Lesson Plan

Biodiversity Basics

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INTRODUCTION

In this suite of lessons, *Biodiversity Basics*, students begin to prepare to preserve, protect, and repair our planet's biodiversity. Students will consider what it takes to sustain our planet and problem-solve to ensure a sustainable future as necessary steps to participate in the OurEcho Challenge, a middle school competition challenging students to devise solutions to tackle the decline of biodiversity.

Biodiversity Basics is a flexible, researched-based curriculum and curates the best resources from academic and scientific organizations for teachers to enjoy. Students will experience a variety of activities to ensure engagement. Teachers from all disciplines can feel confident using *Biodiversity Basics* with its clear prompts, best practices, and annotated information.

In the four mini-lessons of *Biodiversity Basics*, students will acquire a foundation to learn about biodiversity, the alarming indicators and practices which threaten the planet's ecosystems and species, and initiatives to mitigate these threats. *Biodiversity Basics* is modular and adaptable.

The four lessons can be taught back-to-back, requiring 60 minutes, or tackled in three separate mini-lessons, ranging from 15-30 minutes. Teachers can tailor procedures to meet time constraints, available resources, and learning styles. Lesson extensions are available for each step to broaden students' exploration. Limited instructional time? Teachers and facilitators can refer interested students to the Activity Starters in the OurEcho Challenge Education Guide. Alternatively, teachers and facilitators can lead students to investigate the OurEcho Challenge Brainstorming Worksheet to survey local biodiversity and frame their thinking and planning to enter the OurEcho Challenge.

Lessons and activities include:

- Step 1: *What is biodiversity?* (15 minutes)
- Step 2: *What are different types of biodiversity? What species pose challenges to biodiversity*? (15 minutes)
- Step 3: *What are mitigating factors to strengthen biodiversity?* (30 minutes)
- Step 4: *Next Steps? What can I do to meet the challenge?* (20 minutes)

MATERIALS

Step 1 – What is biodiversity?

- Internet access and projection capability
- Student internet access or copies of linked articles
- Coral Reef design template
- Grassland design template
- Temperate Forest design template
- Estuary design template

Step 2 – What are different types of biodiversity? What species pose challenges to biodiversity?

- Dry erase boards - one per small group
  NOTE: Reusable dry erase boards can be upcycled from dollar store picture frames with plastic panels instead of glass or sheet protectors with blank (recycled!) sheets of paper inside.
- Bundle of dry erase markers in different colors - one per small group
- Paper for Exit Ticket

Step 3 – What are mitigating factors to strengthen biodiversity?

- 2019 UN Findings on Biodiversity - projection or student copies
- Student internet access
- Investigation: Citizen Scientists and Their Efforts to Mitigate Threats to Biodiversity - student copies

Step 4 – Next Steps? What can I do to meet the challenge?

- Student internet access (optional)
- Internet access and projection
- My Action Plan - student copies
- The OurEcho Challenge
- OurEcho Challenge Brainstorming Worksheet - student copies

LEARNING OBJECTIVES

Students will:

- Define biodiversity
- Understand the indicative signs that biodiversity is at risk
- Explore the interconnectivity of ecosystems and biomes
- Consider how species become introduced
- Analyze the impact of invasive species
- Recognize current federal practice to restrict introduction of species
- Survey human activities that threaten biodiversity
- Research organizations and individual citizen scientists' efforts to mitigate harmful trends
- Examine local biodiversity
- Identify critical challenges to local biodiversity
- Learn about the OurEcho Challenge
- Devise an action plan to mitigate a local biodiversity threat

Access all printable Handouts mentioned in this Biodiversity Basics Lesson Plan

TEACHER BACKGROUND

Biodiversity, a shortening for "biological diversity," is the rich and interconnected system of life and it is severely under threat. Encompassing all of the planet's species and habitats, the extent of Earth's biodiversity remains undiscovered. Presently, 1.75 million species have been identified but scientists believe this is a drop in the rich teeming bucket of life and hypothesize there might be approximately 12 million more species that are undiscovered.[1]

We are currently undergoing a sixth period of biodiversity extinction, in which, unlike previous eras caused by natural geological or atmospheric phenomena, human activity is the culprit. Without intervention, vital species will become extinct through the loss of habitat, overuse, climate change, and the introduction of invasive species. Scientists have identified 34 particular "hotspots," regions that demand immediate attention and remediation. These hotspots are a cause for alarm due to their plethora of endemic species and the dramatic loss of their habitats.[2] Because of the interconnectivity of biodiversity, there will be economic, medical, and climate consequences for humanity.

