



OSPAR
COMMISSION

*Protecting and conserving
the North-East Atlantic
and its resources*



OSPAR noise indicators covering the **North Sea**

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Overview

Introduction

- OSPAR ICG-Noise and the Common Indicators

Impulsive noise

- OSPAR 3-year assessment
- Candidate impact indicator

Continuous noise

- Ship noise maps of NE Atlantic
- Joint monitoring: JOMOPANS

Summary

OSPAR Commission

16 Contracting Parties

Belgium	Ireland	Spain
Denmark	Luxembourg	Sweden
Finland	The Netherlands	Switzerland
France	Norway	The United Kingdom
Germany	Portugal	European Union
Iceland		

Observer organisations

Intergovernmental organisations and international non-governmental organisation

Underwater Noise

Intersessional Correspondence Group on Underwater Noise (ICG-NOISE) established in 2014

One **Common Indicator** and two **Candidate Indicators** for underwater noise



OSPAR Maritime Area and Regions:

- Region I: Arctic Waters
- Region II: Greater North Sea
- Region III: Celtic Seas
- Region IV: Bay of Biscay/Iberian Coast
- Region V: Wider Atlantic



impulsive

Wikimedia.org

Pile driving



impulsive

Explosions



Speaker icon

Seismic surveys

impulsive



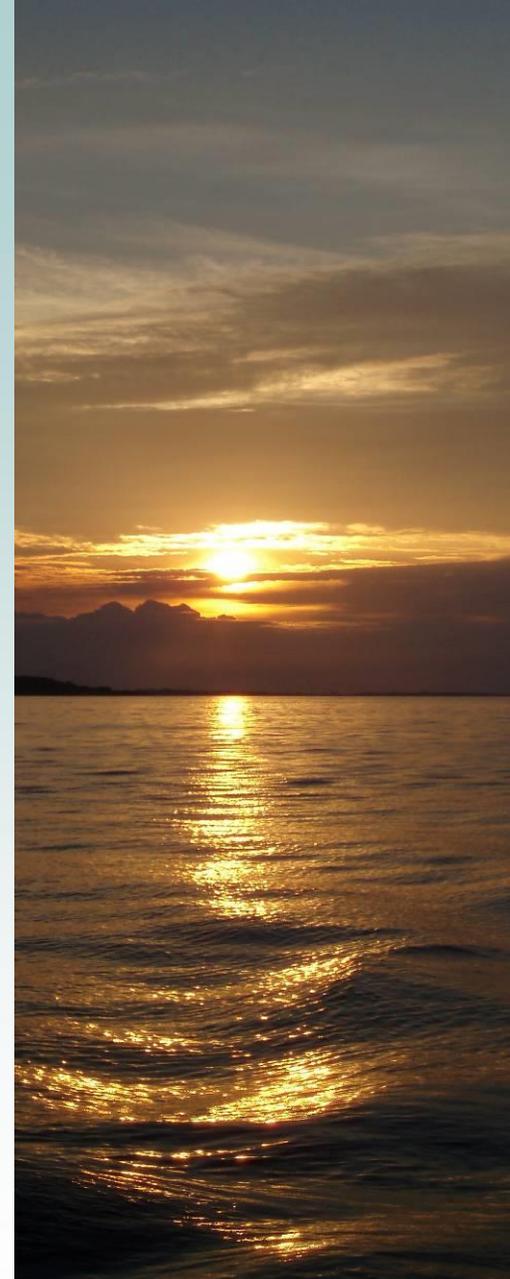
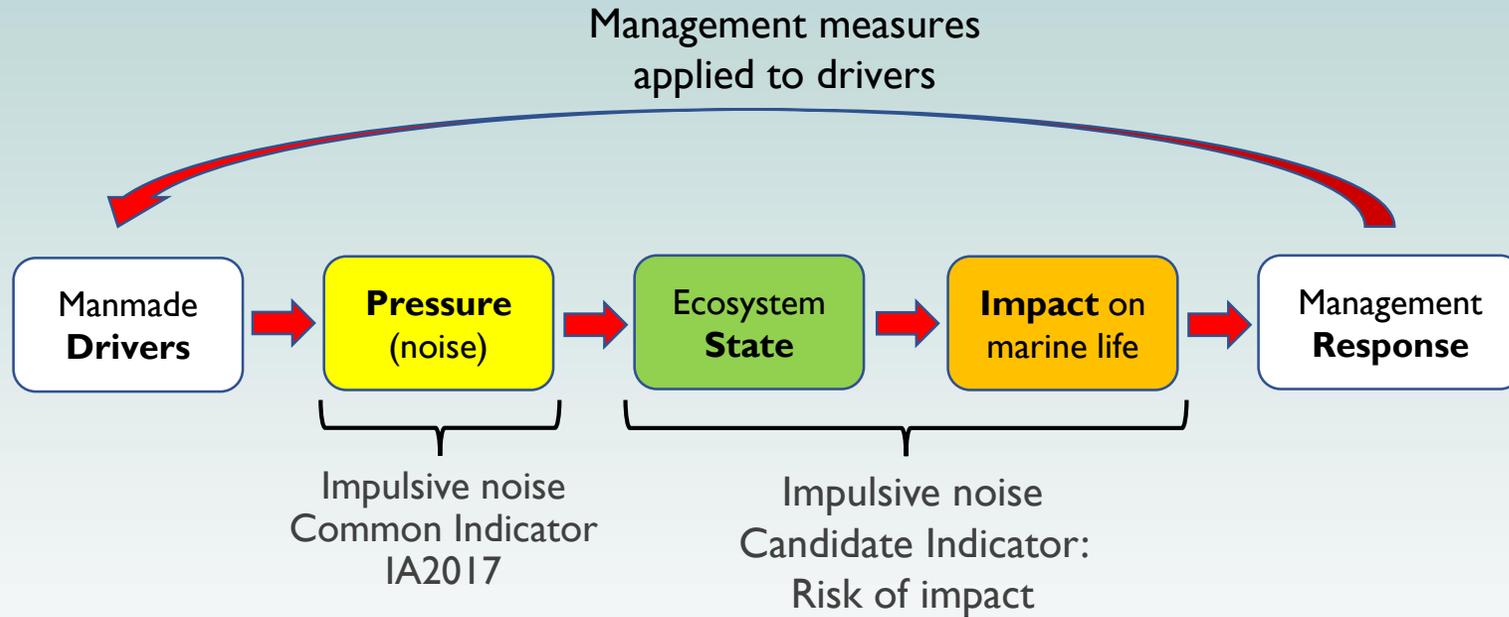
Shipping

continuous

Speaker icon

Management indicators and the DPSIR loop

DPSIR loop



Impulsive noise: OSPAR Noise Registry

- OSPAR commissioned ICES to develop **impulsive noise registry** in 2015
- Interactive database with **time** and **location** of **impulsive noise sources** in OSPAR area
- Registry is hosted on open online portal: <http://underwaternoise.ices.dk>
- HELCOM (Baltic Sea) now uses the same ICES registry

