



LESSON: Coast to Coast: Maintaining Healthy Habitats (3-5)

+ OVERVIEW

In this design challenge, students will discuss ecosystems and take part in a species survival demonstration. This demonstration will challenge students to remove as many species from the environment as possible within one minute and discuss their results. The students will then be presented with the following problem: “Our ecosystem’s population balance has gone out of control. We need to fix our ecosystem to make sure there is equilibrium amongst the species.” The students will put on their engineering hats to assist in maintaining species populations within an ecosystem. The teams will have an opportunity to design a tool to remove the invasive species and restore balance to the ecosystem.

Science TEKS covered in this design challenge

Grade 3 TEKS 3.9A, 3.9C
 Grade 4 TEKS 4.9B
 Grade 5 TEKS 5.9A

New Science Scientific and Engineering Practices covered in this design challenge

Grade 3 TEKS 3.1B, 3.1G, 3.2D, 3.12B, 3.12C
 Grade 4 TEKS 4.1B, 4.1G, 4.2D, 4.12B
 Grade 5 TEKS 5.1B, 5.1G, 5.2D, 5.12B

Math TEKS covered in this design challenge

Grade 3 TEKS 3.4A, 3.4G
 Grade 4 TEKS 4.4H, 4.8H
 Grade 5 TEKS 5.10F

+ The students will be able to:

- > Describe the physical characteristics of an environment and how these characteristics support a population
- > Describe environmental changes that cause some organisms to thrive, and others to perish
- > Describe the flow of energy through food webs and predict how changes to the ecosystem affect the food web
- > Solve a problem using the engineering design process



+ Students will use the following STEM fluency skills:

- > Communication
- > Collaboration
- > Creativity
- > Critical Thinking
- > Resilience
- > Time/Resource Management
- > Innovation
- > Adaptability

+ Materials needed for this design challenge

Material	3rd and 4th Grade Value	5th Grade Value
> Biodiversity box	No cost	No cost
> Artificial turf	No cost	No cost
> Turf container	No cost	No cost
> Tweezers	4 counters per pair	\$40 per pair
> Straws	1 counter per straw	\$10 per straw
> Scissors	1 counter per pair	\$10 per pair
> Scotch tape	1 counter per roll	\$10 per roll
> Hand rake	4 counters per rake	\$40 per rake
> Hand shovel	3 counters per shovel	\$30 per shovel
> Sieve (net)	3 counters per sieve	\$30 per sieve
> Comb	3 counters per comb	\$30 per comb
> Plastic spoon	2 counters per spoon	\$20 per spoon
> Plastic fork	2 counters per fork	\$20 per fork
> Chenille sticks (pipe cleaners)	1 counters per stick	\$10 per stick
> Fan	2 counters per fan	\$20 per fan
> Flashlight	2 counters per flashlight	\$20 per flashlight



+ Materials needed by the facilitator:

- > Computer
- > Projector
- > Slide deck for the lesson
- > Copies of the score card per group
- > Timing device
- > Coins/tokens/Fake money
- > Biodiversity box preset (large beads, medium beads, and lettuce seeds)
 - o Lettuce seeds will represent the invasive species
 - o May add a 4th species by including small beads

+ FACILITATION GUIDE

SECTION	PROCEDURE
INTRODUCTION	<p>Slide 1: Coast to Coast: Maintaining Healthy Habitats</p> <ul style="list-style-type: none"> > Introduce today's lesson on ecosystems. <p>Slide 2-3: Objectives</p> <ul style="list-style-type: none"> > Explain to students that they will do all of the following in today's activity: <ul style="list-style-type: none"> ▪ Describe the physical characteristics of an environment and how they support a population ▪ Describe environmental changes that cause some organisms to thrive, and others to perish ▪ Describe the flow of energy through food webs and predict how changes to the ecosystem affect the food web ▪ Solve a problem using the engineering design process <p>Slide 4: Ecosystem</p> <ul style="list-style-type: none"> > Discuss food webs and the role of species within the food web. <ul style="list-style-type: none"> ▪ Ask students how species have adapted to survive in this food web/ecosystem. ▪ Why are sharks the apex predator? ▪ How do fish, turtles, and crabs survive from the hawk? <ul style="list-style-type: none"> • Hiding in the seaweed • Using camouflage