For more information about biodiversity, we recommend this comprehensive briefing:
Carrington, Damian, "What is biodiversity and why does it matter to us?" *The Guardian*, 12 March, 2018, https://www.theguardian.com/news/2018/mar/12/what-is-biodiversity-and-why-does-it-matter-to-us.

[1] United Nations Education, Scientific and Cultural Organization, "Learning to Protect Biodiversity" video, https://youtu.be/kHhspf5IfdE.

[2] California Academy of Sciences, "DIY Science: What is a Biodiversity Hotspot?" https://www.calacademy.org/explore-science/what-is-a-biodiversity-hotspot

PROCEDURE

Step 1 – What is biodiversity? (15 minutes)

PAIR

Pair students and encourage them to develop working definitions for the following vocabulary: • **Biodiversity** • **Habitat** • **Species biodiversity**. Review the terms in the Glossary & Vocabulary to check for understanding.

Vocabulary:

Biodiversity: biological diversity in an environment as indicated by numbers of different species of plants and animals

Ecosystem: the complex of a community of organisms and its environment functioning as an ecological unit

Biome: a major ecological community type (such as tropical rainforest, grassland, or desert)

VIEW

- Prepare students to actively learn a definition for **biodiversity** and encourage them to take notes.
- Watch the World Wildlife Fund International's video, "What is Biodiversity?" [2:50]. https://youtu.be/b6Ua_zWDH6U [*NOTE*: Video will begin after a short ad.]

REFLECT

Expand student understanding of biodiversity by extrapolating beyond the concepts introduced in the video. Suggested discussion questions include:

- Why do you think it is good there is rich biodiversity? [anticipated responses may include the connections between all life; rich biodiversity makes for cleaner air, ensures stable food supply]
- Consider the geography and species referenced in the video. What examples can you provide of how a particular geographic feature or organism is a benefit to humans? [anticipated responses may include the Amazon rainforest is the lungs of the earth by turning CO2 into O2; bees pollinate plants for human consumption; organisms decompose and make the soil rich for farming; fish feed on plankton and grow to be eaten by humans; exotic plants have medicinal use; mangrove wetlands prevent land erosion and protect our coastlines]
- How has human activity reduced biodiversity? [anticipated responses may include overbuilding; altering habitats; pollution; overfarming and overfishing]
- Why do you think the lion population of Africa has been reduced? [anticipated responses may include overhunting; loss of habitat]
- Why do you think Europe has experienced such a dramatic loss of insects? [anticipated responses may include altering habitats; the use of pesticides in farming]
- What do you think accounts for the tremendous loss of Pacific bluefin tuna? [anticipated responses may include overfishing; pollution; shipping lanes may alter the habitat]

CREATE

- Explain that a **biome** is an ecosystem across a broad geographic region or a major ecological community type (such as tropical rainforest, grassland, or desert).
- Challenge students to create a diagram, map, or illustration of an assigned **biome** that includes the interconnectivity of its ecosystem's biodiversity.
- Place students in small working 'ecosystem' groups: Coral Reef, Grassland, Temperate Forest, and Estuary. Distribute the following materials to each group:

  Coral Reef Biome:

  1. Coral.org's Coral Reef Biodiversity - internet access or student copies
  2. Coral Reef Biome design template

  Grassland Biome:

  1. Ask A Biologist's Grasping Grasslands - internet access or student copies
  2. Grassland Biome design template

  Temperate Forest Biome:

  1. New Hampshire PBS' NatureWorks Temperate Deciduous Forests - internet access or student copies
  2. Temperate Forest Biome design template

  Estuary Biome:

  1. Santa Barbara's National Center for Ecological Analysis and Synthesis' Kids Do Ecology: World Biomes: Estuaries - internet access or student copies
  2. Estuary Biome design template
- Share and post student designs in the classroom. These will be referenced in Step 2.

