Speed Reductions as a Solution to Reduce Underwater Radiated Noise & Greenhouse Gas Emissions

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TNO innovation for life

Saturn
Developing Solutions for Underwater Radiated Noise

SATURN has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101006443.

Speed reductions will reduce vessel source levels

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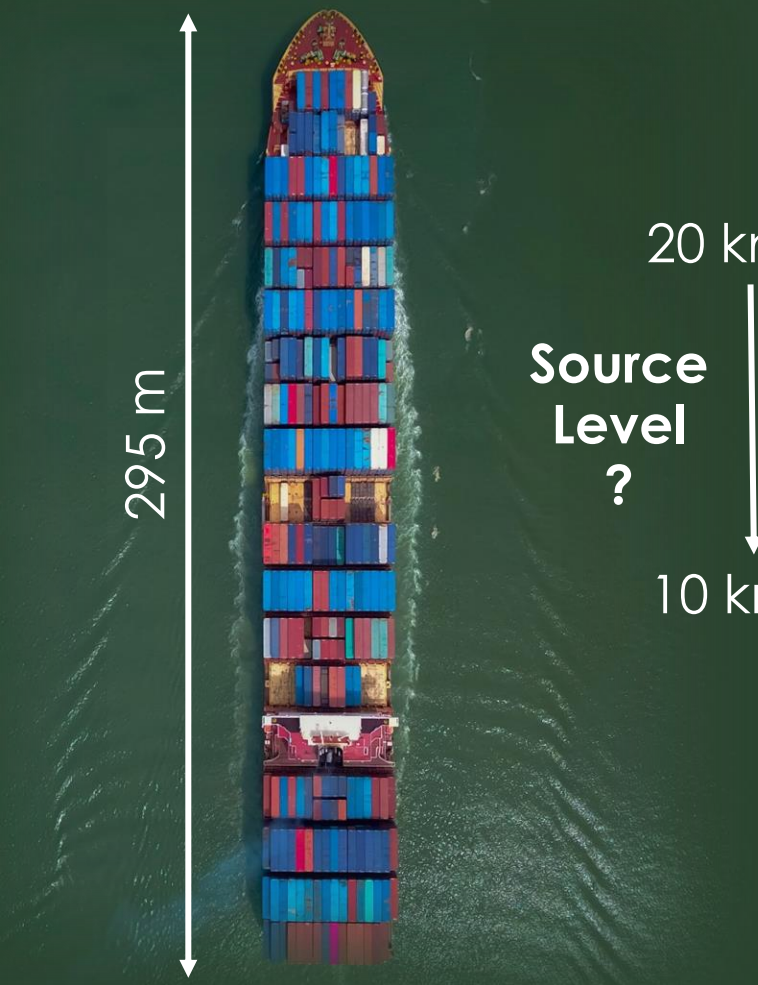
Containership



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20 knots

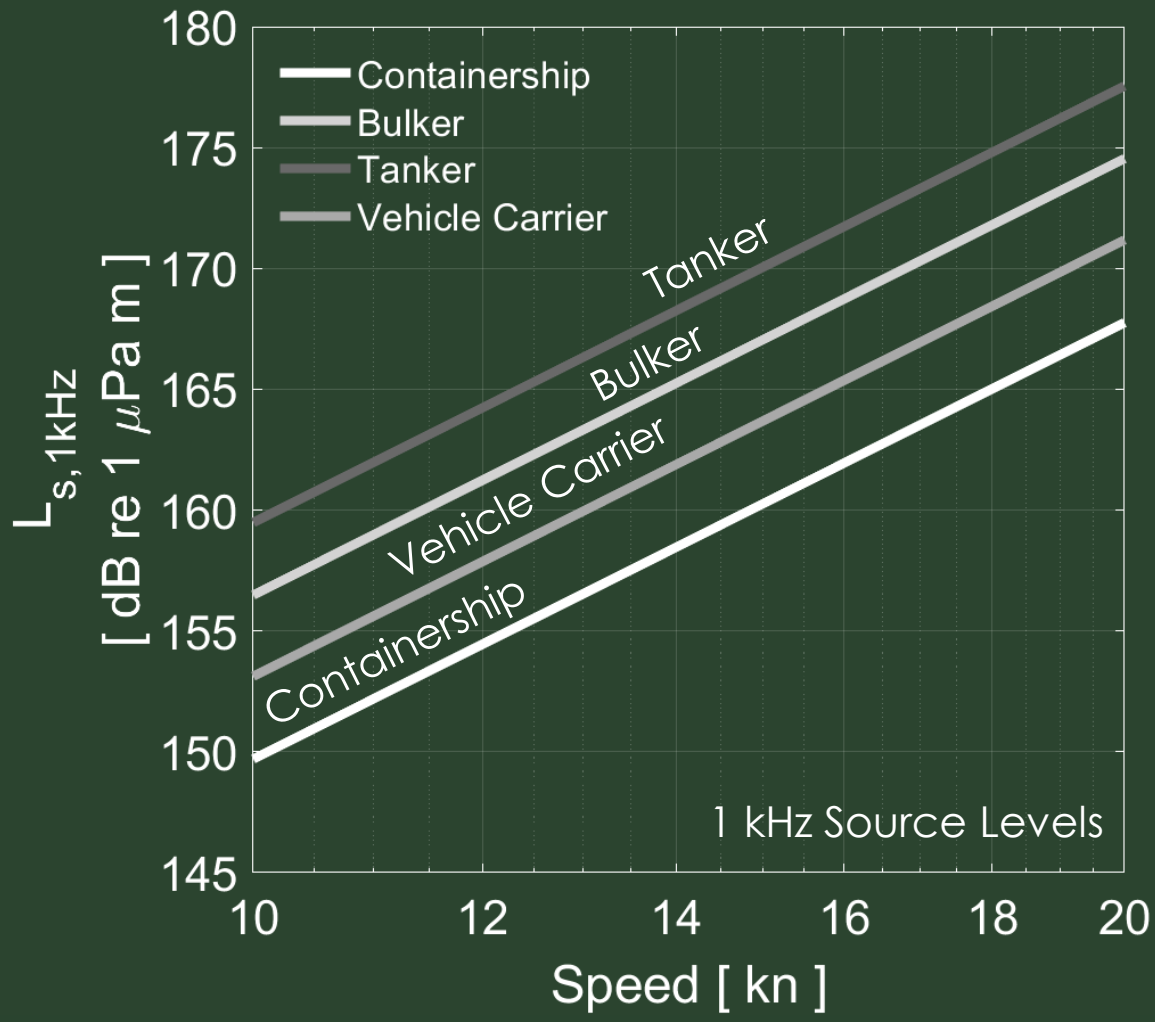
Source Level ?

