THE BIODIVERSITY CONSULTANCY

Briefing Note

# Offshore Wind Energy and Whales

## Key takeaway

- This briefing note outlines the most likely causes for the recent observed increase in whale deaths and highlights potential benefits to whales from offshore wind farms.
- The development of offshore wind farms is not considered a significant threat to whale populations if the risks are adequately assessed and adequate mitigation measures are implemented.
- The threshold for permanent auditory injury from geophysical surveys would only occur in individuals closer than five metres from the sound source, which is a highly unlikely occurrence.
- Vessel traffic related to offshore wind developments is unlikely to make a significant contribution to cetacean mortality.

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## Introduction

There is considerable public interest in the increased frequency of whale strandings, particularly Humpback Whales (*Megaptera novaeangliae*) and North Atlantic Right Whales (*Eubalaena glacialis*), along the U.S. East Coast since 2016 (Thorne & Wiley 2024). Over 200 humpback whales have washed ashore, critically injured or dead, from 2016-2023 on U.S. East Coast beaches (Travers 2024). This event was declared an "Unusual Mortality Event" (UME) by NOAA in April 2017, and includes humpback whale deaths from 2016 to present along the Atlantic coast from Maine through Florida (NOAA Fisheries 2025). These events have led some to suggest that there is a potential link between whale deaths and offshore wind energy development taking place along the coast. These claims have been refuted by the National Oceanic and Atmospheric Administration (NOAA) which, along with the Bureau of Ocean Energy Management (BOEM), issued a statement finding "*no evidence to support speculation that noise resulting from wind development-related site characterization surveys could potentially cause mortality of whales*" (NOAA 2024).

This briefing note outlines the most likely causes for the recent observed increase in whale deaths and discusses potential benefits to whales from offshore wind farms.

It examines and analyses the available evidence for the three main categories of potential impact to whales from offshore wind energy: underwater noise (including auditory injury and displacement), vessel collisions and entanglement.

## Underwater noise and whales

It is considered possible that whales and other marine species could be impacted by underwater noise associated with offshore wind farm exploration and construction. The direct effects of noise are thought to pose the greatest threat (Wilson *et al.* 2010). Extended exposure to high noise levels in the marine environment, from any source, could lead to injury of the hearing structures in cetaceans (whales, dolphins and porpoises) and, potentially, permanent hearing loss and death could occur in cetaceans at the source of extremely loud sounds (Morell *et al.* 2021; Orekhova 2023). This section shows how serious impacts to whales from noise during offshore wind farm exploration and construction are unlikely, and compares risks from these activities to other, higher-risk, activities in the marine environment.

### Offshore wind geophysical surveys vs. tactical naval sonar and oil and gas geophysical surveys

Geophysical surveys for marine developments, along with tactical naval sonar, are both associated with impacts on marine life, particularly whales, as they often generate loud, low-frequency sounds that can interfere with whale behaviour, cause physical injuries, and may even result in strandings (D'Amico et al. 2009; Broker 2019). However, there are distinct differences in the sounds produced by these activities and therefore the risk they pose to whales.

Mid-frequency active sonar (MFAS), used in naval exercises, has been associated with multiple cetacean mass stranding events (MSE). These have primarily involved beaked whales (family: *Ziphiidae*), though other cetaceans may also be vulnerable. MSEs of beaked whales were extremely rare prior to the 1960s but increased significantly after the development of naval MFAS (Bernaldo de Quirós *et al.* 2019). At least 10 beaked whales were stranded from 2007 to 2019 within the Mariana Archipelago, Western Pacific, half of which occurred during or within six days after naval activities (Simonis *et al.* 2020). Similarly, 14 beaked whales stranded in the Canary Islands (Spain) in September 2002 during a NATO naval exercise using MFAS (Bernaldo de Quirós *et al.* 2019). The link between naval sonar and cetacean deaths is believed to have given rise to the concerns over offshore wind geophysical surveys. The tactical sonar during naval exercises which are linked to the MSEs operate at source levels of up to 245 dB re 1 μPa2s (Evans & Miller 2004). In contrast, the most commonly used equipment for geophysical surveys for offshore wind is the 'Boomer' ('Sparkers' are typically used for floating offshore wind), which operates at a source level 212 dB re 1 μPa2s. It is important to note that sound is measured on a logarithmic, rather than linear, scale.

Hence, the source levels of the tactical sonar are substantially louder than those from the equipment used in geophysical surveys for offshore wind.

