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Eolien et biodiversité

Séminaire
2017



21 et 22 novembre

Artigues-près-Bordeaux



MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE
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*Quantifying consequences of acoustic disturbance on
marine mammal populations: a decision support tool
for offshore windfarm development.*

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Introduction

- ✓ Climate change issues urge the development of marine renewable energies in Europe.
- ✓ Construction of offshore wind turbines, often involving pile driving, produces intense noise.
- ✓ This underwater noise raises concerns about impacts on marine species, especially marine mammals.



Introduction

- ✓ Hearing is the primary sense for marine mammals for detecting signals from prey, predators, conspecifics and the environment.





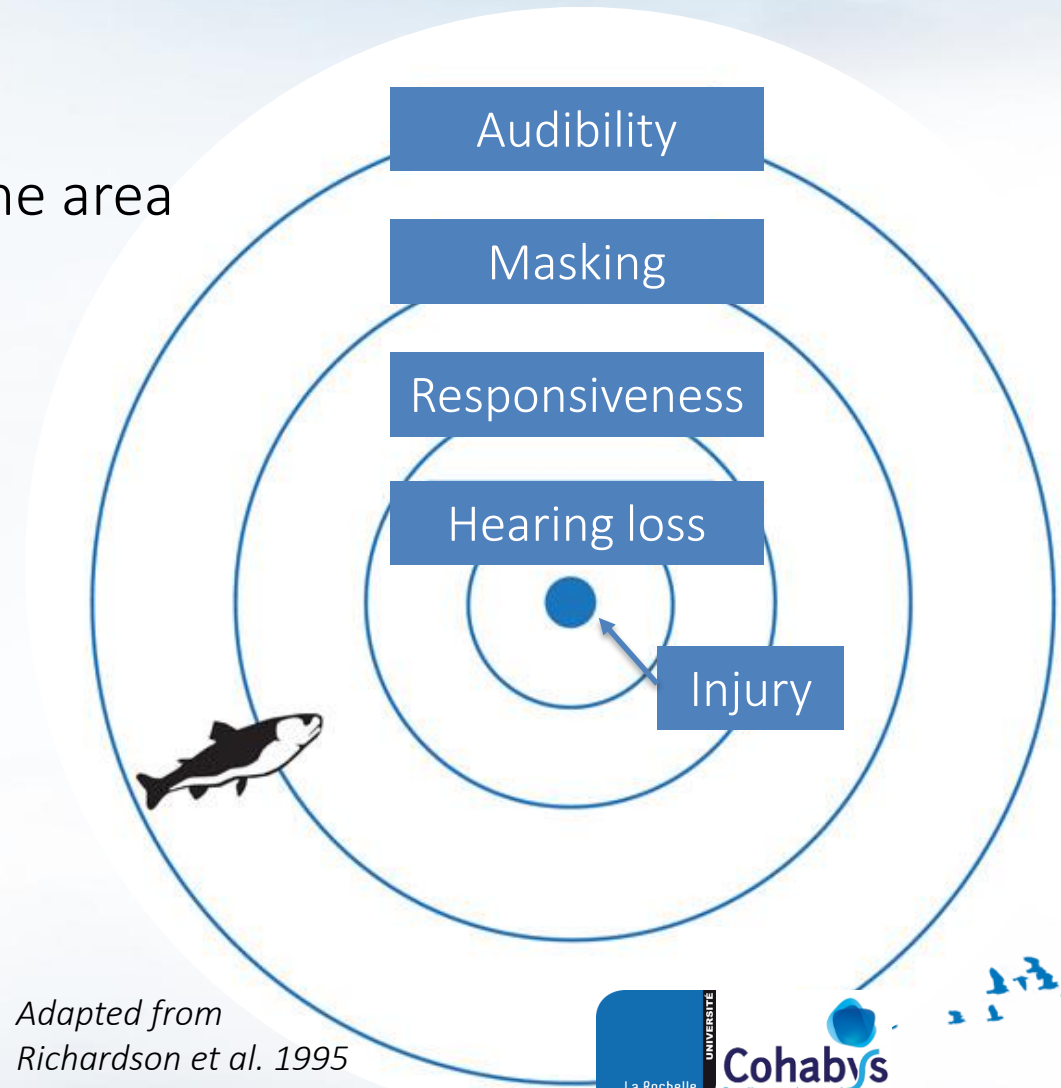
Introduction

✓ Intense noise can have negative effects on auditory system of marine mammals:

- Masking
- Behavioural response (BDT) => avoidance of the area
- Physiological effects
 - => temporary hearing loss (TTS)
 - => permanent hearing loss (PTS)
- Injury (death)



Decreasing individual fitness
Effects on population?



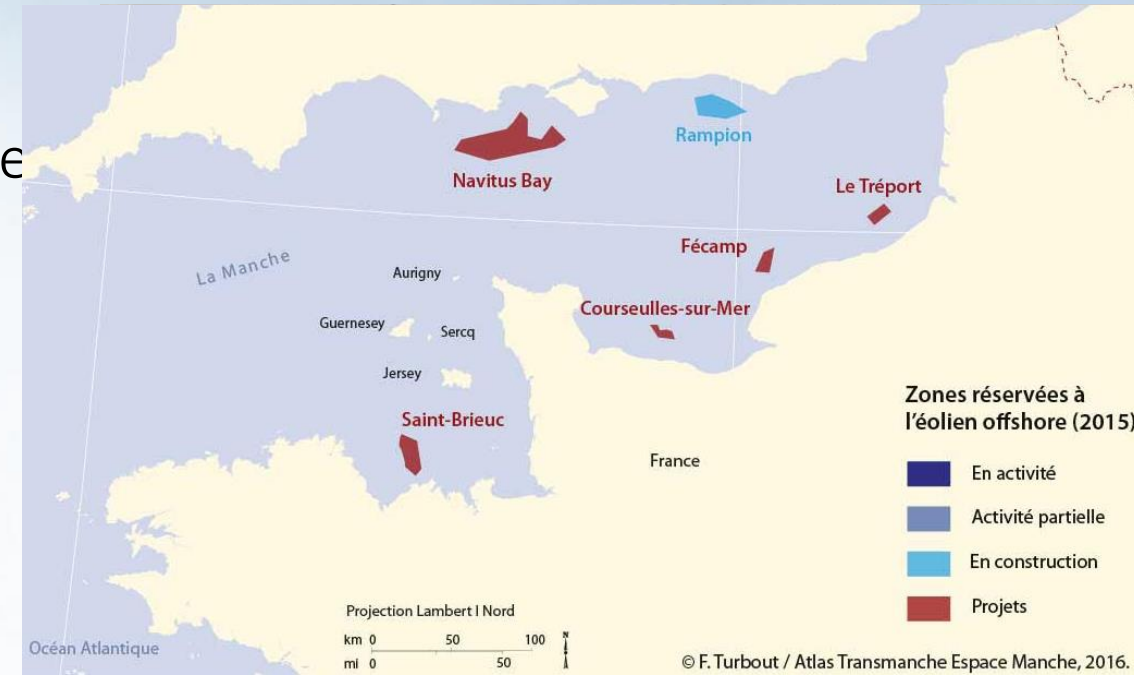
Adapted from
Richardson et al. 1995



Introduction

✓ The English Channel

- Important conservation issues : harbour porpoise seals, numerous marine protected areas.
- Strong anthropogenic pressures
- 6 wind farm projects



✓ Aims of the study

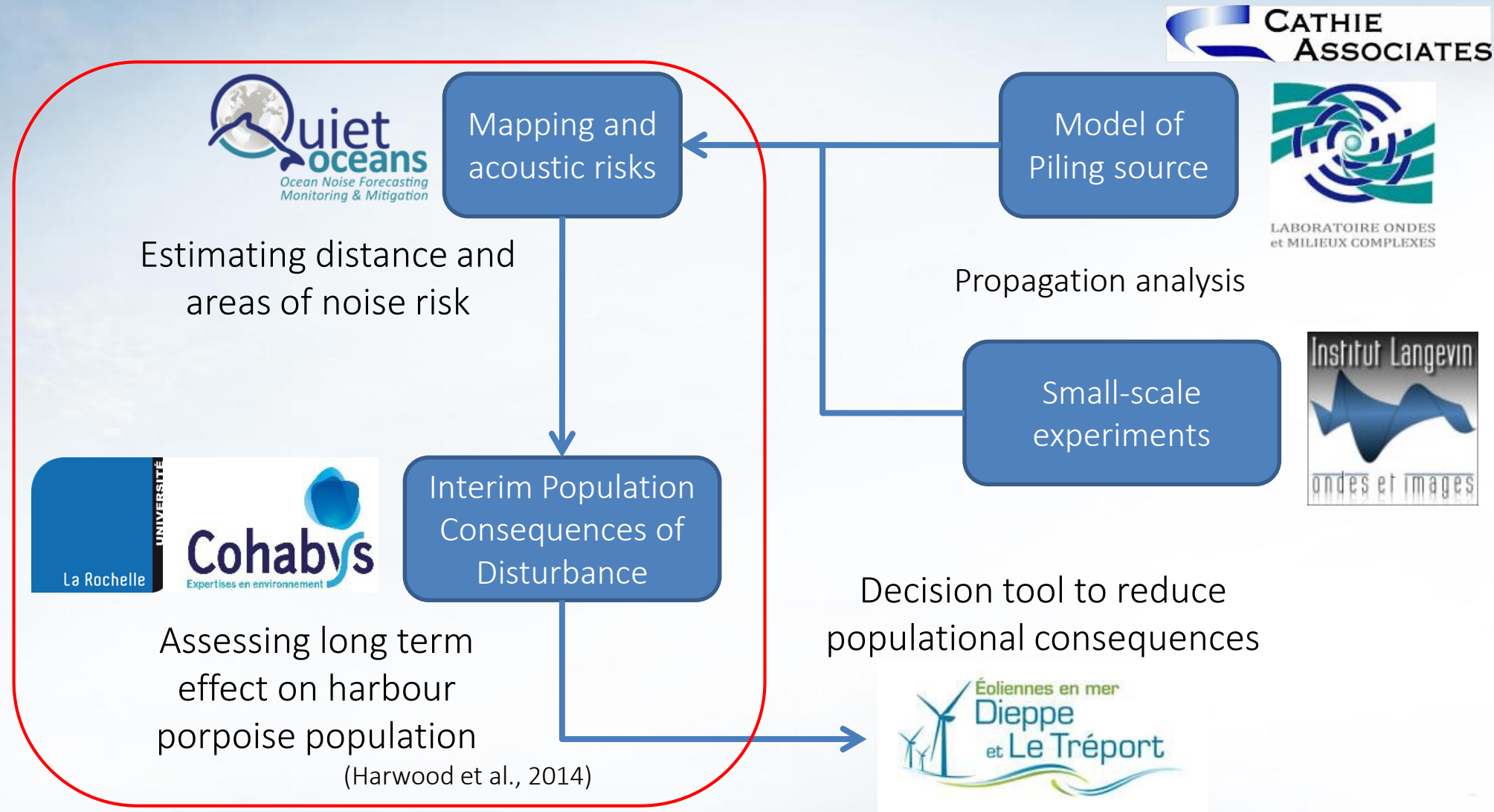
- Predicting long term effects on harbour porpoise population of the pile driving in Dieppe-Le Tréport (English Channel).
- Comparing five noise reduction measures at decreasing levels of efficiency to provide a decision support tool to stakeholders.



