Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
PRE-CONSTRUCTION				

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
1) Presence of Vessels and Equipment Use (Noise)	Birds	• Ongoing disturbances from turbines and ship traffic can result in chronic stress to avian populations and may impact bird species' ability to thrive and reproduce successfully (Bech-Hansen et al. 2019; Breuner C.W. 2011). • Marine mammals are negatively impacted by the underwater noise associated with shipping, but the impacts of noise on marine birds are virtually unknown. Most marine birds use sight to find prey while diving; however, some birds dive to depths where little light is available or frequently dive at night, which suggests that they are likely to rely on senses other than vision. Additionally, hearing is important for many birds in the air and while in their colonies. Emperor penguins and king penguins, as an example, find their partners in large, noisy colonies by using distinctive sounds, a process that may be negatively impacted by nearby noise. This could be true of species off the coast of Nova Scotia. Research in the high Arctic also shows that fish populations, such as arctic cod, are disturbed and displaced by vessel noise, which is problematic for the marine birds, such as black guillemots and northern fulmars, that prey upon them (Lyons and De Oliveira Menezes, 2020). • Despite the lack of research about the effects of acoustic disturbance caused by shipping on marine birds, Dooling and Therrien postulate in their 2012 study that the impacts are likely similar to how land birds and other marine vertebrates experience acoustic disturbance. Birds in the air are known to be sensitive to continuous noise exposure and blast noise, both of which can cause physical damage to the auditory system. Noise above certain levels can also mask communication between birds. Levels too low to mask communication could still result in harmful behavioural and physiological impacts (Dooling and Therrien, 2012). • Gull and tern abundance has been observed to increase post-construction compared to other seabirds at an offshore wind farm in the UK (Petersen, 2005). It is unclear if this attraction was related to roosting opportunities on above water infrastructure, new food sources from the creation of artificial reefs, or if they were attracted by vessel activity (Petersen, 2005).	• Minimize vessel numbers on site or ensure vessels using the site are travelling at low speeds. • Undertake monitoring during all activities including Real-time Vessel-based Reporting to identify and share sightings. • Limit vessel activity to localized active areas to minimize disturbance.	Bech-Hansen M., Kallehauge R.M., Bruhn D., Castenshiold J.H.F., Gehrlein J.B., Laubek B., Jensen L.F., and Pertoldi C. (2019). Effect of Landscape Elements on the Symmetry and Variance of the Spatial Distribution of Individual Birds within Foraging Flocks of Geese. Symmetry 2019, 11, 1103;oi:10.3390/sym11091103 Breuner C.W. (2011). Chapter 5 - Stress and Reproduction in Birds. Book Chapter: Hormones and Reproduction of Vertebrates Birds 2011, Pages 129-151. Lyons and De Oliveira Menezes, 2020 Dooling, R.J. and Therrien, S.C. 2012. Hearing in Birds: What Changes from Air to Water. Advances in Experimental Medicine and Biology. Springer New York. pp 77-82. doi.org/10.1007/978-1-4419-7311-5_17 Petersen, K. (2005). Bird numbers and distributions in the Horns Rev offshore wind farm area. National Environmental Research Institute. https://tethys.pnnl.gov/sites/default/files/publications/Petersen_2005.pdf Lyons K and De Oliveira Menezes, E. (2020). Reducing impacts from shipping in marine protected areas: A toolkit for Canada. The Impacts of shipping on marine birds. Prepared for WWF.

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
2) Accidents and Unplanned Releases	Birds, Bats and Insects	• Accidents at sea during site surveying and investigation work, i.e., vessel collision and resulting fire/explosions. • Planned and unplanned/accidental release of chemicals and hydrocarbons could occur during installation/construction or decommissioning of offshore wind turbines, foundations, and/or facilities. • Accidental releases include leaks of fuels or hazardous materials leaks, suspended sediments, or trash from vessels. The impacts of these materials affect resources in different ways. Accidental releases from different sources, e.g., vessels and structures, have different pathways by which the IPF will affect resources, i.e., from a mobile source when a release could occur anywhere and could be widely distributed versus impacts from a known, fixed point such as a structure.	• Development of pollution management plans, contingency plans and environmental protection plans to prevent and mitigate the effects of unplanned releases. • Ensure equipped vessels and crews trained to execute the work tasks, assess the field conditions and to handle severe weather conditions are used. • Install observers to watch changes in sea state and weather conditions. • Ensure vessels have reliable and maintained navigation systems, propulsion systems and control systems including adequate reserve power and sufficient redundancy in these systems. Technical systems may be further developed to decrease the effect of human error in accident causation. • Establish emergency procedures to guarantee personnel safety. The appropriate facilities and procedures should be in place to evacuate and rescue personnel. • Establish a reporting system to record and follow-up incidents and near misses, including visiting collisions. This system must also identify trends and allow further controls to be implemented. • Proper waste management procedures must be followed to reduce the impact of potential chemical releases on the environment. • Use of underwater cameras to monitor potential planned, or unplanned or accidental releases of chemicals and hydrocarbons during work could help to monitor and mitigate negative impacts.	Dai, Lijuan., Ehlers, Sören., Rausand, Marvin., Bouwer Utne,. Ingrid. (2012). Risk of collision between service vessels and offshore wind turbines. Volume 109. 18-31. https://www.sciencedirect.com/science/article/pii/S0951832012001585

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
Construction & Decommissioning				
2) Accidents and Unplanned Releases	Birds, Bats and Insects	See Pre-construction	See Pre-construction	See Pre-construction
3) Presence of Vessels and Equipment Use (Noise)	Birds	See Pre-construction	See Pre-construction	See Pre-construction

