Memo Study area and Discounting in “Kader Ecologie & Cumulatie (KEC) 5.0”

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Background

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The KEC assessment for seabirds aims to quantify the impact of displacement and/or collisions caused by (future) offshore wind farms (OWFs) on populations of several seabird species. The most recent version of this impact assessment (KEC 5; IJntema *et al*. 2025, Soudijn *et al*. 2025) included four scenarios with impacts from OWFs: three national scenarios (*Basic*, *Basic plus* and *Total*) and one international scenario. Each of these impacted scenarios is compared with a single unimpacted or baseline scenario, which is a scenario without OWFs and serves as a reference scenario. Ultimately, population effects of OWFs are evaluated using the Acceptable Level of Impact (ALI) methodology. The ALI tests whether the outcome of an impacted scenario, relative to the outcome of the unimpacted scenario, exceeds a predefined threshold value.

To improve the assessment of population effects in the "Kader Ecologie & Cumulatie", Rijkswaterstaat has commissioned Waardenburg Ecology and Wageningen Marine Research to investigate a series of improvements and methodological issues. In this memo we address the following four issues raised by Rijkswaterstaat:

- The possibility to include near-shore and coastal wind farms in the assessment by including them in the study area.
- The motivation of the current boundaries of the international study area, including an assessment of the potential consequences of changing the boundaries of this study area and the possibility of using species-specific international study areas.
- The application of discounting on already operating wind farms implicitly included in source data.
- The possibility to include wind farm specific operational dates in the impact assessment.

General considerations for defining a population

Two of the four subjects discussed in this memo include the (geographic) scope of species populations. Ideally the delineation of a population should be based on ecological reasoning, where the distribution of a particular species must overlap with the study area. Hence, one could discuss whether determining species-specific geographic boundaries are possible. Key for defining populations, however, is a definition of a population.

From an ecological perspective, cumulative impacts should be tested at the level of a population. As Wetlands International (2025) defines: "*Ideally a population can be defined as a distinct assemblage of individuals which does not experience significant emigration or immigration*". However, defining clear bird population boundaries is often difficult, as, in practice, the degree of exchange between individuals between different (breeding) (geographic) delineations is often unknown. Hence, the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) Technical Committee, as cited by Wetland International (2025), refines the definition of a "*biogeographic population"* as a conservation management unit to "*a population of a species or a sub-species that is geographically discrete from other populations at all times of the year, or at some times of the year only, or is a specified part of a continuous distribution so defined for the purpose of conservation management"*.

Currently, for the national scenarios within the "Kader Ecologie & Cumulatie" (KEC), the relevant population for local marine bird species is defined as *"the individuals using the Dutch Continental Shelf (NCP)*, and for the international scenario as *the individuals using the Southern and Central North Sea (between 51° N and 58° N)"*. The number of individuals is then calculated based on density maps of the areas. Hence, within KEC 5.0, the study area definition was kept the same for all species for practical purposes. For migrating birds, the relevant population was defined as the source population of the flyway crossing the North Sea.

Including near-shore and coastal wind farms

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Currently, wind farms in coastal and nearshore areas are not taken into account in the cumulative impact assessments within KEC. However, these wind farms could affect the same group of individuals that are affected by OWFs, if these individuals make use of those areas. In this section, we explore whether the individuals making use of the NCP also make use of coastal and nearshore areas. If this is the case, coastal and nearshore wind farms affect the same population, and hence should be taken into account from an ecological perspective. We describe pros and cons of incorporating these wind farms into the scenarios used within the KEC. Subsequently, we describe the data requirements for including these areas in the cumulative impact assessments within KEC or Environmental Impact Assessments (EIA), and whether this is currently possible.

Used definitions:
Near-shore area: the zone within 12 miles from the coastline. In this document, we discuss the relevance of the following Dutch areas for each of the KEC study species: Delta area, Wadden Sea and IJsselmeer area.
Coastal area: the area up to and including the dunes

The relevance of coastal and near-shore areas for offshore populations

The individuals being part of the 'population' definition used in KEC 5.0 can make use of a larger area than the defined study area. For example, the Dutch Delta area is very suitable for several of the studied species. The same holds for other coastal and nearshore areas. Nearshore is defined as the offshore area within 12 miles from the coast. Table 1 gives an indication of the relevance of the Delta area, Wadden Sea and IJsselmeer area for each of the study species. If a certain species also makes use of one of these areas, it would be advisable to include those wind farms in the cumulative impact assessment.

Table 1: Relevance of coastal and nearshore areas, scored by expert judgement. If the relevance of an area for a certain species is set to 'Y', this means that individuals making use of the North Sea also make use of that specific area and hence individuals from the population defined in KEC 5.0 also risk impacts from wind farms in those specific areas.

Species	**Delta area**[1]	**Wadden Sea**[2]	**IJsselmeer area**	**Dutch coastal areas**[3]
Northern gannet	N	N	N	Y
Arctic skua	N	N	N	Y
Great skua	N	N	N	Y
Black-legged kittiwake	N	N	N	Y
Little gull	Y	Y	Y	Y
Lesser black-backed gull	Y	Y	Y	Y
Herring gull	Y	Y	Y	Y
Great black-backed gull	Y	Y	Y	Y
Common tern	Y	Y	Y	Y
Sandwich tern	Y	Y	N	Y
Razorbill	N	N	N	Y
Common Guillemot	N	N	N	Y
Bewick's swan	N	N	Y	Y
Brent goose	Y	Y	N	Y
Common shelduck	Y	Y	Y	Y
Curlew	Y	Y	Y	Y
Bar-tailed godwit	Y	Y	N	Y

Red knot	Y	Y	N	Y
Black tern	Y	Y	Y	Y
Common starling	Y	Y	Y	Y

[1] as defined by Lilipaly *et al.* (2025)
[2] Specifically the Dutch Wadden Sea area. For international scenarios, the area would have to be reassessed using expert judgement for Germany and Denmark.
[3] coastal area is the area up to and including the dunes.

