INPUT PAPER

A4.1: Joint working group to develop a biodiversity risk assessment framework for enhanced PI governance

PROMEA

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1 Executive summary

The purpose of this document is to assist BIOWIND partners in using the tool developed to assess the risks of wind projects on biodiversity sensitivity and impacts and monitor mitigation measures. In addition, the document will facilitate project partners in organising an online joint working group to test, validate and provide suggestions for the refinement of the tool.

To this end, the document includes the following sections:

- ✓ **Background and rationale:** provides the context of the Activity A4.1 and partners' involvement.
- ✓ **Overview of the tool**: describes the use and the structure of the tool.
- ✓ **Proposed indicators framework**: lists and presents the indicators relevant to biodiversity sensitivity and impact assessment for both onshore and offshore projects. It also includes a detailed explanation of the scoring methodology used.
- ✓ **Mitigation measures monitoring framework**: offers an overview of the mitigation actions required at each project stage, based on the project's risk rating.
- ✓ **Organisation of the joint working group**: provides guidelines and suggestions for the composition and implementation of the joint working group.
- ✓ **References**: lists all references used in the report.
- ✓ **Annex:** contains supportive, informative material on mapping ecosystem services and biodiversity resources.

2 Background and rationale

In their efforts to achieve the green transition and decarbonisation targets set by the EC, EU regions face interconnected challenges, including social opposition to wind energy, often driven by public concerns over biodiversity. The increase in wind energy production undeniably impacts local biodiversity and essential to all- ecosystem services. However, with proper project design, site selection, mitigation measures, and comprehensive monitoring, these impacts can be minimised to a level that ensures public acceptance and biodiversity protection.

To this end, the Interreg Europe BIOWIND project which aims to increase social acceptance for wind energy in EU regions through environmental and community-based planning, includes Activity A4.1 – *a Joint working group focused on exchanging insights to develop a biodiversity risk assessment framework for improved PI governance*. As part of Activity A4.1, BIOWIND partners will convene to exchange viewpoints and refine the evidence-based tool following PROMEA's groundwork over the proposed joint approach and tool. The tool is designed to support wind project site selection, permitting procedures, monitoring mitigation measures' effectiveness, and implementation status across all project stages. This enables partners to strengthen the governance of their Policy Instruments (PIs), in relation to wind energy expansion and biodiversity considerations. Overall, Activity A4.1 builds on the results of Activity A1.1- *Joint elaboration on the environmental and socioeconomic drivers of public opposition to wind power projects* and Activity A3.4- *Study visit to the "Vöyrinkangas" wind farm in South Ostrobothnia, Finland*.

3 Overview of the tool

The tool enables users to estimate the risk of a wind project to biodiversity and ecosystem services by assessing sensitivity and impacts at all project stages, based on the specific characteristics of the site. Accordingly, based on the determined risk category, the tool provides the required mitigation measures, monitoring requirements, and success criteria for each project stage. Furthermore, users can rate the effectiveness of mitigation actions and indicate their implementation status.

The tool, formatted as an Excel file, is structured into six sheets:

1. *Instructions* sheet, provides guidelines for users,
2. *Main dashboard*, where users input data, such as *Project name*, *Project location* and select the *Type of Project* (onshore or offshore). After scoring each criterion, the project's *risk category* is displayed.
3. *Sensitivity assessment* sheet, where users score criteria related to biodiversity sensitivity,
4. *Impact assessment* sheet, where users score criteria related to impact on biodiversity,
5. *Scoring guide* sheet, which provides a detailed description of all scores for each criterion related to sensitivity and impact indicators.
6. *Mitigation measures monitoring framework* sheet, lists required actions, monitoring requirements and success criteria for each project stage, from the design to decommissioning. These measures are determined based on the final risk rating, which is derived from the biodiversity sensitivity and impact assessment results of each wind energy project. Users can add comments and select implementation status and rate the effectiveness of the listed mitigation actions.

After selecting the project type, users can refer to the scoring guide and assign scores to each criterion listed in the sensitivity and impact assessment sheets. The tool will automatically calculate the overall scores and determine the risk category for the wind project. Users can then monitor the required mitigation measures for each project stage using the mitigation measures monitoring framework sheet. To ensure the validity of the biodiversity sensitivity and impact assessment process for each wind project, users should study the Environmental Impact Assessment (EIA). EIAs typically include data, such as species surveys, habitat mapping, species migration pattern studies, and marine surveys for offshore wind projects, providing a comprehensive understanding of the specific project site.

4 Proposed indicator framework

The proposed indicator framework includes a set of indicators to assess biodiversity sensitivity and impact both on onshore and offshore wind energy projects. The following sections present indicators listed under each category.

