Report

Seabirds and Offshore Wind Development in Portugal

Mapping the Way Forward

Developed by

Contributed by

Supported by

June 2024

Seabirds and offshore wind development in Portugal: mapping the way forward

SPEA – Portuguese Society for the Study of Birds

Project coordination

Joana Andrade

Executive team

Ana Almeida, António Vulcano, Hany Alonso, Joana Andrade e Nuno Barros.

Reference

Barros, N., A. Vulcano, A. Almeida, H. Alonso & J. Andrade. 2024. Seabirds and offshore wind development in Portugal: mapping the way forward. Portuguese Society for the Study of Birds, Lisboa (unpublished report).

Acknowledgments

This report was supported by the Oceano Azul Foundation. We acknowledge contributions from Birdlife partners (VBN, NABU, Natuurpunt). We are grateful to our colleagues Maria Dias, João Guilherme and Beatriz Morais for their availability and commitment to the sensitivity mapping study.

Index

1. Summary 4

2. Background and energy targets 5
- 2.1 - At EU level 5
- 2.2 - In Portugal 8
- 2.3 - The way forward 9

3. The importance of Portuguese continental waters for seabirds 11
- 3.1 - Breeding seabirds 11
- 3.2 - Wintering seabirds 11
- 3.3 - Migratory seabirds 12

4. Offshore Wind development and potential impacts on seabirds 14
- 4.1 - Sensitivity mapping 16

5. Offshore Wind development in Portugal 21
- 5.1 - State of play 21
- 5.2 - Renewable Acceleration Areas (RAAs) 23
- 5.3 - Recommendations for mapping RAAs 32
- 5.4 - RAAs designation in Portugal - a general overview 34
- 5.5 - Case studies 35

6. Auction format and criteria 38
- 6.1 - State of play 38
- 6.2 - Non-price criteria 39
- 6.3 - Case studies on social and ecological criteria 40
- 6.4 - Recommendations 44

7. Monitoring 47
- 7.1 - General considerations 47
- 7.2 - Case studies 49
- 7.3 - Recommendations 50

8. Mitigation 53
- 8.1 - The mitigation hierarchy 53
- 8.2 - Case studies 57
- 8.3 - Recommendations 57

9. References 60

1. Summary

Offshore wind energy stands as a critical component of Portugal's renewable energy strategy, pivotal in mitigating climate change by reducing reliance on fossil fuels. However, its expansion must be carefully managed to avoid adverse impacts on marine biodiversity. While wind power offers significant benefits in terms of reducing carbon emissions, its implementation necessitates meticulous planning, mitigation strategies, and adherence to environmental regulations.

Seabird populations, which rely on Portuguese waters throughout the year for breeding, wintering, and migration, face significant threats from the expansion of offshore wind farms. Challenges include disturbances during construction, operation, and decommissioning phases, increased maritime traffic leading to collisions, alterations to habitats, and disruptions to flight paths and foraging areas. These impacts can compound existing pressures from human activities like bycatch and overfishing.

To address these challenges, robust research, empirical validation, and cumulative impact assessments are imperative. Sensitivity mapping, exemplified by initiatives like those led by SPEA and cE3c, provides essential insights for balancing renewable energy development with marine ecosystem conservation. These maps guide decision-making processes by identifying areas unsuitable for offshore wind development, safeguarding critical bird habitats and migratory routes.

Recommendations for offshore wind energy development underscore the importance of stakeholder engagement, transparent criteria, and ecological considerations. Non-price criteria, encompassing ecological and social factors, play a crucial role in ensuring the sustainability of projects. Strong baseline characterization, coordination of survey efforts, and transparent mitigation strategies are essential for minimising environmental impacts and ensuring project success.

The mitigation hierarchy, which prioritises avoidance, minimization, and offsetting of impacts, serves as a guiding principle for sustainable project development. Avoidance, achieved through strategic siting and spatial planning informed by sensitivity mapping, is deemed the most effective approach due to its lower costs and higher likelihood of success. Each step in the hierarchy requires thorough implementation, with a focus on minimising adverse effects on marine wildlife.

In essence, sustainable offshore wind development hinges on robust monitoring, stakeholder engagement, and adherence to ecological principles. By integrating these considerations into project planning and implementation, Portugal can achieve its renewable energy goals while safeguarding marine biodiversity and supporting local communities.

2. Background and energy targets

Climate change is one of the greatest threats to people and biodiversity. Renewable energies can mitigate climate change by reducing dependence on fossil fuels and consequently greenhouse gas emissions.

Wind energy is one of the most commercialised renewable technologies and the focus is increasing on the marine environment. At the same time, a series of grid infrastructures are also planned in the open sea in order to transport the energy produced to land.

In addition, other marine renewable energy technologies (tides, waves, currents, floating solar) are at different stages of technical and economic feasibility and have advantages and disadvantages in terms of complementing the variability of wind energy production.

Depending on the speed of their development and their impact on biodiversity these technologies could become increasingly important over the next decade.

2.1 At EU level

Under the 2030 Climate and Energy Framework (1), the European Union has set targets for reducing greenhouse gas emissions by 42% compared to 1990 levels by 2030 and by 80-95% by 2050; increase the share of renewable energy to 32% of final energy consumption; and to improve energy efficiency by 32.5% by 2030.

The REPower EU plan (2) has proposed increasing this target to at least 45% by 2030. In addition, the EU has committed itself to achieving carbon neutrality by 2050.

(1) https://data.consilium.europa.eu/doc/document/ST-169-2014-INIT/en/pdf
(2) https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

To ensure that offshore renewable energy can help reach the EU's ambitious energy and climate targets for 2030 and 2050, the Commission published a dedicated EU strategy on offshore renewable energy on 19 November 2020 (3) which proposes concrete ways forward to support the long-term sustainable development of this sector. It sets targets for an installed capacity of at least 60 GW of offshore wind and 1 GW of ocean energy by 2030, and 300 GW and 40 GW, respectively, by 2050.

More recently, in 2023 (4), EU countries have agreed on new, ambitious long-term goals for the deployment of offshore renewable energy (4) up to 2050 in each of the EU's five sea basins, with intermediate objectives to be achieved by 2030 and 2040. The European Union installed more than 3 GW of new offshore wind energy capacity in 2023; offshore wind installations (5) will rapidly pick up towards the end of the decade and will be, by 2030, almost the same as new onshore installations.

The combined figures give an overall ambition of installing approximately 111 GW of offshore renewable generation capacity by the end of this decade - nearly twice as much as the objective of at least 60 GW set out in the EU Offshore Renewable Energy Strategy in November 2020. This then rises to around 317 GW by mid-century, reaching the goal of the Strategy.

Overall, the situation for Europe's wind industry looks promising. Investments in new wind farms are up and auction volumes are at record levels. More permits are coming through and the supply chain is returning to profit. Governments are committing to take actions, and have recently endorsed the EU Wind Power Package and European Wind Charter to speed up implementation, offering financial support to the wind industry through the Innovation Fund and the European Investment Bank.

The EU policy framework aims not only to combat the climate crisis, but also to increase energy efficiency and security. This will only be successful if renewable energy expansion and replacement of fossil fuels is combined with significant increases in energy efficiency and drastic reductions in energy consumption and material use. Additionally, protecting and restoring nature and biodiversity both on land and at sea, is of pivotal importance to ensure that rapid acceleration of renewable energy does not jeopardise the environment, ecosystems and natural resources we depend upon, hence the need of having a climate nature friendly energy transition.

Spotlight on the Renewable Energy Directive and the Renewable Acceleration Areas

The Renewable Energy Directive (RED)113 is the legal framework for the development of renewable energy across all sectors of the EU economy. Among its general objectives are

(3) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:741:FIN&qid=1605792629666
(4) https://energy.ec.europa.eu/news/member-states-agree-new-ambition-expanding-offshore-renewable-energy-2023-01-19_en
(5) Wind Europe - WindEurope - the voice of the wind energy industry

higher EU renewable energy targets (42,5% by 2030), the identification of Renewables Acceleration Areas (RAAs), the speeding up of permit-granting procedures for projects, and facilitating power purchase agreements. MS need to update their **National Energy & Climate Plans (NECPs)** by June 2024, indicating what their fair share of installed renewable energy should be towards the overall EU target. The Directive qualifies **RES (Renewable Energy Systems) as Imperative Reasons for Overriding Public Interest (IROPI)** under the EU Nature Directives (which comprise the Habitats and Birds Directives), which means that by 3 months after the entry into force of the amended version of the RED (24 October 2023), until climate neutrality is achieved, MS shall ensure that, in the permit granting procedure, the planning, construction and operation of renewable energy plants, the connection of such plants to the grid, the related grid itself, and the storage assets are presumed as being in the overriding public interest and serving public health and safety.

RAAs should be based on sensitivity maps or any other appropriate tool that carries out a Strategic Environmental Assessment (SEA). Member States (MS) are given 18 months for the mapping for the deployment of renewable energy in their territory (renewable energy and related grid infrastructure) needed to meet nationally determined contributions towards renewable energy targets. MS have 27 months to adopt plans that designate a subset of areas as renewable acceleration areas: they should give priority to artificial and built surfaces (such as rooftops and transport infrastructure), and exclude Natura 2000 sites, other PAs and major bird and mammal migratory routes, as well as other areas determined on the basis of sensitivity maps and other tools (except for built surfaces), using appropriate tools for determining areas where plans would not have significant environmental impacts, and establish appropriate rules for effective mitigation measures to be adopted in order to avoid adverse environmental impacts.

Before their adoption, plans shall be subject to a SEA or an Appropriate Assessment (AA). This needs to be done even if a project is not within a Natura 2000 site but may have an adverse impact on the biodiversity within such sites. Within 6 months, MS may declare areas as RAAs which have already been determined to be suitable for accelerated development, if the plans have been subject to a SEA (or AA), if projects have appropriate mitigation measures. The acceleration of the permitting process (Article 16 of the RED) states that the permitting of offshore projects within RAAs is limited to a period of 2 years. The acceleration of the permitting process also hinders environmental standards, as it is exempt (except for any impacts on Natura 2000 sites) from Environmental Impact Assessments (EIA) unless it is proven to have a significant effect on the environment. Competent authorities need to give explicit reasons for requiring an EIA, and if so, within 6 months. If there is a negative impact on species protection, the operator would have to pay monetary compensation to the species protection programme for the duration of the operation of the development. Until February 2026, MS can designate RAAs for one or more renewable energy sources.

Although it is welcoming to see that the RED facilitates the acceleration of the permitting process to speed up renewable energy developments, which is very much needed to ensure a rapid energy transition at sea, it is essential to prioritise the protection and restoration of marine ecosystems alongside the expansion of offshore renewables. This requires concerted efforts from both industry and governments to minimise impacts on nature from renewable energy developments, rectify any residual harm, and implement ambitious and large-scale measures to restore and enhance nature at sea by reducing and removing existing pressures. With sensitivity maps, MS can achieve the strategic spatial planning of offshore wind development. Maps can help to speed up existing planning processes and inform and corroborate (but not substitute) EIAs once sites are selected for development.

A robust evidence-base of potential ecological impacts of offshore wind farms and offshore transmission grids during the different phases of their lifecycle (e.g., construction, operation, decommissioning) is of paramount importance to ensure that developments minimise harm to nature. Baseline data of at least 2 years are necessary for a sufficient description of species occurrence and long-term monitoring programmes are vital to fill knowledge gaps and address uncertainties about the magnitude and extent of the long-term impacts of offshore wind. The mitigation hierarchy should inform measures to firstly avoid and then to mitigate negative impacts on nature, starting from the planning phase. When it comes to seabirds, numerous species have exhibited consistent and pronounced avoidance behaviour when encountering offshore wind farms. Various studies highlight the lower abundance of many different species and families of seabirds, such as gulls, terns, auks, and gannets within wind farms compared to areas outside, hence proper spatial planning is key to avoid displacement.

2.2 In Portugal

The Portuguese government goes even further and aims to achieve carbon neutrality by 2045, reiterating its goal "to increase the share of renewable energies in electricity production to 80% by 2026, 4 years ahead of the target set in the National Energy and Climate Plan." (6)

This target will only be achieved if the expansion of renewable energy is combined with a significant increase in energy efficiency and a sharp reduction in final energy consumption – and offshore renewable energy is set to be a big contributor for these targets.

(6) https://www.jornaldenegocios.pt/empresas/energia/detalhe/governo-reitera-meta-de-aumentar-para-80-opeso-das-renovaveis-ate-2026

Based on the dispatch of the Minister of Economy and Sea 4760/2023 from April 20 (7), the Directorate-General for Natural Resources, Security and Maritime Services (DGRM), the entity responsible for planning the national maritime space, prepared the proposal of the Allocation Plan, which will automatically update the Portuguese Maritime Spatial Planning Situation Plan - PSOEM, creating potential areas for the commercial exploitation of offshore renewable energy.

The National Energy and Climate Plan 2030 (PNEC 2030) (8), approved by Council of Ministers Resolution 53/2020 (9), is the main energy and climate policy instrument for the 2021-2030 period. The ambition of this plan was reinforced in the first version of the revision of the PNEC 2030, presented on 30 June 2023, in which a target of 2 GW was set for ocean-going wind technology and the government assumed the ambition of allocating a capacity of 10 GW by 2030, through competitive procedures.

At the same time, the Allocation Plan (public consultation version) made available by the Portuguese Government set the same target of 10 GW by 2030, with an initial stage of 3 GW in 3 areas to enter auction procedures. This is a very ambitious target that surpasses neighbouring countries such as Spain, that being much bigger in area, committed to achieving 3 GW by 2030.

2.3 The way forward

The development of offshore wind energy can help to contribute towards reaching the EU target of cutting CO2 emissions by 55%. However, biodiversity loss and ecosystem health must not be overshadowed when implementing measures to reduce greenhouse gas emissions.

Energy infrastructure for primary energy generation and distribution, including renewables and related grid networks, can have damaging consequences for nature if poorly sited in important areas for wildlife – and in the ocean, things are no different.

However, with careful planning, site selection, management and mitigation, offshore wind power can make a significant contribution to reducing climate risks to nature and people with minimal short-term species and sites' conservation risks.

Offshore wind and other marine renewable energy developments, and related network and energy infrastructure, all need to be planned, built and operated with respect for nature conservation and according to ecological capacities if they are to provide a sustainable solution to climate change.

(7) https://diariodarepublica.pt/dr/detalhe/despacho/4760-2023-212075877
(8) https://www.portugalenergia.pt/setor-energetico/bloco-3/
(9) https://files.diariodarepublica.pt/1s/2020/07/13300/0000200158.pdf

All impacts to marine wildlife and ecosystems, and its appropriate monitoring and mitigation need to be carefully assessed and regulated before licences are granted. It is necessary to have sufficient baseline information on distribution, abundance and trends within the area of potential effect. It has been recommended that at least two years of baseline data are necessary for a sufficient description of species occurrence (Diederichs et al. 2008) taking into account that our knowledge of the environment and species distributions tends to be lower further offshore and in deeper waters (Adaramola 2015) (10).

Marine renewable energy installations and associated grid infrastructure should not jeopardise compliance with environmental legislation, but rather contribute to legal synergies and implementation in all relevant legal frameworks. This includes achieving the objectives of the EU Nature Directives (Birds and Habitats Directives) and the Marine Strategy Framework Directive (MSFD). International legislation and Multilateral Environmental Agreements (MEAs) place considerable emphasis on avoiding harmful effects from renewable energy projects.

Research and data collection on the impacts of offshore renewable energy infrastructure on marine biodiversity is insufficient. It is imperative that independent and rigorous monitoring and research programmes are implemented, funded by the national government and the energy sector, in consultation with the relevant experts. Special attention should be paid to migratory routes (including for terrestrial species crossing bodies of water, such as birds and bats), breeding areas and feeding grounds.

(10) WWF. (2014). Environmental Impacts of Offshore Wind Power Production in the North Sea A Literature Overview.

