Biodiversity Lesson 3: *The Engineer*

Educator's Lesson Plan

Objective

In *The Engineer*, students will:

1. Identify a threat to a specific ecosystem.
2. Design a solution to preserve an ecosystem's biodiversity and ecological services.
3. Evaluate peers' design solutions.

Time Required: 180 minutes

Materials Required	**Safety/Other Considerations**	**Science & Engineering Practices**
● Computers for research ● Paper ● Colored pencils/markers ● Building materials options: various types of paper, tape, glue, or any other teacher-approved materials needed for designing and constructing a device model. *Potential student model materials may include: cardboard, plastic cups, aluminum foil, saran wrap, empty water bottles or 2-liter soda bottles, plastic tubing, cotton balls, pipe-cleaners, etc.*	None	● Designing Solutions ● Developing and Using Models ● Communicating Findings/Design (Oral Presentation)

Inquiry Scale: Leveling Information

Level 1: most teacher-driven (*recommended for grades 4-5)*
Select one ecosystem and one threat of interest from Appendix A to use as the class activity. Tip: Choose an ecosystem and ecosystem threat that you think would be most exciting to your students, or have the class vote on which ecosystem and threat they'd like to use.
Use the associated research links to review the selected ecosystem as a class. *(Note: you can write the research link from Appendix B on the board or make copies of the chosen ecosystem threat card and distribute to students.)* Together, fill in the appropriate research section of the Student Guide Planning Organizer. Next, review this section of the Student Guide by discussing all questions with students. Conduct a class-wide brainstorm list of design solutions, writing ideas on the board.
Allow student teams to choose which design they'd like to complete based on the class brainstorm. Students will work in teams to complete the remainder of the Student Guide Planning Organizer. Provide support to each group, as needed.

Level 2 (*recommended for grades 5-6)*
Select one ecosystem and one threat of interest from Appendix A to use as the class activity. Tip: Choose an ecosystem and ecosystem threat that you think would be most exciting to your students, or have the class vote on which ecosystem and threat they'd like to use.
Review the Student Guide Planning Organizer with students. Then, students will use the associated research links from Appendix B to review the ecosystem and complete the appropriate research. *(Note: you can write the research link from Appendix B on the board or make copies of the chosen ecosystem threat card and distribute to students.)* Assist students in completing the research section as needed. When they're done, review the research as a class.
Next, have students help brainstorm a list of ideas for creative solutions. To assist students' thinking, provide examples from Appendix A as needed. Student teams will then complete the remainder of their Student Guide Planning Organizer. Check in on each group to ensure progress and provide assistance to groups who need additional support.

Level 3 (*recommended for grades 6-7)*
Choose one ecosystem from Appendix A to focus on for this class activity. Tip: Choose an ecosystem and ecosystem threat that you think would be most exciting to your students, or have the class vote on which ecosystem and threat they'd like to use. Review each section of the *Engineering* challenge with students: research, planning, creating, reflecting, and presenting. Choose an ecosystem of interest (separate from the one selected for the class to use) to model for students, reviewing how to use the research links provided to complete the Student Guide. Review the planning portion of the challenge, encouraging students to brainstorm potential solutions to preserve the biodiversity and ecosystem services of the area. Assign student teams the threat they will focus on for the ecosystem. Students can choose a threat of interest from Appendix B and complete all aspects of *The Engineer* independently. *Note: You can choose whether to assign one threat for the class or allow students to pick. You can cut up the threats for students to pick out of a bag, make copies of the ecosystem card to distribute to each group, or project the card on the board.*
Lead students through the first sections of the Student Guide Planning Organizer and consult with student groups to assist in brainstorming ideas unique to their ecosystem threat. Students decide individually what solution they will engineer and complete the remainder of the *Engineering* challenge independently.

Level 4: most student-driven (*recommended for grades 7-8)*
Choose one ecosystem from Appendix A to use for this class activity. Tip: Choose an ecosystem and ecosystem threat that you think would be most exciting to your students, or have the class vote on which ecosystem and threat they'd like to use. Students can choose a threat of interest from Appendix B and complete all aspects of *The Engineer* independently. *Note: You can choose whether to assign one threat or allow students to pick. You can cut up the threats for students to pick out of a bag, make copies of the ecosystem card to distribute to each group, or project the card on the board.* Use class sessions to consult with student groups and coach students through this challenge.

Agenda

I. Show PowerPoint to introduce *The Engineer* Activity (10-15 minutes)
The PowerPoint will review essential concepts learned in *The Make* and provide context for the students' upcoming *Engineer* challenge.