A multidisciplinary research project : RESPECT

Methods

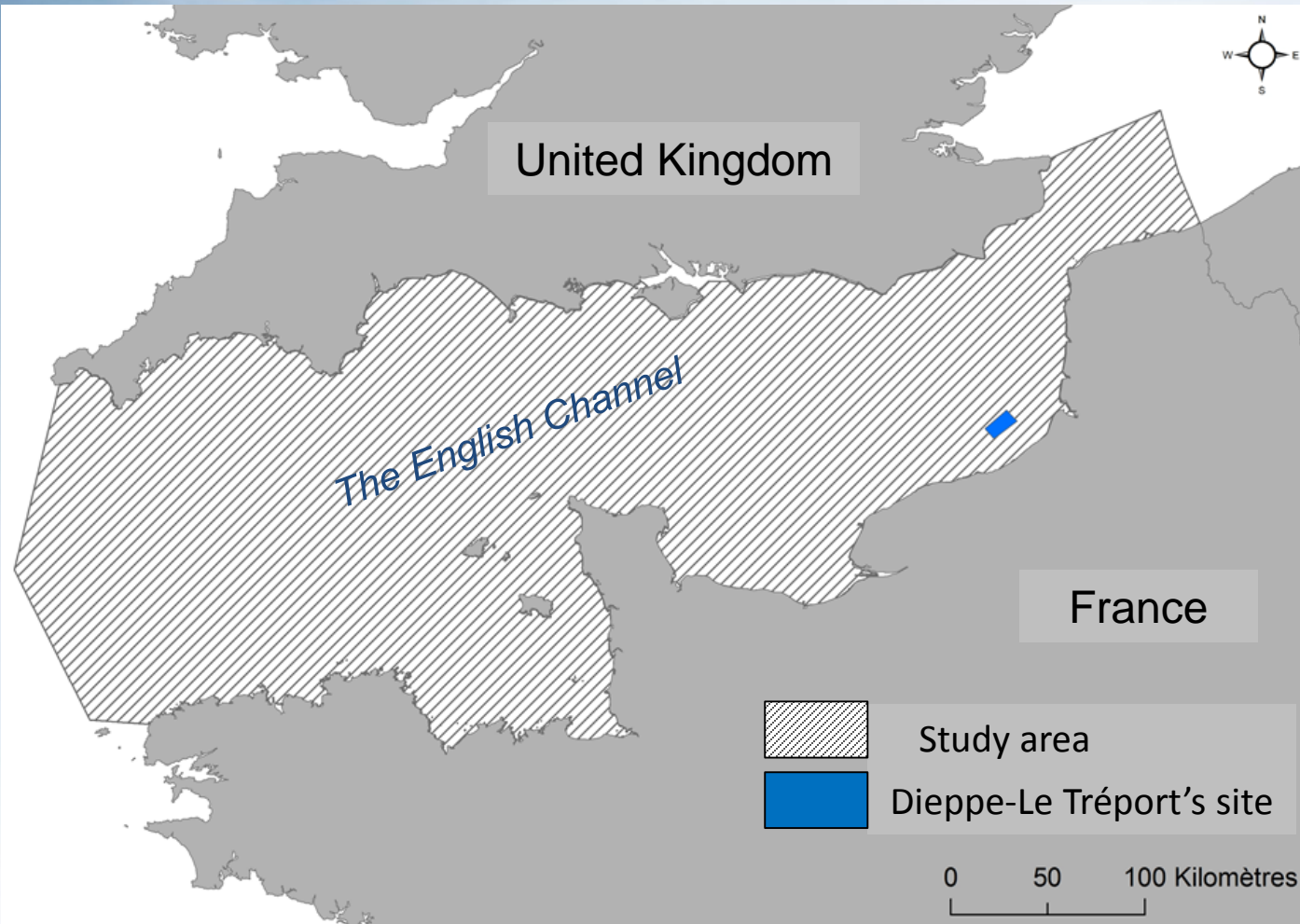
« Réduction des Empreintes Sonores des Parcs Eoliens en mer :
Comprendre pour de nouvelles Technologies »





Methods

The study area : the English Channel



- 93,000 km²
- an ecological unit
- ~ 30,000 harbour porpoises
- wind farm project in Dieppe Le Tréport

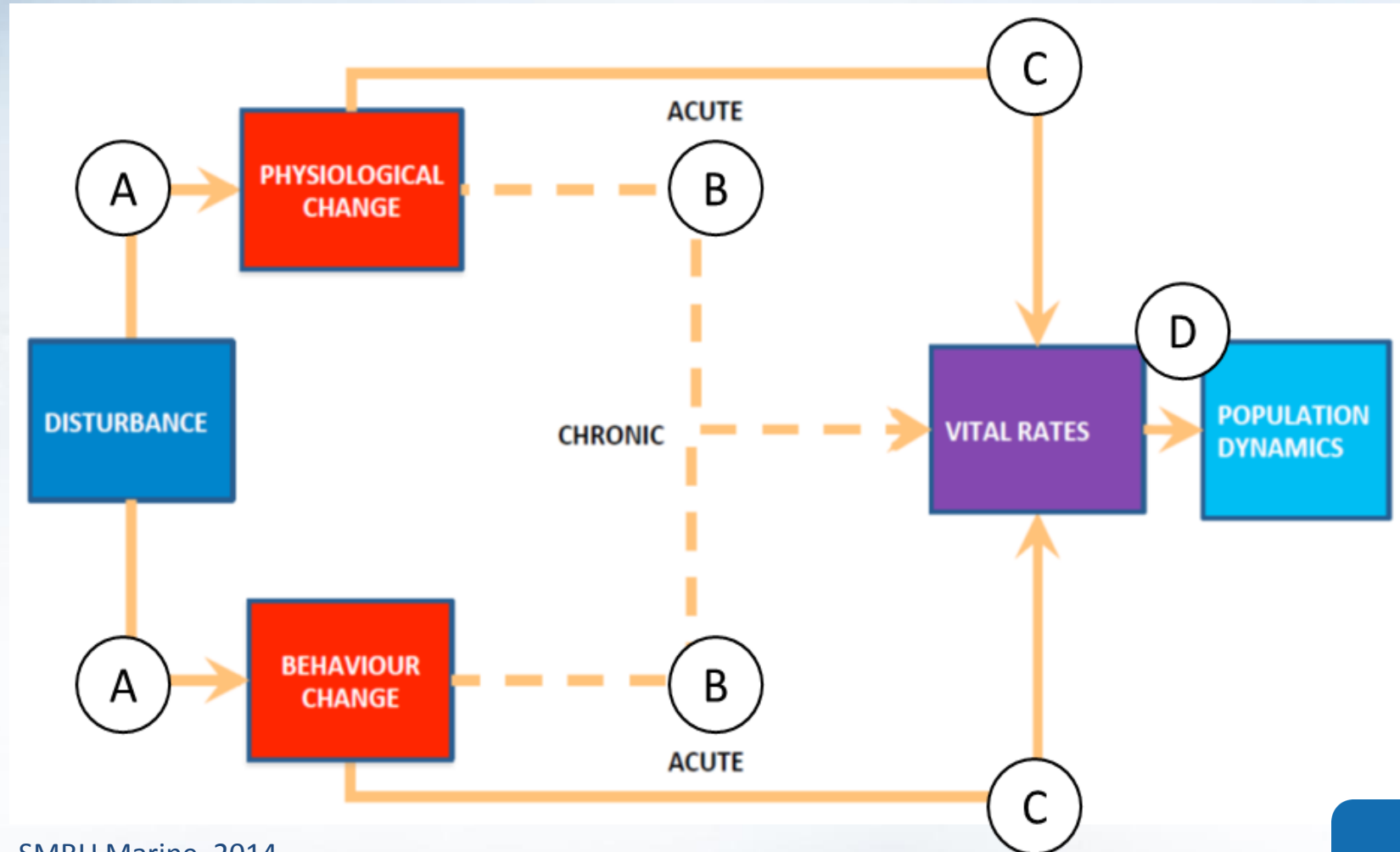




Methods

Interim PCoD : *Population Consequences of Disturbance*

- ✓ A model to predict the effect of a quantified disturbance on the population trend.