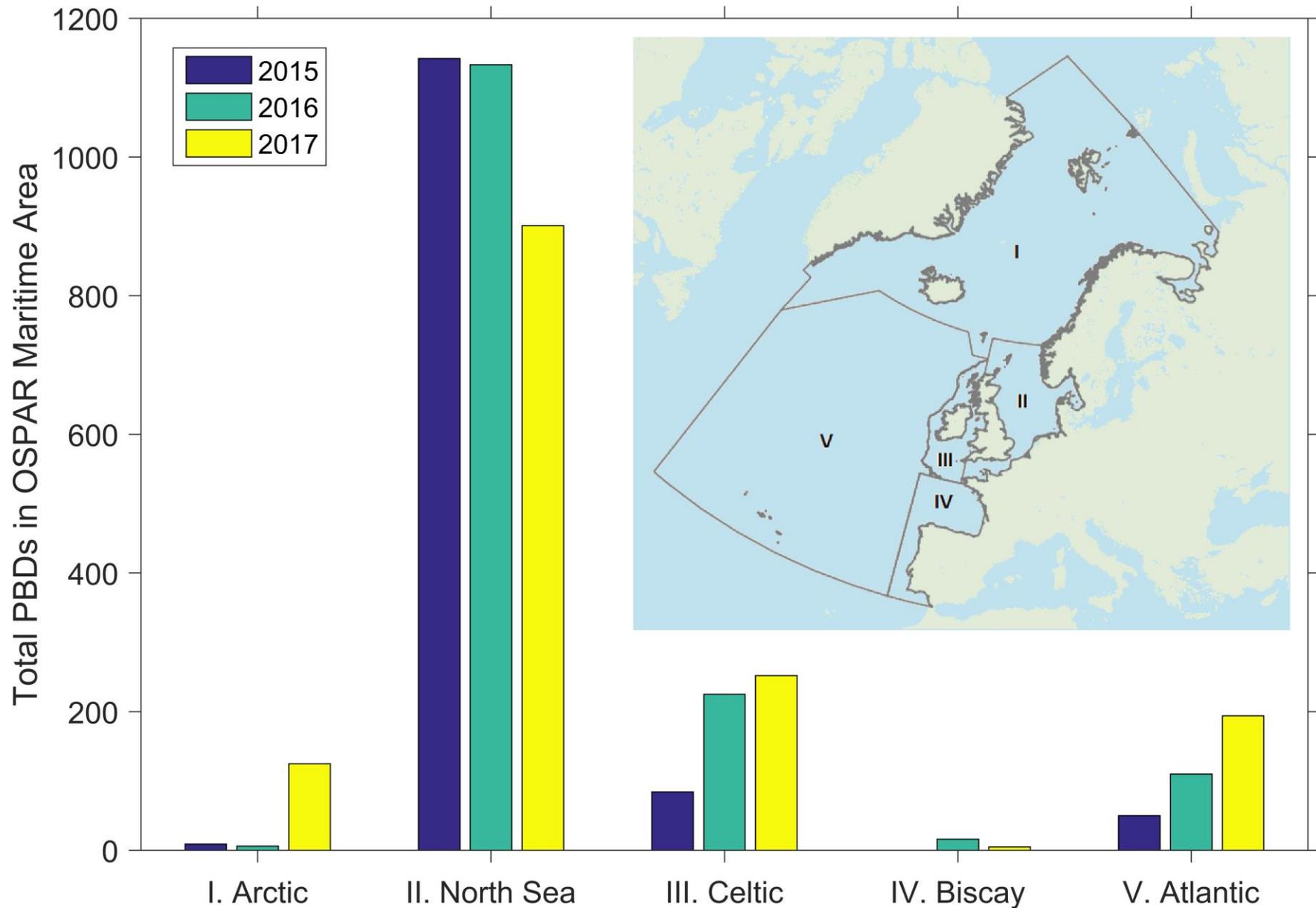
Industry

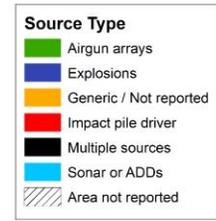
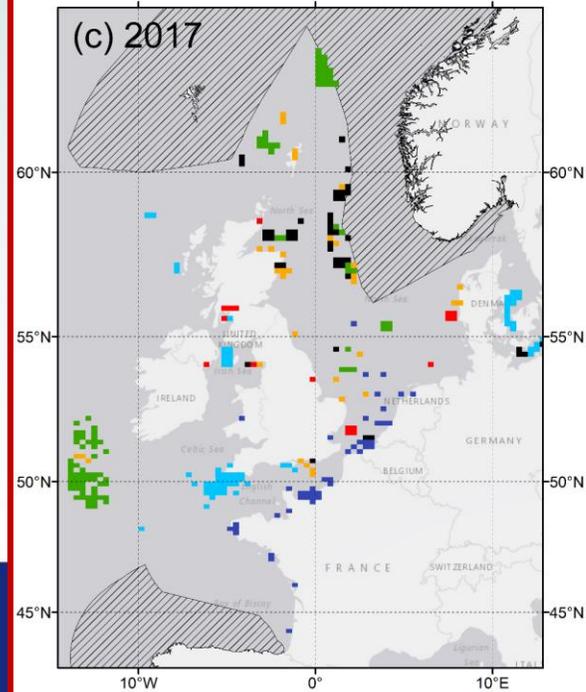
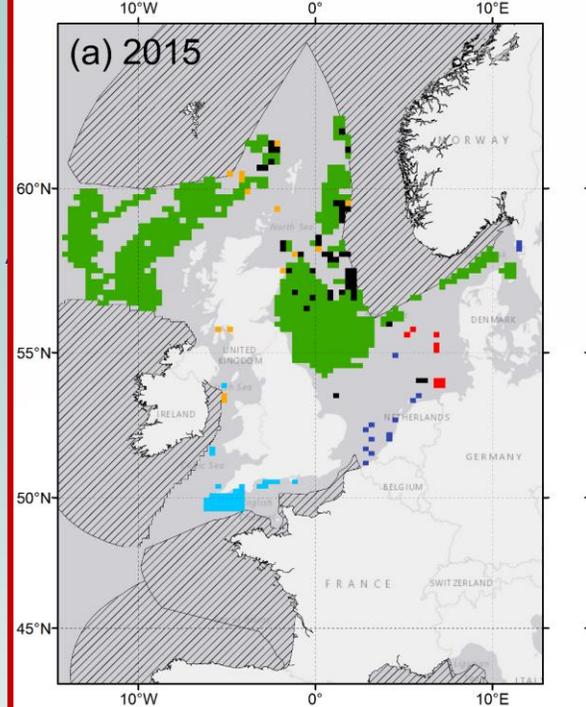
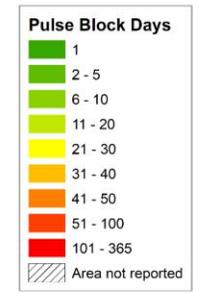
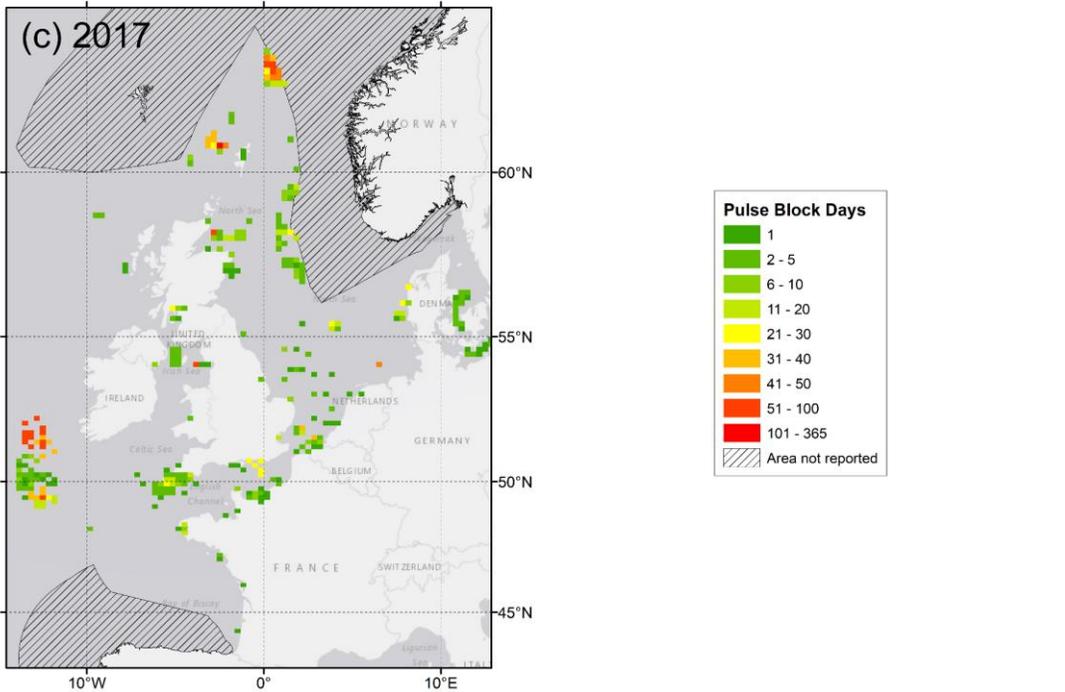
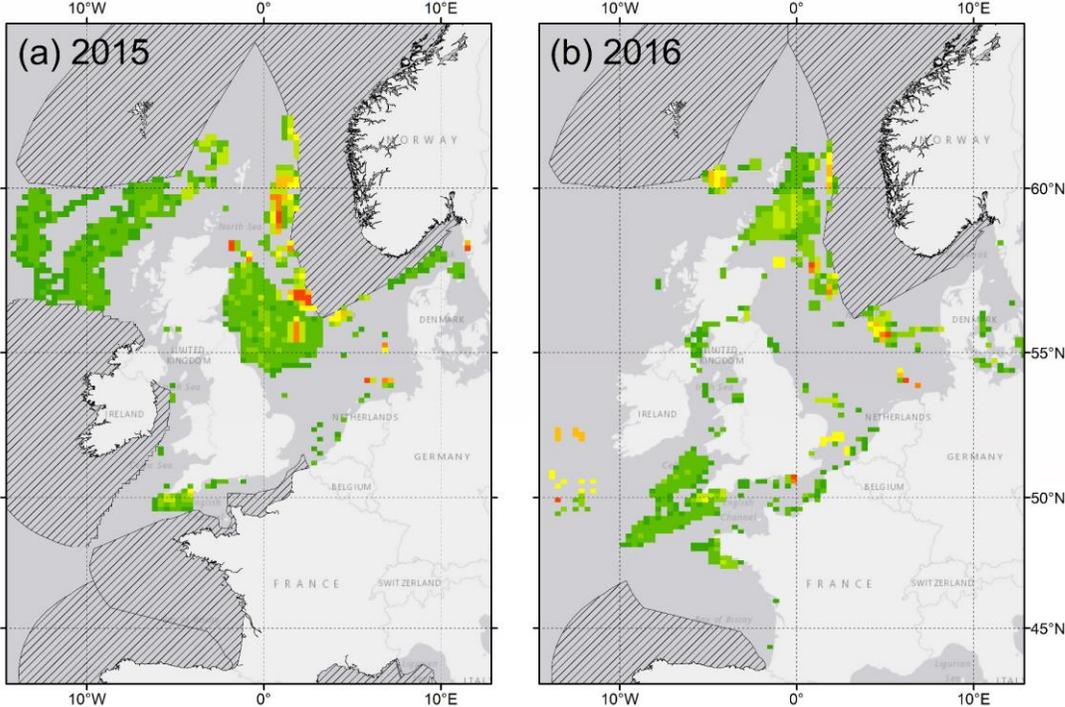
The screenshot shows the ICES CIEM website interface. At the top left is the ICES CIEM logo. To the right are navigation links: Contact, Sitemap, FAQ, Glossary, SharePoint Login, and Admin. A search bar labeled 'Search Everything' is also present. Below these are main menu items: EXPLORE US, NEWS AND EVENTS, MARINE DATA, PUBLICATIONS, and COMMUNITY. A secondary menu includes 'Impulsive Noise Register', 'Submit data', 'Submission status', 'Map', and 'Web Services'. The main content area features a map of the North-East Atlantic region with colored markers (red, green, cyan) indicating noise sources. To the right of the map are several filter options: 'Noise Base Data' (checked), 'Download' (with a PDF icon), 'Years' (checkboxes for 2008-2016), 'Noise value codes', 'Source Event', and 'Mitigation systems'.