Slowdown: 10 – 50%

10 knots

JOMOPANS-ECHO reference spectrum model

MacGillivray & de Jong, 2021



Speed reductions reduce noise impacts to wildlife

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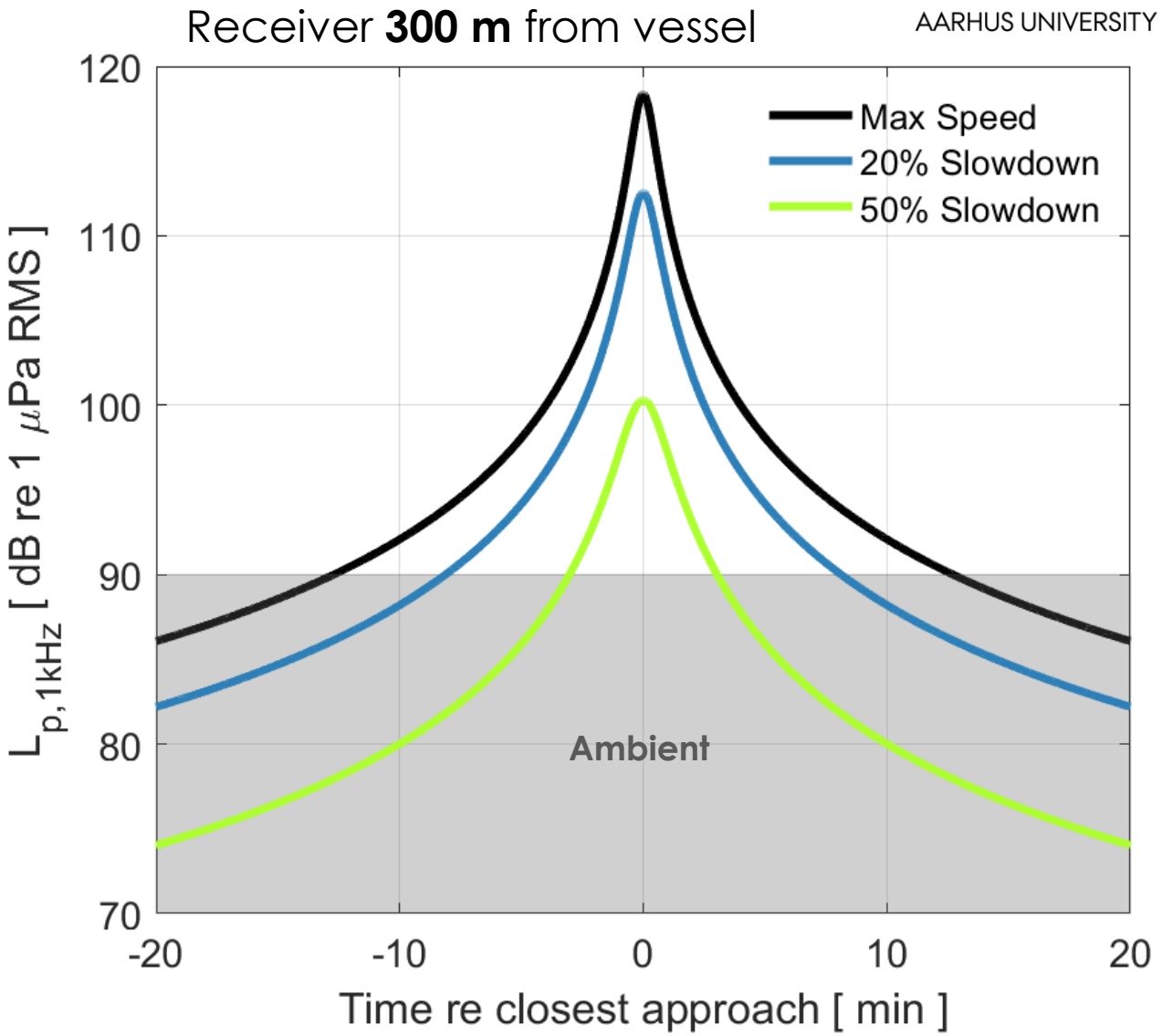
- **Proxies for noise impact:**
  - Maximum received level (dB re 1 µPa)
  - Exposure duration (min)
- **Max received levels ↓**
  - 20% (16 kn) = 6 dB
  - 50% (10 kn) = 18 dB
- **Exposure duration ↓**
  - 20% (16 kn) = 36%
  - 50% (10 kn) = 76%
- **Slowdowns ↓ noise impacts**