4.1 Environmental indicators for biodiversity sensitivity assessment

4.1.1 Conservation status

The conservation status of a species indicates its risk of extinction and is categorised primarily by the IUCN[1] Red List of Threatened Species, which is the most recognised global system for assessing species' conservation statuses. The IUCN classifies species into several categories based on their population trends, geographic distribution, and threats they face ('International Union for Conservation of Nature and Natural Resources', 1960). The main categories are indicated in the following table.

Status	Description
Extinct (EX)	No known living individuals remain
Extinct in the wild (EW)	Surviving only in captivity or outside their historical range
Critically endangered (CR)	Faces an extremely high risk of extinction in the wild
Endangered (EN)	Faces a very high risk of extinction in the wild
Vulnerable (VU)	Faces a high risk of extinction in the wild
Near threatened (NT)	Likely to qualify for a threatened category in the near future
Least concern (LC)	Widespread and abundant; does not qualify for a higher risk category
Data deficient (DD)	Insufficient data to assess extinction risk
Not evaluated	Has not yet been evaluated against the criteria

Table 1.IUCN Conservation status categories

The conservation status of a species is a critical factor in assessing biodiversity sensitivity concerning wind development, as it helps assess the potential impacts of wind energy projects on various species and their habitats within specific sites. Identifying the conservation status of species present in an area proposed for wind park is essential for conducting a biodiversity sensitivity analysis. Areas with high concentrations of threatened or endangered species, along with areas that consist of bird migratory routes are considered more sensitive to environmental impacts.

Wind power installations primarily impact bird and bat populations through collisions and pose additional pressures to species that are already threatened or endangered. Migratory species can be especially vulnerable due to their regular movement patterns. Additionally, wind farm construction and operation, increase noise levels and can disrupt species' habitats and affect breeding patterns. Therefore, wind energy developments in the EU-27 must comply with the EU birds and habitats directives, which protect species and habitats within the Natura 2000 network of protected areas. National laws also require developers to conduct detailed environmental impact assessment to evaluate potential risks to birds and implement mitigation measures throughout wind project development and operation.

[1] International Union for Conservation of Nature (IUCN)

4.1.2 Habitat value

Habitat value refers to the importance and quality of a specific area in supporting diverse species. It considers factors like habitat uniqueness and species' richness, structural complexity and its role in providing essential resources such as food, shelter/nest and breeding/spawning grounds. It involves classifying habitats based on their ability to support a variety of species, particularly rare or threatened ones, and the role of each habitat in providing significant ecosystem services. Ecosystem services are the benefits that both humans and animals obtain from natural ecosystems and can be categorised into the following: a) provisioning services, such as food, freshwater, natural medicines, and biomass fuel b) regulating services, such as air quality, pollination, climate regulation and water purification, c) supporting services, such as soil formation, photosynthesis, and nutrients cycling, and d) cultural services, such as recreation and ecotourism, as illustrated in Figure 1.

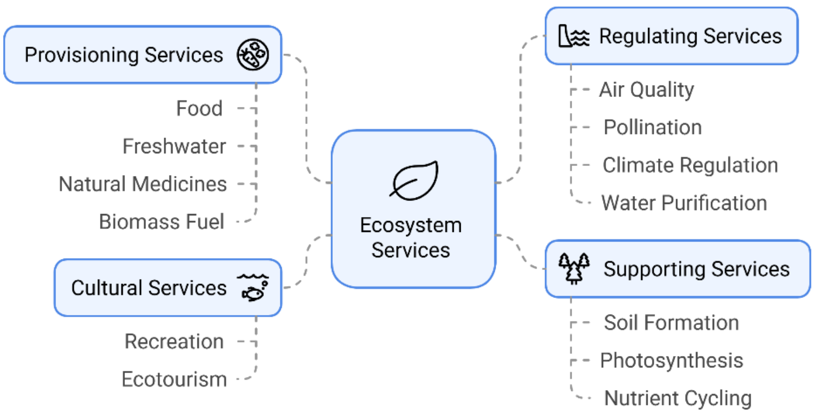

Figure 1. Ecosystem services

Ecosystem services are vital indicators for assessing habitat value in terms of ecosystem health and functionality, as healthy ecosystems provide a wide range of irreplaceable services. Wind power development may impact an ecosystem's ability to provide essential services, affecting species and local communities that depend on them and contributing to environmental degradation. Hence, identifying and evaluating ecosystem services can uncover potential impacts of wind power projects on local ecosystems and their ability to maintain the provision of these essential functions. Accordingly, this process will enable developers to implement targeted mitigation strategies to minimise negative impacts, and help permitting authorities prioritise authorising projects that plan to apply such strategies (Feld et al., 2010).

Additional information concerning approaches developed to facilitate mapping and assessment of ecosystem services are available in the Annex (6.1 Approaches to map and assess ecosystem services).

