A Symbol for Change *Teacher Notes*

Teacher Material

Unit Overview

In this high school NGSS-aligned life science unit, students explore the impact of climate change on bald eagle populations. They will gain an understanding of the basic science behind climate change and projected effects to temperature and precipitation patterns. Based upon this learning, they will generate hypotheses about the impact of climate change on bald eagle behaviors and habitats. They will design models to test their hypotheses and analyze the outcomes to draw conclusions about the possible impact on bald eagle populations. Finally, they will present actions at multiple levels (school, community, state, national, global) that could support the bald eagle population and design an infographic to convey these ideas to an audience of their choice.

Next Generation Science Performance Expectations Addressed

HS-LS2-1- Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

> **Clarification Statement:** Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.

HS-LS2-6 - Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

> **Clarification Statement:** Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.

HS-LS4-5 - Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

> **Clarification Statement:** Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.

HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

NGSS Science and Engineering Practices Addressed	NGSS Crosscutting Concepts Addressed
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. **Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	**Scale, Proportion, and Quantity** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. **Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Influence of Science, Engineering, and Technology on Society and the Natural World** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
Enduring Understandings	**Essential Questions**
In stable conditions, the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem Changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.	What interactions keep an ecosystem stable? What conditions could contribute to altering an ecosystem? How could they do so? What are long-term consequences of ecosystem change? How can models help us understand ecosystem change?

21st Century Skills Addressed

Core Content and Interdisciplinary Themes

- Subject Area Mastery
- Global Awareness
- Civic Literacy
- 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
- 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
- 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
- Audubon Climate Report: Bald Eagles
- *Ecology and Evolution* article on climate change and bald eagles
- USGS study on potential impacts of climate change on multiple bird species
- *Science* map showing bird population shifts
- NASA's Global Climate Change website

Student Material

Bald Eagles: A Symbol for Change

"It's a punch in the gut. The greatest threat our birds face today is global warming."
Gary Langham, Audubon Chief Scientist

According to NASA's Goddard Institute for Space Studies:

- 9 of the 10 warmest years on record have occurred since the year 2000.
- Our global temperature has increased 1.4° F since 1880.
- Arctic ice is decreasing at a rate of 13.4% per decade.
- Land ice is decreasing by 287 metric tons per year.
- Sea levels are increasing by 3.42 mm per year.

Changes measured in millimeters and degrees may not sound like a lot to you initially, but the impact to our Earth's environment is significant.

Consider the bald eagle. Many say that the bald eagle is a conservation success story. As far back as 1940, Congress was concerned about the shrinking population of our national symbol, passing the Bald and Golden Eagle Protection Act in an effort to prevent the hunting and poisoning that threatened these species. In 1973, Congress passed the Endangered Species Act. The bald eagle, threatened by habitat destruction and pesticide use—especially DDT—was one of the first hundred species placed on that list. As of 2007, the bald eagle recovered sufficiently to be removed from the Endangered Species list. However, in New Jersey bald eagles are still considered endangered during breeding season and threatened at all other times.

In 2014, the New Jersey Division of Fish and Wildlife (DFW) recorded 146 active nesting pairs of bald eagles, up from only one in 1973. Kathleen Clark, a biologist with DFW, says, "With continued management and monitoring by concerned landowners and volunteers, the future of the bald eagle in New Jersey looks bright." That said, this bird still faces disturbance and habitat loss. Volunteers and biologists must actively monitor and search for nests to continue habitat protection efforts.

Duke Farms is a leading force in New Jersey in these protection efforts. The bald eagle webcam at Duke Farms creates a connection between the public and the birds that otherwise might not have been possible. It enables scientists and everybody else anywhere in the world to observe, hypothesize, and collect data about eagle growth, behavior, and habitat.

As a national symbol in America, the bald eagle represents freedom. The bald eagle was revered by several Native American tribes, and considered to represent courage, wisdom, and strength. Could the bald eagle become the symbol for addressing climate change? What is the real projected impact of climate change to the bald eagles at Duke Farms and nationally? What could be the impact to these ecosystems as a whole?