Step 2 – What are different types of biodiversity? What species pose challenges to biodiversity? (15 minutes)

HOOK

Project or share U.S. Customs Declaration form and focus students' attention to questions #11 and #12. [*NOTE*: This is a sample form, publicly available on Wikipedia Commons.]

Ask, "Why do you think every person entering the U.S. needs to answer these questions honestly?" Share that the class will investigate the reasoning behind these questions in the next mini-lesson.

REINFORCE

Review what is biodiversity and share the components that make a healthy web or net of biodiversity. Elicit examples from diversity among:

- **Species:**
  - The richness of species
  - This can include simple organisms, like those with single cells, and complex types, like animals
  - A huge variety of species contributes to more resilient biodiversity to ensure that the loss of one does not alter the entire system
  - The Amazon rainforest is a great example of the richness of species in an ecosystem
  - If time allows, share a snapshot of the animal species found there: *UN WebTV: Unseen World by Paul Rosolie*, 2013 [4:49]
- **Genetics of species:**
  - Variances within species mean that if a habitat changes, organisms can adapt, if necessary, and survive
  - Variances in genes can help species fight disease and continue to survive
  - Different breeds of animals or plants can illustrate genetics of species
- **Ecosystems:**
  - Within a larger ecosystem exist many different ecological systems
  - This can include more opportunities for species to hide from predators and find food and energy
  - Broadly, California is a strong example of ecological diversity, with a variety of landforms and climates
  - Encourage students to think beyond geographic location to appreciate ecosystems that are richer than habitats in other locations; the particular range of species will make one ecosystem inherently more diverse
  - If time allows, view California Academy of Science's *Ecosystem Biodiversity* [4:13]

Vocabulary:

Species biodiversity: the existence of many different kinds of plants and animals in an environment

Habitat: the place or environment where a plant or animal naturally or normally lives and grows

Indigenous: produced, growing, living, or occurring naturally in a particular region or environment

Introduced species: organisms that are not native or natural to a habit which have been accidentally or purposefully brought to a new habitat

Invasive species: a species that is not native to a specific location, and that has a tendency to spread to a degree believed to cause damage to the environment, human economy, or human health

CREATE

Guide students to render ecosystem relationships that represent a strongly knit web of biodiversity on dry erase boards with colored markers. Place students in small working groups and distribute dry erase boards and markers. Groups can decide on a) what ecosystem to represent and b) methodology of presentation to organize the information.

NOTE: If technology is available, DKFindout.com offers beautiful representations of over ten different Habitats and Ecosystems of Animals which students can access for inspiration for different ecosystems. The Oct. 2014 Pew Charitable Trust Briefing offerings a great example of a food web, The Bering Sea Food Web, to use as an example.

CHALLENGE

Reconvene and pose the following questions to explore:

- What might happen to your food web if a new species was introduced that was not a **native** species?
- What do you think could make this introduced species **invasive**?

HIGHLIGHT

- **Invasive** species are generally transferred by humans, either intentionally or accidentally. They can be introduced to deal with overpopulation of an animal species, to diversify plant life for ornamental purposes, or just as a result of human transportation of goods.
- "All **invasive species** are introduced but not all introduced species are invasive."[3] A species becomes invasive when it attains a competitive advantage over food and alters the ecosystem.

Ask, "For centuries, species have been introduced to new ecosystems. How do you think they have been transferred to new habitats?"

[3] California Academy of Sciences, "DIY Science: Introduced Species and Biodiversity," https://www.calacademy.org/explore-science/introduced-species-and-biodiversity.

