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Instituto Português
do Mar e da Atmosfera

PRR RP-C21-i07.01

TECHNICAL STUDIES FOR OFFSHORE ENERGY POTENTIAL

2023-2026

Acquisition of multichannel reflection seismics- IPMA

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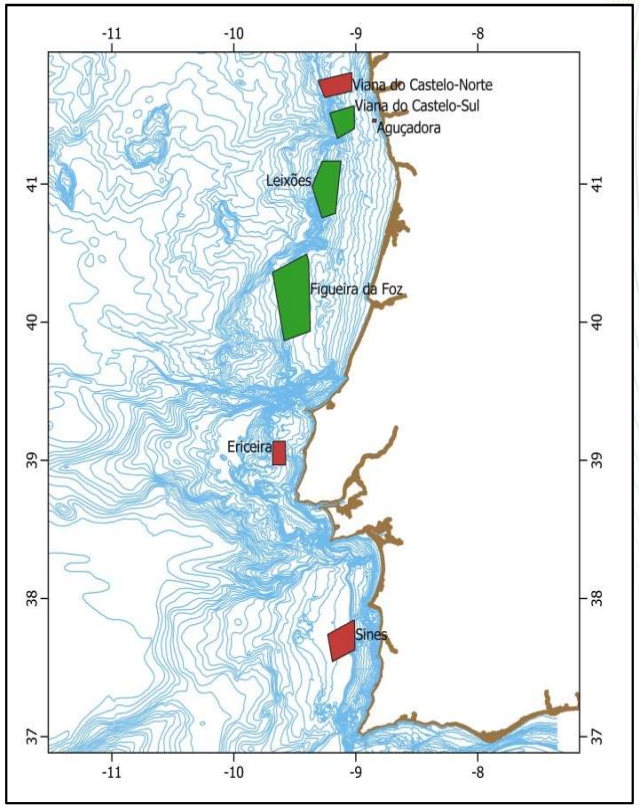
OFFSHORE WIND FARM (OWF) AREAS

Area_ID	Area (km2)	Power (GW)	Distance from coast (nm)		Water depth (m)		
			Max.	Min	Max.	Min.	Mean
Figueira da Foz	1325	4	34.1	21.7	530.4	124.4	178.9
Leixões	644	2	32.3	22.5	324.4	120.0	150.5
Viana do Castelo-Sul	294	1	17.9	10.5	560.1	73.0	110.1
Total	**2 263**	7	---	---	---	---	---

Depth range: – ~50 m to –550 m

IPMA areas: 2 063 km²

IPMA lines: ~21 000 km



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OBJECTIVES OF THE STUDIES

- Provide detailed relevant data on the morphology, geology, geophysics and geotechnical properties of the seafloor
in order to inform OWF developers towards engineering and financial strategies

- Provide relevant data for the definition of environmental status and baseline

Windfloat Atlantic Project (Portugal)

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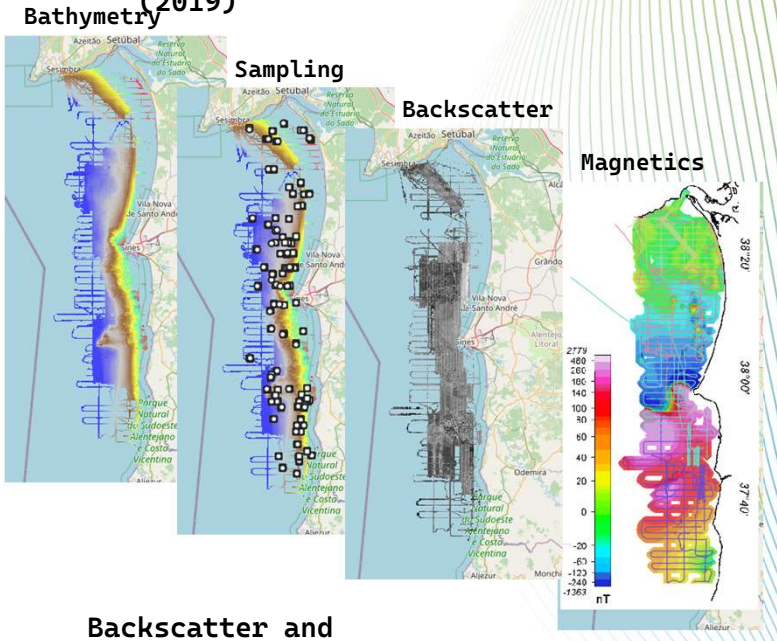
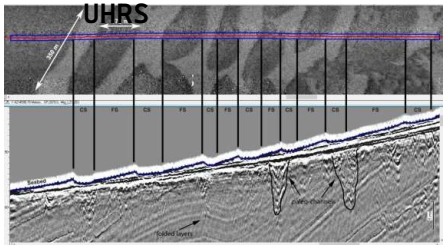
TERMS OF REFERENCE (ToR)

