

# 2009 ATEEC Fellows Institute



Instructional Activity

## Wind Turbine Siting: Wildlife Concerns



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## Wind Turbine Siting Considerations – Birds and Bats



The search for alternate sources of energy is heading in many different directions. One of the leading alternative energy sources available in the mid-west is wind energy. While this industry holds great promise for the future, it is not without its critics. Students who are studying the future of energy production will need to evaluate the positive and negative aspects of any project.

This material presents an investigation designed to give students the opportunity to struggle with the real life scenario of where to place a commercial scale wind farm for a small town and how to balance the pros and cons of such a project. Please check the teacher and student pages on this site for a ready to go class activity.

Image: 2009 ATEEC Fellow Roger Everhart photograph of the Iowa Lakes Community College wind turbine.

## Wind Power Wildlife Team



ATEEC Fellows Roger Everhart and Wendy Lawton work on this material.



### **Roger Everhart, School of Environmental (HS) Studies, Minnesota**

Roger currently teaches Environmental Science, AP Biology, Field Ornithology, and Marine Biology at his high school, which we like to refer to as the Minnesota Zoo school. He is a USFWS licensed bird bander, Envirothon Team coach, and a volunteer naturalist. Because Roger's school believes in travel experiences for all students, Roger has had opportunities to shepherd students to overseas study destinations. Roger's acclaimed high school is described on the [George Lucas Educational Foundation's Edutopia website](#).



### **Wendy Lawton, Pingree School, Massachusetts**

Wendy has been teaching courses like AP Environmental Science, Ecology, Oceanography, Anatomy, and Introductory Physical Science. She devotes significant lab time to field studies of campus ecosystems and water quality. She recently participated in courses and workshops on whale ecology and on Colorado River ecosystems. Wendy has sponsored student trips to the Big Island of Hawaii; to Florida where students swam with the Manatees in the Crystal River in Florida and snorkeled in the Florida Keys; and to New England to explore coastal tide pools, canoe on the Ipswich River, and participate in a whale watch.



## Student Wind Farm Activity

### Where Should We Build a Wind Farm? Impacts on the Local Environment

#### *Student Assignment Sheet*

The need to find sources of alternative energies for the future is a problem that will impact many different communities in many different environments. No solution is perfect. Every decision comes with a variety of impacts. Your team has been hired as a consulting firm that specializes in the evaluation of impacts on wildlife from large development projects, in this instance, a wind farm that will generate ½ of the power needed by the local community.

**Team Objective – Your team is to produce and present a suggested plan for the placement of a 100-turbine wind farm on a piece of land that is adjacent to your hometown. Your proposal will focus on the local natural environment and people living near the wind turbine farm so that there will be the least amount of negative impacts as possible while, at the same time, allowing the wind farm to be commercially viable.**

#### **Background Research on Siting a Wind Farm**

You will first need to determine the parameters that are used in the siting of wind farms for electrical production. You should be able to answer the question "What is the potential for commercial wind at your site?" The site that you are considering can be either land-based or offshore. If your location is not appropriate to wind development, what is the closest feasible location for a wind farm?

Your background research results should include a topographic map of the area including:

- meteorologic data of potential wind resources.
- locations of sensitive habitat that might be impacted
- locations of species of special concern that are found in the area
- known or possible migratory routes of wildlife
- human habitations in or near the proposed site

Some suggested resources to get you started are:

- [www.nrel.gov/wind](http://www.nrel.gov/wind)
- [www.windpoweringamerica.gov](http://www.windpoweringamerica.gov)
- [www.windenergy.com/documents/guides/0372\\_Siting\\_guide.pdf](http://www.windenergy.com/documents/guides/0372_Siting_guide.pdf)

## Research Wind Farm Impacts on A) Wildlife and B) Humans

In choosing a location for your wind farm you should consider the following factors:

- Habitat that is to be developed
- Local wildlife species present and breeding in the area
- Species that potentially migrate through this area
- Species of special concern that might be present (endangered species etc.).
- Proximity to human habitation



Photo by Roger Everhart

**A) Impacts on Wildlife:** Human manipulation of the environment has not traditionally put potential impacts on wildlife as a high priority for consideration. In the development of wind farm projects, people are becoming more concerned about the impacts of these facilities on animals such as birds and bats. Because native wildlife populations might be involved, state and federal wildlife laws become a factor in your decision.