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IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
4) Avoidance I don't think avoidance is an IPF. It is a measure taken in response to an IPF. Maybe the IPF can be characterized as "Presence of wind turbines over potentially large areas impacting migration/foraging of birdddds"?	Birds	• Migratory birds may adjust their migration timing to avoid high-risk periods near wind farms, potentially leading to asynchrony with mating patterns, loss of critical resources and adverse breeding conditions (Pulido 2007, Nemes et al. 2023). • Birds may have to travel greater distances to find food, expending increased energy and causing potential fitness consequences during sensitive periods, e.g., breeding and migration (Dierschke et al. 2016; Exo et al. 2003; Leopold et al. 2013; Masden et al. 2010; Pettersson 2005). • Reduced foraging efficiency and nutritional stress if birds must settle for suboptimal foraging areas (lower prey availability, less suitable prey in terms of size and type) (Langston and Pullan 2003; Reid et al. 2022). • Increased competition and territorial disputes with resident individuals in new foraging areas (Humphreys et al 2015; Leopold et al. 2013, Pettersson 2005). • Breeding and nesting disruption potentially leading to nest abandonment, reduced reproductive success and population decline overtime (Peschko et al. 2020). • Increased distance travelled, which increases energy expenditure and can affect individual fitness and the ability of some species to complete their migration successfully (Drewitt and Langdon 2006; Masden et al. 2009; Petterson 2005; SEER 2022). • Decreased genetic exchange among bird populations, which can have long-term implications for genetic diversity and adaptation (Justen and Delmore 2022). • There are limited studies on the effects of OSW farms on birds during turbine construction, but there is evidence that enhanced ship and maintenance traffic, noise, lighting and concentrated activity in the development footprint of the windfarm are likely to be disruptive and of a different nature, compared to the prior undisturbed situation, as well the subsequent operational phase. During the construction period, changes to shipping lanes and traffic and modification of fishing activity in the vicinity may also impact come into effect, while extreme disturbances, e.g., pile driving, can have potential effects on birds, as well as their prey (Fox and Petersen, 2019).	• Reduce to the extent practical the intensity of construction activity and support vessel traffic, or adjust the timing of activities to avoid coincidence with the presence of vulnerable species; these actions may help minimize some displacement impact. • Work in smaller, localized work zones to reduce potential impact	Pulido F. (2007). The Genetics and Evolution of Avian Migration. Biosience, Vol. 57 No. 2. Nemes, C. E., S. A. Cabrera-Cruz, M. J. Anderson, L. W. DeGroote, J. G. DeSimone, M. L. Massa, and E. B. Cohen (2023). More than mortality: Consequences of human activity on migrating birds extend beyond direct mortality. Ornithological Applications 125:duad020. Dierschke V., Furness R.W., and Garthe S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation 202 (2016) 59–68. https://doi.org/10.1016/j.biocon.2016.08.016 EXO K-M., Huppop O. and Garthe S. (2003). Birds and offshore wind farms: a hot topic in marine ecology. Wader Study Group Bull. 100: 50–53. Leopold M.F., van Bemmelen R.S.A., and Zuur A.F. (2013). Responses of Local Birds to the Offshore Wind Farms PAWP and OWEZ off the Dutch mainland coast. IMARES - Institute for Marine Resources & Ecosystem Studies, Report number C151/12. Pettersson, J., & Fågelvind, J. (2005). The impact of offshore wind farms on bird life in southern Kalmar sound, Sweden. Swedish Energy Agency. https://tethys.pnnl.gov/sites/default/files/publications/The_Impact_of_Offshore_Wind_Farms_on_Bird_Life.pdf Peschko V., Mendel B., Muller S., Markones N., Mercker M., and Garthe S. (2020). Effects of offshore windfarms on seabird abundance: Strong effects in spring and in the breeding season. Marine

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IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
				Environmental Research Volume 162, December 2020, 105157. Masden, E. A., Haydon, D. T., Fox, A. D., Furness, R. W., Bullman, R., and Desholm, M. (2009). Barriers to movement: impacts of wind farms on migrating birds. – ICES Journal of Marine Science, 66: 746–753. https://doi.org/10.1093/icesjms/fsp031 SEER, U.S. Offshore Wind Synthesis of Environmental Effects Research (2022) Bat and Bird Interactions with Offshore Wind Farms. Available at: https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Bat-Bird-Interactions.pdf , Last accessed: 21 August 2023. Justen H. and Delmore K.E., (2022). The genetics of bird migration. Current Biology 32, R1042–R1172, October 24, 2022.