4.1.3 Population significance

Population significance measures the percentage of a species' total population that occurs within the project area or is likely to interact with it. This indicator helps quantifying the importance of a specific area in maintaining species populations and assessing potential project impacts on species of concern. It indicates that biodiversity sensitivity increases as the proportion of a population affected by wind energy production grows. Population significance considers species' population dynamics, vulnerability, reproduction rates, and seasonal fluctuations. Population percentages are typically determined by:

- Using historical data from regional, national, or global databases and comparing them against known breeding population estimates.
- Conducting site-specific surveys.
- Using GPS or satellite tracking data to identify migration patterns of populations passing through a specific area (European Commission et al., 2020).

Onshore and offshore wind farms impact on population significance, since their construction and operation can lead to habitat loss and fragmentation, thereby affecting species and reducing population size of those that rely on those habitats. Additionally, since wind turbines generate noise, many terrestrial, avian and marine species experience disruption in communication, feeding, nesting, and reproductive behaviours. However, in certain cases, wind farms can also enhance species populations and positively influence population significance. One such case is offshore installations, where wind turbine foundations act as artificial reefs providing habitat for many marine species and allowing them to nest and reproduce (Horwath et al., 2021).

4.1.4 Marine ecosystem value

Marine ecosystem value measures the ecological significance of a marine area based on its role in supporting species and ecosystem functions. It categorises areas according to their contribution to biodiversity conservation, species life cycles, and ecological importance. Marine ecosystems may include critical habitats supporting high biodiversity and sensitive species, important breeding grounds for species reproduction, and regular feeding and foraging areas. In addition, many marine areas serve as migration routes for species movement, ensuring the connectivity of multiple habitats. Yet, some areas may demonstrate low ecological value in terms of biodiversity significance and contribution to marine ecosystem functions. The marine ecosystem value of an area is typically defined based on a) water quality sampling, b) mapping of marine food web relationships and c) assessment of ecosystem services.

Offshore wind farms impact on marine ecosystems throughout project phases, with these impacts varying depending on different marine ecosystem values. The construction and operation of offshore wind parks can lead to habitat alterations, affecting species that rely on them. In addition, increased noise levels, as well as temperature increase, in the case of unburied cables, can further exacerbate the degradation of critical marine habitats (Horwath et al., 2021). In conclusion, defining the marine ecosystem value of an area proposed for a wind park is critical for ensuring proper site selection and biodiversity protection, thereby reducing potential negative impacts.

4.1.5 Benthic sensitivity

Benthic sensitivity refers to the vulnerability of the seafloor communities to disturbance. The benthic zone located in the seafloor hosts a wide range of organisms from fungi to larger invertebrates that are crucial components of marine ecosystems, contributing to nutrient cycling, decomposition of organic matter, habitat formation, and serve as food source for species belonging to the higher trophic levels.

Offshore wind park installations can affect the seabed, altering the benthic environment and causing disturbance to benthic species, thereby disrupting their contribution to critical ecosystem functions. Yet, adopting a “no trawling” policy near offshore wind parks, which is a common practice, can promote the flourishing of benthic species. Disturbance can also be caused by the installation of wind turbines foundations, increased noise levels and vibrations during the construction and operation phases, as well as heat and electromagnetic field emissions from cables (Solan et al., 2016). However, some invertebrates tend to colonise wind parks' foundations and develop new habitats. In this case, during the decommissioning phase, project developers commonly adopt a partial decommissioning approach in order to minimise additional impacts on benthic communities.

4.2 Environmental indicators for biodiversity impact assessment

4.2.1 Collision risk

The collision risk measures the probability of wildlife, such as birds, bats and marine species colliding with rotating wind turbine blades or other relevant infrastructure, potentially causing injury or mortality. Collision risk depends on turbine design, environmental conditions, species' flight patterns, and seasonality in the case of migratory birds. Typical methods to define collision risk may include radar monitoring surveys and GPS and satellite species' movement tracking. Acknowledging that social opposition to wind energy often stems from biodiversity impacts, project developers adopt various solutions and approaches to mitigate these effects. Such solutions may include- but are not limited to technologies, such as monitoring systems, autonomous video surveillance, and collision avoidance systems to minimise the risk of collision.

4.2.2 Habitat loss

Habitat loss refers to the reduction or complete elimination of species' habitat due to wind project construction and operation. Since the construction and operation of wind parks require the development of access roads, the installation of foundations and transmission lines, some level of interference is inevitable. However, defining the extent of habitat loss during the project design phase remains critical to establishing proper mitigation and offset strategies. Habitat loss is measured as a percentage and is calculated by comparing the pre-construction habitat area with the area occupied by wind project infrastructure. This percentage is then assessed against the total habitat area, which may extend beyond the project area.

