

From: Emilie Reuchlin [REDACTED]@doggerland.earth>
Sent: 16 September 2024 15:46
To: Dogger Bank South
Subject: Please confirm receipt of registration and representation Doggerland Foundation
Attachments: 20230608_Letter_Dogger Bank_offshore_windenergy_Doggerland[17].pdf; MCB2023_14327[34].pdf; Daewel et al 2022 offshore wind farms projected to impact primary production and deoxygenation.pdf

U ontvangt niet vaak e-mail van [REDACTED]@doggerland.earth. [Meer informatie over waarom dit belangrijk is](#)

Dear madam, sir of the Planning Inspectorate,

I could not find the registration of my organisation Doggerland Foundation and our submitted information in your overview. I submitted information and expected to see Doggerland Foundation represented in the Dogger Bank South offshore windfarm permit process (on website <https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/EN010125/representations?page=1>)

I hope you can let me know what went wrong. Our key points have been submitted previously with the authorities (please see the relevant points listed in our 2023 letter to RT Hon Grant Shapps) and I hereby attach them once more. Also attached is a study by Daewel et al 2022 specifically trying to predict changes as a result of OWF on the Dogger and the effects on habitat quality and prime ecological functions. The areas designated for wind energy on UK Dogger total roughly 2260 km² (Dogger Bank A+B+C, Sofia). With DB South East and South West that will become 3240 km² (roughly quarter of the UK Dogger Bank), not counting infrastructure like cables. And impact will exceed beyond 25% of the Dogger Bank to the entire area, due to e.g. (noise) pollution and changes in primary production, stratification, sedimentation etc. Hence our objection to the expansion of OWF Dogger Bank South East and South West and our plea to:

...immediately stop additional wind development in the Dogger Bank; i.e. to not open up new areas Dogger Bank South East and South West, nor Dogger Bank D to wind development; to not grant consent to development.

...change the destination of areas Dogger Bank South East, South West and Dogger Bank D to areas of (active) restoration for nature.

...steer clear of wind development inside protected and other vulnerable areas, considering the negative, underestimated impacts and the inability so far to fully account for and assess cumulative impacts to MPAs.

...stick to EC guidelines for cumulative EIAs and uphold the level of scrutiny in EIAs, HRAs and other impact assessments that need to be applied to any activity with likely (significant) effect, which has been explained and reviewed*

I hope you can confirm our formal registration and representation,

Best wishes,
Emilie Reuchlin

* Appleby, T., Condon, J., Rammelt T., Reuchlin-Hugenholtz, E. & Solandt. J.-L.. (2020) Report to inform appropriate assessment of fishing operations on the Dogger Bank SACs, Blue Marine Foundation, WWF, Client Earth & Marine Conservation Society.

Emilie Reuchlin
Managing Director



+ [redacted]
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The Planning Inspectorate
Yr Arolygiaeth Gynllunio

Dogger Bank South Offshore Wind Farms – Project Update

A project update has been published.

The register to have your say period closed on Friday 6 September 2024.

Comments (relevant representations) from those who have registered to have their say are now published.

[View the comments](#)

You can view the [Project information](#) for more information.

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

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To be entered at later stage: in short: do not plan offshore wind farm in marine protected areas such as the Dogger Bank SAC.

Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea

Ute Daewel ¹, Naveed Akhtar ¹, Nils Christiansen¹ & Corinna Schrum^{1,2}

The wind wake effect of offshore wind farms affects the hydrodynamical conditions in the ocean, which has been hypothesized to impact marine primary production. So far only little is known about the ecosystem response to wind wakes under the premisses of large offshore wind farm clusters. **Here we show, via numerical modeling, that the associated wind wakes in the North Sea provoke large-scale changes in annual primary production with local changes of up to $\pm 10\%$ not only at the offshore wind farm clusters, but also distributed over a wider region.** The model also projects an **increase in sediment carbon in deeper areas of the southern North Sea due to reduced current velocities, and decreased dissolved oxygen inside an area with already low oxygen concentration.** Our results provide evidence that the ongoing offshore wind farm developments can have a **substantial impact on the structuring of coastal marine ecosystems on basin scales.**

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The North Sea is a shallow shelf sea system in which the interactions between bathymetry, tides and a strong freshwater supply at the continental coast foster a complex frontal system, which separates well-mixed coastal waters from seasonally stratified deeper areas. The shallow coastal areas and sandbanks combined with stable wind resources make the North Sea an ideal area for renewable energy production and have made the North Sea a global hotspot for offshore wind energy production¹. The recently negotiated European Green Deal to support the European target to phase out dependence on fossil fuels will further accelerate the development of offshore renewable energy² and a substantial increase of installed capacity (212 GW by 2050³) is planned in the North Sea as a consequence to Europe's strategy to be carbon neutral by 2050. The size and magnitude of the already installed (28 GW European offshore wind farm capacity by 2021⁴) and the planned offshore wind farm (OWF) installation⁵ has raised concerns about their impact on the marine environment⁶ and scientific efforts have increased to understand and assess the implications of these large structures for the marine system. In addition to impacts on the regional atmosphere⁷, multiple physical^{8,9}, biological^{6,10} and chemical¹¹ impacts on the marine system have been identified. The underwater structures, such as foundations and piles may cause turbulent current wakes, which impact circulation, stratification, mixing, and sediment resuspension^{12–14}. Most studies conclude that the direct hydrodynamic consequences of the windfarm structures are mainly restricted to the area within the wind farms^{15,16}. However, some speculate also, that the cumulative impacts of an increasing number of offshore installations might result in substantial impacts on the larger scale stratification^{13,17}. Larger scale effects of offshore wind energy production, well beyond the wind farm areas, are introduced to the atmosphere by infrastructures above the sea level and the energy extraction itself¹⁸. Atmospheric wakes appearing in the lee of wind farms extend on scales up to 65 km and beyond, depending on atmospheric stability, with a wind speed reduction of up to 43% inside the wakes¹⁸ leading to upwelling and downwelling dipoles in the ocean beneath¹⁹. Previous modeling studies^{9,19} showed that these dipoles are associated with vertical velocities in the order of meters per day and consequent changes in mixing, stratification, temperature, and salinity. Recently, Floeter et al.²⁰ provided empirical evidence for the existence of these upwelling/downwelling dipoles showing distinct structural changes in mixed layer depth and potential energy anomaly inside the wind wake area of OWFs in the summer stratified area of the southern North Sea. A first assessment of the large-scale integrated impact of atmospheric wakes from already existing OWFs on the hydrography of the southern North Sea revealed the emergence of large-scale oceanic structures with respect to currents, sea surface elevation, and stratification⁸.

For the marine ecosystem the effects of OWFs might or might not be severe, positive or negative. As van Berkel et al.¹⁶ explain, the evaluation of ecosystem effects through BACI (before-after-control-impact) surveys are challenging due to the spatio-temporal variability of the natural system, regional and global trends, as well as other anthropogenic impacts, such as changes in fishing effort, eutrophication, and noise levels, while the focus of investigations is on selected fish and seabird species. In the literature we find, so far, a number of studies related to immediate impacts of OWFs on marine fauna⁶, such as the artificial reefs effect^{21,22} or the impacts of acoustic disturbances on fish and marine mammals^{23,24}. Indirect impacts are, however, likely even more important, more complex, and more difficult to investigate. This includes consequences of restricted fisheries inside the OWFs²⁵ as well as the impacts of the above-described modulation of the physical environment on the structuring of the pelagic¹⁰

and benthic²² ecosystem. It is well known that modifications in mixing and stratification also impacts nutrient availability in the euphotic zone^{26,27}, however, the picture of the ecosystem impacts is less clear for some obvious reasons: (i) The changes in nutrient concentration would start a cause-effect chain that translates into changes in primary production and effectively alters the food chain; (ii) In a dynamic system like the southern North Sea, which is characterized by strong tidal and residual currents, changes in the biotic and abiotic environment are exposed to advective processes; (iii) The expected changes depend strongly on the prevailing hydrodynamic conditions, which makes it difficult to disentangle natural from inflicted changes. Other than a high-density suite of physical and biological observations, numerical modeling studies are the only means to build BACI studies as scenarios with and without the disturbance can be simulated²⁸. In a previous modeling study, van der Molen et al.²⁸ proposed such an approach for an OWF at Dogger Bank, a relatively shallow, well-mixed area of the North Sea using a relatively coarse hydrodynamics-ecosystem model in combination with a wave model. Their study, however, was restricted to a single OWF, which was parameterized simply as a reduction in wind speed above the OWF.

