

Green Energy: Safe for the Bald Eagle? *Teacher Notes*

Unit Overview

In this middle school NGSS-aligned earth science unit, students explore the Duke Farms bald eagle cam feed and historical footage as well as documentation of recent Duke Farms conservation and sustainability efforts. As they do so, they will also learn about human energy consumption and the importance of more “green” energy sources. Students will use this exploration into the often-paired goals of conservation and sustainability to identify how they can sometimes be at cross-purposes. With a focus on the needs of bald eagles, students will use engineering principles to propose a renewable energy plan for their school or town and write an environmental impact statement that balances the desire for conservation of the bald eagle population with the desire for renewable energy. They will end by creating a media campaign to share their plan with a relevant audience.

Next Generation Science Performance Expectations Addressed

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).

MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

NGSS Science and Engineering Practices Addressed	NGSS Crosscutting Concepts Addressed
<p>Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</p> <p>Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)</p> <p>Apply scientific ideas or principles to design an object, tool, process or system. (MS-ESS3-3)</p> <p>Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).</p> <p>Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)</p>	<p>Cause and Effect Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS3-4)</p> <p>Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2), (MS-ESS3-3)</p> <p>All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1), (MS-ESS3-4)</p>
Enduring Understandings	Essential Questions
<ul style="list-style-type: none"> • Changes to the Earth’s environment can have different impacts—negative and positive—for different living things. • Human activities have significantly altered the biosphere. • As human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. • Every technological change is likely to have both intended and unintended effects. • Renewable energy resources, and the technologies to exploit them, are being rapidly developed. 	<ul style="list-style-type: none"> • How do human activities affect Earth systems? • How do humans depend on Earth’s resources? • How do living organisms alter Earth’s processes and structures? • How can humans balance their needs for resources with conservation?

21st Century Skills Addressed

Core Content and Interdisciplinary Themes

- Subject Area Mastery
- Global Awareness
- Environmental Literacy

Learning and Innovation

- Critical Thinking and Problem Solving
- Creativity and Innovation
- Communication and Collaboration

Information, Media and Technology

- Information Literacy
- Media Literacy
- Information Communication and Technology

Life and Career

- Flexibility and Adaptability
- Initiative and Self-Direction
- Social and Cross-Cultural Skills
- Productivity and Accountability
- Leadership and Responsibility

Teacher Resources

- [Duke Farms Eagle Cam](#)
- [Stewardship at Duke Farms](#)
- [Duke Farms' Bald Eagles e-book](#) by Jim Wright. This user-friendly resource contains information about bald eagles in general, and the eagles at Duke Farms in particular. Excellent pictures from all stages of eagle growth and of eagle banding, habitat, and cultural importance.
- [Duke Farms Eagle Cam Blog](#), maintained by Jim Wright
- [Teacher Blog on Duke Farms' eagles](#) by Diane Cook, 2015 winner of Duke Farms Eagle Cam Lesson Plan Contest.
- [Duke Farms Eagle Cam FAQs](#) and their Facebook [Eagle Cam Teacher Page](#)
- Conserve Wildlife Foundation [eagle lesson plan database](#)
- Check in with Duke Farms for ["Using Eagle Cam in the Classroom" Professional Development workshops](#) each January
- [NJ Bald Eagle Field Guide](#)
- [Bald Eagles in the Meadowlands and Beyond e-book](#) by Jim Wright. Information about bald eagles' comeback in New Jersey and beyond.
- [Bald Eagle Fact Sheet](#)
- [USFWS NJ Bald Eagle Success Story](#)
- [Scientific American article on bird deaths](#)
- [Popular Science article on bird deaths from solar, other energy sources](#)
- [Preparing Your Own Environmental Impact Statement](#)

Designed for Duke Farms by IDE Corp.

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The bald eagle holds a special place in our nation's history. Not only is it recognized as America's bird, but it has made a remarkable comeback after being listed as endangered under New Jersey's Endangered and Nongame Species Conservation Act in 1973, and as federally endangered throughout the lower 48 states under the Endangered Species Act (ESA) in 1978. It is a felony under the Bald and Golden Eagle Protection Act to kill a bald eagle, punishable by a fine of \$200,000 and prison time. In New Jersey, these legal protections meant that the bald eagle population has grown from only one nesting pair in 1973 to at least 135 nesting pairs in 2015. The bald eagle is truly an ESA success story.

Duke Farms, located in Hillsborough, New Jersey, is home to a high-profile pair of nesting bald eagles, with their eagle webcam live feed providing a window into the life of bald eagles for viewers worldwide. Duke Farms also serves as a model of environmental stewardship and inspires visitors to become informed stewards of the land. The buildings and landscapes at Duke Farms have been designed to be sustainable. Their solar panels provide 100% of the electricity required to power Duke Farms, with the energy that the property does not use transferred to the local public power grid.

Green energy sources—like wind and solar—are critically important to address pollution and climate change. That said, they are not without some alarming consequences. The need for sustainable energy sources can be in conflict with the protection of bald eagles. As the nation seeks to increase sustainable energy sources, bald eagles are dying once again.