4.2.3 Barrier effect

The barrier effect measures the level of disruption of species' natural movements caused by wind energy infrastructure. Wind energy infrastructure creates a physical obstacle that may interrupt or alter species' movement patterns and behaviours, daily movement corridors, or foraging and migratory routes. This forces various species to modify their normal behavioural patterns, following longer and more energy-consuming routes, which can lead to exhaustion, impact their health and reproduction and result in isolation from their groups or even increased mortality rates (Marques et al., 2020).

4.2.4 Disturbance effect

The disturbance effect measures the impacts associated with wind project construction and operation activities, such as noise, vibrations, electromagnetic fields, and visual obstacles, that disrupt species' normal behaviours. Such behaviours may include feeding, breeding, resting, nesting and communication patterns. Wind project-induced impacts pose a risk of displacement to animals that exhibit avoidance behaviour in search of a safe place to continue their lives. Hence, the disturbance effect measures the impact of wind project activities on wildlife by determining whether they cause permanent, long-term or temporary displacement or result in minor behavioural modifications.

4.2.5 Marine impact

Marine impact refers to the ecological effects of offshore wind parks on marine biodiversity, habitats, and ecosystem services. It involves assessing the stressors introduced by offshore wind projects, to determine whether their construction and operation cause minimal, limited, substantial, or major effects on marine ecosystems or lead to their complete destruction. Offshore energy production can have both negative and positive effects on marine ecosystems, with negative impacts being more commonly reported, appearing in up to 10% of a comprehensive review of all relevant scientific literature. The ecological stressors associated with the negative impacts of offshore energy production can vary by geographic region, depending on the environmental characteristics and vulnerability of the affected area (Galparsoro et al., 2022). Hence, the assessment of marine impact is case-specific, considering the unique characteristics -in terms of species, habitats, and ecosystem services- of the project area.

4.2.6 Benthic impact

Benthic impact refers to the specific effects of offshore projects on benthic communities and habitats. These impacts can range from extreme disruption and benthic community elimination to moderate or minor disruption that cause limited changes in benthic ecosystems. The depth of the water, along with the type of foundations (piled or gravity foundations) and electrical export cables used for wind turbine installation, largely determines the degree of interaction between the wind project infrastructure and benthic ecosystems on the seabed. In deep waters, anchors with mooring lines are installed in the seafloor to stabilise floating turbine foundations, while in shallow waters foundations are installed directly into the seabed with scour protection to minimise the risk of erosion. Scour protection typically consists of hard surfaces such as layers of rocks, placed on the seabed and around foundation components to prevent erosion. Scour protection can crush benthic habitats and attract invasive alien species, further impacting benthic organisms and marine life (Horwath et al., 2021).

4.3 Scoring methodology

The proposed indicators framework matrix categorises sensitivity from 1 (low) to 5 (critical) and impact from 1 (negligible) to 5 (severe), including different indicators tailored to each project type (onshore/offshore), as indicated in the following table.

Sensitivity assessment					
	Indicators applicable to all type of projects			Indicators applicable to offshore projects	
Score	**Conservation status**	**Habitat value**	**Population significance**	**Marine ecosystem value**	**Benthic sensitivity**
5	Critically endangered species present	Critical habitat/Breeding ground	>10% of species population	Critical ecological value/Irreplaceable ecosystem services	Unique/Sensitive communities
4	Endangered species present	High-value habitat/ Important migration corridor	5-10% species population	High ecological value/Carbon storage-nutrients cycling	High biodiversity value
3	Vulnerable species present	Moderate-value habitat/Regular feeding-nesting area	1-5% species population	Moderate ecological value	Moderate biodiversity value
2	Vulnerable species present	Low-value habitat/Area occasionally used	0.1-1% species population	Limited ecological value	Common habitat type
1	Only least concern species present	Minimal-value habitat/ Area rarely used	<0.1% species population	Low ecological value/Low biodiversity	Low sensitivity habitat

Impact assessment						
	Indicators applicable to all type of projects				Indicators applicable to offshore projects	
Score	**Collision risk**	**Habitat loss**	**Barrier effect**	**Disturbance effect**	**Marine impact**	**Benthic impact**
5	Very high risk/Major flyway	>50% habitat loss	Complete barrier to movement	Permanent displacement	Complete marine ecosystem destruction	Extreme disruption/Benthic community elimination
4	High risk/Regular flight path	25-50% habitat loss	Major deviation required	Long-term displacement	Major ecosystem structural changes	Severe disruption/Major benthic community structural breakdown
3	Moderate risk/Occasional flights	10-25% habitat loss	Moderate deviation required	Temporary displacement	Substantial ecosystem modification	Moderate disruption/Substantial benthic community modification
2	Low risk/Rare flights	5-10% habitat loss	Minor deviation required	Minor behavioural changes	Limited ecosystem alteration	Minor disruption/Limited benthic community changes
1	Negligible risk	<5% habitat loss	No significant barrier	No significant disturbance	Minimal detectable ecosystem effect	Minimal disruption/Negligible impact on benthic community