- ToR were established to be followed in the geophysical and geotechnical surveys reconnaissance surveys
- ToR inform on:
  - Study phases:
    1. *Desktop studies*
    2. Geophysical surveys
    3. Geotechnical surveys
    4. Ground model
  - Requirements for data aquisition
  - Requirements for data processing and interpretation
  - Resolution of the data
  - Deliverables:
    - Work plan
    - Reports
    - Data packages: raw data and interpreted/integrated data

Mineplat Project Data Examples (2019)



Backscatter and UHRS



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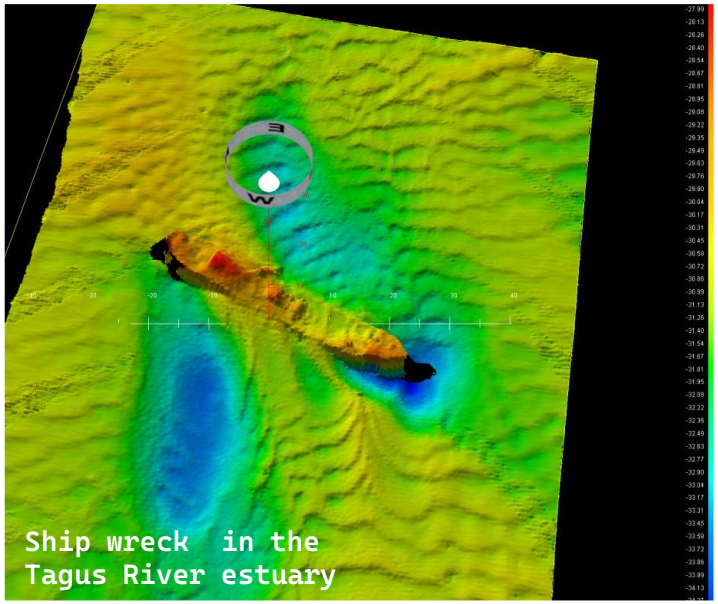
TERMS OF REFERENCE (ToR)

DESKTOP STUDIES

- Data compilation of existent information on:
  - Geology
  - Geophysics
  - Geotechnics
  - Archeology
- Maps
- Report



(IPMA 2020)

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TERMS OF REFERENCE (ToR)

METHODS

- Geophysics
  - Multibeam
    - Bathymetry
    - Backscatter
  - Side Scan Sonar
  - Magnetics
  - Seismic reflection
- Geotechnics
  - Seafloor superficial sediments
  - Vibrocores
  - Cone penetration tests

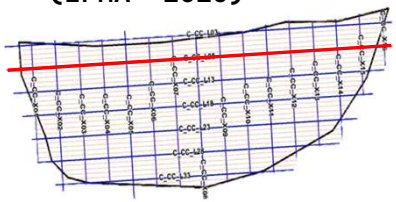
TERMS OF REFERENCE (ToR)