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Operations & Maintenance				
1) Avoidance [same comment as above]	Birds	• Besides habitat alterations associated with wind farms, the visual intrusion caused by the turbines, the rotating blades, noise and vibration resulting from turbine operation, and human or vehicle circulation due to the construction or maintenance activities, may cause disturbance to birds. Such activities may trigger an avoidance response that can occur at three spatial scales: (i) Macro-avoidance when birds avoid the wind farm as a whole, (ii) meso-avoidance if turbine arrays or single turbines are avoided, and (iii) micro-avoidance, which consists in last-second evasion of the rotor blades. • Depending on the study design and wind farm layout (with clustered/random turbines) it may not be possible to fully separate macro and meso-avoidance (Marques et. Al, 2021). • Observed avoidance includes last-second maneuvering to avoid collisions, redistribution of birds within a windfarm due to turbines/turbine rows or redistribution outside the perimeters of wind farms (Skov et al. 2018; SEER 2022). • Avoidance has been observed at small and larger scales ranging from within 10 m of turbines to 1.5 – 3.0 km (Skov et al. 2018) and as far as 4 km (Petersen et al. 2006). • Studies at OSW projects have generally reported that seabirds engage in micro-avoidance behaviours at a rate greater than 95% (Skov et al. 2018). • Migrating Eiders rounding the southern tip of the Gedser peninsula approaching the Nysted Offshore Wind farm showed adjustments to flight trajectories to avoid the turbines at distances up to 3 km. Some species were almost never seen flying between the turbines (Red-throated Divers and Northern Gannets), others rarely (Common Scoter), while yet others showed little avoidance (Cormorants and large gulls). At Horns Rev, 71-86% of all large bird flocks heading towards the windfarm at 1.5-2 km distance avoided entering the wind farm and flying between the turbine rows. The same pattern was confirmed at Nysted (78%), predominantly amongst waterbirds,	• Collect accurate and detailed baseline data to predict species distribution at sea. • Use accurate multi species/multi season data to model marine bird distribution and abundance across a proposed development site. • Complete weight vulnerability of species and perform the validity to ensure predictive accuracy and ecological relevance. • Interannual variability and climate change can be incorporated to account for predicted future interactions with OSW development. • Adopt the process of avoidance and minimization during site selection. • Avoid placing turbines in areas of relatively higher concentrations of birds, i.e., migratory or local flight routes, wintering or breeding areas, to reduce the risk of an impact. • Avoid siting of projects in/near sensitive bird areas or bird conservation areas. • Placing turbines further apart may reduce the level of displacement/avoidance that could occur. • Roosting opportunities can be limited through structural design and deterrence, including installation of anti-perching infrastructure. It is unclear, however, if perching behavior increases collisions (Croll et al 2022).	Kahlert, J., Petersen, I. K., Fox, A. D., Desholm, M., & Clausager, I. (2003). Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand. National Environmental Research Institute. https://tethys.pnnl.gov/sites/default/files/publications/Kahlert-et-al-2004.pdf Marques A.T., Batalha H., and Rernardino J. (2021). Bird Displacement by Wind Turbines: Assessing Current Knowledge and Recommendations for Future Studies. Birds 2021, 2, 460–475. https://doi.org/10.3390/birds2040034. Skov, H., Heinänen, S., Norman, T., Ward, R., Méndez-Roldán, S., & Ellis, I. (2018). ORJIP Bird Collision and Avoidance Study (p. 248). Offshore Renewables Joint Industry Programme. https://tethys.pnnl.gov/sites/default/files/publications/Skov-et-al-2018.pdf SEER, U.S. Offshore Wind Synthesis of Environmental Effects Research (2022) Bat and Bird Interactions with Offshore Wind Farms. Available at: https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Bat-Bird-Interactions.pdf , Last accessed: 21 August 2023. Petersen I.K., Christensen T.K., Kahlert J., Desholm M., and Fox A.D. (2006). Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. NERI Report Commissioned by DONG energy and Vattenfall A/S 2006. National Environmental Research Institute Ministry of the Environment. Denmark

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		mostly migrating Eiders, but including a wide range of species (Fox and Petersen, 2019). • Birds may be attracted to OSW farms by perching opportunities. This may increase collision risk (Dierschke et al. 2016; Hill et al. 2014; NatureScot 2020). • Cormorant and gull species have been observed roosting on turbines and showing preference for locations along the perimeter of offshore wind farms in Europe (Kahlert et al. 2003; SEER 2022). Cormorants and falcons have been observed perching on offshore wind turbine fixed foundations in both Europe and the US (Hill et al. 2014; Stantec 2020). • When avoiding OSW farms, species may experience functional habitat loss due to displacement, which could in turn result in increased energy consumption if the alternative foraging habitats are of poorer quality, or if the individuals have to travel longer distances to reach their foraging areas (Garthe, 2023). • When placed in natural or seminatural habitats, infrastructures associated with the wind energy industry can modify the landscape, resulting in habitat loss and fragmentation, which may alter species behaviour, potentially leading to multiple ecological impacts and ultimately population-level effects (Marques et al. 2021). • Different seabird species respond differently to the development of OSW farms, with behavioural reactions ranging from complete avoidance to attraction. A recent review of 20 OSW farms in European waters found that species responded differently and sometimes inconsistently across studies, ranging from strong avoidance to strong attraction to OSW farms. • Avoidance was mainly due to birds responding to OSW structures and was stronger when the turbines were operating but could also occur as a result of boat traffic to and from the OSW farms (Garthe et al. 2023).		Dierschke V., Furness R.W., and Garthe S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation 202 (2016) 59–68. https://doi.org/10.1016/j.biocon.2016.08.016 Fox A.D. and Petersen I.K. (2019). Offshore wind farms and their effects on birds. Dansk Orn. Foren. Tidsskr. 113 (2019): 86-101. Donald A. Croll, Aspen A. Ellis, Josh Adams, Aonghais S.C.P. Cook, Stefan Garthe, Morgan Wing Goodale, C. Scott Hall, Elliott Hazen, Bradford S. Keitt, Emma C. Kelsey, Jeffery B. Leirness, Don E. Lyons, Matthew W. McKown, Astrid Potiek, Kate R. Searle, Floor H. Soudijn, R. Cotton Rockwood, Bernie R. Tershy, Martin Tinker, Eric A. VanderWerf, Kathryn A. Williams, Lindsay Young, Kelly Zilliacus (2022). Framework for assessing and mitigating the impacts of offshore wind energy development on marine birds, Biological Conservation, Volume 276. Accessed from Framework for assessing and mitigating the impacts of offshore wind energy development on marine birds - ScienceDirect Hill, R., Hill, K., Aumüller, R., Schulz, A., Dittmann, T., Kulemeyer, C., & Coppack, T. (2014). Of birds, blades and barriers: Detecting and analysing mass migration events at alpha ventus. In Federal Maritime And Hydrographic A & Federal Ministry For The Environment (Eds.), Ecological Research at the Offshore Windfarm alpha ventus (pp. 111–131). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-02462-8_12 NatureScot. (n.d.). Information note—The Effect of Aviation Obstruction Lighting on Birds at Wind Turbines, Communication Towers and Other Structures. Retrieved

