Learning Activity:

Climate Change and Biodiversity

Activity Type:	Analyzing and Interpreting Data
Focus Area:	Science
Time Required:	Two to four days/class periods

Overview

The effects of climate change extend far beyond rising global temperatures. Changing rainfall patterns, catastrophic storms, and rising sea levels are also threats to our environment due to climate change. As a result, wildlife species have continued to face more problems and are pushed closer to extinction. In this activity, students will make the connection between climate change and biodiversity by performing a vulnerability assessment to determine how well species can adapt to the impacts of climate change.

Learning Objectives

At the completion of the activity, students should be able to

- define and give examples of climate adaptation
- identify factors that make certain species more vulnerable to changes in their climate and environment than other species
- explain the connection between climate change and declining biodiversity

Deep cracks in the dry rice fields, Philippines

Standards

Next Generation Science Standards

- MS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- HS-LS4-5: Biological Evolution: Unity and Diversity. 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.

Common Core Standards: English Language Arts and Literacy in Science

- WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.

Materials Needed

- Printed copies of or digital access to WWF's species assessments
- Internet access for additional research
- Copies of the included student handout (optional)
- Display board such as dry erase, smart board, or computer screen (optional)

Vocabulary

Adaptation: changes to a plant or animal that make it better equipped to survive under the conditions of its environment

Biodiversity: all the different kinds of life found in one area, including animals, plants, fungi, bacteria, and genetic material

Climate: the average condition of the weather at a place, usually over the long term, as exhibited by temperature, wind velocity, and precipitation

Climate adaptation: actions to reduce vulnerability to actual and expected changes in climate

Climate change: a change in climate over time due to natural causes or human activity

Climate vulnerability: the degree to which a system is susceptible to or unable to cope with adverse effects of climate change

Ecosystem: the living (e.g., humans, wildlife, plants) and nonliving (e.g., air, water, soil) components in an area that interact with each other in an interconnected way

Evolution: a cumulative inherited change in a group of organisms over time

Extinct (Conservation Status): when there is no reasonable doubt that the last individual of that species has died

Greenhouse gases: gases such as water vapor, carbon dioxide, methane, and nitrous oxide that absorb some of the sun's heat energy and trap it in the atmosphere, making Earth warmer

Activity Procedure

Part 1: Engage

- As a warm-up bell-ringer exercise, ask students to create their own definitions of "climate change" and "adaptation." Encourage them to use prior background knowledge of the terms and provide them with context clues within sentences, if needed. Call for volunteers to share their ideas and discuss as a class, using the provided definitions in the vocabulary section, as needed.
  - Based on the discussion, challenge the class to consider the term "climate adaptation" and develop a definition together. Once students have contributed ideas, establish a definition; display it for reference, if desired.
- Allow students several minutes to perform research on their own, or research as a class, the Bramble Cay melomys, the first mammal species lost to human-induced climate change.
  - Ask students to recall the definition of "climate adaptation." Lead a class discussion based on the following questions:
    - Was the Bramble Cay melomys able to adapt to the changes to its environment?
    - What traits of the Bramble Cay melomys made it vulnerable to the effects of climate change?
    - What ultimately caused the Bramble Cay melomys to go extinct?
- Now that students are thinking about how wildlife can be affected by climate change, inform them that, throughout this project, they will learn about the ability of certain species to adapt to climate change impacts and how adaptation in turn affects biodiversity within the surrounding ecosystem. In this project, students will complete a research study that follows steps similar to species vulnerability assessments performed by wildlife scientists. These assessments inform scientists how they can help species adapt to a changing climate. Use the overview and the following key question to introduce the project:

Key Question: ***How is biodiversity affected by climate change?***

- Have students generate a list of questions that they feel need to be explored as they complete this project and attempt to answer the key question. Examples could include the following questions:
  - What makes a species vulnerable to the effects of climate change?
  - Why are some species better able to adapt to changes in climate than other species?
  - What is the connection between individual species adapting to climate change and biodiversity?