SAMPLING STRATEGY

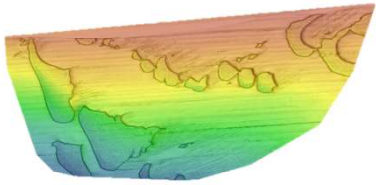
- Requirements:
  - Bathymetry and side scan sonar: total coverage
  - Line spacing:
    - Main lines <= 200m
    - Cross lines <= 600m
  - Two crossings per line
  - Prioritary lines >= 20% of total

- IPMA (2 263 km²)
  => 21 000 km

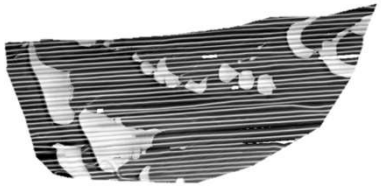
Project CHIMERA, Costa da Caparica (IPMA 2020)



Line position map



Batimetria multifeixe



High backscatter in white

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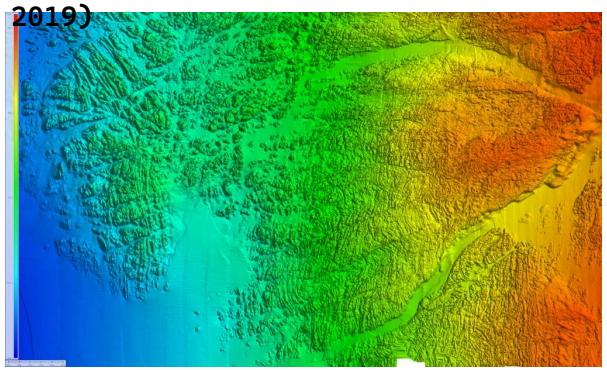
TERMS OF REFERENCE (ToR)

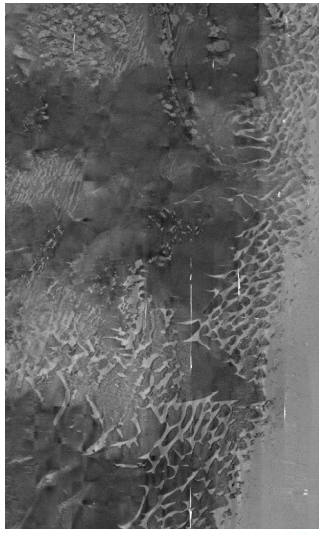
MULTIBEAM BATHYMETRY (MBES)

- Acquisition:
  - Positioning
    - Horizontal: Better than 1 m
    - Vertical: Better than 0.1 m
  - Total coverage with overlap >= 30%
  - Resolution of MDT <= 2% of water depth
  - N° points MDT > 4
  - Frequency of SVP's >= 4 per day

- Processing & Interpretation:
  - Corrections: positioning, acoustic, tide, filtering, reduction to HZ
  - Identification of contacts on UHRS, SSS, MBES and MAG

MINEPLAT project, Alentejo (IPMA 2016-2019)





Backscatter
High backscatter in white

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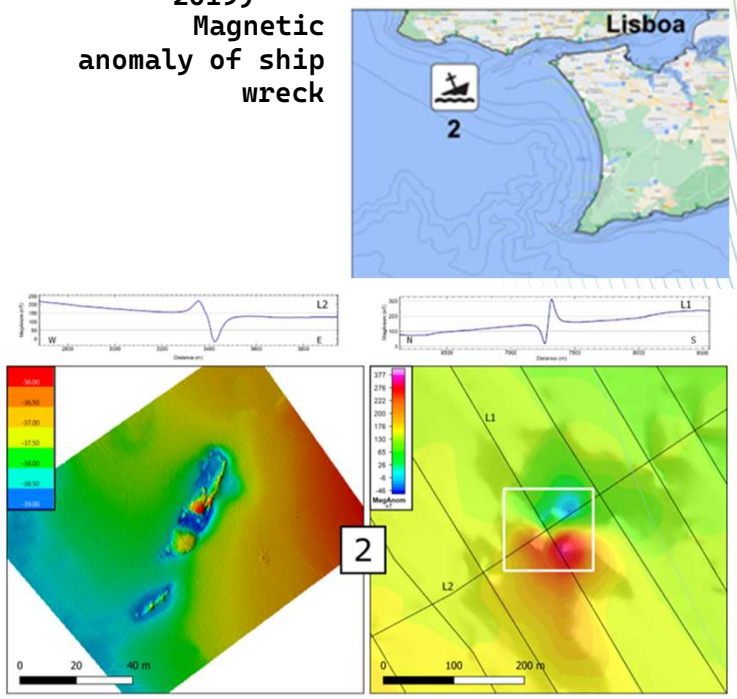
TERMS OF REFERENCE (ToR)