Table 2. Scoring guide

The **overall sensitivity score** is calculated as follows:

- For onshore projects:
  Conservation status + Habitat value + Population significance / 3
- For offshore projects:
  Conservation status+ Habitat value + Population significance+ Marine ecosystem value + Benthic sensitivity /5

The **overall impact score** is calculated as follows:

- For onshore projects:
  Collision risk+ Habitat loss+ Barrier effect + Disturbance effect /4
- For offshore projects:
  Collision risk+ Habitat loss+ Barrier effect + Disturbance effect+ Marine impact +Benthic impact /6

The **final risk rating** is calculated as follows:
Overall sensitivity score × Overall impact score

The risk categories are indicated in the following table.

Risk score range	Risk category	Description
20-25	Critical	The project introduces a very high risk of severe and irreversible impacts on biodiversity. Project redesign and strong mitigation measures are required to prevent significant biodiversity loss.
15-19	High	The project entails a substantial risk with potentially significant impacts on biodiversity. Significant mitigation efforts are required to minimise impacts.
10-14	Moderate	The project carries a moderate level of biodiversity impact that could be minimised with appropriate mitigation measures. Yet, long-term monitoring is required.
5-9	Low	The project entails a relatively low risk and impacts on biodiversity are minor and can be restricted with standard mitigation strategies.
1-4	Negligible	The project involves a minimal risk with no significant impacts on biodiversity. The project is unlikely to adversely affect biodiversity or ecosystem functions.

Table 3. Risk score classification categories and descriptions

5 Mitigation measures monitoring framework

The construction and operation of wind parks require the development and installation of infrastructure, such as foundations, access roads, and transmission lines, which can fragment previously continuous habitats and create barriers to wildlife movement, thereby increasing habitat fragility. It is important that decisions about project feasibility, prioritisation, as well as necessary mitigation measures are informed by sensitivity and impact analysis (Bennun et al., 2024). Such mitigating measures may include -but are not limited to- altering turbine locations, timing construction activities to avoid critical species' breeding seasons or even creating alternative habitats to offset potential impacts.

Habitats already fragile due to other factors, may have limited capacity to recover the disturbance caused by additional pressures, such as those related to wind energy development (Dey et al., 2024). Internal factors, such as slow-growing species, endemic species and sensitive biotopes can further exacerbate an ecosystem's fragility, making it more susceptible to degradation or depletion and may result in irreversible biodiversity loss. Biodiversity loss has been considered as one of the top three global risks by the World Economic Forum (Biodiversity and Fragility, 2023). Biodiversity hot spots are de facto considered fragile habitats, since they are areas which host endemic species that cannot be found elsewhere and have at least 70% of their primary native vegetation. The World Economic Forum (2020) has identified infrastructure and built environment, along with energy and extractives as two of the three critical socio-economic systems to address biodiversity loss. In this regard, the World Economic Forum emphasises the importance of planning the development of infrastructure by enacting mitigation hierarchy principles to minimise the risk of habitat disruption, including the creation of wildlife corridors (The Future of Nature and Business, World Economic Forum, 2020).

Mitigation hierarchy principles is a widely adopted best-practice framework that assists wind project developers in minimising the negative impacts of development projects on biodiversity. The following figure (Figure 2) illustrates the essential steps of the mitigation hierarchy principles.

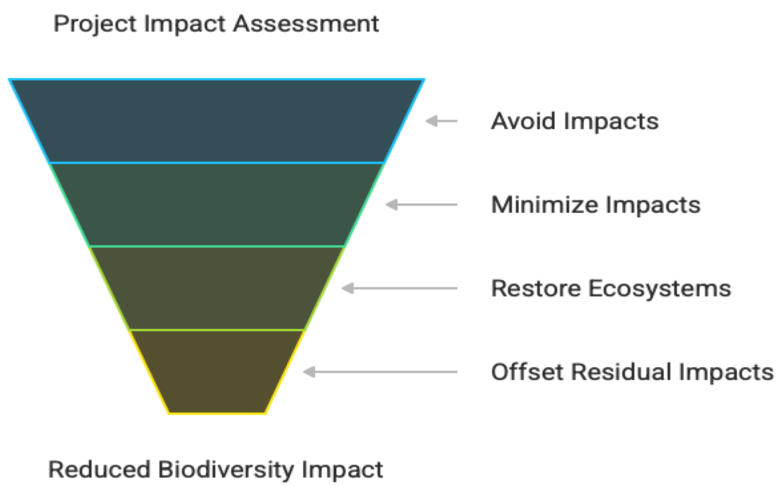

Figure 2. Mitigation hierarchy principles

The proposed indicators matrix incorporates a mitigation measure monitoring framework, outlining required actions, monitoring requirements and success criteria for each project stage, from the design to decommissioning. These measures are determined based on the risk category, which is derived from the biodiversity sensitivity and impact assessment results of each wind energy project. In addition, users can select implementation status, rate the effectiveness and add comments regarding the required mitigation actions. The following table presents for each risk category, the required actions, monitoring requirements and success criteria at each project stage.