3. The importance of portuguese continental waters for seabirds

3.1 Breeding seabirds

The main seabird colonies to be found in mainland Portugal are concentrated in the Berlengas archipelago where the only known colonies of Procellariiformes can be found. In this archipelago, the most recent estimates (2015) point to 800- 975 breeding pairs of Cory's Shearwater *Calonectris borealis* and 410-784 pairs of Band-rumped Storm Petrel *Hydrobates castro* (Oliveira et al. 2016).

The archipelago also hosts around 62 pairs of European Shag subspecies *Gulosus aristotelis aristotelis* (Del Moral & Oliveira 2019), 2,397 pairs of Yellow-legged gull *Larus michahellis* and about a dozen pairs of Lesser Black-backed Gull *Larus fuscus* (Catry et al. 2010, Oliveira et al. 2022).

Other important seabird colonies on mainland Portugal can be found at Ria Formosa, Algarve. This SPA harbours small colonies of breeding Little terns *Sternula albifrons*, with a total of 580 pairs recorded in 2024 (N. Oliveira, personal communication), as well as a significant breeding population of Audouin's Gull *Larus audouinii.* This last species is classified as Vulnerable (VU), and Barreta Island is currently, at a global scale, the most important nesting site for the species, harbouring 7292 pairs in 2024 (N. Oliveira, personal communication). Small numbers of Common Tern *Sterna hirundo* and Black-headed Gull *Larus ridibundus* can be found breeding in large estuaries along the coast (e.g., Tejo, Sado, Aveiro).

3.2 Wintering seabirds

The Portuguese coast also has a very diverse list of non-nesting seabird species throughout the year. For many seabirds, the waters off mainland Portugal are transit territories between the North Atlantic, the South Atlantic and the Mediterranean Sea, representing part of a flyway between their breeding and wintering territories – the so-called East Atlantic Flyway - or just another stage in their long journeys of dispersal across the open ocean.

For some species and populations of seabirds, the Portuguese EEZ is also an important wintering site ground, with birds spending several months feeding in Portuguese waters.

Some of the non-breeding seabird species that use the continental EEZ do so in numbers considered important, relatively to their global or European populations, such as the Critically Endangered (CR) Balearic Shearwater *Puffinus mauretanicus*, the European Storm Petrel *Hydrobates pelagicus*, the Northern Gannet *Morus bassanus*, the Great Skua *Catharacta skua* and the Mediterranean Gull *Larus melanocephalus.*

The non-breeding season is also the time of the year that harbours the largest diversity of gull species, and when alcids such as the Razorbill *Alca torda* or the Atlantic Puffin *Fratercula arctica* are more abundant.

In the specific case of the Balearic shearwater, a large part of the world's population is present in Portuguese continental waters during the non-reproductive period, which is mainly during the summer and autumn months (Catry et al. 2010), highlighting the importance of areas such as the Cabo Raso IBA/SPA and Aveiro-Nazaré IBA/SPA (Ramírez et al. 2008) for this threatened and protected species.

3.3 - Migratory seabirds

During migration seasons, the number of seabird species travelling through our waters increases dramatically. Some are exclusively passage migrants, such as the Great Shearwater *Ardenna gravis*, the Sooty Shearwater *Ardenna grisea* or the Arctic Jaeger *Stercorarius parasiticus.*

However, significant migratory fluxes are also recorded for seabird species that also have a wintering population, such as the Northern Gannet, Lesser Black-backed Gull or Sandwich Tern *Thalasseus sandvicensis.*

To illustrate the intensity of the migratory passage of seabirds along the Portuguese coast, more than 300,000 birds were registered migrating southwards from land at Cape Carvoeiro by Elmberg et al. (2015) in 90 days of monitoring on a single autumn migration season.

For some species like the Northern Gannet, the entire European population migrates through Portuguese Coastal waters during their migrations. Their numbers are especially high between January and March (pre-breeding migration) and also in October and November (post-breeding migration) in which the passage rate can be higher than 500 birds per hour. On days of highest migratory intensity, the passage rate can exceed 2500 birds per hour in Cape São Vicente (Monitoring Program 'Dias RAM') and 2000 birds per hour in Cabo Carvoeiro (Elmberg et al. 2020).

Table 1. The 10 most abundant seabird species during post-breeding migration in 2015, including passage rates and dates of passage peaks, adapted from Elmberg at al. 2015.

Species	Total counts	Estimated totals	Max passage rate(bird/h)	Passage peak	Migratory passage period
Morus bassanus	207 608	415 000	2 240	01/Nov	43% btw 3 Oct – 13 Nov
Calonectris borealis	32 281	65 000	1 041	06/Nov	50% btw 24 Oct - 13 Nov
Puffinus puffinus	16 086	-	1 042	16/Sep	94% btw 12-18 Sep
Puffinus mauretanicus	15 222	30 000	114	16/Sep	88% btw 12 Sep – 13 Nov
Melanitta nigra	6 346	-	155	01/Nov	75% btw 1 Oct – 13 Nov
Thalasseus sandvicensis	5 661	-	87	12/Sep	71% in Sep
Catharacta skua	3 877	-	45	16/Sep	92% btw 5 Sep – 13 Nov
Ardenna grisea	2 874	-	119	16/Sep	71% in Sep
Stercorarius parasiticus	1 146	-	33	16/Sep	52% btw 12-18 Sep
Stercorarius pomarinus	1 124	-	19	16/Sep	72% btw 22 Aug - 3 Oct

The movements of seabirds, especially those that prioritise gliding, are highly dependent on wind speed and direction, so seabirds tend to follow the direction of the prevailing winds in order to optimise energy expenditure (González-Solis et al. 2009).

During the summer and autumn, the prevailing winds (which in the EEZ of mainland Portugal blow from the northern quadrant) mean that seabirds migrating across the Atlantic tend to cross our EEZ in high numbers in the post-breeding/autumn migration – roughly August – November, depending on the species.

At specific times of the year, many hundreds of thousands of seabirds travel the entire latitudinal length of the Portuguese coast, both on their way to wintering areas and on their way back to their nesting areas. For this reason, in addition to their location, the size and shape of the proposed areas for offshore wind development, as well as the cumulative effects cannot be disregarded.

It should be noted that many other bird species (including many waders and waterfowl, for example) migrate over the ocean, along the Portuguese coastline. Despite the absence of continuous monitoring and lack of knowledge on the numbers and migratory routes of many of those species, sporadic bird counts in the coastline reveal high passage rates during migratory periods. (11)

(11) https://ebird.org/checklist/S126273034; https://ebird.org/checklist/S118572381; https://ebird.org/checklist/S44587310

4. Offshore wind development and potential impacts on seabirds

Despite the key role they play in marine, coastal, and terrestrial ecosystems seabirds have to deal with an increasingly crowded and dangerous ocean and multiple threats (Dias et al. 2019).

Human pressures, including bycatch, overfishing, disease, and introduced predators in islands, have resulted in seabirds being one of the most threatened animal groups (Dias et al. 2019), with the expansion of offshore wind farms posing an additional threat for these birds (Halpern et al. 2015).

Offshore wind energy installations can have harmful effects on the marine environment, particularly on seabirds, as evidenced by a series of studies by BirdLife International and the RSPB (Royal Society for the Protection of Birds) on the effect of wind farms on birds.

The results of those studies highlight the following impacts:

- **Displacement and disturbance**: displacement and disturbance can occur during the construction, operation and decommissioning of energy installations, either due to the presence and/or associated infrastructure, or by human activity. Additional maritime traffic during construction and later for regular maintenance can lead to considerable disturbances.

- **Collision mortality**: offshore renewable energy installations, particularly wind farms, can cause significant collision mortality of sensitive species, especially in the case of inadequate or poorly designed installations. It is necessary to invest in collision monitoring to validate risk models and to develop mitigation solutions.

- **Habitat destruction, alteration and loss**: habitat damage, alteration and loss can be associated with the installation of infrastructure, for example through the introduction of artificial substrates into sandy areas of the seabed.

The effect of this can be significant, particularly if local oceanographic processes are altered (i.e. changing currents and mixing of different water layers), introducing changes in benthic and pelagic habitats or communities which could lead to wider ecosystem modification and influencing the abundance and availability of prey, with implications for the food chains.

- **Barrier** and avoidance **effects**: Barrier effects can be caused by installed devices, particularly wind turbines, interrupting or diverting flight lines or other links between feeding, resting and nesting areas, or by blocking migratory routes, resulting in increased energy expenditure for species as they deviate from the structures that they see as obstacles.

Most of these effects have been poorly studied in existing offshore renewable energy projects to accurately quantify their magnitude or the subsequent implications for marine wildlife, including seabirds.

Many of the current impact predictions are based on modelling that has not been validated by empirical data. There is an urgent need to invest in further research into these issues which should look into the cumulative impacts, and to adopt the precautionary principle whenever there is uncertainty.

It should also be noted that power grid infrastructures, such as submarine cables and transmission lines, can have detrimental effects on wildlife and marine habitats, and further studies should be also commissioned on the potential negative impacts of such infrastructures.

It is also important to note that the presence of renewable energy infrastructure can displace other human activities at sea, such as fishing. This could have subsequent impacts, e.g. on prey availability (due to changes in abundance and distribution) extending the impacts of a development far beyond its initial footprint. Co-location and multi-use among renewable energy and fishing should be further investigated and assessed to understand potential risks and benefits.

It's worth mentioning as well that these potential impacts do not work in isolation, and the final impact does not represent the sum of the individual impacts.

The **cumulative impacts** of these effects and the combined impacts of human activities on the marine environment must be taken into account when weighting biodiversity for the purposes of designating the acceleration areas.

The emergency of **floating offshore wind** holds yet an additional layer of knowledge gaps – and therefore of caution - as for the vast majority of wind development already in place in Europe is made of fixed structures.

In the particular case of Portugal, the offshore wind development will be based mainly on floating structures due to the length of the continental shelf, which highlights the importance of robust studies beforehand given the few information and knowledge about this technology. Moreover, floating turbines enable development in previously inaccessible offshore areas making it even more critical that effective assessment of mitigation of wildlife related impacts are taken into account from the very early stages of development.

4.1 Sensitivity mapping

It is widely recognized by the scientific community that sensitivity mapping constitutes a powerful tool for promoting the sustainable development of renewable energy resources while conserving important marine ecosystems and biodiversity. By identifying areas of higher sensitivity, stakeholders can work towards minimising negative impacts on seabird populations and supporting their long term conservation.

In this sense, SPEA, the Centre for Ecology, Evolution and Environmental Changes (cE3c) and BirdLife, with the support of the Oceano Azul Foundation, carried out the first dedicated mapping of seabird sensitivity to marine wind farm expansion in mainland Portugal, in order to inform the future siting decisions, and consequently, contribute to a sound marine national planning.

In what was the first offshore wind energy sensitivity mapping adapted to the waters of mainland Portugal (Guilherme et al., 2023), 34 species of seabirds that regularly occur along the Portuguese coast up to 65 km offshore (the furthest point from the coast of the areas proposed for new offshore wind farms) were assessed. In the absence of information on the location of acceleration areas, this mapping should be carried out to the entire nautical zone.

According to the last revision of the Renewable Energy Directive (RED), sensitivity maps are considered as an appropriate tool to identify areas other than Natura 2000 sites and areas designated under national protection schemes for nature and biodiversity conservation, major bird and marine mammal migratory routes, to be excluded from the designation of Renewable Acceleration Areas (RAAs) for the development of renewable energy infrastructures. Therefore, sensitivity maps could be used by Member States (MS) as a crucial tool to inform sound spatial planning.

- **Methodology**

For each species, its density in each season (using the distribution maps from the Atlas of Portuguese Seabirds) (12) and their sensitivity to offshore wind farms were considered.

(12) https://www.atlasavesmarinhas.pt

The estimated sensitivity was based on factors associated with the risk of collision, risk of disturbance, and national and international conservation status of each species.

To map the sensitivity of seabirds to offshore wind energy, a Species Sensitivity Index (SSI) was developed, refining methodologies developed in previous sensitivity studies (Garthe & Hüppop, 2004; Furness et al., 2013; Bradbury et al., 2014; Certain et al., 2015; Serratosa & Allinson, 2022). The SSI was then applied to density distribution maps of seabird species that occur along the Portuguese coast (based on their seasonal probability of occurrence and national population numbers).

For each species, data was extracted and compiled on 11 species-specific ecological and behavioural factors (table 2) related to their (i) vulnerability to collision with wind farm structures (4 factors), (ii) vulnerability to exclusion due to disturbance caused by wind farms and associated maintenance (3 factors) and (iii) conservation status (4 factors).

According to these values, Collision Vulnerability (CV) and Displacement Vulnerability (DV) scores were calculated for each species. These scores were then weighted by the Conservation Value (CS) to obtain a Collision Sensitivity Index (CSI) and a Displacement Sensitivity Index (DSI) for each species. The final SSI values were the maximum ranking between the CSI and DSI for each species.

Table 2. Species-specific ecological and behavioural factors considered in the Sensitivity Analysis, related with the vulnerability to collision and displacement to offshore windfarms and the conservation status of species.

	Species-specific ecological and behavioral factors
Vulnerability to collision	• Time flying at collision risk height • Time flying at sea • Nocturnal flight activity • Flight maneuverability
Vulnerability to displacement	• Disturbance by wind farm structures • Disturbance by vessels and helicopters • Habitat flexibility
Conservation status	• Portuguese Conservation status • European Conservation status • Global Conservation status • Adult annual survival

- **Main conclusions**

The 34 seabird species analysed had very different SSI values (average SSI = 0.363, range: 0.176 - 0.730). It was found that 19 species are more sensitive to collision (i.e., CSI >

DSI) and therefore more exposed to the risk of direct mortality, while the remaining 15 species are more vulnerable to exclusion due to disturbance associated with wind farms (i.e., CSI < DSI). Species such as the Great Black-backed Gull, the Audouin Gull, the Sandwich Tern and the Common Tern showed higher vulnerability to collision (CV), compared to other species, while the Common Scoter, the Razorbill, the Northern Gannet and the Little Gull evidenced the highest vulnerability to displacement (DV) values.

In terms of SSI, when the vulnerability values were weighted by the conservation value (CS) of each species, the Balearic Shearwater, the Audouin's Gull and the Common Scoter emerge as the most sensitive species (i.e. highest SSI). When vulnerability values were not weighed by the conservation values, the most sensitive species are the Common Scoter, Great Black-backed Gull, Razorbill, Audouin's gull, Northern Gannet, Little Gull and Sandwich Tern.

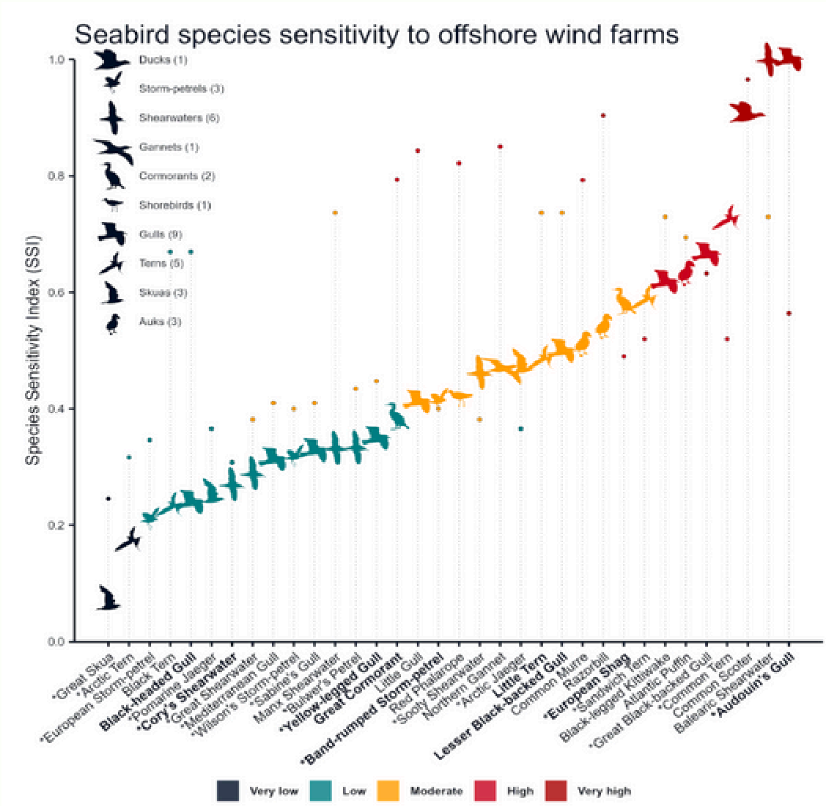


Figure 1: Seabird species sensitivity to marine wind farms (from Guilherme et al., 2023). Closed circles show the vulnerability score (VS), i.e., the highest value between the rescaled (i.e., range 0-1) Collision Vulnerability (CV) and Displacement Vulnerability (DV); silhouettes show the Species Sensitivity Index (SSI), i.e., the highest value between the rescaled Collision Sensitivity Index (CSI) and Displacement Sensitivity Index (DSI). The 34 seabird species are scored into five categories of sensitivity (very low; low; moderate; high; very high), according to their VS (closed circles) or their SSI (silhouettes). The categories of sensitivity are set on a comparative basis between species. Species names with an asterisk (*) have CSI > DSI. Species with regular breeding populations along the Portuguese mainland coast are in bold. Number of species per taxonomic group in brackets.