SIDE SCAN SONAR AND MAGNETICS

- Side Scan Sonar
  - Simultaneous acquisition with MBES
  - Positioning by USBL
  - Total coverage including nadir on adjacent line
  - Resolution:
    - Depth < 200m, <= 2m
    - Depth >200m, <= 3m
  - Processing, mosaic, identification of contacts

- MAGnetics
  - Transversal gradiometer (pref.)
  - Positioning by USBL
  - Sensitivity>= 0.01 nT/√Hz
  - Sampling frequency>= 10 Hz
  - Intensity, position and altitude callibration (continuous)
  - Processing, anomalies maps, identification of contacts

Project TAGUSGAS (IPMA 2019)
Magnetic anomaly of ship wreck



Multibeam bathymetry Magnetic anomaly grid

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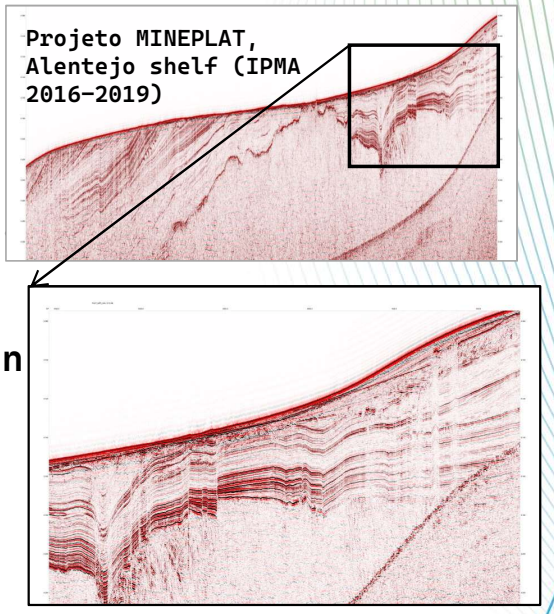
TERMS OF REFERENCE (ToR)

SEISMIC REFLECTION (UHRS / SBP)

- UHRS multi-channel
  - Coverage>= 25% of lines
  - N° de canais /streamer >= 48
    - Spacingde 3.125m to 1 m
  - Offset:Max.80m , Min.1/4 Depth
  - Penetration >= 100 m
  - Vertical resolution < 1m
  - *CMP* spacing (on*stack*) < 1.57m
  - Trace spacing <= 1.5m
  - Vertical resoltion < 1.5m
  - CMP spacing (on stack) < 1.57m
- Sub Bottom Profiler
  - Total coverage
  - Penetration >= 3m
  - Vertical resolution <= 0
  - Complete wave at 24 bits
- Processing and interpretation

- UHRS single-channel
  - Streamer: 8 a 24 hidrofones
  - Active section w. 2m to 8m
  - Offset: Max.150m, Min.5m

Multichannel Seismic



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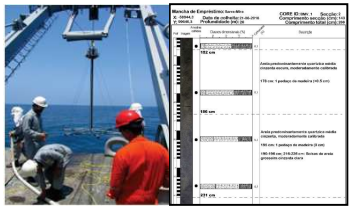
TERMS OF REFERENCE (ToR)

