



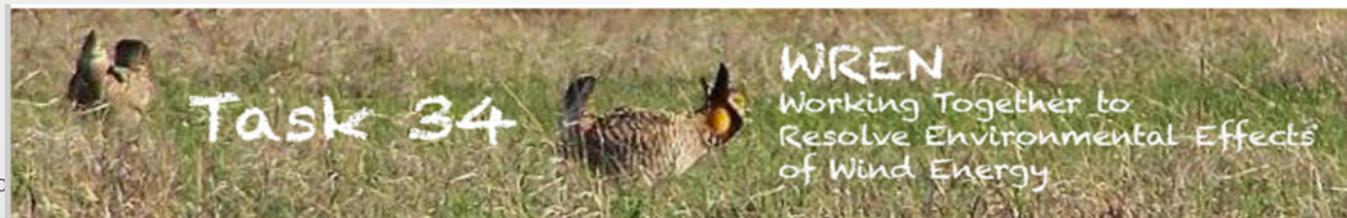
Pacific Northwest  
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# Managing Wind Farms – What is the Role of Adaptive Management?

**Andrea Copping**  
**Pacific Northwest National Laboratory**

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Broomfield CO



- ▶ Introduction to WREN white paper
- ▶ Value of AM in resolving wind and wildlife conflicts
- ▶ Application of AM in wind energy development in US
- ▶ Examples of AM principles in other WREN nations

## I want to thank my co-authors:

Luke Hanna  
Simon Geerlofs  
*Pacific Northwest National Laboratory*

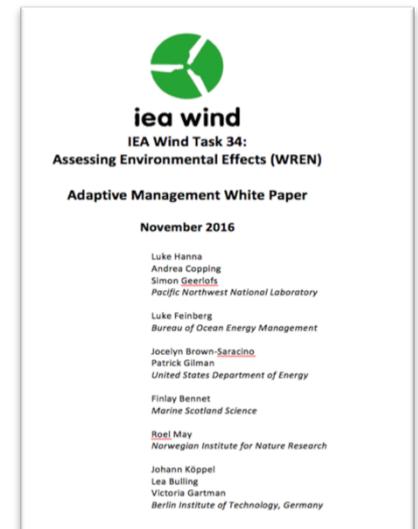
Finlay Bennet  
*Marine Scotland Science*

Luke Feinberg  
*Bureau of Ocean Energy Management*

Roel May  
*Norwegian Institute for Nature Research*

Jocelyn Brown-Saracino  
Patrick Gilman  
*United States Department of Energy*

Johann Köppel  
Lea Bulling  
Victoria Gartman  
*Berlin Institute of Technology, Germany*



# WREN – Working Together to Resolve Environmental Effects of Wind Energy - An International Collaborative Under IEA Wind

Karin Sinclair, *National Renewable Energy Laboratory*  
Andrea Copping, *Pacific Northwest National Laboratory*  
Jocelyn Brown-Saracino, *U.S. Department of Energy*



Credit: Bjørn Iuell, Statkraft. Smøla Wind Facility, Norway

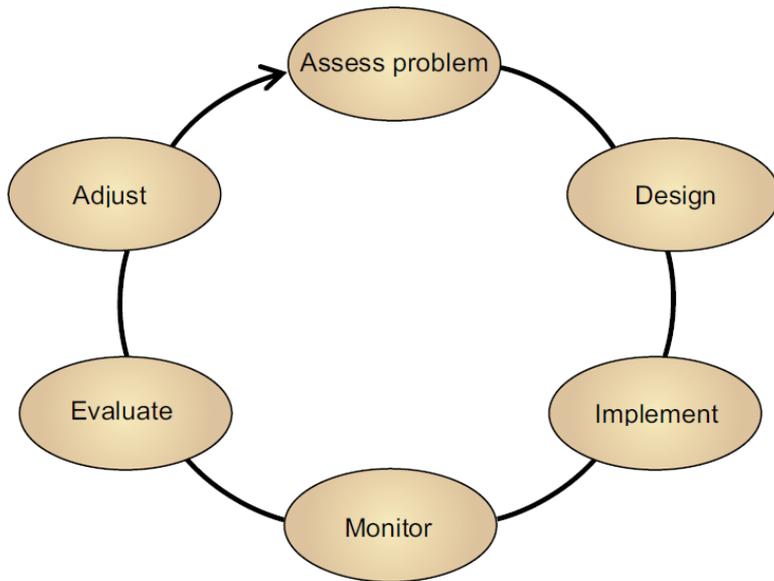
- Facilitate international understanding of environmental effects of offshore and land-based wind energy development
- Ten nations participating, led by US
- Develop white papers (adaptive management; individual to population effects...), short science summaries, webinars, etc.
- WREN Hub  
(<http://tethys.pnnl.gov/about-wren>)