Risk category	Project stage	Required actions	Monitoring requirements	Success criteria
Critical risk	Design	• Relocate turbines from sensitive areas •Reduce project footprint • Install advanced detection systems	• Daily wildlife monitoring • Real-time collision monitoring • Monthly biodiversity surveys	• Zero collision incidents • No displacement of priority species • Maintained habitat quality
	Installation	• Install advanced detection systems • Implement noise reduction measures • Create wildlife corridors • Establish exclusion zones	• Daily wildlife observations • Noise level monitoring • Habitat disturbance tracking • Species displacement monitoring	• Minimal wildlife disturbance • Controlled noise levels • No permanent displacement
	Operation	• Operate automated detection systems • Implement seasonal shutdowns • Maintain habitat enhancement areas • Regular equipment optimisation	• Real-time collision monitoring • Daily species mortality surveys • Monthly biodiversity assessments	• Zero collision incidents • No species population decline • Successful habitat use
	Decommissioning	• Carefully-timed removal activities • Gradual habitat restoration • Enhanced revegetation program • Comprehensive site rehabilitation	• Daily wildlife monitoring • Habitat restoration progress • Species return rates • Environmental recovery tracking	• Complete habitat restoration • Species reintroduction • Ecosystem function recovery
High risk	Design	• Optimise wind farm layout • Create buffer zones • Design habitat enhancement areas • Desing wildlife corridors	• Seasonal surveys • Habitat assessment • Impact modelling • Migration mapping	• Reduced habitat fragmentation • Reduced impact prediction • Adequate buffer zones

Risk category	Project stage	Required actions	Monitoring requirements	Success criteria
	Installation	• Install collision deterrent systems • Create buffer zones • Implement seasonal restrictions/shutdowns • Control construction timing	• Weekly wildlife monitoring • Noise level measurements • Habitat impact assessment • Construction activity monitoring	• Limited wildlife disturbance • Maintained habitat quality • Reduced impact levels
	Operation	• Operate collision deterrent systems • Maintain buffer zones • Conserve habitat enhancement areas • Control operation timing	• Weekly collision monitoring • Weekly species mortality surveys • Weekly biodiversity assessments	• Minimise collision incidents • Stable species populations • Maintained habitat quality
	Decommissioning	• Scheduled removal activities • Biodiversity restoration plan • Diligent site restoration	• Weekly wildlife monitoring • Biodiversity restoration progress • Species return rates	• Successful habitat recovery • Species return confirmed • Site restoration goals met
Moderate risk	Design	• Standard wind farm layout optimisation • Basic buffer zone planning • Regular environmental considerations	• Baseline surveys • Standard impact assessment • Basic habitat mapping	• Standard impact levels • Standard compliance
	Installation	• Standard wildlife protection measures • Standard noise control • Regular construction scheduling	• Monthly monitoring • Impact tracking • Construction supervision	• Controlled disturbance levels • Standard compliance met
	Operation	• Regular wind farm equipment maintenance • Standard biodiversity monitoring practices • Basic biodiversity protection	• Quarterly surveys • Standard biodiversity monitoring • Regular site inspections	• Low impact on biodiversity • Compliance goals met
	Decommissioning	• Standard removal procedures • Basic restoration measures • Regular site cleanup	• Monthly site checks • Basic habitat recovery monitoring • Standard compliance checks	• Site restoration completed • Basic habitat recovery achieved

Risk category	Project stage	Required actions	Monitoring requirements	Success criteria
Low	Design	• Necessary environmental planning • Standard setback distances • Typical construction planning	• Basic wildlife surveys • Standard site assessment	• Minimal impact levels • Regulatory compliance
	Installation	• Standard construction practices • Basic environmental controls	• Standard environmental monitoring process • Basic impact checking	• Standard environmental compliance • Limited impacts
	Operation	• Regular wind farm systems maintenance • Standard operations • Basic environmental monitoring	• Periodic system checks • Standard environmental observations	• Typical operations • Basic compliance
	Decommissioning	• Standard removal process • Basic site restoration • Regular cleanup	• Basic monitoring • Site inspection	• Site restored • Basic environmental requirements met
Negligible	Design	• Standard design practices • Basic environmental considerations	• Regular site checks • Standard biodiversity monitoring	• Insignificant impact • Basic compliance
	Installation	• Basic installation practices • Standard procedures	• Regular checks • Basic impact monitoring	• Minimal environmental impact • Standard compliance
	Operation	• Standard equipment maintenance • Normal operations	• Routine checks • Basic site observations	• Low-impact operations • Basic compliance
	Decommissioning	• Standard removal protocols • Basic site cleanup	• Final site inspection • Basic biodiversity observations	• Site cleaned • Requirements met

6 Organisation of the joint working group

In the context of Activity A4.1, BIOWIND partners will form a joint working group and organise an online workshop meeting to exchange viewpoints on the tool, developed by PROMEA. The following sections outline the indicative composition of the working group and the proposed approach to be followed.