GEOTECHNICS

- Superficial Sediments (SED)
  - Van Veen / Smith-McIntyre dredges
  - Sampling density >= 0.1 sample./km^2
  - Analysis:
    - Granulometry
    - Density and porosity
    - C_{org} and $CaCO_3$
    - 1/3 of samples:
      - Trace metals
      - Organic pollutants
      - Benthic macrofauna
- Vibrocores (AVC)
  - Length >=3m, Pref. 6m
  - Diameter >= 10cm
  - Vibration frequency (pref. >= 28Hz)
  - Sample density >= 0.05 cores/km^2
  - Analises:
    - Colour (spectrophotometry)
    - Magnetic susceptibility
    - P-wave velocity
    - X-ray logging
    - Ages N° >= 0.3/m
    - SED analysis in subsamples each <= 50 cm:
- Cone penetration Tests (CPT)
  - Depth target >= 15m
  - Sampling density >= 0.02 CPTs/km2

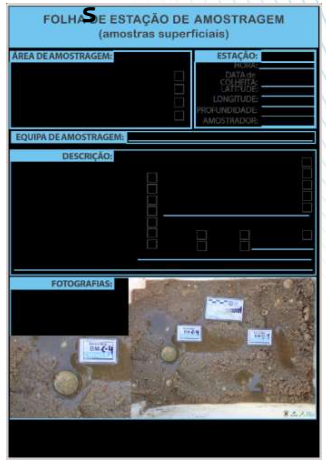
CPT

Vibrocore



Surface sampling

Geotechnics



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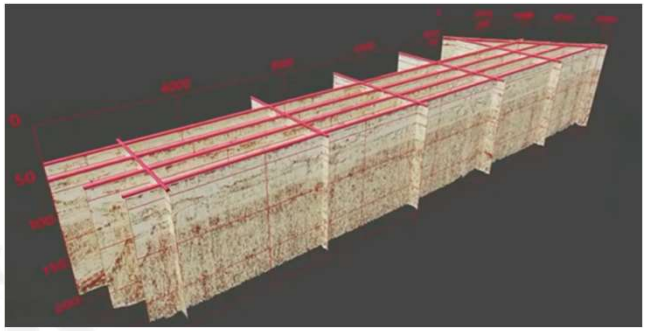
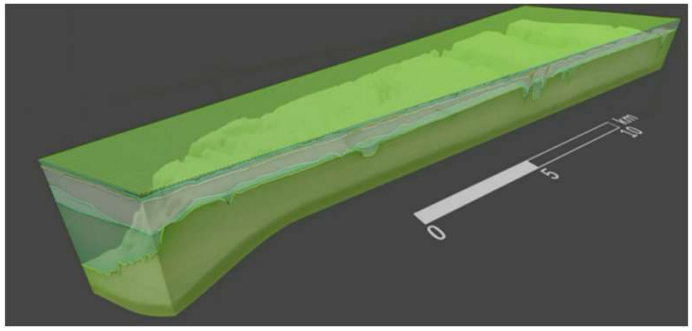
TERMS OF REFERENCE (ToR)

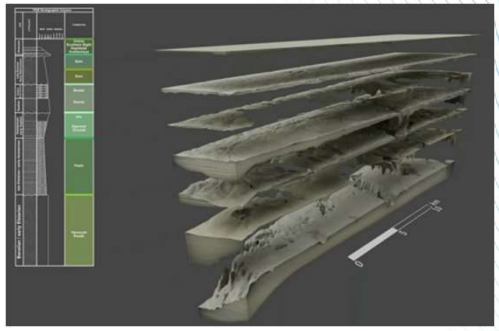
TERRAIN MODEL

- Data intercalibration
- Integrated data interpretation
- Terrain model
- Final report

Terrain model
Tem noorden van de Waddeneilanden (RVO, 2022)