Future OWF installations are planned to be far more extensive²⁹ and the consequences of accelerated deployment for atmospheric dynamics and thermodynamics were shown to be substantial and large scale in the area of the North Sea⁷. The implications of these atmospheric changes for the future ocean dynamics are still unclear. The question on how and to what degree the emergent large-scale structural changes in atmosphere and ocean^{7,8}, under the premisses of large OWF clusters, might affect marine ecosystem productivity remains yet unanswered. Here we address this question while concentrating on the effects of atmospheric wakes to the ocean. Mixing induced by the turbine foundations in the ocean was neglected. For a future offshore wind farm installation scenario, we consider the atmospheric impact as simulated by a high-resolution (~2 km) atmospheric model⁷ to force a fully coupled physical-biogeochemical model for the North Sea and Baltic Sea³⁰. Different to earlier studies⁸ we employ an atmospheric model including a dynamical parameterization of OWFs, which takes into account the size of the windfarm and the number of turbines⁷, and estimates impacts not only on the wind field but on the entire atmospheric physics. The experiment including OWFs (Exp. 1: OWF) follows the design given in Akhtar et al.⁷ that includes all existing and planned OWFs in the North Sea area based on information available in 2015 (see Supplementary Fig. 1) and is compared to a reference simulation (Exp. 2: REF) without OWFs. For our idealized scenario simulation, wind farm parameterization for 5 MW turbines and hub heights of 90 m are used, the rotor diameter was considered as 126 m. The density of installed turbines was chosen to be comparable to currently used densities for similar turbine types. For the spatial distribution of installed capacity all planned wind farm areas (planning status 2015) were used to distribute the turbines for the wind farm parameterization. The installed capacity for this scenario amounts to 120 GW, which is between the 2030 high scenario of 65 GW for the North Sea and the recently agreed commitment of the four countries Denmark, Netherlands, Germany and Belgium (Esbjerg declaration) to install a capacity of at 150 GW by 2050³¹ in the North Sea. The EUs overall plan for the installed capacity in 2050 in the North Sea amounts to 212 GW. Hence, our simplified scenario corresponds approximately to the installed capacity reached in about 15 yrs, by 2037.

The scenario simulations provide evidence that the increasing amount of future OWF installations will substantially impact and restructure the marine ecosystem of the southern and central

North Sea. Changing atmospheric conditions will propagate through ocean hydrodynamics and change stratification intensity and pattern, slow down circulation and systematically decrease bottom shear stress. The model projects that wind wakes of large OWF clusters in the North Sea provoke large scale changes in annual primary production with local changes (increase/decrease) of up to 10%, while region-wide averages in estimated annual primary production remain almost unchanged. In addition, the results show an increase in sediment carbon in deeper areas of the southern North Sea with local increases of up to 10%, and reduced dissolved oxygen at the Oyster Grounds, which is an area where oxygen levels can occasionally fall below 3 mg l^{-1} ³².

Results and discussion

Average system response to OWFs. Our results confirm the direct ocean response identified by earlier studies^{8,9} to the alterations in the wind field (Supplementary Fig. 2) with clearly defined upwelling and downwelling dipoles in the vicinity of the OWF clusters. However, none of the earlier studies could show the systematic, large-scale, time-integrated response of the ocean to large OWF clusters as they are planned to be implemented in the southern North Sea. As a consequence of the substantial amount of energy that is extracted from the lower atmosphere⁷, the ocean responds with a clear and systematic change in stratification, both in strength of stratification (Supplementary Fig. 3) and depths of the seasonal mixed layer. The latter was estimated to be, on average, 1–2 m shallower in and around the OWF clusters (Fig. 1a). This effect occurred most clearly in the deeper stratified German Bight area and around the Dogger Bank region. For OWFs in mixed areas this effect is per definition not relevant and in frontal, less stratified areas the effect is less clear as the stratification becomes naturally interrupted by changes in the frontal position. Changes in mixed layer depth have been reported earlier as a consequence of offshore wind farm wakes due to the reduced wind induced mixing⁸, but also due to the upwelling and downwelling dipoles²⁰. Since the dipole structure is associated with both an uplift and a depression in mixed layer depth²⁰ and is variable in dependence of the wind direction (Supplementary Fig. 2), we hypothesize that the annual average response is mainly a consequence of the reduced wind mixing.

Apart from the effect on the stratification, our simulations show that the ocean responds with a substantial decrease in the annual mean of the vertically-averaged horizontal current velocities in the

range of 0.003 m s^{-1} in large parts of the southern North Sea, but which can locally reach up to 0.0087 m s^{-1} at the OWFs at Dogger Bank and 0.0091 m s^{-1} in the seasonally stratified reach of the German Bight (Fig. 1b). In both of these areas this means a reduction of 15% of the prevailing residual current. At the same time there are also local increases in mean current velocities in the German Bight area and, specifically between the OWF clusters in that area. These result locally in changes in current velocities of about $\pm 10\%$ of the prevailing residual currents, which corroborates the findings by Christiansen et al.⁸, who studied the impacts of existing OWFs in the German Bight area by using an unstructured grid model and a very simple satellite-derived wind wake parameterization. This also shows that the large-scale circulation of the area will be strongly altered with potential consequences for sediment transport as shown below.

Ecosystem impacts. In the southern North Sea, areas with particularly high primary production are co-located with the frontal belt off the coast and around Dogger Bank (Fig. 2a, insert). The majority of future OWF installations are planned in exactly those highly productive areas, which are known to be ecologically highly important³³. Our model results show that the systematic modifications of stratification and currents alter the spatial pattern of ecosystem productivity (Fig. 2a). Annual net primary production (netPP) changes in response to OWF wind wake effects in the southern North Sea show both areas with a decrease and areas with an increase in netPP of up to 10%. Most obvious is the decrease in the center of the large OWF clusters in the inner German Bight and at Dogger Bank, which are both clearly situated in highly productive frontal areas, and an increase in areas around these clusters in the shallow, near-coastal areas of the German Bight and at Dogger Bank. The latter might be fueled by nutrient supply from subsurface waters as a consequence of the upwelling and downwelling dipole as suggested in earlier studies²⁰. Additionally, we also find changes in netPP in areas further away from the OWF clusters, such as a decrease along the fresh water front of the German and Danish coasts and an increase south-east of Dogger Bank at Oyster Grounds, which is typically seasonally stratified and shows lower productivity. Identifying the robustness of these patterns with respect to different weather conditions and interannual variations requires additional analysis and simulations. When integrated over a larger area, the estimated positive and negative changes tend to even