In areas where wind resources and wildlife resources overlap the following can be used as indicators of high-risk situations:

- Bird/bat use of area
- Bird/bat abundance in the area
- Species vulnerability to development
- Topography of area that brings birds/bats in close proximity to the development
- Potential for habitat fragmentation

Sources of information to assess potential high-risk situations can include:

- State wildlife agencies (e.g. Department of Natural Resources, U.S. Fish and Wildlife Service)
- State Ornithological Organizations (e.g. Minnesota Ornithologists Union, [www.mou.org](http://www.mou.org))
- Local Audubon Societies (e.g. Mass. Audubon Society)
- Conservation Organizations –
  - Bat Conservation International - [www.batcon.org](http://www.batcon.org)
  - Bats interacting with wind turbines - <http://www.bu.edu/cecb/wind/video/>
  - National Geographic (barotrauma) – <http://news.nationalgeographic.com/news/2008/08/080825-bat-bends.html>
  - American Bird Conservancy - [www.abcbirds.org](http://www.abcbirds.org)
- Focus on Energy
  - [http://www.focusonenergy.com/files/Document\\_Management\\_System/Renewables/windturbinesandbirds\\_factsheet.pdf](http://www.focusonenergy.com/files/Document_Management_System/Renewables/windturbinesandbirds_factsheet.pdf)
  - National Wind Coordinating Committee - [http://www.nationalwind.org/publications/wildlife/wildlife\\_factsheet.pdf](http://www.nationalwind.org/publications/wildlife/wildlife_factsheet.pdf)
  - Wildlife Interactions Research Meeting V - <http://www.nationalwind.org/events/wildlife/2004-2/presentations.htm>
  - USGS – Fort Collins Science Center – <http://www.fort.usgs.gov/BatsWindmills/>

Monitoring equipment to detect bats and birds – <http://www.detect-inc.com/avian.html#wind>

- Wildlife Protection Laws - Federal and local wildlife laws may need to be considered when developing any large construction project. You will need to be familiar with:  
Migratory Bird Treaty Act  
Bald and Golden Eagle Protection Act  
Endangered Species Act

**B) Impacts on Humans:** Little is understood about the impacts of wind farms on human health for those living near commercial wind developments. Potential issues include “flicker effect” which results from turbine shadows and “wind turbine syndrome,” the supposed effect of low frequency sounds produced by the movement of the turbine blades. Placement of your wind farm must address potential human impacts.

Sources of information include:

- [www.windturbinesyndrome.com/?p=100](http://www.windturbinesyndrome.com/?p=100)
- <http://www.noblepower.com/faqs/documents/06-08-23NEP-ShadowFlicker-FS4-G.pdf>
- <http://www.windpower.org/en/tour/env/shadow/index.htm>
- <http://www.wind-watch.org/videos.php>