# Wind and Wildlife Conflicts: Could AM Provide some Insight and Relief?

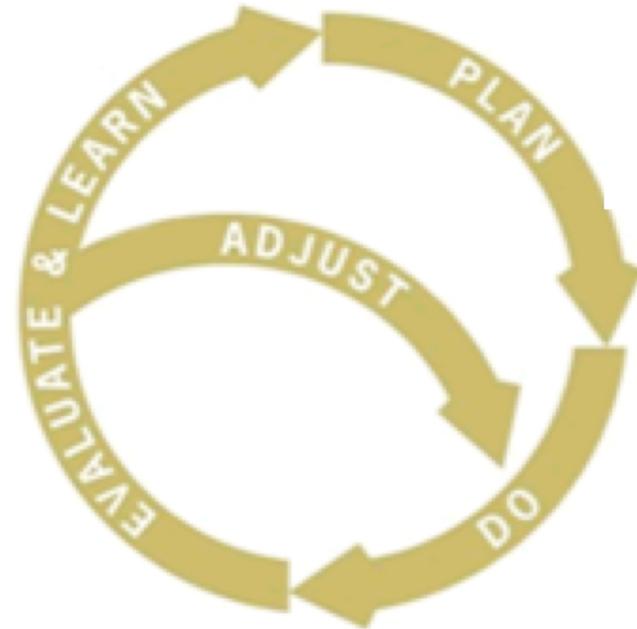
- ▶ Land-based and offshore wind face controversy: potential threats to birds and bats.
  - Siting of LBW increasingly difficult
  - OSW still at early stages of siting in many nations.
- ▶ Scale of threats do not match scale of wind farm.
- ▶ BUT permitting decisions made at single farm level.
  
- ▶ Definition of Adaptive Management
  
- ▶ Potential for Adaptive Management to help wind energy development
  
- ▶ US Dept of Interior Technical Guidance on AM as departure point.



# Adaptive Management Learning by Doing



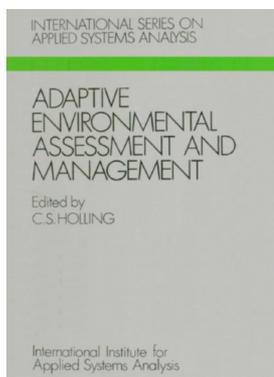
**Single Loop Learning:  
at wind farm scale**



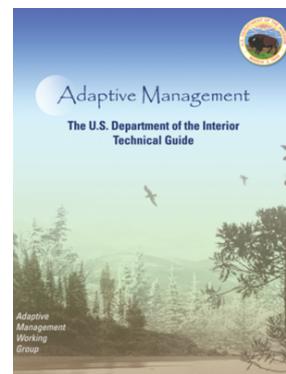
**Double Loop Learning:  
at larger scale**

# Necessary Elements of AM

- ▶ Investigations need to be hypothesis-driven
- ▶ Requires a need and possibility of decreasing scientific uncertainty
- ▶ The results must be sufficient to drive a predictive model
- ▶ Data collection must be nested in these principles to avoid DRIP outcomes
- ▶ Changes in management decisions must be possible
- ▶ These elements meet the requirements and needs of most land-based and offshore wind farms



Hollings et al. 1978. Adaptive Environmental Assessment and Management



Williams et al. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide.

# Adaptive Management in the US

- ▶ Few AM plans in use in the US: examined 16 plans
- ▶ Also, surveyed a dozen practitioners
- ▶ Most plans focus on federally protected species
  
- ▶ Variability among plans:
  - Lack of consensus about concept and practice
  - Limited implementation tools
  - Differing appetite for risk among wind developers
  - Differing opinions about:
    - AM in use at single farm level is not real AM
    - Needs to be hypothesis-based
    - Usefulness of AM due to its adaptability
  - Agreement that Financial risk associated with uncertainty is key concern for use of AM
  
- ▶ Mitigation measures vary:
  - Predetermined limits or boundaries versus
  - More flexible approach

# Information also sought from all WREN countries

- ▶ Limited legislation applicable to AM in most nations
- ▶ No formal regulations found in any of 9 WREN countries for use of AM for wind energy permitting
- ▶ However, several countries are using conceptual attributes of AM to regulate wind energy development
- ▶ US and UK are using AM concepts to regulate wind farms
- ▶ Some examples....



## WREN Nations

France	Spain
Ireland	Sweden
Netherlands	Switzerland
Norway	United Kingdom
Portugal	United States

# Examples of AM application - Portugal

- ▶ No formal AM
- ▶ Wind farm in central Portugal:
- ▶ Kestrel (*Falco tinnunculus*) most commonly killed species
- ▶ Monitoring program changed
- ▶ Developed site-specific mitigation program in cooperation with developers and regulators.