2015-2017: Total PBDs per region

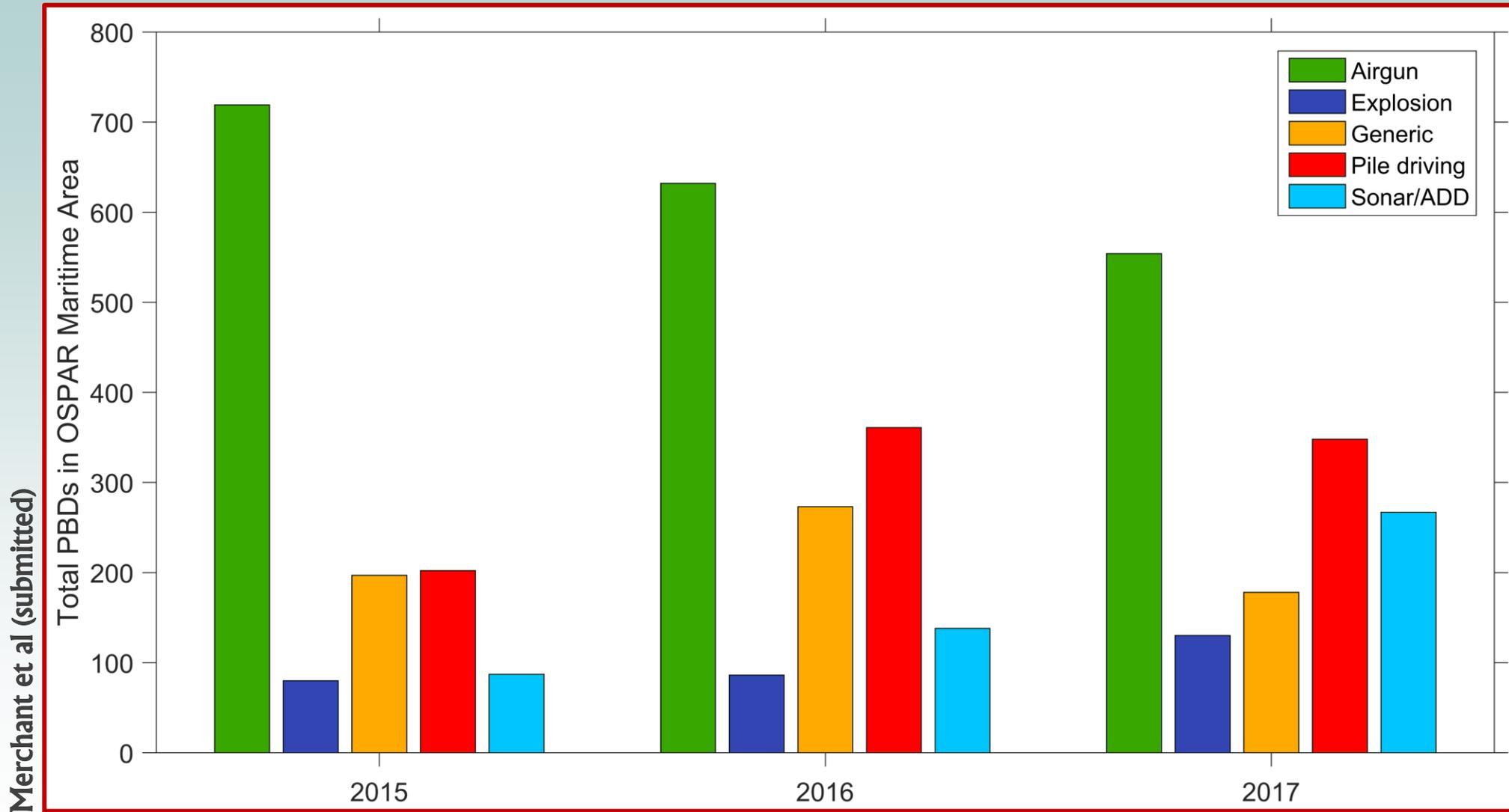
Merchant et al (submitted)





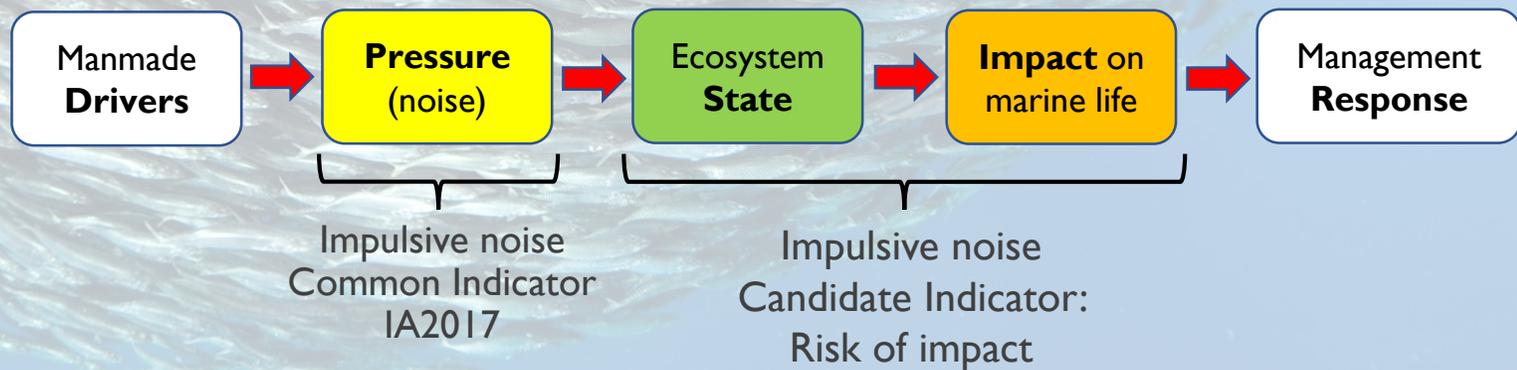
Merchant et al (submitted)