This problem is very complex and multi-faceted, but not one to be ignored. The bald eagle has survived over-hunting, significant habitat loss, and DDT use. Will it survive this accelerated climate change? What might we do at various levels (our school, the local community, our state, our country, world organizations) to support the continued thriving of the bald eagle population? Develop a plan to make an impact on multiple levels and share it with those who can join you in making a difference.

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A Symbol for Change *Unit Rubric*

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Criteria	Novice	Apprentice	Practitioner	Expert
Climate Change	• collects data from models and simulations regarding projected climate change • reviews findings about the effects of climate change from various sources, considering the validity of each source	• analyzes data from models and simulations regarding projected climate change • synthesizes findings from a range of valid sources	• applies conclusions from models and simulations regarding projected climate change to the local environment • evaluates the effects of climate change nationally and locally	all of *Practitioner*, plus categorizes primary, secondary and tertiary effects of climate change to the local environment
Bald Eagle Habitat and Role in Ecosystem	• reviews the current range of the bald eagle habitat • describes the role of a top predator in a food web	• identifies the characteristics that define the range of the bald eagle habitat • contrasts the makeup of the food web for different bald eagle habitats	• predicts the impact upon the ecosystem if the habitat no longer met the needs of the bald eagle range, and the bald eagle moved out of the ecosystem • describes the effects of shifts in prey populations upon top predators in the ecosystem	all of *Practitioner*, plus describes what species could move into changed habitiat
Eagle Observations	• locates a webcam streaming video of bald eagles from somewhere in the country, in addition to that from Duke Farms • identifies aspects of bald eagle behaviors and habitat that would be impacted by climate change	• observes bald eagle behavior and habitat from Duke Farms and one other eagle cam • reviews existing models and simulations regarding the impact of climate change upon eagle populations	• observes and collects detailed data on bald eagle behavior and habitat from Duke Farms and one other eagle cam • hypothesizes regarding the impact of projected climate change upon eagle behaviors and habitat in both locations	all of *Practitioner*, plus • collaborates with peers to review data from a number of different eagle cam locations • compares hypotheses and debates the viability of each for study

Modeling and Data Analysis	• plans a model to project the impact of increased temperature and water levels upon the food source for eagles in a location • identifies the data needed to support the model • outlines the connection between the hypothesis and the model	• evaluates the planned model for accessibility of needed data and validity of results • revises plan as needed to ensure a valid outcome	• designs a model to project the impact of increased temperature and water levels upon the food source for eagles in both locations • analyzes the data and formulates conclusions regarding the impact of climate change on eagle behaviors and habitat • predict the shift in bald eagle habitat as the climate changes	all of Practitioner, plus synthesizes the data with that from several other students' models
Reporting of Findings	• organizes findings to be presented in an infographic, including all of the criteria in the Practitioner column • determines actions at 3 of the following levels that would support the bald eagle population: ○ school ○ local community ○ state ○ country ○ world	drafts an infographic to convey findings, considering: • layout of information to be readable and visually pleasing • organization of information to tell a compelling story • use of color, blank space, and other design elements to enhance the audience's engagement with the content	• designs an infographic to convey findings, including: ○ map showing current and projected bald eagle range ○ hypothesis, model, and outcome of data analysis ○ actions that can support the bald eagle at multiple levels • selects an audience for the infographic	all of *Practitioner*, plus the message of the infographic is conveyed powerfully through a creative layout and format that reflects the message