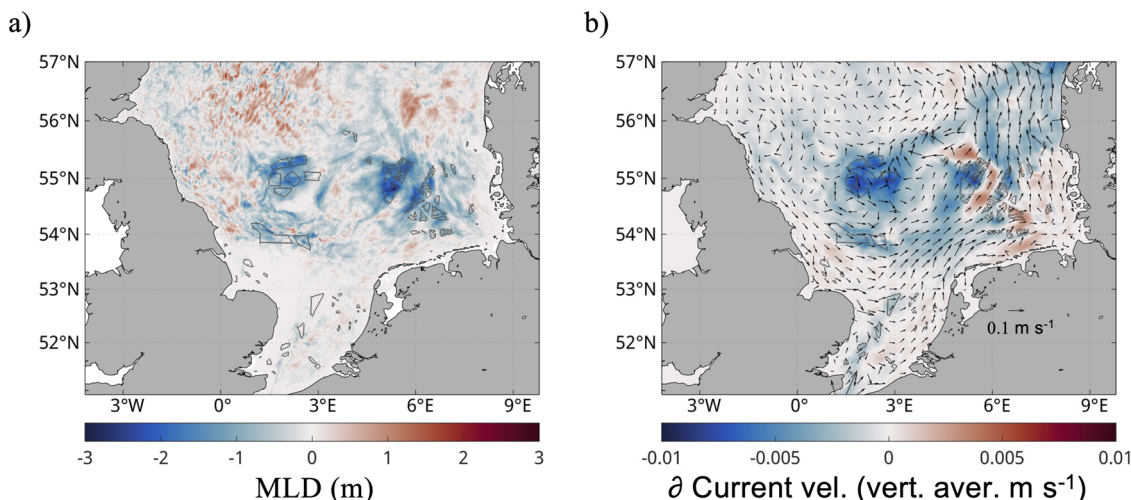


Fig. 1 Annual mean ocean response to atmospheric changes due to offshore windfarms. **a** Estimated change (OWF-REF) in mixed layer depth (MLD); **b** vertically averaged current velocity for REF (arrows) and changes (OWF-REF) (color). Gray polygons indicate location of offshore wind farms. (OWF: simulation experiment considering offshore wind farms; REF: reference simulation).

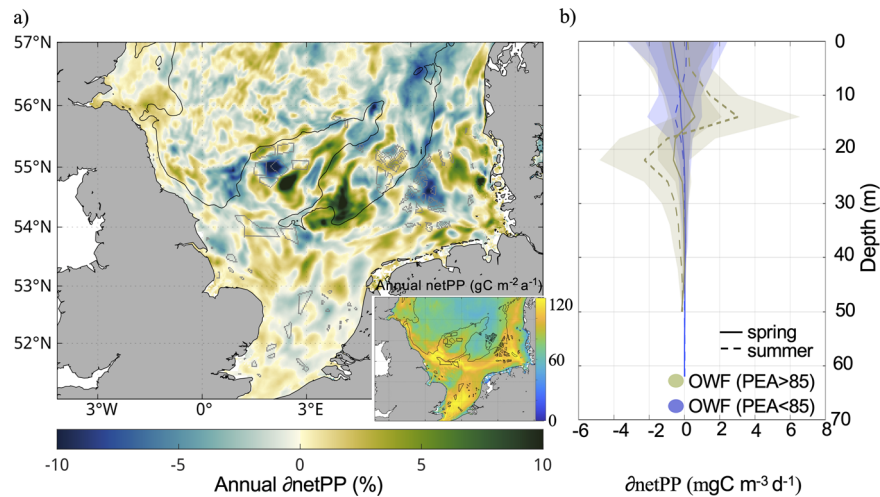


Fig. 2 Annual mean response of net primary productions (netPP) to atmospheric changes due to offshore wind farms. **a** Relative change in annual averaged net primary production for 2010 (OWF-REF). Black contour line indicates potential energy anomaly (PEA) of 85 J m^{-3} roughly separating seasonally stratified from mixed areas; gray polygons indicate location of considered offshore wind farms (insert: annual average of netPP simulated for 2010). **b** Vertical profiles of change (mean and standard deviation) in netPP inside the offshore wind farm areas; blue: less stratified and mixed areas ($\text{PEA} < 85 \text{ J m}^{-3}$); green: stratified areas ($\text{PEA} \geq 85 \text{ J m}^{-3}$) (solid lines: spring; dashed lines: summer). (OWF: simulation experiment considering offshore wind farms; REF: reference simulation).

out. Regional averages for the whole North Sea (model area with longitude $< 9^\circ\text{E}$) as well as for the southern North Sea area (as in Fig. 2a) and the German Bight (latitude: $53.5\text{--}55.5^\circ\text{N}$; longitude: $4\text{--}9^\circ\text{E}$) only show reductions down to -0.5% , while the average reductions in netPP directly at the OWF locations adds up to -1.2% . The direct response of the ecosystem at the OWF sites can be assigned to the changed hydrodynamic conditions. This includes, on the one hand, the clearly defined upwelling and downwelling patterns (Supplementary Fig. 2), which have been hypothesized to play a major role in the changes OWFs provoke in marine ecosystems^{10,20}. Those patterns depend on the wind direction and can be expected to modify the nutrient exchange at the thermocline, as has been shown for temperature and salinity⁹, at and around the OWF clusters. On the other hand, the production changes are directly related to the changes in stratification. A closer look at the vertical distribution of netPP change (Fig. 2b) averaged over the areas with OWF installations (partitioned spatially into OWFs at strongly stratified and less stratified regions and temporally into spring and summer periods) shows that OWFs in clearly seasonally stratified waters experience an upward shift of the vertical production maximum, which occurs typically at the mixed layer depth in summer. This is a consequence of the shallower mixed layer depth, due to reduced wind mixing. This signal is more prominent in summer than in spring. In contrast, OWFs in less stratified and frequently mixed waters show a decrease in production in the upper 20 m of the water column in spring and at the depth of the thermocline in summer.

Additionally, changes in netPP might translate into changes in trophic interactions. The changes in netPP are clearly converted into changes in phytoplankton biomass (Supplementary Fig. 4). However, the response in phytoplankton biomass is relatively small; on average below 1% both inside and outside the OWF clusters (Fig. 3), but can reach up to 10% locally (Supplementary Fig. 4). An exception is the biomass change inside OWF clusters positioned in stratified areas, where the average response is about 2.4% but with large variations. Interestingly these locations also show a relatively strong increase in zooplankton biomass (12%), which indicates that the local ecosystem is additionally structured by top-down control through increased grazing pressure³⁴. In reality the increased zooplankton production at these locations

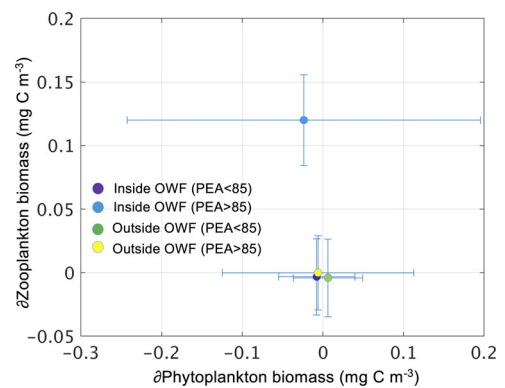


Fig. 3 Fractional change ((OWF-REF)/REF) in annually and vertically averaged phytoplankton and zooplankton biomass. Mean and standard deviation for areas inside and outside the OWF clusters separated based on the potential energy anomaly (PEA) into stratified ($\text{PEA} \geq 85 \text{ J m}^{-3}$) and less stratified and mixed areas ($\text{PEA} < 85 \text{ J m}^{-3}$). Note, for the analysis areas deeper than 60 m were excluded. (OWF: simulation experiment considering offshore wind farms; REF: reference simulation).

might be mitigated by additional higher trophic levels feeding on zooplankton, which is not represented in the model used here. In contrast, outside OWF clusters and OWF clusters in less stratified and mixed areas the model estimates a slight average reduction in zooplankton biomass ($< 0.5\%$). In these regions it is difficult to conclude on the overall trophic response, since the average fractional change in biomass is very small and shows a large regional variation (Fig. 3).

