MACGILLIVRAY FREEMAN'S
DREAM BIG
ENGINEERING OUR WORLD

LIFE SCIENCE:

ENDANGERED SPECIES

Grade level: High School Life Science

Lesson length: 225 minutes (plus ongoing evaluation)

> Students identify a species in their region that is endangered and in need of support. They engineer a device or method capable of supporting that species and its future sustainability.

In the Film

In the film *Dream Big*, engineers are often seen solving the problems of today as well as preparing for the problems of tomorrow. A theme throughout many of the challenges engineers face relates to the overpopulation of the human race. As humans continue to break new ground and expand our civilization, citizens, scientists, and engineers have to determine how to balance the needs of the human race with the needs of our environment and the species we share this planet with.

NGSS Disciplinary Core Ideas

HS-LS2.C Ecosystem Dynamics, Functioning, and Resilience

Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

HS-LS4.D Biodiversity and Humans

Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).

NGSS Engineering Practices

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Dream Big: Engineering Our World is a film and educational project produced by MacGillivray Freeman Films in partnership with the American Society of Civil Engineers and presented by Bechtel Corporation. The centerpiece of the project is a film for IMAX and other giant screen theaters that takes viewers on a journey of discovery from the world's tallest building to a bridge higher than the clouds and a solar car race across Australia. For a complete suite of *Dream Big* hands-on activities, educational videos, and other materials to support engineering education, visit discovere.org/dreambig. The *Dream Big* Educator Guide was developed by Discovery Place for the American Society of Civil Engineers.

Key Words/Vocabulary

Anthropogenic: Resulting from the influence or activity of human beings on nature.

Materials

Per team:

- ☐ Recycled and repurposed materials of student selection and teacher approval. Push students to develop a feasible budget, even if it is zero dollars, and establish materials and sources for those materials.

Teacher Prep Notes

Make sure you are familiar with the engineering code of ethics: asce.org/code-of-ethics/

Prepare to teach students about:

- ☐ Environmental niches
- ☐ Adaptive biology
- ☐ Environmental stressors that affect species populations
- ☐ Changes that disrupt ecosystems and drive species to extinction

Review the examples you will discuss with students in step 4 of the Research and Gather Information phase.

Give some thought to the criteria students could use in the rubrics they develop to evaluate the success of their device. They should include a quantitative and qualitative evaluation of the impact upon the species and ecosystem, adherence criteria and constraints of the challenge, cost effectiveness, feasibility of replication, and aesthetic quality.

Student projects could be reviewed and utilized over the course of weeks or months. The developed devices could be used and revised by new groups of students on a year-to-year basis and evaluated based upon their effectiveness.

To Do

Determine the Problem or Question to Solve: 10 minutes

1. Before they watch the IMAX movie *Dream Big*, give students an overview of what they are about to experience. This film is about engineering and the ways that engineering can inspire, challenge, and enrich our lives. Give students the following questions to think about as they are watching the film:
   - **a.** In the film, what challenges are identified that correlate to population growth?
   - **b.** What are some of the strategies that engineers employ to compensate for the ever-growing population of humans?
   - **c.** What are some of the ways that the safety of society is incorporated into these designs? (Discuss the engineering code of ethics: asce.org/code-of-ethics/)
2. Debrief as a whole class after viewing the film. Allow students to reflect on the guiding questions you gave them.
3. Remind students that every project and structure has a component of engineering. It is the responsibility and challenge of engineers to consider all of the variables at play in each structure that is being built.
4. Introduce the design challenge. As populations continue to increase, the need for more homes, businesses, food, water, fiber, and goods is placing greater demands on our natural surroundings. With expanding development, we alter the habitat that supports nonhuman organisms. Students will acknowledge the impact that humans have on the environment and think critically about how to compensate for the losses of those organisms. Students will identify and select a species that is threatened or on the cusp of extinction in their region. They will determine the root causes (anthropogenic or otherwise) that are contributing to the demise of that species. Students will then engineer a method to help sustain and promote the species.