Sonar used for offshore oil and gas exploration also emits much stronger pulses of sound than sonar used for wind farm surveying (Eisenson *et al.* 2024). Oil and gas geophysical surveys generally use airguns, which emit high energy, low-frequency impulsive sound that travels long distances and can disrupt important whale behaviours and lead to auditory injury at close range (Marine Mammal Commission 2025). These airguns operate at source levels of up to 260 dB re 1 μPa2s (Nedwell & Howell 2004; Broker 2019), which exceeds those of both naval sonar (up to 245 dB) and offshore wind survey sonar (212 dB). Also, compared to navy sonar, airguns used for oil and gas exploration are much more common and ongoing, typically blasting every 10-12 seconds for days, weeks or months at a time (Tibbetts 2018; Lamoni & Tougaard 2023). To date, there is no conclusive evidence of these airguns causing whale mortality, although several stranding events have been linked to these seismic surveys. For example, approximately 75 Melon-headed Whales (*Peponocephala electra*) died in 2008 after entering a shallow estuary in Madagascar, which coincided with a survey vessel using high-powered multi-beam echo sounding (MBES) equipment (Southall *et al.* 2013; Broker 2019). Also, Engel *et al.* (2004) explored the potential link between humpback whale deaths and seismic surveys for oil, off the Brazilian coast, concluding that the timing of the surveys coincided with an unusual increase in adult humpback whale strandings in the area. The deep penetration seismic airgun surveys, used in oil and gas exploration, are not used for offshore wind energy projects (BOEM 2023).

NOAA highlight that *"the sound from offshore wind geophysical surveys are very different from those used in oil and gas surveys or tactical military sonar. They produce much smaller impact zones because they generally have lower noise, higher frequency, and narrower beam-width… Any marine mammal exposure to sound from these surveys would be at significantly lower levels and shorter duration, which is associated with less severe impacts to marine mammals"* (NOAA 2024).

The threshold for permanent auditory injury of large and medium-sized whales is 183 dB re 1 μPa2s (Southall et al. 2019). Whilst source levels of geophysical surveys for offshore wind exceed this figure, a recent study which reviewed case studies from a number of geophysical surveys highlighted that the dissipation of sound in the marine environment means permanent auditory injury from geophysical surveys would only occur in whales "*closer than five metres from the sound source, i.e. a highly unlikely situation in the real world*" (Wang 2019). The chances of a whale being so close to the sound source is very small, and would be made even smaller through the use of marine mammal observers (see Mitigation actions section below). Further, Thorne & Wiley (2024) compared the timing and location of humpback whale strandings and offshore wind geophysical surveys during the US East Coast humpback

whale “Unusual Mortality Event” (UME) of 2016–2022, and the results showed no link between whale strandings and geophysical surveys. In fact, the largest increase in strandings in New Jersey was observed in 2019, when no surveys took place in this state (Thorne & Wiley 2024) (See the final section of this briefing note for more details on this study). It is also important to highlight that, in contrast to naval tactical sonar which often operates with little or no mitigation (Evans & Miller 2004), impacts from offshore wind geophysical surveys are generally mitigated through the use of marine mammal observers to detect any animals present (Wang 2019).

## Offshore wind pile driving

Pile driving is the most common method used to secure the fixed bottom turbine foundation to the seafloor during construction (Bailey *et al.* 2014). Other foundation technologies are also starting to be used, such as suction bucket jackets, which allow installation without the use of mechanical force, minimising noise (Ørsted 2025). The loud sounds emitted during pile driving can potentially cause injury or rupture of auditory structures or other organs in whales, and if severe, could lead to death either directly from internal bleeding, or indirectly through disorientation leading to strandings (Madsen *et al.* 2006; Parvin *et al.* 2007). The source level for pile driving is typically 180–210 dB re 1 µPa2s. Petersen et al. (2011) used a case study of pile driving in the Gulf of St Vincent, South Australia, with a source level of 204 dB re 1 µPa2s. The results indicated that permanent auditory injury in cetaceans is predicted to occur only within 2-3 m from the source for a single impact. Temporary injury can occur at further distances (10-20 m). They concluded that permanent auditory injury (and therefore risk of death) is unlikely to occur in cetaceans in this case (Petersen *et al.* 2011). Even at 210 dB re 1 µPa2s, risk of permanent injury (and subsequent death) would be very small. Regarding the mass stranding event, a study by Thorne & Wiley (2024) found no link between the construction of offshore wind farms and whale strandings during the “Unusual Mortality Event” (UME). They compared humpback whale strandings in areas of turbine construction during the UME and concluded that the timing and spatial distribution of turbine construction does not match up with the pattern of humpback whale strandings. Turbine construction only occurred off the coasts of Rhode Island and Virginia during this time. The data suggested that other factors may be influencing the strandings, as the strandings in Rhode Island occurred after turbine construction, and the strandings in Virginia occurred prior to construction starting (Thorne & Wiley 2024).

