WindWise Education

Wind Energy Activities for Students

LESSON 13: WHAT IS WIND POWER'S RISK TO BIRDS

WindWise Education Curriculum

ISBN 978-1-4951-4354-0

LESSON 13

WHAT IS WIND POWER'S RISK TO BIRDS?

KEY CONCEPT

Learn how bird behavior and ecology are related to avian impacts from wind turbines and how scientists study these impacts.

TIME REQUIRED

1–2 class periods

GRADES

6–8
9–12

SUBJECTS

Technology
Mathematics
Living Environments

BACKGROUND

A common question when discussing wind energy is, "Will the turbines kill birds?" Scientists called ornithologists study this issue to provide information on whether or not, and to what degree, birds may be impacted by turbines. This lesson teaches students about bird behavior and ecology, after which they will use data to perform an avian risk assessment at a potential wind farm site.

OBJECTIVES

At the end of the lesson, students will:

- know about some avian behaviors such as feeding, migrating, and nesting
- be able to collect, evaluate, and use data from a variety of sources
- understand how birds can be impacted by turbines

METHOD

Students will play the role of ornithologists studying potential impacts to birds at the proposed Chautauqua wind farm in New York. They will read about how birds can be impacted by wind turbines and then answer questions based on reading passages. They will then use the information from the reading passages, along with data on birds and wind farms, to determine potential risk to raptors (birds of prey such as hawks and eagles) at the proposed wind farm site.

MATERIALS

- ❑ Student reading passages and student worksheets*
- ❑ Calculators

*included with activity

Additional Resources for every lesson can be found at http://learn.kidwind.org/windwise/. Resources include presentations, videos, extension activities, and other materials.

KidWind PROJECT®

www.KidWind.org

GETTING READY

Make copies of the activity reading passages and student worksheets.

ACTIVITY

Step 1: Beginning questions for students

If students have not discussed wind energy and wildlife before, begin the class by asking students what they know about it:

- Have you ever seen a wind farm?
- What have you heard about wildlife and wind turbines?
- Do you think turbines are very dangerous to birds? Why?
- What do you think birds are doing when they collide with turbines?

This may bring up a wide range of thoughts and preconceptions about wind energy. Continue the discussion by asking students how they think a scientist might conduct studies to determine the potential impacts to birds at proposed wind farm sites.

- How can scientists find out what types of birds may be in an area where they want to build wind turbines?

  Scientists can observe birds at the site, look at published information on birds found in that location, and look at maps with information on bird locations, and knowledge of the habitat of local bird species. Special radar systems can also be used to see where birds are flying at a particular site, even at night.

- What would you want to know if you were studying birds at a wind farm?

  Information would include the type of birds, how high they fly, whether or not they fly in the area of the turbines, whether the species avoids areas containing wind turbines, whether the species' vulnerability to impacts from wind farms has been demonstrated at other existing facilities etc.

Step 2: Initial research

If time and resources allow, ask students to conduct their own online research by typing "birds and wind turbines" into a search engine. This will produce a wide variety of information from pro-wind and anti-wind energy groups as well as scientific papers. Have a brief discussion about what students find.

Step 3: Learning about birds and turbines

Tell students to read the first reading passage, "Birds and Turbines," and then answer the Step 1 questions on the student worksheet. Students can be divided into small groups, if you like.

Step 4: Learning about risk assessment

Ask students to read the second reading passage, "Project and Avian Risk Assessment Overview," and then answer the corresponding questions on the student worksheet. Part of this exercise will require the students to calculate the potential mortality (deaths) to raptor species at the proposed wind farm site.

Students will finish the activity by answering the Step 2 questions requiring them to apply what they have learned and consider what the risk assessment results really mean for raptors at the proposed Chautauqua wind farm site.

Step 5: Wrap up
At the end of the lesson, discuss how developers, communities, and policymakers could balance the potential wildlife impacts with the desire for developing wind energy. Consider posing the following questions:

- When would bird mortality be one of the most important issues in siting a wind farm?

  Bird mortality would be an important issue when a threatened or endangered species is involved, when a wind farm is near environmentally sensitive areas such as national parks or local bird refuges, when the potential wind farm site is in the migratory path of birds, and when there is a large amount of community concern about potential impacts to birds. For example, the endangered whooping crane migrates along the path where there is the greatest potential for wind energy.
- How would a developer monitor the site after the wind farm is built to document and report any bird issues?