Site-wise, standing out as particularly worrying are:

The two sites of **Viana do Castelo (North and South)**, as (i) they overlap with areas of high sensitivity for seabirds, (ii) their proximity to the coast leads the migratory corridor to gradually taper off into a narrow corridor between (future) wind farms and the coast, (iii) they are in the vicinity of an area adjacent to the border located in Spain's waters (cumulating the impacts of these structures on migratory birds, the effects of which remain unknown).

The Ericeira site, as it (i) overlaps with the areas of high sensitivity and (ii) is located between two SPAs, Ilhas Berlengas (13) and Cabo Raso (14), imposing a barrier to seabirds on the move, particularly during migrations, when these areas are particularly important for species such as the Northern gannet and the Balearic shearwater. Moreover, this area is in the vicinity (~35 km) of the only mainland breeding colonies of Cory's shearwater and Band-rumped Storm-Petrel (Ilhas Berlengas), so the presence of wind farms can negatively affect these species during their foraging trips during the breeding season, as indicated for other species (Peschko et al. 2020, 2021). Indeed, tracking data confirmed the existence of foraging grounds used by Cory's shearwaters breeding in Berlengas within the proposed Ericeira site (Haugh).

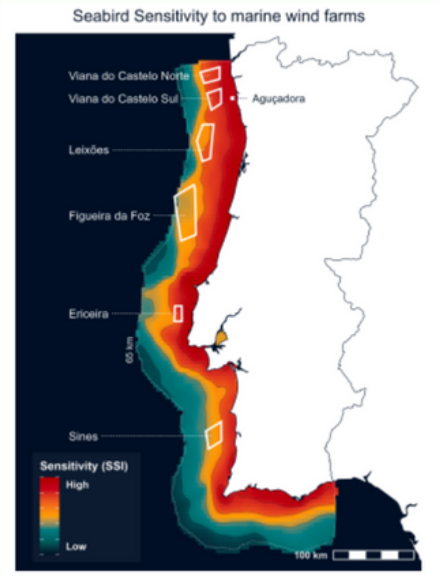


Figure 2: Seabird sensitivity to marine wind farm expansion in Portugal (from Guilherme et al., 2023). Seabird sensitivity to marine wind farm expansion in Portugal was calculated using density-distribution maps (ind. per 4×4 km grid cells) across the seasons of the year each species occurs in Portugal (Meirinho), and a Species Sensitivity Index (SSI) estimated using species-specific factors related with species' vulnerability to collision with, and displacement due to disturbance from marine wind farms. For each of the 34 species, we multiplied the natural log of the density in each grid cell by the respective SSI value. The final map was obtained by summing the values in each cell across species (see Methods). Isolines delineate five categories of sensitivity: low (dark blue) to very high (dark red). Boundaries of proposed wind farm sites are in white (the Aguçadoura site is a pilot marine wind farm in operation from 2020).

(13) https://natura2000.eea.europa.eu/natura2000/SDF.aspx?site=PTZPE0009
(14) https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=PTZPE0061

It is important to highlight that this work may probably have underestimated the sensitivity within and around the Sines site – particularly for migratory seabirds. The methodology used to produce the base maps for the Atlas of Seabirds of Portugal (i.e., at-sea surveys; Meirinho et al., 2014) does not capture passage peaks of migratory species, nor the exact routes taken by the birds actively migrating.

Recent tracking studies suggest that, along the Portuguese mainland coast, actively migrating seabirds tend to use areas closer to the coast along the northern part of the coast, but take a direct, more offshore path between the Cape Espichel and the Cape of São Vicente, potentially crossing the Sines site; this is the case for important species, such as the Balearic Shearwater (PNA Puffin Baléares - 15; Wikelski et al., 2023) and the Northern Gannet (Juvenile Gannet GPS PTT data, Bass Rock 2018-19 - 16).

The extraordinary international importance of Portuguese waters for seabirds puts into perspective the role - and therefore the responsibility - of the Portuguese government to ensure that concessions approved for the construction of wind farms have the least possible impact on important national and international populations of seabirds and other species.

It should be noted that seabirds are already one of the groups most threatened with extinction due to other human impacts on ecosystems, such as incidental captures in fisheries, climate change or the introduction of predators into their colonies. Therefore, the possible impacts of offshore wind energy should be taken into account in a transnational and cumulative impact logic.

(15) https://www.movebank.org/cms/webapp?gwt_fragment=page%3Dstudies%2Cpath%3Dstudy2266929053
(16) https://data.seabirdtracking.org/dataset/1815

5. Offshore wind development in Portugal

5.1 State of play

In late 2022, a joint dispatch (17) from the Secretaries of State offices of Sea, Environment and Energy created an inter-ministerial working group aiming at planning and operationalizing offshore wind development in Portugal (GTERO - Interministerial working group for the planning and operationalization of electrical producers centers based on renewable energy sources of origin or oceanic location). It was divided in 3 sub-groups aiming, respectively to: (1) propose "go- to-areas" and design and implement the Portuguese Allocation Plan for Offshore Wind; (2) evaluate technical requirements regarding development models and connection to the grid; and (3) evaluate requirements regarding port infrastructures

In January 2023, a first proposed map of "go-to-areas" was revealed for public consultation by DGRM – Directorate General for Natural Resources, Safety and Maritime Services – leaders of sub-group 1.

This first draft included overlaps with SPAs and areas very close to shore and thus received general criticism for the Portuguese NGOs due to lack of consideration for ecologically important areas and also lack of transparency and stakeholder involvement.
In September 2023, a new map was unveiled, having eliminated overlaps with N2000 areas.

In the following month the final version of the Allocation Plan (PAER) was released for public consultation. It included the final proposal of the "go-to areas'', several annexes and the Environmental Report of the Strategic Environmental Assessment made in parallel with the PAER.

(17) https://diariodarepublica.pt/dr/detalhe/despacho/11404-2022-201394418

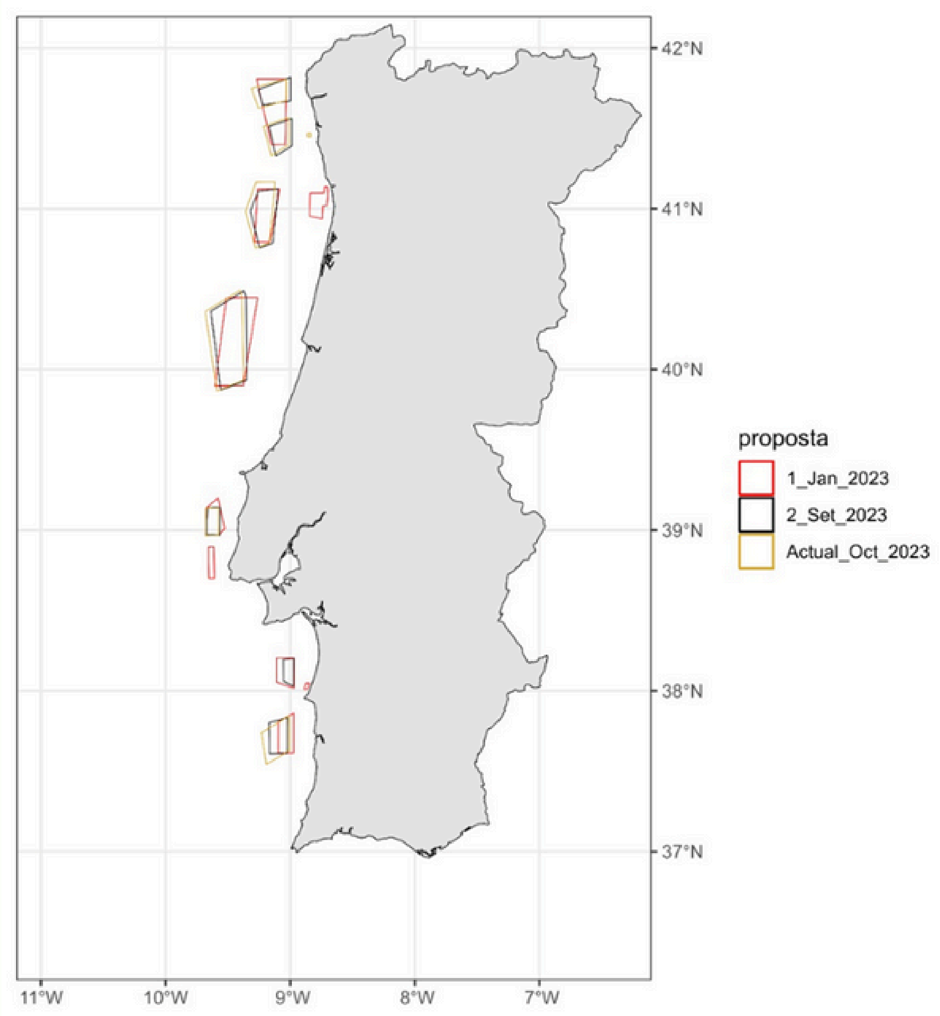


Figure 3: Evolution of proposed "go-to areas" for offshore wind development in Portugal throughout 2023, culminating the final proposal in October.

The final version of the PAER awaits publication and legal adoption and its information – including areas, characterization and good practices will be embedded in the national MSP.

In late October 2023, shortly after the PAER entered public consultation (ending in December) the government opened a call (18) for receiving non-binding expressions of interest from developers, to which 50 consortiums responded to (19).

The final version of the PAER indicated that its objectives regarding concession targets and timings were to auction 3,5 MW/km2 in until 2025 and 10 GW until 2030.

(18) https://diariodarepublica.pt/dr/detalhe/anuncio/220-a-2023-223575040
(19) https://expresso.pt/economia/economia_energia/2023-11-15-Leilao-eolico-offshore-em-Portugal-atrai-50-empresas-40b2f0f8

In January 2024, although at that time a proposal for definition of auction models and criteria was still underway, led by the office of Secretary of State of Energy and the PAER still awaited the results of the public consultation process, the government met again with developers in order to disclose state of play, present initial pre-qualification criteria and the Terms of Reference of state-led geophysical, geotechnical and environmental baseline monitoring assessments.

5.2 Renewable Acceleration Areas (RAA)

Although the final proposal for the areas to be allocated to offshore wind development have suffered a twist for the better along their 3 versions concerning potential impacts for seabirds, some concerns still remain – regarding ecologically important areas and species identified in the sensitivity mapping.

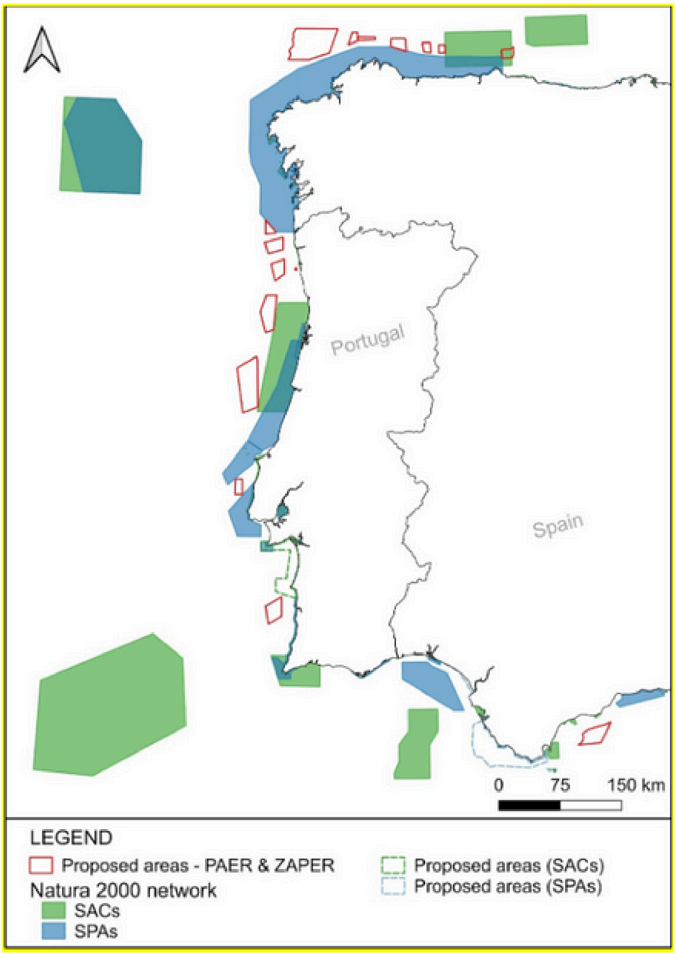


Figure 4: Map of RAAs for Portugal and Spain (West) overlapping with Natura 2000 sites.

In the final proposal, 6 areas have been proposed as "go-to areas", not overlapping with N2000 areas but some located very close, as can be seen in the map above. This proximity carries risks, as concentration and distribution of birds outside N2000 areas might still be high and therefore potential risks for species very relevant, as the sensitivity maps highlight.

VIANA DO CASTELO

Viana do Castelo Norte and Viana do Castelo Norte are the 2 northernmost areas proposed in the PAER. The NE tip of "Viana do Castelo – Norte '' is located 7 nautical miles from shore. This is a concern that the migratory corridor of the Eastern Atlantic Flyway can be funnelled against the shoreline. Ideally, for seabirds, this area would be at least 10 miles from the coast, such as the '' Viana do Castelo - Sul" area, which is 10.5 miles away. This is one of our greatest concerns in the current map of proposed areas, especially in the post-nuptial migration period, a concern reinforced by results of the sensitivity mapping exercise.

- **Cross-border impacts**

Seabirds know no borders. As such, the only way to consider impacts on cross-border zones is to take into account both sides of the border. In the case of the North border, as can be seen in the image below, "Viana do Castelo – Norte" area is almost adjacent to the "Nor1" zone in Spain – also designated for offshore wind development in the Spanish plan. The main difference lies in the fact that this area is approximately 13 nautical miles from coast, contrasting with the 7mn of the Portuguese one and consequently, with a potential impact substantially smaller for seabirds (although this has not been studied with sensitivity mapping).

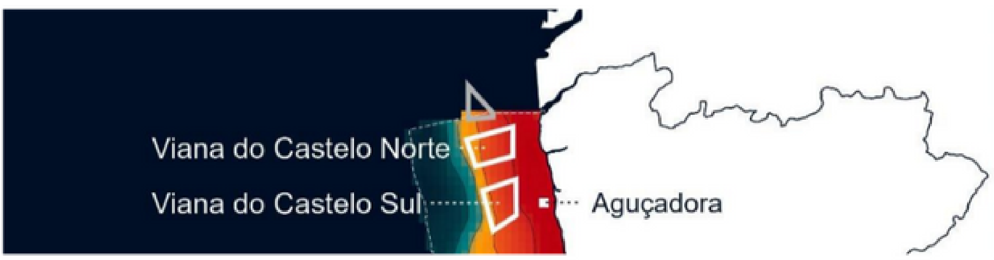


Figure 5: Viana do Castelo and Nor 1 areas with a sensitivity mapping layer on the Portuguese side (adapted from Guilherme et al., 2023).