Data requirements for including coastal and near-shore areas

To accurately include coastal or nearshore wind farms, estimations for the collisions should be available, subject to the same model assumptions or calculated in a way that they can be transferable to the outcomes of offshore analysis. Currently we use different models for modelling offshore (Caneco *et al*., 2022) versus onshore (Kleyheeg-Hartman *et al.*, 2018) collision victims. For modelling collision victims onshore, we use direct count data to estimate the flux (birds at risk), which is subsequently translated into expected number of victims based on empirical data on collision findings. In contrast, searching collision victims is not possible in the offshore environment. Hence, density maps of seabirds (e.g. van Donk *et al*., 2024) or estimated fluxes of migratory birds are used to calculate/assess bird flux through offshore wind farms, which is translated into expected number of victims based on a probabilistic collision rate model.

A prerequisite to include coastal, near- and offshore wind farms in a population-level assessment would be to understand the degree to which populations from the North Sea make use of coastal and near-shore areas (as mentioned in Table 1). Inclusion of these additional areas requires two main adjustments of the methodology:

- the boundary of the population definition and hence the definition of the population size needs to be reassessed.
- the number of victims should be adjusted to include wind turbine collisions in these areas

Defining a population size

Currently, the population size of local seabirds is based on density maps (e.g. van Donk *et al*., 2024), and calculated as '*the individuals using the Dutch Continental Shelf (NCP)*, and for the international scenario as *the individuals using the Southern and Central North Sea (between 51° N and 58° N)'*. If nearshore and coastal areas are to be included in the assessment, this provides two options.

1) The first option is to keep the population size the same, and still base this on the density map in this area. In that case, the only adjustment is to include coastal and nearshore wind farms in the number of collision victims. This will result in a stronger impact than previously assessed, as the impact of an increased number of wind farms will be assessed on the same population.

2) The second option is to adjust the population size to include individuals in the relevant areas. Note that the current methodology of defining the population size based on the density map cannot directly be applied for this extended area, as the density map only covers the offshore areas. Hence, this option would require a larger density map or a different approach of defining the population size.

Given the mentioned data requirements of the second option, we suggest using the first option and keeping the population definition the same. The adjustment in the impact assessment will then be on the selection of relevant wind farms. For species with victims in those nearshore and coastal wind farms, this makes the impact assessment more strict than without including those wind farms.

Note that if the study area is to be adjusted in the future (for example to the Ospar II region, see next chapter 'Boundaries of the international study area'), the population definition will change as well. Also note that with an open population, any definition of the boundaries of the population is arbitrary. In the outer parts within the defined population boundaries, exchange will take place. Under the EU Birds and Habitats Directives (Directive 2009/147/EC and 92/43/EEC), each Member State like the Netherlands is responsible for protecting species within its territory. For species occurring both at sea and on large inland waters, such as those in the IJsselmeer, Delta and major rivers, national-scale population assessments are essential. These assessments integrate data across habitats to evaluate interactions with wind turbines. Accordingly, we suggest to consider impact evaluations for these waterbird species to be conducted at the national level, covering all relevant wind farms, both onshore and offshore.

Defining a boundary for the selection of relevant wind farms, and estimate victims from relevant populations

One option to define boundaries for the population could be to use geographical boundaries if these are defined. For example, for the Dutch Delta area, Lilipaly *et al.* (2025) argue that inside this area, breeding colonies of for example gulls exchange, while there is less exchange with breeding colonies outside this area. This accepted geographic boundary could be used for the inclusion of the Delta area within the impact assessment. However, note that not all individuals from that area may make use of the North Sea.

As a general approach, we suggest that the boundary of the area with additional relevant wind farms should be based on whether the wind farms pose a risk for individuals from the 'North Sea population', defined at a species-specific level. As pointed out in the previous

section, different species and different populations within those species use the North Sea and coastal and near-shore areas at different levels, and those do not necessarily align with geographical boundaries. For instance, for Lesser Black-backed Gulls breeding in the Dutch Delta, Gyimesi *et al.* (2011) showed that individuals from a colony in the Dutch Delta 25 km from the coast in Lake Volkerak, rarely visited the North Sea (2% of the tracks). That would imply that for this species only colonies and hence also wind farms closer than 25 km to the North Sea shore would be relevant to be taken into account when cumulating with OWFs, and not all colonies and wind farms in the geographical region of the Delta.
At the other hand, there is clear evidence that individuals from Dutch breeding colonies of Lesser Black-backed Gulls, Herring Gulls and Sandwich Terns right along the shoreline and in the dunes make use of the North Sea (van Bemmelen *et al.* 2022, Vanermen *et al.* 2022, van Bemmelen *et al.* 2024). Therefore, also wind farms situated along the coastline should at least form part of the cumulative impact assessments of offshore wind energy developments. Note that the species list for cumulative impact assessment within KEC and EIAs not only includes Dutch breeding seabirds, but also seabirds only visiting the Netherlands. Of these, we have evidence that Little Gulls can use for instance Lake Ijssel, and hence presumably pass by coastal wind farms that many other seabirds would not (Fijn *et al.* 2022).
However, all in all, given the low number of studies for single species on the use of the North Sea by coastal or inland colonies, it is currently not possible to define a definitive boundary for the study area to be included onshore. Defining a geographic scope for inclusion of wind farms on land requires a much better understanding of the use of the North Sea by onshore colonies and we suggest further research in the colony ranges of the species considered to be able to include onshore wind in future assessments.

Estimated numbers of victims are available for nearshore and coastal wind farms based on environmental impact assessments. However, only victims which stem from the relevant population as defined in the previous paragraph should be taken into account. Note that victims from coastal and near-shore wind farms may also stem from more inland populations. This means that a better understanding is required on which part of the estimated victims in near-shore and coastal wind farms can be attributed to the defined population. In other words, an allocation of victims to different populations is required. Only the victims from the defined population should be taken into account. Note that the knowledge on the origin of victims is relatively unknown. Hence, this requires the development of an approach to allocate victims. Moreover, note that density maps are currently only available for the North Sea, and not for inland areas. Victims from collisions can be estimated based on fluxes instead of density maps. Note that coastally breeding species may also suffer from habitat loss due to near-shore or coastal wind farms, not only due to a loss of foraging areas, but also due to potential loss of breeding areas. However, the effects of habitat loss are currently exclusively estimated based on density maps. Habitat loss may not only affect the Sandwich tern (assigned in KEC as species affected by habitat loss), but also for example gulls (not assigned as habitat loss species for the offshore environment) if they lose suitable breeding areas.

In addition, note that the use of species-specific limits for populations and wind farm scenarios does not promote the applicability of the impact assessment. For that reason, we suggest using the same population boundaries and wind farm scenarios for all species. In case this results in a larger area than defined based on ecology, this sometimes leads to the belief that this is an unrealistically worst-case approach. However, if a species does not occur in a certain region within the population boundaries, no victims will be expected in this region. Hence, including this area (with no victims) will not affect the impact assessment.