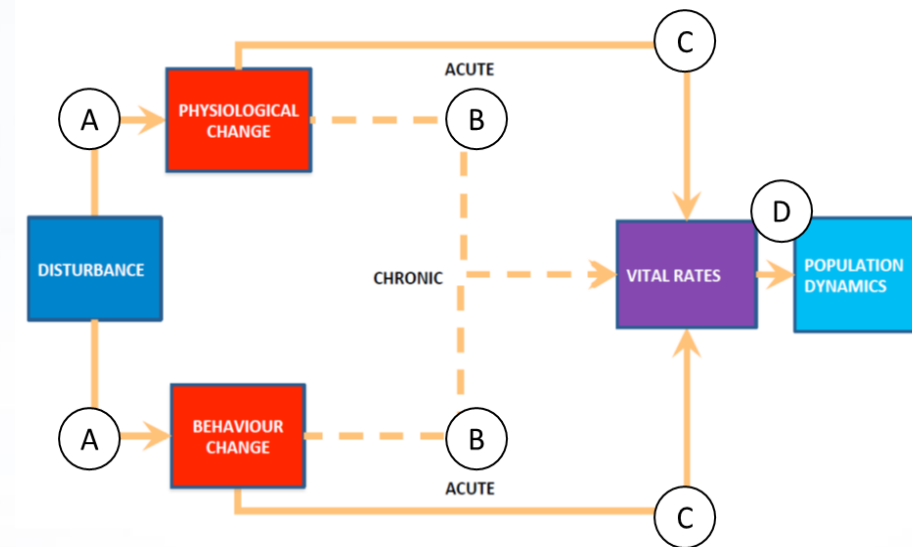
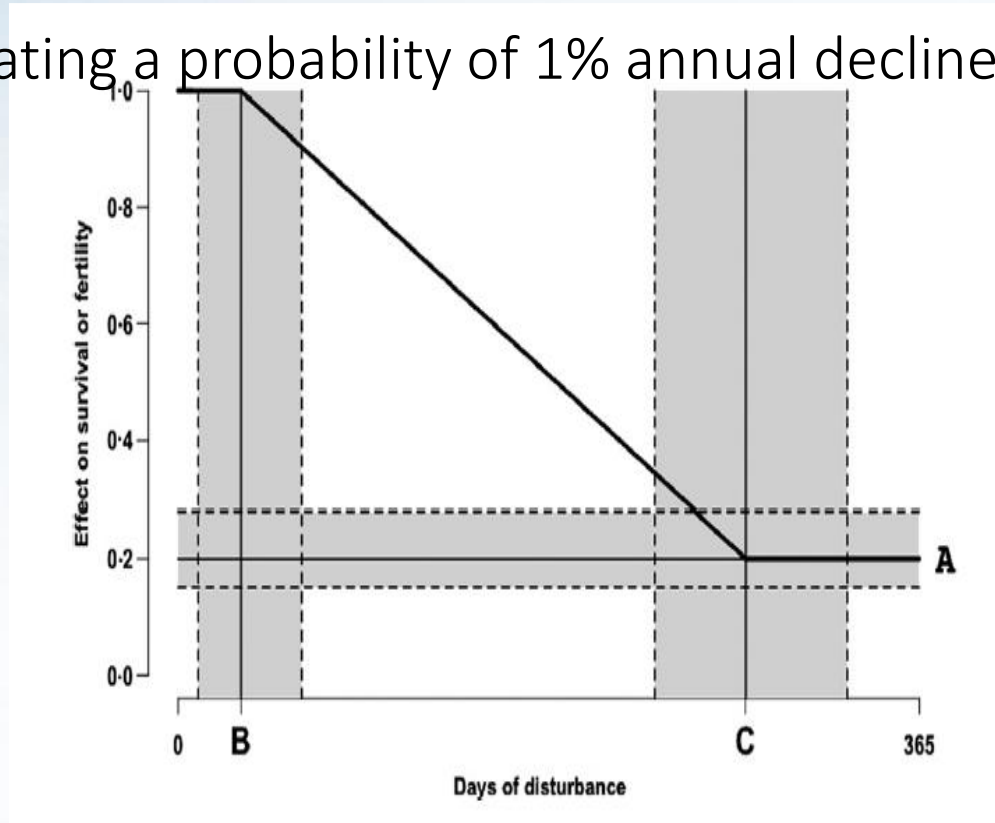


SMRU Marine, 2014





- ✓ A model to predict the effect of a quantified disturbance on the population trend.
- ✓ Establishing a dose-response relationship between the number of days of pile driving and survival/fertility rates (fitness parameters).
- ✓ Calculating a probability of 1% annual decline in the simulated disturbed populations.



SMRU Marine, 2014



Methods

Implementing the IPCoD model

Construction parameters:

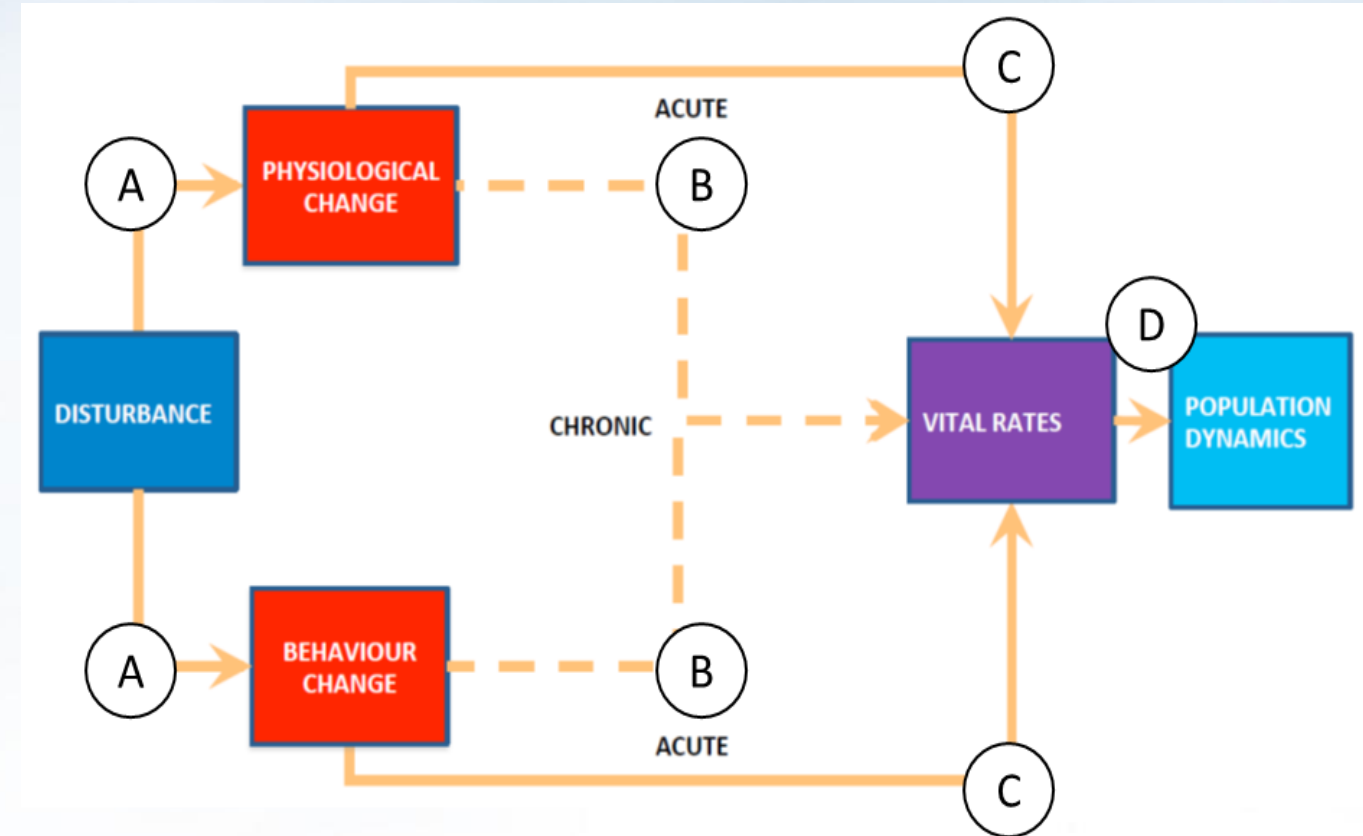
- Duration : 2 winter seasons
- Days of pile driving : 90
- Diameter of the pile : 8.5 m (fictive case)

Biological parameters:

- Age 1st birth: 5
- Calf survival rate: 0.6
- Juveniles survival rate : 0.85
- Adults survival rate : 0.925
- Fertility: 0.48

Population parameters:

- Population size : ~ 30,000 individuals
- Simulated populations : 500
- Years after construction : 25 y
- Numbers of affected animals (BDT & PTS) : for 5 reduction measures at decreasing efficiency levels