Speed reductions reduce time soundscape impacted

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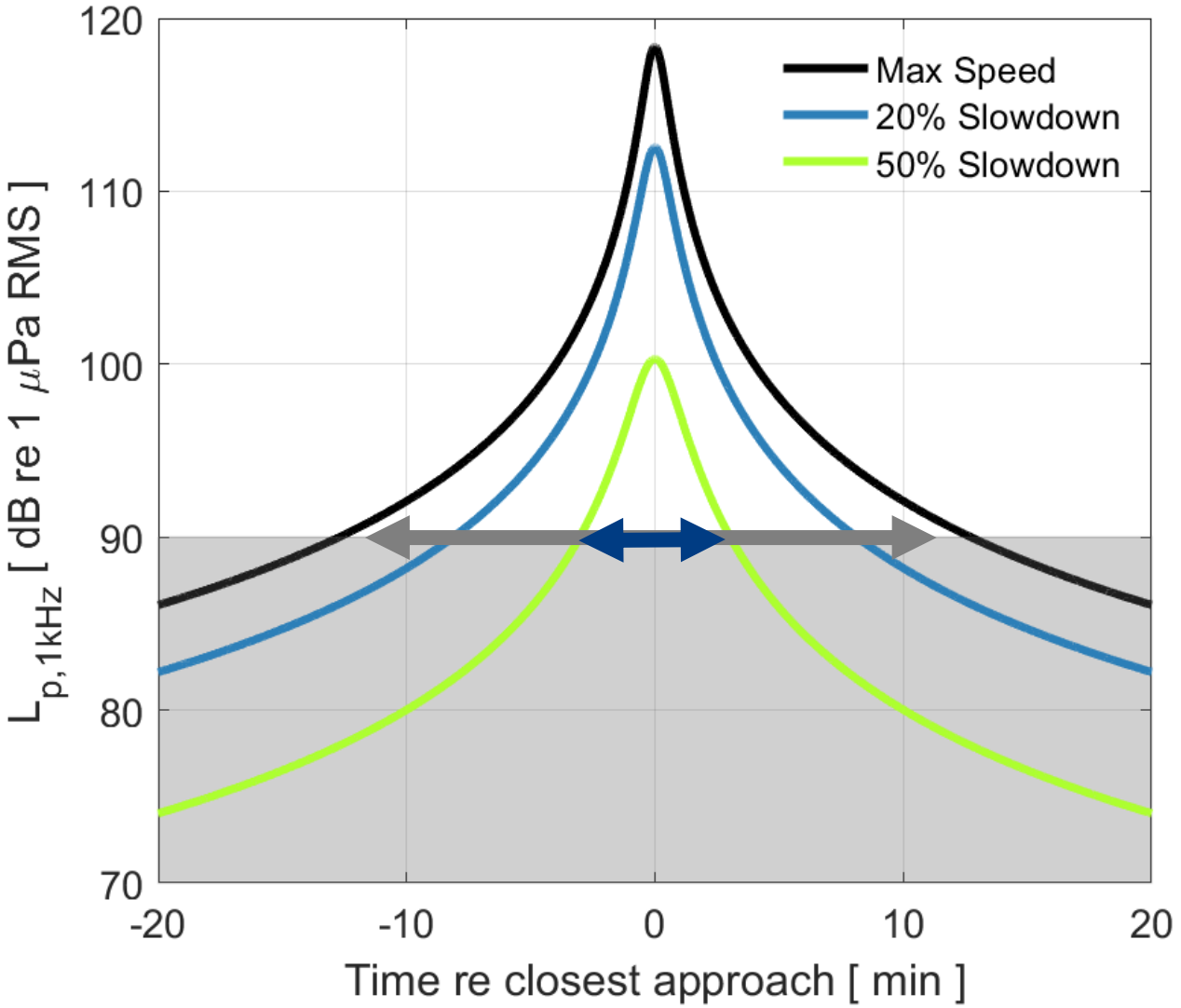
- Are slowdowns a zero-sum game approach?
- **Slowdowns ↓ time impacted**
- Supported by field measurements of cargo vessels (ZoBell et al. 2021)
- **Not a zero-sum game approach!**