Besides the changes in the pelagic ecosystem our model results highlight a substantial impact on sedimentation and seabed processes. The overall, large-scale reduction in average current velocities (Fig. 1b) results in reduced bottom-shear stress up to 10% locally (Fig. 4a). The reduced resuspension of organic carbon from the sediments results in an increased amount of organic carbon in the sediments in large parts of the southern North Sea (Fig. 4b). This becomes specifically evident at and close to the OWF locations in deeper areas and at the Dogger Bank. The average increase in sediment organic carbon amounts to almost

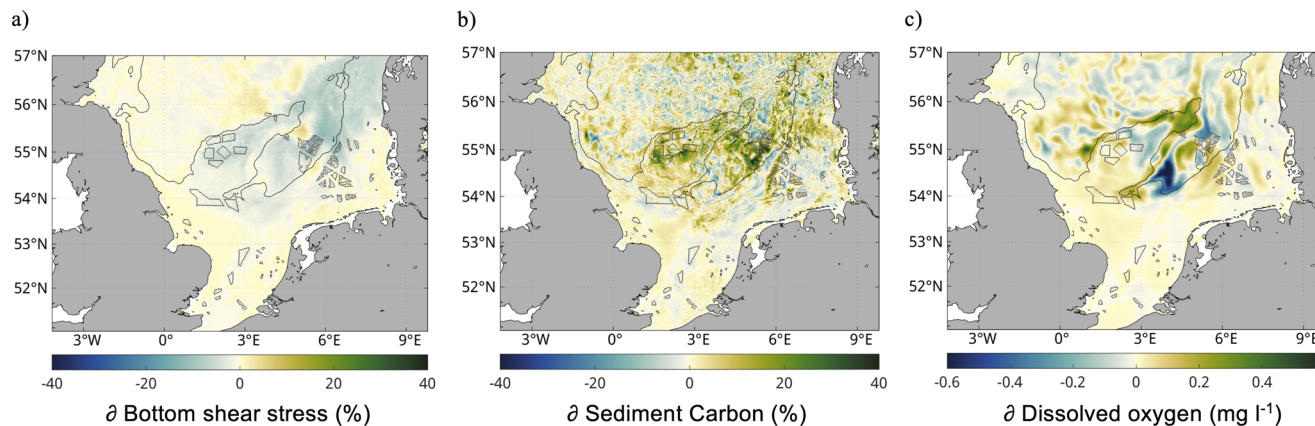


Fig. 4 Annual mean response of benthic processes to atmospheric changes due to offshore wind farms. **a** Relative change in annually averaged bottom shear stress; **b** relative change in annually averaged sediment organic carbon; **c** absolute change in dissolved bottom water oxygen (average July–September). Black contour line indicates potential energy anomaly of 85 J m^{-3} ; gray polygons indicate location of considered OWFs. (OWF: simulation experiment considering offshore wind farms; REF: reference simulation).

10% directly at the OWF locations and 6% in the German Bight area. However, averaged over larger areas the effect is less pronounced with only a 0.2% increase North Sea wide. Our findings on reduced resuspension are consistent with findings from van der Molen et al.²⁸ for his case study of an OWF located on Dogger Bank. Their model indicated an associated reduction in light attenuation in the water column leading to a slight increase in primary production. In large parts of the southern North Sea light can be considered the major limiting factor for primary production in summer²⁶. Our results confirm changes in light availability (Supplementary Fig. 4c) in the subsurface, however, the pattern is strongly related to the pattern of change in primary production, which indicates a dominant effect of phytoplankton self-shading. In addition, our results do not show that the reduction in resuspension is necessarily related to an overall reduction of particulate organic matter concentration in the water column. Considering the cause-effect chain that leads to higher-primary production under improved light conditions, but would in turn increase phytoplankton self-shading, the quantification of this effect on longer time scales remains to be studied in the future.

In addition to changes in sediment-carbon distribution the model indicates an impact of OWF on bottom water oxygen in the southern North Sea (Fig. 4c). Oxygen is a key biogeochemical component in marine ecosystems, and often considered as an indicator for ecosystem health³⁵. Even though the highly dynamic North Sea is not known for extensive low oxygen areas, earlier studies reported the potential for low oxygen events in the central North Sea, more specifically at the Oyster Grounds^{32,36}. The Oyster Grounds denotes a bathymetric depression, which partly limits the exchange with the surrounding water and supports the development of summer stratification. As a consequence, organic material tends to accumulate in bottom waters at the Oyster Grounds, which is associated with enhanced oxygen consumption. Observations in this area show that dissolved oxygen concentrations in bottom waters can occasionally fall below 3 mg l^{-1} ³², and also in our reference simulation dissolved oxygen in bottom water was below 4 mg l^{-1} in late summer and autumn. According to our simulation the Oyster Grounds is an area, which would be especially impacted by large-scale OWF installations. Due to increased primary production on the one hand, but also by the reduced advective currents and bottom shear stress the dissolved oxygen concentrations in late summer and autumn were further reduced by about 0.3 mg l^{-1} on average and up to 0.68 mg l^{-1} locally in our simulations. In other areas of

the southern North Sea, the effect was estimated to be less severe, or even showing an increase in dissolved oxygen concentration, like e.g., along the edges of Dogger Bank.

Consequences for higher trophic levels and management. Within this study, we estimated the so far underrated effects of the changed atmospheric conditions by OWFs on the large-scale features of the lower trophic levels of the marine ecosystem in the southern North Sea. The results highlight that, considering the extensive OWF installation plans for the area, the marine ecosystem responds very clearly to the changes in the atmosphere leading to changes in ocean stratification, advective processes and a systematic decrease in bottom shear stress. These changes can be expected to progress into higher trophic levels of the marine ecosystem. The southern North Sea is well-known for supporting a diversity of marine fauna^{37,38} and especially the near-coastal areas are nursery grounds for many economically relevant fish stocks. The estimated changes in the spatial distribution of primary production might impact the survival of fish early life stages in specific areas due to e.g., variations in the match-mismatch dynamics³⁹ with their prey or as a consequence of low oxygen conditions. Understanding these changes is pivotal for successful future fisheries management in the North Sea and could influence the identification and implementation of marine protected areas. Additionally, the estimated changes in organic sediment distribution and quantity could have an effect on the habitat quality for benthic species such as lesser sandeel (*Ammodytes marinus*) and other benthic species that live in the sediments in the deeper areas of the southern North Sea⁴⁰. Their spatial distributions might change as it has been shown to depend on the available food quantity and quality⁴¹ as well as the prevailing bottom shear stress⁴².