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IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
				November 16, 2023, from https://www.nature.scot/doc/information-note-effect-aviation-obstruction-lighting-birds-wind-turbines-communication-towers-and Stantec (Stantec Consulting Services Inc.). (2020). Avian ship-based survey final post-construction monitoring report. Prepared for Deepwater Wind Block Island LLC. Garthe S., Schwenmer H., Peschko V., Markones N., Muller S., Schwemmer P., and Mercker M. (2023). Large-scale effects of offshore wind farms on seabirds of high conservation concern. Scientific Reports (2023) 13:4779, https://doi.org/10.1038/s41598-023-31601-z.
	Bats	The literature accessed speaks mainly to bat collisions, rather than to impacts associated with avoidance.	N/A	N/A
(2) Collision	Birds	• Taller turbine size, larger rotor dimensions and faster rotor speeds have been shown to have increased bird collision risk (Thelander et al. 2003). • Large birds with poor maneuverability (such as swans and geese) are generally at greater risk of collision with structures; species that habitually fly at dawn and dusk or at night are also less likely to detect and avoid turbines (Drewitt and Langston 2006). • Lower collision rates have been observed at OSW farms located further offshore and at greater distances from high bird density areas, e.g., breeding colonies, migratory flyways, frequently used flight paths, areas where birds use shallow waters and upwellings and currents for foraging (Drewitt and Langston 2006; Everaert and Stienen 2006; Hill et al. 2014; Kerlinger and Curry 2002; Petterson 2005). • Species /species group may influence collision risk. • Passerines, e.g., warblers, vireos, thrushes and sparrows, account for nearly 60 percent of avian fatalities documented at onshore wind facilities (AWWI 2020; Erickson et al. 2014). Similar carcass types have been found at offshore and coastal	• Usie radar, acoustic deterrents and bird detection systems to monitor bird activity and to deter them from approaching wind turbines. • Visual deterrents, including the use of ultraviolet light or painting a single turbine blade black, may alert flying animals to the presence of wind turbines. Audible noise deterrents for birds typically are not successful, as individuals can become habituated to the sound. • Ultrasonic deterrents mounted on the nacelle of wind turbines have mixed results for deterring bats; more research is needed to demonstrate consistent reductions in mortality. • Feathering the wind turbine blades, i.e., adjusting the angle of the blades parallel to the wind and increasing the	Thelander C.G., Smallwood K.S. & Rugge L. 2003. Bird risk behaviors and fatalities at the Altamont Pass Wind Resource Area. Period of performance: March 1998–December 2000. BioResource Consultants, Ojai, California. http://www.nrel.gov/docs/fy04osti/33829.pdf Drewitt A.L. and Landston R.H.W. (2006). Assessing the impacts of wind farms on birds. Ibis (2006), 148, 29–42. https://doi.org/10.1111/j.1474-919X.2006.00516.x Everaert, J., & Stienen, E. (2007). Impact of wind turbines on birds in Zeebrugge (Belgium) Significant effect on breeding tern colony due to collisions. Biodiversity and Conservation, 16, 3345–3359. https://doi.org/10.1007/s10531-006-9082-1 Hill, R., Hill, K., Aumüller, R., Schulz, A., Dittmann, T., Kulemeyer, C., & Coppack, T.

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		structures including lighthouses, platforms and ships (Hill et al. 2014; Huppop et al. 2016). Passerines are the most abundant group of birds in North America and migrate nocturnally. • Observed collisions at nearshore and OSW sites in the U.S. and Europe include gulls, terns, phalaropes, cormorants, jaegers, skuas, sea ducks, pelicans and songbirds. Notably, these include large birds with less maneuverability, e.g., gull and waterfowl species (Everaert and Stienen 2006; SEER 2022). • Large raptors, such as eagles and hawks, and species that are known to frequent offshore areas, including seabirds and waterfowl, are considered at a higher risk of collisions with OSW turbines (Watson 2022, Goodale et al. 2019). • Migratory birds that traverse offshore wind farms during their seasonal migrations are also susceptible (Degraer ert al. 2021). • Individual characteristics (age, health, behaviour such as foraging, breeding and migration) can impact collision risk. For example, research conducted at lighthouses, oil platforms and ships shows collision risk increased with periods of increased activity (Hill et al. 2014; Huppop et al. 2016). • Some species may be attracted to wind farms due to artificial lighting and/or perching and foraging opportunities. This may increase collision risk (Dierschke et al. 2016; Hill et al. 2014; NatureScot 2020). ***See light attraction IPF below.*** • Poor weather conditions, e.g., fog and rain, can increase collision risk due to poor visibility. Strong headwinds and low-lying clouds also influence collision rates as migrating birds tend to fly lower under these conditions (Willmott et al. 2013). • Methods commonly used at land-based farms, such as carcass searches are not feasible at OSW sites, limiting post-construction monitoring at OSW farms to incidental observations and remote collision detection monitoring technologies; the latter are currently under development. This may lead to under-reporting collision rates (Drewitt and Langston 2006; Kaldellis et al 2016; SEER 2022). • Bird collision risk at OSW sites may not be comparable to collision risk at other structures such as lighthouses, oil platforms and ships due to differences in lighting and structural features. Research shows, among other factors, lighting, masts and	cut-in speed of the turbine, i.e., the wind speed at which the turbine blades begin to spin and produce energy, serves to mitigate risk of collision. • For highly threatened species, human observers and automated detection technologies can be used to shut down turbines when species of special conservation concern approach (Allison et al., 2019). • Increasing the minimum rotor height has the potential to reduce the risk of collision for a number of seabirds, many of which rarely fly above about 25 m, but regularly fly at around 20 m (MRP 2019). • By reducing the rotor swept area the number of collisions will automatically be reduced. In particular, the blade width and the radius of the rotor may make most differences in the number of predicted collisions (MRP 2019). • The use of a soft start during construction as a routine mitigation measure might reduce the impacts on prey species upon which seabirds rely (MRP 2019). • Develop technologies and methodologies to record collision incidents in the offshore environment • Validate collision risk modelling to ensure inclusion of the right parameters to predict risk and accurately value the relative importance of each parameter. • Investigate the efficacy of deterrents, curtailment and other operational	(2014). Of birds, blades and barriers: Detecting and analysing mass migration events at alpha ventus. In Federal Maritime And Hydrographic A & Federal Ministry For The Environmen (Eds.), Ecological Research at the Offshore Windfarm alpha ventus (pp. 111–131). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-02462-8_12 Kerlinger, P., & Curry, R. (2002). 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AWWI Technical Report: 2nd Edition: Summary of Bird Fatality Monitoring Data Contained in AWWIC. Washington, DC. Available at www.awwi.org.