Most seabirds breeding in Europe head south in the post-breeding period. In the Portuguese coastal strip, the numbers are at least in the hundreds of thousands. The extreme northwest of the Iberian peninsula is one of the major hotspots for this mass migration.

This led to the designation of SPAs along the entire Eastern Atlantic migration corridor on the coast of Galicia, the latest of which (and bordering with Portugal and Nord 1 area) happened in January 2024 (20).

(20) https://seo.org/se-amplia-la-superficie-marina-protegida/

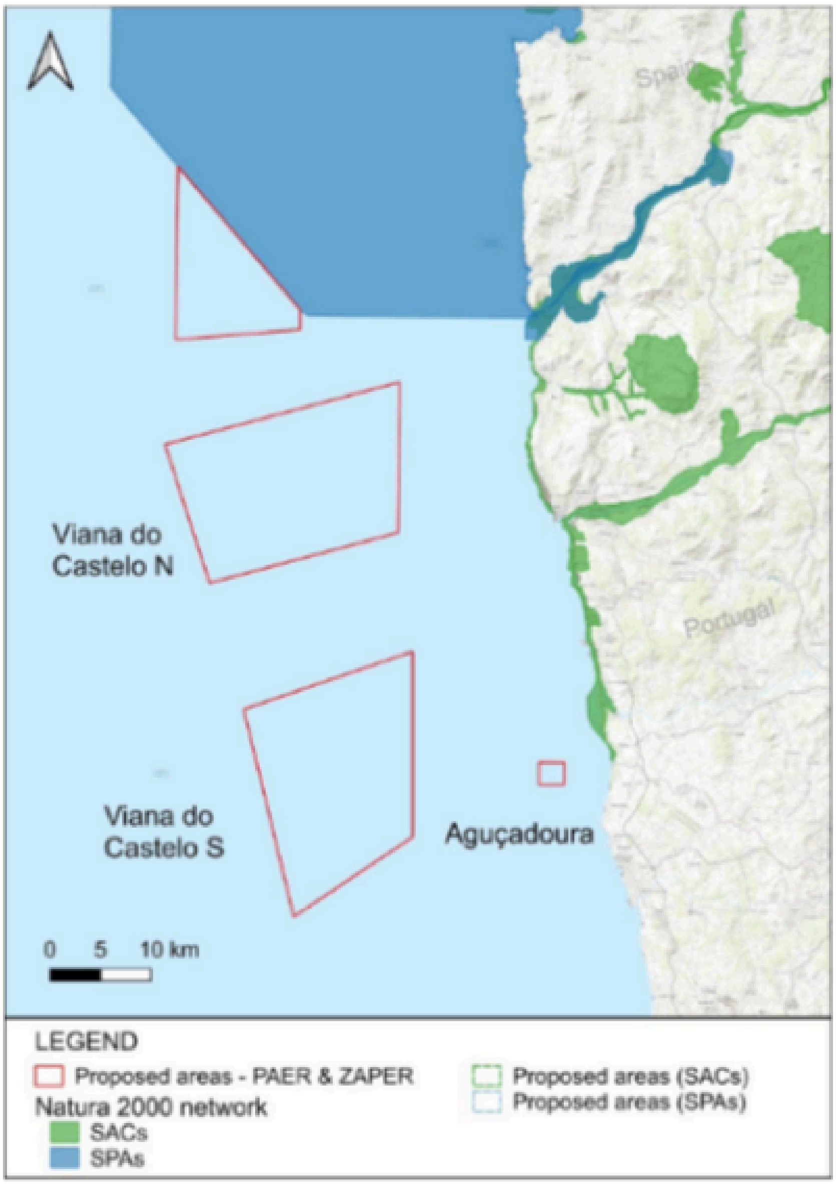


Figure 6: Natura 2000 areas overlapping with Viana do Castelo areas as defined in PAER and Nor 1 area defined in the ZAPER (Spain).

In the current map of "go-to areas", the Spanish effort to protect their seabirds comes up against the Portuguese border – which is not only serious for biodiversity but also does not seem coherent in the international strategic panorama.

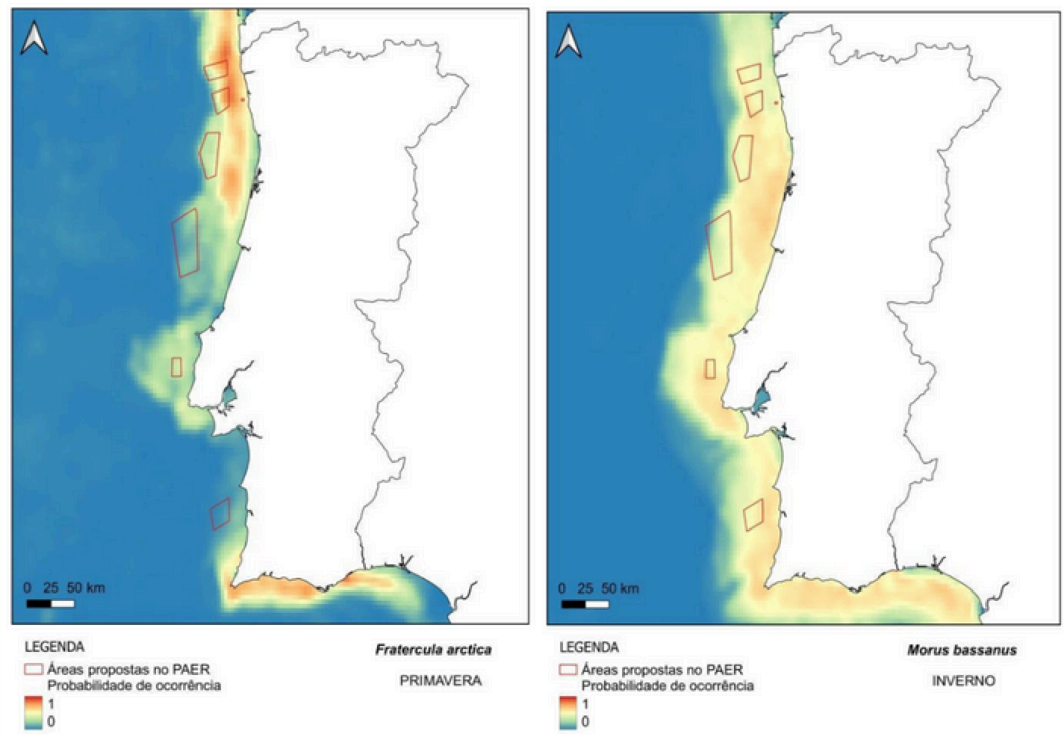
In the current scenario, it is predictable that a very high number of seabirds may deviate from the "Nor 1" area (where it is necessary to carefully study the barrier effect) and directed to Portuguese waters where they will find "Viana do Castelo – Norte" area - as it is closer to the coast than Nor 1.

It is already questionable that Nor 1 area shortens the adjacent Natura 2000 network on the Spanish side. But even worse is that "Viana do Castelo – Norte" further narrows the East Atlantic Flyway for seabirds

This funnelling increases the risk of collision impacts on the Portuguese side and may expose seabirds to an additional energy toll at a time in their life cycle when they are more vulnerable to this expenditure, and may subject them to increased pressure from impacts from other human activities.

- **Potential impacts**

Both Viana do Castelo areas can potentially have a significant impact on migratory or wintering pelagic species such as the Kittiwake Rissa tridactyla, Great Shearwater and Sooty Shearwater, and lie on areas with high densities of **Northern Gannet** and **Auks**.



Figures 7 and 8: Probability of occurrence of Atlantic Puffin in the Spring (left) and Northern Gannet in the winter (right) in relation to proposed areas.

The figure on the right referring to existing data for Atlantic Puffins during the spring period (this wintering species returns late to nesting areas in northern Europe) serves as an example of the importance that the area seems to acquire for alcids - one of the most important at a national level.

These species – **Razorbill, Common Guillemot** *Uria algae* and **Atlantic Puffin** – are passage migrants and winter birds that generally fly close to the surface, however, they are quite vulnerable to adverse weather conditions and consequent lower food availability.

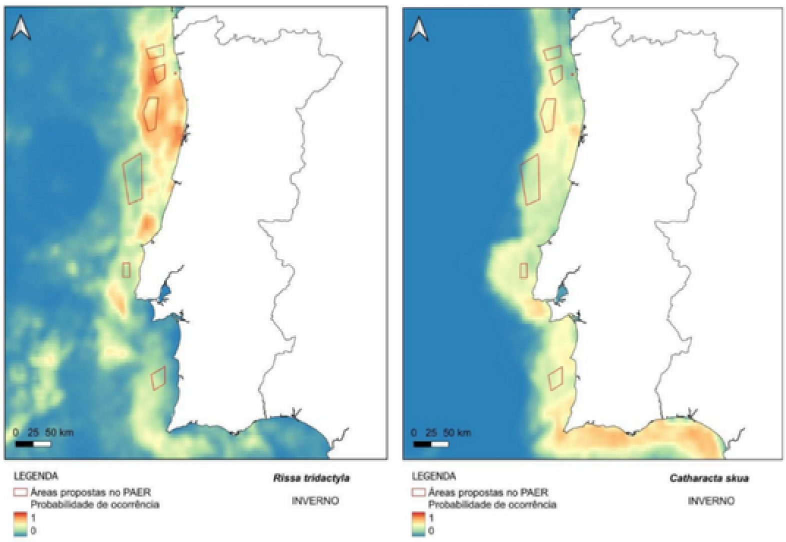
The **Northern Gannet** is a very abundant species on the Portuguese mainland coast, with relatively coastal habits. It is mainly a wintering bird and passage migrant, however it is present throughout the year due to the presence of juveniles, immature birds and non-breeding individuals.

Due to its deep diving feeding behaviour and considerable flight height, it has a high sensitivity index.

Despite being a species well distributed throughout the coast, Viana do Castelo areas coincide with an area with a high probability of occurrence of the species in the wintertime, the time of year when it is most regularly abundant on our coast.

LEIXÕES

Bordering the SCI Maceda – Praia da Vieira (21), this is considered to be an area of medium sensitivity for seabirds considering offshore wind development. The main concerns reside on it being potentially problematic for wintering or migrant species that have a marked pelagic behaviour such as the **Great Shearwater** or **Kittiwake**, or others like **Great Skua.**



Figures 9 and 10: Probability of occurrence of Kittiwake (left) and Great Skua (right) in winter in relation to proposed areas.

(21) https://eunis.eea.europa.eu/sites/PTCON0063

Gulls are groups that, due to their feeding behaviour and flight height, usually have a high level of sensitivity. In Portugal they are essentially migratory and/or wintering species, with some exceptions.

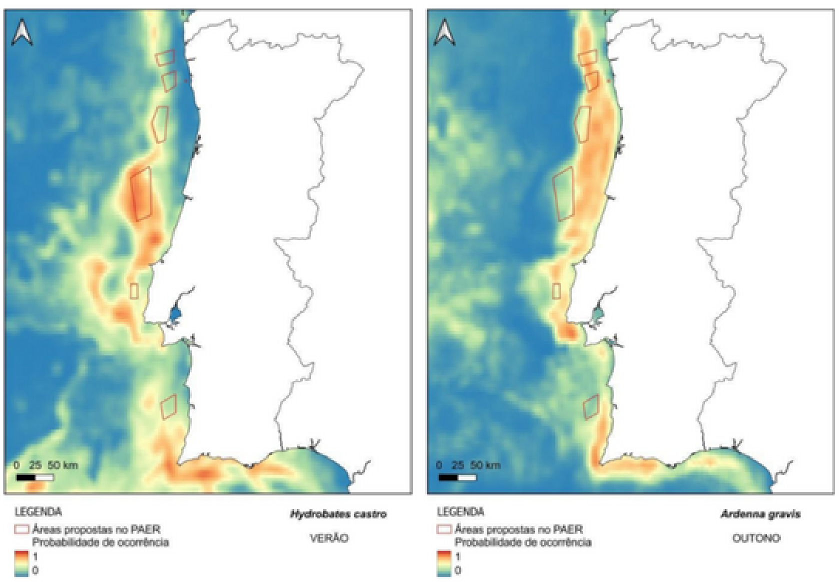
Kittiwake has deeply pelagic habits, and its abundance and distribution in the country depends on adverse weather conditions far offshore. For this gull, the northern areas furthest from the coast will be the most problematic, like Leixões.

Also noteworthy is the Great Skua, with winter populations but also a passage migrant , with apparent higher densities in the area, associated with the presence of the species from which it steals prey from (kleptoparasitism).

FIGUEIRA DA FOZ

This is the largest of the proposed areas, having grown substantially to the West since the first version proposed, moving away from the SCI "Maceda-Praia da Vieira". In the mapping exercise carried out, Figueira da Foz is the area that presents the lowest sensitivity values, however it is not free from concerns or the occurrence of species with high conservation value.
It is worth highlighting its potential impact on pelagic species such as the **Band-rumped Storm Petrel**, a species that nests in the Berlengas archipelago, as well as the cumulative effects to which it contributes.

Due to its extension and proximity to the "Leixões" area, the barrier effect/displacement potentially caused by this combination of areas could have relevant implications for the Eastern Atlantic migration corridor, so **its cumulative effects must be considered.**



Figures 11 and 12: Probability of occurrence of Band-rumped Storm Petrel in the summer (left) and Great Shearwater in the autumn (right) in relation to proposed areas.

Regarding the Band-rumped Storm Petrel, a breeding population occurs at Berlenga, behaving as central-place forager for several months and being highly dependent on the nearby areas for foraging, including offshore areas. Figueira da Foz area lies within the sites of high probability of occurrence for this species during the breeding period, and the Band-Rumped Storm Petrel can be affected through a barrier effect, leading to displacement or increasing the collision risk for the species.

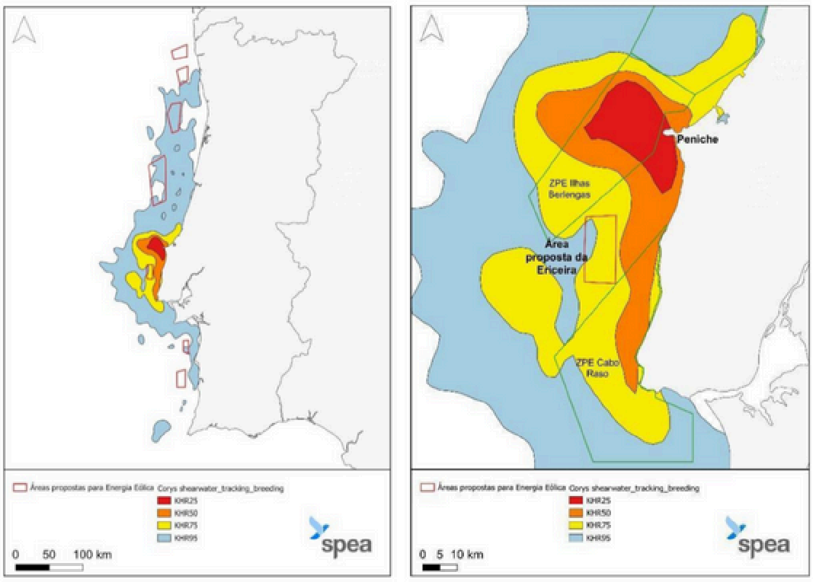
ERICEIRA

This is an area of high sensitivity **between two SPAS (Ilhas Berlengas - 22 and Cabo Raso - 23), very close to Berlengas archipelago**, which could have impacts on the only nesting populations of pelagic seabirds in mainland Portugal – Cory's Shearwater and Band-rumped Storm Petrel.