## Individual Student Activities

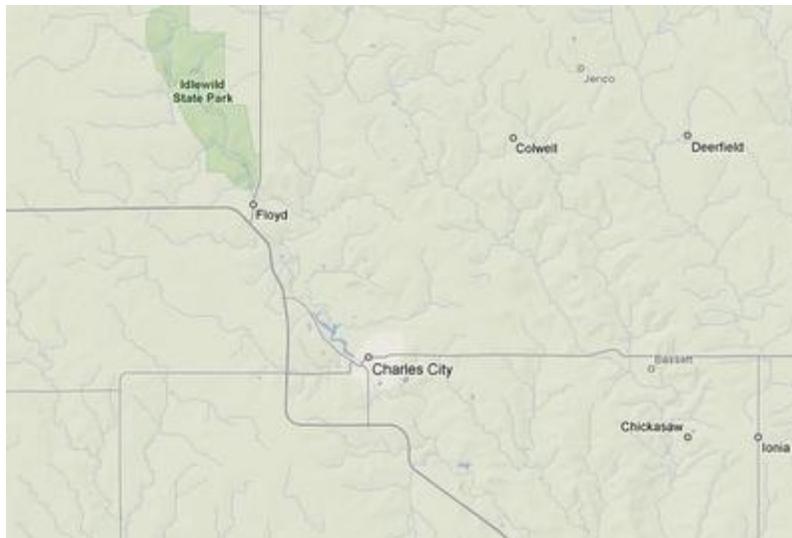


Figure #1. Example of one type of map that can be used to site a wind farm.  
(Source – Googlemaps)

**Team Tasks** – Each student on the siting team will be responsible for obtaining and synthesizing a part of the information that will be used by the team to suggest a location for a 100 turbine wind farm. Each task should include a list of keywords and definitions relevant to the research. The team must come to a consensus final decision.

- **Student Task #1** – Produce a map that shows all major ecological and human features that may be pertinent to the placement of wind turbines.



- **Student Task #2** – Describe all factors that could have a potential impact on native wildlife at this site. Include information on nesting habitat, migratory routes of animals, species of special concern (endangered or threatened species, etc.).
- **Student Task #3** – Describe potential impacts on humans living in proximity to the wind farm. Consider issues such as shadow flicker, “wind turbine syndrome” and the physiological effects of noise.
- **Student Task #4** – Describe regulatory agencies and other stakeholders who have an interest in wildlife and environmental impacts of development projects. Include those agencies that must approve the proposal for your project.

## Final Presentation Product

A variety of possible presentation formats can be used by the group to summarize this investigation. Possible formats for this final product are:

- PowerPoint presentation
- Poster presentation
- Presentation/Discussion with other students
- Presentation to outside experts
- GIS produced maps with supporting documents
- Formal written position paper



## Teacher Background and Resources for Student Activity

### Wind Farm Siting Concerns – Impacts on the Local Environment

#### *Teacher Resource Page*

#### **Introduction**

Wind power as an alternative energy source is expected to provide 20% of the energy needs for the United States. Some of the states offering the greatest potential for development of utility scale wind resources include: Texas, Iowa, Nebraska, South Dakota and California. Although many physical and economic criteria are considered in the siting of a wind farm (such as average wind speed, wind direction, proximity to power grid, infrastructure and land use), feasibility studies should also include the potential impacts on the environment. Of special concern for both land-based and off-shore wind farms is the impact on wildlife and on human health. This activity provides a framework for student groups to research a particular aspect of environmental impact, share their knowledge with classmates and participate in a class analysis and discussion culminating in a recommendation for wind farm siting in the chosen area. Consider applications for both land-based and off-shore installations.

#### **Key facts**

The preferred siting of wind farms is limited to open areas with high average wind speeds and removed from high concentrations of breeding, roosting or migrating populations of birds and bats. Impacts of wind turbines on birds and bats is not limited to collisions but also includes displacement due to disturbing wildlife during both construction and operation of wind farms. In the case of bats, significant mortality is attributed to barotrauma or hemorrhaging due to bats becoming trapped in low pressure vortices. Density of turbine placement and orientation in relation to migratory flight path and altitude is important as well as the impact of a wind farm on use of natural areas downwind of the farm. Proximity to feeding, roosting and nesting grounds are important to consider. There may also be fragmentation or loss of habitat due to access and communication corridors in addition to turbine footprint and scour effect with offshore installations.

Human health impacts are largely centered on the sensitivity of individuals to noise and shadow flicker (visual disruption of light due to the shadow cast by the rotating blades) along with a range of disturbances causing physiologic disturbances under the umbrella of “wind turbine syndrome.” Some groups are more likely to be affected than others due to age and special pre-existing conditions (such as children afflicted with autism with heightened sensitivity to noise). Sleep disturbances are the most common identifiable complaint.