Montero *et al.* (2025) modelled the impacts to keystone species of various scenarios of offshore wind developments, concluding that noise during construction is likely to cause displacement of cetaceans to avoid auditory injury. Despite this disturbance and likely behavioural changes of whales, redistribution of whales farther away from construction areas may reduce impacts of any subsequent construction noise.

Montero *et al.* (2025) also concluded that offshore wind developments, despite potentially causing displacement, are unlikely to lead to changes in the overall biomass values of cetaceans. It is also thought that, after construction, whales may be attracted back to the offshore wind farm area with the increased structure creating new feeding opportunities via an artificial reef effect (Degraer *et al.* 2020; Secor *et al.* 2024). Though the evidence for this to date is inconclusive, with a study from the Netherlands indicating potential attraction of harbour porpoise (*Phocoena Phocoena*) to an offshore wind farm, whilst another from Denmark found the same species avoiding an offshore wind farm after construction (Scheidat *et al.* 2011; Teilmann & Carstensen 2012).

### Mitigation actions

Mitigation measures are generally applied to reduce impacts on marine fauna including cetaceans. For example, in the U.K., the Joint Nature Conservation Committee (JNCC) have developed mitigation guidelines for geophysical surveys and pile driving (JNCC 2024). The guidelines recommend the use of marine mammal observers (MMOs) and passive acoustic monitoring (PAM) to conduct pre-construction searches for marine mammals, and avoiding starting noisy activities when marine mammals are detected within 500 m of the area of impact. Potential impacts can be further mitigated through the use of "soft-start" procedures whereby noise levels are allowed to increase gradually, alerting animals to these activities and giving them an opportunity to leave the area before sound reaches a level where it may cause harm.

Active mitigation methods, such as the use of acoustic deterrent devices (ADDs) and noise abatement systems, e.g. bubble curtains, are also appropriate in some cases, notably in relation to pile-driving. Each method has limitations, therefore a combination is often recommended (JNCC 2024). The development of offshore wind farms is not considered a significant threat to whale populations, if the risks are adequately assessed and adequate mitigation measures are implemented (Wang 2019).

## Other potential causes of whale deaths

### Vessel collisions

Vessels are required during surveying, installation and maintenance of offshore wind farms. An increase in offshore wind energy developments may also increase vessel traffic (Bailey *et al.* 2014; BOEM 2021; Farmer *et al.* 2023). Vessel strikes can cause death or serious injury in large whales. Mortality is more likely when vessels are traveling at high speed and in regions with high vessel traffic. Large ships (>80 m) are thought to be responsible for most large whale mortalities (Winkler *et al.* 2020; Thorne & Wiley 2024). The International Whaling Commission (IWC) has compiled a database of the worldwide occurrence of vessel strikes to cetaceans, with a total of 1,162 reports.

Winkler *et al.* (2020) analysed 933 of these, dating from 1820 to 2019. ~62% occurred in the Atlantic Ocean and ~29% occurred in the Pacific Ocean, with the US having the largest number of any country. The majority (~63%) of species involved were Baleen Whales, and 57.4% of collisions resulted in the death of the animal. BEOM has produced a risk assessment to model encounter rates between large whales and vessel traffic from offshore wind energy on the Atlantic outer continental shelf (OCS) (BOEM 2021). This model can be used to produce graphics to show the number of expected animal encounters as a heat map along vessel routes to assess collision risk. Nevertheless, despite increased vessel traffic due to offshore wind, Winkler *et al.* (2020) found that the majority of identified vessels involved in cetacean collisions were ferries, sailing yachts and passenger vessels. According to Thorne & Wiley (2024), increases in vessel traffic associated with wind energy development are likely to be small relative to the very high vessel densities occurring in mid-Atlantic states. Furthermore, many developers implement mitigation measures, such as vessel speed limits and designing routes that avoid areas of greatest marine mammal density. Therefore, vessel traffic related to offshore wind developments is unlikely to make a significant contribution to cetacean mortality.

### Entanglement

Other potentials risks from offshore wind to whales include primary and secondary entanglement in floating offshore wind mooring systems (Farr *et al.* 2021). Mortality could occur via tissue damage, starvation, or drowning. Primary entanglement is where the animals become entangled in the mooring lines themselves, whilst secondary entanglement is where other materials, e.g. discarded fishing gear, becomes entangled in the mooring lines and this goes on to entangle animals (Maxwell *et al.* 2022). Of these, secondary entanglement is believed to pose the greater risk to marine mammals. The results of a study by Farr *et al.* (2021) suggest that while mooring lines are unlikely to pose a major threat to most marine megafauna groups, baleen whales incur the greatest risk of entanglement among cetaceans. BEOM has produced an animation as a method of communicating the potential risk to whales from these mooring systems (Copping & Grear 2018). However, at this stage there are few floating offshore wind developments anywhere in the world where this issue can be tested and no appropriate industrial analogues that can be applied (Copping & Grear 2018). The risk of secondary entanglement could be mitigated through the use of regular monitoring and removal of entangled materials.