2015-2017: PBDs by source type overall

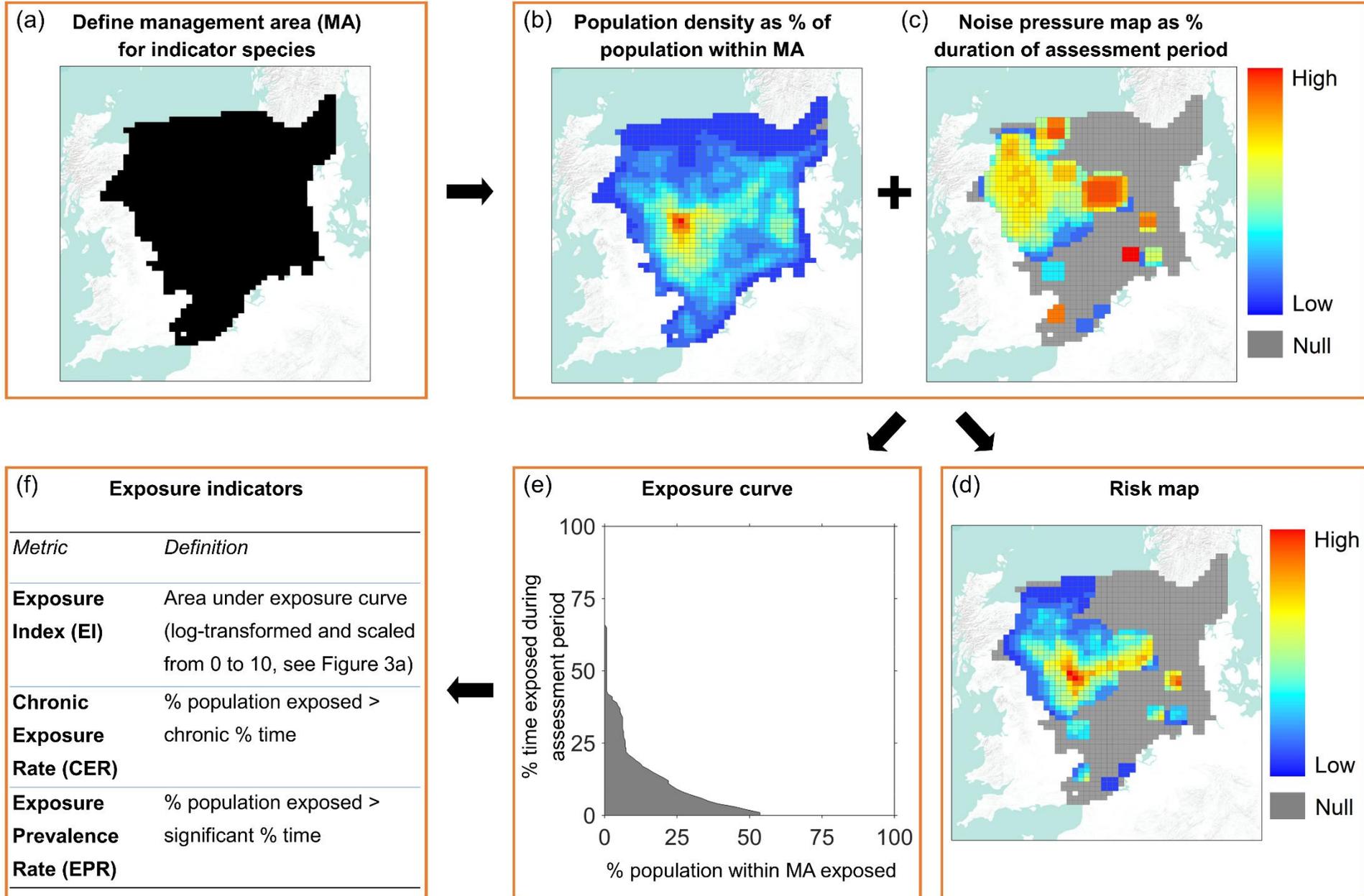


OSPAR Impulsive noise impact indicator

- What is **risk of impact** on marine life?
- **Impact Indicator** for impulsive noise to be assessed in 2019/20



Impact indicator methodology: overview



Define indicator species & management area

(a) Define management area (MA)

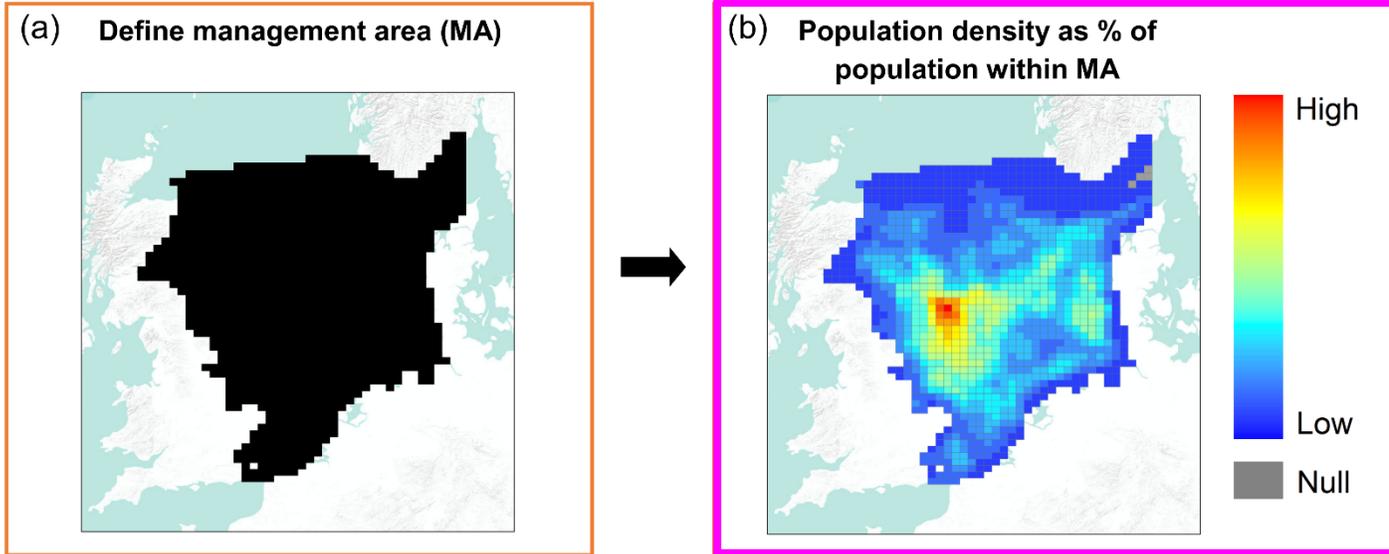


- **Management area:**
 1. Spatial boundary for population at ecologically relevant scale (management unit)
 2. Defined habitat (e.g. MPA, spawning area)

- Allows indicator to be based on **percentages** of the **population** or **habitat** exposed

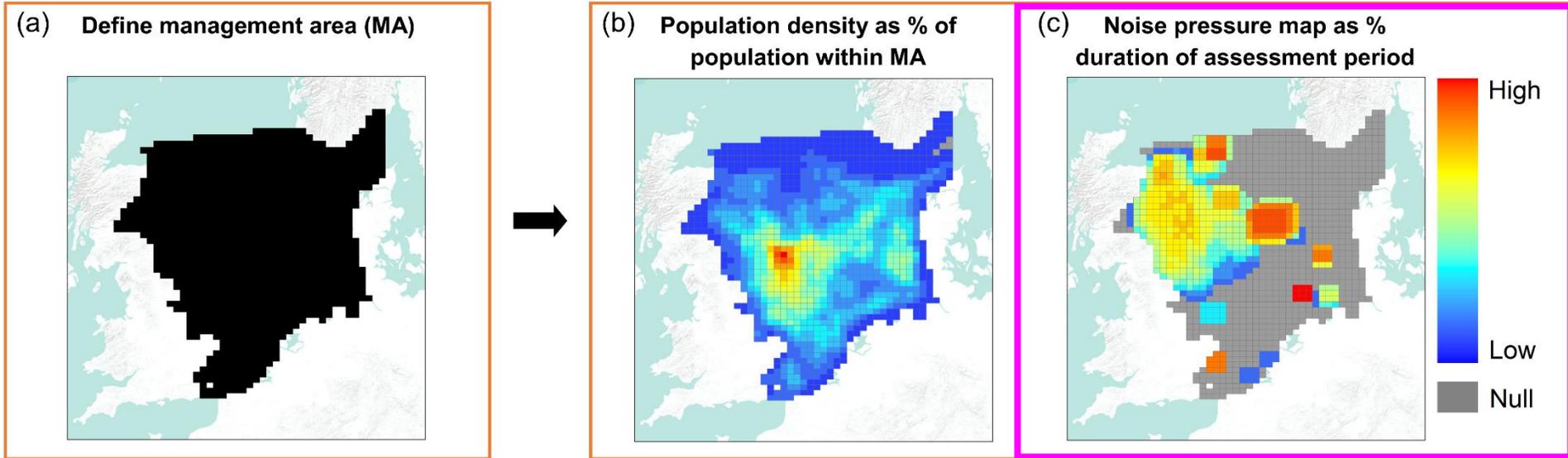
- For OSPAR, could be **OSPAR Regions** or appropriate **management unit** for indicator species, or **recognized habitat**

Population density (if available)