  Researchers conduct surveys of dead birds, called carcass surveys, to determine if birds are being killed and, if so, what kind. Researchers can also determine if birds are being displaced, or not using the site as they normally would.
- How do you think developers, scientists, and policymakers should balance the desire for wind energy with potential impacts to wildlife?

  They should consider populations of animals, not just individuals, and the costs and benefits of all types of energy production.

EXTENSION

In this section, students come up with ideas for wind turbine designs that will minimize potential impacts to birds. They will look online for a wide variety of wind turbine designs and consider power production along with wildlife impacts. Turbines have been designed in many ways in order to increase power production and decrease wildlife impacts.

VOCABULARY

migrate – Movement of animals from one location to another, often across very long distances, in search of food, water, and breeding opportunities.

mortality – The number of animals killed.

ornithologist – A scientist who studies birds.

raptors – A category of birds that includes all vultures, hawks, falcons, kites, harriers, and eagles. They are often called "birds of prey."

risk (to wildlife) – The probability that loss or other adverse effects will occur to wildlife.

rotor swept zone (RSZ) – The airspace covered by the turning of turbine blades.

siting – The process used to determine the specific location of a wind energy facility and its turbines.

utilization – The total number of birds flying in the space where wind turbines are spinning at a wind farm.

utilization rate – The number of birds per unit of time (hour) in the space where turbines are spinning at a wind farm.

RELATED ACTIVITIES

- Lesson 12: How Does Energy Affect Wildlife?
- Lesson 14: Can We Reduce Risk to Bats?
- Lesson 15: How Do People Feel About Wind?

READING PASSAGE 1: BIRDS AND TURBINES

A common question when discussing wind energy is, "Will the turbines kill birds?" Many people have heard accounts of birds being hit and killed by wind turbine blades. However, most research shows that wind turbines kill relatively few birds, at least compared with other human-made structures.

Table 1. Number of estimated annual bird deaths from human causes.

HUMAN CAUSE	ASSOCIATED BIRD DEATHS PER YEAR (US)
Cats	Hundreds of millions
Power lines	130 million to 174 million
Windows (residential and commercial)	100 million to 1 billion
Pesticides	70 million
Automobiles	60 million to 80 million
Lighted communication towers	40 million to 50 million
Wind turbines	10,000 to 40,000

It has been estimated that from 100 million to well over 1 billion birds are killed annually in the US due to collisions with human-made structures, including vehicles, buildings and windows, power lines, communication towers, and wind turbines. Recent US studies indicate that bird mortality at wind turbine projects varies from less than one bird per turbine per year to 7.5 birds per turbine per year, with an average of 4.72 birds per turbine per year. This means that between 10,000 and 80,000 birds may be killed each year at wind farms across the country; less than 1 percent of these are thought to be raptors (birds of prey). This is important because many species of raptors are threatened or endangered.

Although some birds are struck by turbine blades, turbine strikes are a very small risk to birds in general and are only a minor contributor (less than 1 percent) to bird fatalities caused by humans. Nevertheless, avian impacts from turbines are a concern for developers, scientists, and regulators.

Raptors (such as hawks, eagles, and vultures) are often studied at potential wind farms because they are at the top of the food chain and have naturally smaller populations than other more common species. (In addition, some raptors, such as eagles, are protected by law.) Top predators concentrate a lot of the biological processes of the ecosystem in a relatively small number of individuals. Thus removing "x" number of individuals from the population of a top predator can have more of an overall impact on the population and the ecosystem than would removing the same "x" number of individuals from a species at the bottom of the food chain that has a much larger population. For example, both grass and lions are important parts of the Serengeti ecosystem, but taking out 100 lions would have a much bigger impact than would taking out 100 grass plants.

Research has shown that birds can be impacted by wind energy production in three major ways: collisions, avoidance, and direct habitat impacts.

Collisions

Collisions with turbine blades, towers, power lines, or with other related structures are the most recognized impact from turbines. These collisions happen when birds are flying in the vicinity of the structures. Scientists observing birds have found that there are several behavioral factors that contribute to bird collisions with structures at wind farms.

Migration: Bird species that do not live in one place for the entire year are called migratory birds. Migratory birds travel from one location to another, or migrate, in the spring and fall. Some of these migrations can be over very long distances, and birds need to conserve as much energy as possible when they fly. One way birds save energy during migration is by traveling on air currents. Air currents are moving streams of air. Birds use these streams of air to help move them over their long migration route. Migrating birds come into conflict with turbines when their migration paths take them through wind farms, since wind turbines are placed to take advantage of the high-volume air currents, often on high ridges and hilltops.