Area exposed to noise is reduced when vessels slowdown

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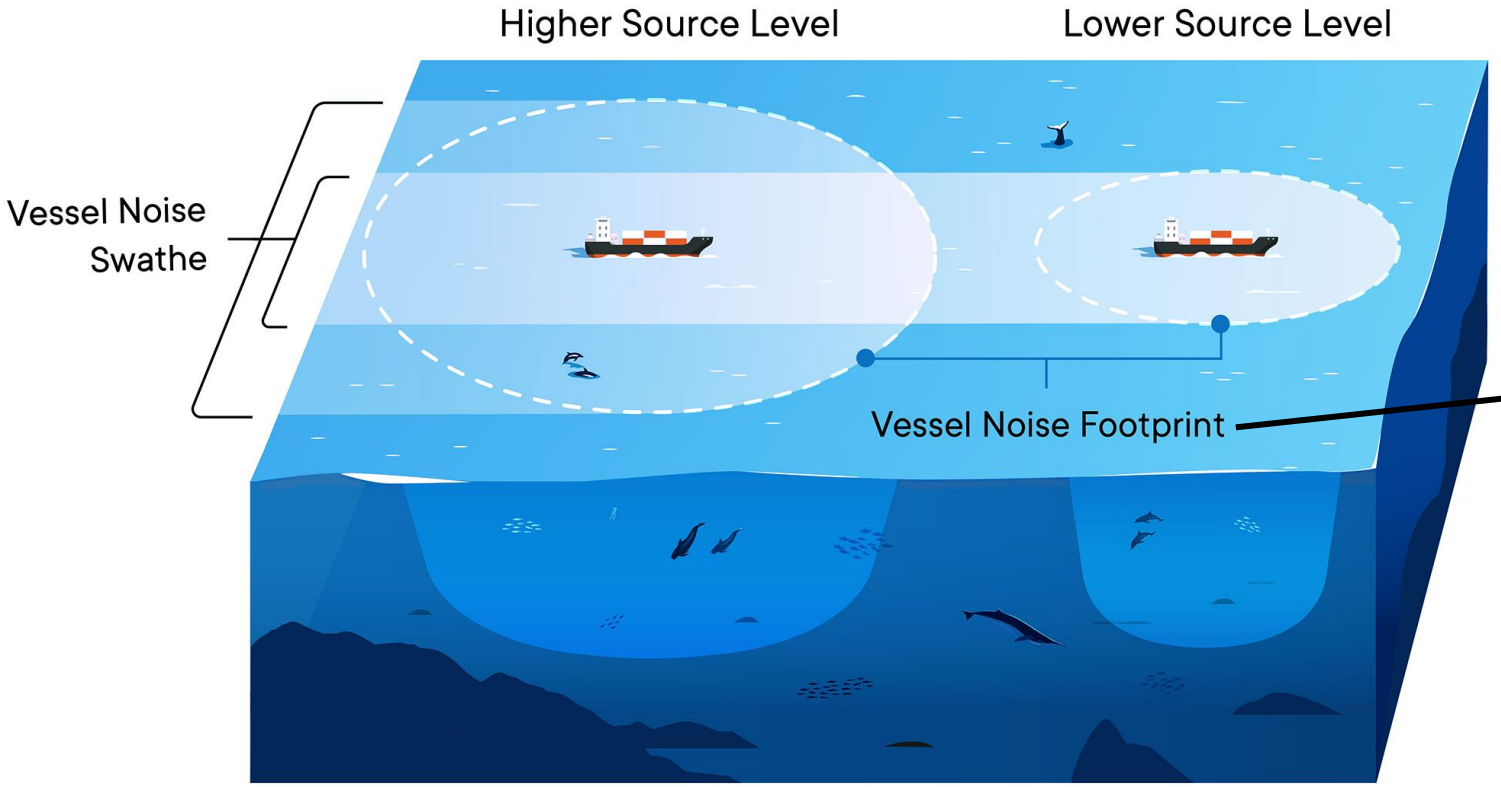
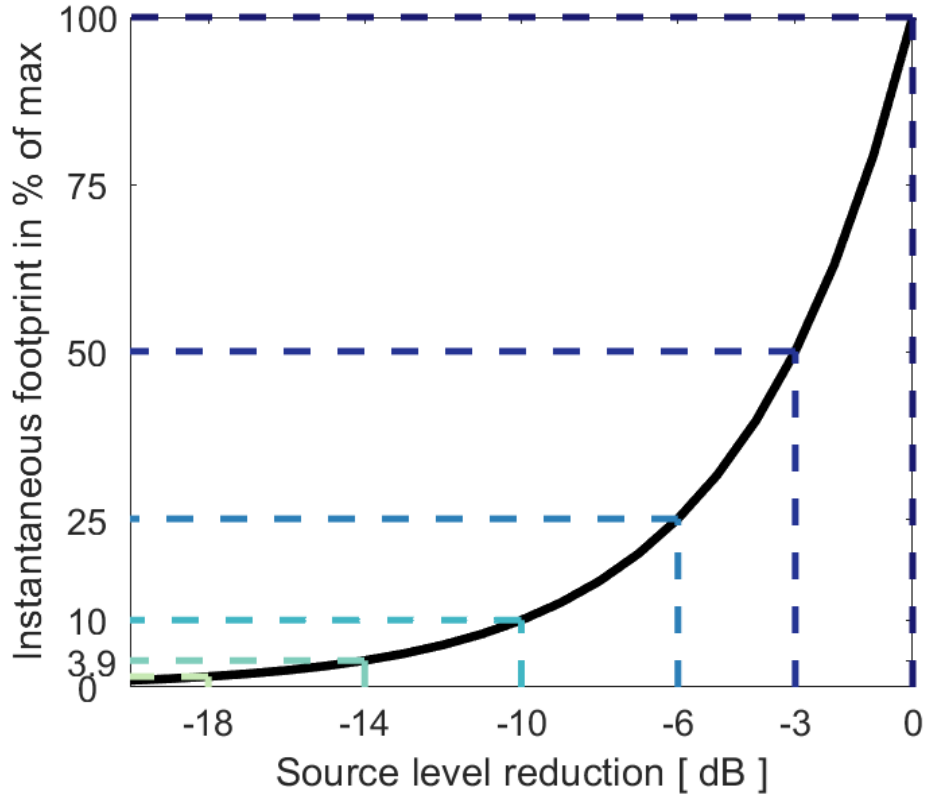