6.1 Composition of working group

Achieving a balanced representation of participants from all BIOWIND regions adopting the tool it is essential to capturing varied perspectives and ensuring that the tool is tailored to users' needs. Representatives from regional authorities involved in the wind permitting process form the main target group. However, inviting wind energy project developers, environmental experts from agencies and NGOs, and representatives from other regulatory authorities relevant to the wind energy production, can add significant value to the discussions in the working group.

6.2 Working group approach

It is highly recommended that the joint working group meeting includes structured discussions on the tool, focusing on its usability, applicability, effectiveness, and areas for improvement. To ensure a smooth and organised meeting, coordinators are encouraged to develop and share the agenda with the participants in advance. The meeting organiser can provide the tool, along with this report, which includes a detailed presentation of the tool and guidelines for use. These materials should be shared well in advance to allow participants sufficient time to explore and familiarise themselves with the tool. Participants can apply real case scenarios, such as upcoming or proposed onshore and offshore wind projects, to demonstrate and test the tool's functionality. In addition, collecting and documenting participants feedback, including suggestions for improving the tool, will be essential for the finalisation of the tool, as PROMEA will refine it based on their input.

7 References

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8 Annex

8.1 Approaches to map and assess ecosystem services

Several approaches have been developed to facilitate mapping and assessing ecosystem services, including:

a. Biophysical methods, focusing on quantitative assessment of the biophysical processes that generate ecosystem services using process-based or empirical models.
b. Socio-cultural methods, such as the participatory mapping approach, emphasising on local community's perceptions and values associated with ecosystem services.
c. Economic methods, applied to quantify the economic value of ecosystem services, following a cost-benefit analysis approach.
d. Expert-based quantification, based on a relative scoring approach.
e. Integrated assessment frameworks, such as the Driver-Pressure-State-Impact-Response (DPSIR) Framework which is used to analyse interactions between societal activities and environmental conditions (Kristensen, 2004).
f. GIS techniques and remote sensing technology, (Burkhard B, Maes J (Eds.), 2017).

The Rapid Assessment of Wetland Ecosystem Services (RAWES) is a methodology developed for assessing wetland ecosystem services based on biophysical methods and expert-based quantification. Similarly, the Common International Classification of Ecosystem Services (CICES) is another framework built for assessing and classifying ecosystem services which is widely used in European Initiatives, such as the Mapping and Assessment of Ecosystems and their Services (MAES) process, which aims to map ecosystem services across Europe to fulfil commitments under the EU's Biodiversity Strategy (European Commission. Joint Research Centre., 2020).

An indicative ecosystem services assessment sheet is provided below (Table 2).

Ecosystem services		Explanation/ Examples	Scale of importance	Describe benefit	Scale of benefit
Provisioning services	Fresh water	Water used for domestic drinking supply for irrigation, for livestock, etc.	Choose an item.		Choose an item.
	Food	Crops, fruit, fish, etc.	Choose an item.		Choose an item.
	Biomass fuel	Fuelwood, peat etc.	Choose an item.		Choose an item.
	Fibre	Timber, wool, straw, etc.	Choose an item.		Choose an item.
	Genetic resources	Rare breeds used for crop/stock breeding, etc.	Choose an item.		Choose an item.
	Natural medicines	Plants used for drug manufacture	Choose an item.		Choose an item.
	Energy harvesting from air or water flows	Hydropower, Wind power	Choose an item.		Choose an item.

Ecosystem services		Explanation/ Examples	Scale of importance	Describe benefit	Scale of benefit
Regulating services	Air quality regulation	Absorption of pollutants, oxygen production, and dust and particle capture	Choose an item.		Choose an item.
	Climate regulation	Carbon sequestration, temperature regulation, etc.	Choose an item.		Choose an item.
	Water regulation	Flow moderation, groundwater recharge, water purification	Choose an item.		Choose an item.
	Flood hazard regulation	Water absorption, flow regulation during intense rainfall events, etc.	Choose an item.		Choose an item.
	Pest regulation	Presence of natural predators such as birds and insects that contribute to the restriction of invasive alien species.	Choose an item.		Choose an item.
	Erosion regulation	Vegetation cover, organic matter which serves as surface protection, sediment trapping	Choose an item.		Choose an item.
	Water purification	Filtration, nutrient cycling, etc.	Choose an item.		Choose an item.
	Pollination	Crop pollination, wild plant reproduction, or gamete dispersal in a marine context.	Choose an item.		Choose an item.
	Fire regulation	Moisture retention, vegetative composition including fire-resistant species	Choose an item.		Choose an item.
	Noise and visual buffering	Presence of vegetation such as trees, shrubs that a) serve as barriers absorbing and deflecting sound waves, and/or b) obstruct undesirable	Choose an item.		Choose an item.