Furthermore, Ericeira area is located **only 7.5 nautical miles from shore**, which in our opinion could have significant impacts on the populations of seabirds that use the area, particularly when migrating.

- ### Potential impacts

This area could interfere with a crucial phase in the life cycle of the Cory's Shearwaters breeding in Berlengas archipelago, which, as can be seen in the figure below, frequently use the area to be allocated to offshore wind as feeding grounds in chick-rearing stage.



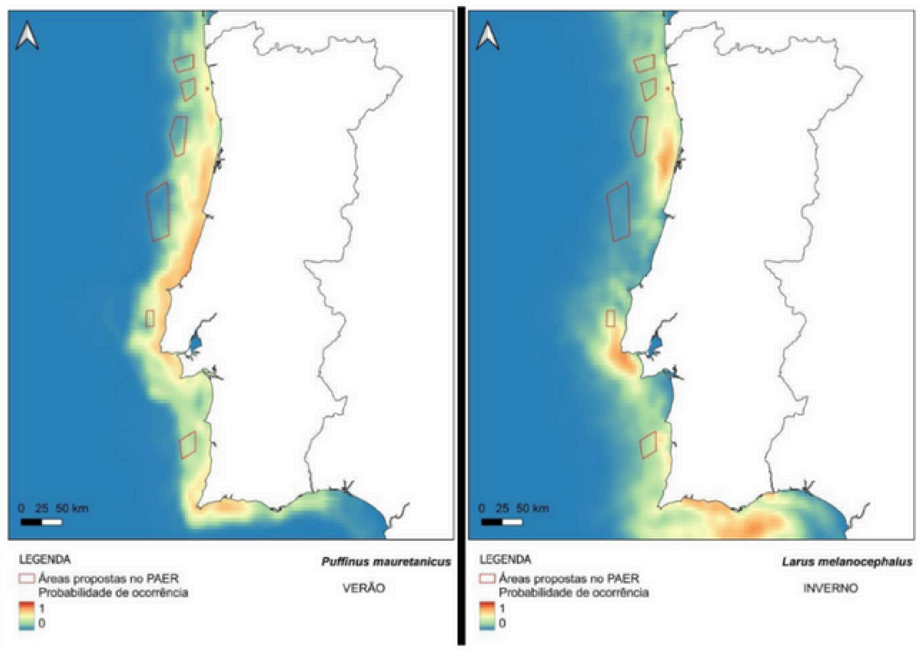
Figures 13 and 14: Areas most used by Cory's Shearwaters breeding in Berlengas during chick-rearing stage (43 GPS tagged birds, August and September 2010-2012). Red, orange and yellow (Kernel 25, 50 and 75) represent areas most used (project FAME 2010-2013). On the right, kernels are overlapped with SPAs and proposed "go-to areas".

(22) https://eunis.eea.europa.eu/sites/PTZPE0009
(23) https://eunis.eea.europa.eu/sites/PTZPE0061

The figures above summarise the tracking results of 43 breeding adults tagged in the Berlengas archipelago during the chick-rearing stage. Although the waters around the archipelago are the most used for foraging trips, the Ericeira "go-to area" is also used, and potential exclusion/barrier effects could force the birds to have to expend more energy to feed, possibly with longer journeys.

This means additional effort on breeding birds, longer periods at sea and thus without feeding chicks, and as such can **negatively impact breeding success**. A possible collision can also have lethal effects not only for the birds that collided, but also for their offspring.

In addition to the expected impacts on breeding populations, due to its proximity to the coast, the implementation of wind farms in this area would affect a great abundance and diversity of migrant seabirds, with the area having particular importance for species such as the **Northern Gannet, Balearic Shearwater** or **Mediterranean Gull.**



Figures 15 and 16: Probability of occurrence of Balearic Shearwater in the summer (left) and Mediterranean Gull in the winter (right) in relation to proposed areas.

The Balearic shearwater holds a Critically Endangered (CR) status, a high sensitivity index and is a species for which Portuguese waters are vital for virtually the entire global population of the species. In the figure above we see the importance of the area for the species during the post-nuptial concentration period.

Coastal censuses carried out in Cabo Raso show that this area – immediately south of the Ericeira "go-to area" – has one of the highest Balearic Shearwater passage rates at a national level.

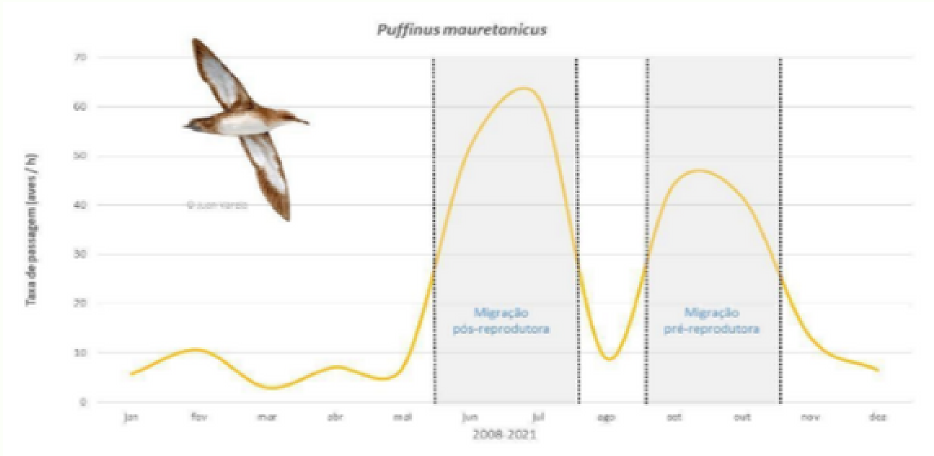


Figure 17: Passage rates of Balearic Shearwater (birds/hour) along the year in regular coastal counts in Cabo Raso (2008-2011).

The **Mediterranean gull** is a passage migrant and locally abundant wintering seabird, with concentration sites – essentially coastal – being well documented. For this species, this area can have a significant impact, as it is one of the most important areas for the species in Portugal.

Furthermore, this Ericeira "go-to area" **may overlap with an area considered preliminarily for a proposal for classification as a Marine Protected Area of Community Interest**, in a partnership between Oceano Azul Foundation and the Municipalities of Cascais, Mafra and Sintra.

SINES

Roughly 10 nautical miles offshore, the Sines "go-to area" extends to the 500 metre depth line. The main concerns regarding this lie in the fact that it is the area for which there is less quantity of baseline seabird data.

Additionally, it can have potential impacts on pelagic seabird species or those that have been documented to choose not to follow the coastline south from Cape Espichel, carrying out a "straight down" pathway that lead them further offshore – such as the **Northern Gannet** (24).

We are also concerned about possible impacts on migratory and/or locally abundant species such as the **Great Skua** or **Mediterranean Gull**.

(24) https://data.seabirdtracking.org/dataset/1815

It is necessary to **collect more data on the distribution and abundance of seabirds in the area**, especially during the migratory periods, in order to better understand the ecological sensitivity of this region, in respect to the implementation of offshore renewables.

5.3 Recommendations for mapping RAAs

Designing areas for offshore wind development must be a transparent process, based on the best available scientific evidence,participated by all relevant actors and updated regularly with the latest up to date information, in order to guarantee adequate planning.

In order for this process to be transparent and robust, and in order to meet the objectives set by the European Union, the designation of Renewables Acceleration Areas (RAA) must be undertaken according to a precautionary approach for the marine ecosystem, thus **allowing the mitigation hierarchy to be fulfilled**. This begins with "impact prevention", which must necessarily ensure that the areas to be affected are outside areas of high risk for biodiversity.

As such, we consider that the definition of the RAAs must necessarily follow a set of criteria if we really want to promote a fair energy transition for the environment and people.

- **Excluding of Marine Protected areas and other ecologically sensitive areas**

RAAs must follow a precautionary approach, **excluding sensitive areas** such as **Natura 2000 Sites, Marine Protected Areas, migratory corridors for sensitive species and any other ecologically sensitive areas.**

This is clearly highlighted in the revised edition of the **EU Renewable Energy Directive (25) - article 15 c) 1. ii)** that states RAA design must "exclude Natura 2000 sites and areas designated under national protection schemes for nature and biodiversity conservation, major bird and marine mammal migratory routes as well as other areas identified on the basis of sensitivity maps".

Furthermore, **blue carbon ecosystems (26), priority areas for nature conservation and priority habitats of community importance** (not covered by N2000), must be preserved by excluding them from offshore renewable energy developments and related infrastructure.

(25) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413&qid=1699364355105
(26) Highly productive coastal ecosystems that are particularly important for their capacity to store carbon within the plants and in the sediments below, such as mangroves, tidal and salt marshes, and seagrasses.

It is essential to assess impacts on wildlife and habitats, prioritising respect for marine ecosystems and promoting ocean resilience, with interconnected climate, energy and marine biodiversity protection policies.

- **Prioritising areas with low impacts on biodiversity**

A Strategic Environmental Assessment (SEA) must be carried out before any RAAs designation, taking into account the best social and environmental information available from all relevant stakeholders, regardless of it being originated by the public sector or other scientific institutions. This will allow the identification of biodiversity rich areas or other holding vulnerable species or habitats.

Along with other parameters such as – but not exclusively - wind potential, biodiversity richness and importance should be taken under consideration in the prioritisation of possible allocation areas, in order to avoid and minimise environmental impacts from an early stage. Proper siting of wind turbines remains the best possible measure when carrying out marine spatial planning.

This strategic evaluation must be ambitious **focusing on each area allocated** and should determine the **maximum number of wind turbines or water surface area occupied by them and their optimal location within each "go-to area"** as well as any other restrictions to which the projects must be subject. This evaluation must consist of a process of reinforced public participation that ensures that all social sectors are informed, can express their opinions and have a space for consultation from the early stages and before decision-making. The SEA must provide the promoters with the biodiversity values critical for consideration in a later auction stage.

- **Using science as a cornerstone**

The designation of areas for offshore wind development should be based on the **best available science**, especially considering impacts on seabirds, which are particularly affected by the development of offshore wind structures.

Producing a robust **sensitivity mapping** is the best tool available in order to inform the design process regarding species and sites with higher risk of negative impacts that should be made prior to the final design stage. This exercise can be updated when new information regarding population estimates or ecological parameters are made available or when there are updates in the conservation status of seabird species.

The designation of RAAs in line with the 2030 energy targets defined by the EU should consider **ecosystem-based maritime spatial planning**. This approach is essential for policy consistency across the EU, as, in addition to the location of wind farms, other important aspects must be taken into account, such as **associated maritime traffic**. This must be carefully evaluated and regulated before granting licences. Aspects such as the specific route of service vessels, frequency, time of the year, speed, must be robustly evaluated to minimise and avoid impacts on key species and ecosystems.

It is also important to note that the presence of renewable energy infrastructure **can displace other marine activities, such as fishing**. This could have subsequent impacts, for example, on the availability of prey, extending the impacts of an enterprise far beyond its initial footprint.

Understanding how offshore renewables and other human uses and activities can and cannot share marine space (e.g., the types of fishing, including the gear types, that can operate within offshore wind farms) is vital to provide clarity and certainty for all marine stakeholders and decision makers. Fishing within wind farms must be exclusively accessible to sustainable, well-monitored, low impact and best-practice fisheries and subject to a site-specific permit, ensuring there is robust regulation in place. **Optimising sea space for nature recovery and climate mitigation is vital for low impact fisheries** and must be at the forefront of co-location decisions.

- **Assuring fair and ambitious stakeholder engagement process**

The designation of RAAs should be done in consultation with interested and involved parties, based on the best available information, following an ecosystem-based and precautionary approach that considers the **socio-economic impacts on local communities.**

Local communities, the scientific community, civic society organisations and other **relevant stakeholders can provide valuable information** that can influence area designation, resulting in early changes or even mitigation before costs mount and discomfort rises. This helps to balance the progression of offshore wind energy with the needs and knowledge of the local population to obtain a more positive and consensual result.

An identified, embracing and diversified group of relevant stakeholders should **validate** the final version of the areas.

5.4 RAAs designation in Portugal - a general overview

In Portugal, although there was an effort to exclude Natura 2000 areas from the final version of the RAAs proposed, ecologically significant areas for seabirds remain overlapped with it (mainly Viana do Castelo and Ericeira), as identified in the Seabird Sensitivity Mapping, performed by SPEA and CE3c, and presented publicly on Sep 27th 2023. This goes against the need to exclude other areas identified as sensitive from being designated as RAAs, as stated under the last text of the RED.

Although admitting "uncertainty" and "knowledge gaps" regarding impacts on marine ecosystems and pointing out specific negative impacts for seabirds, the SEA was carried out without consulting the scientific community, leaving out crucial biodiversity information.

The Portuguese RAAs designation was carried out by an inter-ministerial group, with very little stakeholder engagement. The final version of the PAER mentions 10 meetings held by the DGRM to discuss RAA design-related issues: 8 with Fishers' Associations and 2 with the energy sector - leaving out all other relevant stakeholders such as the scientific community and civic society organizations, including NGOs.

Although this lack of involvement was not a good start, we have seen some openness from the Portuguese Government to discuss future procedure developments with Environmental NGOs, both from DGRM and Energy Secretary of State. The government is still discussing and analysing auction models in order to produce recommendations regarding next steps. However, due to the anticipated government election that took place in March 2024, there is still a general feeling of uncertainty regarding future developments.

Apart from taking part in the sensitivity mapping exercise, Portuguese BirdLife partner SPEA followed all the RAAs designation process. During it, SPEA teamed up with other 3 Portuguese NGOs – Sciaena, ANP|WWF and ZERO in order to provide more robust and diversified inputs to relevant documents and public consultations and participating in events. SPEA also joined the Med-OCEaN coalition, working together with regional NGOs, developers and grid operators for a sustainable offshore wind development.

5.5 Case studies

Italy and Poland

BirdLife partners in Italy (LIPU) and Poland (OTOP) have recently received specific funding to develop avian onshore and offshore sensitivity maps at national level to support the expansion of renewable energy infrastructure with careful consideration of the potential impacts on birds and biodiversity. The main steps to create the final maps were the following:

1) Identify and compile datasets & national workshops;
2) Develop a methodology for mapping avian sensitivity to wind energy development, which main steps are summarised in the figure below;
3) Produce sensitivity maps. These were followed by presentation, outreach to and engagement with national stakeholders.

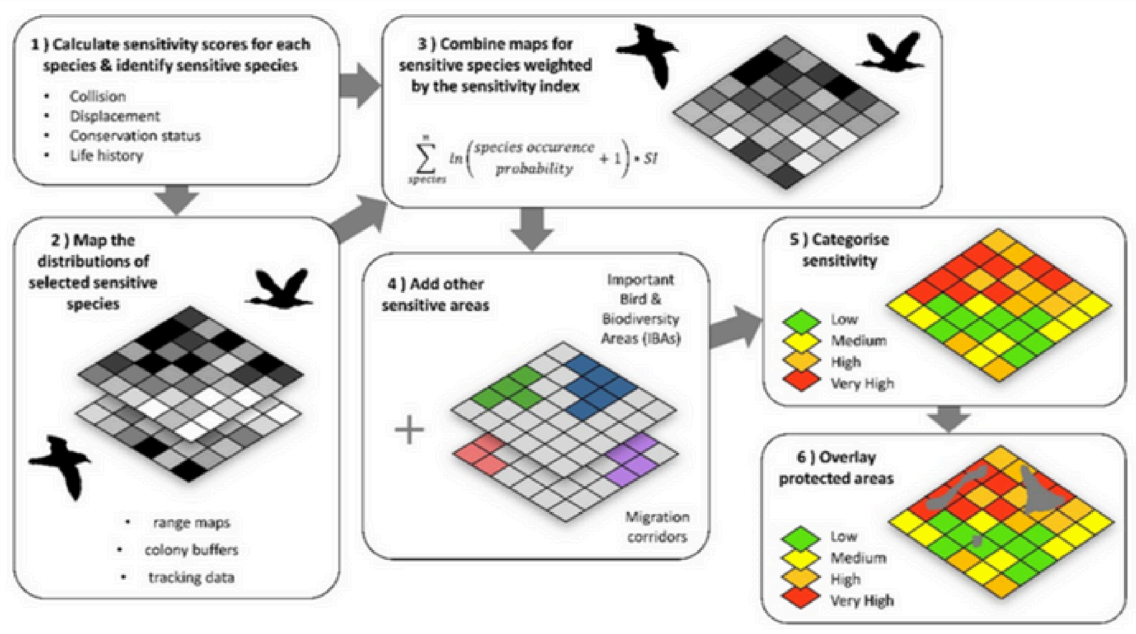


Figure 18. General workflow containing the six main steps to calculate the offshore bird sensitivity. (Image used for Italy offshore sensitivity maps - BirdLife and LIPU, in litt.).