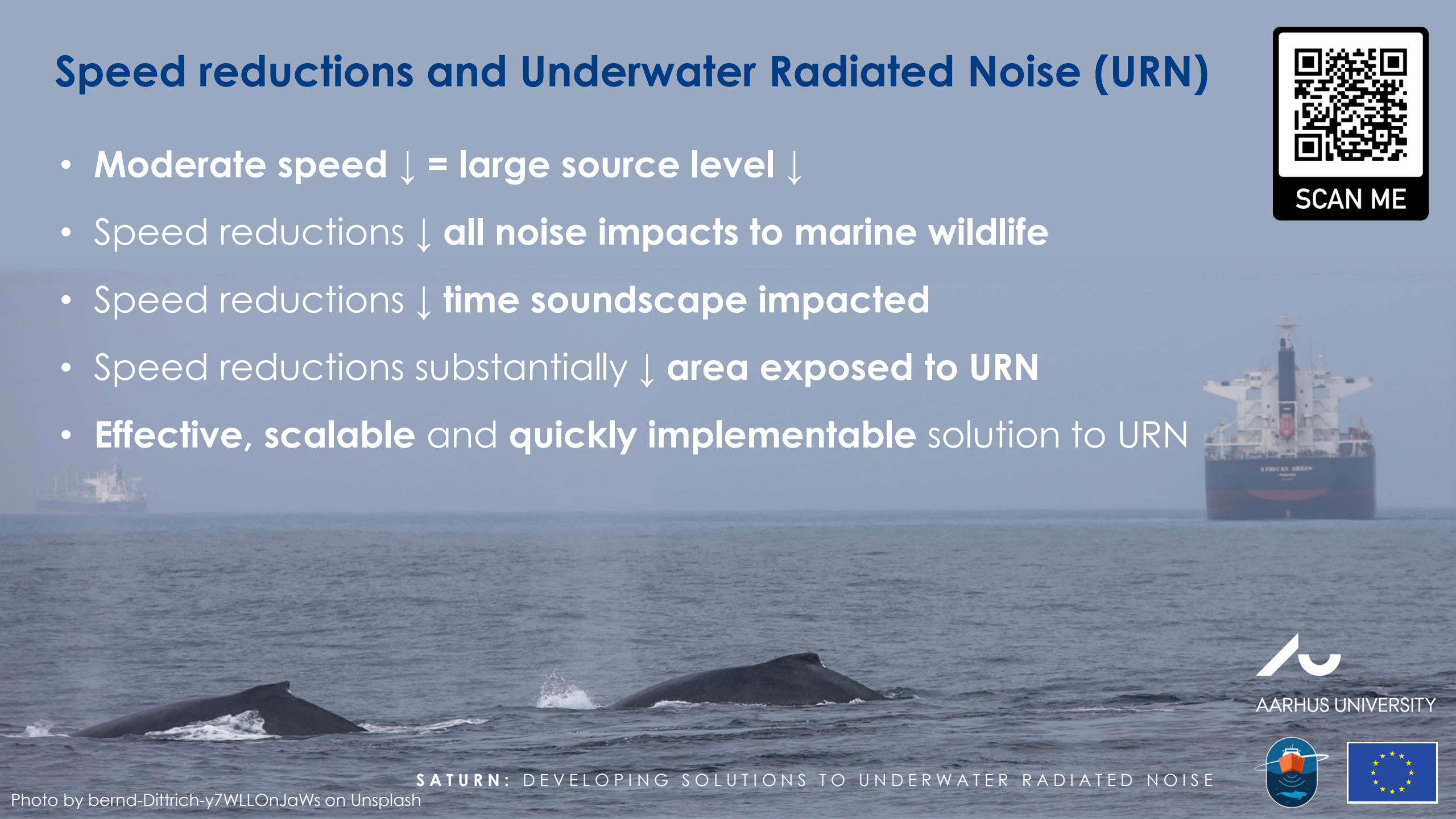
Illustration by **Amy Dozier** (MaREI, UCC)