- How do fish and crabs survive from turtles?
 - Hiding in small holes that turtles cannot fit inside
 - Quicker than their predator
- What will happen if we remove the seaweed?
 - Everything will eventually disappear because the herbivores would not have food and the food web would be disrupted.
 - Animals would either die or move somewhere else.
- > Ask students what happens when a species disappears from an ecosystem.
 - Other species could go endangered or extinct
 - The environment could be destroyed by overgrazing or overpopulation
 - Negative impact on breeding grounds
 - Food sources might become scarce
 - Invasive species outcompete apex predators and have no natural predator
- > Ask students: How can we protect ecosystems?
 - Protect the existing environment as sanctuaries or national parks
 - Avoid or limit practices that destroy the environment like littering
 - Remove an invasive species by utilizing traps or other removal procedures

Slide 5: Invasive Species

- > Ask students: What is an invasive species?
 - Introduced, nonnative organism that begins to spread and has the potential to cause harm to the environment or to human health.
- > Invasive Species Examples
 - Quaker Parrot or Monk Parakeet
 - Native to South America, all major cities in the US have a flock of monk parakeets due to human release.
 - Lionfish
 - Native to South Pacific and Indian Oceans, invasive lionfish have no natural predators due to its venomous spines.
 - Zebra Mussels

- Native to fresh waters of Eastern Europe, zebra mussels can smother native mussel populations and clog water intakes.

Slide 6-7: Part 1 Predator vs. Prey

- > This species survival demonstration or activity will challenge students to remove as many species from the environment as possible within one minute and discuss their results.
- > Students will establish on their team who will be picking the invasive species out of the ecosystem.
- > Students will place their piece of turf onto the table with the grass side up and dump the contents of the biodiversity box onto the turf.
- > Using only one hand, the picker will collect as many of the species as possible within 30 seconds. They can only pick one species up at a time.
- > Once the 30 seconds is up, they will separate the species into the mini cups according to the color and size, and then count how many were picked out of the ecosystem.
- > Ask students which species they picked the most and which were the least picked.
- > Ask students why the beads were picked more.
 - They were easier to see because they were bigger and brighter
- > Ask students how they think their experience connects to an ecosystem's food web with predators and prey.
 - Predators will target the easier-to-catch prey leaving population imbalances. These imbalances put the health of an ecosystem at risk.
 - As the turtle's food source decreases, it might starve or leave the ecosystem.
 - If the turtles are gone then fewer sharks would survive.
 - Fish and jellyfish populations would increase, and their food sources would become scarce.

Slide 8: Engineering Design

- > Ask students the question. What is engineering?
 - Explain to students that engineering is when engineers take what they know and apply it to solve problems by designing a product or process.

Slide 9: Engineering Design

- > Ask students the question. What are some examples of engineering jobs?



Slides 10-12: Engineering Jobs

- > Show students pictures related to engineering jobs connected to the challenge.
- > Environmental Specialist
 - Ask students what they see in the pictures.
 - Coordinates and facilitates soil and groundwater sampling.
 - They focus on using their skills and knowledge to help protect and improve the environment while also making a positive impact in human health and well-being.
- > Sustainability Specialist
 - Ask students what they see in the pictures.
 - Environmental sustainability aims to improve the quality of human life without putting unnecessary strain on the earth's supporting ecosystems. It's about creating an equilibrium between consumerism and the living world.
- > Design and Construction
 - Ask students what they see in the pictures. Ask them: How does it look different from architecture?
 - Manages engineering projects; holds architects, engineers, designers and contractors accountable to ensure projects are on schedule, on budget, of quality, and meet overall needs.

Slide 13: Engineering Design

- > Ask students the question: who can be an engineer?
 - Anyone!