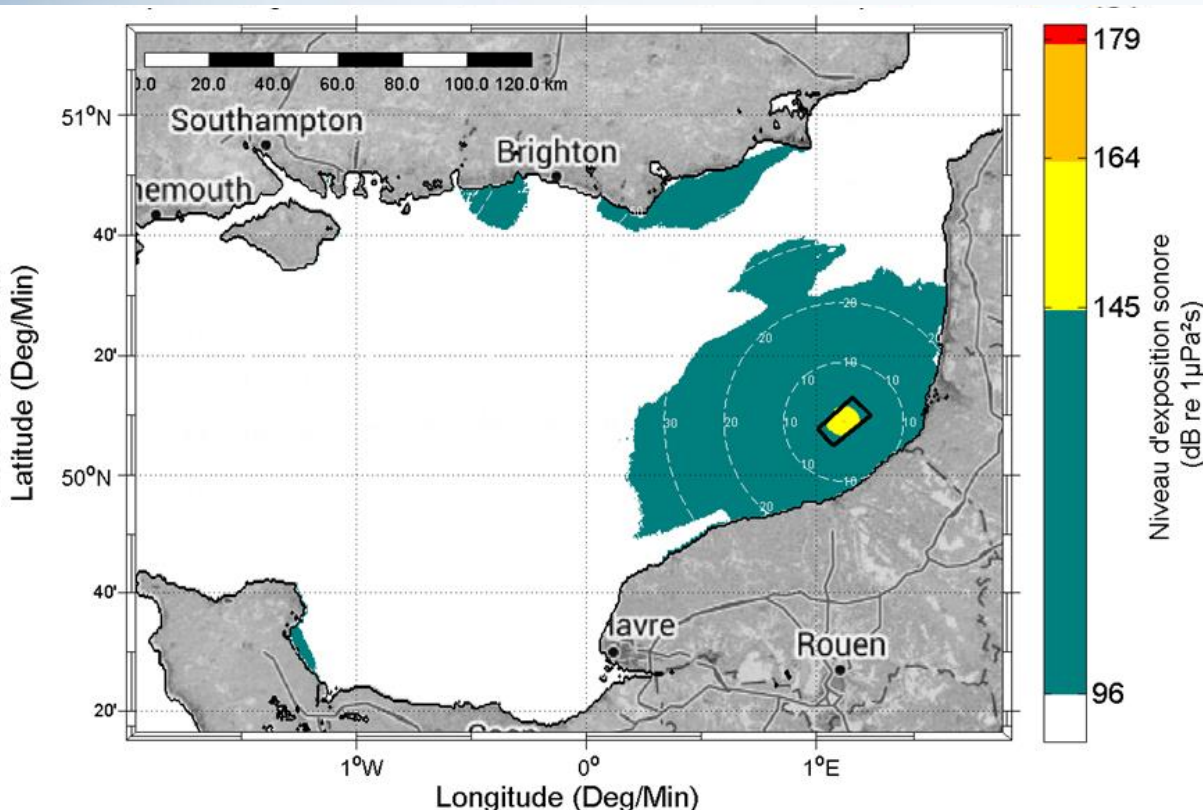




Methods

Mapping noise exposure at decreasing levels of efficiency :
from 'maximum theoretical gain' to 'no gain' by step of 1 dB

- ✓ Sound exposure level without reduction (1m): 217 dB re $1\mu\text{Pa}^2\text{s}$
- ✓ 5 noise reduction measures : Big Bubble Curtain (BBC), Bubble Curtain solution IHC (IHC), Little Bubble Curtain (LBC), Hydro Sound Damper (HSD), RESPECT Internal Fluid (IF)



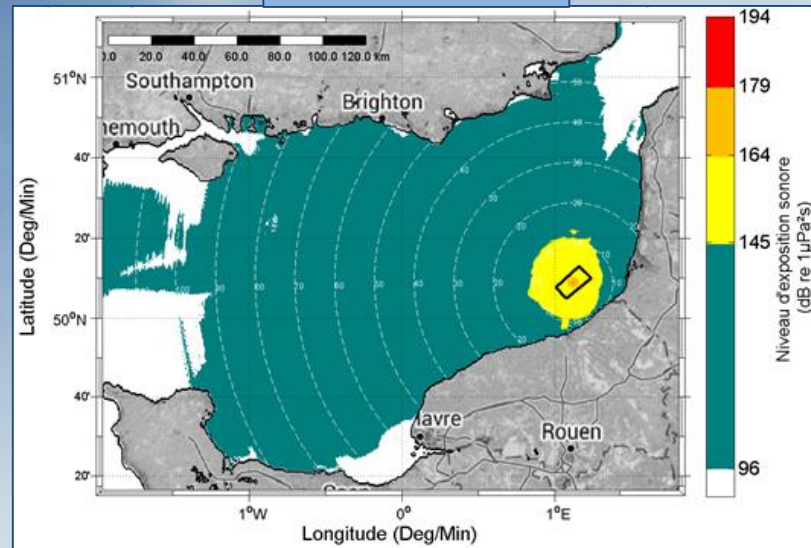
- ✓ Significant metrics :
 - Noise exposure area (km^2)
 - Median radius (NM)

Methods

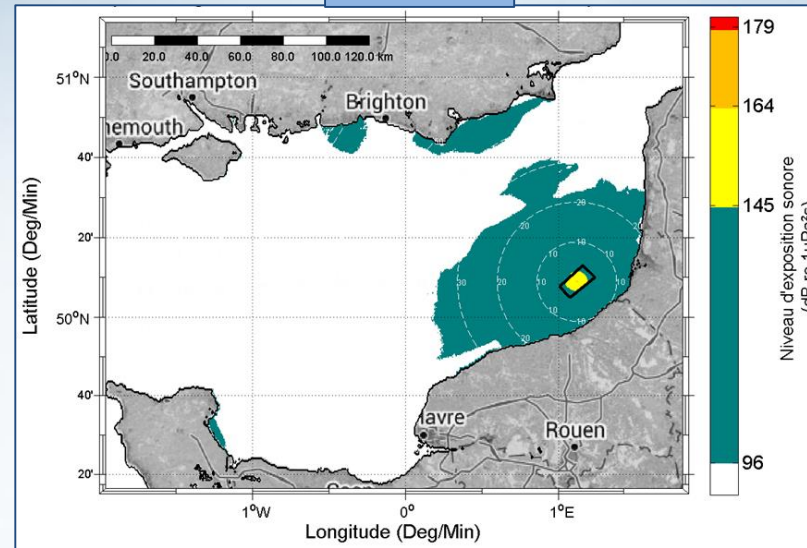
Spatial extent of the noise exposure (BDT and PTS)