Speed reductions and Underwater Radiated Noise (URN)

SCAN ME

- **Moderate speed ↓ = large source level ↓**
- Speed reductions ↓ **all noise impacts to marine wildlife**
- Speed reductions ↓ **time soundscape impacted**
- Speed reductions substantially ↓ **area exposed to URN**
- **Effective, scalable** and **quickly implementable** solution to URN



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SATURN: DEVELOPING SOLUTIONS TO UNDERWATER RADIATED NOISE

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North Sea slow steaming case study

Minister for the North Sea

Royal Belgian Shipowners' Association

FEDERAL PUBLIC SERVICE MOBILITY AND TRANSPORT

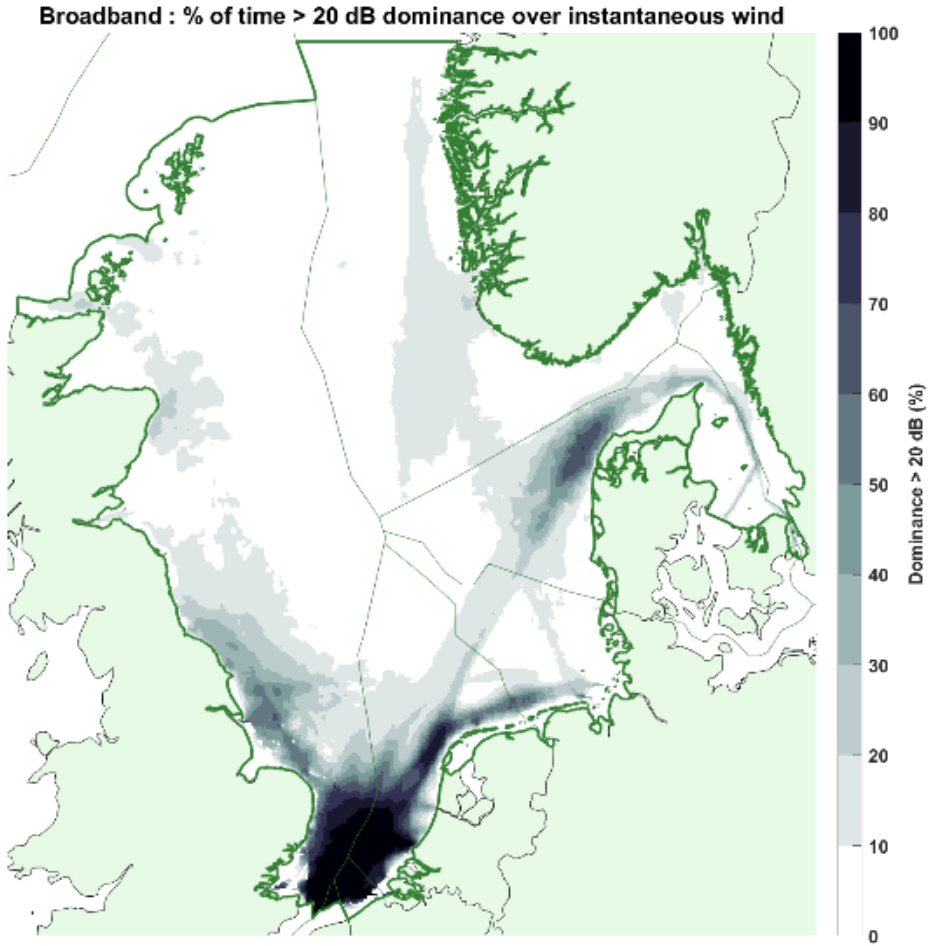
federal public service HEALTH, FOOD CHAIN SAFETY AND ENVIRONMENT