In the United States, tens of thousands of sleek wind turbines, towering approximately 300 feet above the ground and occupying little space from landowners, are currently in operation and many more are planned. The blades of a wind turbine slice the air at 200 mph. In 2012, the American Bird Conservatory has estimated the annual loss of birds from the blades of wind turbines to be as high as 573,000. Since then, vastly more turbines are in operation, and more than 1.4 million bird deaths are projected by 2030 or earlier, if the United States meets its goal of producing 20 percent of its electrical energy with wind. If that figure reaches 35 percent, as new Department of Energy projections suggest, up to 5 million birds could be killed annually due to wind energy.

Solar energy can also be problematic. The intense heat from mirrors used in some solar energy arrays can cause harm by incinerating or even vaporizing birds that attempt to pass through the area. Birds can also mistake the reflection off the solar panels for reflection off water, and swoop down to the water only to crash into the panels.

Green energy facilities may not be intentionally hurting the eagle population, but the impact cannot go without notice. With the industry still growing, the death rate will rise. How can we balance the need for conservation of the bald eagle population with the need for renewable energy? Observe eagles' needs and habitats on the Duke Farms eagle cam. Then, determine how to meet the needs of your community with renewable energy and write an Environmental Impact Statement for this plan with a focus on its impact on the bald eagle population. Finally, share your project through a media campaign designed for your community.

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Green Energy: Safe for the Bald Eagle? *Unit Rubric*

Criteria	Novice	Apprentice	Practitioner	Expert
Human Impact on the Earth	<ul style="list-style-type: none"> Define the Earth’s four systems: hydrosphere, geosphere, atmosphere, and biosphere. Identify natural resources consumed by humans. 	Construct arguments about how the human population impacts the biosphere and one other of the Earth’s systems.	Synthesize an argument, supported by evidence, for how the human population impacts the biosphere and at least one other of the Earth's systems.	All of Practitioner, plus make specific predictions about how the impact of humans on the environment will change as the human population grows.
Bald Eagle Needs and Habitat	<ul style="list-style-type: none"> Describe bald eagle habitats and name three necessities to the survival of bald eagles. Discuss what impacts humans have on the bald eagle population. 	<ul style="list-style-type: none"> Provides information and reasons to why bald eagles reside in a particular habitat and why this is important to their survival. Identifies examples of human impact on the bald eagle population 	<ul style="list-style-type: none"> Determine the needs of New Jersey’s bald eagle population. Evaluate the impact of human development on the bald eagle population. 	All of Practitioner, plus suggests other areas in the US that could provide habitat for bald eagles.
Sustainable Technologies	<ul style="list-style-type: none"> Determine energy needs of your community. Research green energy solutions. 	Decide what green energy solution(s) could meet the needs of your community. Consider both energy needs and local constraints (i.e. terrain, local wind or sun conditions) on your choice.	Evaluate green energy solutions to determine how well they meet the needs of the community while minimizing harm to the bald eagle population.	All of Practitioner, plus evaluate the same green solutions in a neighboring state which will minimize harm to the bald eagle population.

<p style="text-align: center;">Environmental Impact Statement</p>	<p>Review sample Environmental Impact Statements. Explain what you want to emulate and what you want to avoid.</p>	<p>Outline your Environmental Impact Statement, including all criteria outlined in the Practitioner column</p>	<p>Write an Environmental Impact Statement to propose your energy solution, including:</p> <ul style="list-style-type: none"> • criteria you had to meet for energy production • constraints on your energy choice • potential impacts on the natural environment that may limit possible solutions • potential impacts on the local bald eagle population • description of how your solution provides a balance between energy needs and eagle conservation 	<p>All of Practitioner, plus drafting the Environmental Impact Statement to the New Jersey governor or other elected official in order to initiate change and awareness to help protect the bald eagle population.</p>
<p style="text-align: center;">Campaign</p>	<p>Determine the audience that should be made aware of your proposed green energy project.</p>	<ul style="list-style-type: none"> • Choose a medium through which to share your proposed green energy project with your intended audience. • Explain why this medium is the best choice for this audience. 	<p>Develop a media campaign to share your project you're your audience. You must reference specific energy AND eagle habitat needs and show how your solution is the best possible plan.</p>	<p>All of Practitioner, plus publish the campaign on a social media site or reach out to a local news source to possibly showcase your media campaign.</p>