Part 2: Explore

- Before they perform their own species climate vulnerability assessment, students will first practice by interpreting existing assessments. This will give them a better understanding of the criteria that scientists use. WWF scientists have researched the vulnerability of monarch butterflies, polar bears, African elephants, snow leopards, mountain gorillas, Asian elephants, and giant pandas to the effects of climate change. Arrange students into groups (if preferred) and assign each student/group one of the aforementioned species.
- When performing a species vulnerability assessment, scientists look at a variety of factors that can be organized into four categories. Each factor within these categories is given a rating of low, medium, or high, based on the level of risk to the studied species. Review these categories with your students.
  - **Sensitivity:** how well the species will survive, based on current traits (e.g., current extinction status, population count, how narrow or wide their geographic range spans, how well they can survive in different temperatures, specific dietary requirements)
  - **Adaptive Capacity:** how easily the species can respond to changes in climate (e.g., ability of individuals to disperse or move, the number of offspring in one breeding cycle, genetic variation within the species)
  - **Exposure:** how exposed the species currently is, and is expected to be in the future, to changes in weather and climate
  - **Other Threats:** existing threats facing the species that can be worsened by climate change (e.g., habitat destruction, poaching, pollution, other invasive species)

Polar bear on an ice floe, Svalbard, Norway

- Distribute a copy of or provide digital access to the vulnerability assessment to the students for their assigned species.

  Monarch butterflies: worldwildlife.org/pages/monarch-butterflies-and-climate-change
  Polar bears: worldwildlife.org/pages/polar-bears-and-climate-change
  African elephants: worldwildlife.org/pages/african-elephants-and-climate-change--2
  Snow leopards: worldwildlife.org/pages/snow-leopards-and-climate
  Mountain gorillas: worldwildlife.org/pages/mountain-gorillas-and-climate-change
  Asian elephants: worldwildlife.org/pages/asian-elephants-and-climate-change
  Giant pandas: worldwildlife.org/pages/giant-pandas-and-climate

- Allow students/groups to read through their species assessments and organize each trait based on its rating of low, medium, high, or unknown vulnerability status. Refer to this example for the African elephant:

LOW	MEDIUM	HIGH	UNKNOWN
Population size	Temperature tolerance	Freshwater requirements	
Diet	Susceptibility to disease	Generation time	
Food abundance	Dispersal ability	Projected climate exposure	
Habitat specialization	Reproductive rate	Other threats (poaching, habitat loss, human conflict)	
Current climate exposure	Genetic variation		

- Based on the findings of their species assessment, how would students rate their species in terms of vulnerability to climate change? Are they highly vulnerable, moderately vulnerable, or less vulnerable? Have students explain their evaluation, making sure that they have incorporated what they learned about climate adaptation with respect to their species.
- Remind students that the goal of these species assessments is to determine conservation strategies that will help protect species highly affected by climate change. Be sure that students review the last page of their assessment that outlines the recommended strategies to help the species adapt to changes in climate. Pose this question: *How do you think scientists came to these determinations?* Students should recognize that, in most cases, the suggested strategies are based on the criteria given a medium or high vulnerability rating, as these are the factors that put the species at risk.
- Now that students have been introduced to climate vulnerability assessments, they can follow similar steps to create their own assessment of an endangered species of their choosing. You can elect to have students work in groups or individually on their species assessment. Have students/groups select an endangered species that was not included in the assessments in the previous step. It may be helpful to use WWF's Species Directory for ideas.

- Using what they learned earlier and the included (optional) handout, students will research the various criteria deemed as indicators of vulnerability and, for each, assign a rating of low, medium, high, or unknown. For each rating they assign to a trait, students should also note the specific references they used to gather the information, using only credible sources such as scientific studies or science-based websites (the IUCN Red List and the WWF webpages are recommended).

Part 3: Explain

- After they complete their trait assessments, students should repeat the previous steps by tallying up the low, medium, high, and unknown rankings and highlighting what they learned about the species' ability to adapt to climate change.
- Review with students some of the ongoing projects of WWF's Wildlife Adaptation Innovation Fund. These projects were developed after scientists assessed the vulnerability of species to the effects of climate change and determined which traits made those species most vulnerable. They then designed projects to improve the animals' ability to adapt to changes, which would make them less vulnerable.
  - Focusing on the traits they classified as medium and high vulnerability, have students brainstorm ideas of conservation action plans to help their species better adapt to the changing climate.
  - Encourage students to share their species vulnerability assessments and recommended conservation measures with their peers.