Conclusions

Individuals from the assessed populations (individuals making use of the North Sea) also use the coastal and nearshore areas, which means wind farms in these areas can affect these populations. Hence, from an ecological perspective, it would be wise to try and incorporate coastal and near-shore wind farms in the assessments.

However, the current data availability and general understanding of the (overlap) in the populations of the North Sea and in the near-shore and coastal area hinders the integration of both areas in one assessment. Firstly, the definition of the population needs to be reconsidered. Additionally, if the population definition is kept at ‘the individuals making use of the (Dutch or Southern and Central) North Sea’, it should be kept in mind that not all victims from near-shore and coastal wind farms will stem from this population. Hence, integration of these areas in the impact assessment requires apportionment of victims from these areas; which part of the victims stems from the relevant population? Concluding, inclusion of near-shore of coastal wind farms necessitates a better scientific understanding of the extent to which victims from nearshore and coastal wind farms stem from the ‘North Sea population’.

Boundaries of the international study area

Author(s): Vincent Hin; Eleni Melis; Martin Poot

Considerations in delineating the international study area

This section provides an overview of the considerations involved in delineating the boundaries and total extent of an international study area for the assessment of cumulative environmental effects, an essential component of the Environmental Impact Assessment (EIA) process. The delineation of a study area in the context of cumulative impact assessment requires a careful balance between ecological relevance, legal requirements, methodological rigour, and practical feasibility. There is no universal standard for such delineation; it must be justified on a case-by-case basis through transparent and evidence-based reasoning.

Especially in the case of highly mobile and widely distributed seabird species, cumulative effects do not operate solely at national or local scales, but impacts can influence international seabird populations on a large spatial scale. The question is: how large? By assessing effects in a spatially coherent manner, it becomes possible, at least in relative terms, to estimate the contribution of the Dutch Exclusive Economic Zone (EEZ) to the overall impact on a particular population (as elaborated in the recent KEC 5.0 reports). This enables policymakers and regulatory authorities to understand which jurisdictions may bear greater responsibility or which areas may be approaching ecological thresholds in terms of pressure.

In delineating the international study area within this context, two key aspects are particularly relevant:

1. Biogeographical distribution and connectivity of seabird populations

Many seabird species such as northern gannets, black-legged kittiwakes, and auks have breeding populations in several countries but migrate through or overwinter in the marine waters of other nations. The study area should therefore align not only with national EEZ boundaries but also with biologically meaningful population boundaries, which are species specific and typically defined at the scale of migratory pathways or metapopulations. For some populations, the entire North Sea or even the wider North-East Atlantic may be the relevant region for assessing potential population effects.

Cumulative assessments must consider how individual offshore wind farms may collectively impact birds from multiple colonies across different countries. This requires data from ringing and tracking studies and population-level research to understand species-specific foraging areas, flight routes, and sea-use during breeding, migration, and wintering periods.

2. The validity and scope of the legal and policy context: National vs International

Legally, cumulative effects should be considered on relevant scales. Although seabirds are highly mobile, wide-ranging species, it might not be legally required to assess cumulative effects of offshore wind farm development on spatial scales that extend far beyond the North Sea. According to Noordover & Alekperova, (2024), international OWFs only need to be included in Dutch impact assessments if the national (cumulative) effects give reason to do so. In the UK and EU, Strategic Environmental Assessments (SEAs) and regional marine planning frameworks require the use of large-scale spatial units that are appropriate for assessing cumulative effects on national and biogeographical populations of highly mobile seabirds. International treaties and directives, such as the EU Birds Directive, the UN Convention on the Conservation of Migratory Species (CMS), and OSPAR, call for cross-border cooperation and data sharing. Compared to the current international study area, the OSPAR Greater North Sea area extends beyond the Shetland islands in the North, and the English Channel in the South.

In summary, this means that for offshore wind developments affecting seabirds, the spatial scope of the cumulative effects assessment is determined by both ecological and legal boundaries. The study area must therefore reflect the full spatial ecology of the species concerned, while also accounting for the scope of both national and international legislation and policy frameworks. Before we discuss the potential implications of changing the international study area, we first give the background information how the current international study area was selected. We then shortly outline the methodology that is used to calculate population effects of collisions and habitat loss, in order to better understand the potential consequences of changing the study area.

Background of current boundaries defined for the international study area

The boundaries of the international study area can be traced back to the third KEC assessment (Figure 1; Van der Wal *et al*. 2018). The study area used by Van der Wal *et al*. (2018) included the Southern and Central North Sea, where the Dutch Continental Shelf (DCS) is an integral part of the Southern North Sea. The demarcation between the Southern and Central North Sea coincides with the 56° latitude line just north of the most northern part of the DCS (Figure 1). In the KEC assessment before that (i.e. KEC 2.0; Leopold *et al*. 2014), only the Southern North Sea was included, which roughly coincides with the area in between 51°N and 56°N. The French part of the Southern North Sea was not included in either KEC 2 (Leopold *et al*. 2014), KEC 3 (Van der Wal 2018), or KEC 4 (Soudijn *et al*. 2022), and was only added to the most recent update of the KEC (see the small part north of the Strait of Dover, KEC 5.0; Soudijn *et al*. 2024).

In Van der Wal *et al*. (2018), no specific motivation is given for the boundaries of the international study area, other than that it includes the Central and Southern parts of the North Sea. The international study area as used in KEC 3 is likely derived from the WINDSPEED1 project (Van der Wal, pers. comm.), which was funded by the Intelligent Energy Europe (IEE) programme and examines the potential for offshore wind energy deployment in the Central and Southern North Sea in relation to competing use functions (Schillings *et al*., 2012). According to Schillings *et al*. (2012), the WINDSPEED project *"analyses the OWE [offshore wind energy] potential in the relevant portion of the North Sea for the countries Belgium, Denmark, Germany, Norway, the Netherlands and United Kingdom by taking into account several constraints"* (Schillings *et al*., 2012). Within WINDSPEED, a decision-support tool was developed to map out locations suitable for development of wind energy production. It is therefore unlikely that the study area in the WINDSPEED project, as later used within the KEC assessments, was primarily chosen based on ecological knowledge of seabird distribution and use of the North Sea. Instead, the northern most boundary of this study area likely coindices with the northern most OWFs planned at that time. From the distribution maps produced by Waggitt *et al*. (2020) it can be inferred that the geographical range of the seabird species that are being assessed within the KEC, is much larger than the current international study area (Southern and Central North Sea). Instead, the WINDSPEED and KEC study area likely demarcate areas that seem suitable for OWF deployment in the North Sea based on current space use and economic and logistical constraints. There is also no direct relationship of the WINDSPEED / KEC study area and areas used by OSPAR or ICES.