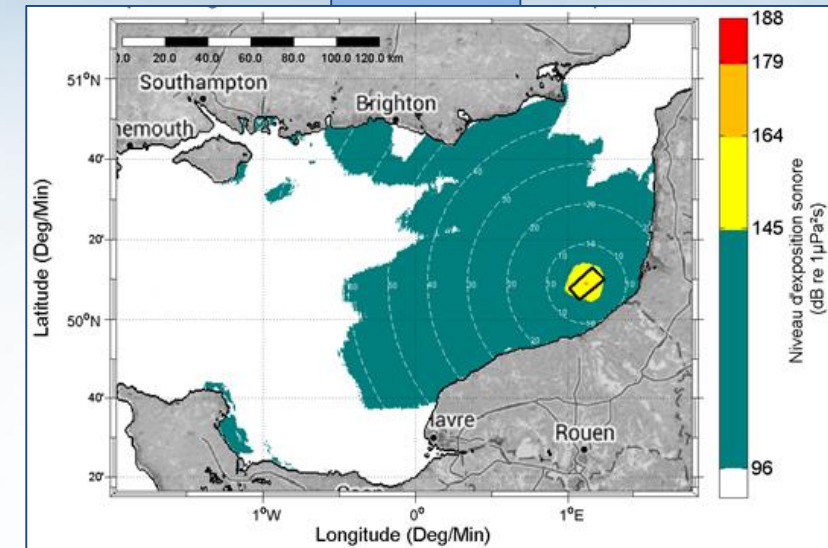
No measure



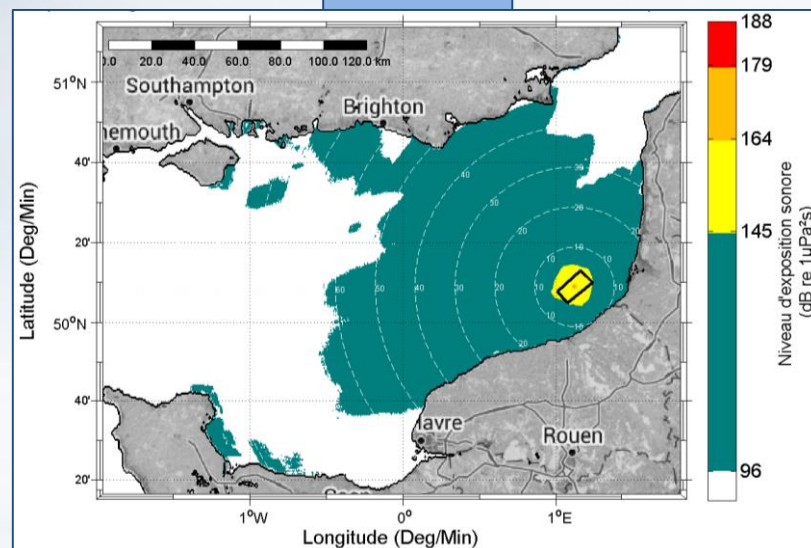
BBC



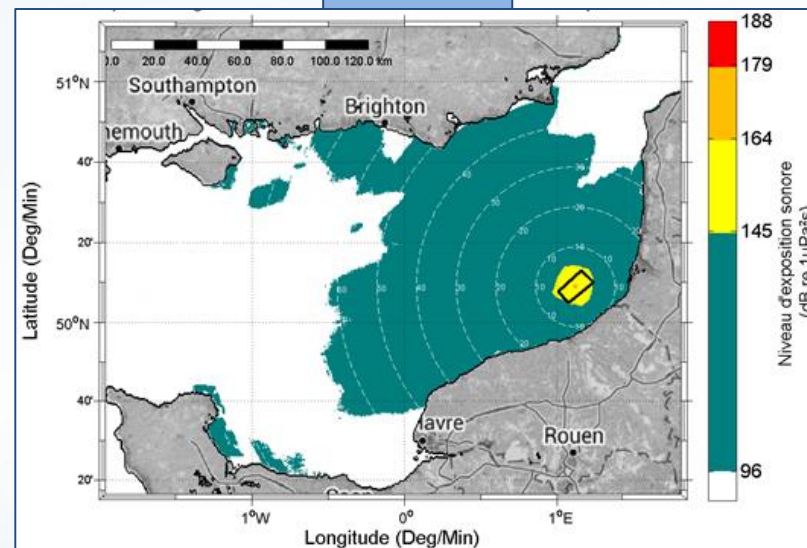
IHC



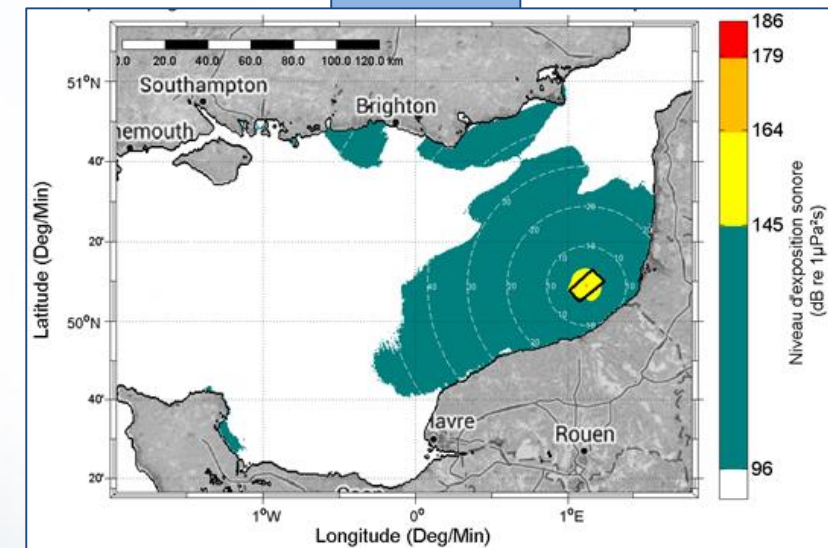
LBC



HSD

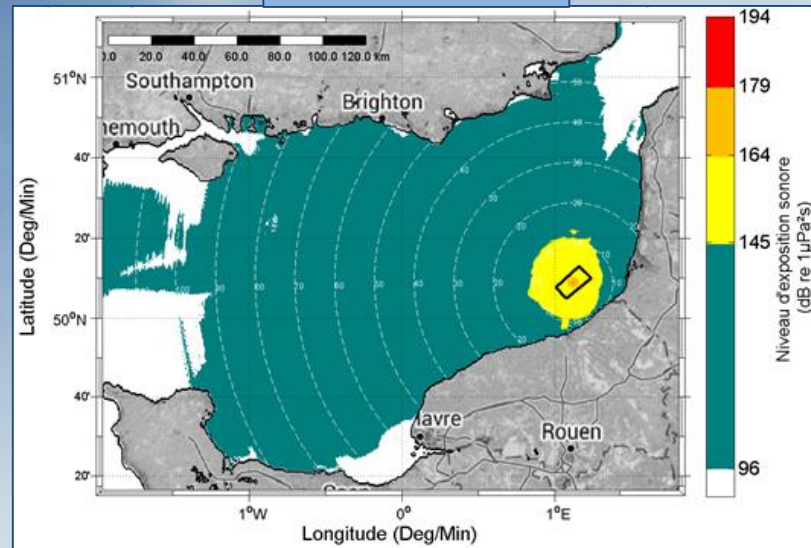


IF

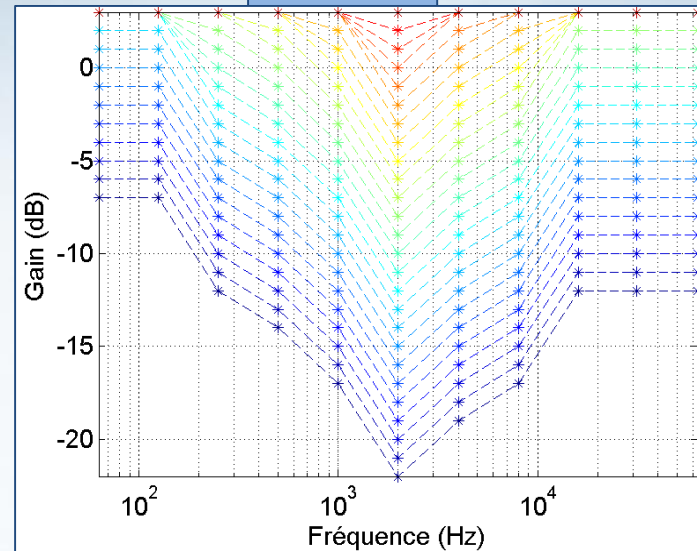




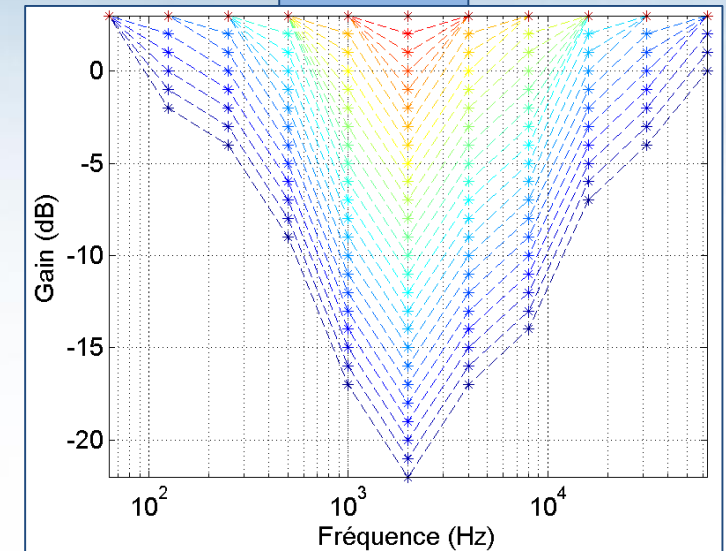
No measure



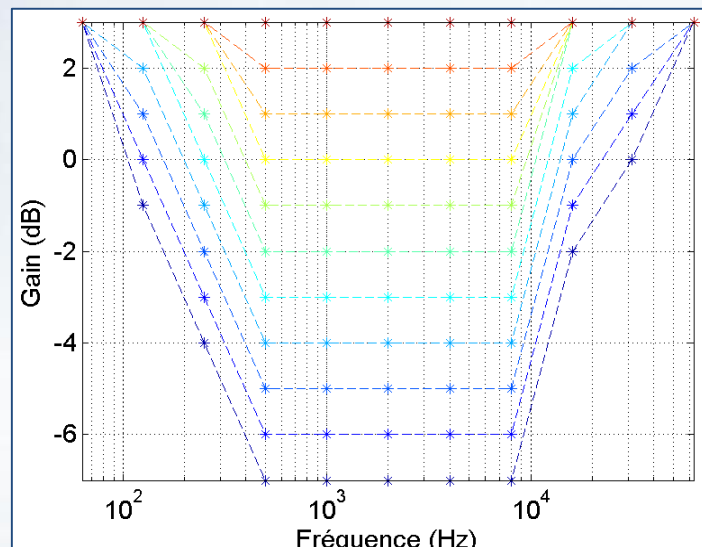
BBC



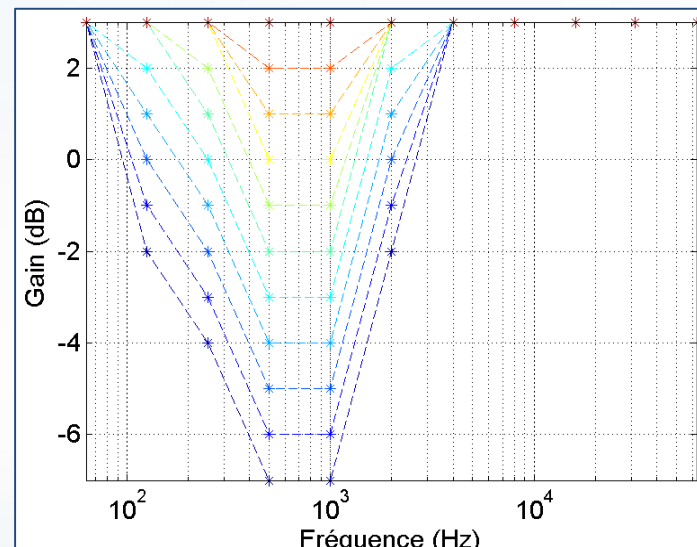
IHC



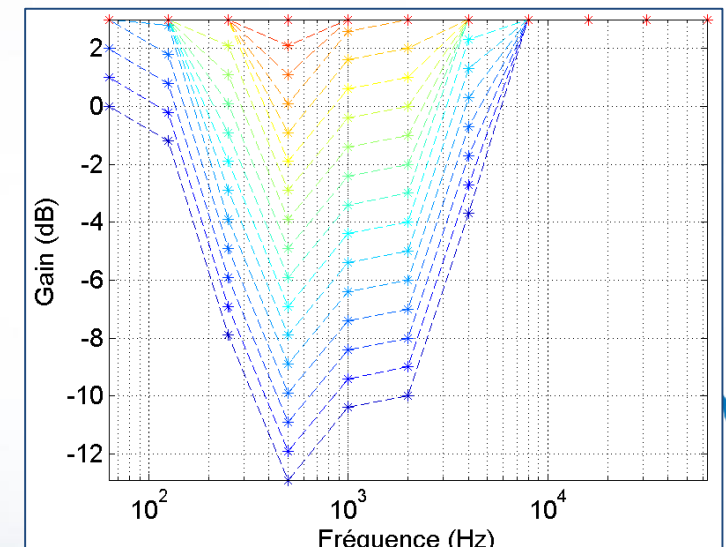
LBC



HSD



IF





Methods

✓ Acoustic thresholds

