviour**, **physiology**, **morphology**, and **survival** will be monitored before, during and after exposure

5. Outreach

- Providing essential data for the process of establishing GES noise boundaries (policy)
- Conducting research in consultation with construction companies (sector)
- Building on existing knowledge on fish welfare and underwater noise characteristics (science)