For Poland, seabirds using the waters in the non-breeding season are the most important, so their distributions using non-breeding range maps were mapped and the patterns were validated using data from offshore surveys. For Italy, the non-breeding range maps in combination with breeding seabird data from nesting site counts and GPS tracking data were used, along with migration corridors for terrestrial birds derived mainly from tracking data.

The maps have permitted, by indicating the 4 different degrees of sensitivity (low, medium, high, very high) and hence identifying areas of lower and higher sensitivity at country level scale, to suggest the main areas where there should not be developments and the main areas suitable for the development of wind energy. Such maps are **not** meant to **substitute** rigorous **Environmental Impact Assessments** (EIAs), **Strategic Environmental Assessment** (SEA) or any other Appropriate Assessment (AA). Therefore, by mapping the sensitivity to wind farms in the entire territory, BirdLife partners could take this product into talks with key stakeholders, including government agencies and industry, and start lobbying for proper siting of renewables. Italy and Poland are still in their infancy when it comes to wind developments (especially at sea), hence the maps are very timely to influence the public debate and decision making process. The study has also highlighted the importance to keep filling in main knowledge gaps and providing suggestions for further research for different species of interest, namely sensitive species that are at risk due to planned developments. The information from the maps should be overlapped with current levels of development and expected growth in the future, in order to safeguard the habitat, species or geographic areas that are at risk due to planned development.

Malta and Spain

BirdLife partners in Malta and Spain have also conducted or are in the process of conducting a similar exercise at sea; this mapping exercise has been well acknowledged by the Partnership, also building on BirdLife's experience with the Avian Sensitivity Tool for Energy Planning (AVISTEP).

Others

Other countries have also developed offshore sensitivity maps to wind installations, such as Norway, Germany and the UK, while others are in the process to or have expressed their interest in doing so. Therefore, there seems to be a momentum among the seabird community to push for the development of such maps, given also the acceleration of the legislative process to get wind farms in place.

Additionally, other BirdLife partners in the region, among which are Ireland, Croatia and Greece, are looking into funding opportunities to produce offshore sensitivity maps.
BirdLife is in the process of finalising a Marine Important Bird Area (IBA) Toolkit, which aims to guide the designation of mIBAs from tracking data, some of which are stored in the Seabird Tracking Database hosted by BirdLife. These data, therefore, offer a great opportunity to identify areas other than PAs, which are highly used by the target species, and should contribute to the identification of sensitive areas, therefore ultimately informing the spatial planning of the target countries.

6. Auction format and criteria

6.1 State of play

Between the PAER and the news that has been made public, it's recognized that the objectives for 2030 are to reach a production capacity of 10 GW, with the process being initiated by the auction of lots in the northern areas of Viana do Castelo, Leixões and Figueira da Foz , totaling 3,5 GW.

After the release of the proposed areas from public consultation, non-binding expressions of interest were collected from 50 consortiums interested in producing offshore wind energy in Portugal (27). This speaks for volumes of current competition and the consequent demand and speed to which institutions are subject to move the process forward.

Original timings were delayed by the publication of the public consultation report and political instability in Portugal. Currently, with a new government in place, expectations are that the first auction will take place still during 2024.

A series of recommendations regarding auction format and criteria were proposed by the governmental Working Group from the previous government. The options on the table include a centralised model in one or two phases (unified or sequential). The latter would proceed without approaching grid connection, as contracts would take on the Contract for Difference (CfD) model in a later stage (28). An initial auction procedure would take place, after pre-qualification criteria being met, for granting rights to the use of maritime space (TUPEM - Title for private use). This would allow consortiums to initiate necessary studies and monitoring before price negotiations.

The Portuguese procedure will not be immune to its associated risks, namely those related to inflation and recent price escalation of around 40% (29), plus uncertainties regarding the immaturity of floating technology.

(27) www.dgeg.gov.pt/media/irrd0uu1/20231115-lista-de-resultados-anuncio-220-a_2023.pdf
(28) https://eco.sapo.pt/2023/11/13/leilao-eolico-offshore-avanca-sem-ligacao-a-rede-areas-maritimas-serao-as-primeiras-a-ser-leiloadas/
(29) https://www.theguardian.com/business/2023/nov/14/wind-developer-orsted-bosses-exit-us?CMP=Share_AndroidApp_Other

However, regardless of the model used, what is of the utmost importance is the need to **consider non-economic criteria, namely ecological ones, in such a way that they acquire a decisive role in the consideration of tender proposals, right from the pre-qualification phase**; and that the design of the auction procedures can be done over time, in a **ponderated and participatory way.**

6.2 Non-price criteria

As with any type of auction that could be applied, CfD competitions can easily slip into price-focused competitions, unless the rules are defined in time, taking this into account and finding ways to counter this trend. If Portugal opts for a two-phased auction, then non-price criteria assume even a more important role, right from the start.

Therefore, it is our understanding that the inclusion of non-economic criteria in the rating of tender proposals — both TUPEM and CfD — must have a strong component of social and ecological ambition in order to ensure the success of the projects in the long term.

The Guidelines on state aid for climate and environmental protection and energy (2022) indicate that in CdF auctions, non-economic criteria may include a 30% component in the weighting of proposals (30). However, there are no guidelines regarding the pre-qualification stage, no framing for a two-phased auction nor is a model provided on how each State can apply this consideration.

This guidance means an extra layer of complexity since non-economic criteria are essentially qualitative, so each process must find an effective, coherent and transparent way to quantify each proposal in order to ensure fair competition.

It is our understanding that the Portuguese State should adopt an ambitious position regarding non-economic criteria - starting with creating **strong social and environmental criteria in the upcoming TUPEM auctions.**

Only in this way could the Portuguese state be coherent in aligning its ambitions in energy production goals and tackling the climate crisis with the commitments made in marine conservation and social inclusion.

(30) eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:52022XC0218(03)

- **Examples of non-economic criteria**

Ecological - Ecosystem monitoring; Biodiversity risk assessment; Impact mitigation; Biodiversity net gain;
Sustainability - Incentives for circular economy and environmental footprint mitigation programs throughout all project phases;
Innovation - Filling information gaps; Development of science and technology to achieve the objectives of other non-economic criteria;
Social - Stakeholder involvement; Co-management committees & consultation of local communities; Promotion of local employment.

The inclusion of non-economic criteria in offshore auction processes has recently gained strength as a mechanism for social acceptance and environmental robustness, with this information coming from the industry itself.

In its position paper on the topic (31) **Wind Europe** states that "Non-economic criteria in national offshore wind auctions can be an important tool for EU governments to encourage the innovation required to achieve the goals of the European Green Deal. They allow you to achieve 2 objectives: "take advantage of the industry's strengths (...) and citizens demand that the European Green Deal meets the highest environmental, technical and social requirements". And gives as examples: "Reward projects with low impact on biodiversity"; "Reward projects with a strong component of local community involvement".

In its statement on the upcoming EU Power Package (32) the **Offshore Coalition for Energy and Nature (OCEaN) Coalition** highlights that "the proper design of competitive offshore wind bidding processes via non-price criteria is pivotal for sustaining European wind energy development, preserving the competitiveness of European industries, and implementing projects with high sustainability and ecological standards."

6.3 Case studies on social and ecological criteria

It is of utmost importance that offshore wind projects must be compatible with the conservation of biodiversity and marine ecosystems and beneficial for surrounding populations and local communities. Only by holding auctions that have been environmentally and socially assessed by experts and giving considerable weight to ecological and social criteria, is the way to ensure the protection of marine ecosystems and the minimization of negative impacts on biodiversity, other marine uses and local communities.

(31) windeurope.org/wp-content/uploads/files/policy/position-papers/20220413-WindEurope-Position-paper-non-price-criteria-in-auctions.pdf
(32) offshore-coalition.eu/documents/ocean_windpowerpackage_statement_on_ecological_criteria_in_owf.pdf

Overall, the industry seems more inclined to support the use of non-price criteria, although non-price criteria can span across a wide range of sectors and this could bring in some complexity. MS should make full use of the option given by the European Commission to include at least 30% of non-price criteria and ideally be more ambitious and go further (33).

We believe it is important to take advantage of the experience of countries that are more advanced than Portugal in the development of offshore wind energy, in order to learn from past mistakes made by others as well as follow on the footsteps of what has already proven to be successful, in such a flat area of uncertainty and information gaps.

- **Belgium - Princess Elizabeth Zone**

In this auction, Belgium prioritised **social criteria** in its design. In January 2022, in an auction for 3.15-3.5 GW in the "Princess Elizabeth zone", the Belgian government created a public consultation process to receive feedback on the proposed auction criteria (34).

These criteria binded a total of 2% of the investment for community participation. It also had sustainability criteria, a nature preservation plan that was based on innovation and investment to support this preservation. Nature inclusive design or in general taking marine biodiversity into account as non-price criteria did not make it in the end, which is to be considered a missed opportunity.

The pre-qualification criteria for this auction were divided into 3 categories: technical, financial; **minimum engagement of citizens and stakeholders to ensure democratic and inclusive participation.**

- **Germany – Offshore Wind Law**

At the end of 2022, the German sea hosted 1500 wind turbines connected to the grid. With such an advanced level of offshore wind energy development, Germany was careful to define a piece of national legislation that sets the framework for both rules and expectations for all sides. There are actually only two small OWFs within the 12 nm zone in the North sea, but more offshore wind in the Baltic Sea as the EEZ is very small. There has been an agreement not to have OWFs within 12 nautical miles from the coast to avoid most severe ecological impacts. However, there are companies that are currently pushing for moving into the 12 nm zone. However, as most areas are designated as national park areas, there is little space and a lot of resistance to be expected. Furthermore, the responsibility within the 12 nm zone lies within the authorities of the federal states whereas the EEZ is national responsibility. As federal states are less prepared to deal with offshore wind projects, the bureaucratic obstacle might be relatively high for individual wind farms.

(33) Communication from the Commission – Guidelines on State aid for climate, environmental protection and energy 2022 (europa.eu)
(34) https://economie.fgov.be/sites/default/files/Files/Energy/public-consultation-on-the-offshore-wind-tender-for-the-princess-elisabethzone.pdf

In their 2023 auctions, Germany went even further than the existing European Union guidelines suggestion for non-price criteria. Successful bidders are expected to offer a concession payment per KWh produced which makes up 60 percent of the award criteria. For pre-investigated areas (majority of areas, where agency for Federal Maritime and Hydrographic Agency did a first data gathering). **The other 40% are made up by qualitative criteria** which are:

- Decarbonization efforts in the context of offshore wind development;
- Percentage of electricity sold via B2B Power Purchase Agreements;
- Technology used for the foundations with respect to noise levels and sealing of seabed;
- Efforts to combat skilled worker shortages in the offshore wind industry.

For other areas, which are a minority of areas so far, but including ecologically critical areas, only the price is used as a criterion. In June 2023, the German government launched a tender for 7.3GW in 4 areas. It was a "Zero-subsidies" model auction – in which promoters assume all the risks and the winning bid was 12.6 billion euros for non pre-investigated areas.

Under the recent Offshore Wind Farm Law, the value of the proposals to be allocated by the government is defined as follows:

- 90% to lower energy costs;
- 5% for marine biodiversity conservation;
- 5% to promote responsible/sustainable fishing.

These 10% for conservation and sustainable fisheries was partly used last year to plug general budget holes. The debate about the budget is ongoing this year as measures and projects to help species mostly affected by energy transition are difficult to define. Despite the good financial allocation to the last two points, there are some caveats: for example, benefits from removing fishing pressure from OWFs is considered as compensation (regulated by Government). This is dubious at best as fishing effort is displaced and harmful fishing is still allowed in many MPAs in German waters. Furthermore, some ecological impacts are going to be potentially "compensated" financially by an environmental budget that should prepare actions to benefit species affected by the energy transition, with the risk that the money will mostly be spent to monitor effects on sensitive species (e.g. migration monitoring system) or implement measures such as planting seagrass meadows which are ecologically important but does not necessarily compensate for any loss of those most sensitive species concerning OWFs.

In case of RAAs, there is the suggestion that whenever mitigation measures are not ready for implementation and might cause some delay, financial compensation can be conducted, therefore Germany allows developers to just pay into a national fund to offset environmental impacts and doesn't apply strict requirements for mitigation. Implementation of the new RED is worrying as all areas, defined in the MSP as MPAs and migration routes will be treated as RAAs.

There are additional and comprehensive provisions requested by the federal agency that can differ between individual wind farm projects. They can include e.g. noise limitation measures, deterrence devices, temporal windows for construction, limitation of noise effects on overall areas and MPAs, soft-start procedures, bird and bat monitorings during operation phase, temporary curtailments for bats, and are largely dependent on the location of the OWF.

- **Holland - Hollandse Kust VI**

This is perhaps the most paradigmatic case of prioritising ecological criteria in the history of the development of offshore wind farms in Europe, with a clear willingness to make a positive contribution to biodiversity and thus accelerate the large-scale roll-out of offshore wind at national level.

At the site Hollandse Kust VI, aiming at 756 MW, the Dutch government had 49 proposals, only 28 of which were considered. The auction criteria were as follows:

- Financial Offer – 20 points
- Guarantees for project completion – 40 points
- Contribution to the energy grid – 40 points
- Investments to benefit native marine biodiversity – 40 points
- Stimulation for innovation and solutions to benefit marine biodiversity – 60 points

This was therefore an auction with **50% ecological criteria** constituting an example for Portugal to follow. Furthermore, the ecological (qualitative) criteria were evaluated by an **independent panel of 6 experts**, in order to guarantee transparency and competence in the selection of the winning proposal. The winning consortium had to provide a detailed plan of the proposed methodology for **mitigating impacts on seabirds, bats, porpoises, fish, benthic habitats and knowledge sharing**. These plans are public (35).

Although the price criteria for this auction represented merely 10%, the bidding value of the winning proposal was 63.5 million euros. As this was (like the Germany model) a "Zero-subsidies" auction, the Dutch government will not provide any further financial support throughout the life of the project. And it will invest the tender money in ensuring that offshore wind farms are designed taking into account the environment and other activities in the maritime space.

(35) https://ecowende.nl/en/discover-our-innovations/

6.4 Recommendations

Taking into account the current Portuguese scenario and the examples coming from countries with offshore wind energy development in more advanced stages of maturity, we suggest the following:

- **Ensure the preponderance of ecological criteria and other non-economic criteria (e.g., social criteria) in the pre-qualification phase/TUPEM competitions, ideally higher than the 30% proposed by the EC.**

It is essential that only those who ensure that they will carry out ambitious and comprehensive monitoring (including during the pre-qualification phase/stage) and mitigation plans may have rights over Portuguese maritime space. A weighting matrix must be found to ensure this, more ambitious than a simple "yes or no" questionnaire. Furthermore, it is necessary to ensure that ecological and social criteria are not undermined next to broader environmental and sustainability criteria - obviously these are also important.

Because the Portuguese Sea, its wind and its biodiversity, belong to all Portuguese citizens and it is up to the Portuguese government to look after them.