BDT > 145 dB re $1\mu\text{Pa}^2\text{s}$

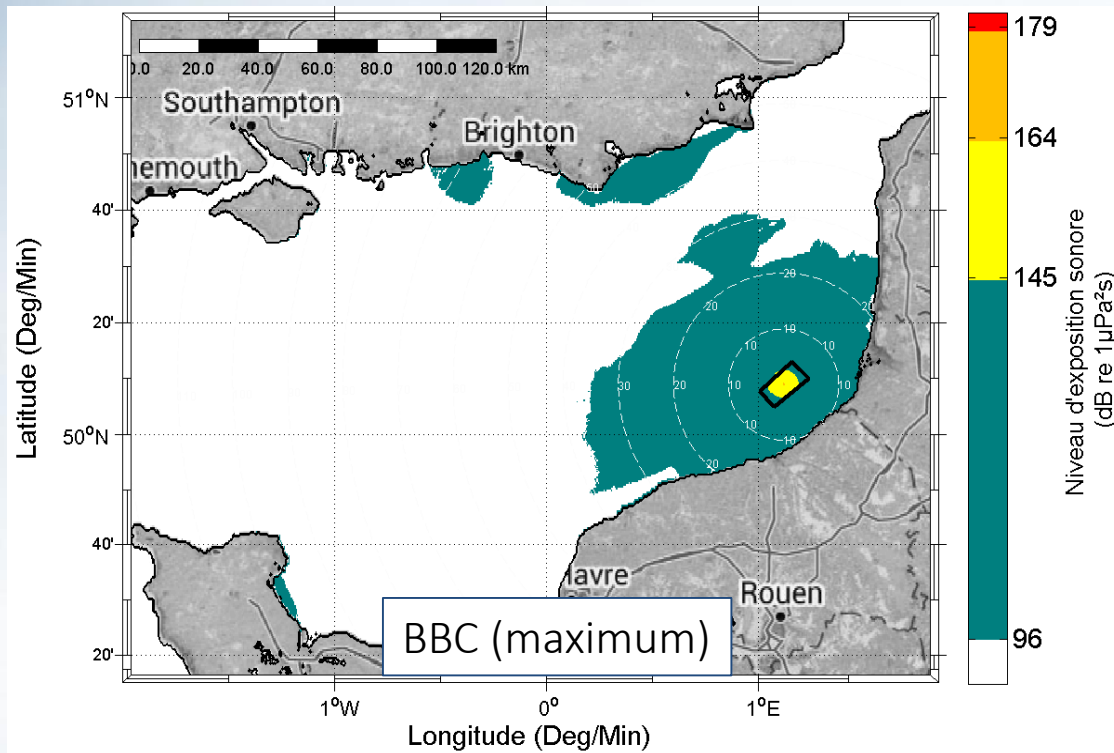
PTS > 179 dB re $1\mu\text{Pa}^2\text{s}$

Estimating the number of affected porpoises:
behavioural disturbance (BDT) & hearing loss (PTS)

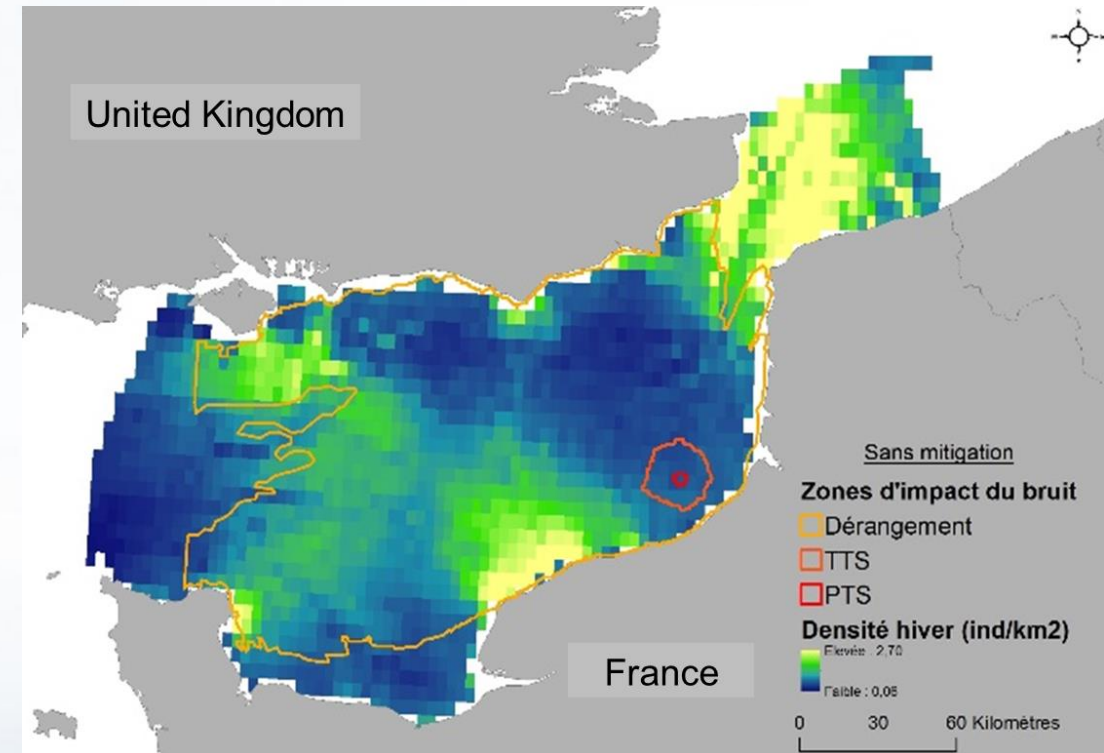


Implementing the IPCoD model

Sound exposure level (dB re $1\mu\text{Pa}^2\text{s}$)



Harbour porpoise density (individuals.km⁻²)

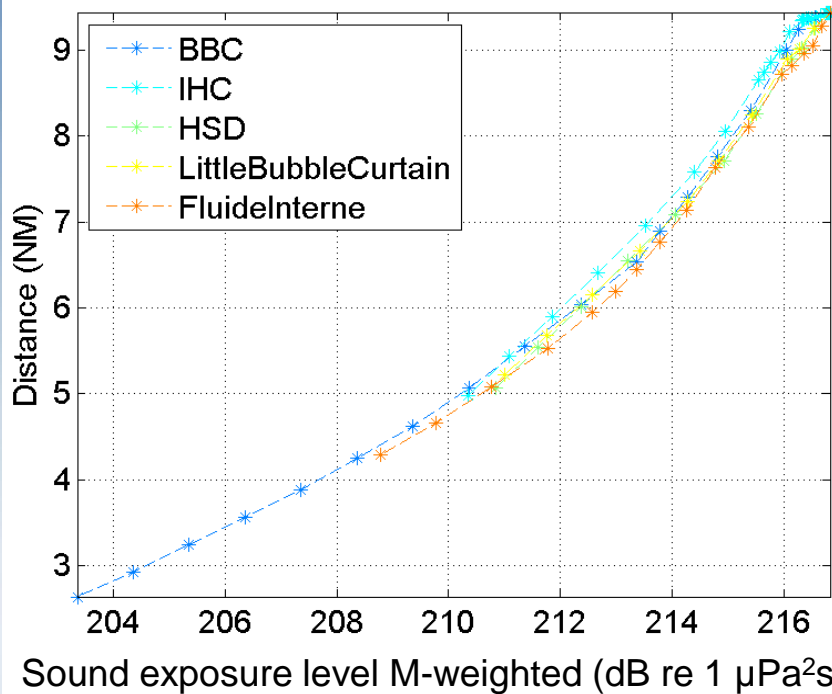




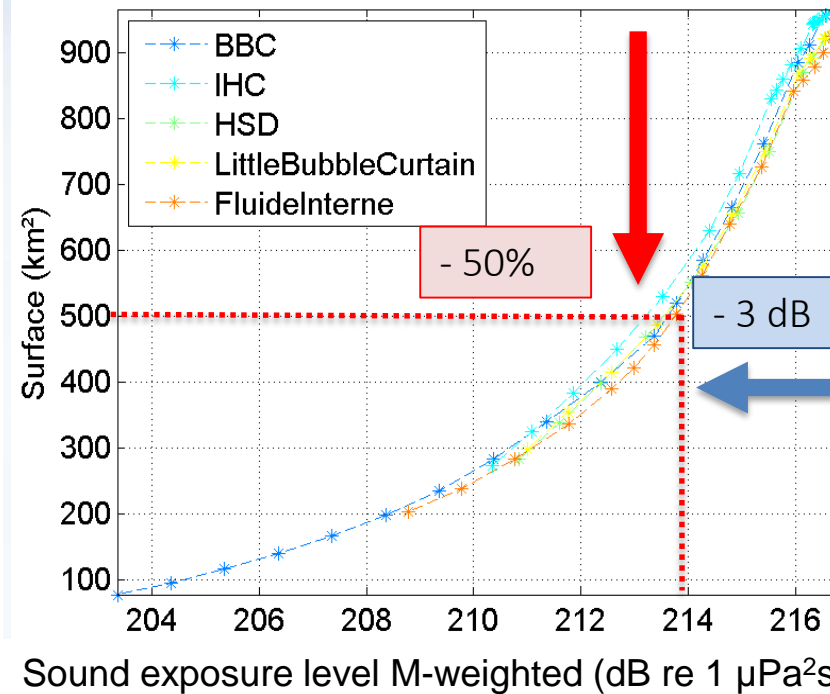
Results

Effect of the noise reduction on behavioural disturbance area (BDT)