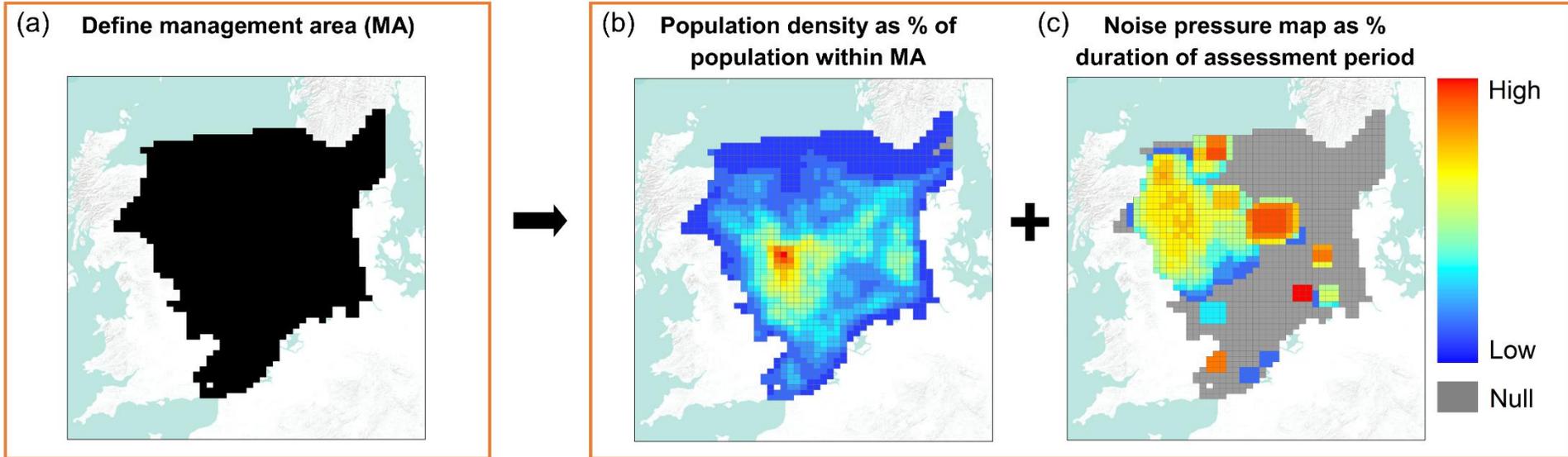
- Risk of impact depends on density of animals in affected area at the time [example data is from Gilles et al (2016)]
- Indicator should be density dependent where possible, preferably also with temporal variability (e.g. seasonal)
- Population density is normalised to be % of population within management area
- If density data not available, habitat area can be used

Noise pressure map



- Noise pressure map % duration of assessment period that each cell is exposed
- OSPAR INR data spread into neighbouring cells according to the “distance of effect” for impulsive noise on the indicator species (Brandt et al. 2016; Gomez et al. 2016)
- Data is gridded data similarly to cumulative effects assessment (Halpern et al 2008; Maxwell et al 2013)

Risk map



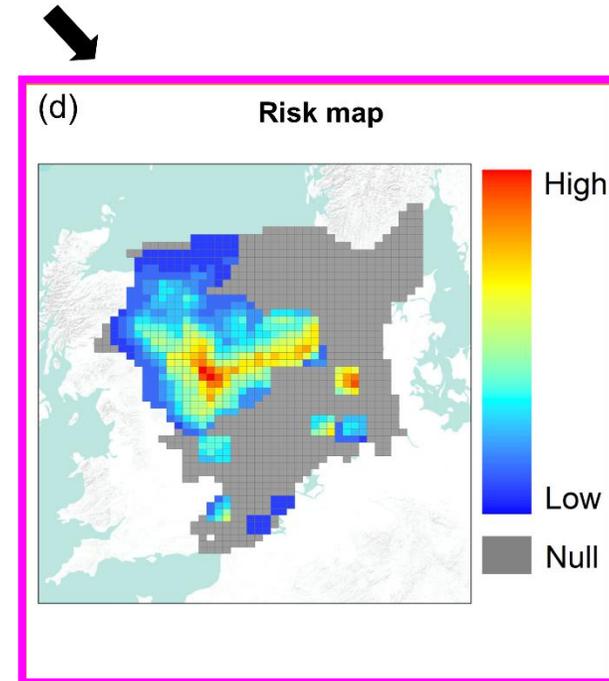
- Risk map computed using CEA methodology in (Maxwell et al 2013) for cumulative effects assessment:

$$RI_i = D_i \times S_i$$

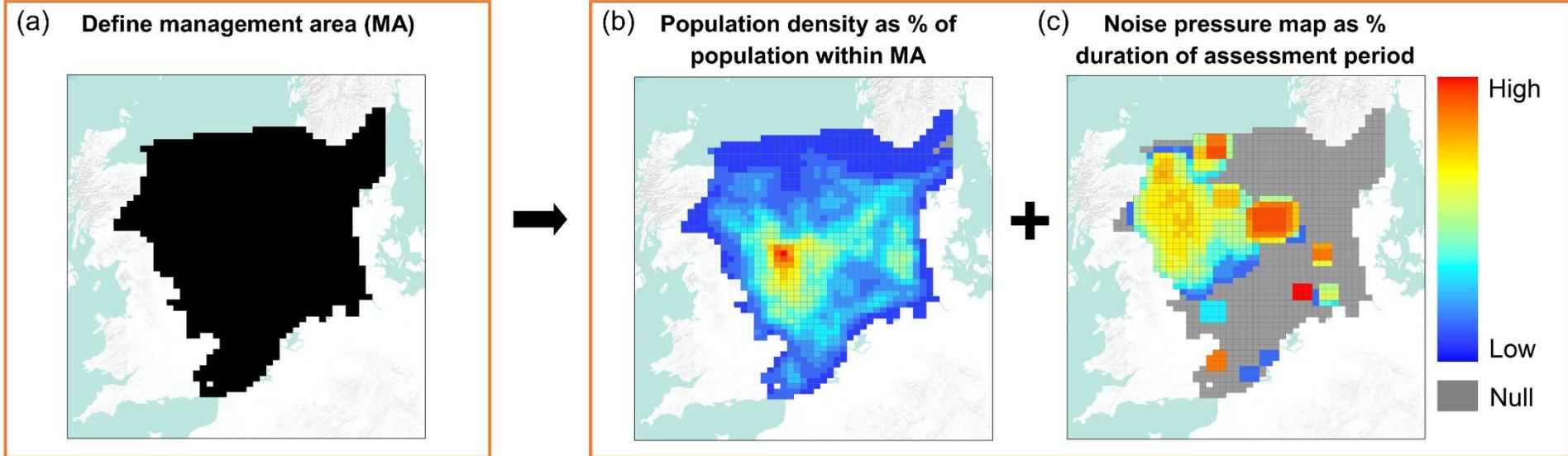
for i th ICES statistical sub-rectangle:

RI_i = risk index ; D_i = log-transformed noise pressure map value ; S_i = animal density map value

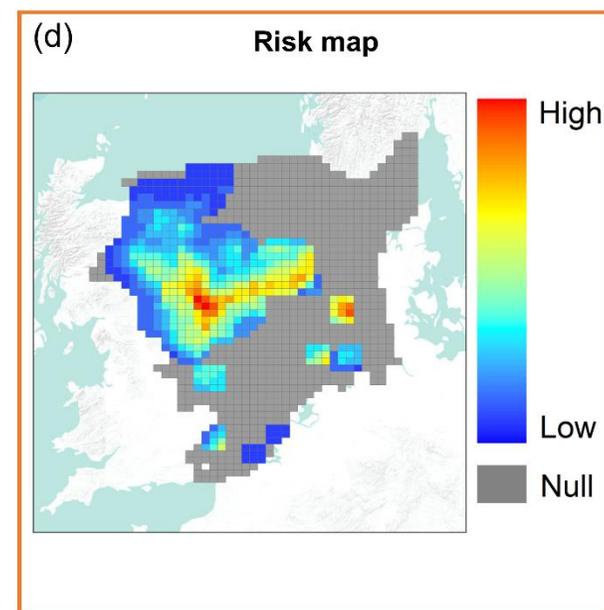
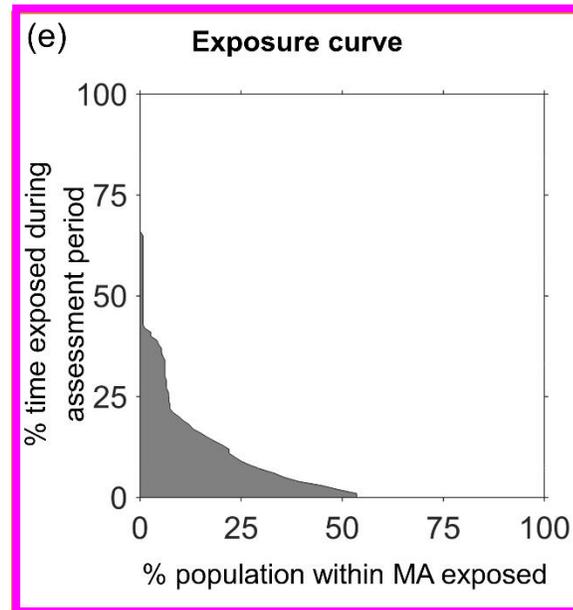
- Shows greatest cooccurrence of population density and noise pressure