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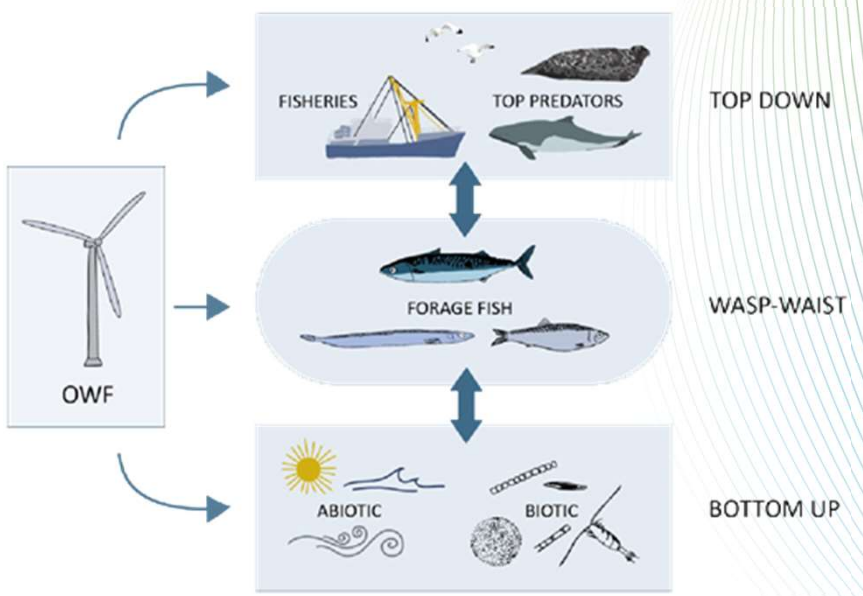
TERMS OF REFERENCE (ToR)

ENVIRONMENT

- Contaminants in the water column
- Circulation and upwelling patterns
- Productivity in the water column, plankton and non-indigenous species (NIS)
- Plankton dispersal patterns
- Structure and sediment contamination
- Chemical contaminants in fish and other products
- Benthic fauna communities (incl. NIS)
- Vulnerable Marine Ecosystems (VMEs)
- Communities of demersal, pelagic, pelagic migratory organisms
- Seabirds, marine mammals and reptiles
- Trophic webs
- Fishing activity
- Storage, data management and information mapping



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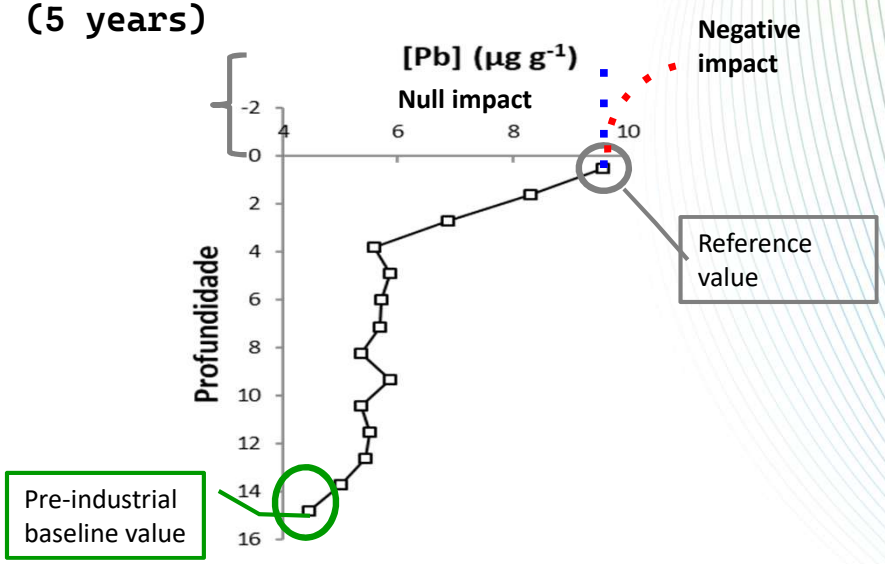
KEY STUDY

STRUCTURE AND SEDIMENT CONTAMINATION

Evaluate potential transfer of contaminants from structures (marine litter due to coating flaking, persistent organic pollutants from paints) and galvanic protection anodes (metals)
Contaminants in the water column

Establish the contamination reference values by:
- Metals
- Persistent Organic Pollutants
- Marine litter
- Microplastics