Consequences of changing the size of the study area

For both the effects of collision and habitat loss, the methodology as used within KEC relies on density maps of seabirds. For the international scenario, the density maps from Waggitt *et al*. (2020) are used. From these maps, the number of casualties is calculated either using the displacement-matrix approach (for habitat loss effects) or using a stochastic collision risk model (sCRM; for collision effects). To arrive at a mortality rate, the number of casualties is divided by the total number of birds on the map, taking into account seasonal variation in abundance.

As a result, decreasing the study area will decrease both the number of casualties, if this smaller study area excludes certain wind farms, but also decrease the total size of the population on which these casualties are applied. It is therefore not straightforward to predict how a decrease in the study area will affect the mortality rate, as this depends on the ratio between the effect on the number of casualties, relative to the effect on bird abundance. Similarly, increasing the study area will increase the total number of birds on the map, but also require including additional (future) offshore wind farm areas that will increase the calculated number of casualties. The ultimate effect on the mortality rate will depend on the size of these additional wind farm areas and the relative bird densities at these sites.

These methodological considerations provide two straightforward, hypothetical cases under which the effect of changing the study area can be predicted. First, adding or excluding areas with high densities of seabirds, but no OWFs, will, respectively, dilute or increase the effect of the OWFs present in the original area. Second, adding or excluding areas with no, or very low densities of seabirds will have no effect on the assessment, even when there are OWFs in these areas. Obviously, these are hypothetical cases and, as outlined above, the choice of study area should primarily be based on ecological reasoning and legal requirements.

Considering data availability, it should be first noted that survey effort on the DCS is much higher than survey effort on other parts of the Central and Southern North Sea. Although species distribution modelling can be used to predict seabird density on un-surveyed locations (Waggitt *et al*. 2020), low survey effort is inherently associated with high uncertainty. For example, extending the study area northwards will therefore likely further increase uncertainty of the assessed impacts.

Furthermore, for many seabird species, key demographic parameters, such as breeding success, adult survival, and recruitment, are only monitored at a limited number of colonies. These data are essential inputs for population modelling, which is the main tool to evaluate the cumulative impacts. If the spatial extent of the study area becomes much broader than the current international study area, the reliance on extrapolated or assumed values increases, thereby reducing ecological credibility and robustness of model outcomes.

Alternative choices for the current international study area

In this section we provide an overview of the advantages and disadvantages of the two most obvious alternatives for defining the international study area:

- Species-specific study areas
- OSPAR Greater North Sea Area (see Figure 2)

To understand the consequences of using species-specific study areas, we focus on the extreme case of the Sandwich tern. If the distribution of the entire biogeographical population of the Sandwich Tern was to be used as a basis for assessing cumulative effects, this would imply that such effects for this species would need to be considered as far as the South African coast. In addition to the question of whether sufficient data are available regarding the birds and their interactions with human activities across such a vast area, it is also relevant to ask to what extent current policy requires such a broad spatial scope. For species such as the Sandwich tern, but also the northern gannet, which exhibit complex, large-scale migratory patterns, cumulative pressures may arise from wind farms far beyond the borders of the North Sea. Most individuals of these species occurring in the North Sea migrate through areas such as the English Channel, the Bay of Biscay, or the Iberian shelf, and even further south and are therefore also impacted by offshore wind farm developments in those areas. This is an important argument to use species-specific study areas and incorporate all impacts along the migratory pathway of each species. However, despite potential species-specific differences, the ecological relevant scale is generally much larger than the local scale over which impacts should be cumulated from a legal perspective. In addition, when including far distant regions in a Dutch or North Sea focused assessment, it becomes increasingly difficult to quantify the contribution of Dutch or North Sea related wind farms to total cumulative pressure across the full annual cycle of a species. Dutch assessments must reflect a balance between ecological responsibility and legal relevance, and when using species-specific study areas, legal relevance decreases, and practical and methodological constraints increase, particularly related to data availability.

A more realistic approach may be to adopt the formal OSPAR Greater North Sea Area as the basis, which would better align with both data availability, policy frameworks and the international assessment performed by OSPAR itself. The boundaries of the OSPAR Greater North Sea Area are significantly larger than those of the current international study area (Figure 2), yet not so extensive as to result in insurmountable limitations in data availability. At the international level, the first steps have recently been taken to assess cumulative impacts on seabirds using the OSPAR region as spatial delineation but using a coarser methodology than that applied in the KEC study (Figure 2; Piet *et al*., 2025).

As previously indicated, expanding the international study area inevitably leads to a decline in both the quality and quantity of available data, thereby increasing the uncertainty in the assessment of cumulative effects. However, this uncertainty remains substantially lower than would be the case under a species-specific study areas that cover the entire ecological relevant area for each species. This holds particularly for species with the widest distributions such as the sandwich tern and northern gannet. As the most important available data source, Waggitt *et al*. (2020) covers the OSPAR Greater North Sea region well. Notably, this area also coincide with the zone where the most significant future offshore wind energy developments are expected.

Another advantage of using the OSPAR boundaries is that they are not only formally recognised within policy frameworks, but also spatially coherent in relation to seabird ecology as the OSPAR regions are of greatest relative importance for the breeding populations within those regions based on the relative amount of time spent in those regions within their annual life cycle (Wakefield *et al.* 2013). The majority of seabird species breeding along the coasts of the various OSPAR regions generally remain within these regions during the breeding and/or wintering season, and enter and/or leave the region during migration along fixed pathways, such that the occurrence within the species' life cycle in the region is predominantly determined by birds of regional origin.