## Activity

This activity is intended to be one component of a larger unit on wind power and assumes exposure to the fundamentals of wind farm siting and energy output. Background information could be obtained through text and/or article readings, class discussion or audio visual presentation. *The set of Google Groups developed by the 2009 ATEEC Fellows offer a foundation for understanding various topics related to wind power.*

This is an excellent opportunity to employ cooperative learning strategies. (For example, if you or your school is involved with a particular methodology for structuring cooperative learning, such as that of Dr. Spencer Kagan, then such a method may be applied.) Group work is most effective when each student has a specific responsibility, task or role. Requirements for class presentation can be geared to the technology available and preferences of the students. (Ex: PowerPoint presentation, oral presentation with visual aids, etc.)

### Suggested materials and resources:

- Introductory video on wind farms  
Check internet sites such as Youtube, PBS.org, History.com, National Geographic and search engines such as Google video. Video resources are included in the Virtual Field Trip area of this 2009 ATEEC Fellows Institute project.
- Topographic maps of the area under consideration.  
Google Earth or NASA's World Wind are available for free download by students and educators
- State and federal agency websites and fact sheets
- National Weather Service and NOAA websites
- Local utilities and alternative energy industries
- County or town zoning offices for local ordinances
- Access to SmartBoard or projection equipment for sharing of PowerPoint presentations.
- Links provided within the student guidelines provide a starting point for student investigation. Students should explore additional current resources.

### Goals:

- Students will work cooperatively to explore locations in their state that offer potential utility-scale wind farm development and specifically the impact of such an installation on resident and migrant wildlife and human health.
- Students will explore a variety of current resources to gather the most recent information available.
- Students will become familiar with legislation offering protection to endangered species and species of special concern.
- Students will become familiar with state or local ordinances that pertain to wind power installations.
- Students will identify ecologically sensitive habitats and potentially impacted species in the area and assess the level of risk.
- Students will learn about the anatomical and physiological characteristics that put a species or individuals at greater risk of harm.



- Students will expand their vocabulary to include key terms relating to wind power technology and its potential impacts.
- Students will utilize technology in their presentation of information.
- Students will analyze all information presented and generate a formal recommendation. The recommendation may also include mitigation actions to minimize negative impacts of the proposed wind farm.

## Web Resources

### Kutztown University, Pennsylvania, Wildlife and Wind Energy Conference Presentations, 2006

- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Webb&Boone2.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Webb&Boone2.pdf)  
Pending Appalachian Wind Energy Development
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Cohn2.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Cohn2.pdf)  
Ethics, Wildlife, and Potential Siting of Utility-Scale Wind Energy Facilities On Appalachian Ridges
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Glitzenstein.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Glitzenstein.pdf)  
Federal Wildlife Laws And Wind Power
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Manville.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Manville.pdf)  
Using Pre-, During- and Post-construction Monitoring to Assess Risk at Mountain Wind Development Sites
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Mangan2.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Mangan2.pdf)  
Wind Energy and Site Evaluation in Pennsylvania
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Riposo.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Riposo.pdf)  
Costs and Benefits of Wind Energy Toward a Sustainable Energy Future for the Mid-Atlantic
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Boone\\_Claimed%20Benefits.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Boone_Claimed%20Benefits.pdf)  
An Evaluation of Claimed Benefits From Industrial Wind Energy Development of the Appalachian Region: *What We Get in Exchange for Environmental Harm*
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Heintzelman.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Heintzelman.pdf)  
From Hawk Shooting to DDT to Wind Turbines: Historic Raptor Perspectives in Siting Utility-Scale Wind Energy Facilities of Pennsylvania's Appalachian Ridges
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Kunz.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Kunz.pdf)  
Methods of Assessing Presence and Activity of Birds and Bats and Wind Energy Facilities
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Gannon.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Gannon.pdf)  
The Current Status of Bat Surveys In Pre- and Post-Wind Farm Construction: What Do They Tell Us?



- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Peterson&Lambert.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Peterson&Lambert.pdf)  
Bat Studies in Highland County, Virginia and Pendleton County, West Virginia
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Evans2.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Evans2.pdf)  
Monitoring Avian Nocturnal Migration Activity Using Radar and Acoustic Methods
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Boone\\_GIS.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Boone_GIS.pdf)  
Using GIS Technology to Evaluate Forest Habitat and Public Land Impacts of Wind Energy Development
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Jackson2.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Jackson2.pdf)  
A Case Study of Save Our Allegheny Ridges (SOAR): Citizen Involvement in Potential Siting of Proposed Utility-Scale Wind Energy Facilities on Forested Ridges in Bedford County, Pennsylvania
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Gregory.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Gregory.pdf)  
The Media and Wind Power
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Linowes2.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Linowes2.pdf)  
The WindAction.org Website and Its National Role
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Capouillez.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Capouillez.pdf)  
Commercial Wind Development on Pennsylvania State Game Lands Review Guidelines
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Zadnik.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Zadnik.pdf)  
Virginia's Experience with Industrial Wind Development
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Fry.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Fry.pdf)  
Avoiding and Mitigating Wind-turbine Mortality and Habitat Loss
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/Bildstein.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/Bildstein.pdf)  
Raptors and Wind Energy: The View from Hawk Mountain
- [http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker\\_Presentations/GAO\\_execsum.pdf](http://www.kutztown.edu/acad/geography/wildlife&windconf/Speaker_Presentations/GAO_execsum.pdf)  
Wind Power: Impacts on Wildlife and Government Responsibilities for Regulating Development and Protecting Wildlife

#### **Penn State Personal Web Server**

(Provides web services in a unified place for PSU departments, organizations, faculty, general student population)

- <http://www.personal.psu.edu/faculty/m/r/mrg5/Sciamer2-04.pdf>  
When Blade Meets Bat: Unexpected Bat Kills Threaten Future Wind Farms

#### **Nonprofit Groups, Pennsylvania**



- [http://pa.audubon.org/news\\_20060119.html](http://pa.audubon.org/news_20060119.html)  
The Audubon Society: Ridgetop Important Bird Areas, Raptors, and Wind Turbines
- <http://www.abcbirds.org/newsandreports/stories/090612.html>  
American Bird Conservancy: Progress on Protecting Birds from Wind Turbine Collisions
- <http://www.abcbirds.org/abcprograms/policy/wind/>  
American Bird Conservancy Wind Program
- [http://www.lgnc.org/Press%20Releases/Res\[1\].%202006-1A.pdf](http://www.lgnc.org/Press%20Releases/Res[1].%202006-1A.pdf)  
The Lehigh Gap Nature Center (non-profit) Board of Directors Resolution

#### **Virginia Wind (Site Developed by Several Private Citizens)**

- <http://www.vawind.org/>  
Wind Damage: American Bird Conservancy Calls for Provisions to Minimize Bird and Bat Kills by Wind Turbines in Renewal of the Production Tax Credit
- [http://www.vawind.org/Assets/Docs/Brandes\\_WindpowerandRaptors.pdf](http://www.vawind.org/Assets/Docs/Brandes_WindpowerandRaptors.pdf)  
Windpower and Migrating Raptors: An Unresolved Issue
- <http://www.vawind.org/Assets/Docs/Battered.pdf>  
Battered by Harsh Winds: Must bats pay the price for wind energy?
- <http://www.vawind.org/Assets/Docs/Key%20Issues%2001-06-06.pdf>  
Impacts of Wind Energy Development on Wildlife: Key Issues of Concern

#### **Government Sites**

- <http://www.fws.gov/habitatconservation/wind.html>  
The Fish and Wildlife Service and Wind Energy Development
- [http://www.pwrc.usgs.gov/research/scimtg/2006/posters/Dawson%20poster\\_sm06.dkd.pdf](http://www.pwrc.usgs.gov/research/scimtg/2006/posters/Dawson%20poster_sm06.dkd.pdf)  
U.S. Geological Survey: Assessing Patterns of Nocturnal Bird Migration Through the Appalachian Region