II. Engineer Activity (150 minutes)

As guided by the organizer, students will:

1. Identify the ecosystem they will focus on. See inquiry scale for tips on deciding what ecosystem students will work on.
2. Brainstorm a solution to preserve the biodiversity and ecosystem services.
3. Plan and design a diagram of their design solution.
4. Present solutions and discuss the pros and cons of each.

If students need suggestions or ideas on places to get started on their *Engineering* challenge, give them suggestions from Appendix A: Engineering Suggestions to Spark Student Ideas, located below the Assessment Rubric.

III. Presentation and Assessment (20 minutes)

Students present their final design solutions as if they are presenting to an audience of their peers or community members; assessment parameters are suggested below. As a class, discuss the pros and cons of the competing design solutions.

***The Engineer* Assessment:** Project Grade and Rubric Score Sheet - Biodiversity

Project Submitted by _____

Biodiversity *The Engineer* Checklist: Content Concepts and Practices

Your Challenge: Design a plan or device that can preserve the biodiversity and ecosystem services of the ecosystem

Project Completion:

- ❏ Completion of all aspects of Engineering Planning Guide including:
  - ❏ Background Research for Ecosystem and Ecosystem Threat of Choice
  - ❏ Engineering Solution Planning Template
- ❏ Option 1: Device or plan to preserve biodiversity and ecosystem services
  - ❏ Proof of model design plan (visual aid) that includes:
    - ❏ Title
    - ❏ Sketch/blueprint of device showing proper dimensions
    - ❏ Explanation of how the device works to preserve biodiversity and ecosystem services
    - ❏ Explanation of all parts and how they contribute to the device or plan
  - ❏ Model is neat, professional, and well constructed
  - ❏ Reflection of design process completion
- ❏ Option 2: Technical Drawing of Preservation Plan
  - ❏ Proof of technical drawing plan (poster) that includes:
    - ❏ Title
    - ❏ Explanation of how solution works and how it will preserve biodiversity and ecosystem services
    - ❏ Dimensions
    - ❏ Labels and annotations of all parts
    - ❏ Use of full color
    - ❏ Straight lines drawn with a ruler
    - ❏ *Optional: Include sketches showing multiple views. What would your design look like from the front, side, and top?*
  - ❏ Reflection of design process completion

DCI Standards Checklist:

- ❏ Accurate research and analysis of cause of ecosystem threat and impact of threat on the biodiversity and ecosystem services of the ecosystem
- ❏ Design solution is realistic, relevant and could be used to preserve the biodiversity and ecosystem services of an area.
- ❏ Accurate explanation of how design solution works to preserve biodiversity and ecosystem services

Science & Engineering Practices Assessed

	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Designing Solutions	Applies no scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies minimal scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies adequate scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies complete scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.
Developing and Using Models	Drawings, diagrams, or visual models include major misconceptions or have missing parts. Explanation of the model is minimal or not present.	Drawings, diagrams, or visual models include minor misconceptions or have missing parts. Explanation of the model is minimal.	Drawings, diagrams, or visual models are complete, but contain a minor misconception. Explanation of the model is complete but lacking complexity.	Drawings, diagrams, or visual models have no misconceptions and contain all details. Explanation of the model is complete and complex.
Communicating Findings/Design (Oral Presentation)	Findings/design are incompletely and inaccurately communicated. Or no evidence of using appropriate eye contact, adequate volume, or clear pronunciation.	Findings/design are completely communicated with some misconceptions. Or uses minimal eye contact, inappropriate volume, or inconsistent pronunciation.	Findings/design are completely communicated but lacking depth and complexity. Or often uses eye contact and engaging and appropriate volume and pronunciation, but is inconsistent.	Findings/design are completely communicated with depth and complexity. Or mostly uses eye contact and engaging and appropriate volume and pronunciation.

Teacher Comments:

Final Score: Final Grade:

Appendix A: Engineering Suggestions to Spark Student Ideas

*Ideas provided for learner inspiration to improve upon and create scenarios to apply existing solutions

