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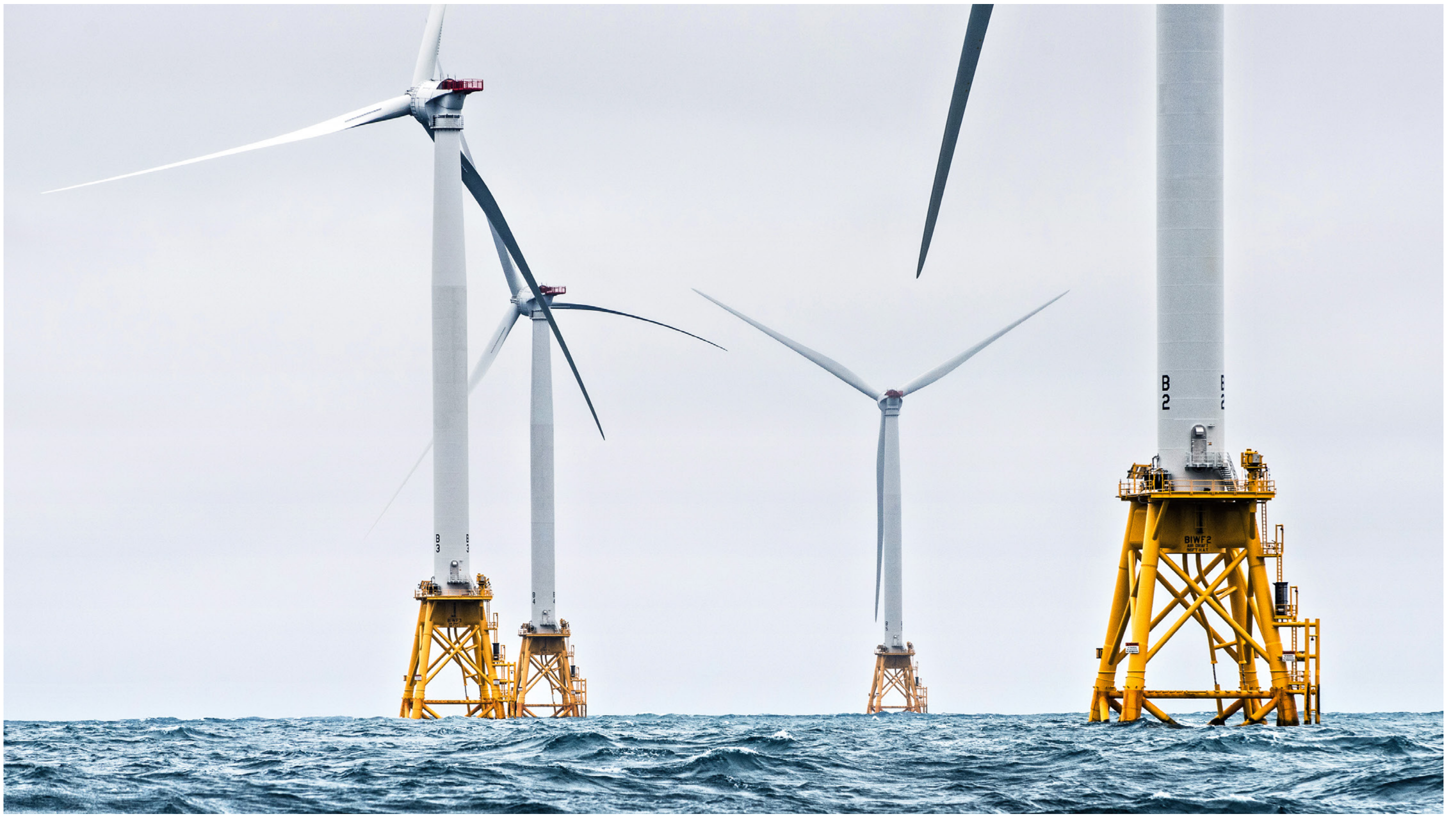
ISSUE BRIEF

HARNESSING THE WIND:
HOW TO ADVANCE WIND POWER OFFSHORE



This is an exciting moment for U.S. offshore wind energy development. With the encouragement of a broad coalition that includes organized labor, business groups, and the environmental community, many East Coast states have adopted ambitious offshore wind goals and are supporting a variety of offshore wind projects that provide healthier air—free of mercury and other pollutants—and thousands of well-paying clean energy jobs.[1] All told, projects capable of producing more than 25,000 megawatts of power could be operational along the Atlantic Coast within the next 15 years, ensuring enough renewable electricity to power at least 12.5 million homes.[2] West Coast offshore wind efforts are also starting to take shape under California's lead, with advancements in newer technologies better suited for deeper waters.

