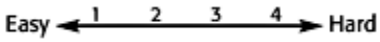
ENGINEERING LAB

Design a Preserve for Your Community

TIME REQUIRED Two to three 45-minute sessions, plus outside assignments if desired

LAB RATINGS



Teacher Prep–1
Student Setup–2
Concept Level–2
Cleanup–1

3D LEARNING

- **SEP Designing Solutions**
- **DCI ETS1.B Developing Possible Solutions; ETS1.C Optimizing the Design Solution**
- **CCC Stability and Change; Influence of Science, Engineering, and Technology on Society and the Natural World**

OBJECTIVE

Students define the criteria and constraints for a community nature preserve, design the preserve, and use a computer simulation to test and optimize their designs.

SETUP AND PROCEDURE

- Organize students into groups of two to four. Make sure each group has access to a computer with a reliable Internet connection.
- Set parameters for the expected level of detail, as this project could take anywhere from two class periods to a full term.
- Provide maps of the local area if you wish students to consider actual landforms and habitats. Many online maps are suitable for this purpose; students will need a way to mark up a portion of the map using software, such as by capturing and saving the image and using drawing tools to mark it up.
- For Extend, consider providing a list of nature preserves for students to select from, to avoid overlap. Set up an online area for students to share their research about the parks, if desired.

COLLABORATE

Suggest to students that they use a draw-pair-share approach when determining the boundaries of their preserve. Each student in the group draws proposed boundaries for the nature preserve, then students pair up and explain to each other why they drew the boundaries where they did. The group then decides on the proposed boundaries of its preserve based on a discussion of each member's ideas.

ANSWER KEY

Conduct Research

Results of student research will vary. Students will likely find that preserve planners consider preserve size, biodiversity, the potential for preserving endangered species, the possibility of connecting with other land areas to form a greenway, and the policy/community concerns about use of the land. Decisions are informed by research into the requirements and habits of targeted species, land use policy, and the concerns and needs of the surrounding human community.

Define the Problem

Problems identified by students will vary but should demonstrate relevance to the species-preservation needs of your local area. The criteria and constraints will also vary but should include requirements that promote the preservation of habitat for the species identified in the problem.

Design Solutions

Student designs will vary but should demonstrate attention to fulfilling the criteria the group identified while working within the constraints it identified. If a group needed to adjust its criteria and constraints, those adjustments should be noted.

Test

Evidence Notebook answers should include summaries of at least three trials and the name of the simulation software used for the tests.

Optimize

Evidence Notebook answers should include a description of the adjustments made following each trial, the intended goal of each adjustment, and the outcome of the test following the adjustment.

Communicate

Student presentations will vary but should address the requirements listed under Communicate. If any student groups wish to present their proposals to government agencies, confer with your school's administration before arranging such a presentation, and ensure students are fully prepared by requiring them to conduct further research into questions they are likely to be asked by government officials.

Extend

Student reports will vary. Students may be surprised to discover that even the most popular national parks faced heavy opposition from locals when they were first founded and for decades afterward. The success of preservation efforts varies depending on the species and the size and management of the preserve.

ENGINEERING LAB

Design a Preserve for Your Community

Preserving natural landscapes for future generations can be hard work! Competing land use interests for agriculture, logging, urbanization, and other purposes must be balanced with the desire to preserve natural habitats. Preservation of land can involve many different stakeholders and be a lengthy process depending on the people, species, habitats, and regulations involved.

How is land selected as a beneficial location for a park or preserve? How much land is needed to maintain high levels of biodiversity? How can you predict whether species will utilize the habitats you provide? In this activity, you will investigate these questions and use a computer simulation to help you design a nature preserve in your local area.

MATERIALS

- computer with Internet access
- map of your local area showing topography, bodies of water, and forest areas

DESIGN CHALLENGE Define the criteria and constraints for a community nature preserve, design the preserve, and use a computer simulation to test and optimize the design.

CONDUCT RESEARCH

Refer to the Engineering Design Process flow chart on the next page as you design, test, and optimize your nature preserve.

Before you begin planning your design, do some research to learn how environmental scientists and other professionals design nature preserves. Record your findings in your Evidence Notebook. Use these questions to guide your research:

- What factors are considered when determining the location, size, and shape of a preserve?
- How are habitats engineered to increase and maintain high levels of biodiversity?
- How do scientists predict the ways that different species will interact and utilize the resources in a preserve?