Teacher Material

A Symbol For Change *Scaffold for Learning*

How-To Sheets ▪ Collect climate data from models ▪ Read/analyze data ▪ Making infographics ▪ Designing a digital model	**Learning Centers** ▪ Comparing ecosystems ▪ Analyzing climate data ▪ Evaluating infographics	**How-To Videos/Podcasts** ▪ Causes & effects of global warming ▪ Read/analyze climate data ▪ Eagles habitat ▪ Eagles role in the ecosystem	**Homework** ▪ Summarize research/data ▪ Locate and analyze climate data ▪ Outlines food web for both eagle locations observing, indicating top predators ▪ Planning – hypothesis, infographic
Benchmark Lessons ▪ Intro to task ▪ Causes of Climate Change ▪ Effects of Climate Change ▪ Roles in ecosystems ▪ Who has already attempted to make an impact?	**Small-Group Mini Lessons** ▪ Effects of climate changes locally ▪ Effects of climate changes globally ▪ Top predators ▪ Making a hypothesis ▪ What makes a good infographic ▪ Comparing data from digital models	**Outdoor Exploration** ▪ Visit Duke Farms ▪ Describe eagle habitat	**Individual Tasks** ▪ Research ▪ Observe Eagle cam (Duke and one other) ▪ Collect data from observing eagles ▪ Locate & analyze climate data ▪ Develop hypothesis on impact of climate change to both eagles observed ▪ Plans digital model ▪ Designs infographic
Group Tasks ▪ Discussion – global effects, local effects ▪ Hypothesize impact of projected climate change to eagles	**Peer Tutoring** ▪ Peer editing – feedback on hypothesis and infographic ▪ Technology Expert ▪ Climate Data Expert	**Technology Uses** ▪ Research ▪ Climate data ▪ Videos/podcasts ▪ Eagle cam ▪ Digital model ▪ Infographic	**Interactive Websites** ▪ Eagle Cam ▪ Duke Farms eagle blog ▪ Teacher's blog about the Duke Farms eagles ▪ Bald comeback video ▪ Other Eagle Cams in the US

Teacher Material

A Symbol for Change *Sample Science Content Facilitation Grid*

M: Mastered **HW: Needs homework** **ML: Needs small-group mini-lesson** **P: Needs peer tutoring** **Student Name**	Identifies the basic effects of climate change upon temperature and precipitation	Describes the impact of changes in temperature and precipitation upon global systems	Describes the projected impact of climate change upon the local ecosystem	Recognizes the characteristics of a valid source for research	Outlines the food web for a particular bald eagle location, noting the role of the top predator	Identifies the characteristics that define the range of the bald eagle habitat	Explains the connections between climate, food sources, space, and other factors in that range	Analyzes the potential impact of climate change upon the food sources of the bald eagle in one location	Consistently collects accurate observational data on bald eagle behavior and habitat	Develops a clear hypothesis based upon existing data	Plans for a digital model that will project the impact of climate change upon the food sources for the bald eagle for a specific location	Compares two sets of data from a digital model	Synthesizes data to draw an evidence-based conclusion	Organizes findings to communicate an evidence-based conclusion

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A Symbol for Change *Sample Science Facilitation Questions*

COMPREHENSION *Ask questions that ensure students understand content and skills needed to solve the problem.*	What are the primary effects of climate change? What is the role of a 'top predator' in a food web? What kind of hypothesis can be tested with a model?
APPLICATION *Ask questions that ensure the ability of students to apply learning to new situations.*	What is the projected impact of climate change to your local region? What is the connection between the bald eagle in one of your selected locations and other living things in that system? What data is needed to create and test using a model?
CONNECTION *Ask questions that ensure the ability of students to apply learning to their lives.*	What actions can people take to remedy the effects of climate change? How do humans impact the bald eagles' role as top predators in their ecosystems? How does a model help you to view data differently?
SYNTHESIS *Ask questions that encourage students to create new information from existing data.*	Select a living thing in your local ecosystem. How could climate change impact that living thing, both directly and indirectly? What is the role of models in scientific analysis? What is the connection between human responses to climate change at the local, national, and global levels?
METACOGNITION *Ask questions which prompt students to think about their own thinking process*	Why is it so challenging to convince people to be concerned about climate change? How does design influence the impact of a message upon its audience? What is the power of a symbol to create purposeful, passionate support for a cause?