Ocean Ecosystem

Relevant Ecosystem Service: Climate Regulation or Human Food Source

Ecosystem Threat	Cause	Links	Example(s) of how this Impact Biodiversity?	Proposed Design Solutions
Plastic Pollution	Human litter is swept into the ocean	http://www.biologicaldiversity.org/campaigns/ocean_plastics/ http://plastinography.org/lesson1/how-does-plastic-reach-the-ocean.html	Plastic in the ocean can harm and kill marine life when the animals ingest the plastic or get tangled and caught in larger plastic pieces.	Edible plastic for sea turtles Ocean garbage cans
Overfishing	Humans overfishing and taking too many fish at a time	http://www.biologicaldiversity.org/programs/population_and_sustainability/oceans/	When humans overfish, we wind up killing small fish at the bottom of the food chain. This means that medium-sized fish, which normally feed off those small fish, die, and even larger fish who feed off the medium-sized fish die, too. Killing the fish at the bottom of the food chain sets off a chain reaction. Humans can also take too many young fish before they have the chance to reproduce, and other organisms get caught in fishing nets as well.	Design nets that allow the small fish to go through
Oil Spills	Ships leaking oil	http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/how-oil-harms-animals-and-plants-marine-environments.html	Oil damages birds' feathers and mammals' fur. As a result, these animals cannot maintain their body temperatures and they get hypothermia which can kill the animal. They can also ingest the oil, which is toxic. Fish and shellfish may also be affected.	More efficient way to clean up spills

Wetlands Ecosystem

Relevant Ecosystem Service: Water Purification, Flood Protection

Ecosystem Threat	Cause	Links	How Does This Impact Biodiversity?	Proposed Design Solutions
Human Development	Paving over wetland areas to build housing and commercial development	https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/human-impacts-wetlands	Habitat loss due to filling in wetlands causes many animals to lose their homes, safe places for their young, and food sources. It also destroys resting places for migratory birds.	Preserve wetland areas Create manmade wetlands Wetland conservation
Siltation	Soil erosion	http://www.nationalgeographic.org/encyclopedia/silt/	When sediments get washed into wetland areas, these sediments can block sunlight and reduce nutrient levels that plants and small animals need to survive.	Prevent soil erosion Sediment control
Runoff	Fertilizers	https://wwf.panda.org/knowledge_hub/where_we_work/alps/problems/freshwater/	When fertilizers get washed away by rain, they can run into wetland areas. The pollution from these fertilizers can kill plants and animals.	Ways to divert runoff Wetlands buffer Improve drainage

Rainforest Ecosystem

Relevant Ecosystem Service: Climate Regulation, Erosion Prevention

Ecosystem Threat	Cause	Links	How Does This Impact Biodiversity?	Proposed Design Solutions
Logging	Humans cutting down trees for timber and paper products in entire areas without replanting	http://kids.mongabay.com/lesson_plans/lisa_algee/logging.html https://ypte.org.uk/factsheets/rainforests/what-are-the-threats-to-the-rainforests	Cutting down rainforest trees reduces animal habitats and food sources. The loss of topsoil can cause rainforests to slowly turn into deserts. If people cut down trees that provide shade, it raises the temperature of rivers and that can affect river organisms.	Partial cutting Shelterwood cutting Selection management Find a replacement for wood
Human home development	Clear cutting and paving over rainforest to build homes and other structures	http://rainforests.mongabay.com/0803.htm	When humans cut down large areas of rainforest to build homes, it causes animals and plants to lose their habitats. This also has a destructive effect on the atmosphere because there are fewer trees and plants to take in carbon dioxide and release oxygen.	Tree houses
Agriculture	Cutting and burning trees to replace with crops	http://tropicalrainforestscience10.weebly.com/human-impacts.html	Humans cutting down areas of the rainforest to grow crops can destroy the habitats of many plants and animals.	Hydroponics Sustainable farming practices

Appendix B: Research Links for Students

Ocean Ecosystem

Relevant Ecosystem Service: Climate Regulation or Human Food Source

	Threat	Research Links
	Plastic Pollution	http://www.biologicaldiversity.org/campaigns/ocean_plastics/ http://plastinography.org/lesson1/how-does-plastic-reach-the-ocean.html
	Overfishing	http://www.biologicaldiversity.org/programs/population_and_sustainability/oceans/
	Oil Spills	http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/how-oil-harms-animals-and-plants-marine-environments.html

Wetlands Ecosystem

Relevant Ecosystem Service: Water Purification, Flood protection

	Threat	Links
	Human Development	https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/human-impacts-wetlands
	Siltation	http://www.nationalgeographic.org/encyclopedia/silt/
	Runoff	http://wwf.panda.org/our_work/water/

Rainforest Ecosystem

Relevant Ecosystem Service: Climate Regulation, Erosion Prevention

	Threat	Links
	Logging	http://kids.mongabay.com/lesson_plans/lisa_algee/logging.html https://ypte.org.uk/factsheets/rainforests/what-are-the-threats-to-the-rainforests
	Human home development	http://rainforests.mongabay.com/0803.htm
	Agriculture	http://tropicalrainforestscience10.weebly.com/human-impacts.html