FUTURE
(5 years)



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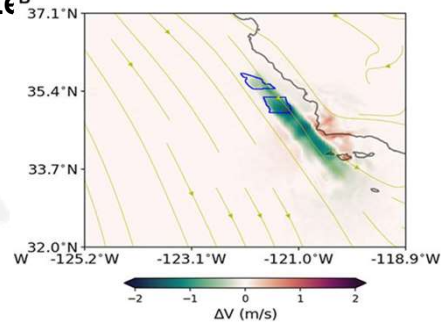
CIRCULATION AND UPWELLING PATTERNS

KEY STUDY

Potential Impacts

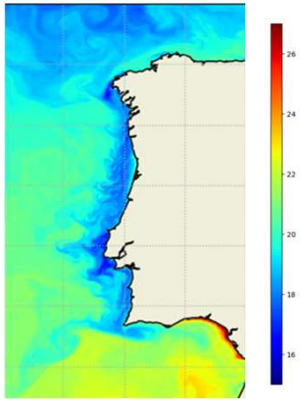
- Shadow effect: change in upwelling patterns due to localized reduction in wind
- Appearance of upwelling/downwelling cells in regions adjacent to wind farms
- Changes in the positions of filaments, vortices and coastal jets, which in turn affect the dispersal of eggs and larvae



Decrease in the N-S wind speed component; coast of California (Raghukumar et al. 2022) https://doi.org/10.3389/fenrg.2022.863995

Study

- Characterization of the mean circulation and dispersal patterns of eggs and larvae of marine organisms using modelling tools
- May be repeated in the future in the presence of wind farms to assess possible impacts



Example of ocean model output. Sea surface temperature (SST), 1/8/2006. Upwelling front with several visible filaments.

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KEY STUDY

BENTHIC FAUNA COMMUNITIES ASSOCIATED WITH SEDIMENTARY AND ROCKY BOTTOMS

- Community composition
- Detection of non-indigenous species
- Diversity indices, multimetric indices for assessing the state of ecological quality
- Identification and assessment of the conservation status of Vulnerable Marine Ecosystems (VMEs)

Image:
Benthic Studies Laboratory,
campaign CMT2022

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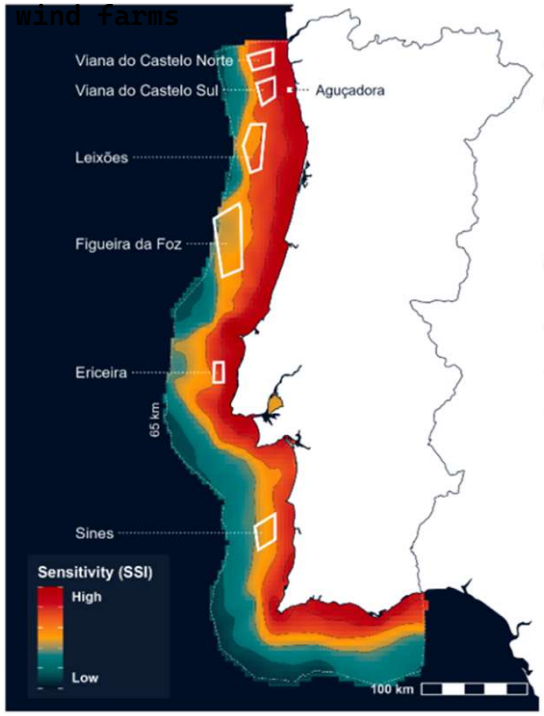
KEY STUDY

ABUNDANCE, DISTRIBUTION, MIGRATORY FLOW AND BIODIVERSITY OF SEABIRDS

- Characterization of communities
- Abundance assessment
- Spatial distribution
- Migratory flows of the main species)

(flight altitude, flight maneuverability, percentage of time in flight activity, night flight activity, susceptibility to disturbance, flexibility in habitat use, biogeographic population, adult survival rate, threat and conservation status)

Seabird Sensitivity to marine wind farms



To be developed by SPEA

spea

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