Offshore wind power is coming not a moment too soon. A 2017 NRDC report titled *America's Clean Energy Frontier* models a national path to reduce dangerous U.S. greenhouse gas emissions by at least 80 percent by 2050.[3] The analysis shows the United States needs to rapidly scale up energy efficiency and all forms of clean energy—including solar power and land-based and offshore wind—to prevent the worst impacts of climate change. The most recent Intergovernmental Panel on Climate Change (IPCC) report describes in no uncertain terms the consequences for both humans and ecosystems if we fail.[4] Increased droughts, more severe storms and heat waves, and greater flooding—even on sunny days—are flashing warning signs. In our oceans, climate change is already bleaching coral, displacing species worldwide, and acidifying the water, making it harder for shell-building organisms like oysters to grow shells and survive. We must kick our fossil fuel addiction.

Yet even with its immense long-term benefits, offshore wind power, like all types of energy development, poses risks to its immediate environment and must be developed responsibly.

Wind farm construction and operation can displace vulnerable ocean wildlife from prime feeding and breeding areas and interfere with animals' abilities to navigate, communicate, and locate food. Many species, already under stress from decades of overfishing, pollution, and habitat destruction and facing new pressures from climate change, may struggle to adapt, resulting in further population declines.

U.S. offshore wind is still a new industry. We are only just beginning to learn from our nation's first commercial project, the Block Island Wind Farm off the coast of Rhode Island, which came online in December 2016.[5] Nearly three decades of offshore wind development in Europe have shown that offshore wind power can be sited and operated with appropriate mitigation measures needed to protect local wildlife.[6] We need to build on these examples and apply lessons learned here in U.S. waters, where differences in our marine ecosystems present new challenges for responsibly developing and operating offshore wind projects.

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SMART OFFSHORE WIND IS WITHIN REACH

We can harness the clean energy we need while protecting our valuable marine wildlife heritage. It is critical that offshore wind projects be sited outside important and sensitive habitats—like the nearshore environment, shoals, shelf breaks, and other unique ocean areas—to minimize impacts to coastal and marine wildlife. We must also adopt science-based measures to avoid, minimize, and mitigate the impacts of wind farm construction and operation on vulnerable ocean life. And we need to support further research to improve our understanding of potential impacts so we can solve any problems and move beyond concerns that prove to be unfounded.

Responsible offshore wind development must seek to avoid, minimize, and mitigate underwater noise.

Offshore wind development activities, including surveys to determine turbine placement and foundation installation, can produce large amounts of underwater noise. Animals' responses to that noise can vary by species. The noise can drown out the sounds that whales and other marine mammals make to communicate and can divert animals from their typical migration routes into areas less suitable for feeding, migrating, or breeding. It could drive animals into shipping lanes, putting them in the path of powerful ships.[7] Some species may avoid areas even after the noise ends. In Europe, harbor porpoises have not returned to some areas that had been filled with the loud sounds of turbine construction.[8] Lessening underwater noise benefits a wide range of ocean wildlife, from the largest whales to shellfish like scallops.[9]

To reduce risk, wind farms should be sited outside critical feeding and breeding areas for especially vulnerable species like the North Atlantic right whale (see page 5). Construction should be scheduled to occur during months when sensitive animals aren't around. Offshore developers can take a page from Europe and use quieter foundation types like gravity-based and suction caisson platforms.[10] Developers can also use noise-reducing installation methods and technologies—like bubble curtains—to muffle the sound of loud pile-driving, which occurs when a foundation's steel platforms are hammered into the seabed.[11] It is also essential to use qualified wildlife observers and underwater recorders to monitor the area during construction, and to pause noisy activities when marine mammals and sea turtles are present.