Feeding: When birds are going after prey such as an insect, small mammal, or another bird, they are very focused on that prey and may not see dangers around them, such as spinning turbines.

Breeding: Some bird species spend most of their time low to the ground (and out of potential harm from turbine blades) until breeding season begins. Then these birds put on a display for prospective mates, during which they jump and fly into the air. These breeding behaviors may put some birds at risk from a turbine strike.

Roosting and Nesting: All energy sources (such as wind, coal, oil, natural gas, nuclear, and hydroelectric) use the power grid to move energy from where it is generated to your home or school. This grid consists of power lines that most often run above ground. Power lines can cause bird injury and death from collisions and electrocutions. When birds roost or nest on power line structures, they are at increased risk. For example, when a bird stretches its wings and touches two energized parts of the structure, it can be electrocuted by the powerful electrical current.

Avoidance

Some birds will only nest and feed in open areas with little vegetation. For such species, areas containing tall objects may be perceived as too dangerous to inhabit, as the tall objects represent places where predators could be hiding. These birds will only live in areas with low-lying vegetation and will refuse to nest or feed in an area if a tall object (such as a tree, building, or turbine) is present.

Direct habitat impacts

Wind farms can have direct impacts on bird habitat. Building and installing turbines and related support structures such as roads, power lines, and buildings can disturb bird habitat. All energy types create this impact. Comparatively, a wind turbine has a very small footprint (the space that each turbine, as well as associated roads and buildings, takes up), so habitat impacts from the turbines are minimal.

READING PASSAGE 2: PROJECT OVERVIEW AND AVIAN RISK ASSESSMENT

Chautauqua Wind Farm proposed site information

In 2003, Chautauqua Windpower LLC proposed to install and operate an approximately 50 megawatt (MW) wind energy facility in the towns of Ripley and Westfield in Chautauqua County, New York. The facility would consist of up to 34 wind turbines, an electrical substation, and power line interconnection to an existing 230 kilovolt transmission line. All of this was planned for a 3-square-mile area.

Turbines

The project proposed 34 turbines. These turbines would have a maximum blade height of approximately 398 feet (121 meters) and a rotor diameter of approximately 253 feet (77 meters) (Figure 1). Each turbine would have a maximum generating capacity of approximately 1.65 MW. With 34 turbines, this is enough to power over 13,000 homes.

Avian Risk Assessment

As part of the planning for the wind farm, in compliance with state and federal standards, an avian risk assessment (ARA) was conducted to address the project's potential impact on birds. An ARA is used to determine which bird species are present at a potential wind site and what risk the turbines may pose to those species. This ARA was conducted using several data sources, including bird observations, background information on the wind site, radar, and past studies and research.

The ARA used a "Utilization, Avoidance, Mortality" (UAM) method to calculate potential impacts to birds at the Chautauqua site. Of specific concern were raptors because raptor mortality (death) has been recorded at other wind farms.

The UAM method of conducting an ARA looks at the presence of birds, characteristics of bird behavior, and mortality studies at similar locations to determine the likelihood of a bird being killed by a turbine. There are three steps in a UAM ARA analysis:

1. Determine Utilization
2. Determine Avoidance
3. Determine Potential Mortality

Determine Utilization (U)

Utilization is the number of birds that fly through the project area in a given period of time (a year, in this case). Avian researchers conduct visual counts in various locations over a period of days to get an idea of how many raptors are present. They do this by searching the sky for several hours at a designated study area and writing down the number of birds seen, how high they were flying, and what direction they were going. In addition to visual counts, the Chautauqua site had information on birds from radar data that was collected as well. By combining this information, researchers were able to get an average number of birds that accessed the study area over a period of a year (Table 2).

Researchers estimated that they were able to "sample" or conduct their observations on 16 percent of the potential wind farm site. Researchers feel very confident that the bird species and abundance (numbers of birds seen) shown in Table 2 are a good representative sample of the whole Chautauqua site.

