# Adaptive Management for Wind and Wildlife Interactions

## ADAPTIVE MANAGEMENT

Adaptive management (AM) is a learning-based management approach that is used to reduce scientific uncertainty, and has been applied to many types of development including filling of wetlands and various forms of renewable energy. AM has been identified as a tool to advance the wind energy industry, although its application in practice has been limited. AM has primarily been actively implemented in the United States, while other nations have applied some of the principles of AM. Many wind energy projects use the mitigation hierarchy or the precautionary principle to guide development, both of which focus on mitigating or avoiding project-related risks or impacts. Overall, AM allows wind energy projects to adapt monitoring and mitigation over time, leading to improved decision-making. The WREN nations have developed a white paper on AM that explores how AM principles are used by the wind energy industry in several nations, and identifies ways the process and its implementation may be improved. See *https://tethys.pnnl.gov/about-wren and https://www.ieawind.org/task_34.html* for more information.

**AM IS DEFINED FOR THIS ANALYSIS AS:**

"Adaptive Management is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process" —NRC 2004; Williams et al. 2009

## BENEFITS AND CHALLENGES OF IMPLEMENTING AM

Considerable benefits can be gained from implementing AM for wind energy farms, including reducing scientific uncertainty and improving policies and practices for future development. Because AM is a flexible and adaptive process, it allows projects to move forward in the face of uncertainty by using hypothesis-driven data collection to learn from previous developments and improve implementation. By doing so, lessons learned can be applied to future wind energy developments. Implementing AM for wind energy has the potential to help advance the industry while reducing environmental effects.

The implementation of AM in wind energy development faces challenges, including a universal lack of legislation and regulations that require and define AM, as well as a lack of tools to assist with consistent implementation. Wind energy developers applying AM to their projects are faced with having to reconcile an adaptable and flexible AM process with one that might impact project financing and efficiency of the permitting process.

Efforts to prescribe mitigation measures and reduce financial uncertainty up front can be inflexible and potentially add substantial costs. On the other hand, it can be difficult to create an adaptive process, then curtail or alter operations, once power purchase contracts or agreements are signed. These alterations could lead to increased costs or loss of production. Most wind energy projects face the combined challenges of the cost of implementing AM, including ongoing costs for monitoring, and potential loss of revenue due to mitigation.

NRC (National Research Council). 2004. Adaptive Management for Water Resources Planning, The National Academies Press. Washington, D.C.

Williams, B.K., Szaro, R.C., Shapiro, C.D. 2009. Adaptive Management: The U.S. Department ofthe Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, D.C.

## AM PRINCIPLES AROUND THE WORLD

Most WREN member countries have no formal use, specific laws, or formal regulations for AM. However, natural resource legislation, regulations, and guidelines for wind energy project development in some member countries include explicit use of AM or application of AM principles. Examples include:

- The Candeeiros Wind Farm in central Portugal used an iterative approach to post-construction bird mortality monitoring. This resulted in identifying the common kestrel as the species most commonly killed at the wind farm, and the development of a site-specific mitigation program built around cultivation of nearby farmland, in cooperation with developers and regulators.
- The operator of the Smøla wind farm in Norway supported research and monitoring activities to test mitigation measures for white-tailed eagles, to decrease scientific uncertainty of potential impacts, and to measure the effectiveness of mitigation measures.
- Luchterduinen offshore wind farm in the Netherlands used AM principles to adjust monitoring for the wind farm. The Dutch government will apply AM principles in the consenting process for 10 new offshore wind farms.
- Wind farms located in the south of Spain are using biomonitors for raptor flight, allowing for real time shutdown of turbines to reduce blade collision. After two years, mortality has decreased by 50% with a small reduction in energy production.
- The Cape Wind offshore wind farm in the US used an AM approach and principles to address the uncertainty associated with the first proposed offshore wind farm in the US, and to ensure that the best available science and technologies were used to monitor and mitigate project impacts on the environment, including impacts to birds and bats.

## RECOMMENDATIONS

The WREN AM paper calls for the need to:

- Adopt a universal definition of AM that is coupled with an agreed-upon set of eligibility criteria and is consistent with the regulatory context in which it is being applied;
- Optimize the spatial and temporal scales over which AM is applied to reduce scientific uncertainty;
- Guide the application of AM by the need to minimize undue financial pressure on projects while ensuring that the natural resources of the nation or region are protected; and
- Establish formal processes and structures within national or regional regulatory bodies to make use of environmental impact data from existing projects to generate knowledge that can be applied to the planning and management of future projects.

AM is being applied at an individual project level, however, challenges associated with measuring change over the spatial and temporal scale for the resource of concern may limit the ability of an individual project to meaning- fully reduce scientific uncertainty and facilitate an iterative learning process.

To be most effective, the implementation of AM should also be considered at a larger spatial and temporal scale than individual projects, including collection and analyses of research data at the ecosystem scale with that of data collected at individual wind farms.

By improving AM for wind energy projects, scientific uncertainty can be reduced, and lessons learned can be applied to aid new wind energy development around the world.

You can find the full text of the Adaptive Management White Paper online on WREN Hub: *https://tethys.pnnl.gov/content/wren-adaptive-management-white-paper.*

Hanna, L.; Copping, A.; Geerlofs, S.; Feinberg, L.; Brown-Saracino, J.; Gilman, P.; Bennet, F.; May, R.; Köppel, J.; Bulling, L.; Gartman, V. (2016). Assessing Environmental Effects (WREN): Adaptive Management White Paper. Report by Bureau of Ocean Energy Management (BOEM), Marine Scotland Science, Norwegian Institute for Nature Research (NINA), Pacific Northwest National Laboratory (PNNL), Technische Universität Berlin, and US Department of Energy (DOE). pp 46.

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WREN
Working Together to Resolve Environmental Effects of Wind Energy

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