Refer students back to the biome designs from Step 1 and ask what would happen to the biomes when:

- Lionfish were introduced to coral reefs in the Caribbean. They have few natural predators outside their native Indian Ocean. They eat other fish and algae which grows on coral. [Source: https://www.fisheries.noaa.gov/feature-story/impacts-invasive-lionfish]
- Emerald ash beetles, accidently brought from Asia, attack ash trees, particularly common to North American forests and urban centers. [Source: https://www.nationalgeographic.com/news/2014/12/141202-emerald-ash-borer-forestry-trees-environment/]
- Cane toads, native to South America, were introduced to Australia to eat beetles preying on sugar cane and have reproduced in the millions, decimating grasslands. [Source: https://www.nationalgeographic.com/animals/amphibians/c/cane-toad/]
- European crabs accidently entered American waters by hitching a ride on ships and now have affected the food web of local estuaries and consumed local fish populations. [Source: https://ocean.si.edu/ocean-life/5-invasive-species-you-should-know]

REFLECT

Redirect students to questions #11 and #12 on the Customs Declaration and reiterate the question, "Again, why do you think every person entering the U.S. needs to answer these questions honestly?"

Refer students to the second page of the Customs Declaration and have students read the government's information about Agriculture and Wildlife Products.

CONSIDER

Pose the following prompt for an Exit Ticket: "Are humans an invasive species to Earth's biodiversity? Explain."

Step 3 – What are mitigating factors to strengthen biodiversity? (30 minutes)

IDENTIFY:

Check for understanding of learning objectives from Steps 1 and 2 and ask, "Why do you think the extinction of species is a bellwether, a sign of alarm, about the health of the planet's biodiversity?"

SHARE:

To reinforce student understanding, talk through these bullet points from the United Nations 2019 report about the health of biodiversity, human activities behind the report, and the task for partners to discuss the causal human activities.

PROBLEM SOLVE:

Emphasize there are many people who are concerned about the planet's biodiversity and motivated to **mitigate** its threats. They are **citizen scientists**, volunteering to research, collect, and **restore** the planet's ecosystems.

Vocabulary:

Mitigate: to lessen or to help

Citizen scientists: volunteers who team up with professional scientists to collect and/or analyze data

Research scientist: a scientist who works primarily with gathering knowledge, understanding and conducting research or investigation, in order to discover new things, etc.

Restore: to put or bring back into existence or use

Students will conduct online research about these **citizen scientists** and nature lovers working to **mitigate** threats to biodiversity.

COLLECTIVELY DEFINE

Ask:

- What is a citizen?
- What is a scientist?
- What do you think is a **citizen scientist**?

Describe the practices of **citizen scientists**, according to **scistarter.org**:

- Research scientists have been partnering with interested people like you and me;
- Participants use the same methods to collect data that scientists use: their data has to be methodical and high quality;
- Hopefully, the data collected by **citizen scientists** can be used by research scientists;
- Research scientists will share their data, partially gathered by volunteers

Distribute Investigation: Citizen Scientists and Their Efforts to Mitigate Threats to Biodiversity, divide students into working groups, and have them access one of the following **mitigating/restoration** biodiversity **citizen scientist** projects or select a different project to explore:

- Leafsnap
- Cedar Creek Eyes On the Wild
- Never Home Alone at NC State University
- The Great Sunflower Project
- iNaturalist
- SquirrelMapper

JIGSAW

Shuffle students to join jigsawed groups with at least one representative of each of the **mitigating/restoration** biodiversity projects. Post these discussion questions for students to hold a roundtable discussion:

- Who are the **citizen scientists**? Who are the **research scientists**?
- What threat to biodiversity are they trying to **mitigate**?
- What human activity caused this threat to biodiversity?
- Is there a species and/or habitat that the citizen scientists are trying to **restore**?
- How are they doing this?
- How successful do you think they are or will be?

Provide time for groups to consider what initiative they would be most interested in joining.

Step 4 – Next Steps? What can I do to meet the challenge?

IDENTIFY

Lead students through an assessment of their community by:

Identifying their ecosystem:
Suggested discussion prompts include: Do we have coastline? Do we live in an arid environment? Do we have estuaries, marshland, or bays? What are our typical weather patterns? What kind of trees are native to our community? What animal life thrives here? What kinds of birds migrate through or to our community? What types of pollinators are native to our region?

Observing human impacts on biodiversity:
Option #1: Discussion:
Suggested discussion prompts include: Have native grasses been planted in municipal centers? Is there a local farmers' market? Does anyone in the community keep bees? Have waterfronts been restored or rivers revitalized? Do community members keep rooftop gardens? Do we have any species locally that are endangered?