The quantification of the effects on species distribution and diversity remains a topic for future studies as the model used here is truncated at the secondary production level and does not allow for species-specific estimates. In addition, the high computational demand for running both models (atmosphere and ocean) on a high resolution currently limits our simulation to one year only, without an additional spinup period to allow for the system to adjust to the OWF-induced changes. The average physical response can be, at least partly (e.g., with respect to mixed layer depth and reduced residual currents), considered immediate and is mainly related to the reduced energy in the wind field. The ecosystem components, in contrast, might need a transition phase to establish a new ecosystem state under OWF influence. Still, the changes we see are a systematic response to the energy

extraction from the atmosphere and will likely consolidate after a few years of simulation, but with interannual variations related to changes in the environmental conditions. A repetition of the simulation experiments with an “end-to-end” model approach⁴³ and multi-annual simulations are required to shed further light on the robustness of the estimated pattern, the transfer of the changes into the food web and its implications for ecosystem services and management. Additionally, further research on the combined effects of atmospheric wakes and anthropogenic mixing induced by the pile structures¹⁷ in the ocean is necessary, as this might counteract the stabilizing effect of the wind wakes. Under the ambitious plans for OWF constructions in the North Sea¹⁷ space becomes one of the major limiting resources for a large number of partly conflicting usage interests⁴⁴. Our results can serve to support the inevitable development of co-use management strategies under the given conditions.

Methods

ECOSMO model description and setup. ECOSMO is a well-established, fully coupled marine ecosystem model for the North Sea and Baltic Sea area. The version of ECOSMO II used here has been presented in detail before⁴⁵ and contains a total of 16 state variables that describes the lower trophic components (phytoplankton and zooplankton) of the marine ecosystem as well as the major macro-nutrient cycles (nitrogen, phosphorus, silicon) relevant for the North Sea and Baltic Sea system. The sediment compartment is included through a simple bottom layer which accumulates organic material. Benthic fluxes of the different nutrients are estimated separately in a non-Redfield manner to account for oxygen-dependent chemical processes in the sediment. On the basis of the free-surface 3D baroclinic coupled sea-ice model HAM(burg)S(chelf)O(cean) M(odel)⁴⁶, the non-linear primitive equations are solved on a staggered Arakawa-C grid with a horizontal resolution of ~2 km and a time step of 90 s. The impacts of the OWF wind wakes were earlier found to be related to the internal radius of deformation¹⁹, which is about 10 km in the North Sea area⁴⁷. The smallest scales resolved by the model are twice the grid size (approx. 4 km). Hence, the internal radius of deformation is well resolved by the model. The vertical dimension is simulated with z-level coordinates with a maximum of 30 layers, with a higher resolution in the upper layers the surface to represent ocean stratification, and increasing level thickness in deeper layers (5 m for the first two layers; 4 m up to depths of 50 m; 6 m for depths between 50 and 92 m; 100 m; 120 m; 140 m; 160 m; 180 m; 200 m; 250 m; 300 m; 400 m; 500 m; 630 m). In total, this adds up to 2516251 wet grid cells. The model uses a second-order Lax-Wendroff advection scheme that was made TVD (total variation diminishing) by a superbee-limiter⁴⁸ that has been described in detail in an earlier study⁴⁹, and which has been shown to adequately represent the frontal structures in the southern North Sea.

The overall model setup including forcing data is comparable to the setup used in Zhao et al.²⁶ but with a different set of open boundary conditions for temperature and salinity. The latter were provided by a global simulation using the Max Planck Institute Ocean Model (MPI-OM)⁵⁰ in a higher resolution setup⁵¹ forced with the NCEP/NCAR reanalysis⁵².

Atmospheric forcing and Windfarm scenarios. A non-hydrostatic model COSMO-CLM with atmospheric grid resolution of ~ 2 km (1100 × 980 grid cells) has been used to simulate the regional climate with and without OWFs in the North Sea. It uses 62 vertical levels with 5 levels within the rotor area. To include the impact of OWFs in COSMO-CLM a wind farm parameterization^{7,53} has been implemented that represents wind-turbine effects as momentum sink and source of turbulent kinetic energy. In this experiment, a theoretical OWF model was used based on the theoretical National Renewable Energy Laboratory (NREL) 5 MW reference wind turbine. It uses a wind turbine with a hub height of 90 m and rotor diameter of 126 m⁵⁴. These turbines have a cut-in wind speed of 3 ms⁻¹, rated wind speed of 11.4 ms⁻¹, and a cut-out wind speed of 25 ms⁻¹. The atmospheric model used a wind turbine density of about $1.8 \times 10^{-6} \text{ m}^{-2}$. Due to coarse atmospheric grid resolution (~2 km), the average effect of the wind turbines within the gridbox is estimated using the average grid box velocity. For both the experiments, with and without wind farms, initial and boundary conditions from coastDat3 simulations⁵⁵ were used. The latter were forced by the European Center for Medium-Range Weather Forecast (ECMWF) ERA-Interim reanalysis⁵⁶. A more detailed description of the experimental configuration, wind farm parameterization and a validation of the parameterization can be found in a previous study⁷.

Strategy for using the models and data analysis. ECOSMO was forced by the COSMO-CLM simulations with and without OWF parameterization for the year 2010. The change in forcing is thereby not constrained to the change in the wind field but comprises changes in all required forcing parameters including pressure, short wave radiation, 2 m air temperature, humidity, and precipitation. The simulations in 2010 were initialized using a 2-year long (2008–2009) spinup

simulation also forced by COSMO-CLM (without OWF parameterization). Considering that the characteristic time scale of the North Sea is in the order of 1–3 years a two-year spinup is sufficient for initializing the simulation, especially since the initial fields for physical state variables were retrieved from a previously conducted simulation with a similar model setup but a different atmospheric and river forcing. The latter simulation started in 1995 with the same setup but atmospheric forcing from the COSMO REA6 reanalysis⁵⁷ and freshwater discharges provided by the mesoscale hydrological model (mHM)⁵⁸, which is a calibrated, grid-based hydrological model for Europe⁵⁹. Ecosystem state variables were initialized from climatological values based on the World Ocean Atlas⁶⁰. Since the atmospheric simulation is computationally very demanding, only one year of the simulation is currently available covering the full ocean model domain.

Model data output has been postprocessed based on daily mean values available for all state variables as well as for biogeochemical fluxes and bottom-shear stress. Potential energy anomaly⁶¹, the energy required to homogenize the water column, provides a measure for the strength of stratification. For the definition of the mixed layer depth we used a temperature criterion suggested by de Boyer Montégut et al.⁶² where the mixed layer depth is defined as the depths at which $\Delta T \geq 0.2 \text{ }^\circ\text{C}$ with respect to the surface layer temperature. Figures were compiled with matlab using the `colormap`⁶³.

Reporting summary. Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

The datasets generated and/or analyzed during the current study are publicly available at the world data center for climate (www.wdc-climate.de) under <http://hdl.handle.net/21.14106/d116dd4f38f47f150e655ab9441601b34b312583>.

Code availability

Model code access for the marine ecosystem model ECOSMO can be obtained upon request.