1.1 Conclusions

The current KEC international study area is derived from the earlier WINDSPEED project and is unlikely to be primarily based on ecological knowledge of seabird distributions and migration. Because seabirds are wide-ranging species, some of which perform large-scale annual migrations, using a smaller international study area than the current one is unjustified from an ecological perspective. However, using species-specific study areas is likely faced with great constraints regarding data availability and quality, and will therefore also increase uncertainty of the assessment. While alignment with the conceptual framework of the Convention on Migratory Species is theoretically sound, in practice, the very large and operationally unmanageable scale of such areas offers little additional scope for actionable policy implementation, either nationally or internationally. Instead, extending the study area beyond European waters (e.g. into African waters) only introduces additional impactful drivers other than offshore wind farm developments. Using the OSPAR Greater North Sea Area is more consistent with international policy frameworks and aligns with the further development of cumulative effects assessment as initiated under the OSPAR framework. While data-related uncertainty may increase the magnitude of this uncertainty will likely remain manageable. Another advantage of using the OSPAR boundaries is that they are also spatially coherent in relation to seabird ecology as the OSPAR regions are of greatest relative importance for the breeding populations within those regions based on the relative amount of time spent in those regions within their annual life cycle. We therefore suggest to adopt the OSPAR Greater North Sea region as the study area for the international scenario of the KEC assessment.

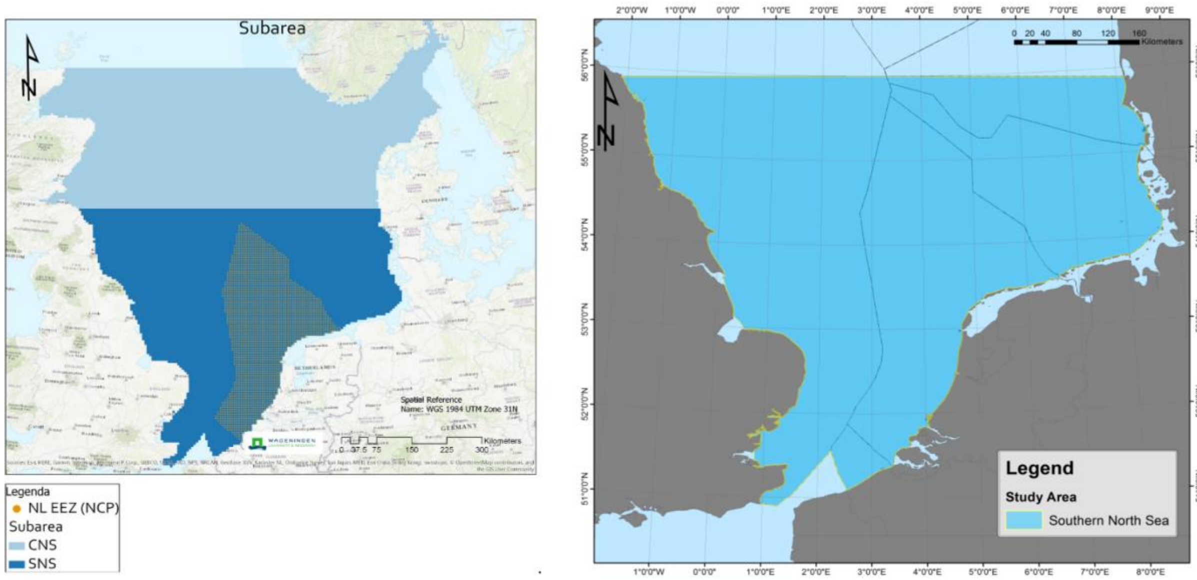

Figure 1: Extent of the study area as used in KEC 3 (left; taken from Van der Wal et al. 2018) and KEC 2 (right; taken from Leopold et al. 2014). The study area used in KEC 2 includes the Southern North Sea, including Belgian, English, Danish and German water between 51 and 56°N. Marginal seas and adjoining estuaries were not included. Note that the French part of the North Sea was not included in both.

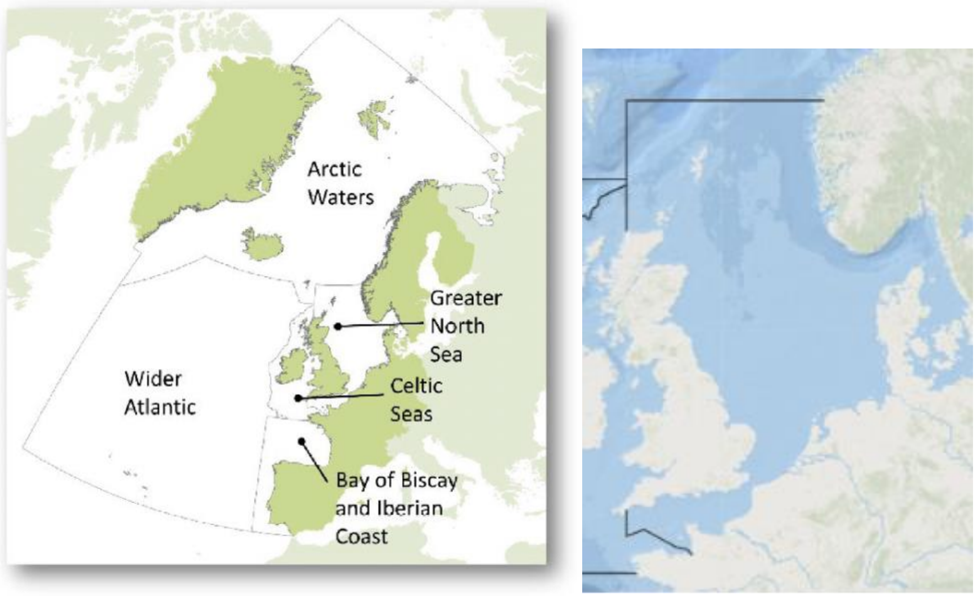

Figure 2: For OSPAR a pilot assessment of cumulative impacts of offshore wind energy has been carried out in three pilots covering three OSPAR regions i.e. North Sea (OSPAR Region II), Celtic Seas (OSPAR Region III) and Bay of Biscay and Iberian Coast (OSPAR Region IV). The pilots differ in terms of information available and hence their level of development and operational readiness (Piet et al. 2025).

Discounting the effects of existing offshore wind farms

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In the analysis of impacts of offshore wind farms on natural populations of birds, the cumulative wind farm scenario should take into account all wind farms which are not part of the population data (Noordover & Alekperova, 2024). This means that in case recent data are available, the impact of older wind farms may already implicitly be discounted. These population data include survey data used for population estimate and/or density maps, as well as input data for the population models. Regarding input data for the population models, the main impacts of OWFs are on the survival rates. Hence, we focus on the data availability for survival rates and survey data. However, note that although the impact is assumed to be smaller, habitat loss and barrier effects may affect fecundity as well.