Part 4: Elaborate

- Help your students think critically about climate change and biodiversity by applying what they've learned to their own community. Discuss the following questions:
  - Are there already signs of climate change in your community?
  - What changes in weather and climate are projected for your community?
  - What species currently exist in your area? Have you noticed more or less wildlife recently, or changing activity patterns at different times of the year?
  - Is your community doing anything to prepare for the effects of climate change?
- Although some amount of climate change is inevitable, we have the power to limit the impacts of climate change and reduce biodiversity loss by slowing our greenhouse gas emissions. Challenge students to reflect on personal behaviors that could be improved to be more climate friendly and set a goal of implementing change in their own lives.

Part 5: Evaluate

Conclude the project by returning to the key question:

> **Key Question:** ***How is biodiversity affected by climate change?***

When reflecting on how climate change affects each of their species, have students conclude what this means to biodiversity and ecosystem health. Discuss and share the benefits that biodiversity brings to nature and ourselves.

Extended Learning Opportunities

- There are certain species, such as crocodiles and sharks, that have survived on Earth since the time of the dinosaurs with little change to their appearance and behavior. As a follow-up to this assignment, have students research why these species have been so adaptable to major changes in the environment.
- In addition to affecting the environment, climate change can also have serious impacts on the economy. Have students select a major business or industry in the area and discuss how climate change might affect its success and what that could mean for the community.
- Download the SEEK app on a mobile phone or tablet to explore the biodiversity in your area and contribute your classroom findings to a global study. Challenge students to think of ways to increase biodiversity locally, such as by planting trees or creating a pollinator garden.
- For additional teaching resources on climate change, check out the Youth for the Planet: Taking Climate Action in Your Own Community toolkit, or for younger students, the Teaching Tools about Polar Bears and Climate Change.

Additional Resources

Webpage: Wildlife and Climate Change

Webpage: Adapting to Climate Change

Webpage: Climate Adaptation and Resilience Program

Article: How WWF is Helping Threatened Species Adapt to Climate Change

Article: Innovative Projects Help At-Risk Species Adapt to Climate Change

Video: Conservation in the Classroom: Helping Wildlife in a Changing Climate with Dr. Nikhil Advani

Quiz: Climate Change Kahoot! Course

See student handout on the following pages.

For more fun classroom activities with a focus on wild species and conservation, visit wildclassroom.org.

Student Handout:

Climate Change Vulnerability Assessment for Species

SPECIES: _____

This tool assesses the vulnerability of species to climate change and is based on four factors: *sensitivity, adaptive capacity, exposure,* and *other threats*. After selecting a species, fill in the following table, adding details where possible.

VULNERABILITY FACTOR: Sensitivity (the inability of the species to persist, as is, under changing climatic conditions)

	LOW VULNERABILITY		MEDIUM VULNERABILITY	HIGH VULNERABILITY
IUCN Red List Status This is found at iucnredlist.org	◯ Least Concern ◯ Near Threatened	◯ Vulnerable	◯ Endagered ◯ Critically Endangered	◯ Not evaluated/ Data deficient
	Comments:			
Geographic Range An example of large is distributed across an entire continent, and an example of small is isolated in one national park.	◯ Large	◯ Medium	◯ Small	◯ Don't know
	Comments/References:			
Population Size For example, the number of mountain gorillas in Africa is small, at just over 1000.	◯ Large	◯ Medium	◯ Small	◯ Don't know
	Comments/References:			

	LOW VULNERABILITY		MEDIUM VULNERABILITY	HIGH VULNERABILITY
Temperature Tolerance What range of temperatures can the species tolerate?	◯ Large	◯ Medium	◯ Small	◯ Don't know
	Comments/References:			
Does the species rely on environmental cues for reproduction? For example, is breeding cued by the arrival of the wet season or spring temperatures? Does temperature influence the gender of the offspring?	◯ No		◯ Yes	◯ Don't know
	Comments/References:			
Does the species rely on environmental cues for migration? For example, regional sea surface temperature affects the upstream migration of salmon and trout.	◯ No		◯ Yes	◯ Don't know
	Comments/References:			
Does the species rely on environmental cues for hibernation? For example, temperature affects the time at which ground squirrels enter and emerge from hibernation.	◯ No		◯ Yes	◯ Don't know
	Comments/References:			