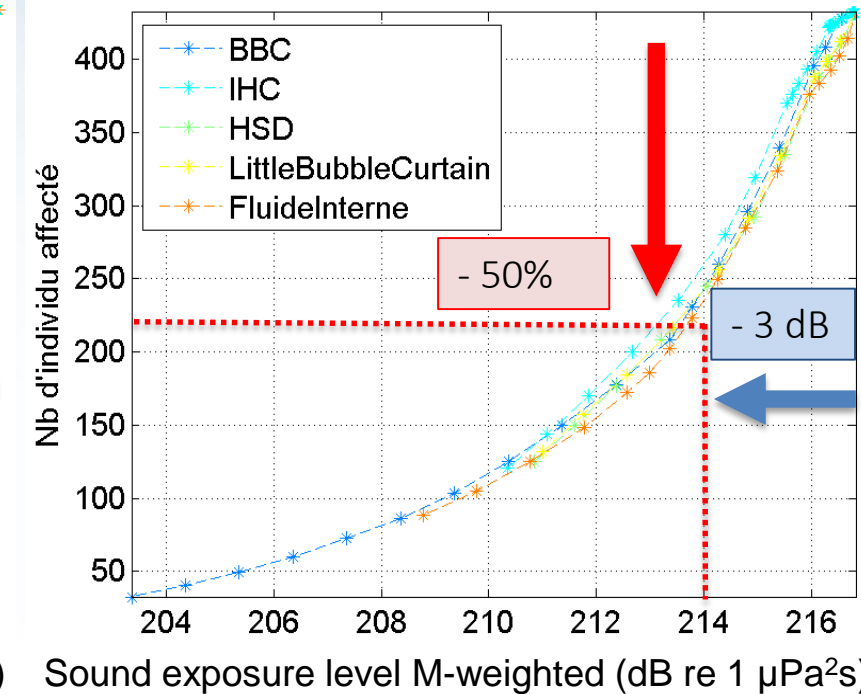
Median radius



Area



Nb of affected porpoises

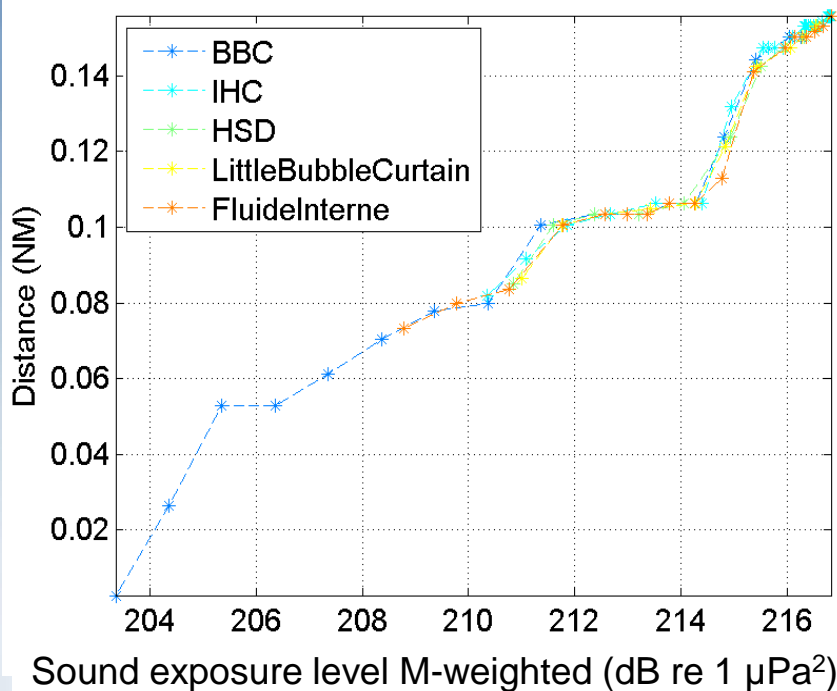


- ✓ All measures show similar effects on radius, area and number of affected porpoises.
- ✓ A decrease of 3 dB reduces by 50 % the area and the number of porpoises affected by BDT.

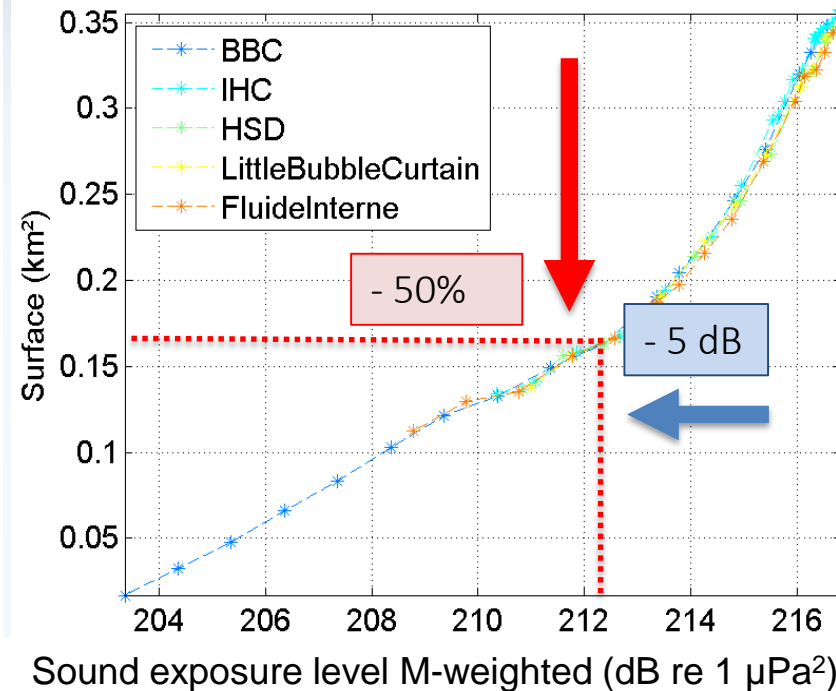


Results Effect of the noise reduction on the permanent hearing loss area (PTS)

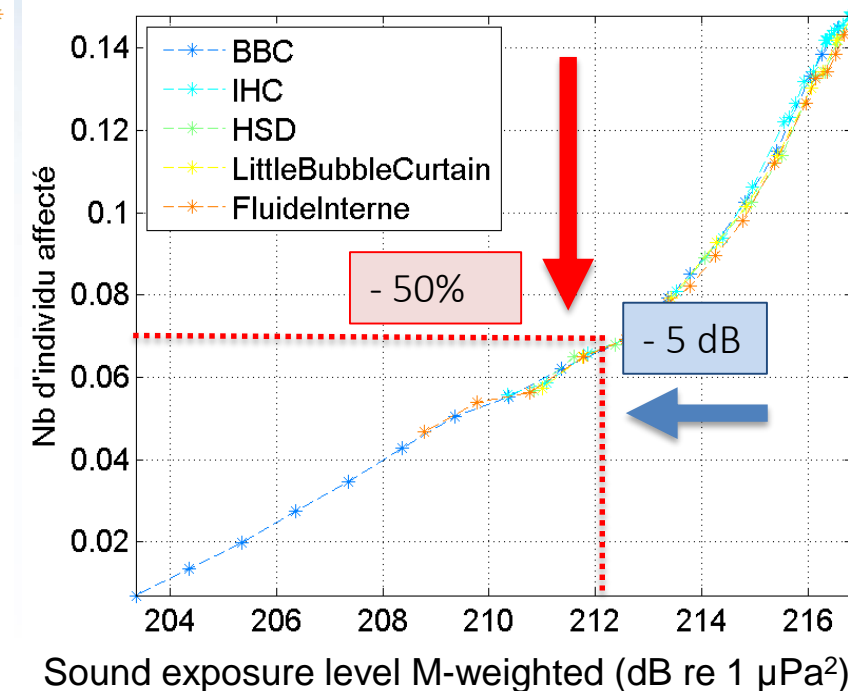
Median radius



Area



Nb of affected porpoises

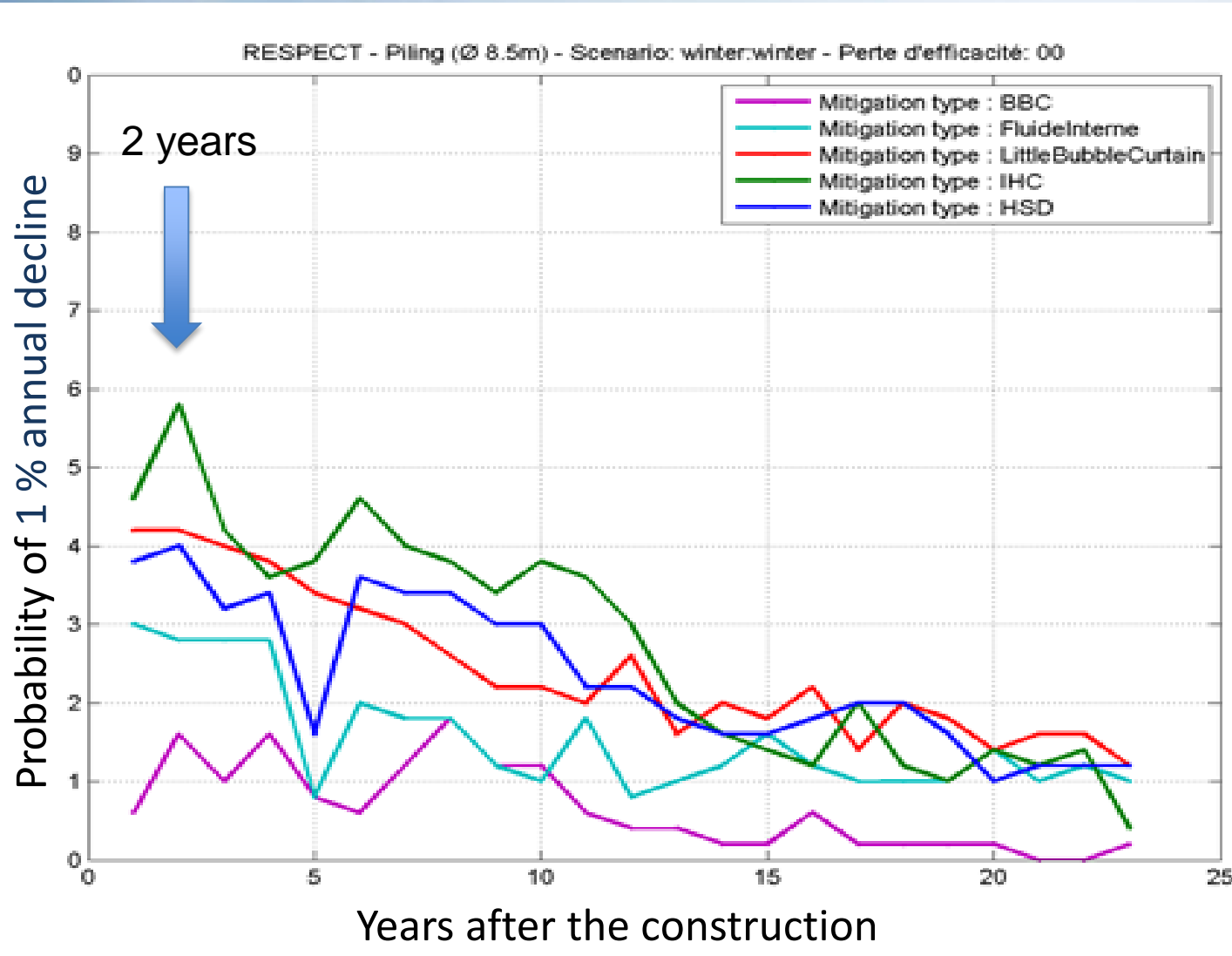


- ✓ All measures show similar effects on radius, area and number of affected porpoises.
- ✓ A decrease of 5 dB reduces by 50 % the area and the number of porpoises affected by PTS.