Slide 14: Engineering Design Process Steps

- > Ask students if they think all engineers solve their problems in one try. Explain to students that it takes many tries to get something correct in engineering. In engineering, there is no such thing as a mistake, only opportunities to learn. It is okay to fail. Just find the mistake and correct it. In engineering, there is never one correct solution. There are always many solutions to a problem and always improvements that can be made. The steps that engineers take to find these solutions are called the *engineering design process*.
- > Ask students to read the first big step (Identify)

	<ul style="list-style-type: none"> ▪ What does identify mean? (To point out or find). Engineers design solutions, what do they need to know first before they can find the answer? (The problem) ▪ How do people know when they have found the correct answer? In engineering, there are no correct answers, just better ones. Explain to students that there are expectations that engineers must meet called <i>criteria</i>. For example, when engineering a football, what does a football need to do? (Bounce, look a certain way, have laces, have air inside, etc.). Those things are all called criteria, by comparing the design to the criteria, an engineer knows a solution will work. Is a child-sized football the same as an adult football? The criteria for both footballs include: leather, the white laces for fingers, and the shape. However, the two footballs would have different criteria on the size. The footballs are similar, but different because of different criteria. ▪ Once the criteria are understood for the design challenge, what could make it difficult for an engineer to design their solution? (Money, time, materials, etc.) Explain to students that these rules are called <i>constraints</i>, or rules that engineers must follow. Engineers are given constraints they must follow when finding the solution to a problem. Think about football again, what are college and professional footballs made from? (Leather). What if instead the rule (or constraint) was to not use leather, could another type of football be made instead? Many of the footballs for sale are made of rubber because the engineer had different constraints. <p>> Ask students to read the next step (Imagine)</p> <ul style="list-style-type: none"> ▪ Ask students what imagine, or imagination, means. Are these things real, or tangible? They may not be real, but they help give us ideas about what things could be. In this step, see what materials are available, then brainstorm, or think, about possible ideas/solutions to the problems. ▪ Explain to students that there are no right answers in engineering. Start with as many ideas as possible. <p>> Ask students to read the next step (Plan)</p> <ul style="list-style-type: none"> ▪ The third big step of the engineering design process is to plan out the idea. Make sure that what is designed can be repeated. A plan will help an engineer identify where mistakes happen so they can be fixed.
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	<ul style="list-style-type: none"> ▪ When planning, begin with the brainstorming phase. Each team member will contribute their ideas, And then the team combines the different ideas! ▪ Once ideas are combined into a single group idea, determine what materials will be used for the solution and make sure the design has met the criteria and constraints of the project. <p>> Ask students to read the next step (Create)</p> <ul style="list-style-type: none"> ▪ The fourth step is to create! Since this is the very first creation, it is called a <i>prototype</i>. A prototype is a first or preliminary model of something from which other forms are developed or copied. A prototype is created to test the engineer's idea or concept. Engineers asks themselves, "Did the idea work the way we wanted it to?" After testing the idea, the engineer will make improvements to the prototype. <p>> Ask students to read the last step (Improve)</p> <ul style="list-style-type: none"> ▪ Finally, the last step is to improve. How does an engineer know if the prototype did well on the test? It must meet certain expectations and follow some rules. But how do engineers determine how well it met the expectations and how well it followed the rules? In school, how do you know if you mastered something? (Grades). The prototypes made today will be scored using a scorecard or rubric. By looking at the score, each team will determine if the design could be better. If improvements should be made, then the team will revisit the plan and decide what to do to improve the score. Remember, there are no correct answers in engineering, just better solutions.
<p>IDENTIFY</p>	<p>Slide 15-16: Identify - Problem</p> <ul style="list-style-type: none"> > Have students read the bolded section. <ul style="list-style-type: none"> ▪ Ask students to <i>identify the problem</i>. > Explain to students that they will put on their engineering hats today to fix our ecosystem by designing a process to eliminate the invasive species. <p>Slide 17: Identify - Criteria (Desired Outcomes)</p> <ul style="list-style-type: none"> > Ask students what criteria or desired outcomes mean. <ul style="list-style-type: none"> ▪ Explain to students those criteria are what engineers use to determine if they have successfully solved the engineering problem.

- > Ask students how we will know if we are successful engineers today.
 - In one minute, design a process that:
 - Removes invasive species (lettuce seeds)
 - Protects the native species (beads)
 - Limits environmental damage
 - Explain to students that their design process can only last one minute.