	LOW VULNERABILITY		MEDIUM VULNERABILITY	HIGH VULNERABILITY
Does the species have any strong or symbiotic relationships with other species? For example, are there significant interactions with a competing species or with predators?	○ No		○ Yes	○ Don't know
	Comments/References:			
Generalist or Specialist Diet For example, the panda feeds only on bamboo (specialist), whereas the black bear feeds on roots, plants, insects, fish and other animals (generalist).	○ Generalist		○ Specialist	○ Don't know
	Comments/References:			
Abundance of Food Source Are the dietary sources abundant within the range of the species?	○ High	○ Medium	○ Low	○ Don't know
	Comments/References:			
Freshwater Requirements For example, elephants need to drink up to 300 liters of water per day (high), whereas leopards can obtain moisture from prey and go for long periods without drinking (low).	○ Low	○ Medium	○ High	○ Don't know
	Comments/References:			

	LOW VULNERABILITY		MEDIUM VULNERABILITY	HIGH VULNERABILITY
Habitat Specialization For example, pandas live only in high altitude bamboo forest (specialists), and elephants live in many different habitats (generalists).	◯ Generalist		◯ Specialist	◯ Don't know
	Comments/References:			
Susceptibility to Disease If the species is at risk for contacting diseases, how big is the risk? To what diseases are the species exposed? Remember to consider diseases that are projected to increase under a changing climate.	◯ Low	◯ Medium	◯ High	◯ Don't know
	Comments/References:			

VULNERABILITY FACTOR: Adaptive capacity (the ability of the species to respond to changes in climate)

	LOW VULNERABILITY ← MEDIUM VULNERABILITY → HIGH VULNERABILITY			
Dispersal Ability The species' physical ability to move as well as barriers to dispersal, such as habitat connectivity and fragmentation	◯ High	◯ Medium	◯ Low	◯ Don't know
	Comments/References:			
Generation Time The average age of the female parent at reproduction (For example, 25 years for elephants is long, and eight years for snow leopards is medium.)	◯ Short	◯ Medium	◯ Long	◯ Don't know
	Comments/References:			
Reproductive Rate The number of offspring produced and the rate at which they are produced (For example, mature gorillas produce one infant about every four years (low), whereas some rodents have a number of offspring at once, multiple times in a year (high).)	◯ High	◯ Medium	◯ Low	◯ Don't know
	Comments/References:			
Genetic Variation For example, cheetahs have relatively low genetic variation, as they are all descendants of a small ancestral population.	◯ High	◯ Medium	◯ Low	◯ Don't know
	Comments/References:			

VULNERABILITY FACTOR: Exposure (the extent of climatic change and variation that the species encounters or is projected to encounter)

	LOW VULNERABILITY ← MEDIUM VULNERABILITY → HIGH VULNERABILITY
To what degree of climate variability is the species currently exposed? Consider current exposure to high variability in temperature and precipitation across the species' range as well as exposure to extreme events (for example, droughts, floods, wildfires, heat waves, and hurricanes).	○ High ○ Medium ○ Low ○ Don't know Comments/References:
What level of change in temperature and precipitation are projected across the species' range? Useful resources for these data include the IPCC and World Bank.	○ Low ○ Medium ○ High ○ Don't know Comments/References:

VULNERABILITY FACTOR: Other threats (any other relevant threats)

	LOW VULNERABILITY ← MEDIUM VULNERABILITY → HIGH VULNERABILITY
Other Threats Examples include habitat destruction, poaching, human-wildlife conflict, pollution, and human responses to climate change that exacerbate these threats.	○ Low ○ Medium ○ High ○ Don't know Comments/References:

Student Handout:

Climate Change Vulnerability Assessment for Species: Next Steps

Organize your findings based on low, medium, or high vulnerability, and interpret results.

Focusing on the areas ranked as medium and high vulnerability, brainstorm conservation action plans that could minimize your species' vulnerability.

Get feedback on your assessment and conservation plan from your peers.