Research and Gather Information: 120 minutes

1. Teach students about the concept of environment niche and adaptive biology.
2. Teach students about the environmental stressors (natural and manmade) that do not force adaptations and may reduce the population of a species.
3. Teach students about extreme changes (anthropogenic cause: resulting from human activity) that can disrupt an ecosystem and threaten the overall survival of a species.
4. Provide a sample scenario that can be shared with students.
   - **a.** Example 1: Brown-headed Nuthatch nc.audubon.org/conservation/make-little-room-brown-headed-nuthatch
   - **b.** Example 2: Bats asce.org/magazine/20160809-bridge-goes-to-bat-for-bats/
5. Divide students into teams of three. Teams should research species in their region whose ecosystems are being threatened or who are experiencing a decline (resource: fws.gov/endangered/species/index.html); they should then choose a species to work with for this project.
6. Students should consider the "trade-off" scenario: with any changes to an ecosystem there will be unforeseen effects that must be accounted for when possible.

Plan a Solution: 20 minutes

Once teams know which species they will focus on, instruct them to plan a design that would relieve the impact and improve conditions for that species, according to one of these options:

Option 1: Design a structure that mimics the habitat that is being destroyed.

Option 2: Design a structure that physically stops the habitat from being destroyed.

Whichever option students choose, they will also need to create a rubric or an instrument to gauge the success of their device.

If students are unfamiliar with the concepts of criteria and constraints in engineering, take the time now to introduce these two key ideas. Engineers look at challenges through the lens of criteria (what does my device have to do?) and constraints (what are the limitations I face in making, testing, and using the device?). Spend some time as a whole class brainstorming the criteria and constraints of this particular engineering challenge.

Make It: 30 minutes

Upon completion of the plan, tell teams to construct and enable their process or device. The product should reflect their research as well as their plan, and they should consider whether or not the process or device can be altered after a period of observation. Remind students that iteration is a vital part of the engineering process.

Test: 15 minutes

Arrange for students to take their structure into nature, in an area frequented by the species they are trying to help. Instruct students to set up the device and begin testing its effectiveness at maintaining the population of a species per the rubric that they developed. How long this part of the lesson takes will vary depending upon the expectations and rubric designed by the students. The testing process may take weeks or even months to evaluate effectiveness. For example, if students build a bird house specific to the needs of a species, their rubric might note telltale signs such as fecal matter, nests, and sightings of the species in question near or in the birdhouse as proof that it is being used as intended.

Evaluate: 30 minutes

Students have created their own rubric as part of the planning process. This assessment tool should include a quantitative and qualitative evaluation of the impact upon the species and ecosystem, adherence criteria and constraints of the challenge, cost effectiveness, feasibility of replication, and aesthetic quality.

Taking It Further

Use technology (microcontrollers, sensors, and coding) to develop monitoring systems that support the tracking of student devices to ensure successful integration into the environment.

For example: Use an Arduino or Hummingbird Robotics Kit to place, on the exterior of a birdhouse, a small light-emitting diode (LED) that is activated when a bird has stepped on a pressure sensor inside the house. If it's within Wi-Fi range, the device could be coded to create an If This, Then That (IFTTT) communication, notifying students via text or email. Learn more at https://ifttt.com/

Explore how environmental engineers are raising awareness and designing solutions to mitigate the impacts our planet is experiencing from pollution, habitat loss, and the declining availability of fresh water.

Document your students' work through our social media outlet: #dreambigfilm

DREAM BIG VIDEO SERIES

WATCH *WATER WISHES: ENGINEERING FOR THOSE IN NEED*

What can an engineering student in New Jersey do to help mountain villagers in Peru who lack clean water to drink? Building a safe water system for people halfway across the globe is an example of how Engineers Without Borders and other organizations are helping people build healthier communities. Go to discovere.org/dreambig/media-assets and visit Educational Webisodes.

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