- 2021 TNO study for Belgian government:

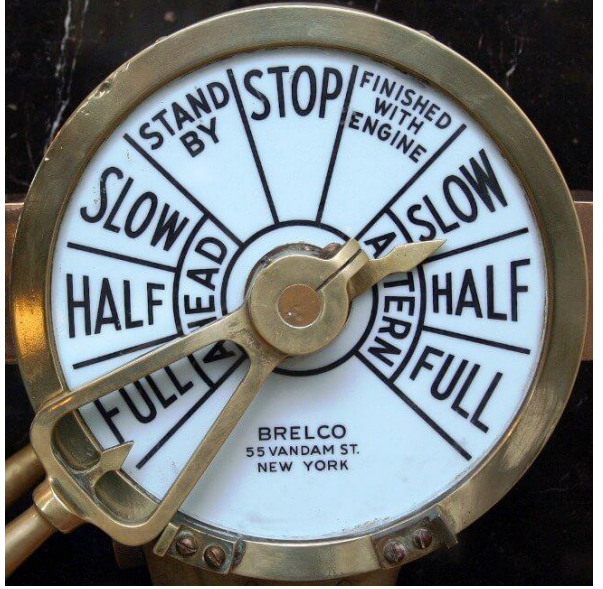
  Options for reducing URN and air emissions

JOMOPANS modelling:

- Shipping noise dominates the background noise all year long in some areas



Slow steaming scenario



Credits: Leo Reynolds/flickr.com

- AIS-based study
- Limit speed to maximum 75% of design speed
- 75% of design speed corresponds with ~36% of design power (MCR)
- **Average emission reduction >10%**
- **Average source level reduction ~3 dB**

- Lower speed = longer at sea.
- Time lost compensated in the studied scenario by reduced port times

Faber, J., Nelissen, D., Hon, G., Wang, H., and Tsimplis, M. (2012). *Regulated Slow Steaming in Maritime Transport: An Assessment of Options, Costs and Benefits.* Delft: CE Delft.

"Speed regulations can best be differentiated to ship type and size, so that ships do not have to operate at technically challenging low loads and in order not to disturb the competition between ship types"

Reduction of emissions by slow steaming

- North Sea Slow Steaming Scenario (speed limit at 75% of design speed)
- Methodology for Dutch emission inventory since 2008
- Reduction in emission of greenhouse gases and pollutants:

Table 1 Calculated yearly reductions of emissions for the proposed slow steaming scenario at the North Sea (based on data of May 2019

Substance	CO2	NOx	SOx	CO	PM10	VOC
Reference scenario	17768	357	16,1	21,7	7,4	17,1
Slow Steaming	15960	318	14,5	22,4	6,7	16,3
Reduction (kilotons/year)	**1808**	**38**	**1,6**	**-0,8**	**0,7**	**0,8**
Reduction %	**10%**	**11%**	**10%**	**-3,5%**	**10%**	**5%**

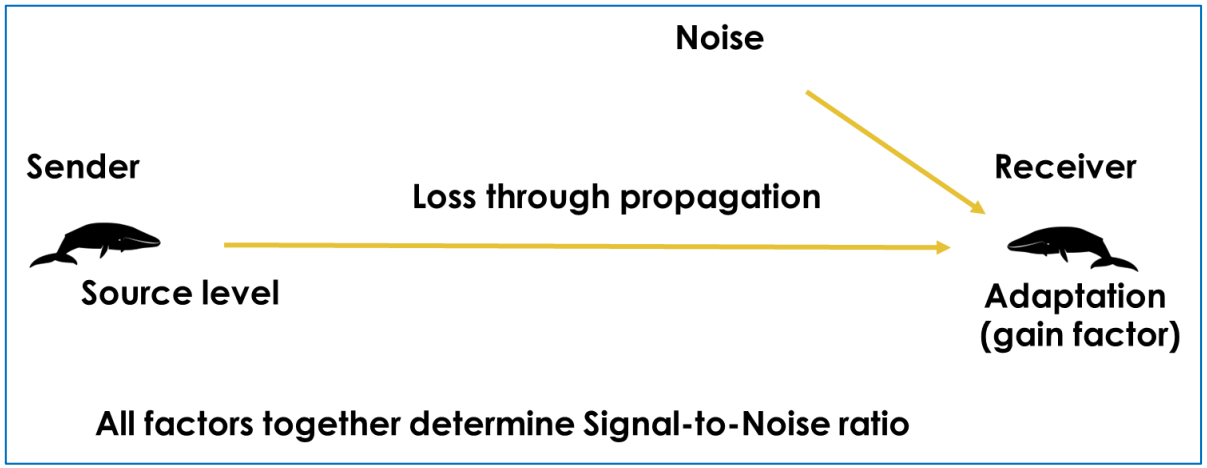
- Carbon dioxide (CO2);
- Nitrogen oxides (NOx);
- Sulphur oxides (SOx);
- Carbon monoxide (CO);
- Particulate matter (PM10);
- Volatile organic compounds (VOC).