Table 2: Raptors observed accessing the study area during 1 year

SPECIES	NUMBER*
Black Vulture	<1
Turkey Vulture	4,850
Osprey	151
Mississippi Kite	<1
Bald Eagle (T, US-T)	33
Northern Harrier (T)	179
Sharp-shinned Hawk (SC)	1,327
Cooper's Hawk (SC)	59
Northern Goshawk (SC)	6
Red-shouldered Hawk (SC)	292
Broad-winged Hawk	7,055
Red-tailed Hawk	1,341
Rough-legged Hawk	33
Golden Eagle (E)	6
American Kestrel	280
Merlin	17
Peregrine Falcon (E)	14
Gyrfalcon	<1
Unidentified Raptor	123
Total	15,766*

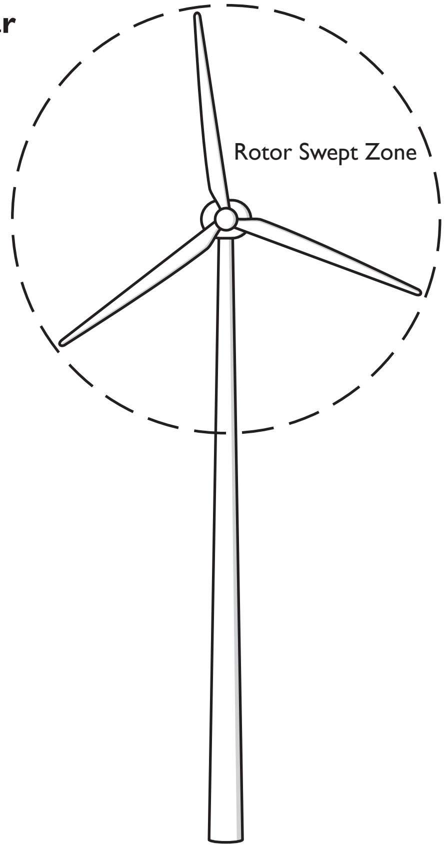

Figure 1: Rotor Swept Zone

*Sampling was conducted for 16% of the total project site. This number represents only 16% of total raptors at the site.

Note: State-listed species designated as E= Endangered, T= Threatened, and SC= Special Concern. Federally listed species designated as US-T= Federally Threatened

Determine Avoidance (A)

Research has documented and established that most birds using the area within the RSZ (see Fig. 1) do not collide with wind turbines. Overall, there is a low probability of a bird collision with a wind turbine. A very high percentage of birds also actively avoid wind turbines by flying over individual turbines, flying around or in between individual turbines, or passing through rotating turbines unharmed. For birds using a wind farm, estimates of avoidance are more than 98 percent (i.e., less than 2 percent of birds are hit and die).

Avoidance rate is calculated using data from similar wind energy facilities. This method uses data collected on number of birds present and number of birds killed at these facilities and is the ratio of fatality rate to passage rate (number of fatalities to number of birds) in the RSZ. The avoidance (A) factor for Chautauqua was determined to be .042 percent.

Determine Potential Mortality (M)

Potential mortality is assessed by multiplying site utilization (U) by the avoidance factor (A). The result equals the approximate number of birds that may be killed by turbines at the wind farm in a year. To calculate the number of birds each turbine may kill, divide overall site mortality (M) by the number of turbines.

Name______________________________ Date_____________ Class________

When a wind farm is being planned, scientists called ornithologists are often hired to assess the location for potential impacts to birds. They look at a variety of factors, from types of birds present to behaviors that might indicate which birds would be affected by the turbines. The scientists complete an analysis of which birds may be impacted, why they may be impacted, and how many may be impacted. They then report the results of this analysis to the wind farm developer.

Ornithologists have designed models that allow them to determine how many birds may be hit by the turbines on a wind farm. This information is critical when determining what types of impacts the turbines may have on the environment.

Your research team collected background information and conducted bird counts at the proposed Chautauqua wind farm site in New York. A summary of the team's findings can be found in the activity reading passages. Use this information to answer the questions on your worksheet. Your answers will help in designing an avian risk assessment for the site.

After reading the passage, answer the following questions:

1. How do wind turbines and wind farms affect birds?

2. What are some of the leading human causes of bird death (mortality) in the US?

3. What is a raptor and why are scientists and regulators concerned about the impact of wind farms on raptors?

After reading the passage, answer the following questions.

4. What is an avian risk assessment and why is it done?

5. What is the rotor swept zone (RSZ)?

6. What is an avoidance rate and how is it calculated?

Name_________________________ Date_______________ Class_________

7. Answer the following questions based on the raptor observation data in Table 2.

   a. How many raptor species were identified at the Chautauqua site?

   b. Which of these species are classified as state or federally threatened, endangered, or of special concern?

8. Based on the information in the risk assessment reading passage, calculate potential avian mortality at the proposed Chautauqua wind farm site by answering the following questions.

   a. Calculate utilization: How many raptors are estimated to be using the Chautauqua research area in a year? Make sure you calculate how many would be found at 100 percent of the Chautauqua site, not just how many were observed by researchers. The table only represents 16 percent of the entire site.