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		guywires associated with these structures contributed to collision risk; the features associated with OSW sites are different (Hill et al. 2014). • Species strongly attracted by offshore wind farms (class 5): great cormorant and European shag. Both species use offshore wind farms as outposts, i.e., the possibility of resting on turbines, met masts and transformer platforms allows them to open new foraging areas far offshore (Dierschke et al. 2016).	impact minimization options for marine birds.	Mainstream renewable Power 9MRP), 2019. Neart na Gaoithe Offshore Wind Farm Environmental Statement. Chapter 25. Summary of Suggested Mitigation and Monitoring. Accessed at: https://marine.gov.scot/sites/default/files/chapter_25_-_summary_of_mitigation_measures.pdf Erickson, W. P., Wolfe, M. M., Bay, K. J., Johnson, D. H., & Gehring, J. L. (2014). A comprehensive analysis of small-passerine fatalities from collision with turbines at wind energy facilities. PloS One, 9(9), e107491. https://doi.org/10.1371/journal.pone.0107491 Hüppop, O., Hüppop, K., Dierschke, J., & Hill, R. (2016). Bird collisions at an offshore platform in the North Sea. Bird Study, 63(1), 73–82. https://doi.org/10.1080/00063657.2015.1134440 SEER, U.S. Offshore Wind Synthesis of Environmental Effects Research (2022) Bat and Bird Interactions with Offshore Wind Farms. Available at: https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Bat-Bird-Interactions.pdf , Last accessed: 21 August 2023. Watson R.T. (2022). Raptor Interactions with Wind Energy: Case Studies from Around the World. Journal of Raptor Research, 52(1): 1-18. Goodale M.W., Milman A., and Griffin C.R. (2019) Assessing the cumulative adverse effects of offshore wind energy development on seabird foraging guilds along the East Coast of the United States. Environ. Res. Lett. 14 (2019) 074018.

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IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
				Degraer, S., Brabant, R., Rumes, B. & Vigin, L. (eds). 2021. Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Attraction, avoidance and habitat use at various spatial scales. Memoirs on the Marine Environment. Brussels: Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management, 104 pp. Dierschke V., Furness R.W., and Garthe S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation 202 (2016) 59–68. https://doi.org/10.1016/j.biocon.2016.08.016 NatureScot. (n.d.). Information note—The Effect of Aviation Obstruction Lighting on Birds at Wind Turbines, Communication Towers and Other Structures. Retrieved November 16, 2023, from https://www.nature.scot/doc/information-note-effect-aviation-obstruction-lighting-birds-wind-turbines-communication-towers-and Willmot, J. R., Forcey, G., & Kent, A. (2013). The Relative Vulnerability of Migratory Bird Species to Offshore Wind Energy Projects on the Atlantic Outer Continental Shelf: An Assessment Method and Database (OCS Study BOEM 2013-207; p. 275). U.S. Department of the Interior, Bureau of Ocean Energy Management. https://espis.boem.gov/final%20reports/5319.pdf
	Bats	• Bat collision risk at onshore windfarms in North America is well documented (Arnett et al. 2008; Cryan and Barclay 2009; Hayes 2013; Smallwood 2013; Martin et al. 2017; Pettit and O'Keefe 2017; Allison et al. 2018). • Fatality estimates due to collisions at onshore wind farms in the U.S. range from 4-7 bats per MW per year up to 50 bats per MW per year at windfarms located along forested ridgelines in the southeastern U.S. (AWWI 2020b).	• Curtailment during high-risk times. • Adjusting angle of the blades (feathering) so that they don't turn at low wind speeds. • Discouraging bats from approaching wind turbines with deterrent technologies, i.e., dim, flickering	Arnett, E. B., Brown, W. K., Erickson, W. P., Fiedler, J. K., Hamilton, B. L., Henry, T. H., Jain, A., Johnson, G.D., Kerns, J., Koford, R. R., Nicholson, C. P., O'Connell, T. J., Piorkowski, M. D., & Tankersley, R. D. (2008). Patterns of Bat Fatalities at Wind Energy Facilities in North America. The Journal of Wildlife Management, 72(1), 61–78.