- **Promote transparency and robustness in the definition of pre-qualification and non-economic criteria, carried out through consulting with experts.**

Technical information and expertise must be asked to specialists in order to build a strong matrix for qualitative criteria in both ecological and social frameworks.

The OCEaN coalition, in its statement on the EU Wind Package (already referred to in the section above) states that "pre-qualification criteria must include environmental requirements" and that "given the lack of experience that still exists in defining pre-qualification criteria and non-economic criteria, authorities must consult stakeholders including NGOs and civil society, and adopt a *learning by doing* approach based on research and scientific data, ensuring transparency in the process". As an example of good practice, OCEaN cites the Hollandse Krust VI auction.

- **Ecological criteria must play a fundamental role in the selection of winning bids**

Regardless of the time scale that can occur between the TUPEM competitions and the CfD competitions, it must be defined in advance that ecological (biodiversity-related) criteria play a central role in the evaluations of winning bids. This factor minimises the potential impact of future projects (including economic ones), allows international biodiversity commitments to be met, fills in information gaps, and gives confidence and framework to investors — who know that if they do not comply with these requirements, they will later not have the right to advance to the next phase.

- **Ensure citizen participation through criteria that promote inclusion and stakeholders engagement**

The involvement of stakeholders and citizens in general must be ensured beyond the usual and mostly "one-way" public presentation sessions. Social acceptance is a relevant factor for the success of long-term projects, as is the effort to create participatory mechanisms to allow investment in the well-being of coastal local communities.

- **Criteria should be clear and measurable**

The criteria must be clear, specific and leave no room for ambiguous interpretations. They must be based on verifiable data and not on subjective judgments. They should be quantifiable and precisely measurable. This allows a direct comparison between offers and facilitates decision making based on concrete data.

- **Qualitative criteria must be evaluated by an independent expert committee**

Qualitative criteria are complex, technical-scientific topics that are extremely difficult to evaluate, filled with uncertainties and information gaps. However, depending on the subjects, there are relevant stakeholders to be found that gather expertise on them and can make informed evaluations.

We suggest that for ecological criteria, and following the example of the Netherlands, future ratings of concurring bids should be carried out by independent experts in the subjects to which the criteria relate to, in order to ensure technical robustness, social justice and above all, transparency of processes.

- **Provide clear indications of how the value of the bids will be used**

In the current scenario, transparency at all stages of the development of renewable energy projects is crucial and public scrutiny, guaranteed.

The Portuguese government must give clear indications, possibly through dedicated legislation, of how the funds it will receive from future auctions will be invested. This will allow, once again, to define the rules of the game right from the start.

- **Take time to reflect on process design and to consult with relevant stakeholders**

The revised EU Renewable Energy Directive set the date of February 21st 2026 as the deadline for states to publish their map of Renewable Acceleration Areas. This provides more than enough time for a strong evaluation, stakeholder engagement and Strategic Environmental Assessment.

In a recent interview (36), when asked what his advice was for Portuguese relevant officials, the Director of Offshore Wind Development at Crown Estate Scotland said "I would certainly advise taking the time necessary to develop the process, making an effort in the design of the process".

Nonetheless, the Portuguese government's actions in relation to the timing and steps of the process that gives rise to competition procedures has been essentially marked by a rush to bid. Portugal collected expressions of interest before the end of the public consultation that defined RAAs (more than 2 years ahead of the deadline), and proceeded with arrangements for the first phase of auctions immediately afterwards - without any decision of disclosure on auction models and criteria.

(36) https://expresso.pt/economia/economia_energia/2023-11-20-A-Escocia-ja-comecou-a-faturar-com-as-eolicas-offshore-conseguira-Portugal-replicar-a-receita--d74c04e5

7. Monitoring

7.1 General considerations

An adequate monitoring protocol is essential for risk screening and achieving the best possible mitigation efforts. Detailed knowledge on the spatial and temporal patterns of seabird distribution and abundance have been identified as critical components for marine spatial planning updates and environmental impact assessments for future offshore wind development. A robust evidence-base of potential ecological impacts of offshore wind farms and offshore transmission grids during the different phases of their lifecycle (e.g., construction, operation, decommissioning) is of paramount importance to ensure that developments minimise harm to nature.

Baseline characterization allows an effective control scenario in order to compare possible impacts and should be carefully planned and implemented in pre-construction field surveys **for at least 2 years.** This can help identify further avoidance opportunities – micro-siting and routing of project infrastructure.

Early risk surveys are to be held during early project planning and should identify biodiversity features at risk from project impacts. Early risk screening can indicate potential elevated risk but does not provide a definitive picture. It is not an alternative to **site-specific assessment for mitigation planning**. Risks may be present that were not evident during screening, while on the other hand potential risk does not always translate into actual risk.

Monitoring at sites is also recommended during the entire construction phase, and for three years during the **operation phase** (F.M 2014) in order to properly assess impacts on the surrounding environment. **Post-construction monitoring** needs to occur throughout the project lifetime evaluating project impacts, informing its minimization, allowing assessment of progress against project goals.

Long-term monitoring programmes are vital to fill knowledge gaps and address uncertainties about the magnitude and extent of the long-term impacts of offshore wind (Ward et al 2010) (Wilberforce et al 2019).

However lots of challenges exist for offshore survey and monitoring. One of the most notorious ones is that collision fatalities are highly difficult to monitor, given also the complexity of collecting carcasses at sea, which highlights the need for a **precautionary approach** during project planning.

Several cutting edge technologies are used for monitoring and risk surveys but still present limitations (e.g. regarding species identification or under inclement weather conditions).

Sensors and camera technology, such as thermal cameras, used to assess species identification within windfarms - eventually leading to automatized mitigation - are evolving but are not yet in a state of maturity that allows confidence in their accuracy.

Remote monitoring like **tracking** and **radar monitoring** are used to refine the knowledge on the use of the area by some species and monitor broader-scale migration patterns.

Flight surveys already allow an incredibly high resolution, making this method one of the most popular and cost-effective for long term surveys. The data gathered is later complemented by human validation and used for risk modelling which could be complemented with the use of artificial intelligence.

Boat-based and direct observation can still be very useful especially for monitoring target-species and collecting detailed data on behaviour, allowing researchers to understand displacement and behavioural changes.

A combination of several methods and a site and species-specific approach should be used in order to collect data on several variables and scales - namely, **species identification, flight height, speed and manoeuvrability, diurnal and nocturnal activity, behaviour in adverse weather conditions, ecological traits such as vision, avoidance and migration patterns**. Only with detailed information on these parameters can feed reliable guidance in risk models and mitigation efforts.

In addition, robust and detailed information on **passage rates, migratory phenology and total estimates of numbers** of migrating seabirds crossing along the Portuguese coast is still lacking for many species. This is very relevant since the numbers of many species are clearly underestimated.

- **Portugal - state of play**

In Portugal, baseline information was gathered for the Strategic Environmental Assessment using desktop research. However, data gathered from projects led by public institutes were considered leaving out most of the pre-existing data, gathered by the other research teams and civil society organisations.

A series of baseline field surveys will be held in the near future, led by IPMA - Instituto Português do Mar e da Atmosfera, focussing primarily on geophysical and geotechnical information gathering, while also including some environmental monitoring for baseline characterization. At this point it is unclear how these surveys will coordinate with developer-led ones.

PAER makes reference to good practices and specific monitoring methods although not putting forward any kind of strategy or indication on future monitoring.

Although the recent changes to the Renewable Energy Directive frames a fast-screening of processes, mostly exempting future projects on RAAs from an Environmental Impact Assessment (EIA) process, the PAER still indicates that EIA needs to happen on a project-base.

7.2 Case studies

Holland - Hollandse Kust West VI

In the already mentioned case of the 2023 auction in Hollandse Krust West VI zone, the winning consortium has committed to a seabird monitoring plan that englobes:

Mapping disturbance and habituation behaviour - Implementation of a 10 to 15 year monitoring and research program using radars, surveillance and thermal cameras and impact sensors, starting in the pre-construction phase;

Improving collision risk models - collaborating with researchers to accurately map migration patterns and routes;

This is an ambitious monitoring programme resulting from an auction with 50% ecological criteria. While we acknowledge that such an ambitious programme might be difficult to implement in other areas and with other technologies (e.g. floating), this is something that should inspire member states and developers.

Belgium - WinMon.Be programme

The WinMon.be programme (37) is the state-led monitoring programme for offshore wind farms in the Belgium sea, conducted by the Royal Belgium Institute of natural Sciences (RBINS).

The RBINS runs this monitoring program integrating part of the environmental permit which englobes 1 year of pre-construction monitoring and 6 years of post-construction monitoring. This is funded by a common funding pot that developers contribute to.

(37) https://odnature.naturalsciences.be/winmonbe2013/

is the RBINS that determines the strategy of the research monitoring and coordinates the entire program. The WinMon.Be is a coordinated long-term programme leading to adaptive management and the outputs of research are shared with the public through open data and available reports.

The methodologies used comprehend seabird surveys (standardised boat-based counts with a control area), collision risk modelling, telemetry research (studying local movements), radar research (detecting migration peaks at night) and sensitivity mapping. The surveys started in 2010 and some of the results indicate that there is a species-specific displacement effect. Northern Gannet, Common Guillemot or Razorbill have a high percentage of avoidance result in habitat loss by the installation of wind farms due to the perception of a visual barrier, while some attraction effect were documented, namely by Great Black-backed Gull Larus marinus and Great Cormorant *Phalacrocorax carbo* (Vanermen & Stienen, 2019).

Other species like the Red-throated Diver *Gavia stellata* show avoidance in a very large area surrounding the wind farms studied, up to 16 km (Mendel et al. 2019). More details on the Belgian seabird monitoring programme are available online (38).

7.3 Recommendations

- **Perform strong baseline characterization**

Baseline characterisation of a proposed development area is a vital first step in the assessment process for offshore wind developments. It underpins impact assessment of marine birds and other terrestrial taxa crossing over the sea (such as birds and bats), and therefore the collection methods, presentation and analyses of the data informing the site characterisation need to be robust, transparent and provide the best available evidence.

These analyses should include both pre-existing data and new data - carefully designed through site-approach, taking under consideration special methodologies for species foreseen to require them and combining technology and direct observation.

- **Survey effort and design should match risk**

Early risk surveys should last **2 years across all seasons** to adequately account for seasonal changes in birds' presence and activity, namely migration peaks for different species. Adequate survey design needs to consider wider geographical landscape and animal movements – e.g. seabird breeding colonies distant from the project or migratory species using portions of the EEZ of the target country.

(38) https://odnature.naturalsciences.be/mumm/en/windfarms/

- **Coordinate survey effort between developers**

Survey methods, albeit site-specific, should be coordinated and ideally standardised between developers at national and international level in order to allow comparison across sites. This is also crucial for the analysis of cumulative impacts.

- **Consider specific monitoring needs**

Based on a solid baseline characterization, and taking into account the species cast present, specific monitoring schemes may be necessary to evaluate foreseen impacts. Micro and macro scales should be considered combining methods such as telemetry, radar monitoring and boat-based surveys for monitoring movements at local scale, while others like flight surveys can be used to better understand displacement.

- **All projects must undertake an ambitious Environmental Impact Assessment (EIA) process**

Significant changes to the Renewable Energy Directive have been recently introduced. One of these mentions that "projects located in Renewables Acceleration Areas should benefit from accelerated administrative permit-granting procedures, including a tacit approval in the case of a lack of reply by the competent authorities". These changes that came into force in November 2023, exempt the very existence of a mandatory EIA, predicting only a "fast-screening" of potential impacts, and, at-most, a request for additional information if there are significant environmental risks that were not initially foreseen in national planning.

These changes are to be swiftly translated into national legislation, creating uncertainty on timing of implementation and possible lack of environmental ambition in early risk screening - which would compromise the correct implementation of the mitigation hierarchy. Therefore it is recommended that EIA is not undermined in the name of public interest.

- **Screen the associated onshore elements**

The potential impacts of offshore energy may have an echo inland or in coastal areas. The possible effects on biodiversity of export cable landfall, onshore substation and any transmission lines that are usually the responsibility of the Transmission Systems Operator (TSO) should not be overlooked. While there should be a parallel development of grid infrastructures in order to meet the fast growth of renewable energy developments, the impacts of such infrastructures should be properly studied and assessed, and mitigated accordingly.

- **Information collected as part of monitoring studies of offshore wind projects must be available to the general public**

This is fundamental in order to promote transparency of protocol and data, as well and contributing to fill information gaps and not duplicating efforts, possibly inspired by the Marine Data Exchange (39) platform. These platforms, even if not supporting the upload of huge amounts of data, allow for sharing detailed reports of methodologies and results. Open access data platforms should be the basis to promote a collaborative approach at transnational level.

(39) https://www.marinedataexchange.co.uk/

8. Mitigation

Assessing and mitigating impacts to marine biodiversity, namely seabirds, is imperative for sustainable construction and operation of offshore wind development, even if impacts of individual turbines or facilities are minor, the cumulative impacts of multiple turbines and wind energy facilities over time and space, have the potential to cause population declines and reverse or worsen trends of species already threatened by several human activities.

8.1 The mitigation hierarchy

The cornerstone of an effective impact mitigation is the overarching concept of the mitigation hierarchy. A well-developed hierarchy for mitigating environmental impacts of offshore wind on marine wildlife includes, in order of priority and timing:

1) Avoidance: strategic siting to avoid high-use areas for vulnerable populations;
2) Minimization: Reducing impacts through temporal or structural and technical alterations to infrastructure and operation;
3) Offsetting: compensation for impacts that cannot be avoided (if needed).

This concept puts all focus on Avoidance. It does so because as you advance in the mitigation hierarchy you not only decrease the probability of a successful mitigation, but you also increase costs, uncertainty of results and credibility among stakeholders.

So, avoiding impacts by an adequate risk assessment through sensitivity mapping and adequate spatial planning are pivotal in mitigation efforts. It is worth noting that each successive step on the hierarchy is considered less optimal, i.e. it is considered far preferable to avoid damage in the first instance rather than rely on offsetting strategies that are often expensive and complex and have limited evidence of success. Each successive step in the mitigation hierarchy should only be considered when it can be demonstrated that the preceding step has been fully enacted.

- **Avoidance**

There are several types of risk for biodiversity associated with project location and specific construction and operational features where relevant. According to Bennun et al. 2021 (40), they can be based on four broad categories of impact:

(40) www.iucn.org/sites/default/files/2022-06/early_risk_screening_guidance_offshore_wind_1.pdf

- Footprint: including habitat loss, degradation, barriers to movement and/or fragmentation (including through behavioural change in wildlife), hydrodynamic changes and introduction of new hard-substrate habitat associated with the physical presence of project infrastructure;
- Collision: bird and/or bat mortality due to collisions with offshore turbines and collision/electrocution on associated onshore transmission lines;
- Underwater noise: marine mammal, fish and turtle injury/mortality due to underwater construction noise;
- Vessels: marine mammal, fish, bird and turtle disturbance, injury and mortality (vessel strike) associated with vessel activity

Sensitivity mapping and marine spatial planning provides information for understanding risks, influencing project design and identification of mitigation measures.

These should be based on the best science available and incorporate stakeholder engagement, namely expert consultation, in order to provide robustness and **reduce uncertainties regarding risks for biodiversity, conflicts with stakeholders and investment risk.**

Early risk screenings use biodiversity data and, through spatial planning, develop project risks and opportunities. This ensures biodiversity risks are accounted for in early project decision-making and informs early mitigation planning and further field surveys as part of project design.

- **Minimization**

Impact minimization is what is necessary to implement to reduce the impacts that were not tackled through avoidance. They are deeply connected to the monitoring procedures in place in order to determinate and prioritise mitigation actions. Minimization is introduced through direct measures and can include:

- *Shutdown-on-demand*

This is a temporary halt in turbine movement activated by pre-defined criteria related to the passage of birds or bats.

Shutdown-on-demand or curtailment can be implemented by real time observations in the field or image-based and radar systems that identify flying animals though a computer software.