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References

1. WindEurope. *Offshore wind in Europe - Key trends and statistics 2019. Technical Report* <https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2019.pdf> (2019).
2. The European Green Deal. Communication from the commission to the European parliament, the European Council, the council, the European economic and social committee and the committee of the regions https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF (2019).
3. Freeman, K. et al. *Our Energy Our Future - How offshore wind will help Europe go carbon-neutral* <https://windeurope.org/about-wind/reports/our-energy-our-future/> (2019).
4. WindEurope. Wind energy in Europe - 2021 Statistics and the outlook for 2022–2026 <https://windeurope.org/intelligence-platform/product/wind-energy-in-europe-2021-statistics-and-the-outlook-for-2022-2026/> (2022).
5. Díaz, H. & Guedes Soares, C. Review of the current status, technology and future trends of offshore wind farms. *Ocean Eng.* **209**, 107381 (2020).
6. Bergström, L. et al. Effects of offshore wind farms on marine wildlife—A generalized impact assessment. *Environ. Res. Lett.* **9**, 034012 (2014).
7. Akhtar, N., Geyer, B., Rockel, B., Sommer, P. S. & Schrum, C. Accelerating deployment of offshore wind energy alter wind climate and reduce future power generation potentials. *Sci. Rep.* **11**, 1–12 (2021).
8. Christiansen, N., Daewel, U., Djath, B. & Schrum, C. Emergence of large-scale hydrodynamic structures due to atmospheric offshore wind farm wakes. *Front. Mar. Sci.* **9**, 1–17 (2022).
9. Ludewig, E. *Influence of Offshore Wind Farms on Atmosphere and Ocean Dynamics* (University of Hamburg, 2014).
10. Floeter, J. et al. Pelagic effects of offshore wind farm foundations in the stratified North Sea. *Prog. Oceanogr.* **156**, 154–173 (2017).
11. Reese, A., Voigt, N., Zimmermann, T., Irrgeher, J. & Pröfrock, D. Characterization of alloying components in galvanic anodes as potential environmental tracers for heavy metal emissions from offshore wind structures. *Chemosphere* **257**, 127182 (2020).
12. Lass, H. U., Mohrholz, V., Knoll, M. & Prandke, H. Enhanced mixing downstream of a pile in an estuarine flow. *J. Marine Syst.* **74**, 505–527 (2008).

13. Carpenter, J. R. et al. Potential impacts of offshore wind farms on North Sea stratification. *PLoS One* **11**, 1–28 (2016).
14. Forster, R. M. *The effect of monopile-induced turbulence on local suspended sediment pattern around UK wind farms. An IECS report to The Crown Estate* <https://ore.catapult.org.uk/wp-content/uploads/2018/12/The-Effect-of-Monopile-Induced-Turbulence-on-Local-Suspended-Sediment-Pattern-around-UK-Wind-Farms.pdf> (2018).
15. Mittendorf, W., Hoyme, H. & Zielke, K. Beeinflussung der Meeresströmung durch Windparks. In *1.Symposium Offshore - Windenergie Bau- und umwelttechnische Aspekte, Hannover 2001* (2001).
16. van Berkel, J. et al. The effects of offshore wind farms on hydrodynamics and implications for fishes. *Oceanography* **33**, 108–117 (2020).
17. Dorrell, R. M. et al. Anthropogenic mixing in seasonally stratified shelf seas by offshore wind farm infrastructure. *Front. Mar. Sci.* **9**, 1–25 (2022).
18. Platis, A. et al. Long-range modifications of the wind field by offshore wind parks—results of the project WIPAFF. *Meteorologische Zeitschrift* **29**, 355–376 (2020).
19. Broström, G. On the influence of large wind farms on the upper ocean circulation. *J. Marine Syst.* **74**, 585–591 (2008).
20. Floeter, J., Pohlmann, T., Harmer, A. & Möllmann, C. Chasing the offshore wind farm wind-wake-induced upwelling/downwelling dipole. *Front. Marine Sci.* <https://doi.org/10.3389/fmars.2022.8> (2022).
21. Degraer, S. et al. Offshore wind farm artificial reefs affect ecosystem structure and functioning: A synthesis. *Oceanography* **33**, 48–57 (2020).
22. Hutchison, Z. L. et al. Offshore wind energy and benthic habitat changes lessons from block island wind farm. *Oceanography* **33**, 58–69 (2020).
23. Mooney, T. A., Andersson, M. & Stanley, J. Acoustic impacts of offshore wind energy on fishery. *Oceanography* **33**, 82–95 (2020).
24. Madsen, P. T., Wahlberg, M., Tougaard, J., Lucke, K. & Tyack, P. Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. *Mar. Ecol. Prog. Ser.* **309**, 279–295 (2006).
25. Barbut, L. et al. The proportion of flatfish recruitment in the North Sea potentially affected by offshore windfarms. *ICES J. Marine Sci.* **77**, 1227–1237 (2020).
26. Zhao, C., Daewel, U. & Schrum, C. Tidal impacts on primary production in the North Sea. *Earth Syst. Dyn. Discuss.* **10**, 287–317 (2019).
27. Lozier, M. S., Dave, A. C., Palter, J. B., Gerber, L. M. & Barber, R. T. On the relationship between stratification and primary productivity in the North Atlantic. *Geophys. Res. Lett.* <https://doi.org/10.1029/2011GL049414> (2011).
28. van der Molen, J., Smith, H. C. M., Lepper, P., Limpenny, S. & Rees, J. Predicting the large-scale consequences of offshore wind turbine array development on a North Sea ecosystem. *Cont. Shelf Res.* **85**, 60–72 (2014).
29. 4cOffshore. Global Offshore Renewable Map. <https://map.4c offshore.com/offshorewind/> (2022).
30. Daewel, U. & Schrum, C. Low-frequency variability in North Sea and Baltic Sea identified through simulations with the 3-D coupled physical-bioeconomic model ECOSMO. *Earth Syst. Dyn.* **8**, 801–815 (2017).
31. *THE ESBJERG DECLARATION On The North Sea as a Green Power Plant of Europe.* <https://www.bundesregierung.de/resource/blob/974430/2040932/b357fa6726099a0304ee97c3a64e411c/2022-18-05-erklarung-nordsee-gipfel-data.pdf?download=1> (2022).
32. Weston, K. et al. Sedimentary and water column processes in the Oyster Grounds: A potentially hypoxic region of the North Sea. *Mar. Environ. Res.* **65**, 235–249 (2008).
33. Munk, P. et al. Spawning of North Sea fishes linked to hydrographic features. *Fish Oceanogr.* **18**, 458–469 (2009).
34. Chust, G. et al. Biomass changes and trophic amplification of plankton in a warmer ocean. *Glob. Chang. Biol.* **20**, 2124–39 (2014).
35. Best, M. A., Wither, A. W. & Coates, S. Dissolved oxygen as a physico-chemical supporting element in the Water Framework Directive. *Mar. Pollut. Bull.* **55**, 53–64 (2007).
36. Greenwood, N. et al. Detection of low bottom water oxygen concentrations in the North Sea; implications for monitoring and assessment of ecosystem health. *Biogeosciences* **7**, 1357–1373 (2010).
37. Daan, N., Bromley, P. J., Hislop, J. R. G. & Nielson, N. A. Ecology of North Sea fish. *Netherlands J. Sea Res.* **26**, 343–386 (1990).
38. Fransz, H. G., Colebrook, J. M., Gamble, J. C. & Krause, M. The Zooplankton of the North Sea. *J. Sea Res.* **28**, 1–52 (1991).
39. Daewel, U., Peck, M. A. & Schrum, C. Life history strategy and impacts of environmental variability on early life stages of two marine fishes in the North Sea: An individual-based modelling approach. *Can. J. Fisheries Aquatic Sci.* **68**, 426–443 (2011).
40. Rindorf, A., Wright, P. J., Jensen, H. & Maar, M. Spatial differences in growth of lesser sandeel in the North Sea. *J. Exp. Mar. Biol. Ecol.* **479**, 9–19 (2016).
41. Reiss, H. & Krönke, I. Seasonal variability of infaunal community structures in three areas of the North Sea under different environmental conditions. *Estuar Coast Shelf Sci.* **65**, 253–274 (2005).
42. Donadi, S. et al. The body-size structure of macrobenthos changes predictably along gradients of hydrodynamic stress and organic enrichment. *Mar. Biol.* **162**, 675–685 (2015).
43. Daewel, U., Schrum, C. & MacDonald, J. I. Towards end-to-end (E2E) modelling in a consistent NPZD-F modelling framework (ECOSMO E2E-v1.0): application to the North Sea and Baltic Sea. *Geosci. Model Dev.* **12**, 1765–1789 (2019).
44. Bundesministerium der Justiz und für Verbraucherschutz. Anlage zur Verordnung über die Raumordnung in der deutschen ausschließlichen Wirtschaftszone in der Nordsee und in der Ostsee vom 19. August 2021. In *Bundesgesetzblatt Teil I Nr. 58 vom 26. August 2021* 44 (Bundesanzeiger Verlag GmbH, 2021).
45. Daewel, U. & Schrum, C. Simulating long-term dynamics of the coupled North Sea and Baltic Sea ecosystem with ECOSMO II: Model description and validation. *J. Marine Syst.* **119–120**, 30–49 (2013).
46. Schrum, C. & Backhaus, J. O. Sensitivity of atmosphere-ocean heat exchange and heat content in the North Sea and the Baltic Sea. *Tellus - Series A: Dyn. Meteorol. Oceanogr.* **51**, 526–549 (1999).
47. Chelton, D. B., Deszoeke, R. A., Schlax, M. G., el Naggar, K. & Siwertz, N. Geographical variability of the first baroclinic Rossby radius of deformation. *J. Phys. Oceanogr.* **28**, 433–460 (1998).
48. Harten, A. High resolution schemes for hyperbolic conservation laws. *Appl. Math. Sci.* **278**, 260–278 (1997).
49. Barthel, K. et al. Resolving frontal structures: On the computational costs and pay-off using a less diffusive but computational more expensive advection scheme. *Ocean Dyn.* <https://doi.org/10.1007/s10236-012-0578-9> (2012).
50. Marsland, S. J., Haak, H., Jungclaus, J. H., Latif, M. & Röske, F. The Max-Planck-Institute global ocean/sea ice model with orthogonal curvilinear coordinates. *Ocean Model* **5**, 91–127 (2003).
51. Müller, W. A. et al. A Higher-resolution Version of the Max Planck Institute Earth System Model (MPI-ESM1.2-HR). *J. Adv Model Earth Syst.* **10**, 1383–1413 (2018).
52. Kalnay, E. et al. The NCEP/NCAR 40-year reanalysis project. *Bull. Am. Meteorol. Soc.* **77**, 437–471 (1996).
53. Fitch, A. C., Olson, J. B. & Lundquist, J. K. Parameterization of wind farms in climate models. *J. Clim.* **26**, 6439–6458 (2013).
54. Jonkman, J. M., Butterfield, S., Musial, W. & Scott, G. *Definition of a 5MW Reference Wind Turbine for Offshore System Development. Technical Report NREL/TP-500-38060 February 2009* <https://doi.org/10.2172/947422> (2009).
55. Geyer, B., Weisse, R., Bisling, P. & Winterfeldt, J. Climatology of North Sea wind energy derived from a model hindcast for 1958–2012. *J. Wind Eng. Indus. Aerodyn.* **147**, 18–29 (2015).
56. Dee, D. P. et al. The ERA-Interim reanalysis: configuration and performance of the data assimilation system. *Q. J. R. Meteorol. Soc.* **137**, 553–597 (2011).
57. Bollmeyer, C. et al. Towards a high-resolution regional reanalysis for the european CORDEX domain. *Q. J. R. Meteorol. Soc.* **141**, 1–15 (2015).
58. Rakovec, O. & Kumar, R. Mesoscale Hydrologic Model based historical streamflow simulation over Europe at 1/16 degree. World Data Center for Climate (WDCC) at DKRZ. <https://doi.org/10.26050/WDCC/mHmbassimEur> (2022).
59. Samaniego, L., Kumar, R. & Attinger, S. Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale. *Water Resour. Res.* **46**, 1–25 (2010).
60. Conkright, M. E. et al. *World Ocean Atlas 2001: Objective Analyses, Data Statistics, and Figures, CD-ROM Documentation*. pp. 17 (National Oceanographic Data Center, Silver Spring, MD, 2002).
61. Simpson, J. H. The shelf-sea fronts: implications of their existence and behaviour. *Philos. Trans. R. Soc. London Ser. A, Math. Phys. Sci.* **302**, 531–546 (1981).
62. de Boyer Montégut, C., Madec, G., Fischer, A. S., Lazar, A. & Iudicone, D. Mixed layer depth over the global ocean: An examination of profile data and a profile-based climatology. *J. Geophys. Res. Oceans* **109**, 1–20 (2004).
63. Thyng, K. M., Greene, C. A., Heland, R. D., Zimmerle, H. M. & DiMarco, S. F. True colors of oceanography. *Oceanography* **29**, 9–13 (2016).