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

IPF	VCs Effected	Understanding of the Issue	IPF Specific Mitigation Measures	Literature
		• Collision mortality has affected migratory tree-roosting bats with long-distance migrant fatalities (e.g., hoary bat, eastern red bat, silver-haired bats) most found at North American onshore wind farms (Kunz et al. 2007; AWWI 2020b) • Low wind speeds (e.g., less than 5 metres per second) have been shown to increase bat collisions (Cryan et al 2014). • Bat collisions may occur nearshore more often than at greater distance as studies show higher bat activity here (Guest et al. 2022; Pelletier et al., 2013; Stantec 2016b). Some studies suggest turbines located greater than 26 km offshore may have limited impacts on bats, but closer turbines could have effects similar to onshore wind farms (Lagerveld and Mostert, 2023; Sjollema et al. 2014; Stantec 2016).	ultraviolet light or acoustic deterrent devices.	Cryan, P. M., & Barclay, R. M. R. (2009). Causes of Bat Fatalities at Wind Turbines: Hypotheses and Predictions. Journal of Mammalogy, 90(6), 1330–1340. https://doi.org/10.1644/09-MAMM-S-076R1.1 Thomas H. Kunz, Edward B. Arnett, Wallace P. Erickson, Alexander R. Hoar, Gregory D. Johnson, Ronald P. Larkin, M Dale Strickland, Robert W. Thresher, Merlin D. Tuttle. (2007). Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecology and the Environment: Volume 5, Issue 6. 315-324. https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/1540-9295%282007%295%5B315%3AEIOWED%5D2.0.CO%3B2 Cryan, Paul. M., Gorresen, P. M., Hein, C. D., Schirmacher, M. R., Diehl, R. H., Huso, M. M., Hayman, D. T. S., Fricker, P. D., Bonaccorso, F. J., Johnson, D. H., Heist, K., & Dalton, D. C. (2014). Behavior of bats at wind turbines. Proceedings of the National Academy of Sciences, 111(42), 15126–15131. https://doi.org/10.1073/pnas.1406672111 Hayes, M. A. (2013). Bats Killed in Large Numbers at United States Wind Energy Facilities. BioScience, 63(12), 975–979. https://doi.org/10.1525/bio.2013.63.12.10 Smallwood, K. S. (2013). Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin, 37(1), 19–33. https://doi.org/10.1002/wsb.260 Martin, C., Arnett, E., Stevens, R., & Wallace, M. (2017). Reducing bat fatalities at wind

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

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				facilities while improving the economic efficiency of operational mitigation. Journal of Mammalogy, 98, 378–385. https://doi.org/10.1093/jmammal/gyx005 Pettit, J. L., & O'Keefe, J. M. (2017). Day of year, temperature, wind, and precipitation predict timing of bat migration. Journal of Mammalogy, 98(5), 1236–1248. https://doi.org/10.1093/jmammal/gyx054 Allison, T., & Butryn, R. (2018). AWWI Technical Report: A Summary of Bat Fatality Data in a Nationwide Databse [Technical Report]. American Wind Wildlife Institute (AWWI). https://rewi.org/wp-content/uploads/2019/02/AWWI-Bat-Technical-Report_07_25_18_FINAL.pdf American Wind Wildlife Institute (AWWI). 2020b. AWWI Technical Report: 2nd Edition: Summary of Bat Fatality Monitoring Data Contained in AWWIC. Washington, DC. Available at www.awwi.org. Guest, E. E., Stamps, B. F., Durish, N. D., Hale, A. M., Hein, C. D., Morton, B. P., Weaver, S. P., & Fritts, S. R. (2022). An Updated Review of Hypotheses Regarding Bat Attraction to Wind Turbines. Animals: An Open Access Journal from MDPI, 12(3), 343. https://doi.org/10.3390/ani12030343 Pelletier, S., Omland, K., Watrous, K. S., & Peterson, T. S. (2013). Information Synthesis on the Potential for Bat Interactions with Offshore Wind Facilities – Final Report (OCS Study BOEM 2013-01163; p. 119). U.S. Dept of the Interior, Bureau of Ocean Energy Management. https://tethys.pnnl.gov/sites/default/files/publications/BOEM_Bat_Wind_2013.pdf Lagerveld S. and Mostert K. (2023). Are offshore wind farms in the Netherlands a

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

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				potential threat for coastal populations of noctule? Lutra 66 (1): 39-53. Sjollema A.J., Gates J.E., Hilderbrand R.H., and Sherwell J. (2014). Offshore Activity of Bats along the Mid-Atlantic Coast. Norteastern Naturalist 21(1), 154-163. Stantec (Stantec Consulting Services Inc.). (2016a). Long-term Bat Monitoring on Islands, Offshore Structures, and Coastal Sites in the Gulf of Maine, mid-Atlantic, and Great Lakes—Final Report (p. 68). Prepared for US Department of Energy. Stantec (Stantec Consulting Services Inc.). (2016b). Vessel-based Acoustic Bat Monitoring: Block Island Wind Farm, Rhode Island (p. 68). Prepared for Deepwater Wind Block Island, LLC.
	Insects	• Evidence is accumulating that insects are frequently killed by operating wind turbines, but it is poorly understood if these fatalities cause population declines and changes in assemblage structures at various spatial scales (Voigt 2020). • Recently, the annual loss of insect biomass at wind turbine sites in Germany was estimated to be1,200 t for the plant growth period, which equates to about 1.2 trillion killed insects per year (Voigt 2020). • One study conducted by the German Aerospace Center estimated that 1,200 tons of insect biomass are lost annually to collisions with Germany's 30,000 onshore wind turbines. • Another academic article explains, "Assuming an average wet mass of 1 mg for an insect… this equates to about 1.2 trillion insects killed per year for all onshore wind turbines in Germany, or 40 million insects killed annually by a single wind turbine in Germany." (McPherrin 2022)	• Obtain an understanding of identification and monitoring of environmental conditions that are favorable for swarm formation and migration. • Insect swarm detection by Radar and Lidar and an according control of the blades is a preventive measure	McPherrin. J. (2022). The Heartland Institute. Published November 15, 2022. https://www.wind-watch.org/documents/wind-energys-impact-on-birds-bats-and-insects/ Voigt. C. 2020. Insect fatalities at wind turbines as biodiversity sinks. Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany. https://docs.wind-watch.org/Voigt-Insect-fatalities-at-wind-turbines.pdf