The latter still presents limitations as it needs a very robust image database, error margins are still deemed inefficient and overall need to improve their accuracy. Hence, image-based detection protocols leading to curtailment may still need human verification. This mechanism can be activated without time-restraints or be active only during part of the year (e.g. migration peaks).

- *Minimum blade height*

Turbine height or distance between lower blade tip and the surface is an important factor to take into account regarding seabird collision risk (41). Different species have different general flight heights and patterns and these can be influenced by a number of factors such as weather or season. It is generally considered that most birds at risk of collision are flying in the lower part of the swept area. For such species, increasing the clearance above the water surface can significantly reduce the number of flights exposed to collision risk.

- *Visual and acoustic deterrents*

These are used to avoid animals from entering wind farms' areas. Visual measures can be painting one blade to increase visibility, although there is not sufficient evidence for offshore wind turbines to demonstrate its effectiveness.

Acoustic deterrents may work onshore in different settings, but like many of these measures further research/trialling is needed to uncover its effects. Ecological traits of different species might be triggering dissimilar or contrasting responses to such deterrents.

- *Minimising non-essential lighting*

Aiming at minimising attraction effect from certain species resulting from artificial lighting interfering with their orientation methods, and thus preventing collisions.

- *Creating buffer-zones*

Reducing impacts can also be achieved through security perimeters and no-traffic zones around areas proved to be important for feeding or resting seabirds.

- *Project designing*

Another approach can be to integrate mitigation in planning stages to create a design that allows for migration corridors within the park itself.

Although promising and deemed to have an increasing amount of future investment on their accuracy and effectiveness, the measures need to be **trialled on a site and species-specific approaches** in order to maximise their success.

One thing to have in mind is that minimisation is **costly and not fully effective**, so no matter how much of it is in place, it won't completely address displacement/barrier effect/habitat loss impacts.

(41) https://tethys.pnnl.gov/sites/default/files/publications/ICES_2012_Turbine_Height_Management_Tool.pdf

For Portugal, everything is yet to be trialled. Although a lot of information has been produced in other countries, there are no species' studies or knowledge to understand how mitigation strategies can maximise their effectiveness in the local context or on species and migration patterns.

Mitigation measures implemented prior to construction are the best way to minimise ecological impacts on the marine environment. Involving stakeholders in the design, siting, construction and operational phases of developments can help to ensure environmental concerns are adequately addressed (Inger et al 2009).

- **Offsetting**

The very last resort, offsetting, is to be considered once avoidance and minimisation have been implemented to the maximum extent feasible. Offsetting is complex and its success has **multiple challenges, namely technical, practical and ethical.**

Typical offsetting ideas include reducing threats to species elsewhere (e.g. building artificial nesting structures or removing introduced predators from nesting sites) or remediating or restoring past damage to biodiversity, not related to the project (e.g. improving fisheries management or habitat restoring).

One of the main issues of offsetting is that some of the actions proposed may already be considered responsibility of other biodiversity-related frameworks or state obligations. And although the measures proposed can actually improve biodiversity, it is unethical to consider them in the scope of a project that has already proven to harm biodiversity even if actively trying to offset such harm elsewhere. Another major constraint is how to ensure that the populations affected by offsetting and restoration - even if from the same species - are the ones being impacted by the specific offshore wind project considering the offsetting. Offsetting in offshore wind is in early concept stages and although some sets of measures appear to be more consensual among scientists, no robust offsetting guidelines exist to date that can be recommended by biodiversity experts.

As a follow-up step, we should **restore/rehabilitate** and improve. The aim of restoring/rehabilitating is to improve degraded or removed ecosystems following exposure to impacts that cannot be completely avoided or minimised. To improve is key to monitor impacts after construction, during the operation phase or towards the end of a project's life cycle, to inform adaptive management. Enhancing biodiversity in and around renewable energy operations (*in situ*) should be the first step, followed by restoring habitat and species away from renewable energy projects (*ex situ*). Restoring habitats damaged for the construction of renewables to their original conditions in a timely manner, or rehabilitating basic ecological functions and/or ecosystem services might be beneficial but it is good to keep in mind that many habitats are challenging to reinstate to their original conditions.

Other actions may provide crucial support to the steps of the mitigation hierarchy, such as supporting conservation actions that might have positive effects on biodiversity, carry out awareness activities to encourage changes in government policies, enhance research on threatened species and/or capacity building for stakeholders. Putting forward a circular economy approach (recovery, recycling, reuse) could be a winning strategy for end-of-life management of wind turbines infrastructure components and materials (also known as decommissioning). A spin-off circular economy from the wind sector could be an economic opportunity to leverage the future market of the sector.

8.2 Case studies

Holland - Hollandse Kust VI

Coming back to this paradigmatic site, the winning bid comprises implementing and studying the effectiveness of a suite of mitigation options that would include:

- Test taller turbines
- Avoidance mechanisms (Sound deterrents and UV-blade painting)
- Test species identification software
- Localised curtailment
- Seabird migration corridor in the middle of the-park
- Set exclusion zones for navigation in rafting areas
- Reduction of lighting
- Waste reduction protocol

Although ambitious, these measures serve as potential methods to be trialled and should be subject to adaptive management.

8.3 Recommendations

- **Thorough application of the mitigation hierarchy and the precautionary principle**

Avoidance must be the cornerstone of every mitigation strategy. This starts in RRAs designation based on sensitivity mapping and informing marine spatial planning, moving on to auction models and protocols with standardised criteria set to minimise ecological impacts and to an ambitious and rigorous early risk screening.

- **Cumulative and transnational impacts must be considered and framed**

For highly mobile and mostly migratory species, cumulative impacts must be taken into account as the true potential impacts for marine life as a whole, including those not directly related to offshore wind as overfishing, prey decline, bycatch, climate change and habitat disturbance.

In a challenging ever changing environment and in an ocean subject to several local, regional and global impacts, a single project can be the difference between life and death for an animal that is already weakened or vulnerable due to one or more of the threats described above (Masden et al 2010).

In transnational projects, mitigation efforts must be coordinated between countries as marine wildlife knows no borders. Site-specific protocols must be subject to collaboration between stakeholders in or to maximise success of both monitoring and mitigation.

- **Investing on filling in knowledge gaps on seabird and other migratory species' ecology, risk screening and response to mitigation measures**

Work is still needed to study and measure the variables in place for the seabird and the other migratory species that use Portuguese waters. Further research is needed on migratory behaviour, flight heights, avoidance or response to trialled mitigation measures - applied to the reality of Portuguese birds that use our coast.

It takes robust behavioural studies that take into account weather conditions and migratory patterns to create risk maps that allow to effectively inform the mitigation. This should be a priority in early planning, namely the definition of auction criteria and environmental monitoring.

- **Promote studies and recommendations that detail potential negative impacts of underwater noise and its mitigation**

Concerns exist about the proximity of the areas of Leixões, Figueira and Sines to Sites of Community Importance (SCI). Despite being slightly separated, the South-East vertices of the first two areas touch within the limits of SCI Maceda-Vieira. However, very little is known about the potential impacts on cetaceans, as this is reflected in the PAER.

- **Undertake an adaptive management by quantifying the efficacy of mitigation (through monitoring)**

Adaptive management is a systematic process intended to improve policies and practices and reduce scientific uncertainty by learning from the outcome of management decisions. On offshore wind development, a scientific-approach to monitoring and mitigation strategies should lead to possible strategic and operational changes.

- **Implement an independent expert-based committee to evaluate monitoring and mitigation**

This commission would be constituted by relevant stakeholders and independent experts and would be responsible for monitoring the implementation of strategies, recommend appropriate site-based monitoring and mitigation measures and evaluate their success -leading to adaptive management.

If this committee reaches the conclusion that in-situ mitigation is not sufficient to minimise cumulative impacts verified, compensatory mitigation can be considered. These measures should be equally considered within this committee, in order to maximise and monitor its impact and ensure transparency in a complex scenario.

- **Opportunities for wildlife created by wind farms should be carefully considered, its impact assessed and should not be framed as mitigation**

The direct or indirect attraction of fish populations, the creation of attached blue economy activities - like seaweed or shellfish farms - or the creation of artificial reefs inside park areas are often referred to as good practices or mitigation strategies.

These actions could lead to increased exposure to factors that have a direct impact on seabirds, such as mortality by collision or bycatch. For cetaceans and other underwater predators it may increase other risks such as entanglement or exposure to electromagnetic radiation and underwater noise - which must be considered in a logic of cumulative impacts. If this is considered, it must be clear that there will be an increased research effort leading to adaptive management. Doubts remain about the real value that these structures add to local biodiversity as do questions arise about how they may mask greater negative impacts associated with wind development itself.

- **A Nature Positive renewable energy transition must place the strict application of each step of the mitigation hierarchy at its core and not as an additional step of the mitigation hierarchy. Delivering actions that achieve positive outcomes for nature should never be justification or additional (action) for impacts from developments that can be avoided or mitigated.**

The Nature Positive (42) concept should be used constructively and not misinterpreted, to avoid the risk of greenwashing. This concept could be co-opted for purposes of greenwashing if companies seize upon the opportunity to claim the status of Nature Positive by supporting auxiliary conservation actions but fail to first address their direct impacts to a sufficient level. The key is therefore to limit growth instead of prioritising growth in a way that every damage to nature is overcompensated.

It is impossible to quantify the negative deficit incurred through the loss of nature such that it can be directly compared with, or indeed compensated by, an act of biodiversity protection or restoration. Some companies would welcome an opportunity to "write off" their negative environmental impact by purchasing biodiversity "credit" elsewhere, but this must be discouraged as greenwashing.

(42) Nature Positive concept advocates for a world where nature — species and ecosystems — are restored and regenerated rather than declining. It emphasises the need to go beyond simply minimising impacts and compensating for losses (i.e., no net loss), by requiring measures to enhance and recover nature following a whole ecosystem approach, not only halting the current trend of biodiversity loss, but reversing this trend.

9. References

- Adaramola, M. (2015). Wind Resources and Future Energy Security: Environmental, Social, and Economic Issues. Apple Academic Press.

- Bradbury G, Trinder M, Furness B, Banks AN, Caldow RWG & Hume D (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. PLoS ONE 9: e106366.

- Diederichs, A. et al. (2008). Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore windfarms. BioConsult. SH report to COWRIE Ltd.

- Catry P, Costa H, Elias G & Matias R (2010). Aves de Portugal, Ornitologia do Território Continental. Assírio e Alvim, Lisboa.

- Certain G, Jørgensen LL, Christel I, Planque B & Bretagnolle V (2015). Mapping the vulnerability of animal community to pressure in marine systems: disentangling pressure types and integrating their impact from the individual to the community level. ICES Journal of Marine Science 72: 1470-1482.

- Del Moral J & Oliveira N (Eds.) (2019). A galheta na Península Ibérica. População reprodutora em 2017 e método de censo. SEO/BirdLife. Madrid.

- Dias MP, Martin R, Pearmain EJ, Burfield IJ, Small C, Phillips RA, Yates O, Lascelles B, Borboroglu PG & Croxall JP (2019). Threats to seabirds: A global assessment. Biological Conservation 237: 525-537.

- Elmberg J, Hirschfeld E, Cardoso H, & Hessel R (2020). Seabird migration at Cabo Carvoeiro (Peniche, Portugal) in autumn 2015. Marine Ornithology 48: 231-244.

- Equipa Atlas (2022). III Atlas das Aves Nidificantes de Portugal (2016-2021). SPEA, ICNF, LabOr/UÉ, IFCN. Portugal.

- Federal Maritime and Hydrographic Agency, F. M. (2014). Ecological Research at the Offshore Wind Farm alpha ventus. Challenges, results and perspectives. Springer Spektrum.

- Furness RW, Wade HM & Masden EA (2013). Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management 119: 56-66.

- González-Solís J, Felícisimo A, Fox J, Afanasyev V, Kolbeinsson Y & Muñoz J (2009). Influence of sea surface winds on shearwater migration detours. Marine Ecology Progress Series 391: 221-230

- Guilherme J, Morais B, Alonso H, Andrade J, Almeida A, Barros N & Dias MP (2023). Mapping seabird and marine biodiversity sensitivity to marine wind farm expansion in Portugal (Versão 1). Sociedade Portuguesa para o Estudo das Aves (SPEA). https://doi.org/10.5281/zenodo.10045918.

- Halpern BS, Frazier M, Potapenko J, Casey KS, Koenig K, Longo C, Lowndes JS, Rockwood RC, Selig ER, Selkoe KA & Walbridge S. (2015). Spatial and temporal changes in cumulative human impacts on the world's ocean. Nature Communications 6: 7615.

- Haug FD, Paiva VH, Werner AC & Ramos JA (2015) Foraging by experienced and inexperienced Cory's shearwater along a 3-year period of ameliorating foraging conditions. Marine Biology 162: 649-660.

- Inger, R. et al. (2009). Marine renewable energy: Potential benefits to biodiversity? An urgent call for research. Journal of Applied Ecology.

- Masden, E. A. et al. (2010). Barriers to movement: modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. Marine Pollution Bulletin, v. 60, n. 7, p. 1085-1091.

- Mendel B, Schwemmer P, Peschko V, Müller S, Schwemmer H, Mercker M, Garthe S (2019). Operational offshore wind farms and associated ship traffic cause profound changes in distribution patterns of Loons (Gavia spp.). Journal of Environmental Management 231: 429-438.

- Oliveira N, Almeida A, Santos Torres, Fagundes AI, Rodrigues P & Andrade J (2016). Updated Information on the Breeding Status of Berlengas Archipelago Seabirds. Report of the Action A1, Project LIFE Berlengas. SPEA - Portuguese Society for the Study of Birds, Lisbon (unpublished report)

- Oliveira N, Alonso H, Magalhães M & Heber S (2022). Censo Nacional de Gaivota-de-patas-amarelas 2021. Em: Alonso H, Andrade J, Teodósio J & Lopes A (coord.) (2022). O estado das aves em Portugal, 2022. 2ª edição. Sociedade Portuguesa para o Estudo das Aves, Lisboa.

- Paiva V (2022). Censo da População Nidificante de Gaivota-de-audouin na Ria Formosa, 2014 - 2022. Em: Alonso H, Andrade J, Teodósio J & Lopes A (coord.) (2022). O estado das aves em Portugal, 2022. 2ª edição. Sociedade Portuguesa para o Estudo das Aves, Lisboa.

- Peschko V, Mendel B, Müller S, Markones N, Mercker M & Garthe S (2020). Effects of offshore windfarms on seabird abundance: Strong effects in spring and in the breeding season. Marine Environmental Research 162: 105157.

- Peschko, V. et al. (2021). Northern gannets (Morus bassanus) are strongly affected by operating offshore wind farms during the breeding season. Journal of Environmental Management.

- Ramírez I, Geraldes P, Meirinho A, Amorim P & Paiva V (2008). Áreas Importantes para as Aves Marinhas em Portugal. Projecto LIFE04NAT/PT/000213 – Sociedade Portuguesa para o Estudo das Aves. Lisboa.

- Serratosa J & Allinson T (2022). AVISTEP: the Avian Sensitivity Tool for Energy Planning. Technical Manual. BidLife International, Cambridge, UK.

- Vanermen N & Stienen E (2019). Seabird displacement. In Perrow MR (Ed.) (2019). Wildlife and Wind Farms, Conflicts and Solutions, 3. Offshore: Potential Effects, pp. 174–205. Pelagic Publishing, Exeter.

- Ward, J. et al. (2010). Assessing the effects of marine and hydrokinetic energy development on marine and estuarine resources. Oceans 2010 MTS/IEEE Seattle.

- Wikelski M, Davidson SC & Kays RW (2023). Movebank: archive, analysis and sharing of animal movement data. Hosted by the Max Planck Institute of Animal Behavior. Available from www.movebank.org.

- Wilberforce, T., El Hassan, Z., Durrant, A., Thompson, J., Soudan, B., & Olabi, A. G. (2019). Overview of ocean power technology. Energy, 175, 165-181.