# Examples of AM application - Norway

- ▶ AM not implemented in Norway
- ▶ Statkraft supports research and monitoring at the Smøla wind farm
- ▶ Mitigation for white-tailed eagles (*Haliaeetus albicilla*) to decrease scientific uncertainty effectiveness of mitigation measures.



# Examples of AM application - Netherlands

- ▶ No formal use of AM in Netherlands
- ▶ AM principles used to adjust monitoring for offshore wind farm
- ▶ Resulted in:
  - Adding bat detectors
  - Modelling effects of pile driving on harbor porpoise (*Phocoena phocoena*)
  - Studies on piling noise on juvenile fish and larvae.
- ▶ Plan to apply AM principles to 10 offshore wind farms



# Examples of AM application - Germany

- ▶ No formal use of AM in Germany
- ▶ Wind farm in southwest Germany curtailed turbine operation to protect bats; curtailment methods adjusted after a year.
- ▶ Wind farm located in northern Germany shuts down turbines to mitigate for collision risk to red kites (*Milvus milvus*), focused on nearby cultivation



# Examples of AM application - Switzerland

- ▶ No formal requirement for AM
- ▶ High altitude wind farm cannot expand until bird and bat impacts better known
- ▶ Monitoring data used to set curtailment requirements, differ seasonally.
- ▶ Stakeholders determine curtailment needs and reassess the project operation periodically.



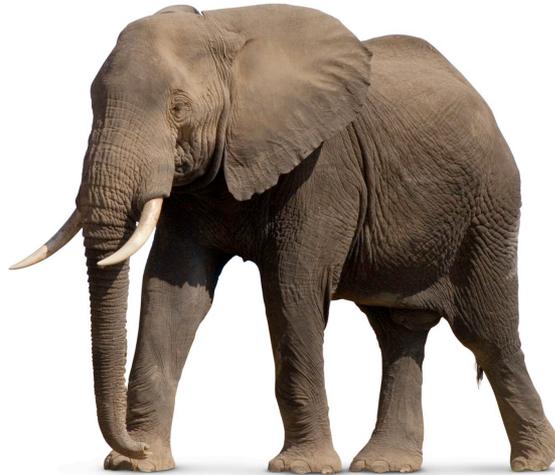
# Examples of AM application - Spain

- ▶ No formal implementation of AM
- ▶ Wind farms in southern Spain killing birds, including the Griffon vulture (*Gyps fulvus*)
- ▶ Monitor birds in flight, stop turbines, then restart after birds are gone.
- ▶ After 2 years, 50% decrease in bird mortality, 0.7% reduction in energy production.



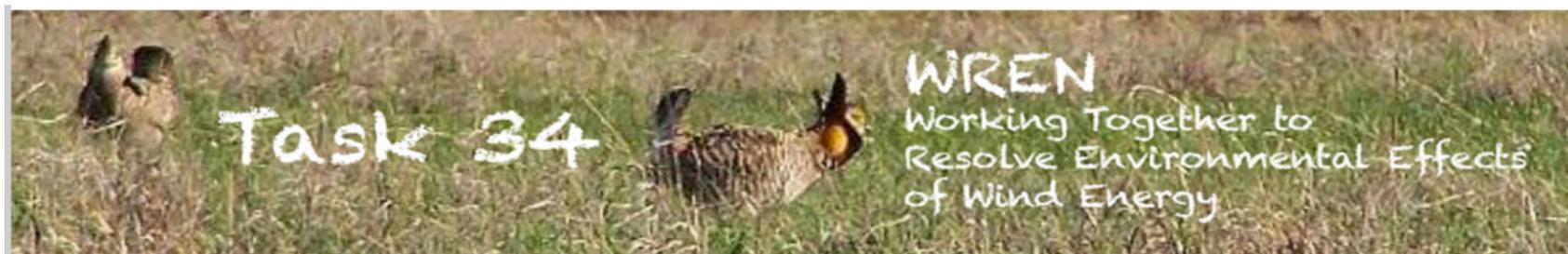
# How should we use AM to further wind energy development?

- ▶ AM most useful at scale larger than single wind farm
  - By pooling data over larger region, examine effects on migratory populations, over appropriate time scales
  - Opportunities to inform future siting and planning for wind farms within regions
- ▶ However, AM can still be useful to assist with management and changes to monitoring/mitigation at single wind farm scale



- ▶ Elephant in the room: who bears the financial burden?
  - Standardized collection of data at farms, for pooling
  - Investment by governments to collect wider scale data
  - Can't be burden on developers, on top of collision risk monitoring at farms

- ▶ Final WREN Adaptive Management white paper will be publically available for download in early December.
- ▶ Webinar on AM archived:  
<https://tethys.pnnl.gov/events/adaptive-management-wind-energy-industry>



# Thank you!

Andrea Copping  
Pacific Northwest National Laboratory  
[andrea.copping@pnnl.gov](mailto:andrea.copping@pnnl.gov)  
206.528.3049



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