      U=

   b. Determine avoidance: What is the avoidance factor used for the Chautauqua site?

      A=

   c. Calculate potential mortality for the entire wind farm site using this equation:

      $(U) \times (A) = M$

d. How many raptors may be killed by each turbine annually?

$$\frac{M}{\#\ \text{of turbines}}$$

9. Is the potential raptor mortality at the Chautauqua site higher or lower than what you thought it would be?

10. What recommendations would you make to the developer who hopes to build a wind farm on this site? What would you tell the developer about potential impacts on raptors?

Weather patterns play an important role in raptor migration. During migrations, raptors often use thermals. A thermal is a column of warm air that rises as the Earth warms. Raptors fly in circles in these thermals to rise higher in the air with less work. Once raptors reach a sufficiently high altitude, they can glide to the next thermal without flapping their wings. Thermals only form over land and are greater on sunny days and over surfaces that absorb a lot of heat (such as a parking lot). There are places where thermals and wind patterns cause large numbers of migrating birds to concentrate. One of these is the Derby Hill Bird Observatory.

The Derby Hill Bird Observatory, located on the southeastern corner of Lake Ontario in Oswego County, NY, is one of the premier hawk watches in the northeastern US. It is located on the edge of Lake Ontario where many migrating birds concentrate. Hawk counts at the site were started in the early 1960s and since 1979 have been conducted every year in a standardized way. On average, 40,000 raptors are counted each spring as they migrate northward, making this site one of the best spring observation sites in the country.

For more information and to see radar maps of hawk migratory flight patterns, go to: http://learn.kidwind.org/windwise/.

Step 1: Read the reading passage called "Birds and Wind Turbines."
After reading, answer the following questions:

1. How do wind turbines and wind farms affect birds?
   Birds can be struck by turbine blades. The presence of turbines can cause birds to avoid using that area as habitat. Habitat can be disturbed by the installation of turbines, power lines, and buildings.

2. What are some of the leading human causes of bird death (mortality) in the US?
   Leading causes are cats, power lines, windows, pesticides, automobiles, lighted communication towers.

3. What is a raptor and why are scientists and regulators concerned about the impact on raptors from wind farms?
   A raptor is a bird of prey such as a hawk, eagle, and vulture. Raptors are a focus of concern because they are at the top of the food chain and have naturally smaller populations than other more common species.

Step 2: Read the reading passage called "Project Overview and Avian Risk Assessment."
After reading, answer the following questions.

4. What is an avian risk assessment and why is it done?
   An avian risk assessment is a study used to determine which bird species are present at a potential wind site and what risk the turbines may pose to those species.

5. What is the rotor swept zone (RSZ)?
   This is the circular area used by the turbine blades as they rotate.

6. What is an avoidance rate and how is it calculated?
   An avoidance rate is the rate at which birds stay away from wind turbines. It is calculated using data from similar facilities, looking at numbers of birds present and numbers of birds killed, and is the ratio of numbers of fatalities to numbers of birds.

7. Answer the following questions based on the raptor observation data in Table 2.

   a. How many raptor species were identified at the Chautauqua site?
      Nineteen

   b. Which of these species are classified as state or federally threatened, endangered, or of special concern?
      Bald Eagle (T, US-T), Northern Harrier (T), Sharp- shinned Hawk (SC), Cooper's Hawk (SC), Northern Goshawk (SC), Red-shouldered Hawk (SC), Golden Eagle (E)

8. Based on the information in the risk assessment reading passage, calculate potential avian mortality at the proposed Chautauqua wind farm site by answering the following questions.

   a. Calculate utilization: How many raptors are estimated to be using the Chautauqua research area in a year? Make sure you calculate how many would be found at 100 percent of the Chautauqua site, not just how many were observed by researchers. The table only represents 16 percent of the entire site.
      U= 98,538

b. Determine avoidance: What is the avoidance factor used for the Chautauqua site?
A= .042

c. Calculate potential mortality for the entire wind farm site using this equation:

(U) × (A)= M
M=41

d. How many raptors may be killed by each turbine annually?
1.2 raptors per turbine per year

9. Is the potential raptor mortality at the Chautauqua site higher or lower than what you thought it would be?
Student answers.

10. What recommendations would you make to the developer who hopes to build a wind farm on this site? What would you tell the developer about potential raptor impacts?
Student answers.