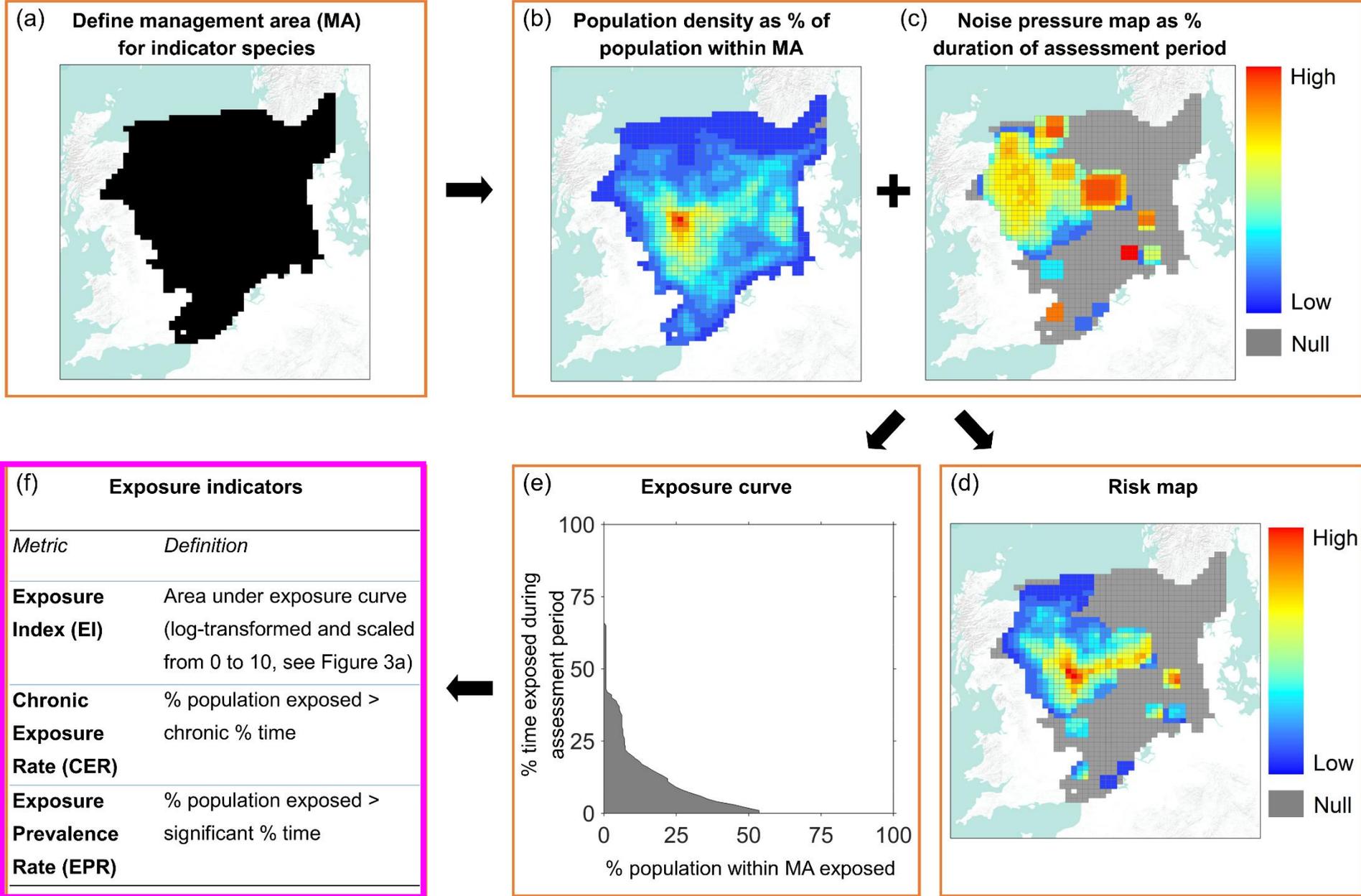
Exposure curve



- % time that a given % of the population (or area) is exposed
- provides quantitative basis for the definition of indicators which track exposure levels



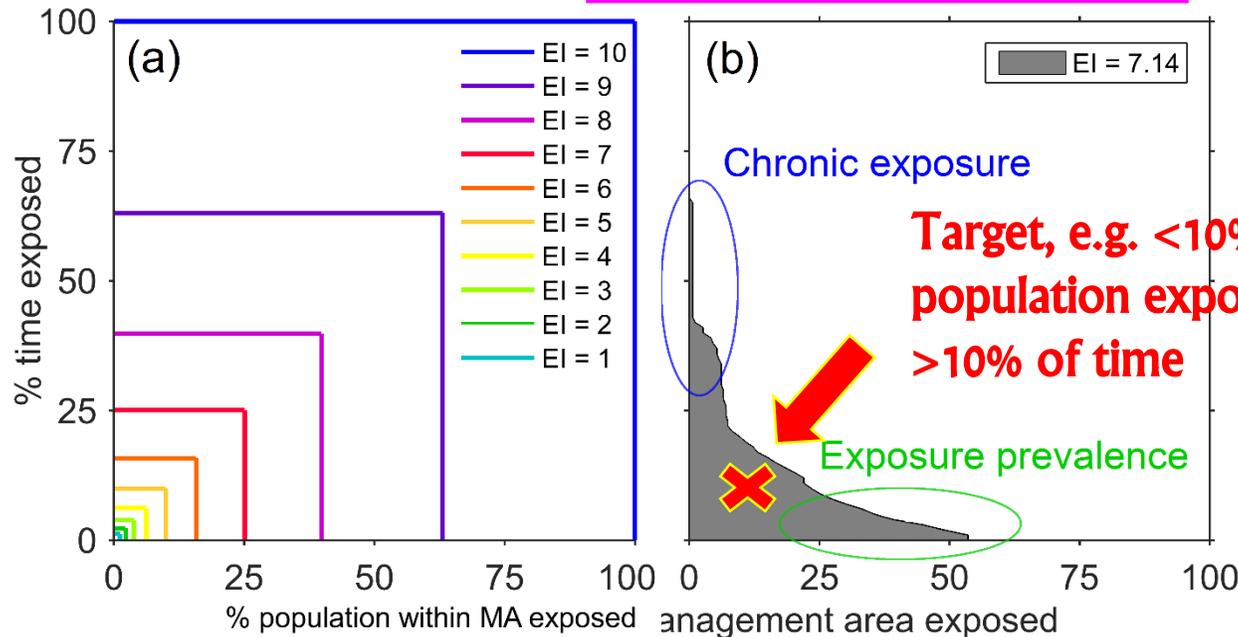
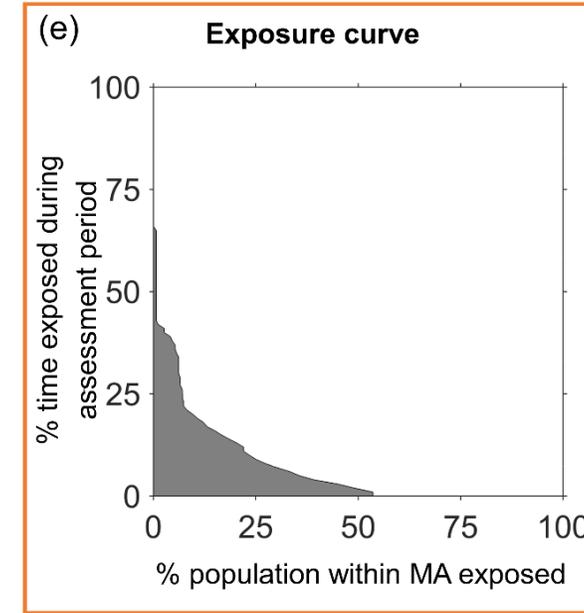
Exposure Indicators