Slide 18-19: Identify - Constraints (Limitations)

- > Ask students what constraints or limitations mean.
 - Explain to students those constraints are rules the engineers must follow.
- > Explain the constraints for this engineering design activity are:
 - Time Limit: Students will have 25 minutes to make changes to your ecosystem and/or tool.
 - Materials: Students can only use the available materials.
 - Counters: Students will have 10 counters to complete this challenge.
 - *5TH GRADE ADJUSTMENT*: Budget: You will have \$100 to complete this challenge.
 - Collaboration: One design element from each team member must be used in the final design. Explain to students that a design element is taking one part of someone's idea and adding it to another.

Redesign: Each team can test their prototype as many times as needed during the 25-minute design phase.

IMAGINE

Slide 20: Imagine- Explore Materials

- > Students will be designing a process to eliminate as many of the invasive species as possible. During the first trial, students experienced how an invasive species can cause damage to the balance of an ecosystem when there is no natural predator to control its population. As a result, they will be designing ways to specifically eliminate the invasive species from the environment. The design will include a step-by-step process using tools they have "purchased" from the supply table. For example, Step 1- Rake the environment. Step 2-Use a spoon to scoop up the species pulled from the rake. Modifications can be done to the tools to better implement their process if desired.
- > Depending on classroom size, each team's process will be tested at a testing location. If space is not available, the teacher or facilitator may go to each team station to test their process.

Slide 21: Imagine- Brainstorm

- > Give students one (1) minute to individually design and draw a plan of what the ecosystem and/or tool will look like. Emphasize that students should not talk during this minute or share ideas. Remind students their ideas will be used as design elements for the final design.
- > After a minute, give students five (5) minutes to present and share their ideas with the group. Let students know that they should focus on key aspects of their idea to be used as design elements for the final design when sharing.

Teacher's Note: If students are struggling with an idea for their design, provide ideas without giving the solution. For example, "This is a design that I tried earlier, but it failed. What could I do to improve it?" Emphasize that the design failed to reinforce that it is okay to fail and to let students know they cannot copy the design and expect success.

PLAN

Slide 22: Plan- Gather Materials

- > Students will need to select the materials to be used for their design process and develop a budget for the project. Students will have 10 counters to "purchase" materials for their design at the classroom supply table. The prices used in this challenge can be found in the materials list. Students will raise them when they are ready to purchase materials. The teacher will make sure the appropriate number of counters is used to purchase each material but will not guide students on following their budget. Students can go over the budget but remind them that they will lose points on their score card.
- > *5TH GRADE ADJUSTMENT: Students will need to select the materials to be used for their design process and develop a budget for the project. Students will have \$100 to "purchase" materials for their design at the classroom supply table. The prices used in this challenge can be found in the materials list. Students will raise their hands when they are ready to purchase materials. The teacher will make sure the appropriate amount of money is spent to purchase each material but will not guide students on following their budget. Students can go over the budget but remind them that they will lose points on their score card.*

Slide 23-24: Plan- Team Member Responsibilities

- > Each team member must be given a responsibility, such as materials manager, banker, head engineer, and quality control manager.



CREATE

Slide 25: Create- Design Your Process

- > Let students know to have fun, be creative with their designs, and work together.
- > Remind students that being an engineer is not about getting the solution on the first try. There is no right answer, just better solutions.

Slide 26: Identify- Criteria

- > Reminder slide for students to look at while working

Slide 26-27: Create – Test

- > Students will calculate their scores when testing in front of the teacher or facilitator.

IMPROVE

Slide 28: Improve - Redesign: Discussion

- > Students will reflect on their scores and discuss:
 - What worked?
 - *Teacher's Note: Focus on the materials being used and ask why they think those materials were helpful. Ask students what characteristics of the environment allowed certain species to be supported. What aspects of their design process allowed the invasive species to become easier to remove?*
 - What did not work?
 - *Teacher's Note: Focus on the materials being used and ask why they think those materials did not work as well. Ask students what characteristics of the environment made it difficult to remove the invasive species.*
 - What do you want to improve?

Teacher's Note: Focus on engineering aspects with students. Ask students why they were designing a process for the ecosystem. Ask students if they found a solution or just part of one. Reinforce that it is okay to not succeed on the first try and that engineering is about making improvements over time. Ask students how they would design their process differently if they had no rules? Ask students if working together was difficult. Learning to work together is very important and it is easier to find a solution with many ideas rather than just one idea.