Depending on how recent the used data are, part of the (older) wind farms may already implicitly be contained in the data. For example, if only data from after 2015 are used, one might argue that the impacts of wind farms operational before that date are likely to be already contained in the natural mortality estimates of a species. Consequently, one could argue that it is not necessary to test for the impact already implicitly contained. Currently, the main analysis of the impact of planned offshore wind on the Dutch Continental Shelf ("Kader Ecologie & Cumulatie 5.0") does not discount for these implicit effects as "... *there is insufficient scientific knowledge and data about when certain effects from offshore wind can be considered in population calculations, and therefore about when they can be discounted in the effect calculations"* (Rijkswaterstaat 2025). In this memo we elaborate on the matter by presenting a reasoning for why we assumed no discounting, as well as under what conditions we might be able to do so.

Why are we currently not discounting?

For the purpose of this memo, we consider the data usage of the current species tested for in the "Kader Ecologie en Cumulatie" (KEC) 5.0. In this analysis of the planned wind farms on the Dutch Continental Shelf, the impact is assessed at the level of the Dutch Continental Shelf (national scenario) as well as the Southern and Central North Sea (international scenario).

In impact assessments, the best available data should be used (Noordover & Alekperova, 2024). The best available data are selected based on the data quality and representativeness (Cf. Horswill & Robinson, 2015). Data from a more recent time period get a higher score for representativeness, but other factors play a role as well, such as representativeness of the population the value is taken from or the sample size leading to the parameter estimate. This means that the most recent data are not always the best available data.

Another issue is that survival rates are often calculated over a longer period, including a time frame before wind farms were constructed. For that reason, we assume for all species that mortality due to older wind farms is not accounted for in the survival rates from literature. This represents a worst-case approach and may for some species be overcautious.

To illustrate the issues raised above, we give some examples:

- for Herring Gull, Kentie *et al*. (2022) present relatively recent survival probabilities. However, these estimates are based on the period between 1986 and 2020, spanning a time range in which both windfarms were absent and present. This creates ambiguity on how much the impact is already contained in the data, making discounting difficult.
- for Arctic Skua, the most recent data source for KEC 5.0 is based on 2014 to 2018 (van Bemmelen *et al*. 2021). However, as this is only based on one colony, these estimates may not be representative for the entire Southern and Central North Sea. Hence, for KEC 5.0 we use a weighted average based on several data sources, including also older sources from before windfarms were built. This creates ambiguity on to what degree the impacts are already contained in the data, making discounting difficult.
- for some other species, recent data from after the construction of windfarms are not available, making discounting impossible as we can say with certainty the impact is not contained in the data. For example, the only available estimate for Common Shelduck adult survival is based on the period between 1962 and 1979. For little gull, no estimates are available at all for survival rates, and estimates for adult survival are based on relatively old data from black-headed gull (1985-2003).

For each of the bird study species (for collision mortality as well as habitat loss), we describe the total time period of data underlying survival rates and the time period on which the national (NCP) and international density maps (CSN) are based within KEC 5.0 (Table 2) (IJntema *et al*., 2025; Soudijn *et al*., 2025). Subsequently, these time periods are compared with the year of the first wind farm being operational. According to the data provided to us for KEC 5.0, the first international wind farm (Horns Rev I) and the first operational wind farm on the Dutch Continental Shelf (Offshore Windpark Egmond aan Zee) were operational in 2002 and 2006, respectively. This comparison gives insight in whether the used demographic data and density maps are more recent than the older wind farms, and hence whether impacts (from older wind farms) are already accounted for in the population estimates.

Based on Table 2, only the common tern and sandwich tern currently employ data from after the operational date of any offshore wind farm in the North Sea. This means that only for these species, correcting for the effects of pre-existing wind farms could be considered.

Table 2: Overview of the data used in KEC 5.0 and the recency of the data used in comparison to the operational date of the earliest offshore wind farms on the Dutch Continental Shelf (DCS) and the Central and Southern North Sea (CSN). [1]For migrant birds a national population is not defined given the inherent international nature of passing, migrating birds. [2]Relative to first non-Dutch offshore wind farm (Horns Rev I) in 2002 and first Dutch offshore wind farm in 2006 (Offshore windpark Egmond aan Zee). Sources: IJntema et al. (2025); Soudijn et al. (2025)

Species	Earliest year / Most recent year of data used to estimate survival parameters	Period used for density map (DCS)/ Population estimate	Period used for density map (CSN)/ Population estimate	Discounting possible (all data later than 2002/2006)[2]?
Northern Gannet	1959/2021	2016-2020	1985-2018	No
Arctic Skua	1995/2018	2015-2020	1991-2020	No
Great Skua	1924/2017	1985-2018	1985-2018	No,
Black-legged Kittiwake	1954/2022	2015-2020	1985-2018	No
Little Gull	1985/2003	2015-2020	1991-2020	No
Lesser Black-backed Gull	1983/2011	2015-2020	1985-2018	No
Herring Gull	1986/2020	2015-2020	1985-2018	No
Great Black-backed Gull	1990/2018	2015-2020	1991-2020	No,
Common Tern	2010/2019	2015-2020	1991-2020	Yes, in NCP Scope
Sandwich Tern	2016/2020	2016-2020	1980-2018	Yes, in NCP Scope
Razorbill	1970/2019	2016-2020	1980-2018	No
Common Guillemot	1983/2011	2016-2020	1980-2018	No
Bewick's Swan	1960/2015	Not Applicable[1]	2015	No
Brent Goose	1950/2020	Not Applicable[1]	2011-2019	No
Common Shelduck	1962/1979	Not Applicable[1]	2010-2019	No
Eurasian Curlew	1996/2022	Not Applicable[1]	1990-2019	No
Bar-Tailed Godwit	2000/2012	Not Applicable[1]	2010-2018	No
Red Knot	1998/2013	Not Applicable[1]	2010-2017	No
Black Tern	1993/2019	Not Applicable[1]	1986-2019	No
Common Starling	1962/2012	Not Applicable[1]	1998-2000	No

When would discounting be ecologically justifiable?