Exposure Indicators

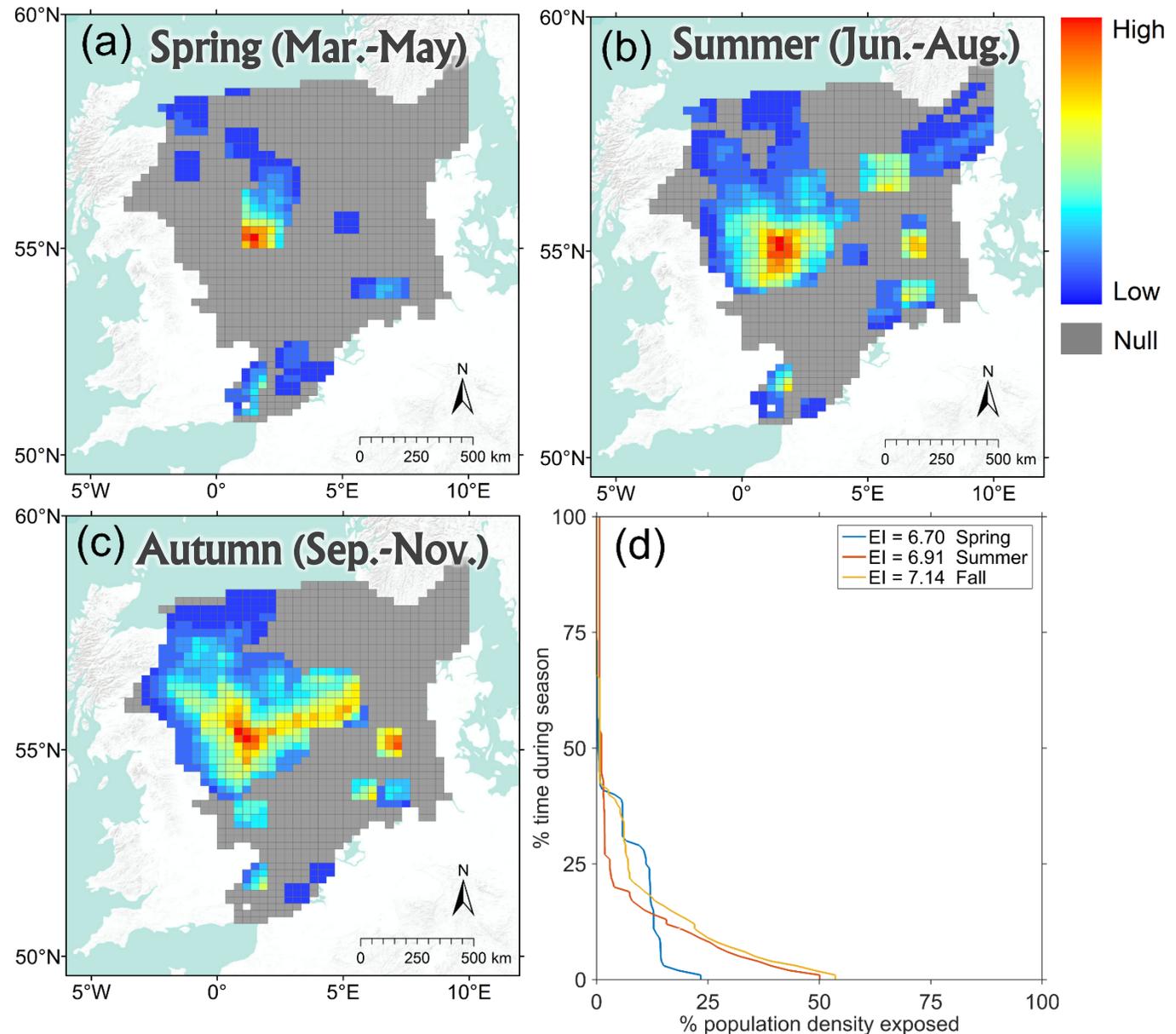
- **Exposure Index (EI)** expresses the overall exposure of the population based on the area under the exposure curve. This area is log transformed and scaled from 0 to 10

(f) Exposure indicators	
Metric	Definition
Exposure Index (EI)	Area under exposure curve (log-transformed and scaled from 0 to 10, see Figure 3a)
Chronic Exposure Indicator (CEI)	% population exposed > chronic % time
Exposure Prevalence Indicator (EPI)	% population exposed > significant % time

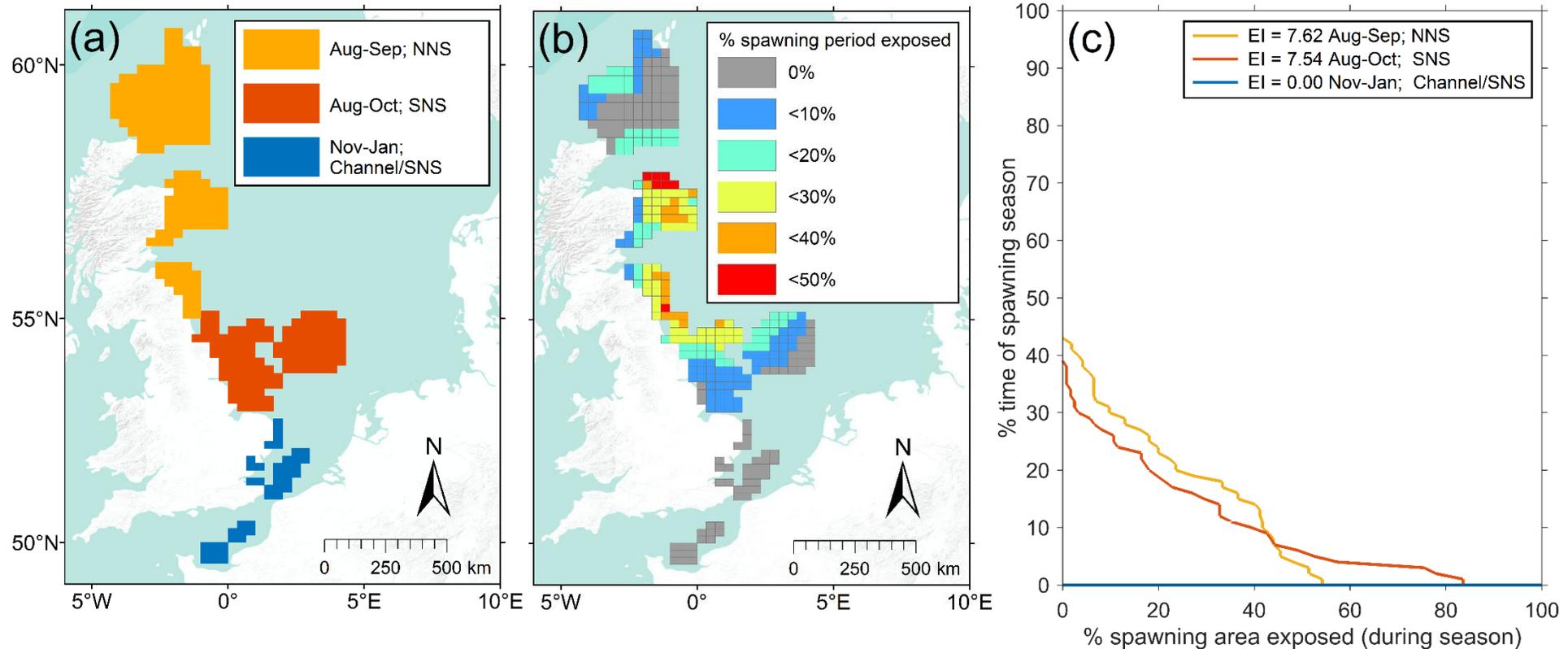


Case study #1: Harbour porpoise

- **Distance of effect:**
~20km
- **Density maps**
modelled based on SCANS II (Gilles et al. 2016) and converted to ICES sub-blocks
- **EI increased with each season**
- **Spring** lowest prevalence, but greatest proportion exposed >20-30% of time
- Shows importance of **Dogger Bank** for population



Case study #2: Herring spawning



- (a) Herring seasonal spawning areas from map used by UK regulators
- (b) % of spawning period exposed, based on distance of effect ~ 37 km (Slotte et al 2004)
- (c) Exposure curves and EI values
- Zero reported exposure for Channel/SNS
- 84% of SNS area exposed during spawning period (high prevalence)
- 10% of NNS area for >30% of spawning season

OSPAR impact indicator

- Methodology published in 2018
- Forms basis of OSPAR Candidate Indicator for risk of impact from impulsive noise
- Assessment due April 2020
 1. Select indicators species
 2. Define Assessment Area
 3. Define Temporal resolution
 4. Density or Area of indicator species
 5. Pressure Maps
 6. Exposure/Risk Map
 7. Exposure curve
 8. Exposure/risk Indicators
 9. Confidence assessment

POLICY PERSPECTIVES

Marine Noise Budgets in Practice

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Keywords

Cumulative effects; ecosystem-based management; marine mammals; marine spatial planning; noise; place-based management; risk-based.

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Abstract

Many countries have made statutory commitments to ensure that underwater noise pollution is at levels which do not harm marine ecosystems. Nevertheless, coordinated action to manage cumulative noise levels is lacking, despite broad recognition of the risks to ecosystem health. We attribute this impasse to a lack of quantitative management targets—or “noise budgets”—which regulatory decision-makers can work toward, and propose a framework of risk-based noise exposure indicators which make such targets possible. These indicators employ novel noise exposure curves to quantify the proportion of a population or habitat exposed, and the associated exposure duration. This methodology facilitates both place-based and ecosystem-based approaches, enabling the integration of noise management into marine spatial planning, risk assessment of population-level consequences, and cumulative effects assessment. Using data from the first international assessment of impulsive noise activity, we apply this approach to herring spawning and harbor porpoise in the North Sea.