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Responsible offshore wind development must aim to minimize ship strikes.

Ship strikes are a leading cause of mortality for marine mammals as well as endangered and threatened sea turtles.[12] While wind farm activities are only one component of overall vessel traffic, they still generate an additional risk of ship strikes, both within and just outside project areas where a greater density of boats may be redirected during construction.

The most effective way to prevent serious injury to marine mammals and sea turtles is to limit ship speeds to no more than 10 nautical miles per hour.[13] The Bureau of Ocean Energy Management, the agency responsible for permitting offshore wind under federal law, should also help develop and test vessel design solutions (e.g., enclosed propellers or modified hull designs) to reduce ship-related noise and collision risks.

Responsible offshore wind development must avoid, minimize, and mitigate turbine conflicts.

Birds and bats can collide with turbine blades or be displaced by the turbines from key feeding areas or migratory pathways.[14] Research from European offshore wind facilities has shown mixed results: Some studies provide grounds for optimism, offering little evidence of collision-caused bird mortality offshore; others note that direct mortality is difficult to quantify in an ocean environment and that even low collision levels can pose a serious risk to imperiled species.[15]

We need a far better understanding of where birds and bats—particularly species already experiencing population declines—fly offshore, including at what heights, to further guide wind farm siting to avoid important areas. We should explore smart turbine designs and operations to avoid and minimize impacts. Tactics like reduced lighting on wind platforms and the use of flashing lights on turbines may help ward off seabirds.[16] Bats may be attracted to turbines, so researchers are also exploring ultrasonic noise emitters and ultraviolet lighting to deter bats from approaching turbines. If needed, briefly stopping turbine blades (known as "feathering" or "operational curtailment") during key migration times for bats (e.g., during warm, slow-wind-speed nights in autumn) could greatly reduce mortality.[17]

The mooring and transmission cables from floating turbine platforms also pose potential scouring issues for habitat and entanglement or displacement risks for marine life like whales.[18] We need baseline studies to understand these risks and to develop best management practices to mitigate any impacts.

Developers must commit to scientific research and long-term monitoring.

Baseline data collection and long-term monitoring of offshore wind project sites are critically important. Knowing more about the status of wildlife populations and oceanographic details (e.g., water temperature, seafloor habitat) will help explain whether and how offshore wind development will impact a proposed site and its surrounding environment. In addition to the research needs described above, we should further explore the electromagnetic fields emitted by power cables that connect turbines to each other and to the shore, particularly their possible impact on species like sea turtles that use the earth's magnetism as a directional cue.[19] As more offshore wind projects come online, we must collect data on how sound levels from their operations in various environmental conditions change with different project layouts and foundation types. We must also develop verified technology capable of monitoring potential bird and bat impacts. Conducting this research and making it publicly available will help to calculate the cumulative impact of multiple projects and guide future offshore wind siting and development.