An example where discounting impacts is currently accepted, is in the impact assessment of coastal and onshore wind farms, like in the Dutch delta area. A common and accepted[1] practice onshore is to only include planned wind farms and assume that currently operational wind farms are already accounted for in the population state (e.g. Klop *et al.*, 2017; Engels, Collier & Prinsen, 2020; Raad van State, 2024). However, it should be noted that onshore survey data are, in general, of higher quality and relevant populations can be more easily defined. For instance, for the Dutch delta area a yearly inventory of breeding birds is executed to estimate the population (*e.g.* Lilipaly *et al.*, 2025) and Schekkerman *et al.* (2021) recently specifically identified the demographic parameters of the area, making a better case for discounting in the Dutch delta. For the offshore environment, executing such a yearly inventory is much harder due to the uncertain nature of the colonies of origin for seabirds on the North Sea. Falling back to estimates of a single, well studied (set of) colonies is risky as the representativeness of this colony for all colonies using the North Sea is unknown.

What the case of onshore wind farm discounting illustrates, is that when data quality and representativeness of recent (after OWF construction) data are sufficient, it can be justifiable to assume that impacts of older wind farms are discounted in the population estimates (density maps and survival rates). In the future, increasing data availability or quality may lead to sufficiently good recent data sources. Note that this will not be the case for all species at the same time, but will occur sooner for well-studied species.

Given the quality and representativeness of currently used data within cumulative impact assessments of offshore wind farms, only the common tern and Sandwich tern currently employ data from after the operational date of any offshore wind farm in the North Sea (Table 2). Note that not all wind farms are discounted in the currently used estimates, but only wind farms up to 2010 for common tern, and up to 2016 for Sandwich tern can be assumed to be discounted in the used data. Moreover, it is very impractical and incomprehensible to apply different scenarios for different species. Hence, we advice not to assume discounting for any of the species.

[1]Raad van State, verdict 2024011242/1/R2

Considerations on applying discounting within the cumulative impact assessment; consequences of assuming discounting while effects are not yet discounted

When assuming that older wind farms are discounted for in the cumulative impact assessment, this means that some impacts have already had their effects on the parameter values of the current models, such as of survival. It is important to emphasize that when it is incorrectly assumed that wind farms are discounted for, the calculated impact may be underestimated, which does not comply with the precautionary principle.

We therefore stress that discounting can only be applied when the data underlying the impact assessment (see Table 2), as well as the (data underlying) thresholds used in the impact assessment, are from a recent time period. Current practice is to use the “Acceptable Levels of Impact” (ALI) framework, for which the threshold is based on the population status (‘Staat van Instandhouding’).

Shifting baseline

If discounting is incorrectly applied, the precautionary principle is not followed, resulting in the risk of ‘shifting baseline’. This means that when the reference point is shifted, the accepted impact increases. As a simple example: if 5% decline is accepted per year, but the reference year is shifted annually, the accepted decline after 5 years is more than 20% in relation to the starting situation. For this reason, discounting should only be applied with good substantiation.

As indicated above, the data underlying the impact assessment (1), as well as the data underlying the thresholds used in the impact assessment (2) need to be based on recent data in order to allow for discounting.

1) Wrongly assuming effects of existing wind farms are discounted in data underlying the impact assessment

If effects on existing wind farms are assumed to be discounted in e.g. the survival rates, but this is in reality not yet the case, this results in an impact assessment that does not follow the precautionary principle. Namely, in this case, the effects of existing wind farms are assumed to already be incorporated in the population models, and hence are not included in the impacted scenario. However, if the impacts of these existing wind farms are in reality not discounted in the survival rates and hence in the population models, this means that the impacted scenario incorrectly includes too few wind farms. In other words, the modelled impact is too low, which makes the impact assessment uncautious.

Table 3 describes the four scenarios which can occur when assuming discounting effects of current wind farms in the underlying data for the impact assessment. Discounting is problematic when effects are in reality not yet incorporated in the data. In addition, if no discounting is assumed, but effects are already discounted in the data, the impact assessment is overly cautious. As a precautionary approach should be followed, wrongly assuming discounting should be avoided.

Table 3 Potential scenarios regarding assumed versus actual discounted effects of data underlying the impact assessment.

Assumed situation \ Actual situation	(part of) the impact is incorporated in the underlying data	(part of) the impact **not** incorporated in the underlying data
Discounting is applied	Assessment is correctly executed	Too much impact is accepted in the assessment
Discounting is not applied	Overly cautious	Assessment is correctly executed

2) Wrongly assuming effects of existing wind farms are discounted in the threshold, or data underlying the used threshold

If effects of older wind farms are incorrectly assumed to be discounted, but the ALI thresholds are not updated based on a recent evaluation of the population status, the acceptable level of impact may be too high and the precautionary principle is not followed. The ALI threshold is (mostly) based on the population status (Dutch: Staat van Instandhouding). This population status is updated every six years. If the actual population status is more negative than the assumed status, this can result in the threshold not being strict enough. Note that the opposite may also be the case: when the current population status is more positive than the assumed situation, this results in an overly cautious assessment.

Assumed situation \ Actual situation	Population status is favorable	Population status is unfavorable
Population status is favorable	Assessment is correctly executed	Threshold is not strict enough
Population status is unfavorable	Overly cautious	Assessment is correctly executed

Finally, policy makers should be aware of the change in the framework definition brought about by discounting in the current impact assessment. Without discounting, the ALI framework tests if the difference between an *unimpacted* and *impacted* situation is unacceptable (Hin *et al.*, 2024), meaning it is tested if the impact of offshore wind *as a whole* would exceed an unacceptable threshold. Whereas, with discounting, the framework tests whether the difference between a situation *impacted by existing wind farms* and a situation *impacted by both existing and newly proposed windfarms* would exceed an unacceptable threshold. This means that with discounting, the reference situation changes from the situation without wind farms to the situation with existing wind farms. The desirability of the implicit change in the definition of testing the impact should be considered in both a policy and legal context.

Conclusion

We conclude that discounting is not currently possible, but might be in the future. It is currently not possible to discount due to a lack of data of sufficient recency and quality. If in the future newly available data would become available, discounting may be possible. However, effects of older wind farms can only be assumed to be discounted when both the data underlying the impact assessment (1), as well as the data underlying the thresholds used in the impact assessment (2) are from a recent time period.