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3) Noise from vessel traffic and turbines	Birds	• The noise generated by offshore windfarms may cause marine birds to avoid the turbines and the areas surrounding them, though little is known about this behaviour or its possible repercussions (Wilson et al. 2010). • Construction and support vessel operations will generate substantial noise profiles both above and below the water surface. The sub-surface noise has the potential to adversely affect seabirds foraging underwater, such as penguins, cormorants, shearwaters, diving petrels (Favaro and Pichegru 2018, Hansen et al. 2020, Pichegru et al. 2017).	• Locate projects away from sensitive bird areas, i.e., wintering and breeding bird areas, migratory and local flight path routes and bird conservation areas.	Wilson, J.C., Elliott, M., Cutts, N.D., Mander, L., Mendão, V., PerezDominguez, R. and A. Phelps. 2010. Coastal and Offshore Wind Energy Generation: Is It Environmentally Benign? Energies, 3(7), pp 1383-1422. Doi.org/10.3390/en3071383 Favaro and Pichegru 2018, Pichegru, L., Nyengera, R., McInnes, A.M. *et al.* Avoidance of seismic survey activities by penguins. *Sci Rep* **7**, 16305 (2017). https://doi.org/10.1038/s41598-017-16569-x
	Bats	• Growing evidence indicates mortality from barotrauma, or lethal exposure to pressure variations that occur around wind turbine blades, is unlikely to be a significant contributor to bat mortality (SEER, 2022).	• Locate projects away from known active bat areas (based on baseline monitoring). • Complete focused post-construction monitoring if mortality from barotrauma is identified. • Install deterrents if evidence of barotrauma is occurring.	SEER, U.S. Offshore Wind Synthesis of Environmental Effects Research (2022) Bat and Bird Interactions with Offshore Wind Farms. Available at: Bat and Bird Interactions with Offshore Wind Energy Development | Tethys (pnnl.gov).
	Insects	No literature identified.	N/A	N/A

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

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4**)** Lights from vessel traffic and turbines	Birds	• The studies that discuss the impacts of light from ships emphasize the dangers of collisions with ships or structures. Marine birds may become disoriented by marine light pollution, or be attracted to artificial light when visibility is low, leading to collisions. • Research conducted at lighthouses, oil platforms and ships shows lighting during inclement weather can disorient and/or attract birds. This may increase collision rates. As above, these findings may not be comparable to OSW (Hill et al. 2014; Huppop et al. 2016). • Gehring et al. (2009) looked at a range of lighting arrangements and showed that white, stroboscopic lights attracted the fewest birds as compared to red flashing lights and steady red lights. • Kerlinger et al. (2010) showed that steady red lights on turbines were more attractive to birds than flashing red lights. Flashing red lights reduced attraction and subsequent kills significantly. • Gehring et al. (2009) further suggested that it is the mode - flashing vs. non-flashing, steady lights - that is the principal factor that increases collision, and that colour may be a secondary consideration.	• Usie flashing lights which are believed to be less attractive to birds than steady lights. Use white (or green) lights that are believed to be less attractive to birds than red lights, which may affect nocturnal migrant navigation. • Good practices include minimizing deck lighting, ensuring that light sources are shaded and directed downward and avoiding broad-spectrum lights whenever possible (Defingou et al., 2019) . • Points lights downward with shielding where possible.	M. Defingou, F. Bils, B. Horchler PHAROS4MPAs: A Review of Solutions to Avoid and Mitigate Environmental Impacts of Offshore Windfarms BioConsult SH on behalf of WWF France, France (2019) Huppop, O. Huppop, K. Dierscke, J. Reinhold, H. (2016). Bird collisions at an offshore platform in the North Sea. British Trust for Ornithology, Bird Study, 1–10. https://docs.wind-watch.org/huppop2016.pdf Gehring. J. Kerlinger. P. Manville. A. (2009). Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. https://pubmed.ncbi.nlm.nih.gov/19323206/ Kerlinger, P.; Gehring, J.; Erickson, W.; Curry, R.; Jain, A.; Guarnaccia, J. (2010). Night Migrant Fatalities And Obstruction Lighting At Wind Turbines In North America. The Wilson Journal of Ornithology, 122(4), 744-754. https://doi.org/10.1676/06-075.1
	Bats and Insects	• Some scientists have proposed that bats may be attracted to OSW Farms because the OSW Farms emit light (which attracts insects) and are prominent landmarks (CRS 2024).	See bird mitigation measures.	Congressional Research Service (CRS). 2024. Potential Impacts of Offshore Wind on the Marine Ecosystem and Associated Species: Background and Issues for Congress. https://sgp.fas.org/crs/misc/R47894.pdf
5) Habitat Displacement [Again, not sure if this is an IPF or a result of the presence of an OSW farm, not sure it matters]	Birds	• Several studies have demonstrated displacement of birds due to the presence of offshore wind farms and related disturbances, e.g., regular ship traffic or continuous turbine operation (Furness et al 2013, Garthe et al. 2023, Peschko et al. 2020; Velando and Munilla 2011). • Displacement occurs when habitats frequently used by birds, e.g., for transiting, resting, roosting, or foraging, are less frequented or abandoned.	• Future research should focus on whether displacement reduces foraging opportunities to the point that it would affect an individual's fitness. • Repeat baseline monitoring to determine if habitat displacement has occurred. • Install anti-roosting deterrents.	Furness R.W., Wade H.M. and Masden E. A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management 119 (2013) 56-66. https://doi.org/10.1016/j.jenvman.2013.01.025 Velando, A. Munilla, I. (2011) Disturbance to a foraging seabird by sea-based tourism: Implications for reserve management in