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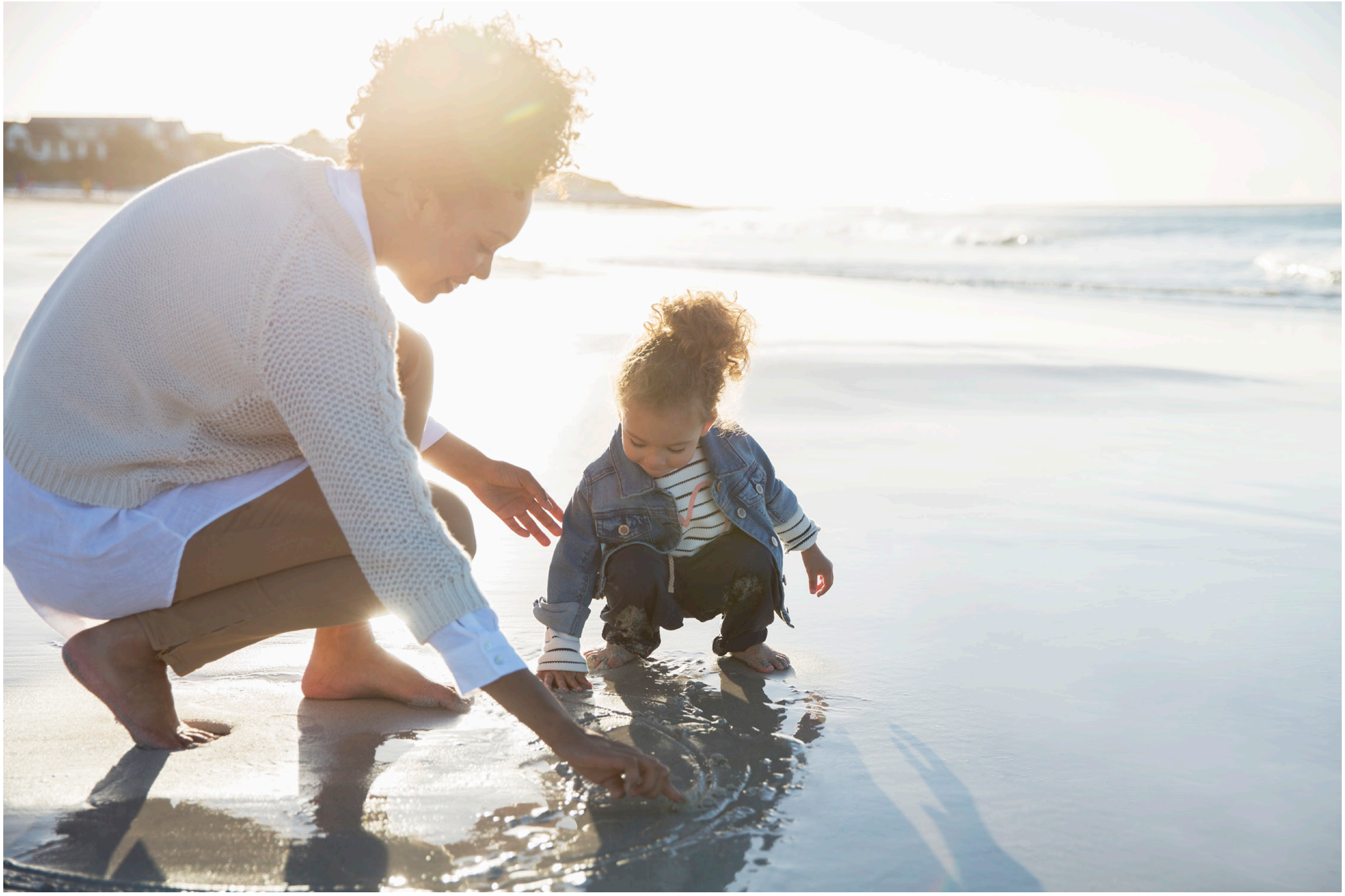
OFFSHORE WIND DEVELOPERS CAN PROTECT NORTH ATLANTIC RIGHT WHALES

With fewer than 420 individuals remaining, the iconic North Atlantic right whale is one of the most endangered marine mammals on the planet.[20] Right whales have been in a severe decline since 2010, largely due to entanglement in fishing gear and vessel collisions. We need to do everything we can to reduce stress on the species if it is to survive and recover.

In January 2019, the Natural Resources Defense Council, the National Wildlife Federation, and the Conservation Law Foundation reached a landmark agreement with offshore developer Vineyard Wind to protect endangered North Atlantic right whales during construction and operation of its 800-megawatt project for Massachusetts, which is on track to become the first large-scale offshore wind project in the United States. Under the agreement, construction will be curtailed in the winter and early spring when right whales are expected to be in the area. During other months, comprehensive monitoring through overflights and underwater surveillance will ensure that disruptive construction activities don't take place when right whales are near the site. Vineyard Wind will also dampen construction noise that impairs the ability of all marine mammals to communicate, find food, and stay on their migratory paths. Finally, the agreement sets speed limits for project vessels and includes additional commitments to long-term right whale research and conservation.[21]

This agreement sets the bar for other offshore wind developers and lays the groundwork for state and federal regulatory requirements. It is a practical demonstration of how the industry can comply with a set of best management practices that environmental groups and scientists have developed for ensuring protection of right whales during offshore wind construction and operation.[22] Working together, we can grow the clean energy we need while protecting our most vulnerable ocean wildlife.