Introduction

Anthropogenic noise is becoming widely recognized as a pervasive and significant threat to wildlife (Francis & Barber 2013). In the marine domain, noise pollution displaces animals (Tougaard *et al.* 2009), heightens physiological stress (Rolland *et al.* 2012), interferes with communication (Parks *et al.* 2007), disrupts foraging (Blair *et al.* 2016), and causes auditory damage (McCaulley *et al.* 2003). Various human activities generate underwater noise, including shipping, pile driving, geophysical surveys, and military sonar. Policy makers are now considering how to manage cumulative noise pollution across these sectors, and in some cases have established ecosystem-level goals. For example, the Marine Strategy Framework Directive (MSFD) requires European Union Member States to attain noise levels “that do not adversely affect the marine environment” (Tasker *et al.* 2010). However, such qualitative commitments have yet to be substantiated by concrete and coordinated manage-

of noise budgets: quantitative targets which regulatory decision-makers can work toward. Current noise management (where it exists) largely involves uncoordinated environmental impact assessments executed on a case-by-case basis, without overarching targets to manage cumulative levels of pollution (Wright & Kyhn 2015). To formulate such targets, the risk posed by noise pollution must first be quantified. Recent studies have made progress in this direction by producing risk maps (Erbe *et al.* 2014) and modeling projected changes in population growth due to noise disturbance (King *et al.* 2015; Verfuss *et al.* 2016). These approaches can inform marine spatial planning and the conservation of managed populations, respectively, however, neither offers a mechanism for setting scalable targets which can be cascaded to decision-makers.

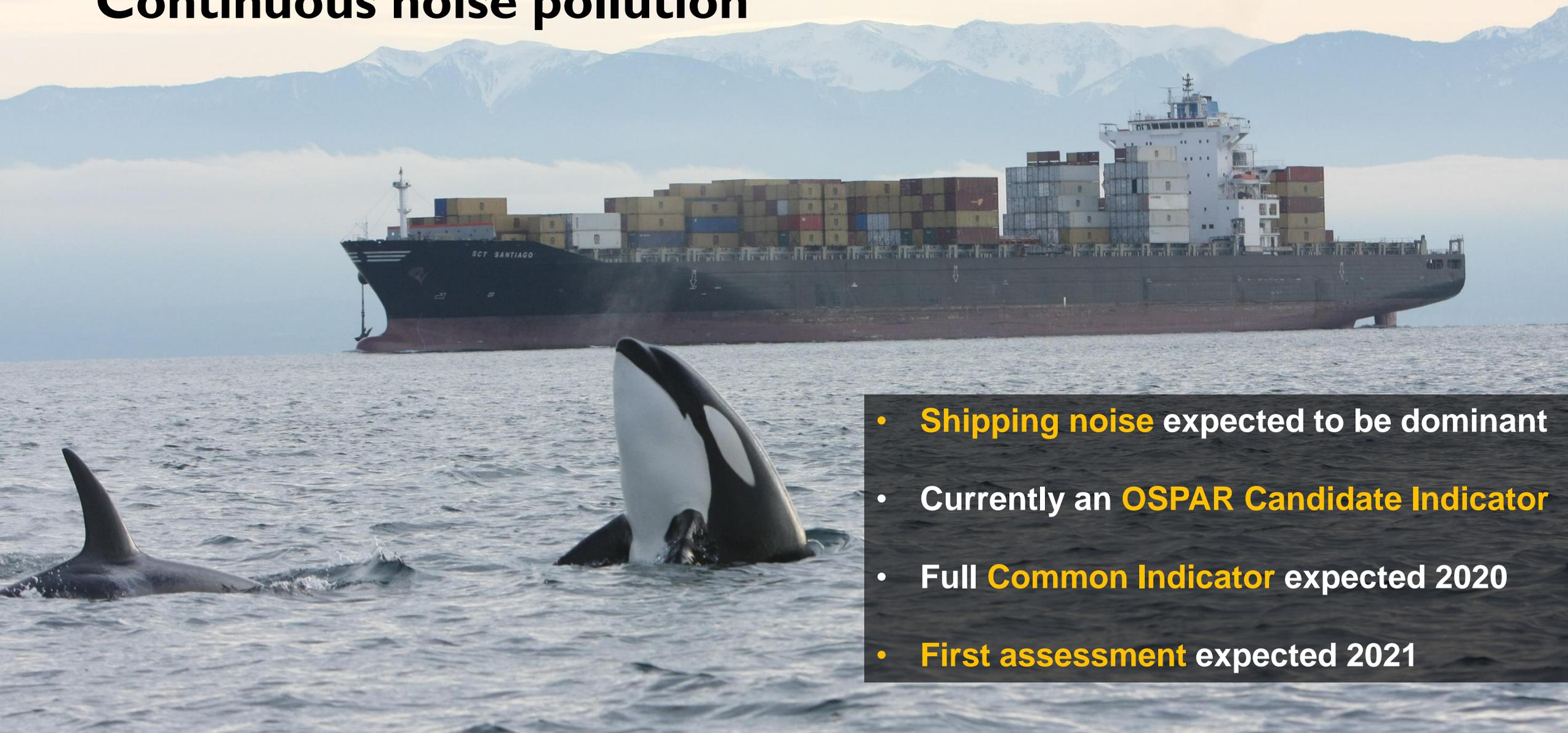
In this article, we define and demonstrate risk-based noise-exposure indicators which address this need, enabling managers to quantify and reduce the exposure of managed populations to noise pollution. We first de-

Impulsive noise: Summary

Pressure from impulsive noise sources now regularly assessed using data in OSPAR Impulsive Noise Registry under OSPAR Common Indicator

Impact: First assessment of risk of impact expected April 2020

Continuous noise pollution



- **Shipping noise** expected to be dominant
- Currently an **OSPAR Candidate Indicator**
- Full **Common Indicator** expected 2020
- **First assessment** expected 2021

Continuous noise: joint monitoring programmes

North Sea

- JOMOPANS project funded by EU INTERREG
- Started Jan 2018
- Field measurements and noise maps for 2019, plus management tools

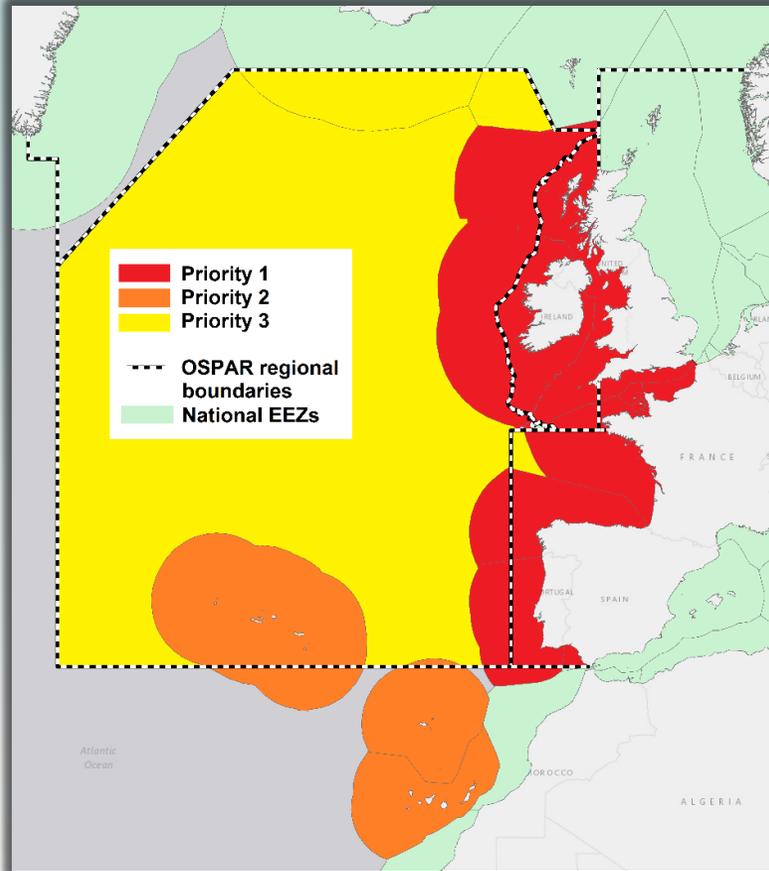


Atlantic Area

- JONAS EU INTERREG project
- Large scale, open ocean habitat
- Started May 2019

Arctic

- No current project proposals
- OSPAR Secretariat in joint initiative with Canada under Arctic Council to address ocean noise



Summary

Impulsive noise

- **Pressure** from impulsive noise sources monitored since 2015 under OSPAR Common Indicator
- **Impact** indicator assessment expected April 2020

Continuous noise

- Currently an OSPAR **Candidate Indicator**
- Full **Common Indicator** expected **2020**
- **Joint monitoring** is ongoing in the North Sea under EU INTERREG project **JOMOPANS**