The data in Table 2 support the decision within KEC 5.0 to not assume that impacts of older wind farms are already discounted for in the population estimates. This table shows that only for two species discounting can potentially be considered. However, only assuming discounting for these two species would lead to the impractical situation of using different impact scenarios for different species. We therefore propose to adhere to the precautionary principle and keeping in mind that falsely assuming discounted impacts can have strong effects on the population level. In combination with practical and technological issues, we therefore advise not to implement discounting in the impact assessments in the near future.

However, if the cumulative impact violates a government-set impact threshold for a well-studied species with recent data and a thorough understanding of the impact contained in the unimpacted scenario, an additional scenario might be used with only wind farms from after this time period.

Incorporating wind farm operational dates

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The KEC assessment compares scenarios with impacts of OWFs, to a scenario without such impacts. In the current methodology, the set of OWFs contained in each impacted scenario is fixed and these impacts are applied for 40 years. The effects of different combinations or configurations of OWFs are tested by comparing the effects of different impacted scenarios. However, an impacted scenario might contain a mix of OWFs in different stages, such as operational, under construction or planning phase. Depending on the stage, an OWF will only have an impact on bird populations for a part of the 40 year period used within the KEC. In addition, some OWFs will be decommissioned within these 40 years. The commissioner therefore requested to explore the possibility of using a so-called *calendar approach* (Figure 3), in which the effects are considered only for the actual (or expected) operational phase of each wind farm. In the current chapter we list the requirements for implementing such a calendar method.

Requirements for implementing a calendar method

The calendar method can be adopted within the KEC assessment for seabirds, but this requires the following adaptions to the framework:

- *Scenarios*. Scenarios for the KEC include a list of OWFs and their specifications (location, size, turbine dimensions, etc). For the calendar method, the OWF scenario should include the (expected) date of start construction, the expected date of start operation, the expected lifetime of the OWF, and the expected period of decommissioning. This information can then be used to construct the list of OWFs that are operational (constructed) within each year of the assessment.
- *Density maps and mortality calculation.* The density maps show the number of birds at a given location and are used for calculating the number of casualties from either habitat loss or collisions, as well as estimating the total population abundance. With the calendar method, the mortality calculation should be performed separately for each unique combination of OWFs occurring within the 40 year assessment period. This mortality calculation should result in a mortality percentage (or risk) as a fraction of the total population size on the map. This implies that the casualty calculation (either displacement-matrix for habitat loss, or stochastic collisions risk modelling for collision effects) will in practise need to be done much more often than without the calendar method, up to a maximum of 40 times more often. Obviously, only a single casualty calculation needs to be performed for the years within the assessment period that contain the same set of OWFs.
- *Population models.* Population models should be adapted to allow for time-varying mortality risks for the updated mortality calculation. The mortality rate applied in a particular year should correspond to the mortality rate that was calculated for the relevant set of OWFs operational in that particular year.
- *Relevant OWF stages.* It should be decided which phases of OWFs should be included in the mortality calculation, *i.e.* whether effects of OWF construction or decommissioning should also be included. This might differ between collision and habitat loss assessment.
- *ALI methodology.* There are no foreseeable adaptions required to the ALI methodology. The currently approved ALI impact methodology can be used without modifications.

Conclusion

It is possible to account for wind farm specific operational dates. This requires calculating the number of casualties for each unique combination of OWFs and including time-varying mortality estimates in the population modelling. Also, it should be decided whether impacts should be considered for only the operational phase of OWFs, or also the construction and/or decommissioning phase.

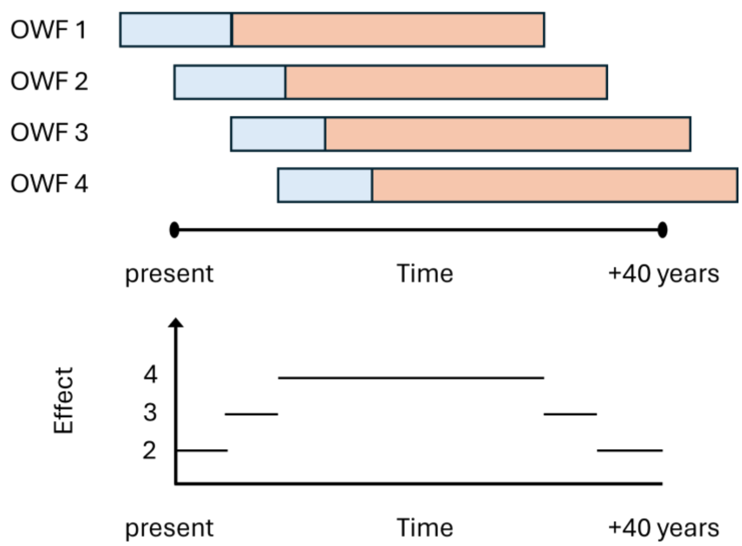

Figure 3: Hypothetical example of the calendar method in which the effects of OWFs are only considered for their construction + operational time. Blue shading indicates construction phase and red shading indicates operational phase. Decommissioning phase is not considered in this hypothetical example. The bottom figure shows the corresponding effect in terms of the number of OWFs considered in the assessment, which changes throughout the period considered (40 years in this case).

Conclusions

Considering the above we reach the following conclusions and recommendations:

- **On the inclusion of near-shore and coastal wind farms,** we conclude that individuals from the assessed 'North Sea population' make use of near-shore and coastal areas, and hence from an ecological perspective these areas should be included in the assessment. However, not all victims from wind farms in these areas stem from the KEC population. More knowledge about the allocation of victims to different populations is required before nearshore and/or coastal areas can be incorporated in the impact assessment.
- **On the reconsideration of the boundaries of the international study area,** we conclude that it is currently unfeasible to use species-specifc study areas and recommend to use the OSPAR Greater North Sea region as the study area for the KEC international scenario.
- **On discounting the effects of existing offshore wind farms**, we conclude that discounting is currently unfeasible: the current data availability necessitates the use of date from before the operational date of the first offshore wind farm. If future data availability makes discounting possible, we stress that discounting certain windfarms also requires an up-to-date status of the ministry set threshold (X) within the impact assessment to adhere to the precautionary principle.
- **wind farm operational dates,** we conclude it is possible to account for wind farm specific operational dates. This requires calculating the number of casualties for each unique combination of OWFs and including time-varying mortality estimates in the population modelling. Also, it should be decided whether impacts should be considered for only the operational phase of OWFs, or also the construction and/or decommissioning phase.

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