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WE NEED OFFSHORE WIND NOW—AND WE NEED TO DO IT RIGHT

Tapping into the wind power off our coasts offers an unmatched opportunity to develop the carbon-free energy we need to address climate change. We can avoid, minimize, and mitigate threats to ocean life from offshore wind development. By placing projects where they are least likely to cause harm, taking precautions when constructing and operating turbines, and committing to understand and protect our ocean wildlife, we can ensure that the offshore wind we need advances in harmony with the protection of our treasured ocean wildlife.

ENDNOTES

1 *Clean Jobs America,* Environmental Entrepreneurs, 2018, https://www.e2.org/wp-content/uploads/2018/05/Clean-Jobs-America-2018.pdf. *2019 U.S. Energy and Employment Report,* Energy Futures Initiative, National Association of State Energy Officials, 2019, https://www.usenergyjobs.org/. EnerKnol Research, "Promise of Offshore Wind Sparks Race for Leadership Among Eastern U.S. States," Visual Primer Series, January 23, 2019, https://enerknol.com/enerknols-visual-primer-promise-of-offshore-wind-sparks-race-for-leadership-among-eastern-u-s-states/. R.N. Salas, W. Jacobs, and F. Perera, "The Case of *Juliana v. U.S.*—Children and the Health Burdens of Climate Change," *New England Journal of Medicine* 380 (2019): 2085-2087.

2 Christopher Martin, "Connecticut Is Set to Join in $70 Billion Offshore Wind Expansion," Bloomberg, June 5, 2019, https://www.bnnbloomberg.ca/connecticut-is-set-to-join-in-70-billion-offshore-wind-expansion-1.1268929. Vineyard Wind, "Benefits," 2019, https://www.vineyardwind.com/benefits/ (accessed June 14, 2019).

3 V. Gowrishankar and A. Levin, *America's Clean Energy Frontier: The Pathway to a Safer Climate Future*, Natural Resources Defense Council (hereinafter NRDC), September 2017, https://www.nrdc.org/sites/default/files/americas-clean-energy-frontier-report.pdf.

4 International Panel on Climate Change, "2018: Summary for Policymakers," in *Global Warming of 1.5 °C: An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, V. Masson-Delmotte et al., eds., https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.

5 *See* Deepwater Wind, "Block Island Wind Farm," http://dwwind.com/project/block-island-wind-farm/ (accessed June 14, 2019).

6 Sue O'Brien, "Lessons Learned From the European Experience," presentation at the State of the Science Workshop on Wildlife and Offshore Wind Energy Development, November 13-14, 2018, Woodbury, New York.

7 L. Weilgart, "The Impacts of Anthropogenic Ocean Noise on Cetaceans and Implications for Management," *Canadian Journal of Zoology* 85, no. 11 (2007): 1091-1116.

8 J. Teilmann and J. Carstensen, "Negative Long-Term Effects on Harbour Porpoises From a Large Scale Offshore Wind Farm in the Baltic—Evidence of Slow Recovery," *Environmental Research Letters* 7, no. 4 (December 6, 2012).

9 L. Weilgart, "The Impact of Ocean Noise Pollution on Fish and Invertebrates," OceanCare and Dalhousie University, May 1, 2018, https://www.oceancare.org/wp-content/uploads/2017/10/OceanNoise_FishInvertebrates_May2018.pdf.

10 Francine Kershaw "Shhh . . . Quiet Offshore Wind Foundations Protect Marine Life," NRDC, April 10, 2019, https://www.nrdc.org/experts/francine-kershaw/shhh-quiet-offshore-wind-foundations-protect-marine-life (accessed June 9, 2019).

11 S. Koschinski and K. Lüdemann, "Development of Noise Mitigation Measures in Offshore Wind Farm Construction," prepared for the Federal Agency for Nature Conservation (BfN), July 2011, updated February 2013, https://www.cbd.int/doc/meetings/mar/mcbem-2014-01/other/mcbem-2014-01-submission-noise-mitigation-en.pdf.