Option #2: On-site Observation:
Bring students outside to observe and catalog signs of biodiversity in their community. Encourage students to index a diversity of plants and trees; animals (reptiles, mammals, and birds); insects; and natural water sources.

Recognizing environmental or ecological concerns:
Suggested discussion prompts include: "Have you heard news about _____:" the water quality? ... noise pollution from traffic or construction? ... the air quality index? ... seasonal allergy symptoms worsening? ... floods, droughts, wildfires, extreme cold or heat? ... pests, like deer, decimating gardens? ... particular animals like bird species decreasing? ... (If in agricultural areas) certain crops suffering lately?

POLL

Poll the class community, or if more time permits, have students develop surveys for their neighbors, families, and community members with platforms like surveymonkey.com and identify the top three community concerns about threats to local biodiversity.

RESEARCH

Provide students with local media outlets and have them conduct online research about regional ecosystem concerns.

PRIORITIZE

Guide students to articulate their chief concerns about local threats to biodiversity and distribute My Action Plan.

CALL TO ACTION

Encourage students to participate in the OurEcho Challenge, distribute the OurEcho Challenge Brainstorming Worksheet, and summarize entry rules. Emphasize that teams of students **must** have an adult complete an entry form on their behalf.

ASSESSMENTS

During the course of *Basics of Biodiversity* activities, students will meet learning objectives by:

- Correctly referencing lesson's vocabulary
- Providing strong responses to discussion prompts with appropriate examples and elaboration

Step 1:

- Effectively creating an interconnected biome in Step 1
- Rendering an accurate web or net of biodiversity

Step 2:

- Appropriately marking up dry erase board to depict the introduction of an invasive species and demonstrating its impact on the ecosystem
- Understanding the connection between U.S. border policy about restricting agriculture and wildlife with the fear of introducing invasive species
- Explaining the impact of invasive species on natural habitats

Step 3:

- Articulating the human causes of species extinction and loss of habitat
- Appreciating mitigating factors to biodiversity
- Researching initiatives by organizations and citizen scientists for habitat and species restoration

Step 4:

- Recognizing region's ecosystem and biodiversity
- Identifying plausible regional environmental and ecological concerns
- Developing an action plan to mitigate one perceived threat to local biodiversity
- (Optional): Entering the OurEcho Challenge

ACTIVITY EXTENSIONS

Step 1:

Students can research the global distribution of biodiversity, where it is richest, where it is compromised, and what scientists have identified as biodiversity 'hotspots.' Creation of maps and posters for a school display or a local library can serve as a community initiative to educate about biodiversity.

Students can develop a biodiversity cost/benefit analysis, using horseshoe crabs as a case study, by investigating the pharmaceutical demand for horseshoe crab blood and the impact on medicine and ecosystems.

Step 2:

Understand keystone species through The Serengeti Rules. Students can identify keystone species and hypothesize what might unfold if a keystone species is compromised or removed.

The economic implications of introduced species can be assessed when students investigate the annual $1.4 trillion global costs[4] because of this intended or accidental practice.
Explore the history of introducing species through human history.

Step 3:

Refer to the Association of Fish & Wildlife Agencies or Cary Institute of Ecosystem Studies for implementation ideas to map school grounds and collect data pertaining to measuring diversity.
Team up with local parks department or ecological organizations to launch a school wide citizen scientist initiative. Scistarter.org provides a database of projects.

Step 4:

Invite a public environmental commissioner or an environmental leader from the community to brief students about local pressing environmental concerns.

Provide students with regional mapping tools for the OurEcho Challenge research:

- Forest Health by state
- Eco-Regions
- Local Air Quality Conditions

[4] California Academy of Science, "DIY Science: Introduced Species and Biodiversity," https://www.calacademy.org/explore-science/introduced-species-and-biodiversity.

ADDITIONAL REFERENCES

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CURRICULUM 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.

MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

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

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

Common Core State Standards Connections:

ELA/Literacy

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)

RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS2-2)

WHST.6-8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS2-2)

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS2-2)

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS2-2)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS2-3)

Social Studies/ELA-Literacy

RH.6-8.7 Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.