## Why the recent increase in whale deaths?

Biologists not involved with the whale stranding response conducted an independent study in 2023 assessing the link between offshore wind and whale deaths, (Thorne & Wiley 2024). This study reviewed spatiotemporal patterns of strandings, mortalities, and serious injuries of Humpback Whales (*Megaptera novaeangliae*), the species most commonly involved, for which NOAA declared an “Unusual Mortality Event” (UME). They found no evidence that offshore wind developments contributed to strandings or mortalities.

However, they did find a relationship between whale mortality and vessel traffic during the study period and concluded that the mass strandings are likely due to vessel collisions. They explain that humpback whales expanded into new foraging grounds in US East Coast waters, possibly due to warming oceans. Simultaneously, vessel traffic has also increased markedly in this area, which has led to significantly increased mortality due to vessel strikes in these newly occupied regions. They do not identify the type of vessels involved, though previous studies have shown that large passenger vessels are involved in many collisions (Winkler *et al.* (2020), and Thorne and Wiley (2024) state that vessel traffic associated with wind energy development is likely to be small compared other types of vessel traffic. Entanglement in abandoned fishing gear is another common cause of whale deaths and has been linked to the recent increases in observed numbers of dead and seriously injured whales (Linden *et al.* 2024; Wright 2024). For example, Linden *et al.* (2024) found strong evidence for increased rates of severe entanglement injuries of North Atlantic Right Whale from 2014, coinciding with the general increase in whale deaths. They show that entanglement in fishing gear and vessel strikes are the primary anthropogenic mortality causes for this whale species, with 75 severe entanglement injuries, 20 entanglement dead recoveries, four severe vessel strike injuries and 25 vessel strike dead recoveries over a 30-year period.

In accordance with NOAA; BOEM, Marine Mammal Commission, and New Jersey Department of Environmental Protection have determined that there is no evidence that offshore wind developments have caused serious harm to whales. Research shows that vessel collisions and entanglements in fishing gear continue to pose a life-threatening risk to whales (Robles 2023). NOAA stated that: *"We will continue to gather data to help us determine the cause of these whale deaths. We will also continue to explore how sound, vessel, and other human activities in the marine environment impact whales and other marine mammals"* (NOAA 2024).

It is worth noting that there may in fact be benefits to whales from offshore wind energy developments. Similar to seals and porpoises, whales may avoid offshore wind farms during construction (Montero *et al.* 2025), however once a wind farm is operational, whales may be attracted back into the wind farm via an artificial reef effect, especially in areas where natural reefs are degraded. The increased structure and new habitats could increase invertebrate biomass and attract fish, therefore promoting feeding opportunities for cetaceans, particularly for whales such as humpback, sei, and fin whales that feed on schooling fishes (Degraer *et al.* 2020; Secor *et al.* 2024). Several offshore wind farms are trialling artificial scour protection made from a range of materials, designed to mimic natural reefs with holes and crevices to attract marine life. This is being highlighted as a positive impact associated with offshore wind farms (Jobson *et al.* 2024).

Other benefits include reduced ship traffic during operation. Despite the occasional maintenance vessels present in offshore wind farms, these areas often create zones where commercial ship traffic is limited, reducing disturbance from ships and the risk of vessel collision with whales (Bailey *et al.* 2014). Indeed, recent evidence from long-term monitoring in the German Bight suggests that operational offshore wind farms may have neutral or even positive effects on some cetaceans, with harbour porpoises showing increased activity in some wind farm areas. The authors suggest that this may be due to artificial reef effects, and refugium effects with the prohibition of fishing (Rose *et al.* 2025).

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As a result of this, every company must learn to thrive economically side by side with nature. But how do businesses synchronise commercial activities with environmental impact to be nature positive? Nature positive is an approach that enhances the resilience of our planet and societies. To enable this change, businesses need to understand their complex relationship with nature.

Since our founding, science and innovation have been at the core of how we identify, evaluate, and interpret biodiversity risk for our clients. We enable transformation to nature positive through guidance, inspiration and collaboration with our partners to deliver practical actions. We are a member of the Task Force for Nature-Related Financial Disclosures (TNFD) Forum and the Science-Based Targets Network Corporate Engagement Program; and a proud partner of industry associations including World Business Council for Sustainable Development, IUCN and UNEP-FI.

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