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Author contributions

C.S. and U.D. conceived the study and designed the study setup. U.D. performed the model simulation with ECOSMO, data analysis, and prepared the manuscript with contributions from all co-authors. N.A. performed the atmospheric model simulation

and prepared the atmospheric forcing data for the ecosystem model. U.D., C.S., N.A., and N.C. contributed to data analysis and manuscript writing.

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Competing interests

The authors declare no competing interests.

Additional information

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RT Hon Grant Shapps
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Oceans Day, 8 June 2023

Subject: Urgent request to stop additional offshore wind development in Dogger Bank Marine Protected Area

Dear Mr. Shapps,

While planning our research expedition to the Dogger Bank Marine Protected Area (MPA) for (active) restoration of nature, it came to our immediate attention that The Crown Estate has leased development areas for additional windfarms on the Dogger Bank. Besides the wind areas in development and construction on the Dogger Bank, three new areas are currently in the pre-application phase: Dogger Bank South East (DBS East), Dogger Bank South West (DBS West), along with Dogger Bank D. This means the UK government is planning to place further large scale infrastructure in some of the best places for restoration of nature.

Despite its severely degraded state, the Dogger Bank still supports endangered, threatened and protected species. So there is real hope for considerable recovery at scale. It is a spawning ground for sharks, rays, cod, mackerel, herring, whiting, common sole and sprat. It functions as a nursery and feeding ground for harbour porpoises, minke whales, grey seals, gannets, puffins and other seabirds. The area supports other important ecological processes and functions such as sediment processing and carbon storage. Because of its properties as a relatively shallow, submerged sandbank with unique seabed structures, the presence of hydrographic fronts and very high primary production, the Dogger Bank has great potential to be restored and contribute to the mitigation of both the biodiversity and climate crisis.

As of June 2022 finally the first real measures have been implemented to ban the bottom-towed fishing practices at the UK Dogger Bank SAC; a measure welcomed by nature conservation organisations across Europe that campaigned hard for real protection since the 1990s. But before we have the opportunity to build up new ecological resilience from the 2022 fisheries closure, new destructive practices are allowed. To be replacing one activity with another detrimental, habitat-altering activity will be a regretful act. If no space is left in the UK side of the Dogger Bank to protect and restore nature, what is the point of having protected areas?

Renewable energy, such as wind technology, is clearly needed to mitigate effects of climate change, but so are effective and recovering MPAs. And the way offshore wind industry is being developed is causing harm to significant parts of marine natural systems: largescale infrastructure already underway and planned in the future in the UK part of the Dogger Bank MPA will significantly modify the habitat and hydrology and harm threatened marine species (impacting fish at the base of the food chain, and



harbour porpoise) and the natural ecological processes that are supposed to be protected here. Construction, operation and decommissioning of large-scale infrastructure such as wind energy on the Dogger Bank previously permitted via Article 6(3) appropriate assessment is highly contentious, based on a poor EIA and does not account for cumulative effects. Permits for the previously consented Dogger Bank projects should not have been granted according to the Habitats Directive. The habitat assessment done at the time was not according to government standards on (cumulative) environmental impact assessment. Also, remedial measures have not been taken, in terms of mitigation and compensation and we question the adequacy of monitoring and license conditions.