Reduction of underwater noise by slow steaming

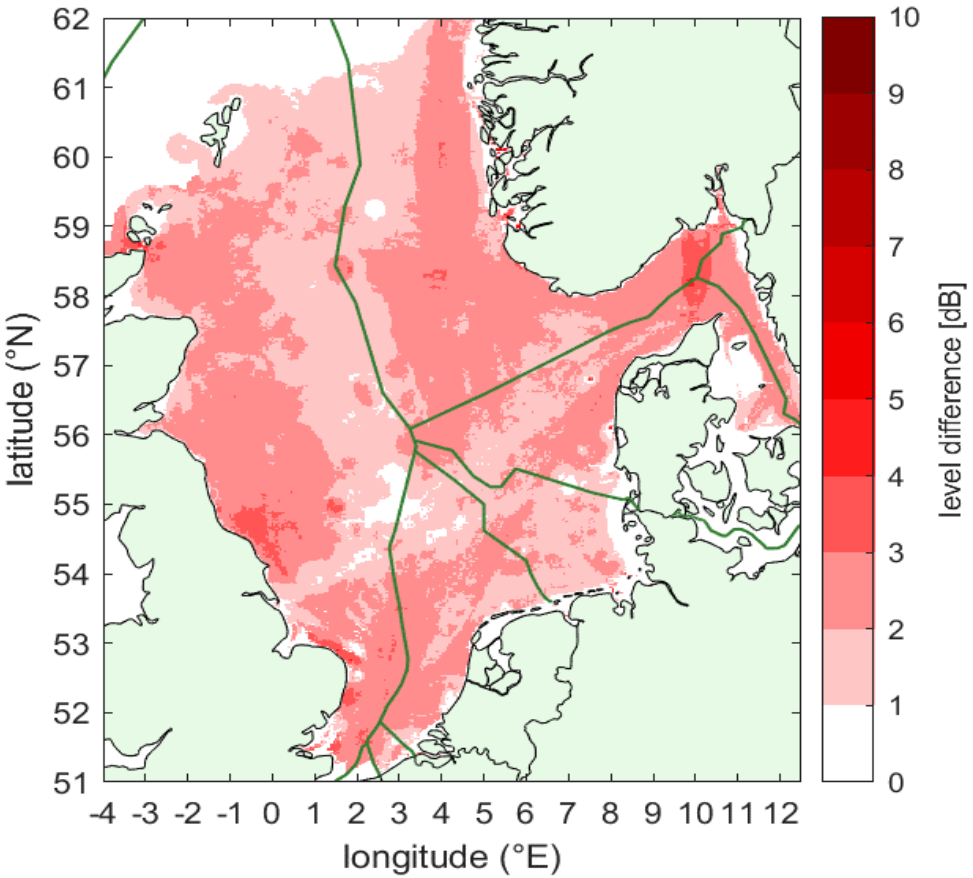
- Local and temporal SPL reductions of 1 to 4 dB
- Space and time average reduction ~1.5 dB

Consequences for impact on marine life:

- A 1.5 dB reduction of background noise leads to an increase of 'listening' range by 10% to 40%



Maximum reduction of broadband SPL, 90% of the month



Co-benefits of speed reductions

↓ Greenhouse Gas Emissions, NOx, SOx, Particulate Matter & Black Carbon

e.g., Khan et al. 2012; Cullinane & Cullinane, 2013; Faber et al. 2017; Leaper, 2019

↓ Underwater radiated propeller cavitation noise (FPP)

↓ fuel consumption & port wait times
↑ reliability of deliveries & price of bulk goods

e.g., Cullinane & Cullinane, 2013; Lee et al. 2015; Leaper, 2019; Jalkanen et al. 2018; Leaper & Renilson, 2021

↓ risk of lethal ship strikes with cetaceans

e.g., Silber et al. 2012; Conn & Silber, 2013; Laist et al. 2014; Leaper, 2019; Morten et al. 2022

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Thank you for listening

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