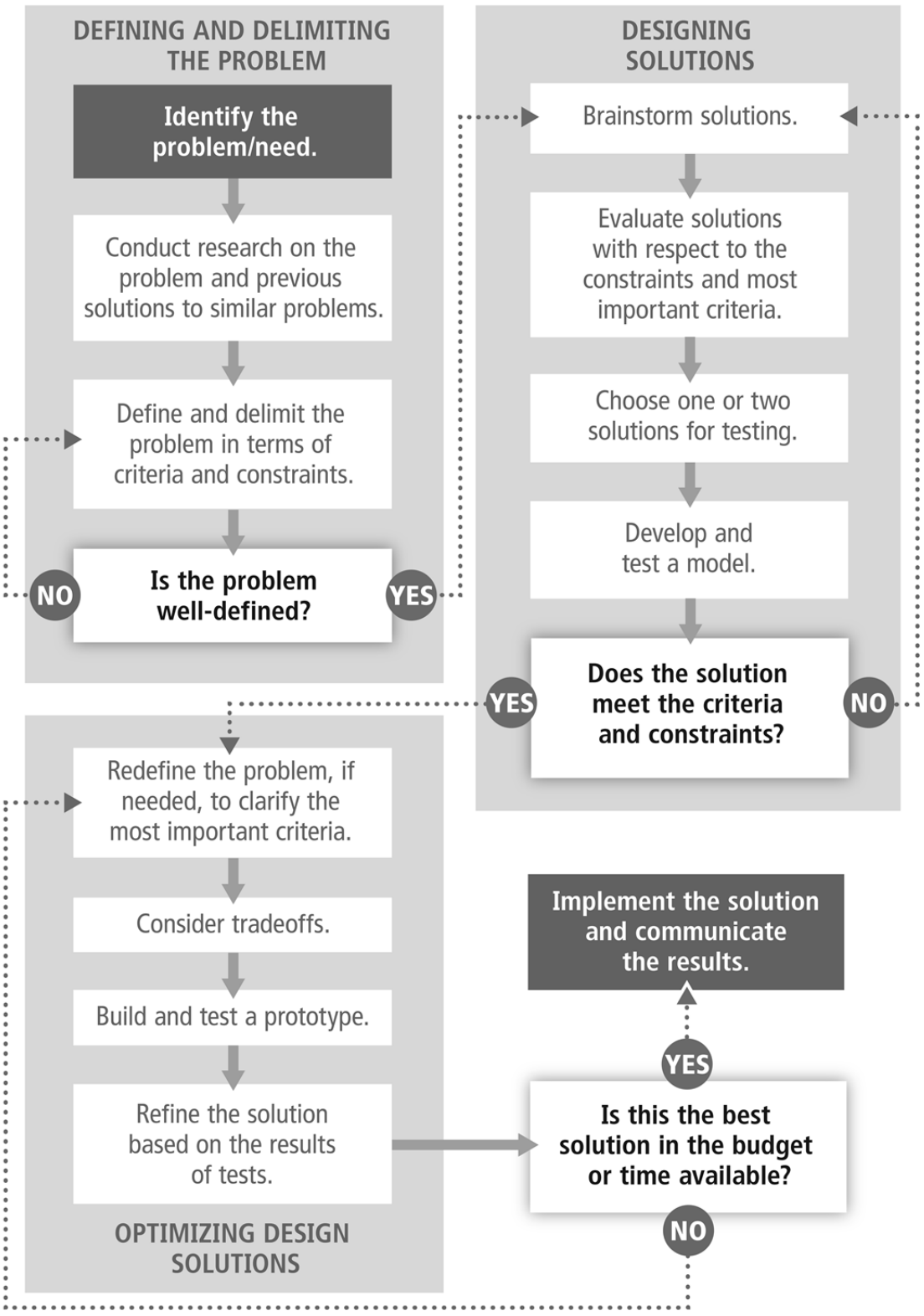
DEFINE THE PROBLEM

Now think about how you might build a nature preserve near your community. Define the problem that building the preserve will solve. Start by gathering information about species in your area that could benefit from a preserve and locations that could be modified to increase the number of habitats for those species.

Then use the information you found to brainstorm a list of criteria and constraints for your preserve. For example, you might hope to maintain biodiversity by supporting a certain number of species in the preserve. Another criteria might be to provide access points and infrastructure for visitors. Constraints might include limited space or the budget available to purchase land.

Define the problem your nature preserve will solve and list the criteria and constraints for the preserve in your Evidence Notebook.

Engineering Design Process



DESIGN SOLUTIONS

Use the information you have gathered to brainstorm an approximate size, shape, and species composition for your preserve. Plot the borders of your preserve on a map of your area, if possible. Record the dimensions and shape of the park, as well as the number and types of species you hope to maintain there. Include any necessary information related to species richness, species interactions, and space requirements for various species. Record your calculations in your Evidence Notebook and show the mathematical models you used.

As you design your preserve, consider the following questions:

- Does the land include invasive species?
- Will the invasive species need to be removed?
- Will features such as ponds, wildlife crossings, or artificial nesting or burrow sites need to be added to provide the habitat that the desired species need?

As you further refine your design, you may need to adjust your criteria and constraints. This is a normal and expected part of the engineering design process. Record these changes in your Evidence Notebook.

TEST

Use a computer simulation to test whether the design you are proposing will meet the criteria and constraints you outlined. Open-source simulation programs can be found on some university websites. Use one of these programs to design your own simulation, or find a ready-made simulation to test your prototype. Run a minimum of three trials, and summarize the results in your Evidence Notebook, including identifying information for the software you used.

OPTIMIZE

Adjust the design for your preserve as needed after each trial. You may need to prioritize your list of criteria and constraints and consider tradeoffs between them. As with adjusting the criteria and constraints, considering tradeoffs is a typical part of the engineering design process. Record adjustments made, reasons for them, and subsequent test results in your Evidence Notebook.

COMMUNICATE

Prepare a presentation to explain the proposed design to your city, state, or federal government. Include a visual representation of the preserve, evidence to support its design, and an explanation of how the evidence supports the claims in your proposal. Include information about how the preserve's design will allow for greater biodiversity, as well other ways it would benefit the community. Finally, name the agencies and organizations that would most likely need to be involved, including landowners, and explain how you hope to obtain funding for your project.

EXTEND

Obtain and Evaluate Information Research the history of an actual nature preserve. You may choose a local, regional, or state preserve, or a national park or wildlife refuge. Who proposed creating a nature preserve in that area? What were the goals—was the intent to save particular species of plants and animals, or was there another driving force? Who was involved in creating the preserve? Who opposed it? How successful has the preserve been in meeting its original goals? How has the preserve changed since its founding, and how has it stayed the same? Which of these changes are natural, and which have been caused by humans? Report your findings to the class in an oral report, or contribute to a class wiki or blog on this topic.