In general, in-combination and cumulative impacts in the North Sea are not measured, underestimated and effectively ignored. They are not assessed against weak conservation objectives based on shifted baselines. The cumulative effects of wind farms together and in combination with other activities until 2030 are already now detrimental to carrying capacity of the North Sea ecosystemⁱ, and scaling up will further degrade the North Sea ecosystem carrying capacity. This will decrease the chances of meeting some significant biodiversity targets, such as Good Environmental Status (deadline 2020 not achieved).

Meanwhile, the North Sea ecosystem is degraded and the Dogger Bank MPA remains in poor and 'unfavourable' condition. The structure, function, habitats, species and ecological processes are under pressure from centuries of overexploitation. They need time, space and quiet to recover and restore, which will not happen with wind energy development driven by lowest cost and what space is left; not accounting for actual impacts to biodiversity and nature restoration objectives. The windfarms planned in the UK part of the Dogger Bank are a testament of this.

It is time we stop letting nature and biodiversity foot the climate bill. Peter Thomson, UN Secretary-General's Special Envoy for the Ocean statedⁱⁱ: *"The Global Biodiversity Framework, is arguably the most important multilateral agreement that we have. Even more so than the climate change process, because if we are living in a world in 200 years' time and we have solved the climate crisis, but in the meantime have seen life fade away through the cascading extinctions of species -which is already underway and is exacerbated if we are not going to get to 30% protection by 2030-, then what good is solving the climate crisis if there is no more life around?"*

We ask you to maximize the benefits of MPAs to fix the biodiversity and climate crisis. To mitigate and adapt to climate change by promoting intact, complex ecosystems with high diversity and abundance of speciesⁱⁱⁱ. We ask that you work on solutions to both crises and not fix one by aggravating the other: wind energy inside a marine protected area is very difficult to justify in law and knowledge of natural ecosystem dynamics.

Specifically, we ask you to:

...immediately stop additional wind development in the Dogger Bank; i.e. to not open up new areas Dogger Bank South East and South West, nor Dogger Bank D to wind development; to not grant consent to development.

...change the destination of areas Dogger Bank South East, South West and Dogger Bank D to areas of (active) restoration for nature.

...steer clear of wind development inside protected and other vulnerable areas, considering the negative, underestimated impacts and the inability so far to fully account for and assess cumulative impacts to MPAs.

...stick to EC guidelines for cumulative EIAs and uphold the level of scrutiny in EIAs, HRAs and other impact assessments that need to be applied to any activity with likely (significant) effect, which has been explained and reviewed.^{iv}

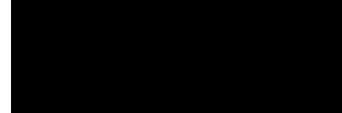


We look forward to receiving your response and to develop a vision and plan to restore the Dogger Bank marine protected area to maximize its contribution to the North Sea MPA network: to combat the biodiversity crisis and restore the North Sea ecosystem, as that remains the intention with protecting this area.

Sincerely,



Emilie Reuchlin



Thomas Rammelt

ⁱ Piet, G. J., Tamis, J. E., van der Wal, J. T., & Jongbloed, R. H. (2021). *Cumulative impacts of wind farms on the North Sea ecosystem*. (Wageningen Marine Research report; No. C081/21). Wageningen Marine Research. <https://doi.org/10.18174/556024>

ⁱⁱ February 7, International Conference for Marine Protected Areas in Vancouver, Canada.

ⁱⁱⁱ Roberts, Callum & O'Leary, Bethan & Mccauley, Douglas & Cury, Philippe & Duarte, Carlos & Lubchenco, Jane & Pauly, Daniel & Sáenz-Arroyo, Andrea & Sumaila, Rashid & Wilson, Rod & Worm, Boris & Castilla, Juan. (2017). Marine reserves can mitigate and promote adaptation to climate change. *Proceedings of the National Academy of Sciences*. 114. 201701262. [10.1073/pnas.1701262114](https://doi.org/10.1073/pnas.1701262114).

^{iv} Appleby, T., Condon, J., Rammelt T., Reuchlin-Hugenholtz, E. & Solandt. J.-L.. (2020) Report to inform appropriate assessment of fishing operations on the Dogger Bank SACs, Blue Marine Foundation, WWF, Client Earth & Marine Conservation Society.



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Our ref: MCB2023/14327

20 June 2023

Dear Emilie and Thomas

Subject: Offshore wind development in Dogger Bank

Thank you for letter dated 8 June, to the Rt Hon Grant Shapps MP, outlining your concerns on the impacts of offshore wind development on Dogger Bank.

Offshore wind provides secure, domestically generated electricity and will play a key role in decarbonising the UK power system by 2035 and achieving net zero by 2050. To reach this ambition, the UK Government has committed to accelerate the rate of deployment of offshore wind farms; and to reform environmental regulations, while maintaining protection of the marine environment.

To take this commitment forward, the UK Government is implementing a new Offshore Wind Environmental Improvement Package (OWEIP). This is designed to streamline environmental assessments, decrease consenting times, and continue to protect our marine environment.

As part of the current planning process for Nationally Significant Infrastructure Projects (NSIPs), which includes offshore wind farms, full consideration of potential effects on environmental receptors are considered and provided in the applicant's Environmental Impact Assessment and Habitats Regulations Assessment. These assessments include a cumulative and in combination assessment of the proposed development's environmental impacts.

However, as you note in your letter, increasingly, cumulative effects of offshore wind deployment are creating a greater need for mitigation and compensation measures to ensure the marine environment is protected. To date, these measures have been dealt with on a project-by-project basis and only considered 'like for like' measures. However, there are frequently delays to project consent due to few viable opportunities for developers to compensate at the individual offshore wind project level, and the challenge of identifying robust and securable measures.

To address these issues, the OWEIP includes measures to:

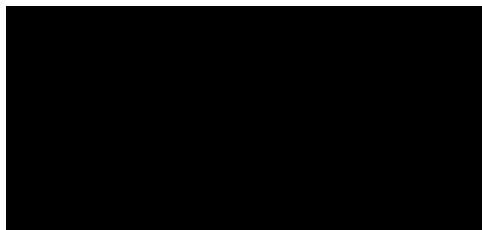
- develop regulations and guidance to streamline the Habitats Regulations Assessment and Marine Conservation Zone assessment process for offshore wind projects;
- enable improved assessment of the environmental effects of offshore wind developments' marine infrastructure on protected sites, and earlier assessment to allow adequate time to resolve discrepancies in evidence and data; and
- ensure that environmental protection of protected areas is addressed early enough in the pre-application planning process to inform adequate and ecologically robust mitigation measures.

It is important to note that any application for development consent is subject to detailed scrutiny through an examination carried out by the Planning Inspectorate, which considers the likely effects of a proposed development on a range of receptors. The Planning Inspectorate takes the advice of Statutory Nature Conservation Bodies, as well as the representations of other interested parties, into account when making its recommendation on whether development consent should be granted. The recommendation will also include details of any necessary mitigation and compensation agreed between the developer and interested parties where impacts cannot be avoided.

Decisions on whether to grant development consent for NSIPs are quasi-judicial and are made on a case-by-case basis on the basis of evidence and considerations which are relevant to the planning merits of each proposed development. As such, it is not appropriate for me to comment on the merits of a specific planning application. Nonetheless, I hope I have provided you with reassurance on the UK's commitment to protecting our marine environment whilst striving to meet our net zero targets.

Thank you again for taking the time to write.

Yours ever,



Rt Hon Graham Stuart MP
Minister of State for Energy Security & Net Zero