12 D.W. Laist et al., "Collisions Between Ships and Whales," *Marine Mammal Science* 17, no. 1, (2001): 35-75, https://doi.org/10.1111/j.1748-7692.2001.tb00980.x. J. Hazel et al., "Vessel Speed Increases Collision Risk for the Green Turtle *Chelonia mydas*," *Endangered Species Research* 3, no. 2 (2007): 105-113, DOI: 10.3354/esr003105. National Oceanic and Atmospheric Administration, "Sea Turtles," February 2019, https://www.noaa.gov/education/resource-collections/marine-life-education-resources/sea-turtles (accessed Jun 6, 2019).

13 J. Hazel et al., "Vessel Speed Increases Collision Risk." P.B. Conn and G.K. Silber, "Vessel Speed Restrictions Reduce Risk of Collision-Related Mortality for North Atlantic Right Whales," *Ecosphere* 4, no. 4, (2013): 1-16, https://doi.org/10.1890/ES13-00004.1.

14 J. Willmott, G. Forcey, and A. Kent, *The Relative Vulnerability of Migratory Bird Species to Offshore Wind Energy Projects on the Atlantic Outer Continental Shelf: An Assessment Method and Database*, U.S. Department of the Interior, Bureau of Ocean Energy Management, August 2013, https://www.boem.gov/ESPIS/5/5319.pdf. E.A. Masden et al., "Barriers to Movement Impacts of Wind Farms on Migrating Birds," *ICES Journal of Marine Science* 66, no. 4 (May 2009): 746-753, https://doi.org/10.1093/icesjms/fsp031. B.M. Van Doren et al., "Autumn Morning Flights of Migrant Songbirds in the Northeastern United States Are Linked to Nocturnal Migration and Winds Aloft," *The Auk* 132, no. 1 (2014): 105-118, https://doi.org/10.1642/AUK-13-260.1. F.A. La Sorte et al., "The Role of Atmospheric Conditions in the Seasonal Dynamics of North American Migration Flyways," *Journal of Biogeography* 41, no. 9 (2014): 1685-1696, https://doi.org/10.1111/jbi.12328. R. Van Hal, A. Griffioen, and O. van Keeken, "Changes in Fish Communities on a Small Spatial Scale, an Effect of Increased Habitat Complexity by an Offshore Wind Farm," *Marine Environmental Research* 126 (2017): 26-36, DOI: 10.1016/j.marenvres.2017.01.009. J.M. Pereira et al., "Using a Multi-Model Ensemble Forecasting Approach to Identify Key Marine Protected Areas for Seabirds in the Portuguese Coast," *Ocean & Coastal Management* 153 (March 2018): 98-107, https://doi.org/10.1016/j.ocecoaman.2017.12.014. A. Conde and M. Prado, "Changes in Phytoplankton Vertical Distribution During an El Niño Event," *Ecological Indicators* 90 (2018): 201-205, https://doi.org/10.1016/j.ecolind.2018.03.015. B. Abrahms et al., "Climate Mediates the Success of Migration Strategies in a Marine Predator," *Ecology Letters* 21, no. 1 (2018): 63-71, https://doi.org/10.1111/ele.12871. A. Drewitt and R. Langston, "Assessing the Impacts of Wind Farms on Birds," *Ibis* 148, no. 1 (2006): 29-42, https://doi.org/10.1111/j.1474-919X.2006.00516.x. R. Furness, H. Wade, and E. Masden, "Assessing Vulnerability of Marine Bird Populations to Offshore Wind Farms," *Journal of Environmental Management* 119 (2013): 56-66, DOI: 10.1016/j.jenvman.2013.01.025.

15 J. Winkleman, *The Effect of the Sep Wind Park Near Oosterbierum, Friesland, the Netherlands on Birds*, DLO Institute for Forestry and Nature Research, Arnhem, 1992, Report no. RIN—92-2. A. Painter, B. Little, and S. Lawrence, *Continuation of Bird Studies at Blyth Harbour Wind Farm and the Implications for Offshore Wind Farms*, report by Border Wind Limited to the UK Department of Trade and Industry, 1999, ETSU report no. W/13/11485/00. W.P. Erickson et al., *Avian Collisions With Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States*, National Wind Coordinating Committee Resource Document, 2001, https://www.osti.gov/servlets/purl/822418. P.M. Cryan et al., "Behavior of Bats at Wind Turbines," *Proceedings of the National Academy of Sciences of the United States of America* 111, no. 42 (September 2014): 15126-15131, https://doi.org/10.1073/pnas.1406672111.