Green Energy: Safe for the Bald Eagle? *Scaffold for Learning*

<p>How-To Sheets</p> <ul style="list-style-type: none"> ▪ Use Design Criteria ▪ Locate and use population data ▪ Read charts/graphs ▪ Cite properly 	<p>Learning Centers</p> <ul style="list-style-type: none"> ▪ Bald Eagles' Needs ▪ Cause & Effect ▪ Evaluating Existing Green Designs/Technologies ▪ Analyzing Population Data 	<p>How-To Videos/Podcasts</p> <ul style="list-style-type: none"> ▪ How population effects the environment ▪ Reading data in charts/graphs ▪ The Design Process ▪ Bald eagles' needs ▪ Bald eagles' habitat ▪ Sustainable energy sources 	<p>Homework</p> <ul style="list-style-type: none"> ▪ Locating green energy technologies in the town, state, country, world ▪ Describe a bald eagle's "dream habitat" ▪ Analyze data ▪ Readings on bald eagle
<p>Benchmark Lessons</p> <ul style="list-style-type: none"> ▪ Introduction to Task ▪ Green Energy ▪ The Negatives of Technology ▪ Human Impact ▪ How Population Changes Impact Earth ▪ The Design Process ▪ What Can Be Done? 	<p>Small-Group Mini Lessons</p> <ul style="list-style-type: none"> ▪ Earth's Four Systems ▪ Earth's Resources ▪ Sustainability ▪ Reading charts & graphs ▪ Using data to support your Effective designs ▪ Media campaigns 	<p>Outdoor Exploration</p> <ul style="list-style-type: none"> ▪ Visit Duke Farms ▪ Observe and describe eagle habitat 	<p>Individual Tasks</p> <ul style="list-style-type: none"> ▪ Research – summarize sources ▪ Observe Eagle cam ▪ Collect data from observing eagles ▪ Locate and analyze population data ▪ Summarize human impact of human development on bald eagle population
<p>Group Tasks</p> <ul style="list-style-type: none"> ▪ Analyze Duke Farms/eagles habitat ▪ Discussions - human impact, negative impact of technology ▪ Evaluate each other's impact statements ▪ Determine who would benefit from sustainable energy 	<p>Peer Tutoring</p> <ul style="list-style-type: none"> ▪ Peer edit impact statements ▪ Technology Expert ▪ Citation Expert ▪ Data Expert 	<p>Technology Uses</p> <ul style="list-style-type: none"> • Research • Population data • Videos/podcasts • Eagle webcam • Media campaign 	<p>Interactive Websites</p> <ul style="list-style-type: none"> ▪ Eagle Cam ▪ Duke Farms eagle blog ▪ Teacher's blog about the Duke Farms eagles ▪ Bald comeback video ▪ American Bald Eagle Foundation

Green Energy: Safe for the Bald Eagle? *Sample Science Content Facilitation Grid*

<p>M: Mastered HW: Needs homework ML: Needs small-group mini-lesson P: Needs peer tutoring</p> <p>Student Name</p>	<p>Define the Earth's four systems: hydrosphere, geosphere, atmosphere, and biosphere.</p>	<p>Construct arguments about how the human population impacts the biosphere and one other of the Earth's systems.</p>	<p>Observe and describe the bald eagle habitat.</p>	<p>Explain why the observed habitat meets the need of bald eagles.</p>	<p>Describe why humans have impacts on the bald eagle population.</p>	<p>Explain how technologies that are meant to help can also have negative effects on the environment.</p>	<p>Explain how Duke Farms and other conservation organizations are dedicated to protecting the Earth.</p>	<p>Describe the energy needs of your community.</p>	<p>Describe your process for planning a green energy solution for your community.</p>	<p>Describe the pros and cons of multiple energy plans for your community.</p>	<p>Explain the components of an effective Environmental Impact Statement.</p>	<p>Describe the audience that would be most interested in your project.</p>	<p>Explain how your proposed media campaign will reach your intended audience. Why is it the best choice?</p>

Green Energy: Safe for the Bald Eagle? *Facilitation Questions*

<p style="text-align: center;">COMPREHENSION</p> <p style="text-align: center;"><i>Ask questions that ensure students understand content and skills needed to solve the problem.</i></p>	<p>What are the Earth's natural resources?</p> <p>What are renewable and nonrenewable resources?</p> <p>What technologies have been created to help protect the Earth's resources?</p> <p>What are some of the threats to the bald eagle population?</p>
<p style="text-align: center;">APPLICATION</p> <p style="text-align: center;"><i>Ask questions that ensure the ability of students to apply learning to new situations.</i></p>	<p>What natural resources do humans use?</p> <p>How is human life impacted by sustainable technologies?</p> <p>How is the bald eagle impacted by human activities?</p> <p>What is the responsibility of the community regarding sustainability?</p>
<p style="text-align: center;">CONNECTION</p> <p style="text-align: center;"><i>Ask questions that ensure the ability of students to apply learning to their lives.</i></p>	<p>How can you conserve the Earth's natural resources?</p> <p>How do our choices affect us, our community, and the world?</p> <p>Why is important to inform your community of sustainable technologies?</p>
<p style="text-align: center;">SYNTHESIS</p> <p style="text-align: center;"><i>Ask questions that encourage students to create new information from existing data.</i></p>	<p>What would happen if humans used up more resources than the Earth could make?</p> <p>Do the pros of sustainable technologies outweigh the cons?</p> <p>How do systems and changes in systems affect you?</p>
<p style="text-align: center;">METACOGNITION</p> <p style="text-align: center;"><i>Ask questions which prompt students to think about their own thinking process.</i></p>	<p>Why is it important to think about the future?</p> <p>What is important to consider both the pros and cons in a given situation?</p> <p>How can one individual make a difference?</p>