Ecosystem services		Explanation/ Examples	Scale of importance	Describe benefit	Scale of benefit
		views such as urban developments.			
Cultural services	Cultural heritage	Forests, mountains, rivers that hold cultural significance, contributing to local identity and heritage.	Choose an item.		Choose an item.
	Recreation and tourism	Hiking, ecotourism, festivals, water sports etc.	Choose an item.		Choose an item.
	Aesthetic value	Known area of natural beauty	Choose an item.		Choose an item.
	Educational and research	Use of the area by local schools for educational purposes or research.	Choose an item.		Choose an item.
Supporting services	Soil formation	Deposition of sediment, organic matter, etc.	Choose an item.		Choose an item.
	Primary production	Presence of plants or algae that convert sunlight, carbon dioxide and water into biomass through photosynthesis.	Choose an item.		Choose an item.
	Nutrient cycling	Decomposition of organic matter and release of nutrients into the soil/water.	Choose an item.		Choose an item.
	Water recycling	Water filtration, surface/groundwater recharge, etc.	Choose an item.		Choose an item.
	Provision of habitat	Presence of habitats and species.	Choose an item.		Choose an item.

Table 4. Ecosystem services assessment sheet

Adapted from RAWES approach[2] and CICES Version 5.1

[2] The Rapid Assessment of Wetland Ecosystem Services (RAWES) approach is a method designed to evaluate the benefits provided by wetland ecosystems. RAWES was developed to meet the needs identified by the Ramsar Convention, formally known as the Convention on Wetlands of International Importance which was an intergovernmental treaty adopted in 1971.

8.2 Useful resources on biodiversity

Resource	Description
Bird Life International: Country profiles	This site displays data per country such as total number of birds, number of globally threatened birds, number of endemic species, map of important bird & biodiversity areas.
Marine important bird areas e-atlas	This site provides an interactive map showcasing critical marine areas for bird conservation. The map allows users to explore various marine IBAs globally, understand their importance, and access detailed information about each site.
Seabird Tracking Database	A resource that compiles tracking data from seabird research projects worldwide. It allows users to explore tracking data for various seabird species, visualise migration routes and foraging areas, and access detailed information about individual tracking projects and the researchers involved.
Avian Sensitivity Tool for Energy Planning	This platform includes information on best practices, research findings, and methodologies for conducting environmental assessments related to avian species in the context of renewable energy projects. It serves as a resource for stakeholders involved in wind energy development, providing tools and guidelines to help minimise risks to birds and their habitats. Up to now the site provides data for non-EU countries.
Critical Site Network Tool	An online resource designed to support the conservation of waterbirds and their habitats. It provides detailed information on species of waterbirds and the critical sites they depend on. The tool is useful for site managers, national authorities, and organisations, helping them make informed decisions for effective conservation efforts.
Soaring Bird Sensitivity Tool	A planning tool designed to help sectors like wind energy assess the impact of their projects on migratory soaring birds. It allows users to a. delineate a search area on the map, b. enter coordinates and buffer distances c. generate reports summarizing relevant data on soaring birds, including species, Important Bird and Biodiversity Areas (IBAs), observations, protected areas, and satellite tracks. This tool is useful for identifying and mitigating potential risks to soaring birds from wind farms and other developments.
Trans Mit	An evidence-based toolkit for mitigating powerline-related avian mortality. This interactive toolkit is designed to help those involved in planning, installing and maintaining electrical powerline infrastructure – including transmission and distribution system operators – to decide when mitigation is the appropriate course of action and to choose the best mitigation techniques to minimise avian collisions and electrocutions, based on the most up-to-date scientific evidence.
The Integrated Biodiversity Assessment Tool (IBAT)	The Integrated Biodiversity Assessment Tool (IBAT) provides access to a large amount of biodiversity data. The free visual data map on the IBAT platform allows users to explore protected areas, key biodiversity areas, IUCN Red List Species, and STAR Layer (Species Threat Abatement and Restoration, at 50km resolution). This tool is particularly useful for understanding biodiversity risks and opportunities at specific sites, facilitating conservation planning and decision-making.

Table 5. Useful resources on biodiversity