16 U.S. Fish and Wildlife Service, *U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines*, 2012, https://www.fws.gov/ecological-services/es-library/pdfs/WEG_final.pdf.

17 P.M. Cryan et al., "Behavior of Bats at Wind Turbines." E.B. Arnett et al., "Evaluating the Effectiveness of an Ultrasonic Acoustic Deterrent for Reducing Bat Fatalities at Wind Turbines," *PLoS ONE* 8, no. 6 (2013): e65794, https://doi.org/10.1371/journal.pone.0065794. E.B. Arnett et al., "Altering Turbine Speed Reduces Bat Mortality at Wind-Energy Facilities," *Frontiers in Ecology and the Environment* 9, no. 4 (2011): 209–214, https://doi.org/10.1890/100103. G.P. Marcos et al., "Dim Ultraviolet Light as a Means of Deterring Activity by the Hawaiian Hoary Bat *Lasiurus cinereus semotus*," *Endangered Species Research* 28, no. 3 (2015): 249-257, https://doi.org/10.3354/esr00694.

18 V. Krivtsov and B. Linfoot, "Disruption to Benthic Habitats by Moorings of Wave Energy Installations: A Modelling Case Study and Implications for Overall Ecosystem Functioning," *Ecological Modelling* 245 (2012): 121-124, doi:10.1016/j.ecolmodel.2012.02.025, http://tethys.pnnl.gov/publications/disruption-benthic-habitats-moorings-wave-energy-installations-modelling-case-study. S. Benjamins et al., *Understanding the Potential for Marine Megafauna Entanglement Risk From Marine Renewable Energy Developments*, Scottish Natural Heritage Commissioned Report No. 791, 2014, https://tethys.pnnl.gov/sites/default/files/publications/SNH-2014-Report791.pdf. A. Copping, M. Grear, and G. Sanders, "Risk of Whale Encounters With Offshore Renewable Energy Mooring Lines and Electrical Cables," presentation at the Environmental Interactions of Marine Renewables conference, 2018, Kirkwall, Orkney, Scotland.

19 A. Gill et al., *COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2: EMF Sensitive Fish Response to EM Emissions From Sub-sea Electricity Cables of the Type Used by the Offshore Renewable Energy Industry*, Centre for Environment Fisheries and Aquaculture Science, Centre for Intelligent Monitoring Systems, Centre for Marine and Coastal Studies Ltd., Cranfield University, and University of Liverpool, 2009, https://tethys.pnnl.gov/publications/cowrie-20-electromagnetic-fields-emf-phase-2-emf-sensitive-fish-response-em-emissions. K.J. Lohmann, P. Luschi, and G.C. Hays, "Goal Navigation and Island-Finding in Sea Turtles," *Journal of Experimental Marine Biology and Ecology* 356, no. 1-2 (2008): 83-95, doi: 10.1016/j.jembe.2007.12.017.

20 R.M. Pace III et al., "State-Space Mark-Recapture Estimates Reveal a Recent Decline in Abundance of North Atlantic Right Whales," *Ecology and Evolution* 7, no. 21 (2017): 8730-41, https://doi.org/10.1002/ece3.3406. P. Corkeron et al., "The Recovery of North Atlantic Right Whales, *Eubalaena glacialis*, Has Been Constrained by Human-Caused Mortality," *Royal Society Open Science* 5, no. 11 (2019), article 180892, https://doi.org/10.1098/rsos.180892.

21 *See* F. Kershaw, "Landmark Offshore Wind Agreement Protects Right Whales," NRDC, January 2019, https://www.nrdc.org/experts/francine-kershaw/landmark-offshore-wind-agreement-protects-right-whales (accessed June 9, 2019).

22 Conservation Law Foundation, National Wildlife Federation, and NRDC, "Best Management Practices for North Atlantic Right Whales During Offshore Wind Energy Construction and Operations Along the U.S. East Coast," March 2019, https://www.nrdc.org/resources/best-management-practices-north-atlantic-right-whales-during-offshore-wind-energy (accessed June 14, 2019).

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