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

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		• Displacement may impact species groups differently. Studies from the U.K. show species observed in lower numbers at OSW farms post-construction included scoters, loons, gannets and alcid species. Some species were displaced up to 2-4 km fromthe OSW farm boundary (Dierschke et al. 2016; Kahlert et al. 2003; Petersen 2005; Petersen et al. 2006). • In some cases, displacement could be temporary. For example, Dierschke et al. (2016) found avoidance during the first year of operation at some wind farms in Europe followed by an eventual increase in species' abundance. This increase was assumed to result from increased prey availability around underwater structures, i.e., artificial reef effect.		marine protected areas. Biological Conservation Volume 144, Issue 3, March 2011, Pages 1167-1174. https://www.sciencedirect.com/science/article/pii/S0006320711000097?via%3Dihub Dierschke V., Furness R.W., and Garthe S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation 202 (2016) 59–68. https://doi.org/10.1016/j.biocon.2016.08.016 Kahlert, J., Petersen, I. K., Fox, A. D., Desholm, M., & Clausager, I. (2003). Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand. National Environmental Research Institute. https://tethys.pnnl.gov/sites/default/files/publications/Kahlert-et-al-2004.pdf Petersen, K. (2005). Bird numbers and distributions in the Horns Rev offshore wind farm area. National Environmental Research Institute. https://tethys.pnnl.gov/sites/default/files/publications/Petersen_2005.pdf Petersen I.K., Christensen T.K., Kahlert J., Desholm M., and Fox A.D. (2006). Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. NERI Report Commissioned by DONG energy and Vattenfall A/S 2006. National Environmental Research Institute Ministry of the Environment. Denmark Dierschke V., Furness R.W., and Garthe S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation 202 (2016) 59–68. https://doi.org/10.1016/j.biocon.2016.08.016

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

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	Bats	• Bats are more likely to be attracted to windfarms than to engage in avoidance behaviours (Cryan et al. 2014). • Bats may be attracted to wind turbines for roosting or breeding if they are tall structures on an otherwise flat landscape, as bats appear to be attracted to tall structures, such as trees and lighthouses (Alhen et al. 2009; Kunz et al. 2007; Horn et al. 2008; Guest et al. 2022). Alhen et al. (2009) documented wind turbines being used for roosting 5.8 km from shore. • Bats maybe attracted to insects that gather close to turbines, microclimates at turbines (lower windspeed, temperature variation), and lights, noise and rotation of turbines (Cryan and Barclay 2009; Cryan et al. 2014; de Jong et al. 2021; Guest et al. 2022; Kunz et al. 2007; Orr et al 2013; Pelletier et al. 2013; SEER 2022).	• Design turbines to minimize the potential for perching and roosting. • Discourage bats from approaching wind turbines with deterrent technologies, i.e., dim, flickering ultraviolet light or acoustic deterrent devices.	Cryan, Paul. M., Gorresen, P. M., Hein, C. D., Schirmacher, M. R., Diehl, R. H., Huso, M. M., Hayman, D. T. S., Fricker, P. D., Bonaccorso, F. J., Johnson, D. H., Heist, K., & Dalton, D. C. (2014). Behavior of bats at wind turbines. Proceedings of the National Academy of Sciences, 111(42), 15126–15131. https://doi.org/10.1073/pnas.1406672111 Ahlén, I., Baagøe, H. J., & Bach, L. (2009). Behavior of Scandinavian Bats during Migration and Foraging at Sea. Journal of Mammalogy, 90(6), 1318–1323. https://doi.org/10.1644/09-MAMM-S-223R.1 Horn, J. Arnett, E. Kunz, T. (2008). Behavioral Responses of Bats to Operating Wind Turbines. https://tethys.pnnl.gov/sites/default/files/publications/hornetal2008.pdf Guest, E. E., Stamps, B. F., Durish, N. D., Hale, A. M., Hein, C. D., Morton, B. P., Weaver, S. P., & Fritts, S. R. (2022). An Updated Review of Hypotheses Regarding Bat Attraction to Wind Turbines. Animals: An Open Access Journal from MDPI, 12(3), 343. https://doi.org/10.3390/ani12030343 Cryan, P. M., & Barclay, R. M. R. (2009). Causes of Bat Fatalities at Wind Turbines: Hypotheses and Predictions. Journal of Mammalogy, 90(6), 1330–1340. https://doi.org/10.1644/09-MAMM-S-076R1.1 de Jong J., Millon L., Hastad O., and Victorsson J. (2016) Activity Pattern and Correlation between Bat and Insect Abundance at Wind Turbines in South Sweden. Animals 2021, 11, 3269. https://doi.org/10.3390/ani11113269 .

Table 1: Impact Producing Factors, Issues and Mitigation Measures – Aerofauna

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				Orr, T., Herz, S. M., & Oakley, D. L. (2013). Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments (OCS Study BOEM 2013-0116; p. 429). U.S. Dept of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. https://espis.boem.gov/final%20reports/5298.pdf Pelletier, S., Omland, K., Watrous, K. S., & Peterson, T. S. (2013). Information Synthesis on the Potential for Bat Interactions with Offshore Wind Facilities – Final Report (OCS Study BOEM 2013-01163; p. 119). U.S. Dept of the Interior, Bureau of Ocean Energy Management. https://tethys.pnnl.gov/sites/default/files/publications/BOEM_Bat_Wind_2013.pdf SEER, U.S. Offshore Wind Synthesis of Environmental Effects Research (2022) Bat and Bird Interactions with Offshore Wind Farms. Available at: https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Bat-Bird-Interactions.pdf , Last accessed: 21 August 2023.