Results

Probability of 1 % annual decline over 25 years
(reduction measures at maximum efficiency)



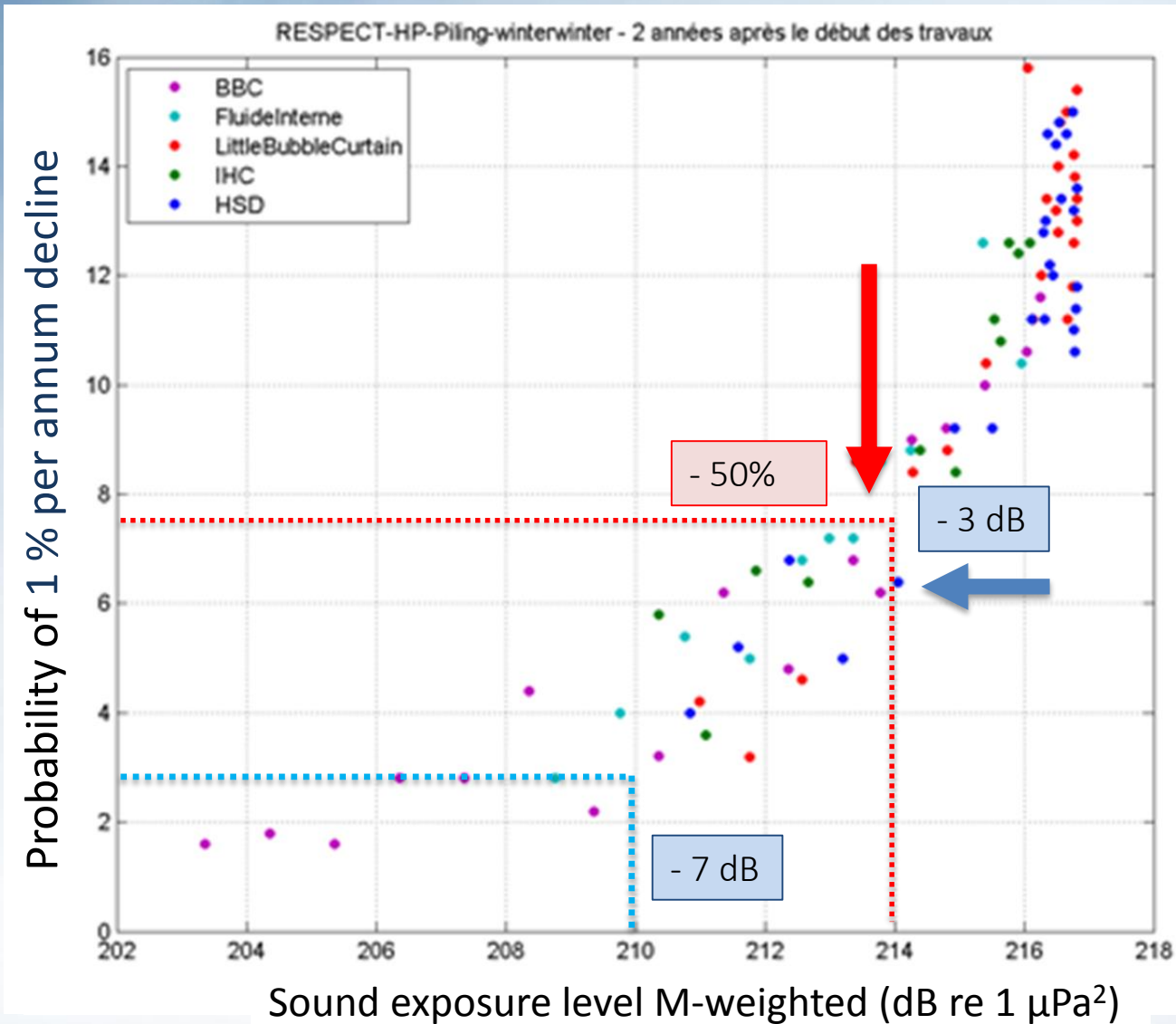
- ✓ Differences occur between noise reduction measures : BBC is the most efficient to reduce long term effects (highest efficiency of noise reduction).
- ✓ Performances are theoretical, sensivity to environmental conditions should be tested => choice





Results

Probability of 1 % annual decline 2 years after construction, when efficiency of the measure is degraded.



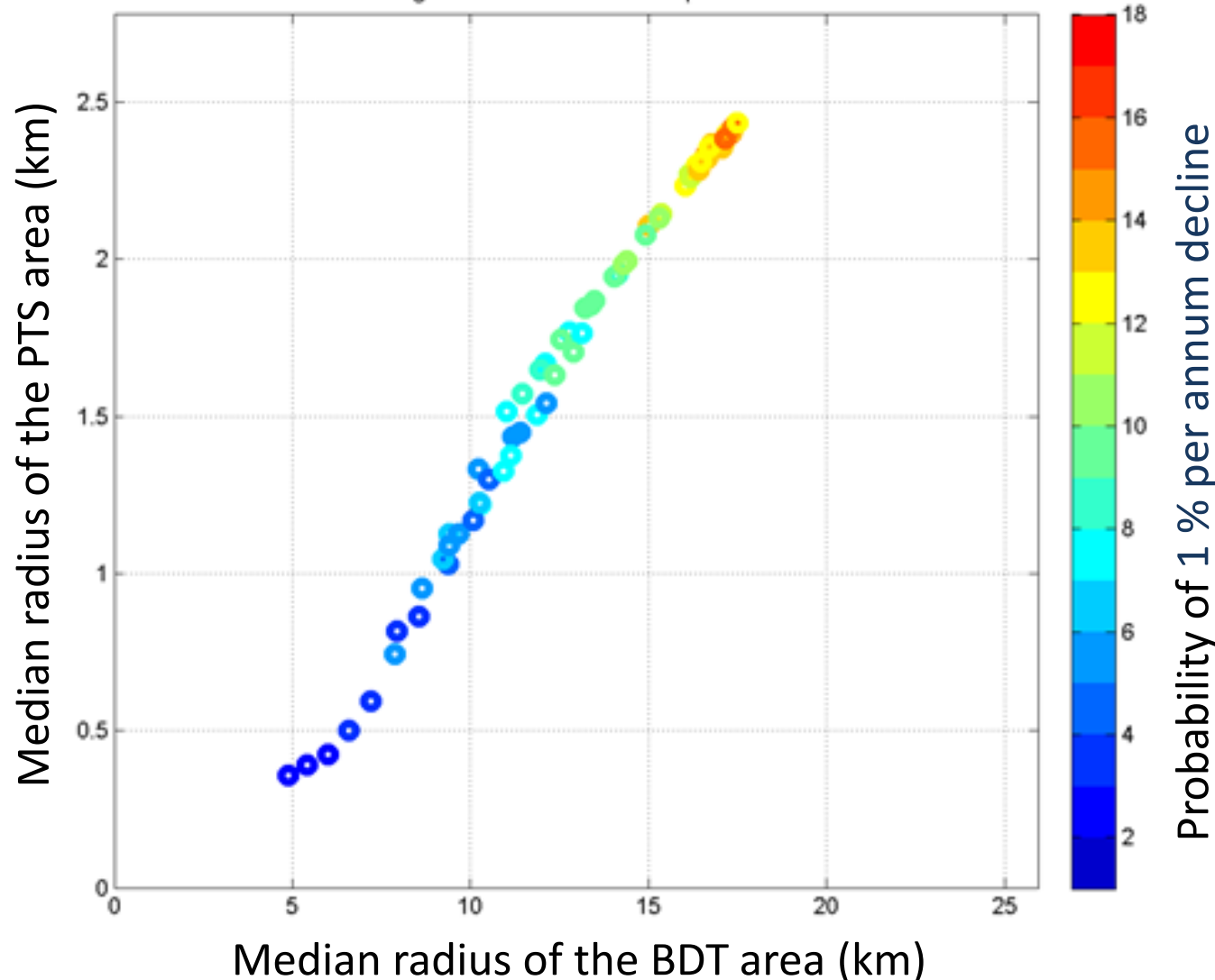
- ✓ All measures show a rapid reduction of the risk.
- ✓ A decrease of 3 dB reduces by 50 % the risk of 1% annual decline.
- ✓ An optimal reduction of noise would be of 7 dB (beyond that gain is minimal).



Results

Relationship between the median radii of BDT and PTS
and the probability of 1 % per annum decline 2 years after construction

RESPECT-HP-Piling-winter:winter - 2 années après le début des travaux



- ✓ The relationship between the radius of the BDT area and the radius of the PTS area is linear.
 - ✓ The longer are the radii, the higher is the risk of population decline.
- => A reduction of the affected area will lead to a reduction of risk of decline in harbour porpoise population.





Conclusions

- ✓ The IPCoD model is a promising step forward for the quantification of noise consequences on marine mammal populations.
- ✓ The IPCoD allowed us to define an optimal level of reduction of noise in Dieppe-Le Tréport windfarm project : 7 dB (SEL).
- ✓ Modelling can be used as a support decision tool for stakeholders and allow to test noise reduction measures (benefits/costs) before the construction.
- ✓ Uncertainties for demographic parameter values, acoustic thresholds, density and movements of animals etc... but knowledge is increasing rapidly.





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Thank you for your attention.
Questions?

The RESPECT project is funded by



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